FARMING FROM THE GROUND UP

THE USE OF LAND RESOURCE INFORMATION AS A BASIS FOR PLANNING FARM-SUSTAINABILITY IN NEW ZEALAND

VOLUME TWO

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INTRODUCTION

The term 'farm plan' is commonly used to describe any farm-scale land evaluation of an individual property, undertaken by a resource management authority for the purpose of promoting some biophysical or environmental dimension of SLM[1]. They were first introduced in the early 1950s as a means for catchment authorities to promote soil conservation on individual farms, and received widespread application up until the local government reforms of the late 1980s. Some regional authorities retained and/or modified farm planning in the early 1990s, while others completely abandoned the practice.

Historically, farm planning has been based upon a well defined system of land resource survey and classification, applied at scales suitable for farm management decision-making. For this reason, historical farm plans could represent a potential source of quality land-resource information suitable for modern-day sustainable farming.

Likewise, the activity of farm planning has represented the application of a comprehensive land evaluation framework. In general, land capability is assessed, land use is evaluated, and options for improved land management are laid out as a 3 to 10 year plan. While purpose and design have greatly evolved since the 1950s, and particularly since the introduction of the RMA, these frameworks may be amendable to land evaluations for whole-farm sustainability (inset).

FARM OR RUN PLANS ARE POWERFUL TOOLS IN EROSION CONTROL AND LAND MANAGEMENT GENERALLY.

THEY MIGHT WELL BE USED MORE WIDELY FOR A NUMBER OF PURPOSES

Poole, 1983, p.22

Farm planning also continues to receive renewed interest from agencies seeking to promote SLM (see for example: Gibbs & Schofield, 1997; Boffa Miskell, 2000; Blaschke & Ngapo, 2002). However, much of what is known about farm planning is either sporadically dispersed within historical literature, or retained as expert knowledge by a select few professionals. In the absence of information concerning farm plans, agencies may unwittingly repeat historical mistakes, or inadvertently and unnecessarily duplicate previous designs. Similarly, they may also be unaware of the innovative and diverse ways that farm planning has been applied throughout the years.

The aim of this study is threefold. Firstly, to determine if traditional farm plans (pre-1988) contain land resource information suitable for modern-day sustainable farming. Secondly, to assess if traditional designs are amendable to the evaluation of modern-day farm sustainability. Thirdly, to provide a reference document on historical farm planning in New Zealand.

All three aims are achieved through an historical review of traditional farm planning and it's associated basis of land resource survey and capability classification. In the main, this has focused on a limited range of historical soil conservation books, catchment and regional authority publications, and a diverse range of scientific articles. This published literature often makes reference to obscure documents and reports that could only be obtained from private collections, or from archive collections maintained by councils. Contributions have also been made from experts with an extensive background in both soil conservation and SLM, and the practical application of the farm plan approach.

[1] *Farm Plan* is used within this chapter as an umbrella term to include early conservation farm plans, soil & water conservation plans, shelter plans, run plans, and orchard plans. It is also used to encompass more recent applications, including sustainability plans, environmental plans, whole farm plans, riparian plans, property plans, property management plans, and so on.

HISTORICAL REVIEW

5.2. AMERICAN BEGINNINGS

The original farm plan approach was developed by the U.S. Federal Soil Conservation Service in the 1930's as a tool to promote and effect erosion control measures on individual farm units. Emergence and design can be credited firstly to the underlying philosophy of the Service itself, and secondly to the technical development of land classification systems that enabled efficient and widespread application of the approach.

5.2.1 THE FEDERAL SOIL CONSERVATION SERVICE

While accelerated soil erosion was apparent throughout the early colonial history of the United States, it wasn't widely recognised as a problem until the rise of the Conservation Movement and subsequent 'soil conservation movement' of the 1890s to 1920s (Selby, 1968), and didn't gain any meaningful political traction until *Soil Erosion a National Menace* was published by the U.S. Department of Agriculture (U.S.D.A.) in 1928. This bulletin had a significant impact on 'public and official apathy towards soil erosion' at the time, such that it has been regarded as the 'classic... beginning of modern soil conservation in America' (Holt, 1949, p.80).

One of the bulletin's authors was Hugh Hammond Bennett, who as a soil surveyor and inspector working for the U.S. Bureau of Soils, developed a rather unique (for the time) appreciation of the relation between physical land resources, land use, and erosion (Helms, 1992). Bennett was a strong and vocal advocate for soil conservation, and amongst many other things, is credited with persuading the U.S. House of Representatives to establish the first soil conservation research program in 1930 (Selby, 1968). Bennett was selected to direct the program.

Bennett established ten 'soil erosion and moisture conservation experiment stations' before the end of 1930 in states and areas with noted erosion problems. As quantitative soil erosion data were rare at the time, these stations focused on measuring actual rates of soil and water losses under different crop rotations, tillage practices, and conservation methods (Helms, 1992). The stations collected such a 'formidable array of actual measurements', that in 1933 an agency of the federal government was established 'to work directly with farmers... and demonstrate that erosion could really be controlled' (Holt, 1949, p80).

This Federal Soil Erosion Service (renamed the Soil Conservation Service in 1935), under the leadership of Bennett, approached the task in a somewhat revolutionary way. Noting the previous failures of *ad hoc* approaches to soil conservation, Bennett insisted that 'successful conservation depended upon the employment of all applicable measures, one supporting another, in a completely coordinated, integrated programme' (Holt, 1949, p.80), and that 'each acre must be used according to its capabilities and treated according to its needs' (paraphrased by McCaskill, 1973, p.188). Bennett was so emphatic about these ideals, that they were adopted as the underlying guiding principles of the Soil Erosion/Conservation Service itself (Holt, 1949; McCaskill, 1973).

Another unconventional contribution from Bennett was to approach conservation farming in a multidisciplinary way. He argued that any procedure useful for determining the capabilities and needs of any given acre, would require technical contributions from the whole field of agricultural science. To effect this, Bennett surrounded himself with a range of agronomists, soil scientists, agricultural engineers, biologists, foresters, farm economists, hydrologists, horticulturalists, and other related specialists, such that the Service apparently resembled a department of agriculture in miniature (Holt, 1949; McCaskill, 1973).

Two early initiatives of the Service were to establish demonstration farms and comprehensive district-scale conservation programmes. Demonstration farms or areas were set-up not far from the already operating experimental stations, to enable the transfer of local information through example (Helms, 1992). Farmer participation was encouraged through offering assistance with labour, materials, and finance (McCaskill, 1973), with the ultimate aim being to work with farmers to plan on-farm conservation (Helms, 1992). As noted by Holt, focusing soil conservation responses on individual farms represented a new approach to erosion control:

> *[This] was the first time that any government agency or any combination of agencies had ever tried to focus on the many soil and water problems of the individual farm, as a unit, all of the disciplines necessary for their solution. In other words it was the first attempt to write a complete farm conservation plan which, while concerned primarily with the conservation of soil and water considered every aspect of the farming enterprise, and was designed to help the farmer obtain the maximum return from his land consistent with its maintenance in a permanently productive condition'*
>
> Holt, 1949, p.81.

These earliest farm plans involved considerable specialist input. As many as half-a-dozen of the Service's technicians may have collaborated together on a farm-specific soil conservation project, with their individual recommendations being co-ordinated into a single integrated plan (Holt, 1949; McCaskill, 1973). However, financial outlay per farm was 'unduly high', and difficulty was expressed with combining the often 'zealous' contributions from the many different technical specialists into one plan. Further, farmer resistance 'to having a whole group of Government men go over his land' became apparent (Holt, 1949, p81). Consequently, while the multidisciplinary approach ensured technically sound plans, it also limited the widespread application of the farm plan approach.

One method used to encourage widespread uptake and application of soil conservation through planning was through district scale projects. This involved the community establishing a conservation district, which was 'a legal subdivision of a state, set up under state law, with boundaries determined by the people concerned' and supervised by officers elected by farmers within the district (Holt, 1949, p.83). While being wholly autonomous, the districts worked with the Soil Conservation Service and other government agencies to integrate and co-ordinate efforts concerning flood and erosion control.

One of the earliest examples was the Muskingum Watershed Conservancy District in Ohio (pop. 65,000), which was constituted in 1933 soon after a series of destructive floods. A district-wide project was undertaken, which was distinguished by two key features. Firstly, the project included a before unseen integrated approach of Federal, State and private interests. Many agencies and interests co-operated in the initial planning phases of the project, which is considered the first time such groups had worked together on such a scale (McCaskill, 1973). Major engineering works were undertaken by the Corps of Engineers (construction of levees, groynes, dams, etc.), while the Soil Conservation Service established research stations and focused on encouraging a collective response from individual farms.

The second feature of the Muskingum project was the approach the Service took to actually effect flood and erosion control. Operating under another of Bennett's philosophies – that flood control was intimately related to soil conservation on farms – they undertook detailed surveys of all private farms in the district. Subsequently, comprehensive farm conservation plans for each property were prepared, and by 1939 all the farms were operating under such plans (McCaskill, 1973).

Such widespread application of the farm plan approach was only made possible through the development of land classification systems (Holt, 1949; McCaskill, 1973). Rather than the cumbersome dependence on a group of specialists to prepare a plan, development and adoption of land classification systems allowed single farm planners to survey individual farms, and work more closely with the farmer concerned to develop a conservation farm plan in a fraction of the time taken previously.

5.2.2 LAND CLASSIFICATION AND FARM PLANNING

Land classification systems have been integral to the development of farm planning in both the U.S. and New Zealand. Not only have these systems made the widespread application of farm planning possible, but in many cases the land classification map has actually represented a summary of the written plan itself (*i.e.* depicting where and when to make land use changes).

Land classification for farm planning represents the cumulative advance and development of many classification systems. This includes the fractional code method (Jones & Finch, 1925), the unit area method (Hudson, 1936), and early erosion surveys that developed into the 'soil conservation procedure' (Fuller, 1936a; 1936b). The latter was developed by the Soil Erosion/Conservation Service, and was gradually refined into the Land Capability Classification (LCC) and its variants, first described by Norton (1939a; 1939b), then advanced by Hockensmith & Steele (1943, 1949) and the USDA (1954), and with minor amendments consolidated by Klingebiel & Montgomery (1961).

5.2.2.1 The fractional code method of land classification

While never used explicitly for farm planning, the *fractional code method* (Jones & Finch, 1925) represents one of the earliest (if not the first) examples of classifying land according to physical features and land use, and was subsequently used as a basis to develop successive land classification systems. The method was originally developed by a group of ten American geographers, to provide factual information in the form of 'field maps'. It was based upon the idea that 'sound generalisations about a region should be based on intensive studies of typical small areas' (*ibid.* p.148).

The geographers explored three different approaches, eventually settling on a method that combines 'observed facts of land utilization and... natural environment' into a single multifactor map (*ibid.* p.150). Physical 'natural environment' features included soils, natural vegetation, three drainage classes, and three classes of slope. Land utilisation also included three classes (tilled, grassed, and 'idle' land) along with additional cultural features such as settlements and transport routes.

Predominant land utilization classes were distinguished through colour coding (manually coloured by pencil), while natural factors and more-detailed land utilization information could be sourced from a numerically referenced legend. The black and white example given in Jones & Finch (1925) has been enhanced to show an approximation of the original colouring scheme, and is presented using one of the seventeen multifactor codes included with the original map (Figure 5.1).

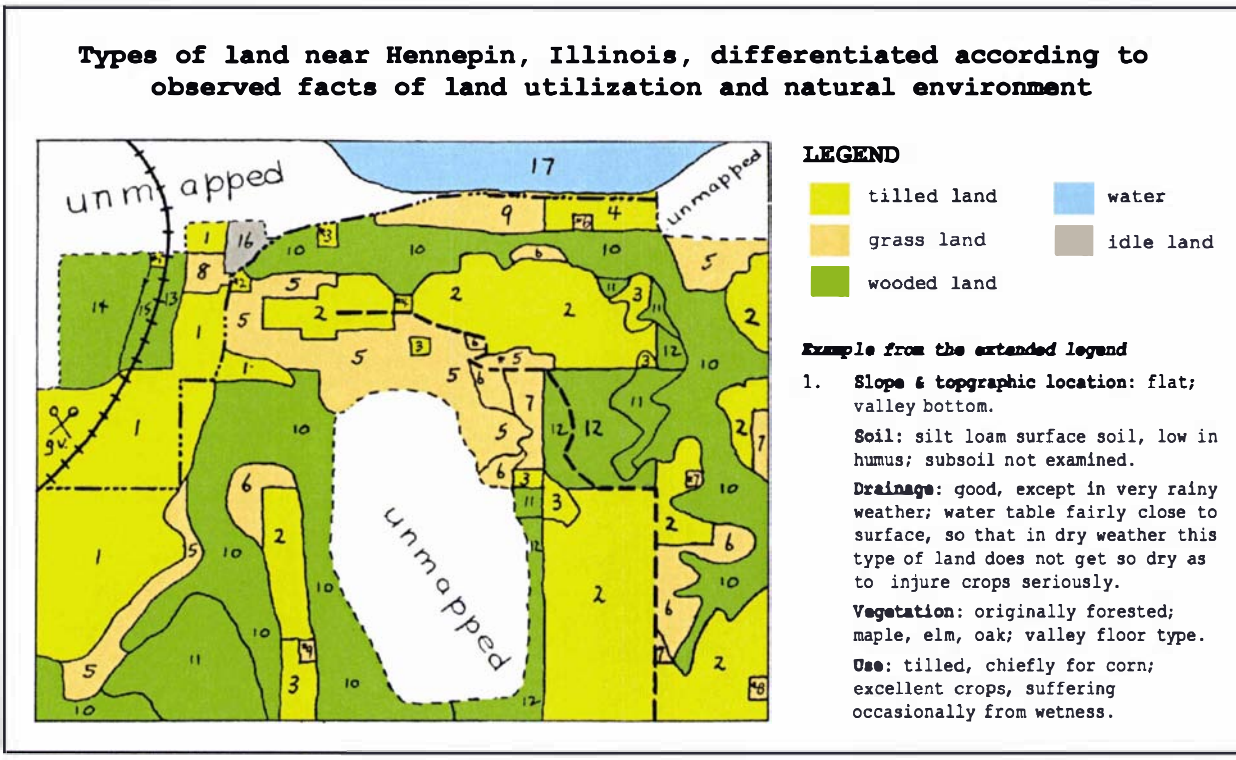


Figure 5.1: Example of the fractional code method of land classification, adapted from Jones & Finch (1925) to approximate the original colour scheme. A scale of '4 inches to the mile' (1:15,840) was recommended for this type of mapping. Units delineated freehand without an aerial photo base, but with the assistance of a ruler, compass and protractor.

Within this method are the beginnings of a 'unit area theory' that becomes more apparent in later classification systems. This is explained as the detailed mapping of small typical areas that exhibit a uniform relation between fundamental geographic factors (utilisation and natural factors). The combination of one set of factors is distinguishable from a neighbouring combination of factors, and can therefore be delineated as a map unit. As the mapping proceeds, spatially dislocated combinations of factors (unit areas) across large areas are identified as being similar, and can therefore be defined as a single collective classification. As an example, while polygons of class two land depicted in Figure 5.1 are spatially dislocated, each polygon is essentially the same in terms of land utilization type, soils, slopes, drainage status, and vegetation. While this 'unit area' idea may seem obviously fundamental to land classification systems of today, in the 1920's it perhaps represented a significantly progressive step in geographical science.

5.2.2.2 The unit area method of land classification

The *unit area method* is an adaptation of the *fractional code method*, developed by the Land Classification Section of the Tennessee Valley Authority in 1935 (Hudson, 1936). Again, while not explicitly used for farm planning, the method served as a basis for later classification systems. In particular, Cumberland (1944b) modified and applied this system to New Zealand conditions, and Greenall *et al.* (1951) employed principles of the method in the Pohangina Soil Conservation Survey (Greenall & Hamilton, 1954).

The unit area method 'represents an attempt to achieve the greatest possible accuracy in field investigation and mapping with ... practical considerations of time and cost' (Hudson, 1936, p.99). It was developed through application, whereby 550 square miles (1425 km^2) of the agriculturally dominant Tennessee River Basin were surveyed and classified. The implied survey purpose was for local authority planning.

Three unique qualities were recognised with the unit area method. Firstly, application of fractional code notations allowed very detailed information to be quickly recorded on base maps, within units not less than 200 acres (81ha) in size. Secondly, aerial photo mosaics were used as base maps, which is credited for improving the speed, accuracy and quality of unit area classifications. Thirdly, the method was adjusted specifically to consider items relevant to land planning in the Tennessee River Basin, suggesting it could also be tailored for use in other areas for different purposes.

The notation system for recording is particularly comprehensive and complex. Six types of land were recognised, with recreational areas, rural settlements, urban areas, and industrial areas being notated with a single Arabic numeral (*i.e.* 1,2,3, etc.). Forested areas had a similar unique identifier, but this was expressed as the numerator of the 'long fraction' portrayed in Figure 5.2. As with the agriculture land type, the denominator of the forest long fraction included seven physical factors.

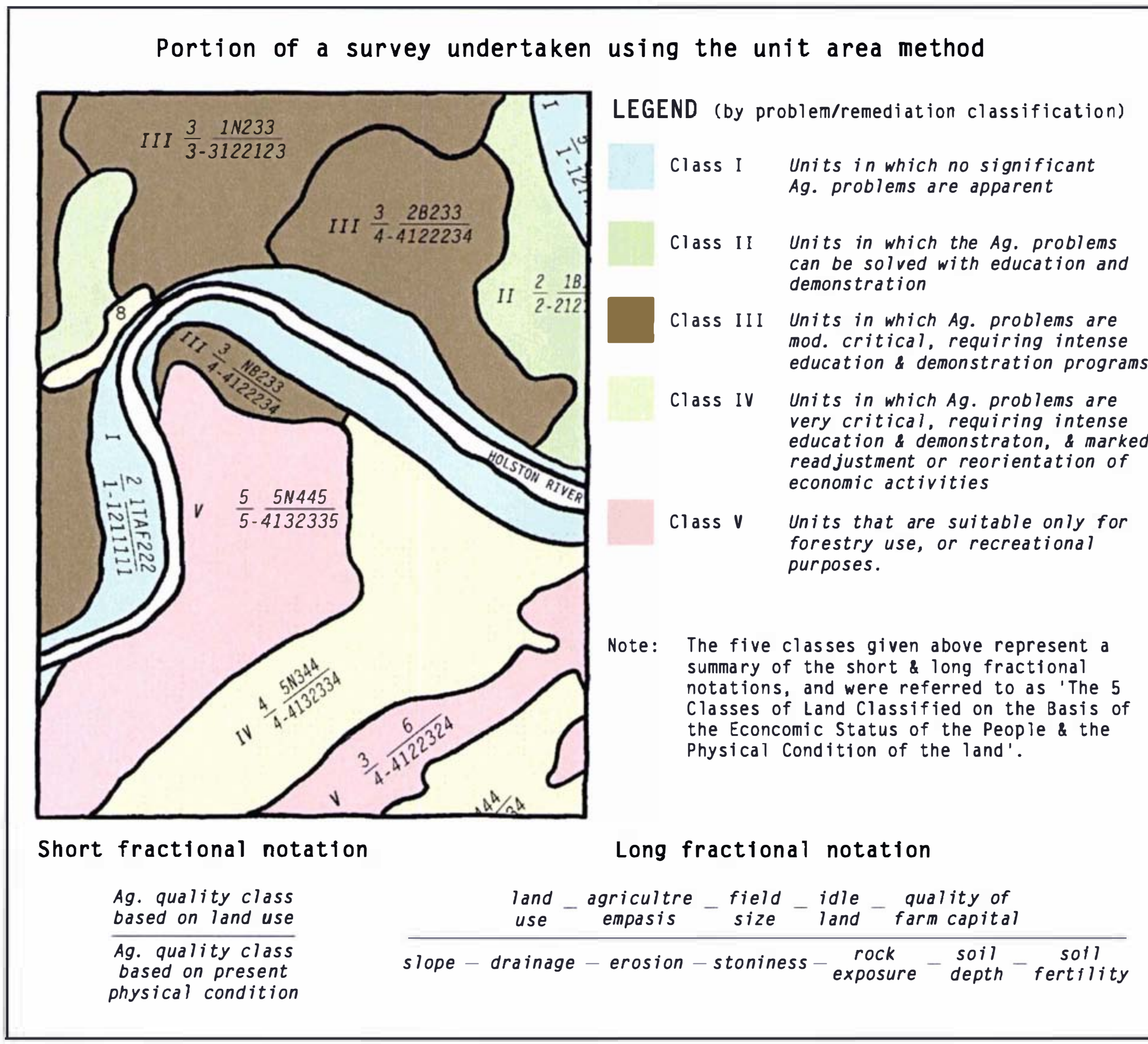


Figure 5.2: Portion of the unit area survey for the Tennessee River Basin, adapted from Hudson (1936) to approximate the original colour scheme, and display the notation system including the overall classification for agricultural land.

The notation for agricultural land included a further five divisions to describe land use type. This was recorded in the numerator of the long fraction, along with classes and ratings for 'agricultural emphasis' (*e.g.* corn, grain, dairying, etc.), field size, amount of idle land, and a rating for farmstead quality. Agricultural land had an additional short fraction notation, representing one of five classes for 'agricultural quality according to physical condition' (denominator), and a further five classes for the 'effectiveness of present agricultural use' (numerator). And to cap it all off, an all-encompassing classification is made to bring together the physical and land use factors of a given unit into one of five possible classes (as described in Figure 5.2). All classifications were qualitatively based upon the observations and judgements of the field mapper.

It is unclear if the unit area method contributed directly to the development of land classification systems used by the Soil Conservation Service for farm planning, or whether the method evolved independently in parallel with the Service's later efforts. Despite this uncertainty, the method was recognised as having value for appraising erosion for the purpose of land planning, and for designing soil erosion control projects by local, state and federal agencies (Hudson, 1936). Further, the fractional notation structure and classification bears a very close resemblance to systems developed by the Service over the 1936-39 period, when land capability classes began to be used (Steele, 1985 *in* Helms, 1992).

5.2.2.3 Erosion surveys

Erosion surveys predating the formation of the Soil Erosion Service influenced the development of later classification systems used for farm planning (Helms, 1992). Bennett was again pivotal in the development and application of these surveys, overseeing detailed surveys in Kansas, Virginia, West Virginia and Texas in the late 1920's, and commissioning surveys over the 1930-33 period to identify sites for experiment stations. No reference explaining the system used could be sourced, although Helms (1992) noted they included only basic information categories, such as depth of soil and subsoil, soil losses, and measurements of erosion debris on foot-slopes and valleys.

Helms (1992) also discusses a more comprehensive erosion survey developed and applied in 1933 as part of a collaborative project involving the University of Georgia and the U.S.D.A. The project focused on Georgia's land use problems, and involved five surveys of the lower Piedmont area where 50% of the farms had been abandoned between 1920-1930. Survey procedure involved classification of land based upon soil, slope (four classes), degree and kind of erosion. Twelve erosion classes were used, with descriptions for each including information on topsoil and subsoil loss through sheet erosion, and whether gullying was shallow or deep. Other categories were given for 'frequently overflowed land' and 'land too gullied for cultivation'.

Helms (1992), who reviewed many American land classification systems, regarded these surveys as the 'philosophical predecessors' to the classification systems used for farm planning. The influence they had on the newly formed Soil Erosion Service is reflected in comments made by Bennett: he referred to them as 'some real erosion surveys, the first ever made in the history of the world', and interpreted their purpose as being 'to classify and map erosion conditions in relation to other physical characteristics of the land, and to the agricultural capacity and needs of the land' (as cited in Helms, 1992). Consequently, the Service adopted a refined version of the survey method in late 1933, specifically for the purpose of farm planning.

5.2.2.4 The 'Procedure for Making Soil Conservation Survey'

The Service's adoption of a modified version of the erosion survey method was driven by a need to collect information on the current use and condition of farm land, which was used as a basis for developing conservation plans for demonstration farms (Helms, 1992). While U.S.D.A soil maps were used for this purpose early on (Holt, 1949), Bennett considered them to be 'little help in farm planning', other than for identifying soil types (Helms, 1992, p.63). Map scales were judged as being inappropriate, and there was little or no information on slope, kind and degree of erosion, or current land use.

A 'Section of Conservation Surveys' was established within the Service, initially headed by Glenn Fuller, who was responsible for applying the previously discussed erosion survey of lower Piedmont. With assistance from co-workers, Fuller tailored and refined the erosion survey method to a four factor inventory system known as the Procedure for Soil Conservation Survey (Fuller, 1936a; 1936b). The procedure was designed specifically for farm conservation planning, and exhibited similarities with Hudson's (1936) unit area method:

> *"At the very outset, it was adopted as a cardinal principle... that soil conservation plans should be predicated upon an inventory of those factors which are of dominant importance in land use. Since these conservation plans had to be made for each field of each farm... it was essential that the inventory be shown in place on a detailed map of each farm"*
>
> Fuller, 1936b, p.463

The factors considered to be of 'dominant importance' included soil type, present land use or ground cover, character and degree of erosion, and slope. These factors were mapped as an inventory code (Figure 5.3) onto 'eight inches to the mile' (1:7,920) scale aerial photos, by delineating out 'each field and each area within which any one of the four factors varies' (Fuller, 1936b, p.463).

Soils were classed according to U.S.D.A Soil Bureau classification systems. Land use or cover included four classes (cultivated land, pasture or range, forest, and 'idle' land), which could be further divided into subclasses representing crop- or land-use specifics (*e.g.* 'cultivated land' could be subdivided into corn, grain, orchard, etc.). It was suggested subclasses should be designed for different surveys, according to the characteristics of the locality. 'Idle' land could be sub-classed into either idle-agricultural and idle non-agricultural land.

The slope classification is a little more complex, with agricultural land and rangeland being assigned their own respective classification systems. Agricultural land was given four slope classes, differentiated by ranges falling within a predetermined 'percent of slope'. Ranges were calculated for different surveys according to local conditions, and classes could be further subdivided where slope exhibited a relation with erosion or appropriate soil conservation measures. Rangeland, however, was more simply assigned a class based solely on percent of slope, which again was also adjusted according to local conditions.

Erosion was classed firstly into either erosion that has 'increased above that which existed under natural conditions' (accelerated erosion), and erosion occurring 'under natural environment which has never supported sufficient vegetation to effect stabilisation' (geological erosion). Further sub-classifications for accelerated erosion could be described by four different components relating to the degree and character of various erosion types (see example in Figure 5.3). The reader is referred to Fuller (1936b) for a more detailed breakdown.

The Procedure had two main distinguishing qualities. Firstly, many of the classes were designed to be amendable to local conditions, which contributed to its applicability to a broad range of conceivable land environments across not only the US, but also overseas. Secondly, a comprehensive range of factors could be recorded on a base map within a delineated polygon, in a way that was readily understood by those with only a basic understanding of the system.

However, while the inventory codes may have been easier to understand than those used by other systems (*e.g.* the unit area method), they still needed to by simplified and translated into 'corrective land use recommendations' for the purpose of farm planning (Helms, 1992). Further, farm plan recommendations regarding land-use change needed to be expressed and justified in a way that farmers could readily understand. These needs were addressed sometime between 1933-39, with the development of an all encompassing classification system that simplified 'classes of land according to use capabilities' (Norton, 1939a; 1939b).

Procedure for Making Soil Conservation Survey

Inventory Code

$$\frac{\text{Erosion - Land use}}{\text{Slope - Soil}}$$

Example

$$\frac{3\ 7\ R\ \hat{F}'\ -\ L}{6B\ -\ 12}$$

3 = 25%-75% of topsoil lost by sheet erosion. Erosion stabilised.

7 = Occasional gullies, uncrossable by tillage instruments.

R = 25%-75% of A horizon lost by wind action

$\hat{F}'$ = Wind accumulations 0-6 inches deep, covering <1/3 of delineated area from which the topsoil previously has been removed and the accumulations are now partially stable.

L = Cultivated

6B = Slope suitable for cultivated crops, with a dominant slope of 6% for delineated area.

12 = Cecil sandy loam

Figure 5.3: Inventory code and example used in the Procedure for Making Soil Conservation Survey. Adapted from Fuller (1936a; 1936b) and Helms (1992).

5.2.2.5 'Classes of land according to use capabilities'

'Classes of land according to use capability' essentially represents the infant version of the Land Capability Classification (LCC) that was to come later. Practical application of the system is comprehensively described in the Soil Conservation Handbook (Norton, 1939a), with a more philosophical account given by the same author, in the same year, as a scientific journal article (Norton, 1939b). Bennett (1939) also gives an account. In itself, the system represents a significant advance on previous efforts, particularly in regard to principles underlying the survey design, how it was applied, and the way in which it was used for extension purposes.

Firstly, the system recognised the need to acknowledge the 'physical, economic, and social factors' related to land use and management of individual farms (Norton, 1939b, p.379). Resulting plans were to be designed according to physical characteristics of the land, but applied and modified according to social and economic factors that may control or influence the actual implementation of recommendations (Norton, 1939a). In effect, the classification was based upon physical inventory, while the social and economic matters were sorted out between the Service technician and farmer in the farm conservation plan (Helms, 1992). This is a recognition that planning future farm operation is a very practical problem, 'one which includes not only the best use of the land but the security and well being of the farm family as well' (Norton, 1939b, p.379).

The integration of physical, social and economic aspects in this manner, suggests these early farm plans were founded upon principal tenets of farm sustainability. That is, promoting or effecting sustainability can only be achieved by reconciling both biophysical and socio-economic objectives.

Secondly, recommendations were given to consider contributions from local farmers when undertaking surveys and drawing up classifications. Service technicians were to rely upon both their own observations as well as the experience of farmers, so as to combine 'local experience with technical knowledge' (Norton, 1940, p.298 as cited in Helms, 1992). Again according to Norton; 'experience of the local farmers and ranchers is interpreted in scientific terms, and both science and local experience are combined to develop a classification designed to assist in obtaining good land management' (*ibid*, p.296). Along with recognizing sustainability principles discussed previously, this represents a particularly mature level of thinking. Not only is it a recognition that farmers are likely to have an in-depth knowledge of their land through virtue of long experience (Chapter 3), but by engaging farmers on a non-controversial and coequal level, they may have been contributing toward a professional rapport with value toward subsequent promotion of soil conservation measures (if required).

Thirdly, considerable effort was given to making the classification system easy to understand and user-friendly. That is, the actual classes of land 'according to use capabilities' were developed to 'simplify the technic and science of agriculture', whereby 'basic physical factors as they apply to sound land use' were grouped into 'a few simple classes which can be readily understood by nearly everyone' (Norton, 1939b, p.379).

The thinking behind this idea recognises land degradation as a social problem, in that the 'masses of people' need to develop an appreciation of 'the principles involved'. They need an 'understanding that large returns from the land for short periods, or misuse in times of stress, destroys it as a resource'. They also need 'an appreciation that it's preservation [*sic*] is a necessity for the maintenance of a permanent civilization' (*ibid.*, p.378). The Service's favoured response was to popularise land sciences 'by putting it in simple, readily understood language' on the premise that this would lead to 'a more rapid and widespread appreciation of the principles governing sound land use' (*ibid.*, p.379).

Also in a social sense, the classification recognises management and choice of land use as a cause of land degradation. This was expressed as inappropriate attempts to transplant types of farming 'not adapted to an area', and the drive to 'produce more than nature was producing under natural cover'. The result being the 'use of land for purposes for which it was not intended', which essentially represents a mismatch between land use and land capability (*ibid*).

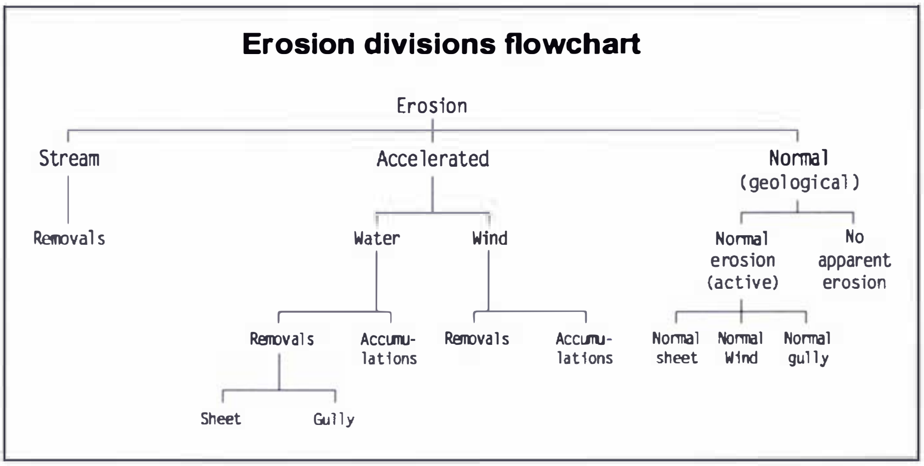


Figure 5.4: Inventory framework used to designate erosion. Interpreted from Norton (1939a).

The mechanics of the system were discretely divided into a method for collecting and recording inventory factors, and a method for deriving the 'classes of land for use capability' (after Norton, 1939a). The inventory included the same four factors of soil type, erosion, slope and present cover or use, as described with the Procedure for Making Conservation Surveys. Soil was recommended as the first factor to be mapped, according to the Soil Survey Manual (Kellogg, 1937).

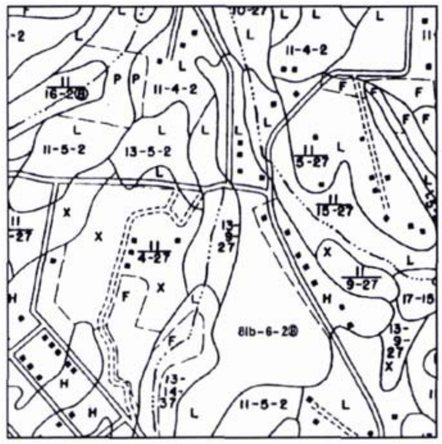
Slope groups were still complicated, but more succinctly explained. They are based upon the idea that soil erosion is strongly related to the properties of soil types and other factors, as they change with changes in slope. Often this could simply be based upon significant landforms, with the slope being expressed as a percent. It was up to the technician to erect location-specific slope groups before undertaking a survey. This included one group for stable cultivated landforms, at least two groups for unstable cultivated landforms where erosion could be controlled, and two or more groups for landforms that require a permanent vegetation cover for protection.

The erosion factor was also more clearly explained. Three top tier types of erosion are recognised, including 'normal' (geological) erosion, accelerated erosion and stream bank erosion. The former are broken down to subclasses of sheet, wind and gully, and then further down to accumulations and removals (Figure 5.4, previous page). Accelerated erosion is evaluated in terms of 'degree of erosion', as determined by the percent of original topsoil, subsoil and parent material that has eroded since the natural state. Type and degree of accelerated erosion is used to derive 'erosion classes', which represent the aggregation of similar symbols, or groups of symbols, identified before undertaking the survey. Classes may include: deposits, 'no apparent erosion', and slight, moderate, severe, and very severe erosion. Classes are particular to the survey location.

Survey inventory for classes of land according to use capability

Inventory Code

$$\frac{\text{Soil}}{\text{Slope - Eroison}} \qquad \text{Land use}$$



Example

$$\frac{81\ b}{6\ -\ 2\ ⑧} \quad or \quad 81b\text{-}6\text{-}2⑧$$

81 = Cecil fine sandy loam

b = 4 - 6 inches of topsoil remaining

6 = Dominant slope of 6% (slope group included in the legend)

2 = Loss of 25-75% of the topsoil

⑧ = Cultivated

Land use designated by a seperate Arabic letter (e.g. L = Cropland)

Figure 5.5: Notation method for recording physical features and land use. Adapted from Norton (1939a) and Helms (1992).

Present land use or cover was mapped into five major classes of cropland (notated as 'L'), idle land (X), pasture or rangeland (P), woodland (F), and a miscellaneous class (H). The first four classes could be further subdivided at the technician's discretion and design, according to the specific nature of the class (*e.g.* X1 for idle land formerly cultivated and available for future agricultural use, X2 for idle land formerly cultivated but unavailable for future agricultural use, and so on). The miscellaneous class was included to describe urban areas, farmyards, golf courses, and other areas not falling with the first four classes.

Soil, slope and erosion were to be notated as compound inventory code on maps, expressed in either a linear or fractional form depending on the shape of mapped units (Figure 5.5). Present land use or cover was recorded separately from the code, and delineated using a dashed line in places not corresponding with physical inventory boundaries. No instructions or examples were given for depicting capability classifications on maps.

‘Classes of land according to use capability’ were developed to simplify the complex factors recorded and observed during mapping. Specifically, classes were to be based upon permanence of soil (as susceptibility to degradation); natural fertility and productivity of soil; climatic environment; and inherent features of land impeding use (drainage, stoniness, hardpans, etc.). The last consideration was later formalised into limiting factor subclasses of the LCC (Helms, 1992). Minor consideration was given to economic factors, in that ‘any land placed in a particular class must give moderate to high yields of one or more of the crops adapted to the region’, implying capabilities must be economically feasible. (Norton, 1939b, p.380).

Classes were defined in general terms with a recommendation that they be adapted and refined to reflect local conditions (Tables 5.1 & 5.2). Hence, different localities and regions were free to apply the classification to their own land types. The objective at this particular time was strongly focused on conservation farming, not uniformity among regions (Helms, 1992). Refinement of classes was also to take account of the dynamics of land capability, in recognition that new technology and knowledge may emerge to overcome land use limitations, or conversely, highlight existing management and conservation practices as being inappropriate (Norton, 1939a, 1939b). Accordingly, classes assigned were not regarded as a permanent indication of a given land area’s capability.

Table 5.1: Descriptions and criteria for deriving arable Classes of Land According to Use Capability, 1939.

Class	***Description***	***Criteria***
I	Suitable for cultivation without special practices	Characterised by: - cultivation not impeded by soil factors (*e.g.* drainage, stoniness, etc.) - ‘erosion promoting crops’ can be grown safely (*e.g.* cotton, corn) - soil has an inherently high physical and chemical fertility
II	Suitable for cultivation with simple practices	Any one of the following factors: - susceptible to erosion when cultivated - cultivation impeded by a soil factor - low natural fertility
III	Suitable for cultivation with complex or intensive practices	Two or more of the following factors: - susceptible to erosion when cultivated - cultivation impeded by a soil factor - low natural fertility
IV	Not suitable for continuous cultivation	Characterised by: - steep slopes - severe erosion - cultivation impeded by a soil factor - low productivity
V	Not suitable for cultivation	Characterised by: - steep, rough or broken topography - extreme stoniness or very poor drainage - very severe erosion

Summarised from Norton (1939a; 1939b).

Table 5.2: Descriptions and criteria for deriving range & forestry classes of land use capability, 1939.

Class	***Description***	***Criteria***
VI	Suitable for permanent grazing without special practices	None given
VII	Suitable for permanent grazing with good management	None given
VIII	Suitable for permanent grazing under very strict range management	Characterised by: - not suitable for mechanical treatment - shallow soil, low moisture retention, excessive run off, severe or high susceptibility to erosion
IX	Unsuited for grazing	Cannot be used for productive agriculture. *E.g.* deserts, bluffs, excessively salty areas

Summarised from Norton (1939a; 1939b).

Two broad capability categories were developed – those in which the most intensive tillage practices can be practiced safely with permanent maintenance of arable soils (classes I – V), and those in which the most intensive utilisation for range farming or forestry can be practiced that is consistent with the preservation of soil and it's plant cover. However, discussion and description of the latter category was relatively sparse, suggesting the classification had been developed primarily for arable farming. Further, Helms (1992) states that the arable class V was not expanded into grazing classes of V thru VIII until 1940 (but no mention of class IX), when the Service attempted to establish the classification into a national system (suggesting the Handbook referenced in this discussion was a revised edition).

5.2.2.6 Classifying Land for Conservation Farming

Implementation of the classification prior to WWII highlighted two main problems. Firstly, unofficial attempts were made to expedite the survey and classification procedure. This was expressed as a temptation and tendency 'for the field men to map capability classes direct, rather than map the soil, slope, and erosion as it actually existed in the field' (Hockensmith cited in Helms, 1992). Such actions should be discouraged, on the basis that the inventory information gained is essentially retained as knowledge, which is largely unavailable to other interests for additional purposes, or for checking the validity of final classifications. Secondly, discrepancies began to emerge regarding regional application of the system, particularly in regard to differences in the types of land assigned the same classification between regions. While 'uniformity between regions' was not the original intent of the classification, a need to coordinate and standardise the system in a national sense eventually resulted in a major revision during the 1950's (Helms, 1992).

Rapid formation of conservation districts in the late 1930s and early 1940s continually increased demand for a wider application of the system, while the 1942 war effort removed experienced personnel from the Service and created a shortage of skilled labour (Helms, 1992). In response, the Service changed its surveying techniques in 1943 with the release of a supposedly streamlined version of the classification system. This was published as a bulletin entitled *Classifying Land for Conservation Farming* (Hockensmith & Steele, 1943).

Again, justification for use of the system was related to both socio-economic realities and land conservation necessities. To fuel the war effort, 'every acre must be made to produce as much as possible of the needed crops for which it is suitable', in recognition that many U.S. farms at the time had fields that 'are not being used with full efficacy'. On the premise that 'all land is good for something', a 'conservation farming' approach was recommended to 'make efficient use of every acre' within the lands' inherent capabilities. The claimed 'first step towards conservation and farming and increased production' was through an 'understanding of land capability', with actual capability classes indicating 'the maximum intensity of use that can be practiced safely in a permanent system of farm management'. Classes were seen to be helpful to the farmer 'in putting [his land] to work for maximum production, protection, and profit', such that his land would 'be put to the use for which it is best fitted' (*ibid*., pages 1 & 2).

Very little detail is given by Hockensmith & Steele (1943) regarding the procedure for undertaking soil conservation survey. Examples suggest it was very similar to that described by Norton (1939), although Helms (1992) implies it was a much streamlined version needed to speed up the process under a reduced workforce. In contrast, considerably more attention was given to explaining how survey information was (ideally) interpreted into capability classes for a conservation district.

Interpretation involved the formation of a committee comprised of farmers, the county agricultural agent, teachers of agriculture, state experiment and extension workers, representatives from local planning authorities, the soil conservation technician, and any other person who could make a technical contribution to the process. They would study the survey map around a conference table, alongside information obtained from experiments and demonstrations, and occasionally undertake field excursions to gain a uniform understanding of the physical factors involved.

The committee would develop a classification of land, whereby eight (or fewer) classes were used to distinguish the 'suitability of land... for cultivation and other forms of use' (Hockensmith & Steele, 1943, p.9). Three classes were designated for land suitable for cultivation; one for occasional or limited cultivation; three unsuited for cultivation but suitable for uses under permanent vegetation (grassland or forestry); and one for land not suited for agricultural use (Table 5.3).

Table 5.3: General land classes for conservation farming, 1943.

Class	***Suitability***	***Management requirements***
I	Cultivation	No special practices
II	Cultivation	Simple practices
III	Cultivation	Intensive practices
IV	Occasional or limited cultivation	Limited use and intensive practices
V	Grazing or forestry	No special restrictions or special practices
VI	Grazing or forestry	Moderate use restrictions
VII	Grazing or forestry	Severe use restrictions
VIII	Wildlife	

Summarised from Hockensmith & Steele (1943).

It was noted that some differences of opinion arise in the development of these classifications. Further, considerable value was apparently afforded to farmer contributions, in that 'experience of farmers is the surest guide' in the development of classifications (*ibid.*, p.9), perhaps in recognition that 'every farmer has made in his own mind some kind of classification of the capability of his [own] land' (*ibid.*, p.7).

Results and conclusions were assembled into a table. This was expressed as a technical land capability table, with different slope groups and erosion classes ordered according to soil groups, to display the physical characteristics of each capability class (Table 5.4). This was later simplified into shorter descriptive names for extension and presentation purposes.

	Land capability classes I thru VIII
List of soil types and groups	Specific slope groups & erosion classes, particular to each soil group and capability class.

Table 5.4: Format of a technical table used to express the grouping of physical factors into capability classes.

Information not explicitly shown in the tables concerns present and potential land use, particularly in regard to appropriate practices and measures assigned to each class. Rather, the committee was to discuss suitable crops, rotations, fertiliser needs, and other management and land use considerations, to produce an additional table that shows general practices recommended for each class of land (Table 5.5). Land capability tables and general recommendations were later aggregated as 'Technical Guides', which represented 'a reliable, authoritative technical guide for soil conservation work in a district' (Hockensmith & Steele, 1949, p.387).

To accompany the tables and guides, land capability classes were related back to the survey units, to prepare maps portraying the colour-coded distribution of the different classes alongside original inventory factors (see example as Figure 5.8). These 'land-capability maps' and their accompanying recommendations 'furnish a simple guide for conservation farming to farmers and agricultural technicians'. They can be used as a basis for farm planning, provided they are supplemented with farm-specific information such as 'the farmer's resources, his choice of crops, his type of farming, and [the] many economic, social, and personal factors' that characterise the uniqueness of a farm as a unit (*ibid.*, p.37).

Land Capability Class	Soil Groups	Practices recommended for...				
		Cropland			Pasture	Woodland
		Crops & rotations	Soil treatments	Supporting practices		
Class IV (blue)	2. Well drained loams to clay loams: Cecil, Davidson, Lloyd, etc. 3. Well drained sandy loams: Appling, Cecil, Wickham, etc.	Kudzu Common lespedera Sericea lespedera	On fair to good soils: 200 to 300 pounds 0-17-8 or or 0-12-12. On eroded soils: 200 to 300 pounds of 4-12-4 or 4-16-4	Stabilisation of gullies & galled spots. Diversion of hill-side water. Cultivated only when necessary to reestablish hay or pasture	Same as class III Orange soils best for pasture For old pasture on soil group 6, 200 to 300 pounds of 0-16-8	Reforestation of available sites Protection from fire and grazing Improvement by cuttings and space plantings

Table 5.5: Example of farming practices recommended, according to the capability of the land, in the Abbeville Soil Conservation District, South Carolina. Adapted from Hockensmith & Steele (1943).

5.2.2.7 The Land Capability Classification

With the end of WWII, the Service focused efforts toward improving the system into what was to become the Land Capability Classification (Hockensmith & Steele, 1949). Efforts were directed at harmonising 'discrepancies across state and district boundaries', and toward resolving 'particularly nettlesome problems' of deciding how to map and classify wetlands, land needing irrigation, and dry-land farming areas (Helms, 1992, p.66).

Initial changes to the system were minor, although comprehensive discussion on the procedure for undertaking soil conservation survey is given by Hockensmith (1947), perhaps to redress the comparatively sparse account given previously (*i.e.* Hockensmith & Steele, 1943). The main refinement of note concerns the capability classification itself, in that the system was amended to explicitly recognise subclasses for land with particular limitations or problems. This included subclasses relating to erosion control, drainage, and severe infertility (Hockensmith, 1947), although classes for many other limiting factors were conceivably possible. However, as the use of many subclasses would challenge the simplicity and user-friendliness of the system, the Service had avoided recommending overt use of subclasses from the outset (Helms, 1992). Formal introduction of subclasses in 1947 was tagged with a proviso that they be 'used only where absolutely necessary' (Hockensmith, 1947, p.14).

By 1949, the now called LCC had been further refined into a three tier system (Hockensmith & Steele, 1949). This included the eight capability classes, better defined subclasses, and a new division referred to as the 'land capability unit' (Table 5.6). Each tier was recognised as a degree of abstraction of actual land capability, ordered according to an incremental level of information and detail. In short, capability units provide more information and detail than the capability classes, with each tier being more or less applicable to different levels of purpose. This design was driven by the preference to keep the system simple, while accounting for the amount of factual detail required for devising sound recommendations and plans. As stated by Hockensmith & Steele (1949), 'actual description of all types of land would be lengthy and cumbersome', with the relative generalisations being a convenient way 'to facilitate easy, quick understanding'.

<table>
<tr><th rowspan="2">Major land use suitability
(Broad groupings of limitations)</th><th colspan="2">Land-capability class</th><th rowspan="2">Land-capability subclass
(grouping of land-capability units according to kind of limitation. This table shows examples only)</th><th rowspan="2">Land capability unit
(land-management groups based on permanent physical characteristics. This table shows examples only)</th></tr>
<tr><th></th><th>Degree of limitations</th></tr>
<tr><td rowspan="4">Suited for cultivation</td><td>I</td><td>Few limitations. Wide latitude for each use. Very good land from every standpoint.</td><td rowspan="4">E.g. Limited by hazard of water erosion; moderately sloping land.
E.g. Limited by excess water; drainage needed for cultivation.
E.g. Limited by low moisture capacity; sandy land.</td><td rowspan="4">E.g. Moderately sloping, slightly acid soils on limestone.
E.g. Moderately sloping, highly acid soil on sandstone or shale.</td></tr>
<tr><td>II</td><td>Moderate limitations or risks of damage. Good land from all-around standpoint.</td></tr>
<tr><td>III</td><td>Severe limitations or risks of damage. Regular cultivation possible if limitations are observed.</td></tr>
<tr><td>IV</td><td>Very severe limitations. Suited for occasional cultivation or for some kind of limited cultivation.</td></tr>
<tr><td rowspan="4">Not suited for cultivation</td><td>V</td><td>Not suited for cultivation because of wetness, stones, overflows, etc. Few limitations for grazing or forestry use.</td><td rowspan="4">I.e. Grouping of sites according to kind of limitation.</td><td rowspan="4">I.e. Sites significant in management of ranges, pastures, forests, etc.</td></tr>
<tr><td>VI</td><td>Too steep, stony, arid, wet, etc., for cultivation. Moderate limitations for grazing or forestry.</td></tr>
<tr><td>VII</td><td>Very steep, rough, arid, wet, etc. Severe limitations for grazing or forestry.</td></tr>
<tr><td>VIII</td><td>Extremely rough, arid, swampy, etc. Not suited for cultivation, grazing, or forestry. Suited for wildlife, recreation, watersheds, etc.</td></tr>
</table>

Table 5.6: Outline of the three tier Land Capability Classification, adapted from Hockensmith & Steele (1949).

The eight capability classes essentially remained unchanged, while the subclasses had been defined a little more concisely as 'convenient groupings of capability units within one land-capability class' according to the *kind* of permanent limitation (*cf.* to the *degree* of limitation for capability classes). Permanent limitations were defined as 'those which limit land use or impose risks of erosion or other damage', and explicitly included slope, inadequate moisture supply, and soil factors (*e.g.* texture too fine or too coarse, shallow soil, etc.). Subclass examples for class III land (suited for cultivation but subject to severe limitations or hazards) could include one subclass for 'sloping land subject to water erosion' and another for 'naturally wet land that produces only if drains are maintained' (Hockensmith & Steele, 1949, p.385).

The land capability unit was defined as 'land-management groups based on permanent physical characteristics' that are essentially uniform throughout the unit's extent. Put another way, 'each land-capability unit consists of land that is nearly uniform in use possibilities and management needs', with units being 'distinguished from each other by permanent mappable land features'. Related to subclasses, units 'that have about the same *kind* and *degree* of permanent land limitations' can be aggregated into a overarching subclass (*ibid.*, p.384). For the farmer, units could provide a great deal of interpretive information (Helms, 1992).

As with previous classifications, capability classes were notated using Roman numerals I thru VIII, and portrayed on maps as respectively coded colours of light green, yellow, red, blue, dark green, orange, brown, and purple. Subclasses were designated by a capital Arabic letter, and the units simply being assigned an ordinary number (Figure 5.6). Along with descriptive legends that were 'written in non-technical language', the land capability maps were considered as 'an indispensable segment of a farm conservation plan' (*ibid.*, p.388).

Figure 5.6: Example of the three part LCC code, 1949.

The Land Capability Classification again underwent minor refinements in the early 1950s, to be published as *A Manual on Conservation of Soil and Water* (USDA, 1954). This was the most comprehensive handbook on land classification and soil conservation yet published, and cast the LCC as 'a systematic arrangement of different kinds of land according to those properties that determine the ability of the land to produce on a virtually permanent basis' (p.26). However, for the most part, only minor modifications were made to the system overall.

The general technique for collecting 'facts about the land' (land inventory) had not been altered, but individual factors had been assigned very defined class thresholds, particularly in regard to soil characteristics. Similarly, the capability classification had been a little-more tightly defined in terms of which types of land each capability class relates to, and the subclasses had been categorised discretely into erosion, climate, wetness, and soil limitations. Land-capability maps and recommendations were considered valuable as a 'simple guide to conservation to farmers and agricultural technicians', although it was recognised that additional social and economic information particular to individual farms would be required to make a farm plan (p.46).

While the LCC had been developed specifically and primarily for these sorts of plans, the Service had also applied it to the additional purposes of district scale planning and land resource inventorying on a nationwide basis. The latter was referred to as the *National Land Capability Inventory*, and represented a source of contention between the Service and the Division of Soil Surveys (DSS).

As discussed by Helms (1992), the Service had originally designed and adopted their strongly soils orientated conservation surveys because existing soil maps and information sources available from the DSS were inadequate, particularly in terms of coverage and scale. Demand for soil conservation and the comparatively high levels of resourcing (in 1950 the Service had 700 surveyors compared to the DSS's 100), combined with the relatively efficient design of the survey and it's procedure, resulted in rapid and extensive inventory mapping across the U.S.

The perceived problem was explained by Charles Kellogg, the head of the DSS at the time. In his view, the soil conservation survey was attuned too closely to one objective (land capability classification for farm planning), which went against the conventional dictum that "soil survey should be a comprehensive inventory of the soils' properties and characteristics", and therefore untarnished by specific purpose. In turn, the soil scientist could interpret such broad soils databases, and make predictions regarding 'how one could expect soils to react under various uses'. So by gearing the survey of soil properties to one purpose, Kellogg believed the "[conservation] survey could fail to meet other needs or interpretations, and another survey would be necessary" (as cited in Helms, 1992, p.66).

Kellogg's views would have a large influence on the LCC. This began with Bennett's retirement, which paved the way for the amalgamation of the then separate Conservation and Soil Survey Divisions into one. While the new survey section remained under the wing of the Soil Conservation Service, Kellogg was appointed to oversee it's operations. He soon ordered a review of the LCC, expressly to standardise and tighten the way in which soils information was collected and used to derive classifications. When the revised Handbook was subsequently released (Klingebiel & Montgomery, 1961), much of the discussion had been notably reoriented towards a soils perspective.

5.2.2.8 Land Capability Classification revision, 1961

Rather than representing a further refinement of the LCC, the review can be likened more-toward an adaptation of the system to that of soil survey and classification. This was expressed as four tiers, whereby the *soil-mapping unit* could be sequentially 'grouped' according to unit similarities, into the *capability unit*, the *capability subclass*, and ultimately into the *capability class* (Figure 5.7). This built upon Kellogg's original idea that an unbiased and comprehensive description of a soil can be 'interpreted' for a broad range of purposes. Hence, as the LCC was integrated into this philosophy, it was relegated to being just another means of deriving 'interpretive groupings made primarily for agricultural purposes' (Klingebiel & Montgomery, 1961, p.1).

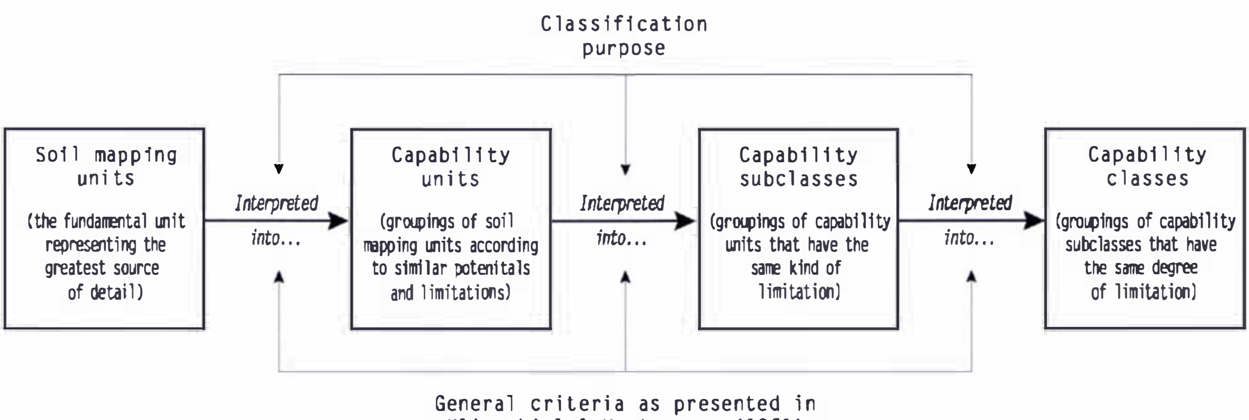


Figure 5.7: Relationship of units and classes in the LCC revision, 1961 (Klingebiel & Montgomery, 1961).

Individual *soil-mapping units* were regarded as the 'building stones of the system'. Essentially these units represented the equivalent of soil types, defined as 'a portion of the landscape that has similar characteristics and qualities, and whose limits are fixed by precise definitions'. They were regarded as 'the unit about which the greatest number of precise statements and predictions can be made', as they provided 'the most detailed soils information' available for making interpretations. The purpose of an interpretation would determine the kinds of soil units grouped, and the degree of acceptable feature-variation between nominated units (*ibid.*, p.2).

Capability units were defined as 'a grouping of one or more individual soil-mapping units having similar potentials and continuing limitations or hazards' (*ibid.*). They 'condense and simplify' soils according to the similarities they exhibit toward crop production and soil management, particularly for 'application to specific fields on a farm or ranch' (*ibid.*, p.12). In turn, *capability units* may be aggregated into *capability subclasses* that have the same kinds of dominant limitations for agricultural land use.

Four subclasses are discretely defined (Table 5.7) to provide the user with 'information about both the degree and kind of limitation'. Where multiple limitations were apparent they were to be prioritised according to their relative degree of impediment to land use, or if they exhibited a similar degree of impediment, according to a standard priority of: erosion → wetness → soil → climate (in most cases).

Symbol	Subclass	Description
e	erosion	Soil groupings where past erosion damage or susceptibility to erosion define the dominant hazard or limitation to use
w	excess water	Soil groupings where the dominant hazard or limitation to use is poor drainage, wetness, a high water table, or excessive overflow
s	soil limitations within the root zone	Soil groupings where the dominant hazard or limitation to use arises from shallowness of rooting zones, low moisture-holding capacity, low fertility difficult to correct, and salinity or sodium
c	climatic limitation	Soil groupings where the climate (as temperature or lack of moisture) is the only major hazard or limitation in their use

Table 5.7: Capability subclass limitations (Klingebiel & Montgomery, 1961).

By definition, Class I land could have no subclass. The *capability class* represents the final level of aggregation, again by placing the relative degree of limitation or hazard into one of eight broad classes. The main differences (relative to earlier classifications) concerned terminology and the very descriptive and defined criteria recommended for deriving classes (summarised in Table 5.8, overleaf).

Providing detailed criteria for deriving capability classes represented an attempt to consolidate the uniformity of the LCC on a nationwide basis (Helms, 1992). Throughout the evolution of the system, different regional offices had been classifying the same types of land into different classes, particularly along regional boundaries. In a similar context, locally derived classes were relatively confined to the range of land types apparent within a given mapping region. Whereas the 'best soil' of one region may be designated Class I, in a neighbouring region the presence of a 'better soil' may relegate the soil of interest to Class II. Because the revised LCC used soil as the fundamental unit, it was thought these problems could be addressed if all classifiers used the same standardised criteria.

Seeking nationwide uniformity with the LCC represents an underlying trend regarding the evolution of American land classification. This can be considered an unfortunate trend in a context of farm planning, as the pursuit of uniformity eclipsed the Service's original reasons for designing and developing the system. Original reasons can be summed as a need to efficiently obtain factual information about farm land; express it in a non-technical way to farmers; and use it alongside other local considerations to derive a farm-specific land use plan with recommendations concerning appropriate production and conservation management. These reasons were greatly dissimilar to those driving classification uniformity (namely the formulation of a national inventory, planning, and reporting), such that the reviewed LCC took away much of the flexibility available to users and technicians at the farm level, particularly in regard to the use of local experience and observations (Helms, 1992).

Major land use suitability	Land-capability class		Example descriptive criteria as presented in Klingebiel & Montgomery, 1961
		Description	
Land suited to cultivation & other uses	I	Soils in Class I have few limitations that restrict their use	Soils are nearly level & deep; erosion hazard low; generally well drained & easily worked; high natural fertility; not subject to damaging overflow
	II	Soils in Class II have some limitations that reduce the choice of plants or require moderate conservation practices	Soils limited by gentle slopes; mod. past or potential wind or water erosion; limitations regarding soil depth, workability, salinity, soil structure; excessive wetness; slight climatic limitations
	III	Soils in Class III have severe limitations that reduce the choice of plants or require special conservation practices or both	Soils with mod. steep slopes; high past or potential wind or water erosion; frequent overflow; limitations regarding permeability; rooting depth; excessive wetness; low fertility; mod. salinity; mod. climatic limiitations
	IV	Soils in Class IV have very severe limitations that restrict the choice of plants, requre very careful management, or both	Soils with steep slopes; severe past or potential wind or water erosion; shallow soils; low moisture holding capacity; frequent overflows; excessive wetness; severe salinity; moderately adverse climate
Land limited in use - generally not suited to cultivation	V	Soils in Class V have little or no erosion hazard but have other limitations impractical to remove that limit their use largely to pasture, range, woodland, or wildlife food and cover	Soils that are nearly level subject to limitations of wetness; frequent overflows; stoniness; or climate
	VI	Soils in Class VI have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, woodland, or wildlife food and cover	Soils limited by steep slopes, severe erosion hazard; stoniness; shallow rooting zones; excessive wetness or overflow; low moisture capacity; salinity; or severe climatic limitations
	VII	Soils in Class VII have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife	Soils more severely limited than Class VI, due to very steep slopes; erosion; shallow soil; stones; wet soil; salinity; unfavourable climate; or any other limitation making them unsuitable for general crops
	VIII	Soils & landforms in Class VIII have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply or to aestheic puproses	Commercially unviable land limited by erosion or erosion hazard; severe climate; wet soil; stones; low moisture capacity; or salinity. Includes badlands, rock outcrop, sandy beaches, river wash, mine tailings, etc.

Table 5.8: Summary of capability class definitions and criteria as recommended in the 1961 LCC revision (adapted from Klingebiel & Montgomery, 1961).

5.2.3 Example of an Early American Farm Conservation Plan

How land classification and farm planning was used to promote and effect land use change can be explained by building a semi-hypothetical description of the farm plan process. This is 'semi-hypothetical' because a singular complete description of the early American farm plan process could not be sourced. Rather, one is constructed using previously cited literature, based around the best obtainable example presented in Hockensmith & Steele (1943).

A 1940's American farm planning exercise involved four overlapping steps, including a soil conservation survey to collect facts about the land; a land capability classification to determine use suitabilities; formulation of recommendations concerning appropriate management and conservation treatments; and bringing it all together as the farm conservation plan. In some cases these steps were undertaken on two levels –survey, classification, and recommendation formulation at the conservation district level, and more specific application at the farm level.

Soil conservation survey was the fundamental starting point for farm planning. Surveys were undertaken either on a farm-by-farm basis prior to 1938 (Hockensmith & Steele, 1943) and during the war period (Helms, 1992), or more preferably on a district, county or watershed basis, as part of a conservation district project (*ibid.*). Where the purpose was individual farm planning, a 'detailed survey' was undertaken, as distinct from a 'reconnaissance survey' used for broader purposes (Norton, 1939a, p.3). Initially, those employed to undertake the surveys were called 'soil surveyors' and 'soil scientists' (*e.g.* Hockensmith & Steele, 1943), later to be replaced with the title 'conservation surveyors' (Holt, 1949).

Hockensmith & Steele (1943) described the actual survey procedure from a farmer perspective:

> *"...farmers will see a... surveyor walking briskly across their fields. He... looks at the surface soil and then at the subsoil... rubbing some of it between his thumb and finger, reflecting a moment, and writing something on a paper. Then he takes a small instrument... and sights through it, looking directly up or down the slope. He glances around, evidently observing the entire landscape, then sketches for a few moments and moves on. He crosses farm boundaries and doesn't appear to be taking any special notice of them. He is preoccupied all the time, as if he were counting steps and making mental notes between stops"*
>
> Hockensmith & Steele, 1943, p.8

The surveyor was obtaining 'facts about the land', primarily focusing on the distribution and characteristics of different soils, slopes, kind and degree of erosion, and land utilisation features such as land use type, vegetation cover, field boundaries, houses and roads. These were delineated according to similarities onto an aerial photo preferably at a scale no smaller than 1:15 840, and described as either inventory code or as an entry in a field notebook. For soils, the surveyor is specifically recording depth, colour, texture, structure and permeability (Hockensmith, 1947).

For a district type survey, the surveyor would end-up with a mosaic of aerial photos portraying polygons of similar land features, and a notebook containing related descriptions and observations. These were used to prepare a map showing the physical inventory factors, land use, and land use capability, and a report structured according to the detailed framework discussed by Norton (1939a). Compilation was undertaken in collaboration with a number of different interests (discussed in Section 5.2.2.6), which also involved the formulation of general capability classes and land use recommendations.

As these reports and maps became available to the local 'soil conservation technician', he (or perhaps she) would then be able to extract and copy the details relevant to a given farm of interest. Details could be verified upon visiting the farm, and used alongside local considerations and observations as the basis for farm planning.

Farm specific soil conservation surveys likely followed a similar procedure. However, it is unclear whether these were undertaken by the specialist 'conservation surveyor' or by the local soil conservation technician. The former was certainly used for surveys of demonstration farms prior to 1938, and it seems practical to suggest the technicians would have been capable of applying the procedure during the labour shortage of WWII, or on an *ad hoc* basis where and when necessary. In the absence maps and information obtained from district level survey, the technician would need to work with the farmer to develop their own capability classes and recommendations.

Hockensmith & Steele (1943) present examples of farm maps prepared for a 151 acre (61ha) farm located in Abbeville County, South Carolina. These maps have been redrawn to improve clarity, and in the case of the land capability map, to approximate the classification's colour scheme. As far as practically possible, the original symbols, hatches, and styles have been reused. The first map (Figure 5.8) depicts a combination of physical land inventory and land capability classes described in Section 5.2.2.6. Unlike the method of Norton (1939a), land use and cover is presented as a separate map (Figure 5.9). Both the first and second maps were used with other considerations to design the final map (Figure 5.10), whereby the recommended land use changes depicted form the basis of a farm plan.

The final map was likely to have been prepared according to a procedure explained by Hockensmith (1947). This involved both the farmer and the technician, and is initially based on a land capability map prepared at the district level:

> *"They first look at the* [land capability] *map to get a good picture of the entire farm. Then they walk over the farm, and the farmer points out the problems that are bothering him and the places... where he needs help. Together they refer to the map to see clearly what each part of the farm can do and what it needs. They talk about the different kinds of land. The farmer points out his different crops. He explains what he wants to do. They look frequently at the land-capability map to see how each parcel of land can be used safely and at the same time produce what the farmer wishes in to get the most from the farm... The needed erosion-control practices are discussed at the spot on the farm where they belong. Terrace outlets are located. Farm pond sites are selected. They agree on treatment of slopes above the pond to provide clear water. Lanes, roads, and fences are changed if necessary in order to follow the contours of the land"*

Hockensmith, 1947, p.16

As the farmer and technician walk the farm, the land uses and treatments they agree upon are marked on another aerial photo. This second map shows the location of works to be undertaken, the new arrangement of fields, fences and roads, and specifies the agreed use for different parcels of land (*e.g.* Figure 5.9). The farmer is supplied with a copy of this 'land-use map', along with the land-capability map and a list of recommendations for each individual field. These jointly developed recommendations may be recorded directly onto the land-use map, or included as a separate document. With this example, the two maps and the set of recommendations constitute the farm conservation plan.

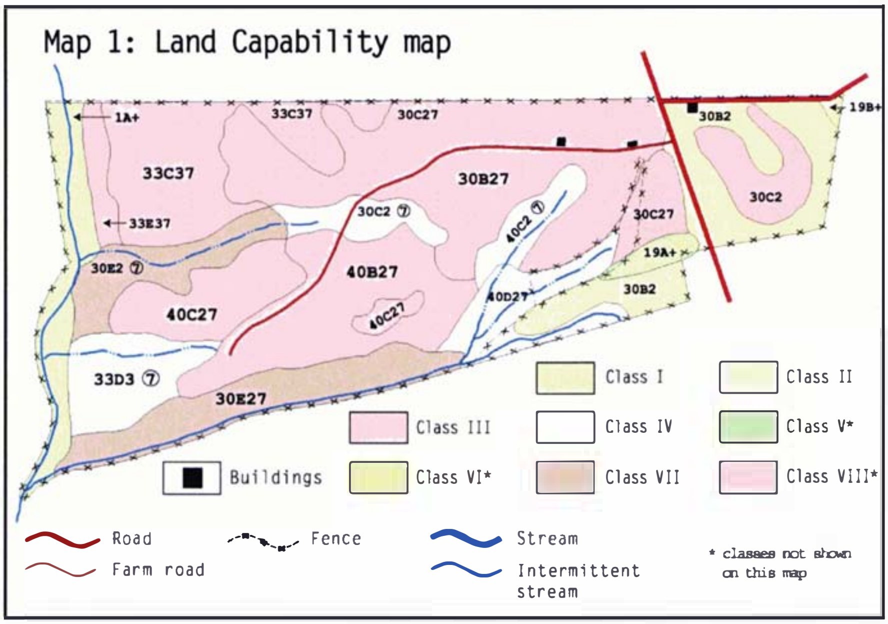


Figure 5.8: Combined soil conservation survey and land capability map of a 151 acre (61ha) arable farm in South Carolina. Inventory code records soil types, slopes and erosion classes explained in Section 5.2.2.6. Only five of the eight possible capability classes were mapped. Adapted from Hockensmith & Steele (1943) to approximate the original colour scheme.

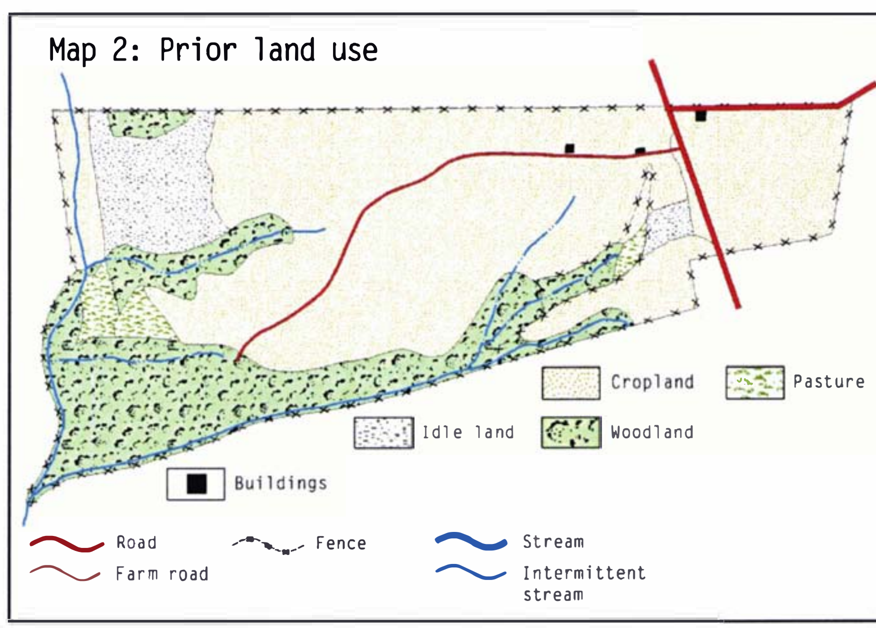


Figure 5.9: Map showing land use and cover at the time of the soil conservation survey. In this case, it has been presented as a map separate from the rest of the inventory. Adapted from Hockensmith & Steele (1943), approximating original hatches, styles, and symbols.

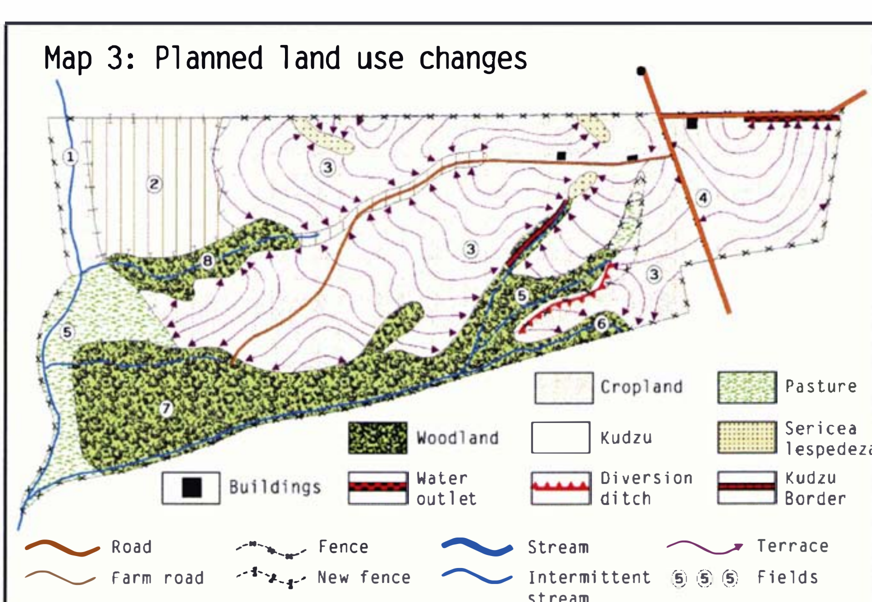


Figure 5.10: 'Land-use map' prepared by working with the farmer to identify, and agree upon, needed and acceptable land use changes. The farm conservation plan comprised of this map, the land capability map, and a list of recommendations. Adapted from Hockensmith & Steele (1943), approximating original presentation design.

Holt (1949) suggests a variation without the land use map, in that "we… give a farmer a map of his farm on which the different land capability classes are shown in distinguishing colours, together with the usual table showing the proper uses and treatments, and he can carry out without further assistance a pretty good conservation plan" (p.83).

Types of recommendations included in a conservation farm plan can be interpreted from Hockensmith & Steele's (1943) discussion of the preceding map examples. For this particular farm, land use before the plan was divided into two large areas of cropland and woodland, and two smaller areas of idle land and pasture (Table 5.9). Crops were gown in large fields 'that included a great deal of steep and eroded land'. A modest livestock inventory included two mules, two dairy cows, and four young cattle.

Table 5.9: Summary of land use change by area for an example farm conservation plan.

Land use	***Area before the plan***	***Area after the plan***
Woodland	39.3 acres (15.9 ha)	34.5 acres (13.9 ha)
Pasture	3.7 acres (1.5 ha)	9.9 acres (4 ha)
Cropland	96.1 acres (38.9 ha)	90.1 acres (36.5 ha)
Idle land	11.9 acres (4.8 ha)	-
Kudzu (forage crop)	-	15.2 acres (6.1 ha)
Sericea lespedeza (forage crop)	-	1.4 acres (0.6ha)

Recalculated from relative areas as a percent of total area.

The conservation farm plan recommended a combination of land use change, adoption of conservation treatments, and refinement of production management and associated practices. Figure 5.10 shows the recommended land use changes, including a minor reduction in the total area of cropland; a greater than twofold increase in the area of pasture; fertilising and sowing idle land in forage crops for grazing and hay; and reducing the area of woodland by two hectares. The number of fields was doubled, with approximately 2.3 miles (3.7km) of new fence.

Conservation treatments focused on sheet and gully erosion primarily through the use of extensive terracing, and in specific locations by the construction of a diversion ditch and a water outlet. All diverted surface-water emptied into areas of woodland or forage crop, on the premise that a continual vegetation cover prevents down-cutting by flowing water. Deeply gullied land (mainly the Class IV) was either given to permanent covers of pasture or forage crop, or replanted with trees and shrubs.

Recommended refinements to management practices were discussed by numbered field. Fields 3 & 4 were to be 'intertilled' (growing two different crops in alternating strips) according to contour. Field 3 was intertilled at '3 terrace intervals', as part of a two year rotation of cotton (or corn) and grain. If corn was grown, this was to be 'interplanted' with cowpeas. Field four was intertilled at 'two terrace intervals', again for a two year rotation, but with a sequence of cotton, then grain, followed by *Sericea lespedeza*. The Class I land of field 1 was given to a rotation of corn (interplanted with velvet beans) and crimson clover for winter, while field 5 was expanded as pasture by clearing some of the woodland. In part, some of the remaining woodland was open to stock for grazing, shelter, and access to water (reticulated stock watering systems were a novelty in 1943), while field 7 was completely given to woodlot forestry managed by 'cutting dead and inferior trees to allow good logs to develop rapidly'. In summary:

> "[The farm's] *conservation and land use problems are difficult, but they can be solved. Classifying the land according to its capability helped the farmer and the farm planner to see the problems clearly, to understand the needs, capabilities, and limitations of the land, and to use each acre effectively for its contribution to farm income and farm life"*
>
> Hockensmith & Steele, 1943, p.45

A less well described example is presented in the 1954 handbook (*i.e.* USDA, 1954). In this case, they present the original land-capability map (Figure 5.11) and a land use map (Figure 5.12). Although the clarity is poor (the picture was taken from a well used 48 year-old handbook, and the picture wasn't all that clear to begin with), Figure 5.11 shows the type of map the farmer would have received as part of a farm plan in the late 1940s to early 1950s. This particular example explains the physical characteristics and management requirements of each unit found within the farm boundary.

The farm itself was a 124 acre (50ha) cotton farm located in the Piedmont Plateau area of South Carolina. A brief description of the land use map and recommendations was given in a context of suitability according to each class, but the new pattern of land use was not clearly distinguished from the old.

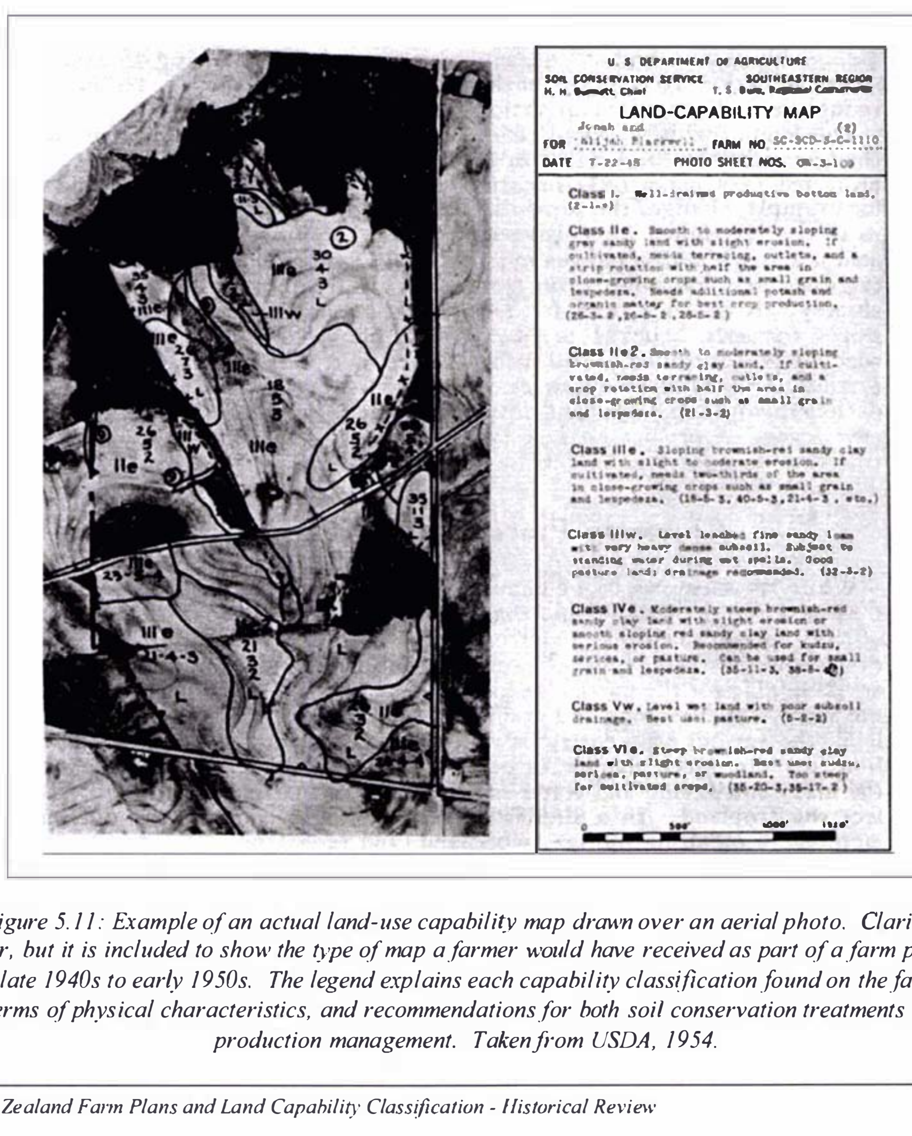


Figure 5.11: Example of an actual land-use capability map drawn over an aerial photo. Clarity is poor, but it is included to show the type of map a farmer would have received as part of a farm plan in the late 1940s to early 1950s. The legend explains each capability classification found on the farm, in terms of physical characteristics, and recommendations for both soil conservation treatments and production management. Taken from USDA, 1954.

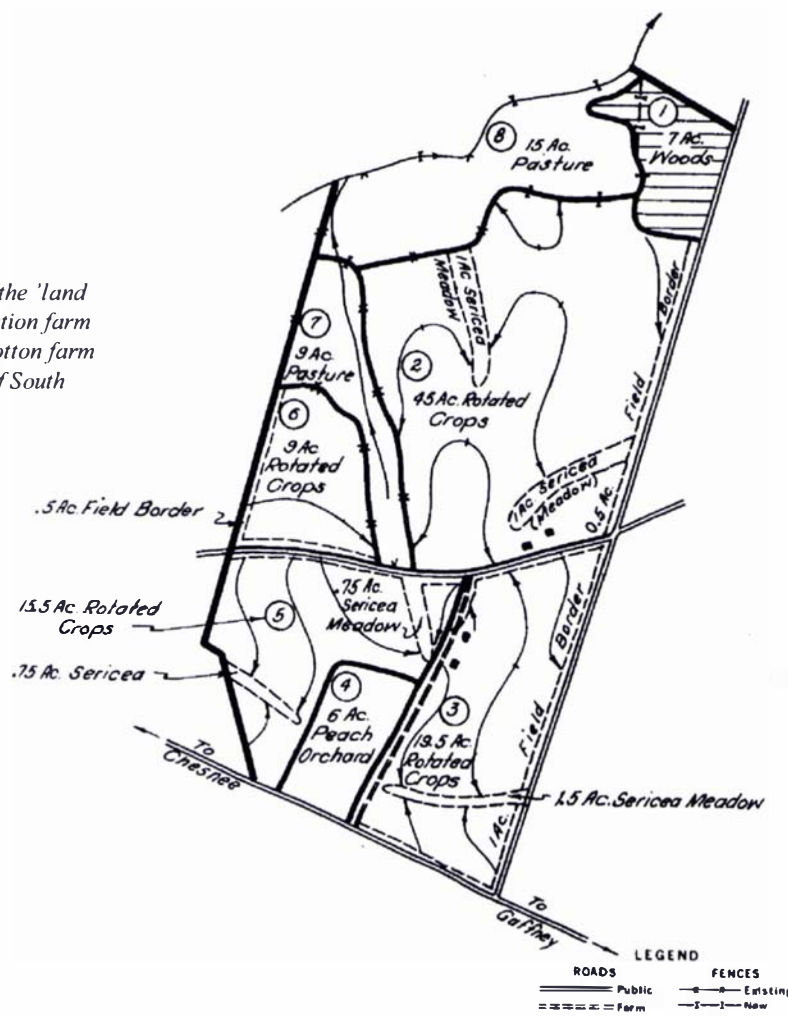


Figure 5.12: 'Land use map' to accompany the 'land capability map' as part of the conservation farm plan. This example is for a 124 acre cotton farm located in the Piedmont Plateau area of South Carolina.

5.2.4 Concluding comments regarding the American system

A feature concerning American farm planning and land classification, is that the procedure was undertaken in a context of promoting and effecting sustainable farming. While this is implicit rather than explicit, ideas of conservation farming, land capability, and farm planning all embody principle tenets of farm sustainability from a 'wise-use' or utilitarian perspective. Within the early American literature reviewed, this is particularly apparent with the terminology used to justify various land classifications. A select range of examples include:

> ***"soil conservation… implies permanent maintenance of the productive capacity of the land"*** Norton, 1939a, p.1 (interpretation: soil conservation is concerned with continually maintaining the lands' ability to sustain production for an indefinite period).

> ***"recommending practices that will make possible its productive use, without deterioration, for a long period of time"*** Hockensmith & Steele, 1943, p.1 (interpretation: recommending the adoption of practices that will maintain or enhance the sustainability of the production system, while at the same time maintaining or enhancing the sustainability of the underlying biophysical system, over an indefinite period of time).

"conservation farming… [is] making part of the farmers' routine all the practices necessary to preserve, improve, and make good use of the soil" Hockensmith & Steele, 1943, p.5 (interpretation: soil conservation involves encouraging farmers to adopt practices to maintain and enhance sustainable use of soil).

"soils are grouped according to… their potentialities and limitations for sustained production of common cultivated crops… [or] soils unsuitable for long time sustained use for cultivated crops" Klingebiel & Montgomery, 1961, p.1

An interpretation for the final citation could be that soils are grouped according to measures of the land's ability to sustain crop production (*i.e.* as potentials and limitations), or in the case of non-arable soils, according to whether or not the soils can biophysically sustain a level of crop production that maintains or enhances other dimensions of farm sustainability (in the context given, this was probably economic viability). In a similar way, 'land capability' can be taken to mean 'the ability of land to sustain an economically sustainable land use', while 'conservation farming' can be broadly interpreted as 'sustainable farming'.

Land capability was defined as 'the suitability of land for a specified purpose' (Hockensmith & Steele, 1943). Expressed diagrammatically (Figure 5.13), land characteristics and properties were related to the comparatively more dynamic requirements of a given system of land use (*e.g.* cropping, grazing), to identify land capability as potentials and limitations. Conservation farming was concerned with designing or refining a farm system that not only operated within permanent and inherent land limitations (*e.g.* steep slopes, stoniness), but also sought to fully capitalise on potentials as far as land capability thresholds would permit. Norton (1939b) expressed this as the 'maximum intensity of agricultural use that can be practiced safely' (p.380). In effect, this represents a means of reconciling the need to protect the productive integrity of land (*i.e.* maintaining/enhancing the ability of land to sustain overtime), while at the same time allowing the farmer to make a living (*i.e.* maintaining/enhancing socio-economic sustainability).

Figure 5.13: Land capability as a relation between land and land use

Conservation farming also recognised the complexity and intradependence of farm systems within the broad scope of the farm planning process. As a complete package, it recognised the need to distinguish biophysical characteristics firstly (as soil conservation survey); secondly to interpret their relation toward economically viable production (as land capability); thirdly to derive practical, socially and economically acceptable solutions (as recommendations); and fourthly to show how management can integrate them into the whole farm system (as the farm plan). Further, it also suggested management as the most important system, both as the cause and solution to soil conservation problems (*e.g.* Norton, 1939b).

The importance of management was expressed as farmer involvement in the process. That is, the farmer should be involved throughout the process, by contributing local knowledge and experience to the survey (Norton, 1940), being involved with the interpretation of land capability classifications and recommendations (Hockensmith & Steele, 1943), and of course by collaborating closely with the technician to develop the actual farm plan. In doing so, the farmer may have gained a greater understanding of the principles involved, and why any land use changes were necessary. In part, this would have been assisted by the non-technical emphasis ingrained into the system from the outset.

To summarise, farm planning was developed by the U.S. Federal Soil Erosion/Conservation Service in response to the country's soil erosion problems. Widespread application was made possible through the development of land survey and classification systems, along with the uptake of the soil conservation district concept. Land classification for farm planning was continually refined, eventually into the four component Land Capability Classification. Throughout, the emphasis behind farm planning and land classification focused on non-technical presentation, coordination and collaboration at the district level, cooperation and integration at the farm level, and an underlying utilitarian philosophy that conservation farming involves effectively using every different area of land according to it's capabilities. Many of these early ideas can be related to conventional ideas of sustainable farming.

American efforts to control widespread land degradation were being effected well before the relatively young New Zealand nation realised it had similar problems. However, when soil erosion finally did receive public and political attention in New Zealand, the country was in a good position to learn from the American example. Consequently, many land classification and farm planning ideas were adopted from the Americans, and adapted to suit New Zealand's unique landscape and environmental conditions.

5.3. NEW ZEALAND FARM PLANS & CLASSIFICATION SYSTEMS

As with America, early New Zealand farm plans are linked with the soil conservation movement. National efforts to address erosion and flooding problems began in earnest with the passing of the 1941 Soil Conservation and Rivers Control Act, and subsequent establishment of the Soil Conservation and Rivers Control Council (SCRCC) and catchment authorities. SCRCC policy underpinned the adoption and development of many American ideas concerning soil conservation, including land capability classification, soil conservation survey, and conservation farm planning. In their refined form, these ideas were applied to individual farms by catchment authority staff.

5.3.1 The rise of New Zealand Soil Conservation

The 1938 East Coast floods are often taken as a starting point for the New Zealand soil conservation movement (Campbell, 1966b; Selby, 1968; McCaskill, 1973). Two high intensity storm events were involved, the first on the 19th February in the Gisborne district, and the second spanning a period of three days in the Hawkes Bay. With the first, 'unprecedented damage was done on farms by slips and washouts' (McCaskill, 1973, p.15), while the second caused 'catastrophic flooding of fertile, riverine lands and collapse of thousands of acres of hillside pastures' (Campbell, 1966b, p.16).

While soil conservation and river control had been practiced on an *ad hoc* basis at least since the early 1900s, the 1938 floods 'brought home to the community the ominous threat and paralysing effects of soil erosion and flooding and generated a wave of sympathetic reaction through the country' (*ibid*). Increasing lobbying pressure was directed at government, who initially responded by commissioning a Rivers Control Committee and a Scientific Committee of Enquiry. The latter produced a report entitled *Maintenance of Vegetative Cover in New Zealand, with Special Reference to Land Erosion* (Committee of Inquiry, 1939), which 'gave the government... and the general public a simple, clear-cut and comprehensive account of the problem and suggestions for tackling it' (McCaskill, 1973, p.20).

However, the government of the time was not particularly interested in a soil conservation. Most administrators and politicians 'were slow to accept the need to act' (Roche, 1994, p.32), and when they eventually did, the response was more concerned with river control than soil conservation. This is reflected in the drafting of the 1940 River Control Bill, which 'had no provision for soil conservation measures' (McCaskill, 1973, p.21). Government attitudes toward soil conservation were largely apathetic, particularly with the Department of Agriculture who stated: 'in general in New Zealand, erosion *per se* is not a basic problem calling directly for action' (*ibid*., p.22).

Persistent political lobbying resulted in the formation of a 1941 Select Committee to investigate the problem of soil erosion and flooding in New Zealand. Submissions were read and heard from numerous local bodies and lobby groups up and down the country. One of the most vocal was the Canterbury Progress League, who amongst other things, advocated the adoption of the American approach to soil conservation.

The Committee recommended major changes to the original Rivers Control Bill, which were eventually accepted and passed into law as the 1941 Soil Conservation and River Control Act (SCRCA). Not only did the Act provide 'a focal point for those who were looking for [soil erosion] remedial measures and assistance' but it also represented the first time government had voiced 'concern about the serious problems of erosion and made provision for coping with them' (Poole, 1971, p.11). Under the Act, a central Soil Conservation and Rivers

Control Council (the 'Soil Council' or SCRCC) was established to oversee and coordinate efforts, including the commissioning of catchment districts to be operated under catchment boards.

5.3.1.1 The Soil Conservation and River Control Council & catchment boards

The Council initially comprised of six members, and was charged with: the promotion of soil conservation; the prevention and mitigation of soil erosion; the prevention of damage by floods; and to ensure land was utilised in a way that would promote the Act's other objectives (SCRCA, 1941, Section 10).

However, the development and implementation of a national soil conservation program was slow in coming. Initial efforts focused primarily on policy development, establishing catchment districts, promotion of soil conservation principles, and a seemingly *ad hoc* approach to erosion control works. Reasons for this slow start included the War, poor relations with the Department of Agriculture, resistance from local authorities, lack of resourcing (particularly with acquiring appropriately trained staff), and resistance from the farming community (Hogg, 1972; McCaskill, 1973; Roche, 1994). As noted by Hogg (1972, p.50), although '1941 saw the official birth of soil conservation in this country, it had very little impact on the rural scene for the next decade'.

Thirteen catchment boards were commissioned between 1943 and 1955 (Figure 5.14) to control and manage their respective 'catchment districts'. These were defined to include 'the whole of a watershed of a river or a group of continuous rivers' for the purpose of 'full control of a river from its source to the sea' (Newnham, 1948, p.51). Membership of these boards included a combination of representatives elected because of their local water and soil interests, and public servants who had regional experience in one or more facets of catchment management (Poole, 1988). Administration was financed through a general rate levied from each boards' district.

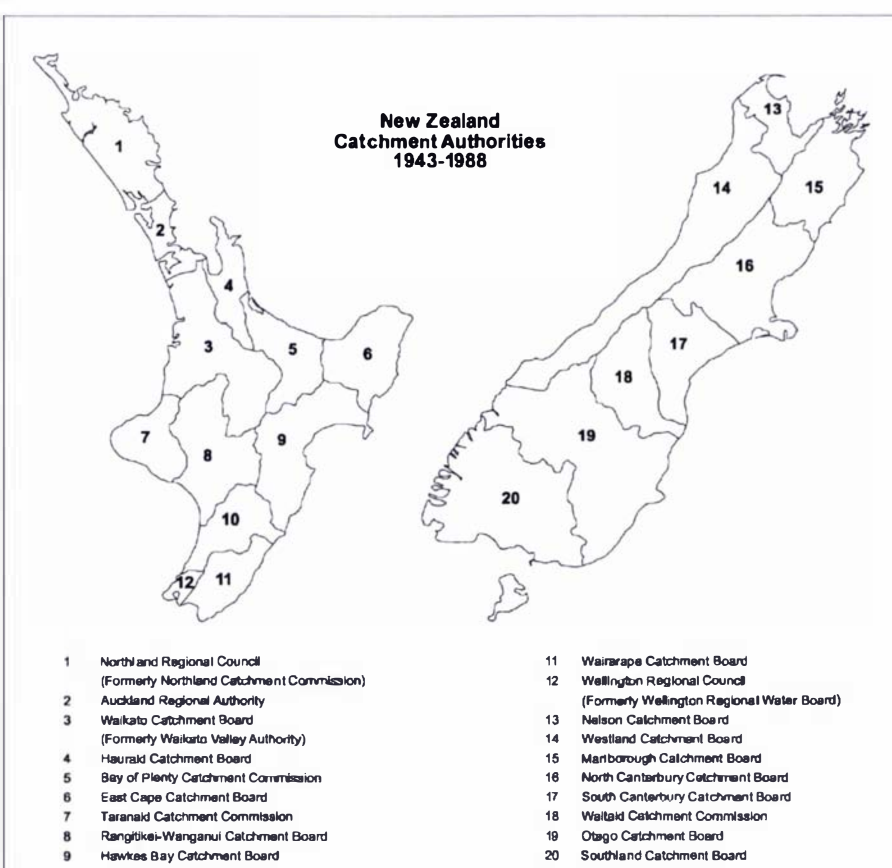


Figure 5.14: Catchment authority districts, 1943-1988 (adapted from Marshall & Kelly, 1986).

Four 'catchment commissions' were also eventually added (Bay of Plenty, Taranaki, Waitaki, Northland), differentiated from boards in that their members were appointed by the local territorial authority, rather than being elected. Other 'catchment authorities' with responsibilities under the Act included the Auckland Regional Authority, the Wellington Regional Water Board, and the Waikato Valley Authority. Auckland and Wellington were given special dispensation because of unique water management issues relating to their cities and population growth (Poole, 1983), while the Waikato Valley Authority was established by a separate Act of parliament in 1956, specifically to coordinate hydroelectric development of the Waikato River (Roche, 1994). This placed the Waikato outside the direct influence of the SCRCC.

Later developments resulted in Waikato's special status being abolished in 1984, and the Authority became a catchment board. Similarly, Wellington and Northland reformed into Regional Councils in 1980 and 1985 respectively, and Manawatu and Rangitikei-Wanganui began operating as the Central Districts Catchment Boards in 1987 (Hughes, 1989).

Catchment boards were 'supervised and controlled' by the SCRC Council as a function under the SCRC Act. While twelve functions were given, only the six with most relevance to this discussion are listed below. These can be broadly reinterpreted as: obtaining new information and identifying erosion solutions through survey and research; extension through demonstration; and educating and assisting individual land owners.

- *The carrying-out of surveys and investigations to ascertain the nature and extent of soil erosion.*
- *The carrying-out of experiments and demonstrations in soil conservation ...*
- *The investigation and design of preventive and remedial measures in respect of soil erosion.*
- *The instruction and supervision of landholders in matters pertaining to soil conservation...*
- *The assistance of persons whose land has been affected by soil erosion or floods.*
- *The general supervision and control of the activities of Catchment Boards.*

Soil Conservation and Rivers Control Act, 1941, Section 11.

Newnham (1948) discusses how these functions were initially interpreted and applied as policy. General policy was aimed at 'the best use of the land, according to the country's needs and capabilities of the soil, having due regard to the requirements of each particular catchment' (p.52). This relates well to early American ideas of maximising production within land capability (*e.g.* Hockensmith & Steele, 1943), and recognises the importance of local conditions in policy application. The policy itself focused on five closely related fields (Newnham, 1948):

1. *Investigating erosion problems*
2. *Information service*
3. *Defining the problem by field surveys*
4. *Demonstrating conservation measures*
5. *Conservation operations on the land*

The last three - field survey, demonstration, and the way in which soil conservation would be carried out - all combined to produce a situation conducive to the emergence of individual farm planning. Field survey would 'provide data from which land capability and conservation needs of each farm... [could] be assessed' (*ibid.*, p.52); farmer-owned demonstration farms would provide examples of how soil conservation could be integrated into the farm system; and the application of soil conservation measures on individual farms would preferably be undertaken by the farmer himself (or perhaps herself), with financial and technical assistance where applicable.

5.3.2 EARLY LAND RESOURCE SURVEYS AND CLASSIFICATIONS (1930S TO 1956)

While the SCRC Council had a direct mandate to undertake conservation type surveys under the Act, it took several years before an acceptable system was developed and officially adopted. Before this, the Council could only make use of a limited amount of erosion-extent information, including that from Taylor (1938) for the North Island, and Zotov (1939) for the South Island. Likewise, a limited amount of information was available from the Department of Agriculture (as land utilisation surveys), and the Soil Survey Branch of the Department of Scientific and Industrial Research (DSIR).

The DSIR began undertaking district scale soil surveys in the mid-1930s and land utilisation surveys in 1939. Many of their later efforts would have an erosion component, or would be specifically orientated toward evaluating the extent and character of erosion. The first of these included 10,000,000 acres of the South Island High Country (Gibbs & Raeside, 1945), and 15,250,000 acres of the southern half of the North Island (Grange & Gibbs, 1947), both of which specifically mapped the type and amount of erosion apparent (NZSN, 1953).

However, the first extensive erosion survey undertaken after the establishment of the SCRC Council was by K.B. Cumberland. This was initially published as an article (Cumberland, 1943) and then republished as a more comprehensive book (Cumberland, 1944a). Cumberland broadly divided New Zealand into seven soil erosion regions (Figure 5.15), differentiated by 'the distinctive form or forms which unnatural soil stripping takes in each area' (*ibid.*, p.9). He discusses erosion types and processes by region, and goes onto recommend 'a stocktaking of the land resources of the Dominion... [including] mapping of current land use and... desirable conservational use of the land'. Such an undertaking would involve the coordinated efforts of a number of experts in different disciplines, and would be summarised 'on a map of land capabilities and needs' (*ibid.*, p.125).

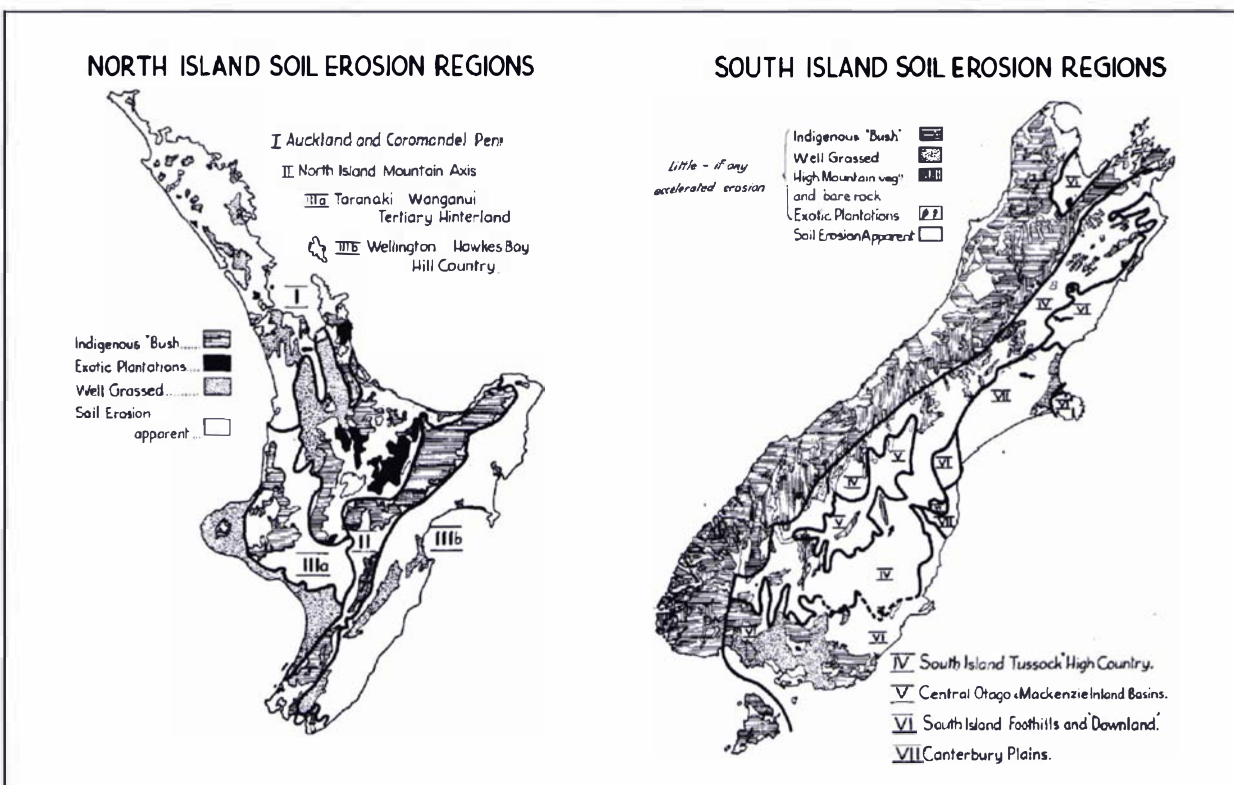


Figure 5.15: New Zealand soil erosion regions from Cumberland (1944a). All white areas indicate where accelerated erosion was noted during the survey.

Early erosion-type surveys gave a broad indication of New Zealand's soil erosion problem, but they were unsuitable for the national soil conservation programme that the Council would eventually adopt. As later policy would highlight, the type of system required would be versatile for application at both national and local scales, be based upon inherent physical features of the land (land inventory), and perhaps most importantly, it should recognise and integrate the impact of present and potential land use (land classification[2]).

5.3.2.1 Early land classification surveys

Land classification surveys were at first undertaken as 'utilisation surveys' by the Department of Agriculture, and secondly by the Department of Scientific and Industrial Research (DSIR). The Dept. of Ag. carried out early utilisation surveys that 'highlighted areas where production could be improved by changing farming practices' (Roche, 1994, p. 32). While these were completely production orientated (*cf.* soil conservation), they 'led eventually to a sharper appreciation of land deterioration… and to calls for a national survey in 1939' (*ibid*).

The DSIR at the time considered national land surveys to be their research domain (Cumberland, 1943; Roche, 1994). Further, they were also aware of the need for land classification as a natural extension of soil survey. As noted by Roche (1994), the DSIR's first district-scale soil surveys (Taranaki, Ashburton County, and Waipa County in 1933 and 1934) highlighted 'the comparative lack of knowledge of the capabilities of various soil types… as a serious deficiency' (p.34). A greater knowledge of soil capabilities was seen to be important for farming, and thus, the national economy. Accordingly, the DSIR advocated a national stocktaking of soil resources in 1935, and formed the DSIR Land Utilisation Committee in 1938.

Later in 1939, staff from the DSIR and Dept. of Ag. worked together under the guidance of the Land Utilisation Committee, on a pilot survey of the Heretaunga Plains (DSIR, 1939), specifically to develop a land use classification system suitable for nationwide application (Roche, 1994). At the same time, the DSIR was also undertaking a 'soil survey and land utilisation study' in Northland. Both studies contributed to the adoption of a system of soil interpretations similar to that advocated by C. Kellogg in America (see Section 5.2.2.8). Grange (1944) refined this into a six class system for forestry and pasture land, which was used by N.H. Taylor in his land utilisation survey of the Gisborne Land District in 1944 (Campbell, 1946). Gibbs (1959; 1966; 1968) discusses how the DSIR's land classification system can be used for multiple purposes, and applies a modified version to the 1:1,000,000 scale Soil Maps of North and South Islands (Gibbs, 1968).

Other land classification surveys made prior to 1949 are listed and briefly summarised by Grange & Smallfield (1949). They divided these surveys into (a) those that deal with the present utilization of the land, and (b) those that classify land according to its suitability for various uses. In most cases, both the utilisation and suitability type classifications represented an interpretation or extension of soil surveys, and thus, were similar in nature to the multi-purpose system adopted by the DSIR. However, one stood out from the rest, in that it proposed a completely different approach to land survey and classification.

[2] Gibbs (1968) distinguishes land classification from soil classification. Soil classification is the grouping of soils with similar physical, morphological, biological and chemical properties. Land classification involves 'the pattern of soils in relation to economic and other non-soil factors such as size and tenure of farms or availability of water and power' (p.125). Hence, soil classification focuses purely on biophysical features, while land classification goes further to include socio-economic features such as land use.

5.3.2.2 The Geographic Approach to land classification survey

Cumberland (1944b) considered the DSIR's land utilisation surveys as being inadequate for a nationwide stocktaking of New Zealand's land resources. While he recognised their objectivity, accuracy, and the detail of land information provided, he dismissed their widespread application on the basis of being too costly and time consuming. In Cumberland's view, the post-war demand for factual land information was likely be 'early, urgent, and insistent' (p.186). As such, Cumberland advocated a land classification system that had 'proved to be a successful attempt to achieve the greatest possible accuracy and detail with field investigation, within certain practical considerations of time and cost' (p.187).

His system was a refinement of the unit area method, adapted to 'suit New Zealand's great variety of regional conditions' (McCaskill, 1973, p.190). Initially Cumberland applied it 'tentatively' to a small area near Christchurch (Figure 5.16), and then supervised a larger survey of 1700 square miles (4400 km^2) extending from the South Pacific coast to Lake Coleridge near the upper Rakaia River. In terms of survey speed for national mapping, Cumberland estimated that a party of two could map 40-140 square miles per day (100-360 km^2/day).

The mechanics of the system differ little from those initially proposed by Hudson (1936). Areas exhibiting similar physical and cultural characteristics were delineated onto either aerial mosaics or topographic maps (at 1:63,360 or larger), and described using the comprehensive long and short fraction notations, and the three tier land classification system. Criteria used to define each digit of the fractional notation was adapted to physical and cultural factors particular to New Zealand conditions, while the three land classifications were similarly reinterpreted to derive land use quality, land physical quality, and a final overarching land classification. Class codes for the final classification were also expressed differently (Figure 5.16).

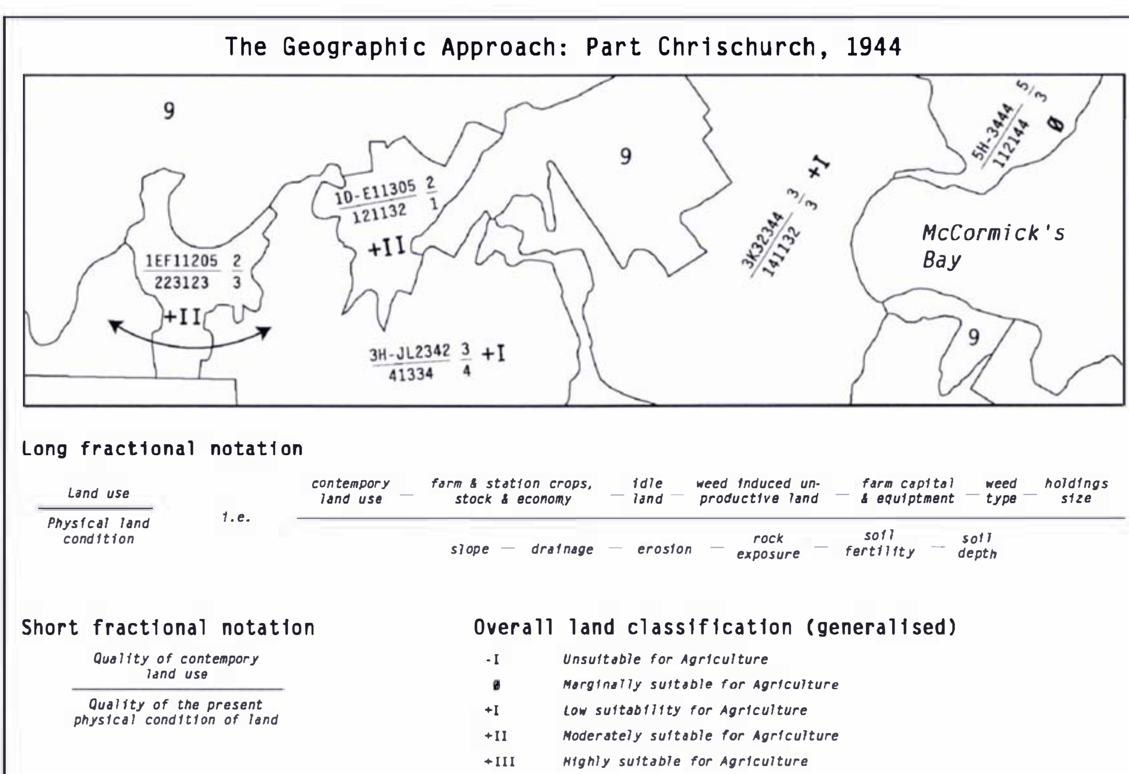


Figure 5.16: The Geographical Approach to land survey and classification for a small area on the outskirts of Christchurch City. Adapted from Cumberland (1944b). Polygons notated as '9' represent built-up areas.

Cumberland also considered the US Conservation Service's land classification system (*i.e.* Norton, 1939a), but like the DSIR's land utilisation method, dismissed it as being too detailed for a national survey. This view was contrary to that of the SCRC Council, who towards the end of the 1940s had begun to look more closely at the multi-scale system then being used by the US Soil Conservation Service.

5.3.2.3 New Zealand Soil Conservation Surveys

In part, Cumberland's method was not adopted at the time because the Council 'had no soil conservation policy or system by which the results of [his] classification could be applied' (McCaskill, 1973, p.190). Such policy was not forthcoming until the late 1940s, when the chairman of the Council ascribed particular importance to *soil conservation surveys* as part of a national soil conservation programme:

> *'the first essential step is to define soil erosion problems and assess conservation requirements by field surveys in each catchment. For this purpose, soil conservation surveys, combining the results of topographic, soil, type and degree of erosion, climate and land use surveys are necessary'.*
>
> (Newnham, 1948, p.52).

The American soil conservation surveys were initially designed for obtaining land information at the farm level (Section 5.2.2). By the late 1940s, the US Soil Conservation Service had developed the system for application at catchment and district scales, and eventually up to the national scale. As later noted by Greenall & Hamilton (1954), the soil conservation survey 'is suitable for reconnaissance surveys, detailed conservation surveys on a scale of twenty chains to one inch [1;15,840], and conservation farm plans on a scale of five chains to one inch [1:3,960]' (p.506). Further, when the Council did eventually begin to consider surveys in earnest, the American system had already been well described, tested, and it's benefits demonstrated.

However, before being suitable for widespread application, the Council needed to adapt and refine the system to suit New Zealand's particular conditions and soil conservation needs. Several high erosion-risk areas were selected for trial soil conservation surveys (listed in NZSN, 1953), including the Pohangina Catchment (1949-50), Wairoa County (1950), Waimate Creek area (1952), Waipaoa Catchment (1952) and Upper Clutha Catchment (1951-52). McCaskill (1973) also discusses a survey undertaken in the Perlorus and Queen Charlotte Sound localities in 1950, orientated toward 'mapping capability for forestry, farming, and recreation' (p.191).

Independent soil conservation surveys were also undertaken around this period by various catchment boards. Roche (1994) makes reference to a Soil Conservation Staff Conference held in 1953, at which some catchment boards indicated that they had already undertaken land use surveys, but had 'filed the results away'.

Official trial surveys had close similarities with the American system described by Norton (1939a, 1939b) and Hockensmith & Steele (1943). However, as these were trials, the surveyors had considerable freedom to modify the system according to their own respective requirements. As discussed at the 1952 Soil Conservators' Meeting in Timaru, this resulted in each survey team adopting their own classification system particular to the areas they surveyed (NZSCA, 1952).

This can be highlighted with two contrasting survey approaches. The first is that used by the South Canterbury Catchment Board in their pilot soil conservation surveys, and the second is the widely reported six class system used in the Pohangina Conservation Survey.

5.3.2.3.1 The South Canterbury Catchment Board's four and seven class system

The early technique used by the South Canterbury Catchment Board (SCCB) for reconnaissance type surveys and 'land capability farm planning' was briefly described at the 1st Soil Conservators' Association Meeting in 1952 (Rowell, 1952). The reconnaissance survey was based on existing soil maps (where available) supplemented by observation and mapping in the field. The procedure for inventory mapping followed recommendations given in a SCRC Council Circular[3] on soil conservation surveys.

Reconnaissance type surveys were used to give an initial perspective of the erosion problem, and to define the areas 'requiring more urgent attention'. In turn, these could be examined more closely through 'detailed conservation surveys'. However, at the time the SCCB did not have the staff to undertake these detailed surveys to any great extent. Rather, they focused their efforts on cooperative demonstration farms (discussed later) and individual farmers who had made special requests.

A detailed survey would involve the preparation of a land inventory map, which would then be used alongside other information (*e.g.* annual rainfall, rainfall intensities) to prepare a land utilisation map. Depending on the landscape of interest, this second map would have either seven classes for the 'flat downlands country', or four classes for the 'pastoral country' (including tussock grasslands). Classes were described according to types of limitations and recommended treatments and practices (Tables 5.10 & 5.11).

Table 5.10: SCCB land capability farm planning classes for 'downland'.

Class	***Slope (x^0)***	***Utilisation***
I	0 - 3	Intensive cropping
II	3 - 7	Moderately intensive cropping with control measures – broad base terraces and grassed waterways
III	7 - 12	One cereal crop and two feed crops – graded banks and waterways
IV	12 - 15	One brassica crop only with 'surface working' in preference to ploughing – permanent grassed diversion banks dividing the slopes – pasture furrows between when sown down.
V	15 - 23	Permanent pasture topdressed – cocksfoot and timothy in mixture – pasture furrowed. If renewed, surface worked in spring and sown early in the New Year.
VI	> 23^0	Permanent pasture with controlled grazing – aerial or blower topdressing with seeding.
VII	-	Unstable land space or close planted to trees depending on erodibility and farm timber requirements.

Rowell (1952)

[3] SCRC Council Circulars represented one of the primary means through which the Council communicated it's policy and guidelines to catchment authorities.

Table 5.11: SCCB land capability farm planning classes for 'pastoral country'.

Class	***Cover***	***Treatment***
A	Lowland tussock country, poa to fescue tussock	Reduction of burning to nil using cattle to control roughage. Cattle proofing fencing, subdivision, aerial topdressing and seeding where necessary. Planting & encouragement of bush and tree growth in gullies. Control pests.
B	Fescue tussock country	Ditto Class A. Subdivision fencing along the approximate line of demarcation between Classes B & C. Controlled grazing.
C	Snow grass	Fencing off from Class B. Spelling for periods to allow regeneration. Light controlled grazing.
D	Bare (geological erosion	Exclusion of stock

Rowell (1952)

This system appears to have more in common with the early land utilisation surveys undertaken by the DSIR and Department of Agriculture, rather than capability classifications then being developed by the US Soil Conservation Service. This is particularly evident with the very prescriptive nature of the utilisation classes, as compared to LCC capability classes which are considerably more general (as distinct from capability subclasses and units).

5.3.2.3.2 The Pohangina Conservation Survey

The Pohangina Conservation Survey was a collaborative initiative between the Manawatu Catchment Board and the SCRC Council. The general purpose was to 'investigate the land use and erosion problems of the whole district', with sufficient detail being obtained to 'provide a firm basis for improved land use and erosion control plans of farm units or small catchments should such be found necessary' (Greenall, *et al.*, 1951, p.78). A total of 34,000 acres (13,800 ha) was surveyed.

The survey technique itself was an adaptation of both the unit area method, and the system then being used by the US Soil Conservation Service. Two types of information were recorded - inherent physical characteristics that are essentially unalterable (*e.g.* soils, geology, slopes, etc.), and the 'social and economic factors that determine the present pattern of land utilisation' (Greenall & Hamilton, 1954, p.507). Within the survey this information was recorded as (from Greenall *et al.*, 1951):

- Climate
- Soils
- Present vegetative cover
- History and development of farming
- Geology, lithology, and physiography
- Slopes and drainage pattern
- Erosion

Only five factors were depicted on the inventory map (Figure 5.17), with the remainder detailed in the report. Field mapping was undertaken at a scale of 1:15,840 using a combination of specially prepared topographical maps and aerial photo stereo pairs. This was referred to as 'Land Inventory Mapping', with delineated units being notated according to the 'Land Inventory Formula'.

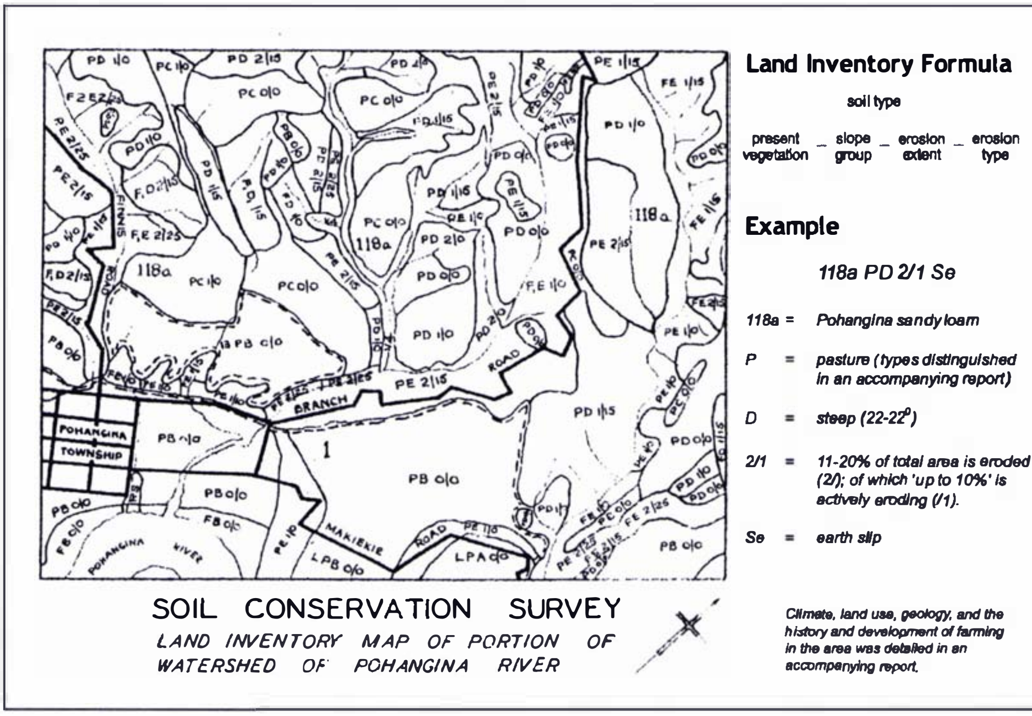


Figure 5.17: Example of the land inventory component of an early soil conservation survey undertaken in the Pohangina County, 1949-1950. Adapted from Greenall (1953).

Soil distribution was interpreted from DSIR Soil Bureau maps, while vegetation covers were grouped into classes (*e.g.* pasture, scrub and fern, pasture with stumps and logs, etc.). District-particular slope groups were erected to describe the combined relation of soils and slopes on erosion. The extent of erosion was estimated as a percent of the total area, and recorded as a compound symbol to differentiate historical and active erosion (see example Figure 5.17). Types of erosion were based on those described by Campbell (1950), and recorded as abbreviations (*e.g.* Ss = soil slip). If relevant, erosion type may have been further described according to depth (*e.g.* gullies) or profile form (*e.g.* tunnel, V shaped or U shaped).

While only five factors were recorded in the inventory, a broader understanding of related land sciences was strongly encouraged. The better the surveyor's knowledge of local climate, soil chemistry and physical processes, geology and its relation to slope, and the protective value of different plant associations, then the better will be the Land Inventory Map (paraphrased from Greenall & Hamilton, 1954, p.508). Likewise, considerable emphasis was given to farm visits and farmer input: 'each farmer was visited, his opinion sought, details of his production and management practices obtained, [and] an inspection made of the farm' (Greenall *et al.*, 1951, p.79). A total of seventy-seven farmers were interviewed between June 1949 and June 1950.

Relevant research, technical information, and local land-use information was considered together with the 'land facts' of the Land Inventory Map, to derive an overall land capability classification. Initially, five capability classes were used (*i.e.* Greenall *et al.*, 1951), but this was updated to six sometime between 1951 and 1954 (as presented in Greenall & Hamilton, 1954), and correlated to the eight class standard after it was officially adopted (Hooper, 1953). The original five classes are summarised in Figure 5.18.

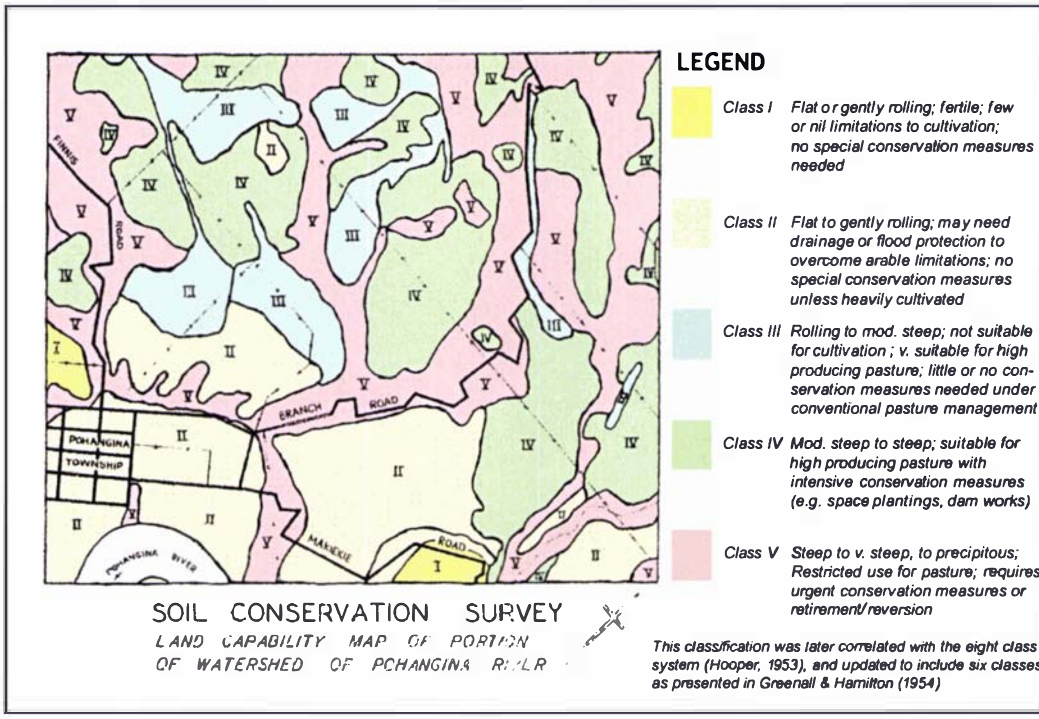


Figure 5.18: Example of the five class land capability system used in the Pohangina Conservation Survey. Adapted from Greenall (1953) to approximate the original colour scheme.

The Land Capability Map was described as 'a provisional district map of proposed general land use to ensure permanent and productive use of the land' (Greenall *et al.*, 1951, p.85). Unit classes presented on the map were described in detail in the accompanying report, including recommendations concerning both production management and soil conservation treatments.

The Pohangina survey went further than just a land inventory and classification, in that it proposed a 'general plan of improved land use, to reduce erosion and flooding, and to increase production' (*ibid.*, p.94). This essentially represented a catchment level scheme, based upon the ideas of conservation farming, individual but collective farm planning, and extension through cooperative demonstration farms.

The Pohangina Conservation Survey was one of the first successful adaptations of the American system and contributed greatly to the development of land classification in New Zealand. However, rapid evolution of the US system during the late 1940s quickly dated the Pohangina Survey, particularly in regard to the five and six class classification used. By the early 1950s, both the Council and the original survey team had recognised the value of adopting the eight class system then being used by the Americans.

5.3.2.4 Official adoption of the eight class land capability system

According to McCaskill (1973), the Pohangina survey team met with a group of South Island surveyors who had been undertaking capability mapping of the Pelorus and Queen Charlotte Sound localities. Upon comparing and discussing their respective survey methods, 'they agreed that certain areas did not fit easily into a six-class capability classification', and recommended to the SCRC Council that the eight class American system be adopted (*ibid.*, p.191).

This recommendation paralleled the Council's own line of thought. In 1950 the Council sent their Chief Soil Conservator (D.A. Campbell) on an international tour to observe soil conservation programs in Australia, the Netherlands, Belgium, Britain, Canada, and the United States. Campbell praised the American land classification system above all others, and subsequently recommended that the Council adopt it.

> *'the application of this classification was studied in U.S.A. during my visit and I found it was the practical answer to classifying land for soil conservation purposes at least, and for many others such as valuation, assessment for land sales purposes, etc. – in fact, it is probably the best overall classification for land yet conceived'*
>
> (Campbell, 1951, p.32)

McCaskill (1973) discusses how a 'member of the Council' who had seen the system at work in America (*i.e.* probably Campbell), strongly recommended that the Council adopt the eight class system. As justification, the Council member argued that any modifications to the system would be easy, the existing American handbooks were relevant and useable, and that the system could be applied to any region in New Zealand.

Visiting American scientists are also credited with encouraging the adoption of the eight class system (MoW, 1969). In 1952, E.A. Norton (who produced the first American handbook on land classification) visited New Zealand and gave a presentation at the 1st Soil Conservators' Association Meeting. He 'saw no reason why the American classification should not fit into New Zealand conditions' (NZSCA, 1952, p.7). At the end of this meeting, a motion 'that the basis of land classification should be on the American system' was passed, and the SCRC Council's Chief Soil Conservator offered to revise an earlier SCRC Council Circular to include detailed descriptions of 'each class specified' (*ibid*).

The Council officially adopted the eight class system in 1952 (Dunbar, 1962; MoW, 1969; LINZ, 1987). Policy regarding the application of this new system was initially aimed at reconnaissance type surveys, although this would eventually extend officially to farm planning when the Council began the second phase of it's soil conservation program in 1955 (Newnham, 1955). Farm planning was endorsed, but for the most part confined to cooperative demonstration farms and Catchment Board initiatives (discussed later).

> *'the Soil Conservation Council's policy is to undertake reconnaissance soil conservation surveys in problem catchments, to evaluate systematically the soil erosion problems, land capability and conservation requirements of the land resources of the country. This data and assistance is available to catchment boards in initiating conservation farm planning'*
>
> (Campbell, 1953, p.15).

The purpose of these new soil conservation surveys was 'to examine the nature of the land (Land Inventory Mapping), assess the capability of each area (Land Capability Mapping), and plan land-use on a farm scale (Conservation Farm Plans)' (Greenall & Hamilton, 1954, p.506). Ideally, soil conservation surveys were to be undertaken primarily by the Council through two teams of surveyors. One team would be based in Christchurch and the other in Palmerston North, with the total number of government survey officers to be employed originally estimated at twelve (Campbell, 1955).

However, "to a large extent the concept of survey 'teams' [was never] much more than mythical in both islands" (Greenall, 1969, p.1). Initially Palmerston North had two government survey officers between 1950-56, none from 1956-63, and eventually three between 1963-66. Christchurch started with two officers in 1955, added another in 1959, but were down to one by early 1966. Significant and consistent numbers were not employed until the transfer of all government soil conservation personnel to the newly established Water and Soil Conservation Division of the Ministry of Works in 1966 (Greenall, 1969).

Consequences of such a small survey workforce included a limited capacity to undertake the numerous detailed surveys required for designing conservation works and preparing farm plans; a reciprocal emphasis on reconnaissance type surveys with insufficient detail for catchment authority activities (particularly pre-1961 surveys based on capability classes without capability units); and a reactionary piecemeal pattern of mapping that 'conveyed no logical or progressive order in working towards some preconceived target' such as national coverage (*ibid.*, p.2).

In many cases this incapacity was masked by enlisting the aid of catchment authority soil conservators resident in the catchment district where a given survey was to be undertaken. These conservators usually 'assisted with field work and local knowledge, leaving the setting of standards and compilation of maps and reports to the government officers' (*ibid.*, p.2). One of the spin-offs from this interaction was that the Council's standards for surveys and classifications was maintained, along with being passed on to the district soil conservators for catchment authority mapping.

Maintenance of standards was a particularly topical issue, as the Council apparently did not make available an acceptably robust set of national standards until 1969. As discussed by McCaskill (1973), soil conservators were 'always conscious of, and frequently deplored, the lack of a suitable manual or handbook which would incorporate national standards and recognised procedures' (p.195). This is somewhat paradoxal, because while catchment authorities were free to undertake independent soil conservation surveys and classifications, they were still required to prepare them according to the standards laid down by the Council.

However, even without an official handbook or manual, application of the eight class system between the 1950s and 1969 appears to be increasingly consistent in the published examples, with the only minor difference being in the way in which land inventory data was recorded. This is perhaps attributable to not only the interaction between government and local catchment authority surveyors, but also the introduction of training programs and the increasing number of unofficial publications detailing the system (*e.g.* publications between 1952 and 1969). However, learning and applying the eight class system consistently would take time, with the earliest examples having a notable degree of variation in inventory recording and capability classification.

5.3.2.5 Early application of the eight class system in New Zealand

Many surveys were undertaken between 1952-56 but few were published, and thus difficult to source. A very small number of examples include surveys of the Porewa Stream Catchment (Sutherland, 1953), Upper Tukituki Catchment (1953), Awhea Catchment (Kelman & Kelly, 1954), Kopuawhara Catchment (Kelman, 1955), and the Upper Shotover River Catchment (Miller *et al.*, 1956). The Awhea and Upper Shotover surveys are discussed briefly to highlight the variation in recording and/or classification methods.

5.3.2.5.1 The Awhea River Catchment

In 1954, the Council's Palmerston North survey team undertook a reconnaissance soil conservation survey of the Awhea River Catchment (S.E. of Martinborough, Wairarapa) in response to concerns regarding severe erosion and river aggregation threatening road communications (Kelman & Kelly, 1954). A pragmatic survey approach was adopted – a rock type map of the area was prepared and used to identify problem areas for more detailed investigation. Specifically, the crushed argillite rock type was known to associate with the area's worst erosion, so the distribution of this rock type was identified and then targeted with soil conservation survey.

Five physical factors were recorded in the Land Inventory Map (Figure 5.19), with locality-particular criteria classes defined for each factor. This criteria was very basic relative to that used in other soil conservation surveys, with the number of classes for each factor ranging from four or five with vegetation, topography, and erosion activity, up to eight for erosion type. Soil type was omitted as a factor because the only soil map of the area at the time was the 1:250,000 General Soil Survey for the North Island (NZSB,1954). This depicted only one soil associating with crushed argillite (Ruatoria silt loam).

Land Inventory Map Code

Inventory Code

1. Vegetation
2. Topography
3. Total accellerated erosion
4. Active erosion
5. Erosion type

Example

T-C-2/4-Sr/H.G./A

T = Pasture with scattered scrub or trees

C = Strongly rolling

2/4 = Up to 20% of unit area with historical erosion (2) and up to 60% of unit area actively eroding (4)

Sr/H.G./A = Slump erosion (Sr)
= Healing Gully (H.G.)
= Underlying rock exposed (A)

Figure 5.19: Land Inventory Map code used in the Awhea Soil Conservation Survey. From Kelman & Kelly (1954).

Six capability classes ranging from Class IV to VIII were used. Classes VI to VII were further divided using geology based subclasses, which exhibited very little similarity to the subclass's then being used with the American system. Rather than limitations, subclassed classifications were divided into rock types including mudstone (VI. M.), argillite with or without gully erosion (VII. A. & VI. C. respectively), sandstone (VI. S.S. & VI. S.), limestone (VI. L.), and bentonitic mudstone (VII. F.). Capability Classes IV and V were not ascribed subclasses, and capability Class VIII was used solely to describe gullies in the crushed argillite country.

A final feature of the classification was that little or no emphasis was given to deriving capability classes in cooperation with farmers and other interests. Similarly, treatment methods and recommendations were orientated more toward a catchment works scheme rather than individual farm planning.

5.3.2.5.2 Land Capability Classification of the Upper Shotover River Catchment

To fulfil it's obligations under the 1941 SCRC Act, the Otago Catchment Board (OCB) began undertaking comprehensive eight-class soil conservation surveys in 1953. The specific purpose was to obtain 'a factual recording of conditions (both natural and induced) in the tussock grasslands' for soil conservation planning (Miller *et al.*, 1956, p.5). Four surveys had been completed by the end of 1956, including the Upper and Lower Shotover, Nevis, and Arrow Catchments.

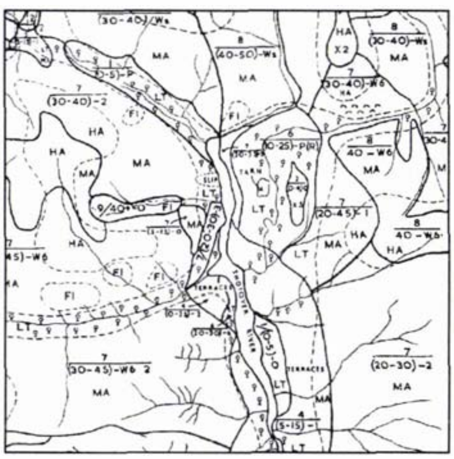
The first of these surveys – the Upper Shotover River Catchment in 1953 – involved a somewhat multidisciplinary soil conservation survey and classification procedure. Rather than just one or two surveyors, a diverse party (made up of a botanist, geologist, pedologist, hydrology engineer, Council soil conservator, and several catchment board conservators), undertook separate investigations particular to their own disciplines. These were carried out independently but simultaneously, such that each was used to contribute to a Land Inventory Map and subsequent Land Capability Map.

Four factors were described in the physical inventory, including soil type, range of slope, erosion, and vegetation type (Figure 5.20). Classes for erosion broadly included geological and accelerated erosion, sheet and wind erosion, and 'healed' erosion. Degree of erosion was indicated according to percent of topsoil removed. For the Land Capability Map (Figure 5.21), five capability classes were recognised without any subclasses. These were explicitly based on the American system, but it is unclear to what degree (if any) land users and other interests were involved in deriving the classes and final recommendations.

Land Inventory Map for part Upper Shotover Catchment

Inventory Code

$$\frac{\text{Soil}}{\text{Slope - Eroison}} \quad \text{Vege-tation}$$



Example

$$\frac{7}{(30\text{-}45)\ \text{-}\ W6} \quad MA$$

7 = Kaikoura soils

30-45 = Slope ranges from 30^0 to 45^0

W6 = Natural Erosion; slips and catslips

MA = Mid altitude snowgrass

Figure 5.20: Land Inventory Map example from the Upper Shotover River Soil Conservation Survey. Adapted from Miller et al., 1956.

Land Capability Map for part Upper Shotover Catchment

Symbol	Class	Potential use
	Class II	Instensive cultivation
	Class V	Intensive grazing
	Class VI	Moderate grazing
	Class VII	Limited grazing (or forestry)
	Class VIII	Waste land or conservation areas (or protection forests)

Figure 5.21: Land Capability Map from the Upper Shotover River Soil Conservation Survey. Note that capability subclasses were not used. Adapted from Miller et al., 1956.

5.3.3 Demonstration farms and farm planning - 1941 to 1956

While early land classification efforts focused primarily on reconnaissance type surveys, progress was also being madc on adapting the farm plan concept to New Zealand conditions. This began with the development of conservation farming systems on government owned Soil Conservation Reserves through the 1940s, and subsequently extended to pilot farm plans for cooperative demonstration farms around the early 1950s. The Council officially adopted farm planning as part of its national soil conservation program in 1955-56.

5.3.3.1 The development and extension of conservation farming

Under the 1941 SCRC Act, the Council was specifically required to carry out experiments and demonstrations relating to soil conservation. Guided by a 'local research for local conditions' philosophy, they sought to fulfil this responsibility by acquiring rundown and eroded farms as Soil Conscrvation Reserves. Most of these reserves were managed as both research stations and demonstration farms. Soil conservation measures and related farming practices developed on these Reserves were packaged as generic conservation farming guidelines. These were first applied outside a research setting as *farm conservation schemes or programmes* for cooperative demonstration farms, and eventually developed into *pilot 'farm conservation plans'*.

5.3.3.1.1 Soil Conservation Reserves

The Council's approach to fulfilling it's research obligations was to firstly collate existing information, and then to 'initiate ongoing trials and research which would result in techniques and practices suited to local conditions' (Roche, 1994, p.75). Toward this end, the Council acquired a total of twenty-four erosion prone farms between 1944 and 1969. These Soil Conservation Reserves (Figure 5.22) were characterised as being 'typical eroded units of land' (Campbell, 1966b, p.17) that were of 'normal size' and could bc 'developed within the resources of the average farmer' (Campbell, 1946, p.31).

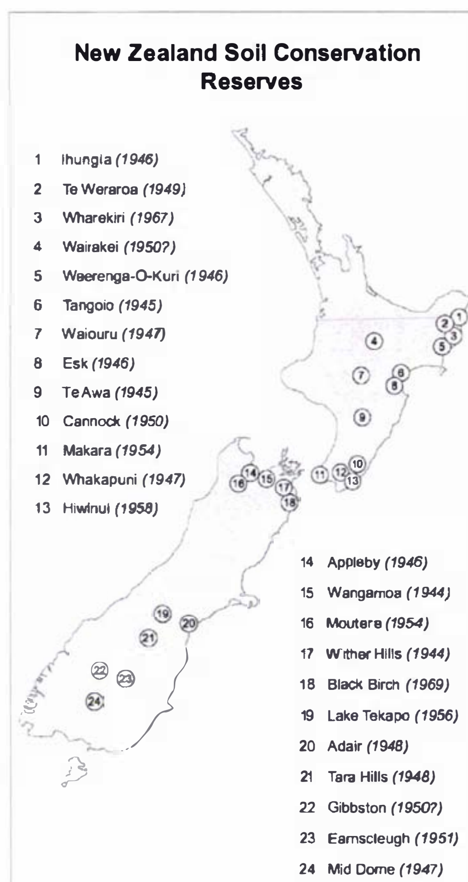


Figure 5.22: Location of Soil Conservation Reserves established between 1944 and 1969. Adapted from McCaskill, 1973. Dates refer to when land was first purchased or acquired.

The first eight properties acquired were hill country farms. As such, they 'provided little scope for applying the array of wcll-known soil conservation practices developed in the United States for ploughable land' (Campbell, 1957, p.3). Accordingly, investigations were directed at identifying what combinations of farm management and conservation treatments were necessary for controlling local erosion, and to devise 'practical methods of conservation farming' (*ibid*).

Early results were combined with those obtained independently by catchment boards into broad conservation farming guidelines (*e.g.* Campbell, 1946; Wilkie, 1950; Campbell, 1955). By 1957, these had been refined into a generic 'conservation farming system' that was considered suitable for adaptation to the needs of various catchment boards (Campbcll, 1957, p.11). Essentially, this recommended system of farming represented a list of guidelines (Table 5.12) that a soil conservator could selectively combine into a 'conservation farming programme' particular to a given farm or catchment.

Table 5.12: Conservation farming guidelines.

	Guideline
1	Restoring fertility and improving hill country pastures by aerial top-dressing, seeding, weed spraying, and rabbit poisoning
2	Appropriate grazing management, including periodic exclusion from grazing; cattle grazing for pasture improvement; various seasonal combinations of sheep and cattle grazing
3	Using trees to protect and stabilise land, including space planting, woodlots, and reversion to native shrubs
4	Contouring as the construction of furrows, banks or terraces. Also includes cultivating soil according to contour
5	Construction of debris dams to control gully erosion, or storage dams to buffer runoff intensities and capture sediment
6	Reduced use of burning as a management tool, and increased effort directed at the control of pests such as rabbits, deer, goats, opossums, and wild pigs

Campbell, 1957

Alongside the development of guidelines, the Reserves also had an extension function as demonstration farms. However, as government owned and funded research entities, they had a limited capacity to demonstrate the 'real-world' practicality of conservation farming. As noted by Campbell (1966b), 'although the demonstration value of work done on the Council's Reserves was effective, doubts existed about its application on farms' (p.18). To overcome this, the Council adopted a policy that encouraged the development of cooperative demonstration farms.

5.3.3.1.2 Cooperative demonstration farms

Cooperative demonstration farms have been described as properties managed according to SCRCC guidelines, but unlike Conservation Reserves, these properties were not owned by the Council (Roche, 1994). They were regarded as an essential linking component in the national soil conservation program. As discussed by Campbell (1946), 'a vital link between [government demonstration farms] and the farmer will be the establishment of small cooperative demonstration areas on individual farms financed partly by the farmer and partly by the Council or catchment board' (p.31). This policy was later expanded to focus on whole farms, and initially applied to a limited number of North and South island properties. Campbell (1966b) claimed these early cooperative demonstration farms had 'proved to be highly successful'. Further, as they were "geared to the farmers' resources and implemented over a five year period, and involved improvement in farm management, they became the fore-runners to conservation farm plans" (Campbell, 1966b, p.18).

The point at which cooperative demonstration farm programs or schemes evolved into *conservation farm plans* is unclear. Some catchment authorities had been piloting their own independent farm plans, particularly the Wairarapa and Manawatu Catchment Boards around the early 1950s. In the Council's 1958 Annual Review (SCRCC, 1958), reference is made to a Wairarapa farm-conservation plan prepared in 1952 and implemented in 1953. Likewise, a soil conservation plan was prepared and implemented in 1951 as part of the Pohangina Conservation Survey (Greenall *et al.*, 1951).

5.3.3.2 *Pilot farm plans*

Pilot farm plans began to emerge in the late 1940s and early 1950s, and continued up until their official adoption as a policy instrument by the Council in 1955-56. Initial attempts loosely followed the American example, in that farm plans represented the follow-on step after district or catchment conservation survey. This was in recognition that soil conservation within a large area can only be fully effective through the active support of local farmers.

A recommended procedure for involving farmers was described by Greenall *et al.* (1951), as part of their Pohangina Conservation Survey. Certain steps in the procedure are still as relevant today as they were 50 years ago. Responsibility for facilitating farmer involvement was given to the local catchment board, by firstly nominating an elite group of farmers:

> *'The chosen men should be good progressive farmers who are recognised as such by their neighbours. These farmers should be visited... [and the district level] plan informally discussed in detail and their support solicited. When support is forthcoming, each farmer... should be asked to invite four or five of his neighbours to... again discuss the plan. As the majority would be members of Federated Farmers it is suggested that a soil conservation section of the local branch be formed... The objective of this local committee would be to foster the adoption of soil conservation farm plans, and to act as liaison between farmers and their catchment board member'*
>
> (Greenall *et al.*, 1951, p.95)

However, this differed slightly from the actual way in which the first group of Pohangina farmers were approached. In June 1951, representatives from the Manawatu Catchment Board (MCB) met with three farmers with properties close to the Pohangina township (Messrs L. Tews, D. Kennedy, & N. Moar), as reported in the Moar Brother's Farm Plan (MCB Soil Conservation Project No. 3/5/3). The purpose of this meeting was 'to discuss... with the three farmers... in one particular catchment... the erosion problem... and to enlist their cooperation in an effort to control such erosion by operations over a number of years'. Each of the three farmers 'expressed their willingness to cooperate, and to have a farm plan prepared by the soil conservators'.

5.3.3.2.1 The Tew's Farm Conservation Plan, 1951

The Tew's Farm Plan was the first, and as such, has been the most widely reported (*e.g.* Greenall *et al.*, 1951; Glass, 1957; McCaskill, 1973). Unfortunately the original working version of the Plan could not be sourced, so the following brief description relies upon second-hand accounts.

The Tew's property (Figure 5.23) was made up of 98 acres (40ha) of flat land given to dairy farming, and 330 acres (133ha) of steep to very steep hill-country given to sheep farming. Only the hill country was considered within the Plan, divided according to the Pohangina Conservation Survey into 300 acres (121ha) of Class IV and 30 acres (12ha) of Class V (LUC 7e16 & 8e2 respectively).

Figure 5.23: Approximate location of Tew's hill country block and inferred capability classes.

The lack of classification diversity at the 1:15,840 scale is offset by the susceptibility of the farm to severe gully erosion. This is particularly dramatic in the Pohangina Valley, attributable to the geological occurrence of deep unconsolidated marine sands. These can erode rapidly and deeply, and if left unchecked, they can form the veritable 'canyons', such as those that had been noted on the Tew's property (Glass, 1957).

The Plan itself included a 'future land use map' and an accompanying report. Recommended map scale was '5 chains to the inch' (1:3960). The map depicted both the original capability classifications, and a number of proposed land use changes (Figure 5.24). Capability classes were likely to have been coloured using pencils and referenced against a legend, similar to the Moar Brother's 1952 farm plan[4]. Likewise, colour codes were probably used to indicate year-by-year changes to fence lines, recommended plantings, conservation works, and other proposed land use changes. The original duration for the plan was ten years (Greenall *et al.*, 1951), although this would have been reduced later to 3-5 years to enable eligibility for conservation subsidies.

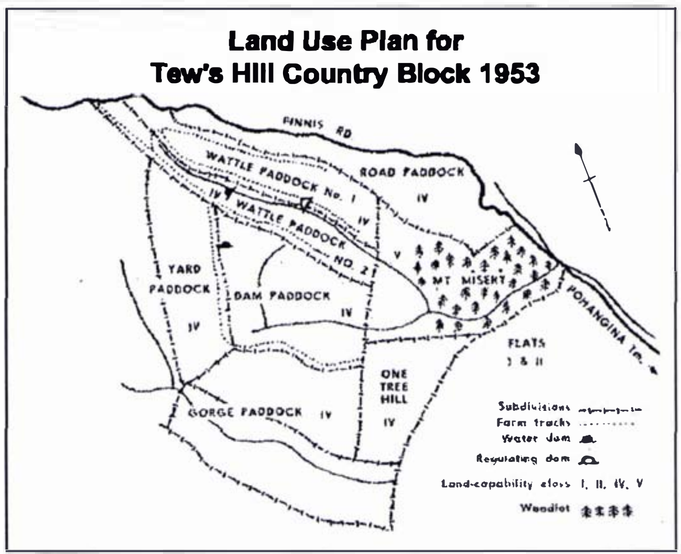


Figure 5.24: 'Future land use map' included with the Tew's Farm Plan. Redrawn from Glass (1957).

The full technical report is presented in Greenall *et al.* (1951). Comprehensive descriptions are also provided by Glass (1957) and McCaskill (1973), so specific details are not repeated here. The report was structured into four sections:

- A general description of farming details (tenure; topography & soils; climate; vegetation; land utilisation; subdivision; and labour).
- An estimation of assistance required through government subsidies.
- A detailed description of treatment for each paddock including stock management (*i.e.* conservation farming recommendations).
- Financial budgets.

From the outset, the purpose of the Plan was strongly orientated towards reconciling socio-economic considerations with soil conservation necessities. As noted by Glass (1957), the intent was to solve erosion problems 'by changes in land use [that] did not involve the farmer in any monetary loss and ensured permanence and maximum productivity' (p.4). Erosion measures included retiring the 30 acres (12ha) of Class V land as production woodlot, extensive pole planting, and gully stabilisation through the construction of flood-regulation dams and flumes.

[4] The Moar Brother's Farm Plan (MCB Soil Conservation Project 3/5/3) is the MCB's third plan prepared after conservation farm planning was officially adopted as SCRCC policy in 1955. However, rather than a discrete self-contained plan, the Moar example represents a collection of subsidy applications, notes, and recommended *ad hoc* works extending back to 1947, along with successive farm plan revisions post 1956. Apparently a pilot farm plan was prepared for the Moars in 1952 (as indicated by MCB correspondence), although the report component has been misplaced. The map component remained because it was used as a basis for later farm plans and revisions.

Erosion control costs were offset by subsidies and land development. Authors of the Plan were coy about subsidy payments, suggesting they may have been even higher than the standard rate (gully control for the Moar Brothers was subsidised at a '3 for 1' rate: for each pound spent by the farmer the government would invest three pounds). Land development involved subdivision redesign; over-sowing and topdressing; improved access tracks and stock water; and the grazing system shifted from set stocking to mob stocking to improve pasture species quality. Much of the land development was also subsidised.

Somewhat unsurprisingly, results from implementing the Plan over three years were touted as 'spectacular' and an 'outstanding success' (Glass, 1957). Costs smoothed out at around six pounds per acre, which was considered low against a resulting 46% increase in sheep numbers wintered, and a 40% increase in wool production. Erosion control was similarly successful. However, high levels of subsidy and specialist input negate this success somewhat. Further, it is debatable if the Plan was indeed a soil conservation plan, as compared to a production development plan with a soil conservation focus.

While the Tew's Conservation Farm Plan was certainly the first pilot undertaken in the Manawatu Catchment, it is not necessarily the first developed in New Zealand as reported by Greenall (1968) and McCaskill (1973). There is a blurred distinction between pilot farm plans, cooperative demonstration farm projects, and even 'inspections for approval of works[5]', meaning it can be quite difficult to identify what does, or does not, constitute a 'farm plan'. Further, it is quite probable that other catchment authorities were developing their own pilots simultaneously, particularly in the case of the Wairarapa Catchment Board. As noted by McCaskill (1973), the SCRC Council had studied 'copious examples' before they officially adopted the farm plan system as policy. Hence, earlier examples may exist, but perhaps have not been as widely reported as the Tew's example.

[5] The Moar Brother's Farm Plan (MCB Soil Conservation Project 3/5/3) provides a number of examples of 'inspection for approval of works' dating back to 1947. In a sense, these represent very crude farm plans similar to single-works examples that emerged in the 1960s. Inspections involved an on-farm assessment by a conservation officer and a brief one or two page report. The report described 'topography, soils, vegetation, slope angle, and erosion type' as one section, followed by a 'plan of control' that outlined the conservation works required and agreed upon, and the amount of subsidy. In two cases, crude maps were drafted on the back of the forms, depicting the location of works, the design of works, and amendments to subdivision.

5.3.3.3 Official adoption of conservation farm planning

Dick (1969) states that conservation farm planning in New Zealand began around 1955, while McCaskill (1973) places it one year later when 'the system of farm plans for soil conservation was instituted' (p.192). In a 'forward' to the 1955 SCRCC Bulletin, the chairman of the SCRC Council suggests the adoption of farm planning was the 'next phase' in the Council's national soil conservation program (Newnham, 1955).

The Council's new policy regarding conservation farm plans was presumably communicated to catchment authorities through a SCRCC Circular. McCaskill (1973) quotes 'the original basic instructions' concerning farm plans as follows:

> *'Farm Conservation Plans will be required in future where more than single self-contained conservation practices are required to combat soil erosion, or where successive follow-up practices are required, or where comprehensive conservation practices are needed on a substantial portion of a holding. To get the best results for the subsidy money expended, subsidies will be conditional on the farmer adopting a mutually-agreed-upon farm conservation plan. This plan will be based on a conservation survey and land capability evaluation of the property, shown on an accompanying plan with legend. This will be used to establish the conservation needs of the property'*
>
> (As cited in McCaskill, 1973, p.199-200)

This directive was rapidly taken-up by catchment authorities around New Zealand. Previous pilot farm plans were used as instruction guidelines by soil conservators, while the associated production results were used to sell the idea to farmers. As Council policy, new farm plans were to include a land capability assessment based on the eight class system. With it's experience gained during the Pohangina study, the MCB was well-placed to produce one of the first official versions of the new farm-conservation plans.

5.3.3.3.1 The Tennet Conservation Farm Plan

According to the Manawatu-Wanganui Regional Council's (MWRC) archives, the first non-pilot conservation plan prepared by the MCB was for B.A.C. Tennet in 1956 (MCB Soil Conservation Project 3 3/13). The location of the Tennet farm was approximately 27km southeast of the Dannevirke township, which placed it just inside the eastern-most boundary of the Manawatu Catchment (Figure 5.25). As inferred from the NZLRI, the property is geologically made up of banded and jointed mudstones, along with 'white argillite' (also known as 'Whangai shale'). Topography ranges from undulating to very-steep hill country, subject to varying degrees of wind, slip, earthflow and gully erosion. At the time the Tennet Plan was prepared, the farm size was 536 acres (217ha), and the dominant enterprises included 100 breeding cattle and 750 breeding ewes.

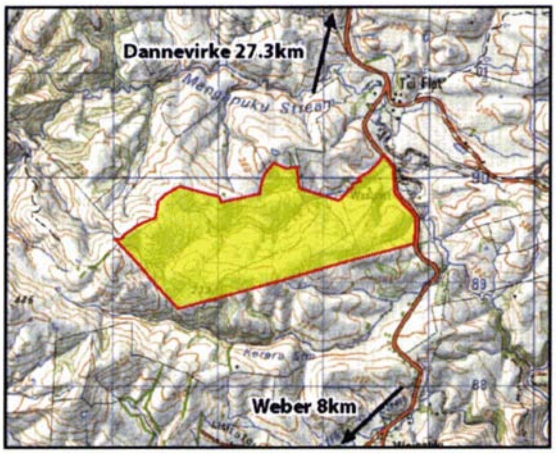


Figure 5.25: Location of the Tennet farm.

The farm plan report gives an indication of the format required by the SCRC Council. The report is succinctly condensed into only seven pages, in-which specific characteristics are described under three distinct sections (Figure 5.26). Generally, only one or two sentences were used to qualify each of the thirteen fields in the farm description section. The absence of a description for geology or rock type is notable. The classification section listed and described the six main capability classes identified on the farm according the eight class system. However, no unit inventory of physical land resources was provided, and it is interesting to note that while a wetness limitation subclass was included for classes IV, VI & VII, no erosion limitation was used for the 'severely' eroding classes.

1. FARM DESCRIPTION	2. CLASSIFICATION	3. PROGRAMME OF WORK
Legal description Climate Aspect Topography Hydrology Soils Vegetation Stock Stock water Shelter General management Pests Erosion	Description of each class presented on the land use & capability map: Class III Class IV Class V Class VI Class VII Class VIII	A. Description of works by paddock B. Technical specific-ations for works C. Tabulated works program by year, including costs & subsidies required D. Works summary

Figure 5.26: The Tennet Farm Conservation Plan format. Each box represents a distinguishable section.

The works programme included recommended conservation treatments broken-down by paddock. These ranged from subdivision refinements (including new fencing), windbreaks, space planting on hillsides, and pair planting along water courses. Unlike the Tew's Farm Plan, the emphasis was strongly on soil conservation rather than production development: apart from minor subdivision changes and oversowing some of the hill country in clover, recommendations for improving production were rather sparse.

Technical specifications were given for the type of fencing required, and the quality of poles and seedlings required for various planting works. In turn, the whole five year programme was tabulated by year, listing recommended works for each paddock, estimated cost of works, and eligibility of works for subsidy grants. Total cost over five years was £1,953, half of which was financed through subsidies.

The map component of the Plan was similar to the Tew's version, in that present land use, recommended land use changes, and the capability classes, were all included together as a single map (Figure 5.27). This has been reproduced as closely as possible to the original version, which was presented at a scale of 10 chains to the inch (1:7,920). Colour pencils were again used to code land capability classes, and to depict recommended works by year.

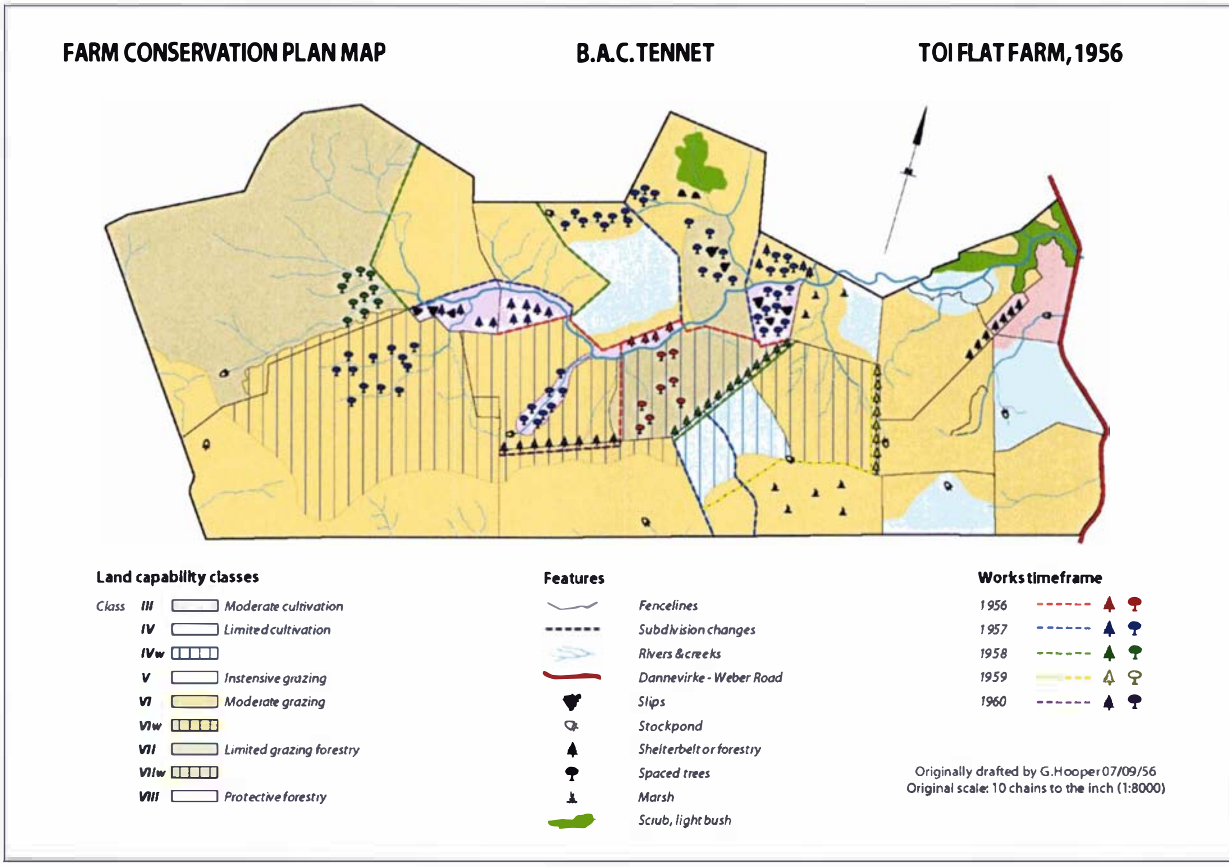


Figure 5.27: Combined LUC & works map redrawn from the Tennet Farm Conservation Plan.

The Plan was submitted to the chairman of the SCRC Council in October 1956. It was 'approved in principle' two months later, provided minor amendments were made to the first year program. This demonstrates part of the communication value of farm plans: the Council was able to interpret works that carried the greatest erosion control benefit, leading them to disapprove many of the shelterbelts and a small woodlot. The Plan was duly revised in December, and in accommodating the Council's recommendations, the five year implementation period was reduced to four.

Although the revised Plan was soon approved, one further requirement needed to be fulfilled before implementation. In the presence of witnesses, the farmer entered into a legally binding agreement with the SCRC Council. In signing this agreement, the farmer was guaranteed payment after works were implemented, while the Council gained a degree of assurance that works would actually be carried out (or if not, the Council was not required to pay the subsidy). Officially, the Plan commenced in April 1957, and was finally completed in 1960.

Successive MCB plans through the late 1950s and early 1960s do not appear to have evolved significantly from the Tennet example. However, the number of plans increased rapidly, which was a feature shared with most of the other catchment authorities throughout New Zealand. Underlying this surge in acceptance and popularity was the ongoing application and development of land capability surveys, which were to eventually consolidate as New Zealand's very own Land Use Capability (LUC) system of land resource inventory and capability classification.

5.3.4 1960s Survey and Capability Classification

Surveying and capability classifications accelerated rapidly in the 1960s. Between 1951 and 1964, over 439,500ha and 1,504,000ha of land had been surveyed in the North and South Islands respectively, totalling around 1.95 million hectares for the whole country (Roche, 1994). In 1966 the SCRC Council reported that the total had risen rapidly to 9.3 million hectares, 7.7 million of which was reconnaissance type survey, and 1.6 million as detailed survey 'in a form suitable for the preparation of soil conservation plans' (McCaskill, 1973, p.195). Progress beyond 1966 is less clear, as different commentators used their own interpretations of survey type and scale in their tallies. In 1968, Greenall (1968) reports 5.7 million hectares of reconnaissance surveys had been completed under the 'Land Use Capability System', and over 2 million hectares at detailed scales of 5-40 chains to the inch (1:3960 to 1:31,680). The total of 7.7 million contrasts with the earlier 9.3 million, suggesting the Council had begun to omit surveys undertaken before the introduction of the 8 class capability system. This total also contrasts against the 8.1 million hectares of survey reported a year later (Dick, 1969), again suggesting increasingly tight criteria were being applied to that which constituted a survey and capability classification.

5.3.4.1 Provisional national land use capability maps and SCRCC Bulletins

Two official initiatives to emerge from the 1960s included the 'provisional national land use capability maps', and the publishing of a series of land use capability surveys. The provisional national maps were completed in 1962 at a 1:1,000,000 scale, and presented at the International Soil Science Conference held at Massey College in that year (Eyles, 1974; Roche, 1994). Although being at a broad scale, the maps 'provided essential basic information on the regional character of land capability' (Roche, 1994, p.83). They have never been officially published despite calls to do so (*e.g.* Greenall, 1969), but a generalised 1:7,600,000 scale example is presented in Roche (1994, p.81). This has been reproduced as accurately as possible using an improvised colouring scheme (Figure 5.28).

Officially published surveys were largely limited to Land Use Capability Bulletins. A total of five Bulletins were published between 1966 and 1973, reporting on surveys that had been undertaken between 1959 and 1971. The first was for the Mararoa River Catchment in Southland (Dunbar *et al.*, 1966), covering an area of 118,577ha at a 1:126,720 scale. The survey and classification approach 'was basically the same as a system used by the Soil Conservation Service in the USA' (p.43). Land units were delineated according to any significant change in the four factors of vegetation, topography (slope), extent and type of erosion. The eight class land capability system was used, although not according to that recommended by the USDA (1954). Rather than using limitation subclasses outright, an alternative classification was erected against the capability classification: this Recommended Land Use classification grouped LUC classes according to 'social and economic influences' to produce four major 'recommended use classes'. These in-turn were reduced to 'use subclasses' to describe the degree and nature of limitations to various potential land uses. This secondary standalone classification was to appear in subsequent Bulletins, and eventually formed the basis for a national 'recommended soil conservation and water management map of NZ'.

The other four Bulletins were published after the official adoption of standards for Land Use Capability Classification in 1969. The second Bulletin described 128,400ha of land surveyed in the Kaituna River Catchment (Bay of Plenty), initially carried out at a scale of 1:15,840 in 1971, but presented at 1:63,360 in 1975 (Nairn, 1975). Such a detailed scale (*i.e.* 1:15,840) was used in soil conservation for land-development blocks.

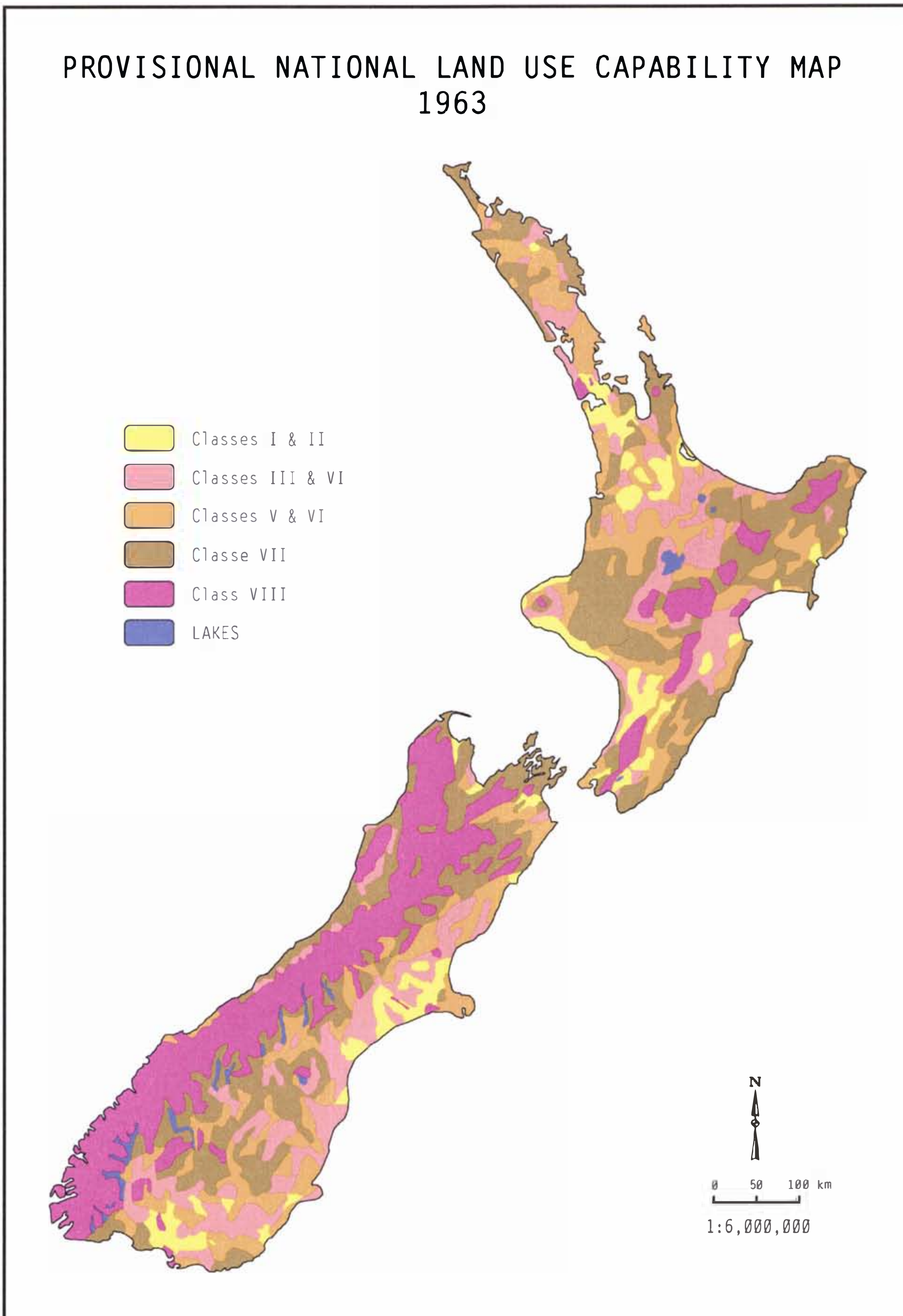


Figure 5.28: Provisional national land use capability map, 1963. Redrawn from Roche (1994).

The third Bulletin described a survey undertaken in 1963, which was subsequently updated to the 1969 standards and published in 1971 (Prickett & Williams, 1971). The land inventory, land use capability, and 'conservation land use maps' were prepared at a scale of 1:15,840, for the Upper Waihopai area in Marlborough. The fourth Bulletin presented a survey for 2.67 million hectares of the West Coast, which while initially starting at a 1:63,360 scale, was completed at a 1:253,440 scale (Prickett & O'Byrne, 1972). The final Bulletin described a 1971 survey of 172,320 hectares in the Awatere River Catchment (Marlborough), at a 1:63.360 scale (Williams & Harvey, 1973). Together, all five Bulletins are characterised as being prepared by national Soil Conservators under the direct control of the SCRC Council, Dept. of Ag., and/or MoW.

5.3.4.2 Survey and classification standards

The number of nationally deployable Soil Conservators was inadequate for the breadth of investigation needed across New Zealand in the early 1960s (Greenall, 1969). This was recognised by the SCRC Council in 1961, who responded by making available $4000/yr grants to catchment authorities, to encourage them to employ their own surveyors (McCaskill, 1973). Although this policy was gradually phased out towards the end of the 1960s (and abolished in 1970), it reduced the interaction during surveys between national-level surveyors and those employed by catchment authorities. In the absence of an official handbook, reduced interaction had implications toward maintaining survey and classification standards, particularly with local soil conservators responsible for undertaking surveys for farm planning.

In part, this was overcome through the widespread use of journal articles and similar publications. McCaskill (1973) notes two that 'were widely used pending the appearance of an official handbook' (p.195), originally published in 1964 and 1966. However, comprehensive descriptions of the eight class survey and capability classification system began to appear in New Zealand literature before this.

Wallace-Ramsay (1961) provides one of the first comprehensive accounts. This was an almost verbatim description the US system presented in USDA (1954), including the capability classification at all three levels – class, subclass, and unit. The only significant divergence was a recommendation for a ninth capability class (inserted between VII and VIII), to describe South Island tussock country that had been modified by topdressing and oversowing. This is reiterated in a more concise account provided in the following year (Wallace-Ramsay, 1962), in which the author makes a portentous statement regarding the redundancy of class V land for describing New Zealand hill country.

Dunbar (1962) also gives a comprehensive description of the full eight class system, and applies it broadly at the class level to describe the Canterbury landscape. Evolution of the LCC in America is acknowledged by referencing Klingebiel & Montgomery (1961), although like many other New Zealand practitioners, Dunbar did not support or advocate the adoption of the four tier system based on soil survey (*i.e.* the inclusion of the base 'soil unit'). This marks a point where New Zealand's own development of a land capability survey and classification system diverges markedly from the United States.

The eight class system is also described in 1962 by the Tussock Grasslands and Mountain Land Institute (TGMLI, 1962) and Knowles (1962), but only to the broad class level. The latter publication uses photographs to demonstrate how each class can apply in practice. The first of the two publications referred to by McCaskill (1973) was also prepared by the TGMLI (*i.e.* Hughs, 1964), with the express purpose of trying to 'interest farmers in the principles of land use capability' (McCaskill, 1973, p.195). Again this acknowledges the use of a modified version of the US system, but not according to the 1961 revision and introduction of explicit soil units.

Modifications to the pre-1961 US capability classification were minor, with each of the eight classes being presented as photographs particular to the South Island situation. However, in recognition that 'land inventory symbols and mapping procedure [were] not as yet standardised throughout the country' (Hughs, 1964, p.14), the recommended method for undertaking inventory surveys was particularly distinctive (Figure 5.29).

Recording of six physical inventory factors was recommended. Soils were to be inferred from existing Soil Bureau publications, and notated according to the soil type. In turn, the soils and their unit boundaries were to be validated with an on-farm visit. Land use was simply ascribed a symbol qualifier (P = grassland; G1 = native grassland; etc.), while aspect was recorded according to compass direction. Two approaches were recommended for notating vegetation. Either the first one or two letters from a given plant's botanical classification were used (*e.g.* Fno = **F**estuca **no**vae-zelandiae = fescue tussock), with each plant listed according to it's dominance. Alternatively, a symbol was used to describe 'plant associations' (groupings of similar plants named after the dominant species). Upper-case **M** and **N** scripts indicated greater than 40% scrub or bush respectively, while lower-case indicated less than 40%.

Slope angle was considerably more simple than that used in the US system. Seven groups were used, ranging from A (0-3^0) through to G (>35^0), which are still used today in the modern LRI mapping system. Similarly, erosion was divided into *erosion type* and the *degree or seriousness of erosion*. Symbols were used to indicate erosion type, while degree was represented by a numerical figure (0-5) 'which usually had some relation to the average proportion of bare ground present in an area' (Hughs, 1964, p.19). Tentative recommendations were also given to record geology and altitude.

PROCEDURE FOR UNDERTAKING LAND INVENTORY SURVEY, 1964

Inventory Code

Soil - Land use - Vegetation - Aspect
―――――――――――――――
Slope - Erosion degree & type

Example

TkS - G1 - Fno Cri Dto m(Lsc) - NW
―――――――――――――――
E - 2 Sh Slp

TkS = *Tekoa Steepland soil*

G1 = *Native grassland*

Fno = *Fescue tussock*
Cri = *Narrow-leaved snow tussock*
Dto = *Matagouri*
m(Lsc) = *Manuka <40%*

NW = *North West aspect*

E = *26^0 - 35^0*

2 = *Slight; 10-20% bare ground*
Sh = *Sheet erosion*
Slp = *Slip erosion*

Figure 5.29: Recommended procedure for undertaking land inventory (Hughs, 1964).

The second publication referred to by McCaskill (1973) focused on the land capability classification rather than the inventory method (Prickett, 1966). This gives a rather technical account of four stages deemed necessary 'to facilitate the translation from capability into an action programme' (p.17). The first stage is inventory mapping; the second is Land Use Capability classification; the third is the derivation of a Potential Land Use map, in which capability is graded according to its suitability for different types of production (only for catchment and district studies); and the fourth is the preparation of a Development or Work Plan at a required scale. A Work Plan may be developed directly from the LUC classification as a 'Farm Plan, Run Plan, Catchment Control Scheme, or other individual plan or community scheme' (p.18), while a Development Plan involves all four stages to produce a plan designed for large catchments or regions.

The transition from Land Inventory Map to LUC Map required the drafting of 'standards' for each capability class. Soil type was used to derive the 'basic capability class', which could then be refined by considering other inventory factors. Standards were considered important 'because they represent an objective approach to the classification' (p.18). Detailed actual examples of standards, capability units, and potential land use derivations were provided as appendices.

Other briefer accounts of the developing inventory and classification system were given in the 1960s, but Hughs (1964) and Prickett (1966) appear to give the most descriptive. However, both hint that the SRCC Council was working towards an official standard, with Hughs (1964) actually referencing an unpublished 'Official Handbook to Land Capability Classification' (p.34). McCaskill (1973) also refers to this, stating that in 1966 the Council had announced 'the long-looked-for handbook was in the final editing stages' (p.196). However, it would be another several years before the standards were finalised and officially published.

5.3.5 1960s Farm Planning

Farm plans became the fundamental base-unit of soil conservation in the 1960s. Acceptance and adoption of the technique is reflected in a dramatic rise in plan numbers, both for individual farms and collectives described as catchment control schemes. Principles underlying the concept also developed according to the New Zealand situation, and tailored variants emerged for the South Island high country; catchments with notable wind erosion problems; and even plans for farms given to orcharding and dairying.

5.3.5.1 Farm plan numbers

In 1960, the SRCC Council estimated the number, type and cost of conservation works required across the country. This highlighted a need for information to evaluate catchment authority proposals, and to judge national soil conservation progress (Roche, 1994). The Council requested that catchment authorities submit five-year plans that described 10% of the total conservation works required in each respective catchment. In doing so, the Council hoped that all major soil erosion problems could be remedied within a 50 year period. These were dubbed 'soil conservation targets'.

Targets for farm plans were ambitious (Table 5.13). Estimates for the number of farm plans needed over the 50 year period was 9556 plans, representing approximately 930,000 hectares of land. In 1961, a total of 213 plans were in operation, increasing by 282 between 1961-64. Combined, this represented around 500 farm plans operating nationwide in 1964 (Campbell, 1964a, 1964b). By 1966 a total of 715 plans had been completed, which was below the national target of 900 set for that year (Roche, 1994). At the end of the decade, a grand total of 1277 plans was reported, although this does not include the number prepared by the MCB (possibly a further 40-100 plans).

Catchment district	Targets[1] 1961	Numbers[2] 1961	Numbers[2] 1964	Numbers[3] 1966	Numbers[4] 1970
Auckland	-	-	0	0	0
Bay of Plenty	-	-	0	0	2
Manawatu	650	10	40	40	?
Rangitikei Wanganui	1250	2	40	81	185
East Cape Poverty Bay	1050	0	2	2	217
Hauraki	-	0	0	6	0
Hawkes Bay	2000	12	30	68	69
Marlborough	178	11	5	17	68
Nelson	1000	0	5	12	84
North Canterbury	472	8	30	58	108
Northland	-	-	0	?	40
Otago	1200	11	37	62	120
South Canterbury	1050	60	45	140	94
Southland	106	4	3	21	24
Taranaki	-	-	-	-	0
Waikato	-	0	0	?	30
Wairarapa	600	94	41	157	195
Waitaki	-	1	4	9	31
Wellington	-	-	-	-	-
Westland	-	0	0	0	0
Total	9556	213	282	725[5]	1277

[1] Campbell (1965)
[2] No. plans up to 1961, & those operating between 1961-64 (Campbell, 1965)
[3] Campbell (1966)
[4] All plans in prep, awaiting approval, in operation, completed, or disbanded. MCB not included. Miller (1988)
[5] Total includes 52 plans for 'Glenmark-Lowry Peaks'

Table 5.13: Farm plan targets and achievements, 1961-70

5.3.5.2 Developments in farm planning techniques and principles

Like the developments in the LUC system, techniques in farm planning also evolved significantly during the 1960s. At the 1961 Annual Conference of the NZ Institute of Agricultural Science, J. Wallace-Ramsay from the Otago Catchment Board (OCB) 'stole the show' with a presentation entitled 'Conservation farm planning looks at the farm as a unit' (Wallace-Ramsay, 1961). This described the application of the farm plan technique in three stages (inventory, capability classification, and plan preparation), drawing heavily upon the US technique, but also relating it to the types of farms found in New Zealand.

Description of inventory and capability classification was a repetition of the US system, although recommended mapping scales differed somewhat. These were given as 10 chains to the inch for general farms (1:7920); 20 chains/inch for small grazing runs (1:15,840); and 40-80 chains/inch for sheep stations (1:31,680 to 1:63,360). Appropriate scale was considered important for meaningful LUC interpretation, in that it allowed the design of 'separate treatments, paddock by paddock, or even acre by acre in some cases' (*ibid.* p.74).

The idea that land should farmed according to its production capabilities and limitations was reiterated a number of times. However, the part that 'stole the show', was the way in which the OCB undertook the final stage of preparing the conservation farm plan. This was based on the participatory and multidisciplinary ideals emphasised in US publications:

> *'Using the Land Capability Map as the starting point... the Soil Conservator consults the farmer on his plans for the future and guides him on correct land use. He obtains... all relevant data on farm management and farm problems. In some cases personal problems have to be solved first before farm problems can be tackled. Where finance is a major problem, it is generally helpful to introduce the farmer to the farm budget... With all this information to hand, the Soil Conservator is ready to prepare a five-year conservation farm plan'*
>
> (Wallace-Ramsay, 1961, p.76)

Accordingly, it can be stated that the OCB had adopted a strongly interactive or participatory approach to the preparation of farm plans. Further, in recognition that the complexity of farming systems makes it 'impossible for one man to know all the facts about farming', the OCB would in some cases consult up to 'as many as 9 or 10 advisory and research officers to aid in the formation of a conservation farm or run plan' (*ibid.* p.77). This included various specialists from the DSIR, the Dept. of Lands and Survey, the Dept. of Ag., the NZ Forest Service, and local stock agents. Using the Land Capability Map as a focal communication tool, the team of specialists put forth their own opinions and recommendations, to be 'channelled through the Soil Conservator and integrated into the conservation farm or run plan' (*ibid.*). Finally, the farmer was given the opportunity to amend the plan, as 'the success of the plan depends mainly upon the one who will carry it out' (*ibid.*).

In the post-presentation discussion, A.F. Greenall (a South Island Soil Conservator who was earlier involved in the Pohangina Survey) remarked that the procedure described was 'the most apt and sophisticated technique at present available'. He further endorsed this after becoming the MoWs Chief Soil Conservator, suggesting that the multidisciplinary/participatory approach should form the basis of all farm planning nationwide (Greenall, 1968).

Wallace-Ramsay put forward a more detailed account of the OCB's technique in 1962, along with introducing the idea of 'grazing charts' (Wallace-Ramsay, 1962, 1963). Grazing charts are a visual means of tracing stock movements and numbers throughout the year, by paddock and by month, in such a way that stocking rate for each paddock can be calculated. Stocking rate by paddock has an integral value in conservation farming, as it represents land capability at a level that is more specific, detailed, and objective than the conventional three tier classification. Explicitly how Wallace-Ramsay used these charts to further high-country soil conservation is unclear (the author is not familiar with high country farming techniques). However, in a more intensive form, such charts could be used to estimate stocking rates of hill country farms, thereby allowing the backward calculation of pasture production to identify the degree of marginality that may be apparent with class VII land.

Another 1960s publication that described farm planning in detail was aptly titled *Farm Conservation Plans* (Knowles, 1962). Although published by the Rangitikei Catchment Board (RCB), this handbook was possibly redistributed to other authorities around the country. A Farm Conservation Plan was defined as follows:

> *'an overall assessment of a farm which has taken into consideration erosion-control and prevention, development and management. It is a comprehensive plan of farm operations over a given period whereby all those practices necessary for reducing soil loss by erosion, and maintaining or increasing production from the land, are dovetailed into a sequence of operations'*
>
> (Knowles, 1962, p.5)

Recommended procedure for preparing a plan was given (Figure 5.30), including a much streamlined version of surveying that, in part, would contribute to a trend experienced in US applications of farm planning. Although advocating 'detailed field inspections' during the survey phase, this was to be undertaken without compiling a physical inventory of land resources. Rather, the mapper was to record relevant land-use features onto an aerial photo (fences, dams, buildings, etc.), and then proceed directly to mapping capability classes as Land Capability Survey. In doing so, the steps of inventory mapping and capability interpretation were undertaken together in the field, which has the result of expediting the entire farm plan process considerably. Directly inferring and mapping land capability was to become the norm for many catchment authorities seeking to achieve the SCRC Council's soil conservation targets, and is still used by many modern-day practitioners (Chapter 6).

'HOW THE CONSERVATION PLAN IS COMPILED'

1. A request to the Catchment Board (CB) is made by the farmer
2. The CB Soil Conservator undertakes a preliminary farm visit to gain an insight into farm management and the erosion problem
3. 'Detailed survey' is undertaken during a second visit
4. Plan & detailed report prepared post-survey. Progress in preparing the plan is discussed with the farmer to integrate additional management and development considerations
5. Plan finalised when both parties are 'fully satisfied' with its content and requirements
6. Presented to the CB for approval, and subsquently presented to the SCRCC for subsidy approval
7. The plan can proceed when formal approval and agreement is obtained from the Council, CB, and the farmer

Figure 5.30: Rangitikei Catchment Board's procedure for preparing a farm plan (Knowles, 1962).

The only proviso given in the handbook was a recommendation that 'the conservator also takes into consideration the soil types that occur within the property and accurately maps their location' (*ibid.* p.13). This hints toward ideas expressed by Klingebiel & Montgomery (1961), although it is a somewhat dubious recommendation unless catchment authority Soil Conservators had pedology training necessary for detailed soil mapping at the farm level. The handbook also included a detailed summary of recommended erosion control methods and management factors required for conservation farming.

Streamlining surveys contrasts against the comprehensive method used by the OCB as described by Wallace-Ramsay (1961, 1962). Perhaps in response, the OCB published their own handbook, based on the RCB version but orientated towards using the full survey method in the South Island (Warrington, 1967). Description of the farm planning procedure was notably more detailed, and included Land Inventory Survey and capability interpretation as two separate steps. Recommended erosion control methods and management factors were focused toward the high country, and included an account of Wallace-Ramsay's (1962, 1963) grazing charts.

5.3.5.3 Farm plan variations

Farm plans were initially focused towards addressing on-farm erosion concerns apparent in New Zealand hill country. However, characteristics of different farming operations and erosion types can be diverse, and it didn't take long for catchment authorities to adapt the farm planning technique to accommodate some of this diversity. In particular, Run Conservation Plans were developed for the extensive holdings of the South Island high country; Shelter Plans were used in districts with notable wind erosion; the Nelson Catchment Board (NCB) developed Orchard Conservation Plans; and to a limited extent, farm planning was applied to dairy farming.

5.3.5.3.1 Run Conservation Plans

Exactly when the concept of Run Conservation Plans (or just 'run plans') was introduced is unclear. McCaskill (1973) suggests the South Canterbury Catchment Board began in the 1950s with a 'tussock-run plan' prepared as part of the Opihi River Catchment Control Scheme beginning in 1951. Another early reference is provided by the TGMLI (1962), in which the procedure for compiling a run plan is given, along with a brief summary of an actual example. The procedure is essentially synonymous with that of Wallace-Ramsay (1961, 1962), expressly applied to extensive high country holdings in the South Island. Run-plan purpose was broadly given as erosion control of high-altitude grasslands, through reduced grazing pressure that could arise with the development and intensification of lower-altitude grasslands (TGMLI, 1962).

The actual run plan example encompassed 24,280ha of high country, with 2000 hectares of class VIII and 15,300 hectares of class VII land. Most of the plan's recommendations were management and production adjustments, including fencing subdivision, feed conservation, lowland irrigation development, oversowing & topdressing, and adjustments in grazing rotations. In doing so, the plan provided 'for the carrying of the existing stock on land capable of rapid improvement... and will exclude the Class VIII land from grazing, and will enable the Class VII land to be lightly grazed and at times completely spelled' (*ibid.* p.6).

The SCRC Council commissioned an investigation into run plans in 1967, focusing primarily on the financial constraints faced by run-holders having to carryout extensive (and therefore expensive) soil conservation controls. 'True high country runs' were concisely defined, including a portentous sentence stating that 'substantial areas of Class VIII land should be retired' (Brown, 1968, p.27). Further, it was recommended that run plans 'must be designed, programmed and financially assessed in much greater detail and with more caution than is usually needed' (*ibid.*). A more formal structure for run plans was conveyed through a SCRCC Circular reprinted in TGMLI (1968).

Five years later, the SCRC Council initiated a meeting in Christchurch attended by 26 organisations and government departments with an interest in the South Island high country. Principal topics discussed included the practice of tussock burning, and perhaps more importantly, the retirement of Class VIII land. As noted by Gibson (1977), the most significant outcome from this meeting was 'the unanimous agreement that Class VIII and eroding Class VII land should be retired from domestic grazing' (p.52). A Joint Policy Statement was forthcoming, essentially representing a cross-departmental policy agreement stating that the prime use of unoccupied and retired Crown land was to be given to soil and water conservation purposes. Overtime, this translated into high country lease-holders having to retire large tracts of class VII and class VIII land.

The significance to run plans and farm planning is twofold. Firstly, run plans became the mechanism through which class VIII and eroding VII was identified, and retired from grazing in such a way that sought to maintain or enhance whole-run productivity, and to a lesser degree compensate run-holders through subsidies. Secondly, retired land was no longer the responsibility of the farmer: 'the land in question will be subject to a management plan based on catchment authority priorities... commissioned and carried out by the administering department' (*ibid.* p.52). In effect, leased Crown land could have two types of plan – the run-holder's Run Conservation Plan for grazed land, and a departmental Management Plan that 'has as its first and overriding objective the management, protection, and improvement of the area for soil and water conservation' (Ward-Smith, 1977, p.16).

The first Management Plan prepared in the South Canterbury district was the 'small but vital' 163 hectare Cloudy Peaks Management Plan (*ibid.*). This began in 1975 with a Tekapo run-holder's acceptance to retire 163ha of land that the SCCB had ascribed a 'high priority for control works'. The plan was administered by the Dept. of Lands and Survey, but the SCCB undertook detritus control works as gully and stream planting, and the construction of gravel traps. The Department contributed by oversowing and topdressing 34ha as a means to promote vegetation cover and stabilise surface erosion.

5.3.5.3.2 Shelter Plans

'Shelter Plan' is one of a number of names used to describe the adaptation of the farm plan approach specifically for wind erosion control. Others include Windbreak Plans, Soil Erosion Windbreak Plans, and Windbreak Tree Planting Plans. It is uncertain when this form of farm planning was initiated, although the NCCB notes provision was made in the 1941 SCRC Act 'for the establishment and funding of windbreak tree-planting as a means of reducing the loss of soil on arable land through the action of wind' (Wethey, 1984, p.1).

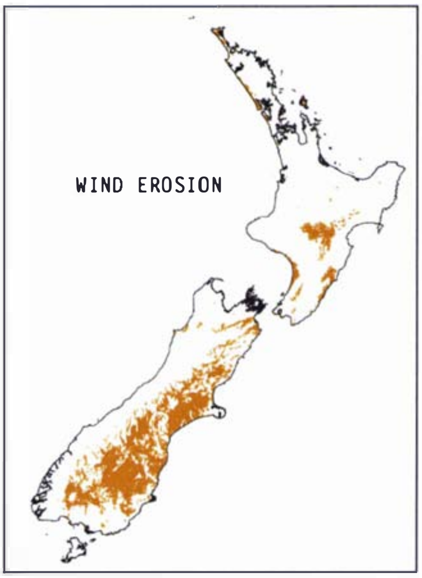


Figure 5.31: Wind erosion in NZ according to NZLRI polygons

It is also uncertain which catchment authority first adapted the farm plan approach to shelter planning. Wind erosion is widespread in NZ (Figure 5.31), particularly in coastal and pumice areas in the North Island, and virtually all of the South Island apart from the West Coast. Southland certainly had a comprehensive shelter planning program (Sutherland, 1986), and Soil Erosion Windbreak Plans reported by Hughes (1989) indicate that significant numbers were eventually prepared by North Canterbury, Otago, South Canterbury, and Wairarapa Catchment Boards.

Sutherland (1986) describes the shelter planning process. The plan begins with a farmer request and a preliminary farm visit by a soil conservator. If the farmer is eligible, then the conservator returns to the office to draft a map showing windbreak locations. Lengths are estimated and used as a basis for a detailed costing. The map, costs, recommended tree-species, and planting program are brought together as the shelter plan, which is then submitted to the catchment board's official Members. If approved, a second farm visit was undertaken, to obtain agreement from the farmer as a legally binding statement.

As with other forms of farm planning, the farmer was typically required to agree to the maintenance of any works. As shelterbelts tend to carry a high maintenance requirement (for permeability and aesthetics), the farmer was visited twice per year over the five-year duration of the plan. During such visits, progress was checked and grant payments approved (grants were only paid after works had been implemented), maintenance recommendations were given, and amendments to the plan were made if necessary. Individual shelter plans were often part of larger district initiatives, similar in principle to catchment control schemes.

It is significant to note that no comprehensive inventory survey and capability classification was required for shelter plans. As such, they represent a comparatively rapid form of farm planning.

5.3.5.3.3 Orchard Conservation Plans

The Chief Soil Conservator of the Nelson Catchment Board (NCB) put forward a more localised adaptation of the farm plan technique in 1966 (Morriss, 1966). He was concerned with inappropriate development of orchards on Moutere gravels, which was leading to erosion problems that he considered unique to the Nelson district. In short, the clay-rich hill soils atop the gravels were being over-cultivated as part of weed control, causing significant erosion and production impairment (Leighs, 1980). In 1964 these problems were brought to the attention of the SCRC Council, who approved the preparation of six Orchard Conservation Plans for demonstration purposes. These eventuated into Soil & Water Orchard Plans in the late 1960s, designed to operate over 10yr timeframes.

Unfortunately Morriss (1966) nor Leighs (1980) offered discussion on how orchard plans were prepared. Rather, considerable detail is given on erosion control techniques developed by the NCB specifically for orchards (*i.e.* orchard 'conservation farming' techniques and practices). It is probable that the procedure aligned closely with that of conventional farm planning advocated by the SCRC Council.

5.3.5.3.4 Dairy farm planning

Conservation farm planning has rarely been associated with dairy farms because, by their very nature, such farms do not usually experience the dramatic soil loss associated with some hill- and high-country in New Zealand. Despite this, the concept was applied as early as 1959, to a small 54.3 hectare farm in Auckland (Glass, 1964).

Prior to the plan, the farm was noted as being remarkably unproductive because of extraordinarily poor drainage from a soil regarded as the worst in North Auckland. Sheet, rill and gully erosion were notable features, while the stream crossing the farm was subject to 'severe flash flooding'. Conditions were so poor that the previous four farmers had abandoned the property.

A conservation farm plan was devised and implemented, involving surface drainage (contouring), planting of waterways, graded banks and other diversions, subdivision, and improvements to farm water supply. At the completion of the five year plan, milk production had increased 55%; pugging & poaching was minimised; problems with pasture pests decreased; erosion was stabilised; and runoff and flooding were controlled somewhat. However, overall, it appears that production advantages far outweighed the conservation benefits.

5.3.5.4 Catchment control schemes

Farm plans as the fundamental unit of soil conservation found expression in catchment control schemes in the late 1950s and early 1960s. It was the policy of the SCRC Council 'to foster complete catchment control schemes wherever possible', as a means 'to integrate river control works with water and soil conservation practices on the land areas of individual river catchments' (MAF, 1974, p.26). As noted by Campbell (1957), the goal was to have individual conservation schemes 'on every farm in a catchment' (*i.e.* conservation farm plans), which could collectively aggregate to completely restore 'balanced control and full use of the soil and water resources' across the entire catchment (p.16). Further, as the benefits would accrue firstly to those who reside in the catchment, rates could be levied to assist individual farmers with soil conservation costs (SCRCC, 1958).

Campbell (1966c) states that the Glenmark Catchment Control Scheme (1954) was NZ's first, although this seems to be predated by the Pohangina (Manawatu) and Opihi River (South Canterbury) schemes. Glenmark, however, is the scheme that has been most widely reported. It involved eight farms over 1230 hectares, with the lower three farms suffering regular flood and siltation damage attributed to runoff and erosion from the upper five farms. This was apparently due to excessive cultivation of rolling hill-country soils subject to summer drought (SCRCC, 1958). On the one hand, lower farms were bearing the brunt of erosion outside their control, while on the other, upper farms may have had the control, but could see no valid reason why they should apply it (as discussed in McCaskill, 1973, p.212).

The solution was conservation plans for each farm in the catchment. Firstly, a land inventory and capability classification was undertaken, and used to identify exactly where the erosion debris was originating from. Secondly, farmers were persuaded that farm conservation plans carried production advantages as well as erosion control benefits. Thirdly, farmers became so committed to addressing the catchment's erosion problems, that they formed themselves into a self-regulating eight-man committee to monitor and ensure implementation of their plans. Technical advice and engineering services were provided, and works were subsidised. A major rainfall event in 1961 completely validated the scheme, with no significant flooding or downstream damage whatsoever.

The success of catchment control schemes such as Glenmark was achieved by the 'dovetailed' application of farm planning – each farm had its own individual plan, but collectively summed to complete catchment control. This idea soon found favour throughout NZ, particularly with problem catchments. Perhaps the most famous is the East Coast Project (and it's immediate variations), whereby a special system of incentives was used to encourage the retirement, afforestation and general erosion control of thousands of hectares of privately owned land, including that found in the dramatically eroding Waipaoa, Waiapu and Awatere Catchments. On a national basis, a total of 24 catchment control schemes were operating in 1970 (covering 670,000ha), which grew to 121 schemes covering more than two million hectares in 1985 (Miller, 1988).

5.3.5.5 The production and subsidy dimension of farm plans

The production and subsidy dimension of farm planning translates as incentives and financial assistance. Widespread acceptance of farm planning (as indicated by farm plan numbers), and development of the farm plan technique, would have been considerably less if these aids had not been used. As discussed, farm plans represented a framework showing the farmer how to offset conservation costs with production gains, thereby enabling him or her 'to get maximum production from his parcel of land without detriment to the soil or his neighbour downstream' (Dick, 1962, p.8). Assisting farmers with production gains during the 1960s was acceptable practice for environmentally orientated organisations, because agriculture was still recognised as the nation's proverbial backbone - what was good for agriculture was good for the nation.

While plans outlined how conservation and production could be harmoniously achieved, they also represented the mechanism through which subsidies were approved and granted. Justification for such 'cost sharing' was similar to that given for production advice. Specifically, the on-farm control of erosion was in the nation's best long-term interest (*i.e.* soil conservation for long-term production); upper catchment control reduced flooding and siltation problems for downstream users; and the cost of implementing control was often outside the means of individual farmers (McCaskill, 1973). Hogg (1972) expands the latter point: 'the justification… is that complete cost of repairing the erosion problems accumulated since initial development of the land, together with the prevention of future problems, would be an unfair charge on the present occupier and may also be too expensive for one generation to bear' (p.51).

The SCRC Council authorised subsidies to farmers through catchment authorities, based on a prescribed scale expressed as a ratio. At a 1:1 ratio, the Council would subsidise £1 for every £1 spent by the farmer on approved erosion control. Ratios and types of subsides fluctuated between the 1940s and 1980s, as described in detail by McCaskill (1973). The subsidy framework was initially simple, essentially translating to £1 for £1 for tree planting, and £3 for £1 for the control of active and severe erosion such as gullying and, to a lesser extent, stream-bank erosion (HBCB, 1948). The array of subsidy types and ratios expanded rapidly in the 1950s, extending to aerial over-sowing and topdressing; fencing materials; fire breaks and access tracks; discharge and irrigation dams; a broad range of earthworks and erosion control engineering; and even airstrip formation. Virtually any dimension of farming related to soil conservation could attract some form of subsidy.

Many of the supported erosion control measures carried substantial production benefits, such that, the SCRC Council 'was careful to try to limit its grant assistance to the soil conservation element in the work' (O'Connor, 1993, p.137). This has been demonstrated with the Council's disapproval of particular works in the initial application of the Tennet Farm Conservation Plan (Section 5.3.3.3). However, the use of public monies to subsidise farmers drew increasing resistance toward the 1980s, from a society that no longer perceived agriculture as the panacea for national well-being.

To some, paying farmers to be responsible land stewards was unjust, because the activity of soil conservation should be just another part of the normal farm operation. Farmers are not only production and business managers, but as discussed in Chapter 1, they are also responsible for managing their farms' land and water resources in a sustainable way. Much of this responsibility was passed onto catchment authorities during the 1950s-80s subsidy period. The twofold offshoot being the distortion of whole-farm viability, and the reinforcing of a view that dissociates production management from environmental management.

A number of attempts were made to formally justify subsidies with cost-benefit analyses in the late 1970s and early 1980s (*e.g.* Harris, 1983), but they were eventually phased-out alongside other similar forms of government assistance around the time of the reforms.

5.3.5.6 Farm plan examples from the 1960s

The basic formula for compiling and implementing various types of farm plans changed little over the years (Gibson,1977), although a broad range of organisation-particular formats were used. Accordingly, rather than attempting to detail format variations between authorities over time, a small number of representative plans from the 1980s are discussed in Section 5.3.8.3. Published accounts of 1960s farm plans and demonstration farms can be sourced from the SCRC Council's *Soil and Water* magazine, including King (1964), Glass (1964), Rowell & Fisher (1965), Hogg (1966), Sneddon (1967), and Pickens (1971).

5.3.6 LATE 1960S TO EARLY 1970S ORGANISATIONAL CHANGES

Although the 1959 Amendment to the SCRC Act (1941) reduced the power of catchment authorities to control private land use, it wasn't until the passing of the Water and Soil Conservation Act (WSC Act) in 1967 that significant changes in organisational structure began to take place. The prevailing 'wise-use' perspective of the conservation movement began to shift in the 1960s, moving towards a view of 'multiple-use' driven by increasing concerns regarding water quality and allocation (Roche, 1994). As a result, the 1967 Act was passed 'as a way of having a coordinated approach to water management… which made provision for the conservation, allocation, use and quality of water; vesting all natural water in the Crown' (Hughes, 1989, p.6).

The organisational structure of soil conservation in NZ soon became considerably more complex and confusing. Roche (1994) gives the clearest account, although understandable discussion can also be found in NWASCO (1979a, 1979b, 1979c) and McCaskill (1973). In brief, the relatively simple structure pre-1967 was supplemented with: the 1967 Act (Figure 5.32); the formation of a Water Allocation Council and Water Pollution Control Council between 1967-71, both of which merged in 1972 as the Water Resources Council (WR Council); the establishment of the National Water and Soil Conservation Authority (NWASCA) with administrative control over both the SCRC and WR Councils; and the Water and Soil Division was created within the Ministry of Works (WSD, MoW) to service the technical requirements of the councils and authority. Collectively, all these organisations were referred to as the National Water and Soil Conservation Organisation (NWASCO).

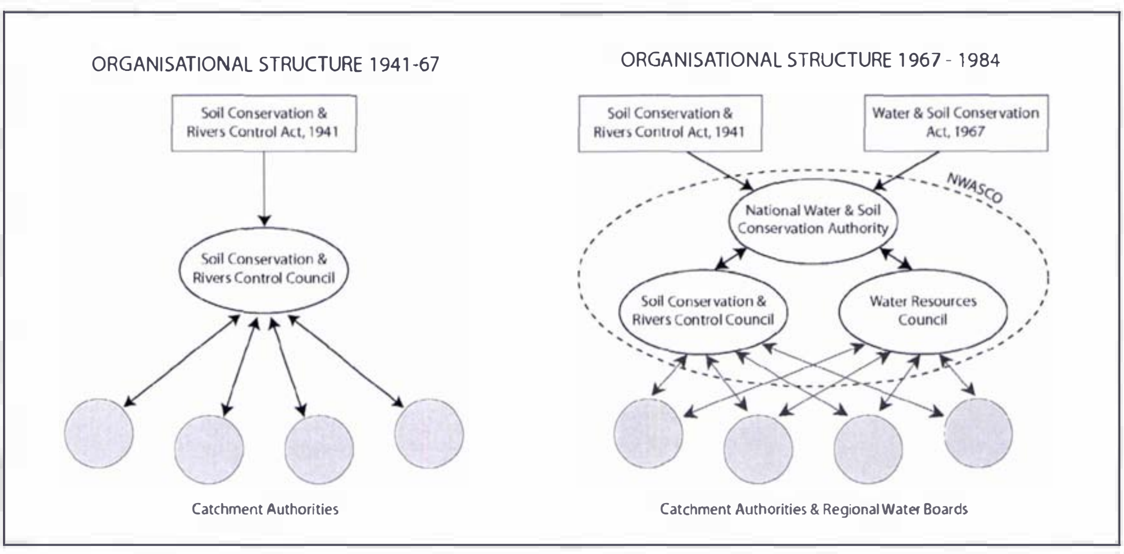


Figure 5.32: Changes in organisational structure of NZ soil conservation 1941-1984 (after Roche, 1994).

This structure continued more-or-less unchanged until the early 1980s when NWASCA was enlarged and given new functions and responsibilities. However, these changes were brief, as the somewhat radical 1984 Labour government soon instigated a series of reforms and restructuring of the state sector. In 1987 the WSC Act was revised and NWASCA was abolished, with many of their responsibilities passing to the newly formed Ministry for the Environment, and down to individual regional councils as an expression of decentralisation. Many other state organisations with ties to soil conservation were similarly disbanded or reformed, apparently emerging as new institutions with 'clearly defined commercial, regulatory, administrative, policy and environmental advocacy functions' (MfE, 1997, p.4:5). Late 1980s developments in legislation eventually culminated in 1991 with the passing of the Resource Management Act (Chapter 2).

5.3.7 Consolidation of Land Resource Inventory and Land Use Capability Classification

Three major successive developments in survey and capability classification occurred after the introduction of the 1967 WSC Act. Firstly, national standards for undertaking Land Inventory Mapping and Land Use Capability classification were finalised and published as a handbook. Secondly, these standards paved the way for a national mapping programme initiated in 1970, which aimed to produce a series of three maps at a scale of 1:250,000. Thirdly, the New Zealand Land Resource Inventory (NZLRI) emerged as an offshoot from the national mapping program, eventually resulting in the inventory and classification of greater New Zealand at a 1:50,000 scale.

5.3.7.1 National survey standards

National standards for surveys and classifications were finally published in 1969 as the *Land Use Capability Survey Handbook* (MoW, 1969). The Handbook's purpose was 'to provide a working guide for soil conservators and others who record facts about the land, or classify land, so as to assess its potential for improved systems of land use within its inherent physical limitations' (p.5). It also states (in bold typeface) that the SCRC Council 'requires strict adherence to standards, as laid down in this handbook, for land inventory compilation and land use capability classification' (*ibid.*).

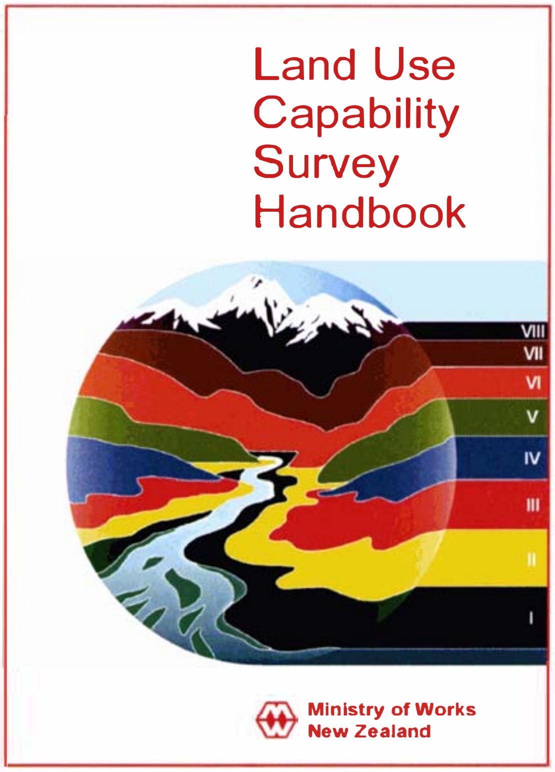


Figure 5.33: Cover of the Land Use Capability Survey Handbook (3rd print) showing an approximation of the colouring scheme used to depict capability classes.

Adaptation of the US system is acknowledged, and Bennet's (the 1st Chief of the US SCS) dictum of using every acre according to its capability is reiterated. LUC Classification was defined as the 'systematic arrangement of different kinds of land according to those properties that determine its capacity for permanent sustained production' (p.12). Detailed instructions were given for preparing 4-5 factor Land Inventory Maps, and how to interpret such inventories into LUC down to the capability unit. This publication is readily available in New Zealand (having undergone at least three reprints since it's first release), so only a brief review of the standards is given.

5.3.7.1.1 Land Inventory Survey

Recommended procedure for undertaking field survey is based around the production of a Land Inventory Map, which groups 'facts about the land' into 'land inventory units'. A four to five factor notation is used to record vegetation, erosion, slope, and either soil or rock type, or both (Figure 5.34 overleaf). Any significant change in one or more factors across the landscape ideally necessitates the delineation of an inventory unit. Land use and climate are also noted during the field survey, and it was recommended that the gathered 'facts about the land' be supplemented by obtaining related published or documented information.

As with Hughs (1964) and Prickett (1966), soils were identified from published Soil Bureau maps, and recorded using recognised symbols for soil type names and phases. Because detailed soil information was unavailable for many areas in NZ, a recommendation was given that soil conservators may undertake their own soil surveys in consultation with the local soil survey office. Two additional soil symbols were put forward to represent bare rock (BR) and significant rock outcrops or boulders (Ro).

Slope was described using the seven slope groups presented in Hughs (1964), and vegetation was assigned five classes as grassland (P, p), permanent cropland (L, l), scrub and fern (M, m), forest (N, n) and miscellaneous weeds, herbs, etc. (H, h). A capital letter indicates that greater than 40% of an inventory unit is covered by a given vegetation class, while a small letter represents less than 40%. Several vegetation classes could be recorded together in order of descending dominance.

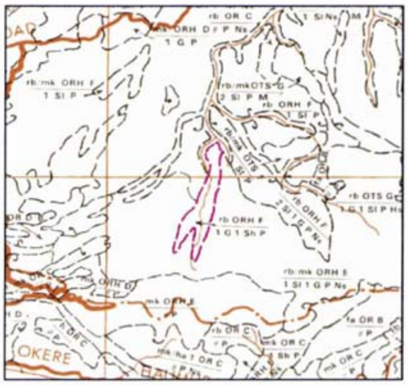
Erosion was similarly based on earlier accounts, divided into natural erosion (symbol = n) and accelerated erosion. The latter was divided into eleven major types, eight of which could be further qualified with a lower-case descriptor. Degree of erosion could be inferred in three ways: as a percent of bare ground; a percent of soil profile loss; and as a rating of seriousness or severity for mass-movement types.

Relative to previous US versions, this method of inventory appears to be comparatively simple, particularly in regard to slope and erosion recording procedures. It provided the basis for conservation survey in the early 1970s, evolving slightly to include more tightly defined classifications for rock type, vegetation and erosion, along with the introduction of compound symbology to express complex slope group arrangements.

EXAMPLE OF LAND INVENTORY ACCORDING TO 1969 STANDARDS

Inventory Code*

$$\frac{\text{Soil and/or rock type - Slope}}{\text{Erosion - Vegetation}}$$



Example

$$\frac{\text{rb ORH F}}{\text{1G 1Sh P}}$$

rb = *Rotoiti Breccia*
ORH = *Oropi sand, hill phase*
F = *26° - 35°*
1G = *Slight gully erosion*
1Sh = *Slight sheet erosion*
p = *Pasture*

* *inventory code arranged in order of decreasing factor permanence*

Figure 5.34: Example of inventory standards presented in the LUC Handbook. (Nairn, 1975).

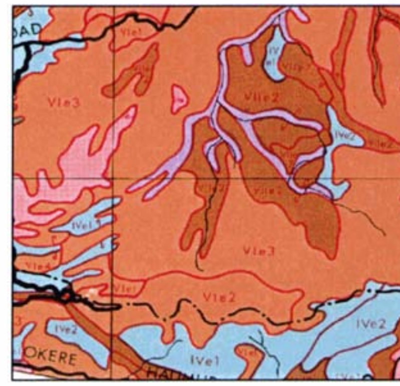
5.3.7.1.2 Interpretation of LUC

The Handbook's standard for LUC classification included the eight class system, in which four classes can be assigned to arable land (I, II, III, IV), and another four to non-arable land (V, VI, VII, VIII). Class V was isolated as being particularly problematic, due to the narrow US definition: 'land unsuitable for cultivation **and** cropping because of limitations too difficult to remove'. This was revised to include: steeper land, that although being unsuitable for cropping, could be cultivated for pasture or forest; and steeper land completely unsuitable for cultivation, but having a class V rating because of high fertility and stability. Characteristics of each capability class were described in detail, and were supported with map and photograph examples. A version of the US colouring scheme was also used, referring to various colour names as 'sap green', 'crimson lake', 'chrome orange' and 'raw umber'. General colouring is approximated in Figure 5.33 (previous page), while an actual example published in 1975 is presented in Figure 5.35.

The four subclasses of *erodibility* (e), *excess water* (w), *rooting zone limitations* (s), and *climatic limitations* (c) were used, whereby a capability class is subclassed according to the most dominant limitation present. Where two limitations were essentially equal, the priority ranking of 'e → w → s → c' was used to define the subclass. Erodibility did not apply to classes I and V, and only rarely to class II.

Being the lowest division of the classification, capability units were recognised as the most important to soil conservators. They group together inventory units that require 'essentially the same kind of management and the same kind and intensity of conservation treatment' (MoW, 1969, p.29). These were based on Klingebiel & Montgomery (1961), but not explicitly down to the level of the soil unit. However, although a number of examples of capability units were given, it was noted that 'strict standards for national application' had yet to be developed because such a task was considered impracticable (p.30).

EXAMPLE OF LAND USE CAPABILITY ACCORDING TO 1969 STANDARDS



Colour	Description
III	Arable land with moderate limitations
IV	Arable land with severe limitations
VI	Non-arable land with moderate limitations
VII	Non-arable land with severe limitations
VIII	Non-arable land with extreme limitations

Figure 5.35: Colouring scheme recommended by the 1969 Handbook (Nairn, 1975).

5.3.7.1.3 Potential Land Use interpretation

Along with inventory and capability classification, a third standard was put forward as Potential and Recommended Land Use (PRLU classification). This represents a supplementary classification, whereby the potential suitability or versatility for a variety of different uses was inferred from the LUC classification. Standards were put forward for pastoral and forestry land uses, although it was recognised that the system could be adapted for recreational, urban, wildlife, and other types of land use. A two tier classification was used, including three PRLU classes for pastoral and two for forestry, and several mutual subclasses based on land-use limitations.

The Handbook also provides a section on the application of inventory and classification, and examples are used throughout. Overall, the handbook provided a generalised national standard for three stages of conservation survey in New Zealand (inventory, LUC classification, and PRLU classification), which is henceforth referred to as the LUC survey system for the sake of simplicity. This framework was used for early 1970s conservation surveys, gradually developing an increased array of more tightly defined standards, particularly in regard to capability units and sub-inventory detail. Such changes were necessary when the system was applied in a national mapping programme.

5.3.7.2 The 1:250,000 national mapping programme

In the same year that the LUC Handbook was published, the MoW's Chief Soil Conservator recommended his staff be assigned the responsibility of undertaking a National Assessment survey, through 'a systematic coverage of New Zealand, with land inventory surveys being conducted on a 40 chain to 1 inch scale[1:31,680], district or regional survey publications on 1 mile to 1 inch [1:63,360], and the national coverage on 4 miles to 1 inch [1:253,440] – with all surveys to the unit level' (Greenall, 1969, p.10).

The national assessment was initiated in 1970 with a policy decision made by the SCRC Council in 1970 (Eyles, 1974). This policy called for the production of three national map-series at a scale of 1:250,000, including a national LUC map to the capability unit level; a 'recommended soil conservation and water management map' of NZ (RSCWM map); and a national erosion map.

The RSCWM map series was 'designed to show relative long term potentials for cropping, pastoral, forestry, water yield, and water management for catchment protection uses' (*ibid.* p.55). The erosion series was made up of 25 maps, which depicted potential erosion severity under grassland in the absence of soil conservation treatments. They were regarded as a 'world first', and were ready for publication in 1983 (NWASCO, 1983).

Back in 1970, the Council recognised that an extensive amount of survey information had already been collected, but it needed to be collated and 'put to the same scale' if it was to be used as the starting point for a national assessment. Accordingly, soon after the initial policy decision was made, the Water & Soil Division of the MoW set about upgrading previous assessments, along with beginning a new phase of field survey to fill in the gaps. An inventory scale was established at 1:63,360, which would provide sufficient detail for subsequent interpretation of the national map series at a reduced scale of 1:250,000.

However, four years after the programme was started, a policy change directed focus away from the interpretive maps, and more towards the publication of the underpinning inventory. Indeed, the 1:63,360 land inventory component appears to have become the main thrust of the entire programme. In a 1987 review of the resulting New Zealand Land Resource Inventory, it is stated that the shift began with the appointment of a new Research Director in 1974, who considered that the 1:63,360 inventory was 'far too valuable a national resource to be withheld from general release' (LINZ, 1987, p.4). It was he 'who redirected emphasis from published maps at 1:250,000 to [the] release of the primary inventory data at 1:63,360' (*ibid.*). Eyles (1975) implies the decision to release the inventory was driven by 'a heavy demand [for] physical data by organisations involved in land use planning' (p.33).

5.3.7.3 The New Zealand Land Resource Inventory

The first published inventory map was presented at the Institute of Agricultural Science Conference in 1975 (Sheet N88). Subsequent maps were published as they were completed between 1975-1979 (a total of 330 maps), with the entire series initially being called *The Land Resource Inventory Worksheets* (Eyles, 1975). These have been described as NZ soil conservation's 'third major advance' (Howard & Eyles, 1979, p.1), and eventually led to the consolidation of a robust and proven LUC System.

Surveying and Worksheet preparation was the responsibility of the MoWs Water & Soil Division, involving 15 land resource scientists divided into two groups that operated from Christchurch and Palmerston North. The groups were multidisciplinary, including geologists, foresters, botanists, and others with earth science and agricultural-science backgrounds. Worksheet preparation began with stereographic interpretation of aerial photography, which along with the consideration of other sources of physical information, allowed broad landform units to be delineated and preliminarily defined using a five factor inventory code. Validation of the units involved 'intensive fieldwork' on foot, vehicle and by air. Land use information was collected from catchment authority staff and 'people managing the land' (NWASCA, 1988, p.2).

Worksheets were presented with two sets of information overprinted onto modified topographic base-maps at the 1:63,360 scale (Figure 5.36). Any given polygonal unit contained a five factor inventory code, along with a classification of LUC. In effect, the national LUC classification had been combined with the national inventory, and was presented as one map series.

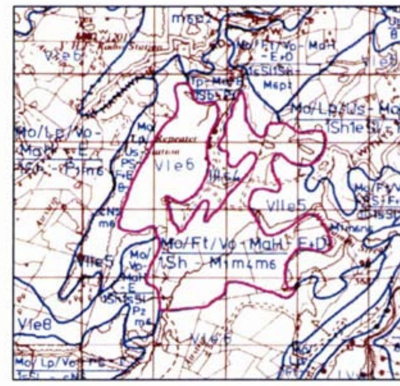
National mapping resulted in significant changes to the LUC system, particularly in regard to the amount of inventory and classification detail needed. Comprehensive explanation of these refinements has been given by Howard & Eyles (1979), LINZ (1987), NWASCA (1988), and most of the Regional Bulletins (that provide regional suites of capability units). However, perhaps the best account is given in *Our Land Resources* (MoWD, 1979), published at the completion of the 1:63,360 Worksheet series.

Format for the inventory code was more-or-less unchanged, apart from the explicit inclusion of both soil ***and*** rock type. The method for recording soil was again based upon reference to existing soil surveys, while slope group notation expanded to describe average, compound and dissected slope types. However, the greatest change was the detailing of standards for vegetation, erosion, and rock type, necessary for consistent application across NZ's varied landscape.

EXAMPLE OF LAND INVENTORY ACCORDING TO 1975-79 WORKSHEETS

Inventory Code

$$\frac{\text{Rock type - Soil - Slope}}{\text{Erosion - Vegetation}}$$



Example

$$\frac{\text{Mo/Ft/Vo - MaH - E+D}}{\text{1Sh - } M_1\, m_4\, m_6}$$

Mo/Ft/Vo	= *Ashes over breccias over welded volcanic rocks*
MoH	= *Matua soil, hill phase*
E+D	= *Compound slopes of 21°-25° and 16°-20°*
1Sh	= *Slight sheet erosion*
$M_1\, m_4\, m_6$	= *Manuka (dominant), fern, & mixed native scrub assns.*

Figure 5.36: Extract from a Land Resource Inventory Worksheet depicting LRI notation and LUC classification.

These detailed standards were published as supporting documentation. Rock-type for the South Island was initially covered by Hill (1975), and then Lynn (1985), while the North Island was standardised by Crippen & Eyles (1985). Versions for both islands were revised and merged by Lynn & Crippen (1991). Standards for erosion classification are given in Eyles (1985), while vegetation was covered by Hunter & Blaschke (1986).

Another major development was the national standardisation of the LUC classification. Rather than initially seeking to begin with a nationwide standard, LUC units were standardised on a regional basis. The South Island represented one complete region (although Marlborough became a standalone LUC region in the 1990s), while the North Island was divided into ten (Figure 5.37). Each region has it's own unique set of LUC units, meaning Northland's VIIe12 is distinctly different from Waikato's VIIe12. Correlation of the ten North Island regional classifications was underway in 1975 (Eyles, 1975), but wasn't completed until 1985 (Page, 1985). Linking units from different regions provided a degree of national uniformity.

To accompany the Worksheets, regional Extended Legends were provided as a means to detail individual capability units. Referencing a given unit could provide three types of supplementary information. Firstly, Worksheet notations are expanded to provide brief detail on each of the five factors used in the inventory code. Secondly, a 'unit description' is given as a general overview of the main defining characteristics of the unit. Thirdly, the 'recommended soil conservation and water management' dimension of the LUC survey system is implicitly built-in to the Extended Legends, expressed as present and potential land uses, and recommendations for fertiliser requirements (pastoral) and conservation treatments.

Along with an Extended Legend, each regional classification was to have it's own 'suites' of LUC units. These are defined as 'a group of LUC units which, although differing in capability, share a definitive physical characteristic which unites them in the landscape' (Jessen *et al.*, 1999, p.13). The 'definitive physical characteristic' underlying various suites is often either landform, rock type, or a particular erosion characteristic. In effect, a suite represents another level of grouping that sits between the LUC unit and the regional classification.

Suites were presented and described in Regional Bulletins. Documentation for these Bulletins didn't begin until 1983 (LINZ, 1987), and the first wasn't released until 1985 (Figure 5.37). A total of four had been prepared by 1988, and a further four were published after the national inventory and classification was revised (discussed overleaf). Bulletins for the greater South Island, Waikato, Eastern Bay of Plenty and the Coromandel regions have never been published, although some exist in draft form.

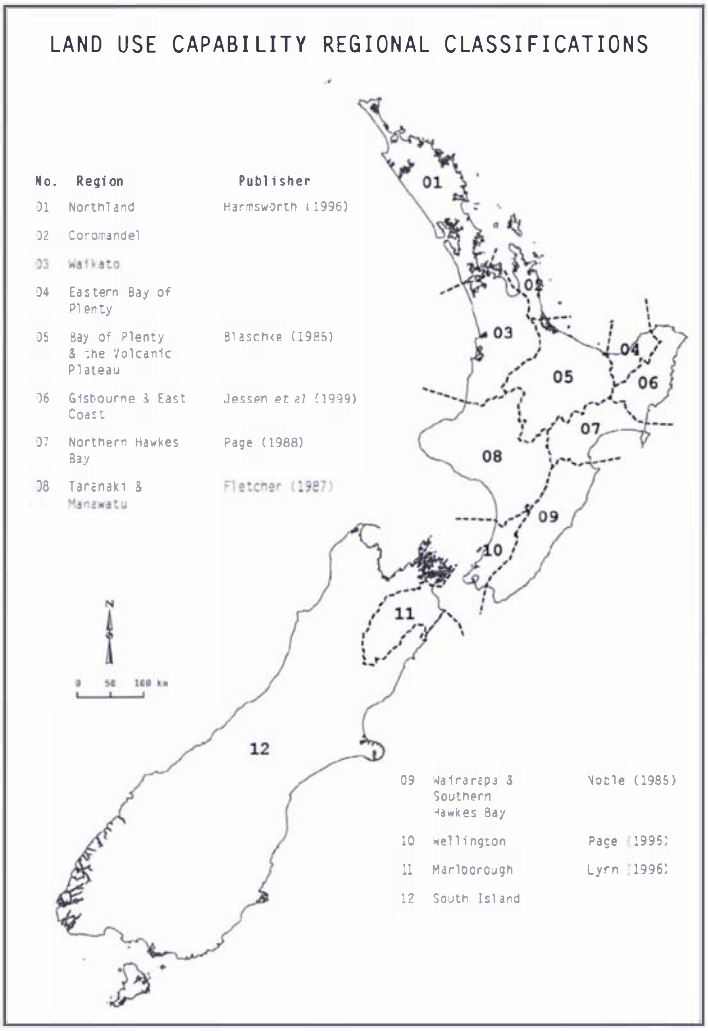


Figure 5.37: Regional LUC classification boundaries, and coverage by published bulletins.

A deferred shift to metric mapping standards occurred after the last set of Worksheets were published in 1979. This fell within the five-year revision period originally envisaged for the Worksheets (Eyles, 1975; Howard & Eyles, 1979), considered necessary for updating the dynamic factors of vegetation, erosion, and land use, and to incorporate new information put forward by other agencies (such as the Soil Bureau). This period was later officially extended to ten years (LINZ, 1987), although no all-encompassing national update has taken place since second edition mapping began in 1979.

Second edition mapping involved two parts: firstly, Worksheets were cartographically upgraded to the then new NZ Map Series 260 topographical base-maps, meaning the national inventory and classification moved from a 1:63,360 imperial scale up to a 1:50,000 metric scale; and secondly, a detailed review of the multi-factor mapping system and LUC class definition, as a means to update inventory factors and classification standards (Eyles, 1999). However, as these updates would fall within the 1980s reform and post-reform period, only five regional programs were actually implemented between 1979 and 1999. These included North Waikato (1980-84), Northland (1985-1990), Wellington (1987-1992), Marlborough (1987-199?) as reported by LINZ (1987), and the Gisborne-East Cape region between 1995-1999 (Jessen, *et al.*, 1999). Because recorded inventory factors represent a 'snapshot in time' (LINZ, 1987), all other regions are represented by increasingly outdated historical data and classifications. This is particularly true for dynamic features such as erosion type, erosion extent, and vegetation, but is less so for more static features such as rock, soil, slope and 'characteristic erosion associations' (Stephens *et al.*, 1997). Likewise, it is feasible to suggest that LUC classifications can change significantly as land improvement becomes more viable (*i.e.* as it becomes more economically and technically feasible to overcome capability limitations).

Worksheets are still commercially available in NZ, although it appears they will not longer be used for any future upgrades (the 2nd Edition Gisborne-East Coast update was not published as Worksheets). Rather, the digital database version has become the norm. Today, this database has been afforded a status of 'Database of National Importance' by the Ministry of Research, Science and Technology (MoRST), and is managed and 'maintained' by the Crown Research Institute (CRI), Landcare Research. However, to some this is an unsatisfactory arrangement, as the database is now used more for research rather than planning (Eyles, 1999), and 'threshold' funding for maintenance limits the ability of Landcare Research to periodically update the database's dynamic factors.

Taken together, the digital database, Bulletins, Extended Legends, Worksheets, standards and the LUC survey system itself, all combine into what is known as the New Zealand Land Resource Inventory (NZLRI) and Land Use Capability Classification. However, colloquially 'the NZLRI' is commonly used to describe the whole system, and in modern-day terms is often used solely in reference to the digital database. In this form, the modern NZLRI contains a total of 101,572 individual polygon units (1999 version), that range in size from the small 3.9ha Taupiri Island (located off the western-most coast of Northland), up to a 51,990ha land unit located in the Raukumara Forest Park (or up to 61,265ha for Lake Taupo). Smallest standalone units (*i.e.* that contain their own notation) used in 1:50,000 Worksheets are generally about 60ha in size, although vinculums (curved hooks) are used to join smaller units down to approximately 15-25ha in size (Page, 1995; Stephens *et al.*, 1997).

New Zealand's tentative beginnings in land survey and classification have evolved over the last sixty years, to be consolidated as a standardised procedure, and applied to obtain almost complete national coverage of LRI and LUC (Figure 5.38). Due to the 1:50,000 scale, this coverage conveys only minor value as a source of farm-level resource information (Chapter 4). However, perhaps a greater value resulted when the standards and procedures filtered down to soil conservators involved in the preparation of farm plans – detailed farm surveys and classifications could now be undertaken across the country in a uniform manner, using the same capability units and inventory standards as those that appeared in the Worksheets.

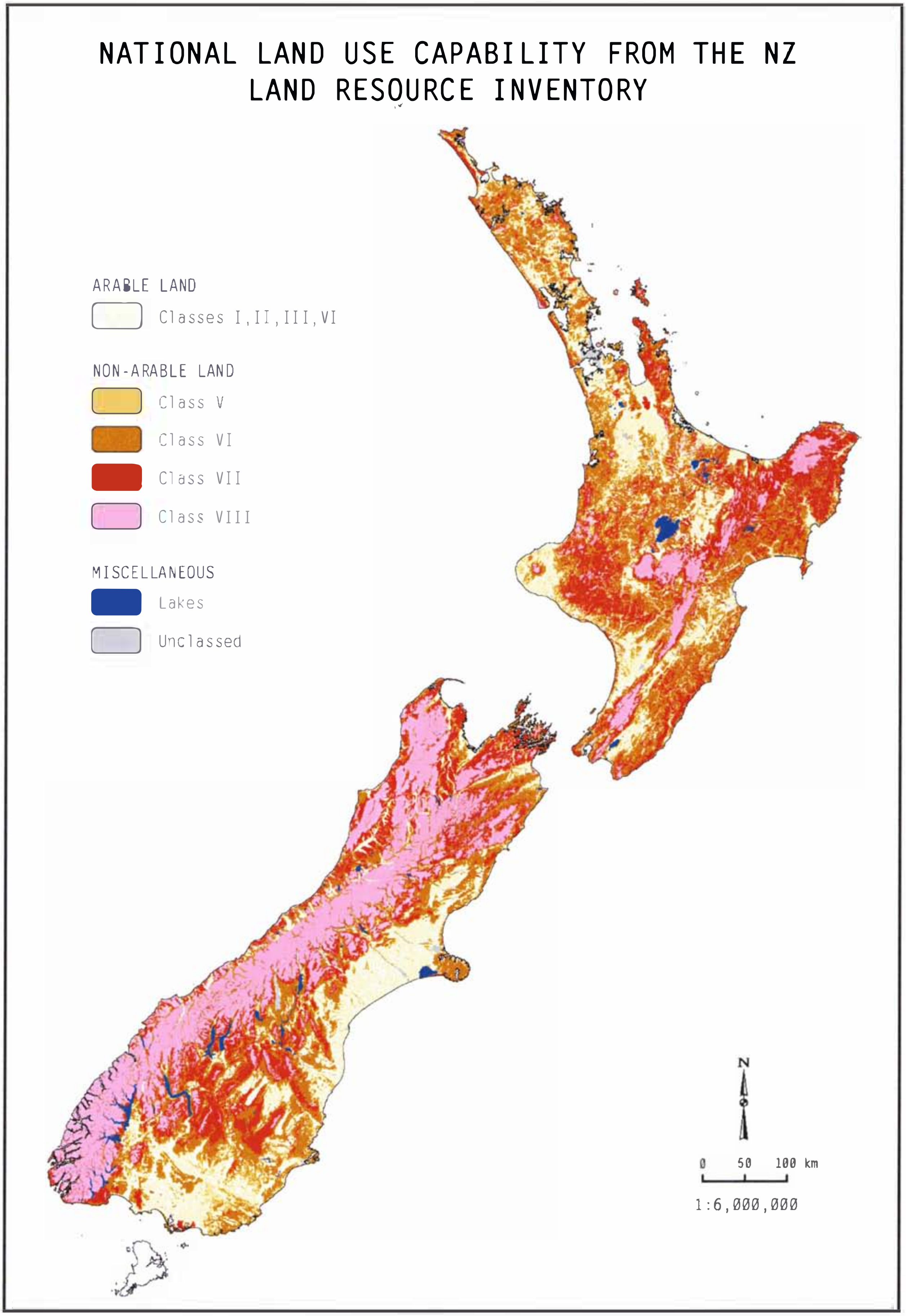


Figure 5.38: Representation of national LUC derived from the NZLRI computer database (Stewart Island not surveyed).

5.3.8 Farm planning 1967 to 1991

Soon after the passing of the WSC Act in 1967, the then conventional 'conservation farm plans' were apparently revised slightly to incorporate the new Act's water management emphasis. As noted by McCaskill (1976), 'the new title for such a plan is Soil and Water Conservation Plan or S.W.C.P., except that, if no water conservation measures are included it will be called a Soil Conservation Plan' (p.19). However, for many catchment authorities this change was in name only, and the originally intended soil-water distinction between the two has rarely been expressed.

Exactly when authorities shifted to SWCPs is uncertain, although the *Water and Soil* magazine begins to cite the title in earnest in 1968 articles. It also appears in the 1969 Handbook, in reference to the multi-scale dimension of the LUC survey system, and as a defined glossary term that only hints at a greater consideration of water management concerns:

> *'Soil & Water Conservation Plans: where single conservation practices do not mitigate an erosion or water control problem... the comprehensive approach of a conservation farm plan is required. Such a plan includes:*
>
> *(a) Initial land inventory survey and land use capability assessment (L.U.C.S.)*
>
> *(b) Design of a conservation programme based on L.U.C.S. and effective, economic soil and water conservation techniques*
>
> *(c) An agreement between the catchment authority and farmer to carry out specified works or practices within a prescribed period...[and] ideally the plan has a balance of soil and water control measures and provides for increased production'*
>
> (MoW, 1969, p.133)

The Handbook's definition does not appear to make any distinction between SWCPs and the prior conservation farm plans, suggesting that farm planning was to continue more-or-less unchanged post-1967 (albeit under a different title). Indeed, generalised SWCPs appear to have become the principal type of farm planning throughout the 1970s and 80s, using an approach that changed little from that used in the 1960s (an exception being the integration of national standards).

This idea of 'business as usual' is supported by the lack of post-1967 instructions on farm planning. Apart from the broad procedure given in the definition above, the 1969 Handbook gave no comprehensive account of how to undertake farm planning. Likewise, the procedures put forward in the early 1960s have never been reviewed and updated with an official publication. However, this has been overcome somewhat, through the introduction of various regional training programs, although the lack of a standard reference on the design of farm plans has been lamented by the trainers (Hicks, 1996).

5.3.8.1 Farm plan numbers 1967 – 1991

Numbers of farm plans completed progressed steadily after 1967, with a total of 800 plans in 1968 (Greenall, 1968), almost 1000 by 1969 (Dick, 1969). The SCRC Council estimated that approximately 1500-2000 farm plans were in operation during the mid-1970s (SCRCC, 1976), but the exact numbers were uncertain because no national review of catchment authority works had been undertaken since 1969.

A new national 'review of progress' was initiated by NWASCA in the early 1980s, to gauge the degree of soil conservation progress since 1969 (Miller, 1988). As part of this review, catchment authorities were asked to report on the number of farm plans for 1970 and 1985, which were either in preparation, awaiting approval, in operation, completed, or disbanded. Summed together, results showed that 1277 plans had been prepared by 1970, which jumped to 4537 in 1985 (Table 5.14). This represents an approximate increase of 30% in farm plan numbers over 15 years.

The national review program reinstated by NWASCA did not endure after the organisation was disbanded in 1987. However, as a tribute to the New Zealand Catchment Authorities' Association (NZCAA), Hughes (1989) collected a range of information from catchment authorities prior to the final stage of the local government reforms in 1989. She reported that the authorities had completed a total of 4731 plans before their replacement by regional authorities. Added to a further 1326 shelter type plans reported by Otago, North & South Canterbury, and Wairarapa Catchment Boards, this represents a grand total of 6057 farm plans prepared since the official adoption of the technique in 1956.

Catchment district	Targets[1] 1961	Numbers[2] 1970	Numbers[2] 1985	Numbers[3] 1989
Auckland	-	0	190	220
Bay of Plenty	-	2	84	287
Manawatu	650	?	?	160
Rangitikei Wanganui	1250	185	417	349[4]
East Cape Poverty Bay	1050	217	423	180[4]
Hauraki	-	0	20	18[4]
Hawkes Bay	2000	69	325	435
Marlborough	178	68	490	110[4]
Nelson	1000	84	200	140[4]
North Canterbury	472	108	384	455
Northland	-	40	357	160[4]
Otago	1200	120	295	360
South Canterbury	1050	94	107	150
Southland	106	24	84	86
Taranaki	-	0	174	290
Waikato	-	30	478	503
Wairarapa	600	195	418	454
Waitaki	-	31	79	352
Wellington	-	-	0	0
Westland	-	0	12	22
Total	9556	1277	4537	4731

[1] Campbell (1965)

[2] All farm plans in prep, awaiting approval, in operation, completed, or disbanded. MCB not included. Miller (1988)

[3] Hughes (1989). An additional 1326 shelter type plans also completed by 1989 (grand total = 6057)

[4] Negative descrepnecies between years for particular districts attributable to different tally methods

Table 5.14: Numbers of farm plans prepared up until 1989.

Farm plan numbers become vague after the establishment of nationwide regional councils and introduction of the RMA. Krausse & Dymond (1996) reiterate previous totals in 1996, by stating that over '4500 individual farm plans, covering more than 50% of the farmed land in New Zealand, have been prepared for soil and water conservation purposes over the last 30 years' (p.29). An attempt to estimate 1991 and 2001 farm plan numbers is made in Chapter 6, along with a discussion on the results of a nationwide farm plan survey undertaken by Blaschke & Ngapo (2002).

5.3.8.2 Soil and Water Conservation Competitions

Another offshoot from the late 1960s was annual Soil and Water Conservation Competitions. These were sponsored by the SCRC Council, but held by individual catchment authorities. The purpose of the competitions was to 'stimulate interest in conservation and to recognise the successful work being carried out on many farms throughout the country' (Dixie, 1968, p.3).

The first was hosted by the Wairarapa Catchment Board in 1967, open to any hill country farmer operating a soil conservation farm plan within the catchment district. Fifty-two entries were received, each of which was judged according ten conservation and production factors that carried their own points weighting. Outright winner was a farm called Blairlogie, considered to show 'the best effort towards soil conservation, consistent with permanent and profitable land use, in relation to the erosion hazard' (*ibid.*). Subsequent prizes were awarded to 'best conservation farms' located in individual counties.

Success of the first competition prompted the Council to sponsor a second in the following year, held by Rangitikei Catchment Board and attracting 40 entrants (SCRCC, 1971). A third was held in 1971 by the South Canterbury Catchment Board (Rowell & MacDonald, 1971), and a fourth two years later in Otago (Wallace-Ramsay, 1973). However, no reference to subsequent competitions could be sourced, suggesting to the author that soil and water conservation competitions tapered off towards the end of the 1970s.

5.3.8.3 Farm plan examples 1967 - 1991

The basic structure underlying farm plans does not appear to have changed significantly between the 1960s and 1980s, possibly because every plan had to include specifications as laid down by the SCRC Council and subsequent administering organisations. Despite this, it also appears that catchment authorities had considerable freedom in the way these specifications were included, giving rise to a diverse range of layouts adapted to the authorities' own catchment situation and preferences. This ranges from simple plans reported on three double-sided pieces of loose-leaf paper, to comprehensive and bound reports of 50 pages or more (and at a standard suitable for general publication).

A detailed review of this diversity would be impracticable (for this chapter). Rather, two examples have been selected, both of which demonstrate pre-1991 farm planning alternatively in the North and South Islands. The first was prepared by the East Cape Catchment Board, while the second was prepared by the Otago Catchment Board. Examples from these two Boards are selected because their regional and unitary successors discontinued traditional farm planning. Traditional models that are still used in a contemporary sense are examined in the following chapter.

5.3.8.3.1 East Cape Catchment Board farm plan example 1987

The first example is for a 1720ha hill country station located near Te Puia Springs (approximately 100km north of Gisborne). Topography is predominately moderately steep to steep, which along with a high rainfall (>1700mm/yr) and a jointed mudstone rock type (80% of the farm), conveys high actual and potential rates of erosion. Farm enterprises include sheep and beef breeding (at 6.6 su/ha).

The station first had a soil and water conservation plan prepared in 1978. Implementation was completed in the early 1980s, necessitating a second plan in 1987. The latter plan is reported here (in a past tense because this plan has also been presumably completed).

The plan included two maps and a report broken into three sections. The first section of the report was given to a physical description of the station, which detailed the four categories depicted in Figure 5.39. Considerable information was given on soils relative to that provided for climate, rock type, topography and vegetation. LUC for the station was briefly introduced, with a more comprehensive breakdown given as an appendix (Figure 5.41). Production was discussed, including stock wintered, stock performance, fertiliser use, and the practice of scrub clearing.

1. PHYSICAL DESCRIPTION SECTION

Location, area & tenure

Property description

Land Use Capability Classification

Management & land use patterns

Figure 5.39: Categories presented in the first section of the East Cape farm plan example.

Previous conservation works are discussed in the second section, along with the areas of the farm that still required treatment (the 'problems'). This led into the proposed programme, which essentially recommended building upon existing debris dams and plantings, over a five year period. Pastoral retirement of a large area of class VII land was discussed, but deferred because the cost to production was considered too high. However, a smaller area was to be retired through electric fencing and afforestation with pines and acacias. The five year programme was presented as a tabulated summary of required works by cost.

2. CONSERVATION WORKS PROGRAMME SECTION

Past works

Problems

Proposed programme

Economics

Acknowledgements

Recommendations

Figure 5.40: Categories presented in the second section of the East Cape farm plan example.

The main body of the report was concise and brief (7 pages), with greater detail provided in the appendices (15 pages). The first appendix was given wholly to outlining works specifications (*i.e.* the standards for undertaking particular soil conservation works) and 1987 prices and costs. The second reduced the five year works programme to annual programs, again tabulated as works by cost. The third detailed the station's LUC classification, and the fourth reviewed soil conservation work undertaken previously.

Although the LUC appendix discussed land resources in detail, no land inventory map was provided. Rather, the maps included LUC units for the station (Figure 5.42), and another depicting the proposed works programme (Figure 5.43). Omission of an inventory map appears to be a characteristic practice of many North Island catchment authorities, irrespective of whether or not an inventory survey was undertaken. In this East Cape example, such a survey did take place (as part of a large scale catchment survey), but the farmer was not provided the inventory data in the form of a map.

3. APPENDICES

Specifications and costs

Annual proposed programme

Land Use Capability Units

Past soil conservation works

Figure 5.41: Appendix headings from the East Cape farm plan example.

The second map used colours to depict where, and in which year, the recommended soil conservation works would take place. Taken together, both maps represent a refinement of the earlier 'two-into-one' LUC/works map described for the Tennet Farm Plan. This practice appears to be common to farm plans from around the country, suggesting it was a standard required by the SCRC Council. Indeed, the first farm plan prepared by the MCB for the Moar Brothers in 1958 (MCB Soil Conservation Project 3/5/3) included a 'two-into-one' LUC/works map, which was initially rejected by the Council with a recommended revision of 'one LUC map, and another showing yearly programs'.

Figure 5.42: LUC map included in the East Coast farm plan example. Original scale = 1:11,440.

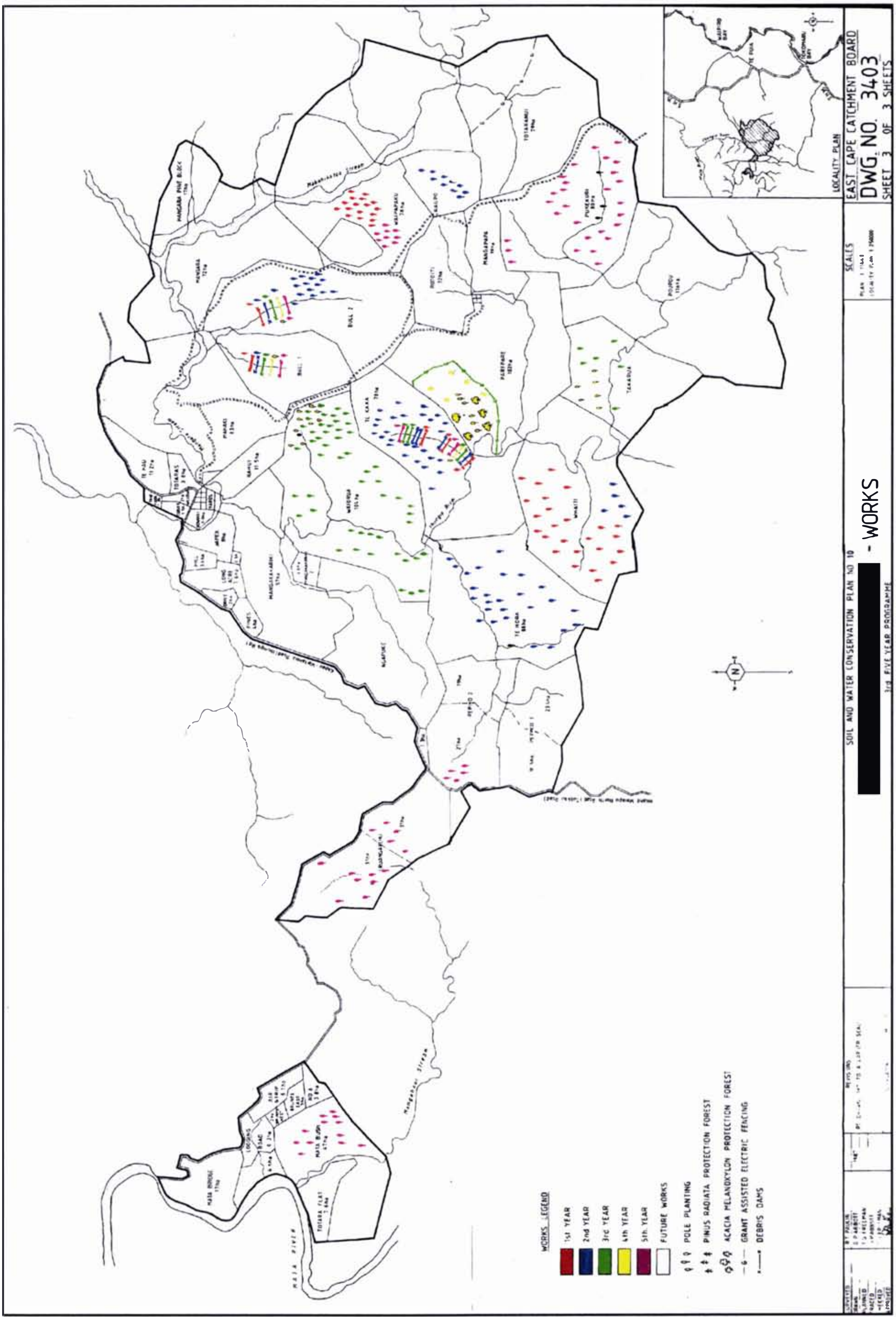


Figure 5.43: Works Programme map included in the East Coast farm plan example. Original scale = 1:11,440.

The maps presented as Figures 5.42 and 5.43 have been downsampled considerably (330% reduction), from the original folded and discoloured (with age) versions included with the farm plan. Hence, clarity is poor, but they have been included to demonstrate the original character of the maps as received by the farmer as part of the plan. Original paper size was A1 (594mm x 841mm), and the original scale was 1:11,440.

5.3.8.3.2 Otago Catchment Board farm plan example 1981

The example selected for discussion was prepared by the Otago Catchment Board in 1981, for a 295ha farm located 4km from the Dunedin suburb of Mosgiel. Layout of the report was very similar to that evident with the East Coast example, including the use of the same major headings. In this sense, two principal sections comprised the main body of the report, with further information included as appendices.

The first section explores the farm situation, with a particularly comprehensive emphasis on describing land resources (Figure 5.54). Of most note is the discussion on geology and soils, both of which go into considerable geological and pedological detail. Likewise, a thorough explanatory account of the erosion process is given. LUC units were briefly tabulated, and as a slight divergence from the traditional soil conservation focus, pests and weeds are discussed. The management category included an overview of subdivision and water resources, and discussion on other production factors such as fertiliser, stocking rate, production performance and pasture renewal.

The second section reviewed soil conservation 'problems' identified on the farm (Figure 5.45), leading onto a set of five objectives for the proposed conservation works programme. This involved an explanation of recommended works according to whether or not they qualify for subsidy, followed by a brief account of how the works were to be paid for. Much of the financial detail and year-by-year works were presented as appendices, as were the technical specifications for undertaking works (Figure 5.46).

While the report structure was very similar to that used elsewhere (albeit more detailed), the greatest distinguishing feature of the Otago farm plan example was the series of three maps. These included not only the standard LUC and works programme maps (Figures 5.48 and 5.49 respectively), but also a land inventory map (Figure 5.47). These three maps have also been reduced considerably from the originals (230% reduction), which were aged copies of copies to begin with. Despite the resulting poor clarity, they demonstrate that the Otago Catchment Board used a detailed format for their maps, particularly in regard to the legends.

1. PHYSICAL DESCRIPTION SECTION

- References
- Legal description
- Location & access
- Climate
- Topography
- Geology
- Soils
- Vegetation
- Wild animals & weeds
- Subdivision & water
- Erosion & depletion
- Land inventory & capability
- Management

Figure 5.44: Categories presented in the first section of the Otago farm plan example.

2. CONSERVATION WORKS PROGRAMME SECTION

- Problems on the property
- Proposed conservation works
- Economics
- Acknowledgements

Figure 5.45: Categories presented in the second section of the Otago farm plan example.

3. APPENDICES

- Specifications and costs
- Annual programme & expenditure
- Summary of yearly totals
- Pole planting specifications

Figure 5.46: Appendix headings from the Otago farm plan example.

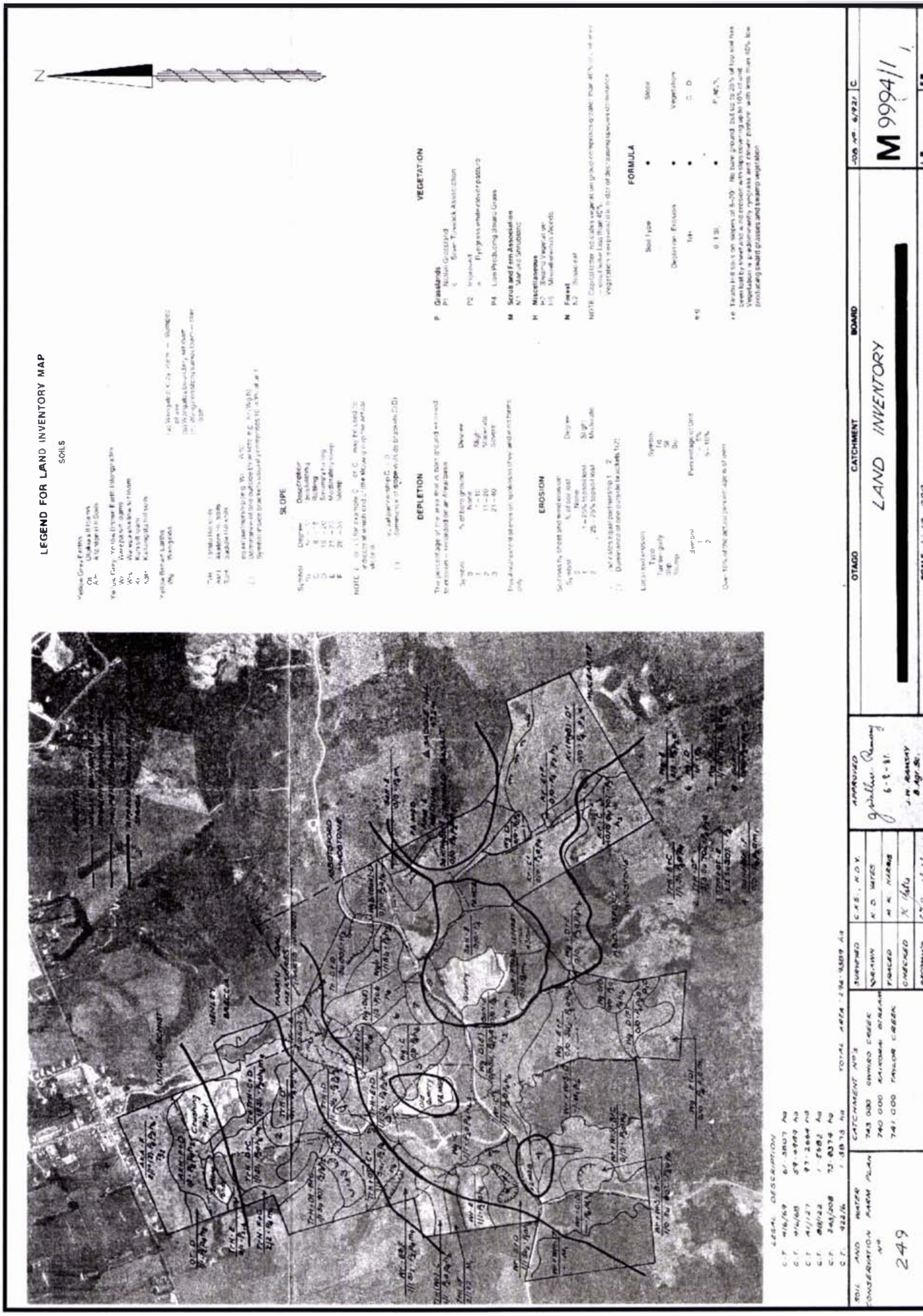


Figure 5.47: Example of a Land Inventory map from an Otago Catchment Board farm plan. Original scale = 1:10,000.

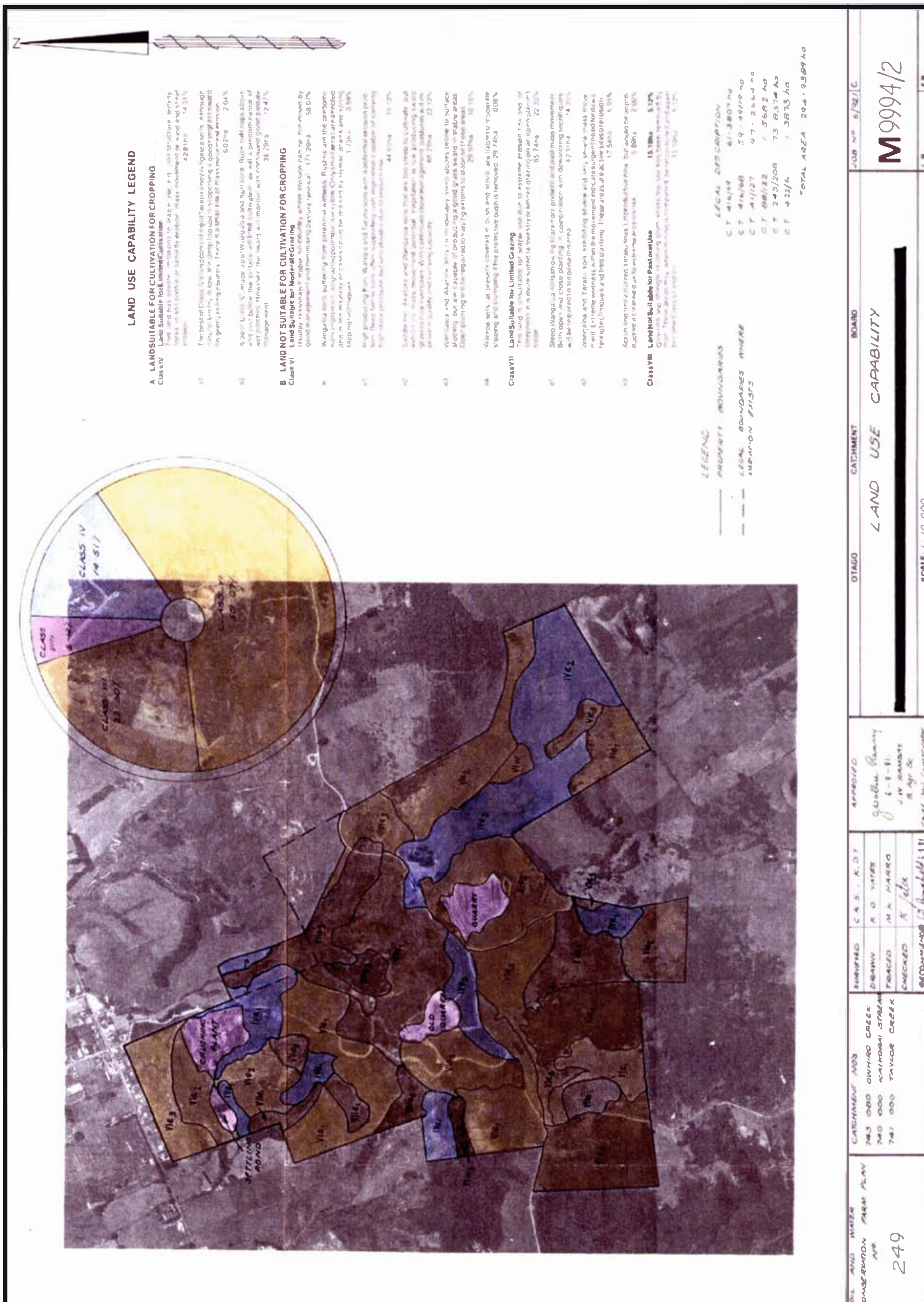


Figure 5.48: Example of a Land Use Capability map from an Otago Catchment Board farm plan. Original scale = 1:10,000.

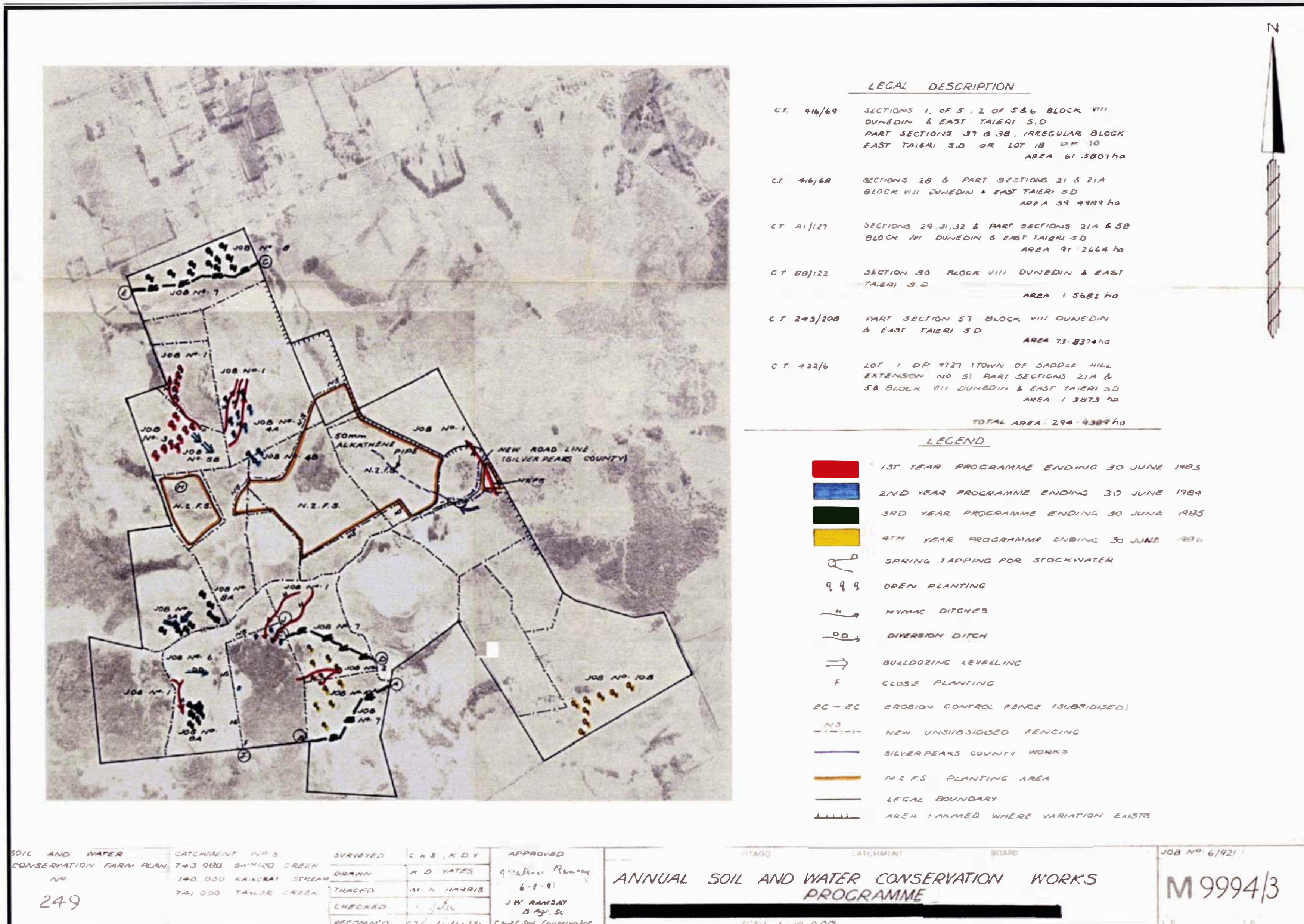


Figure 5.49: Example of a Conservation Works Programme map from an Otago Catchment Board farm plan. Original scale = 1:10,000.

Other notable features concerning the Otago farm plan maps include the depiction of geological 'zones' on the land inventory map, the colouring of LUC units using watercolours, and the presentation of all three maps using an aerial photo base. The use of aerial photos in this way was not unique to the Otago Catchment Board, as the practice was originally recommended in the LUC Handbook (MoW, 1969). However, due to the cost of such photography, and coupled with low quality copying technology pre-1990s, not all catchment authorities regularly used aerial photos as base maps.

One final feature of interest was the manner in which the Otago CB used the LUC classification. Rather than seeking uniformity of LUC units between farms, each farm was given it's own unique classification at the unit level. As portrayed in Figure 5.48, units for individual farms were assigned in a numerically sequential manner (*e.g.* e1, e2, e3, etc.), as opposed to the recommended method of erecting a local or regional classification according to national standards. Hence, an area classed as 6e1 on one farm, may not be the same as a 6e1 classed on a nearby farm. Such inconsistency carries considerable potential for confusion, and it is unclear why the SCRC Council did not apparently intervene.

In a similar sense, the neighbouring Waitaki Catchment Board also had their own system of LUC classification (Grant Cooper, 4th April 2003, per. comm.). Rather than a regional or farm-by-farm classification system, Waitaki used their own catchment classification of LUC to the unit level. Hence, while a unit of 6e1 may be consistent throughout the catchment, it would not necessarily correlate to the regional (*i.e.* for most of the South Island) classification of 6e1.

Taken together, both the East Cape and Otago farm plan examples are broadly representative of the type of farm plans that were prepared during the 1970s and 1980s. A plan would include at least two separate maps of LUC and a works programme, and perhaps a third to show land resource inventory. Inclusion of the third map was not a widespread practice, particularly in the North Island. Reports included two principal sections, the first dealing with a description of the farm and it's resources, and the second outlining a five-year works programme with costs. However, the amount of detail included with reports varied widely – some were notably brief and to the point (*e.g.* Rangitikei Catchment Board), several provided a summarised description with greater detail appended (*e.g.* East Cape and Otago Catchment Boards), while others concisely included all the detail in the main report without relying on appendices (*e.g.* Taranaki Catchment Comission).

5.4. FARM PLAN RELATED INITIATIVES POST-1991

The introduction of the RMA in 1991, along with the shift from catchment authorities to unitary and regional councils, had significant implications for the practice of farm planning. No longer was there a need to prepare plans as a mechanism through-which subsidies were allocated, and the move away from territorial control by a central government (decentralisation), meant that it was up to individual councils to decide whether or not farm planning would be retained as a policy instrument.

Decentralisation and increased autonomy resulted in some councils abolishing the use of farm plans. Either the farm-by-farm cost of preparing plans was considered too high (without national support), or they were no longer considered necessary in the absence of subsidies. Furthermore, the new guiding principle of sustainable resource management formally introduced a more challenging array of social and environmental issues, which traditional soil-conservation orientated models of farm planning could not readily accommodate.

While certain councils retained traditional farm planning, several opted for new initiatives that explored some dimension of farm sustainability from a planning perspective. These initiatives typically involved collaboration between multiple interests focusing on a small number of farms (*i.e.* focus farms), in an attempt to identify a generic formula that could be broadly used to address issues of farm sustainability. The resulting 'formula' was often packaged for extension as a farm planning procedure.

A brief selection of initiatives that resulted in new approaches to farm planning includes: the Taranaki sustainable hill-country projects; the Ruru Farm case study in Wairarapa; Hawkes Bay whole farm planning; the Gwavas and Westview Sustainable Land Management Project (SLMP); the Rabbit and Land Management Programme; and the North Otago Sustainable Land Management Project. These initiatives demonstrate some of the ways in which farm planning was modernised to account for the new challenges of the 1990s.

Although recent developments in farm planning can all be considered as initiatives in a modern-day sense, many bear a marked resemblance to the soil conservation response of the 1940s and 1950s. This is particularly evident as an underlying mix of new science, land assessment, pilot programs and demonstration farms, and attempts to reconcile and integrate biophysical, production and business concerns in a whole-farm manner.

5.4.1 THE TARANAKI SUSTAINABLE HILL COUNTRY PROJECTS

During the 1980s and early 1990s, collaborative research was undertaken in Eastern Taranaki hill-country regarding the relation between pasture production and erosion. In the build-up to the introduction of the RMA, this research was used as a basis for a novel land classification system and farm planning technique, first developed and applied as a pilot farm plan in 1990 (colloquially known as the 'Hopkirk Project'). The success of this Project resulted in the establishment of four demonstration farms (as the Taranaki Sustainable Hill Country Farming Project), and the adoption of the process by the Taranaki Regional Council (TRC) as Sustainable Land Management Plans (SLM Plans). Over 100 of these Plans had been prepared by 1996, when the TRC again changed it's farm planning policy with a return to LUC-based survey for hill country farms (see Chapter 6).

5.4.1.1 Collaborative research

Between 1984-88, a series of pasture production and erosion studies were undertaken in the Eastern Taranaki hill country on three representative farms located at Makahu, Pohokura and Tututawa. This research involved a collaborative effort between the Ministry of Agriculture and Fisheries (MAF), MoWs, and the Taranaki Catchment Commission (TCC). Between 1986-91 another series of research trials were undertaken by the Department of Scientific and Industrial Research (DSIR), specifically investigating erosion processes in the Makahu district. Summarised results from each series of trials have been reported in NWASCA (1987), Gane *et al.* (1991), Blaschke *et al.* (1992a, 1992b), TRC (1992), and DeRose *et al.* (1993).

Position on hillside*	Pohokura	Makahu	Tututawa
Bottom	7300	12600	12300
Middle	6400	9600	9100
Upper	5300	7900	6500
Average	6300	10000	9300

* Uneroded sites only

Table 5.15: Eastern Taranaki hill country pasture production on different parts of hill slopes (Kg DM/ha). From Blaschke et al. (1992a).

Although the results were numerous, three were isolated as guiding principles upon which the Hopkirk farm plan would be based (Blaschke *et al.*, 1992a). Firstly, hill country pasture production was identified as having a strong relation with hill-slope position – pasture production decreased with increasing slope height (Table 5.15). Secondly, a three-way relation was identified between pasture production, erosion, and slope class (Table 5.16), whereby pasture production on different slopes was predicted to decrease in parallel with ongoing rates of erosion.

	Gentle slopes ($20-28^0$)	Moderate slopes ($28-32^0$)			Steep slopes ($33-32^0$)	V. steep slopes ($>42^0$)
Year	≈2150	1900	1990	≈2150	≈2150	≈2150
Est. pasture production (Kg DM/ha/yr)*	9500kg	8900kg	7840kg	≈6400kg?	≈4000kg	<4000kg
% of uneroded level	100% (*no significant erosion*)	94%	88%	≈70%	≈40%?	<40%

* Using current management methods

Table 5.16: Relation between erosion and potential pasture production from different hill slope classes, Makahu, Eastern Taranaki. From Blaschke et al. (1992a).

Thirdly, mean soil depth on different slope classes was related to time since deforestation, to derive a 'soil loss model' for the Makahu district (Figure 5.50). According to the model, slopes less than 28^0 had undergone no significant soil loss since deforestation and appeared capable of maintaining existing levels of pasture production indefinitely (TRC, 1992). Slopes between 28^0 - 33^0 exhibited a slow net soil loss since deforestation, and could continue to support pastoralism for an extended period with only minor adjustments in management. Secondary intermediate slopes (33^0 - 42^0) had lost significant amounts of soil, such that, only some of this class was considered farmable for an extended period under a soil conservation management system. Overall, continued farming of this class was deemed unsustainable. Similarly, the steepest class ($>42^0$) was considered suitable only for retirement to conservation forest (*i.e.* scrub reversion), having regained a steady-state dynamic between erosion and pedogenisis under pasture as a shallow and marginally productive soil.

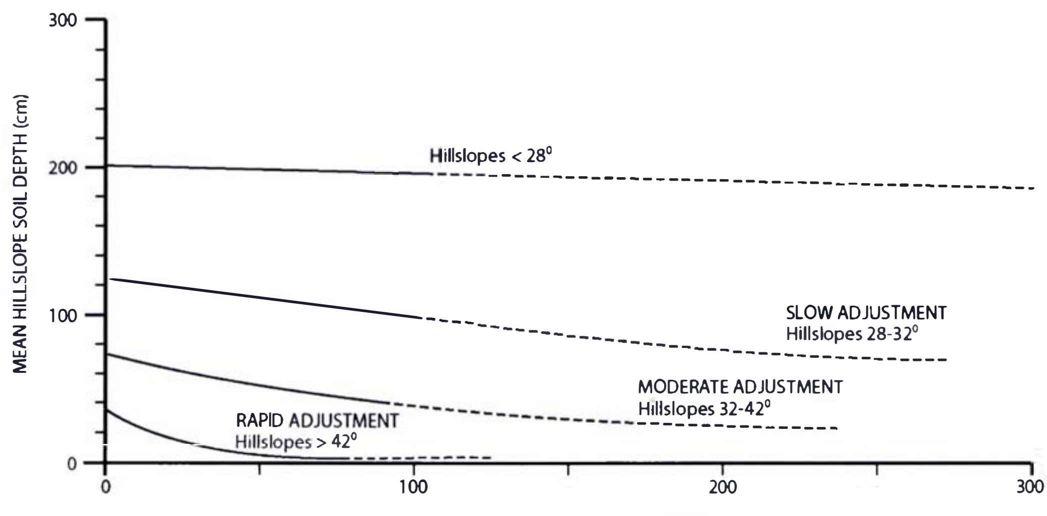


Figure 5.50: Soil loss model for Makahu district demonstrating the change in mean soil depth overtime, on different slope classes (redrawn from Blaschke et al., 1992a).

5.4.1.2 The Hopkirk pilot farm plan

In late 1990, a field day was held at the Makahu property where much of the research had taken place. An outcome from this day, was 'to follow up and examine, on a whole farm basis, the implications of the results and to practically apply the knowledge' (TRC, 1992, p.2). This resulted in the establishment of a pilot study on a representative Eastern Taranaki hill country farm. To be representative, such a farm would require a diverse range of land classes characteristic of Taranaki hill country; an established system of management; and a willing and respected farm manager with a 'responsible attitude to the natural environment' (*ibid.* p.10). The property selected was owned and managed by D. & E. Hopkirk, and hence, the pilot study came to be known as the 'Hopkirk Project'.

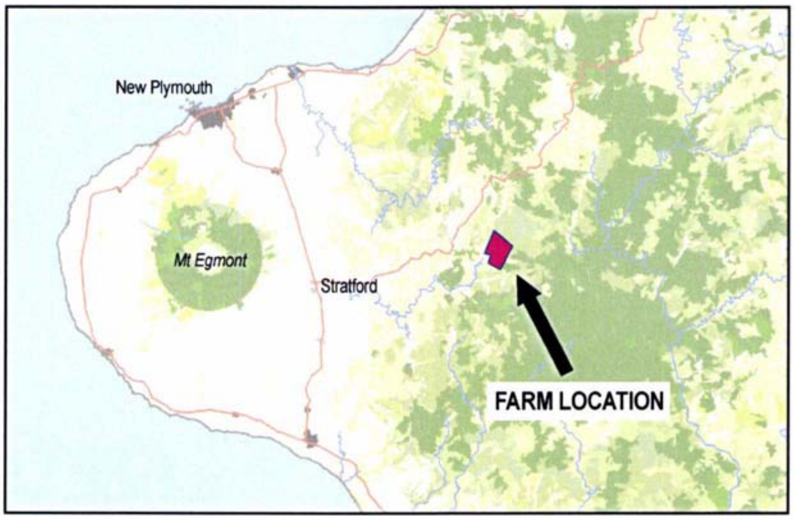


Figure 5.51: Location of the 'Hopkirk Project' pilot farm plan (property size exaggerated).

Briefly, the Hopkirk farm is located 43km east of Stratford (Figure 5.51). The topography of the 784ha property ranges from a small area of flat to gently rolling terrain, with the majority consisting of moderate to very steep hill country. The rock type is predominately andesitic ash overlying Tertiary sandstones, with soils ranging from lowland volcanic loams up to shallow steepland soils. Annual rainfall is approximately 1900mm, and the farm is subject to high intensity rainfall events associated with summer cyclonic storms. Around 5000 stock units were carried, divided between sheep (70%) and cattle (30%) breeding enterprises. At the start of the project, eight hectares were planted in exotic forestry, 650ha as pasture, and 114ha was unfarmed as indigenous forest or scrub.

The broad aim of the Project was to achieve a 'physically sustainable land use which is financially viable without subsides or non-market incentives' (Blaschke *et al.*, 1992a, p.19). Specifically, objectives focused on developing 'an assessment method to identify sustainable farm land use in hill country', and to apply that method to a commercial farm to 'explore options for more sustainable land use while maintaining farm viability and long term profitability' (TRC, 1992, p.4). These two objectives were achieved with the development of a 'sustainable land use' system of classifying land, and the identification and evaluation of alternative land use scenarios using computer models.

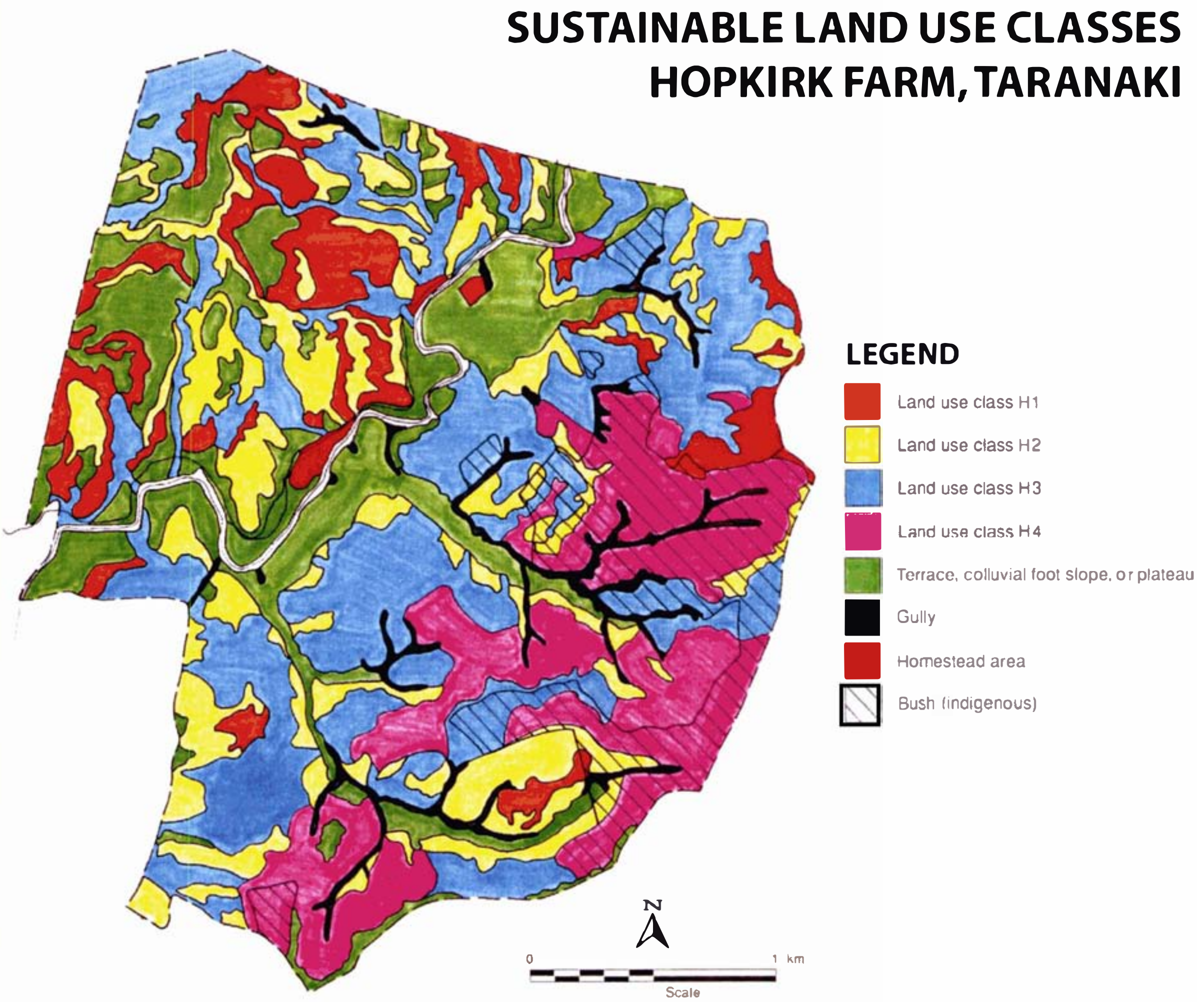
5.4.1.2.1 Sustainable land use classes

The previously described research was used as a basis for the development of a sustainable land use classification. Four hill-country classes were derived from the soil loss model (**H1, H2, H3 & H4**), and a further four were erected to describe characteristic landforms (**T**erraces, **C**olluvial surfaces, **P**lateaux or hill tops, and **G**ullies). Together, these were termed 'sustainable land use classes' (SLU classes), and were used to map the 'physical capability' of the farm onto a 1:10,000 scale aerial photo (Figure 5.52). In turn, an extended legend was constructed to summarise the physical characteristics of each class, and to relate the system to the more conventional LUC classification.

First and foremost, SLU classes were based on erosion as being the main limitation to biophysical sustainability of hill country pastoral production. Hence, Hl had no significant erosion impacting on pasture production, and thus, was considered capable of supporting pastoral land use indefinitely. At the other extreme, H4 could not biophysically sustain a pastoral land use, because shallow soil depths under a steepland pasture (*cf.* forest) were marginally productive, and the revegetation of erosion scars was impaired by continued grazing.

5.4.1.2.2 Scenario evaluation

In effect, sustainable land use classes indicated that around 20% of the farm's area was unsuited to pastoral farming, while over 50% required the integration of soil conservation practices or uses to improve biophysical sustainability (as defined by the soil loss model). Associated requirements of land retirement and soil conservation works would place considerable strain on production and business dimensions of farm sustainability. In an attempt to integrate these three factors, a number of production system (land use system) alternatives were nominated as scenarios, and evaluated against the status quo using the computer modelling packages of Stockpol and the Agroforestry Estate Model (AEM).



EXTENDED LEGEND

Code	*Class description*	*Area*	*Slope (NZLRI)*	*Erosion*	*Soil*	*Closest LUC*
T	Terraces: remnant alluvial deposits at various elevations	6%	Flat to gently rolling (A, B, B+C)	None	Deep *in situ* tephra	IIIc4 (+ IIIe6)
C	Colluvial surfaces: colluvial deposits at the base of hills	2%	Rolling to strongly rolling (C, D, C+D)	Minor surficial	Deep colluvial tephra	IVe7 (+ IIIe6)
P	Hilltops/plateaux: elevated surfaces on bedding plane	4%	Undulating to strongly rolling (B, C, D)	Minor sheet; minor mass movement	Deep *in situ* tephra soils	Vc1 (+ IVe7)
H1	Gentle hill: broad ridges, basins, colluvial infills.	13%	Short upper & lower slopes (E, E+F)	Minor surface & occasional mass movement	Deep tephra soil, *in situ* &colluvial	VIe6 (+ VIe6)
H2	Mod steep hill: triangular front faces, narrow ridges	19%	Short slopes, or low/mid parts of longer slopes (F)	Occasional landslides, significant sheet in places	Deep tephra on faces & gullies	VIIe11 (+ VIe23)
H3	Steep hill: long mid & upper hillslopes	36%	Long slopes (F+G)	Active erosion	Steepland + pockets of tephra	VIIe11
H4	Very steep hill: Upper parts of long hillslopes	18%	Long slopes (G)	Extensively eroded	Shallow steepland – no tephra	VIIIe3 (+ VIIe11)
G/R	Gullies: Narrow deep chasms with very steep walls	2%	Very steep (G)	Mass movement + rock falls	Skeletal soils and bare rock	VIIIe3 (+ VIIe11)

Figure 5.52: Land classification system used in the Hopkirk farm plan (adapted from TRC, 1992).

Baseline data on pasture production and stocking rates for each of the SLU classes were inferred from previous district studies, and adjusted to the fertiliser and erosion history of the Hopkirk farm. Guiding criteria for scenario development throughout, was principally orientated towards intensifying the 'best land' to relieve pressure on 'poor land' (Gane *et al.*, 1991, p.221). While a number of possible scenarios were modelled, only the six most-viable were reported in detail (Tables 5.17 & 5.18).

	Control	Breeding Cows	Dry Ewes	Sheep graze
Policy description	Status quo	Maintenance of a breeding cow herd to produce beef for fattening; stores & replacements	Dairy hfrs on the flatter land while maintaining 'control' sheep & beef policies on steep areas	Dairy hfrs on flatland; maintain sheep no.s on steeper land; flock divided into 'control' & wool production
Total s.u.	5072	4792	4845	4802
Total ha	651	651	651	651
Sheep: cattle	73:27	77:23	77:23	63:27
GM	$131,088	$123,373	$133,806	$153,397
GM/su	$25.85/su	$25.75/su	$27.62/su	$31.94/su

Table 5.17: The three main livestock scenarios reported for the Hopkirk farm plan (adapted from TRC, 1992).

	Full forestry	'Ideal' scenario	Practical scenario
Scenario description	Agroforestry leading to full afforestation, & retirement of 70ha for conservation.	Forestry on most of the pastorally unsustainable land (class H3). Practical limitations overlooked.	Similar to 'ideal' scenario but with practical factors (eg fencing, logging access). Most of H3 & some H2
Area (ha)	651ha	250ha	347ha
Farm cashflows			
Agri only	$93,093	$93,093	$93,093
Farm labour	$450,000	$245,000	$300,000
Contract labour	$425,000	$234,000	$285,000

Table 5.18: The three main forestry scenarios reported for the Hopkirk farm plan (adapted from TRC, 1992).

In short, the 'sheep graze' scenario was identified as the most financially viable stock option, whereby grazing pressure on steepland was reduced somewhat, but not altogether removed. The more-preferred option was the 'practical' agroforestry option, in which all of H4 class was retired, and 347ha of classes H3 and some H2 were to be diversified into forestry. However, the extent to which any of these scenarios were implemented is uncertain, as the Hopkirks later leased their property and withdrew from the extension phase of the project (Morriss, 1998).

Despite this withdrawal, the Hopkirk farm plan represented a new system of assessing hill-land capability (as the ability of hill-land to biophysically sustain pastoral land use), and a new method of identifying, integrating and evaluating alternative land use options that could satisfy the major biophysical, production and business dimensions of farm sustainability. In a slightly refined form, these developments would later be packaged as Sustainable Land Management Plans (TRC SLM Plans), and extended to Taranaki hill country farmers through a follow-on project known as the Taranaki Sustainable Hill Country Farming Project (THCSF Project).

5.4.1.3 Demonstration farms, adoption and extension

The THCSF Project has been reviewed in detail by Morriss (1998). It was first proposed in 1994 by a farm consultant firm (Agriculture NZ), and initiated in 1995 with support from TRC, MfE, MAF Pol and PetroChem. The Project's purpose was 'to extend the pilot study from the Hopkirk's property to study five additional farmers in different locations' (p.8). In doing so, it was envisaged that the participating farms would become focal points of extension and demonstration that would encourage the adoption of more sustainable farming practices throughout the Taranaki hill country.

Including the Hopkirk property, a total of six SLM Plans were prepared for demonstration purposes. However, this was reduced to four with the withdrawal of the Hopkirks and another farmer, which was just one of many setbacks impacting on the overall effectiveness of the Project. Briefly, farmer ownership of the Project was considered poor; a limited number of field-days (4 instead of the initially proposed 18) had disappointing attendance; consultant's skills were found to be lacking; and overall, the Project did not succeed in encouraging the adoption of sustainable farming systems by the wider farming community.

Furthermore, wider application of the SLU classification began to highlight a lack of flexibility with the four hill-country classes (Knowles, 1996). In particular, situations became apparent where an additional hill country class was needed between H2 and H3. Without this, surveyors were applying the H3 class to significantly different landforms, thereby creating a degree of confusion amongst both farmers and consultants. In response, the TRC abolished the SLU classification system in favour of a return to the more versatile LUC approach. As this change occurred partway through the Project, farm plans for each of the six demonstration farms (including those who had withdrawn) were revised and updated. This added an additional financial burden, which in turn lessened resources available for an effective extension program (Morriss, 1998).

TRC's return to the LUC system was matched with a revision of farm planning policy in 1996 (Hicks, 1998). SLM Plans were reoriented as 'comprehensive farm plans', and consolidated as one of several farm planning approaches currently undertaken by the Council (Chapter 6). Despite this change, farm plans based on the Hopkirk model have made a significant contribution to the development of farm planning in New Zealand. While only about 100 plans of this type were produced, the model represents one of the first and most widely reported initiatives concerning sustainability orientated farm plans.

5.4.2 THE RURU FARM CASE STUDY

In 1993, the Wellington Regional Council embarked upon an investigation 'to examine ways the Council could assist landowners in their transition to more sustainable use of the Region's hill country' (Cameron, 1994, p.67). This resulted in the design of a four-module farm planning model, which was later applied to a representative Eastern Wairarapa hill country farm as a pilot (Ruru Farm). Successful application resulted in the model being adopted by the Council for widespread application as Sustainable Land Use Plans.

On first impression, the farm planning technique exhibits similarities to those used in the previously discussed Hopkirk example, particularly in regard to mapping landform classes and the evaluation of alternative land use options. However, on closer investigation these similarities are broad, as the Ruru pilot farm plan demonstrates a number of distinctive innovations that set it apart from other farm planning techniques.

5.4.2.1 *Ruru Farm*

Ruru Farm was selected for the case study because it's landforms and geology were considered representative of a large area of Eastern Wairarapa hill country (Hicks, 1995). The property has an established management and ownership structure, having been in the Maunsell family since 1918. Further, the farm has a long history of soil conservation, beginning with one of the Wairarapa Catchment Board's first official farm conservation plans in 1957, to be followed with an additional four plans between the 1960s and 1990s. Ruru even won Masterton county's 'best soil conservation farm' in the 1968 Soil Conservation Competition (Dixie, 1968).

The farm itself is located approximately 40km NE of Masterton (Figure 5.53), in an area characterised by deep-seated mass-movements associated with jointed and banded mudstones. Annual rainfall is estimated at 1200mm, and the property is likely to experience a significant erosion event (on average) once every six years (Hicks, 1995). Total farm area is 674ha, of which 90% was grazed and 10% was planted in woodlots (at the time of the case study). Enterprises were given to beef (2416 stock units) and sheep (5326 stock units) at a 30:70 ratio.

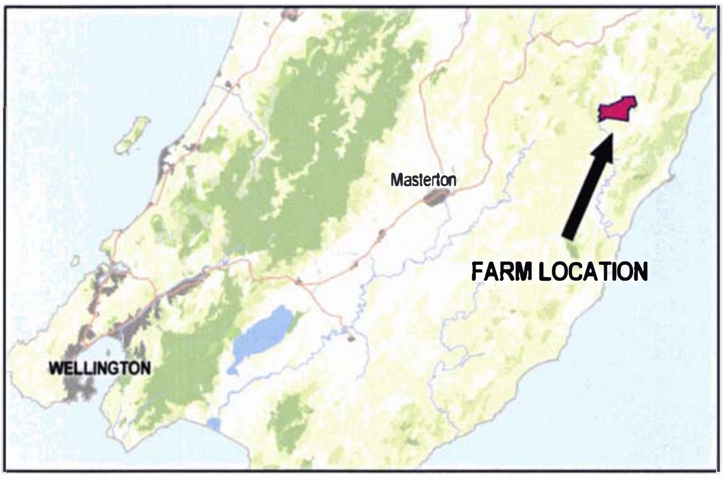


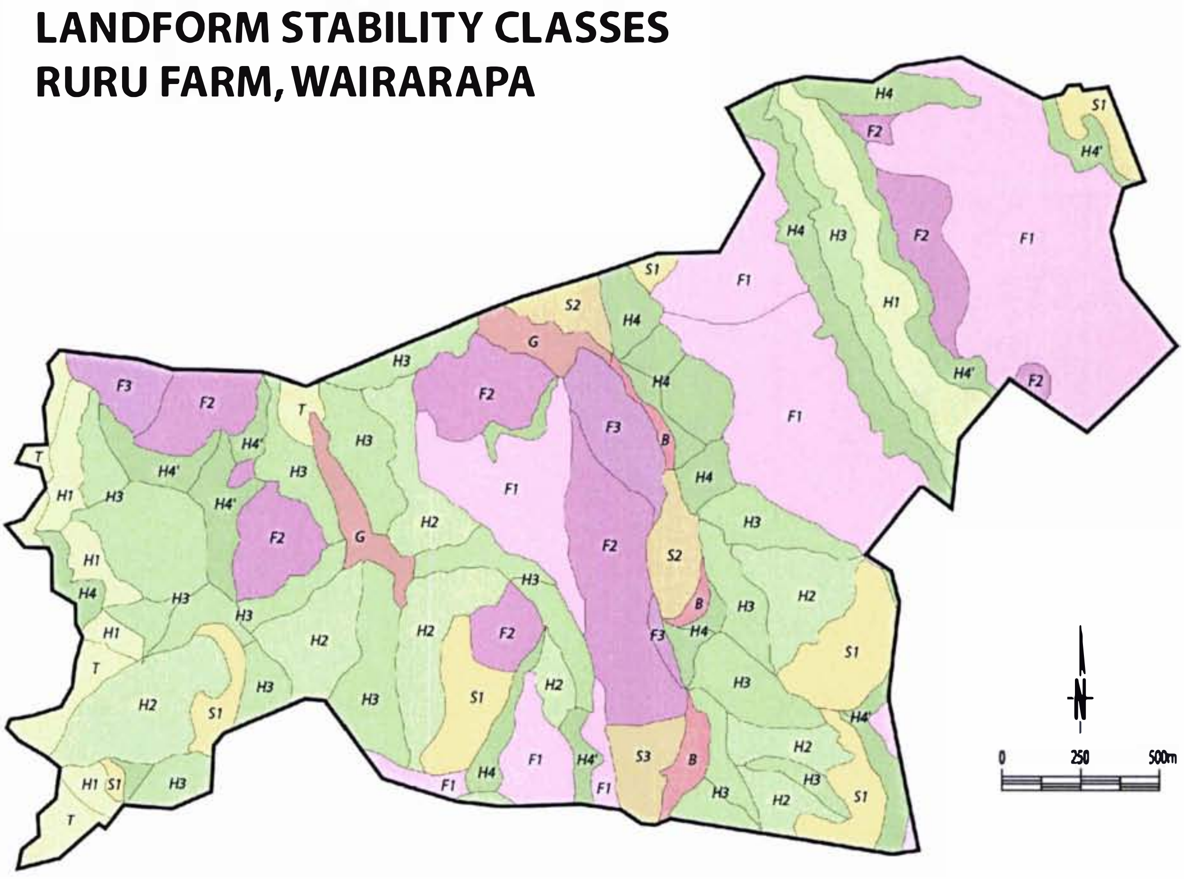
Figure 5.53: Location of the Ruru Farm pilot farm plan (property size exaggerated).

5.4.2.2 *Case study method*

The suggested purpose of the case study was to develop a farm planning 'Decision Support Package', which the WRC could apply to different farms as a means to assess and promote at least four dimensions of farm sustainability. These were divided into modules, including land assessment, production assessment, scenario development & economic assessment, and environmental assessments (Cameron, 1994; Hicks, 1995). This Decision Support Package represents one of the most complete land evaluation frameworks developed for planning sustainable pastoral land use in New Zealand.

5.4.2.2.1 Land assessment

Although a farm-scale LUC classification was referenced during the case study (prepared as part of an earlier farm plan at a 1:10,000 scale), it was not used as a basis for the land assessment. Rather, a new system of land classification was developed, in recognition that the WRC no longer had the staffing resources necessary for widespread farm mapping according to the traditional LUC survey system. This new system was similar to that used in the Hopkirk Project, in that the classification used landforms and erosion as the principal basis for identifying the biophysical ability of land to sustain pastoral land use (Figure 5.54).



LEGEND

	Code	Area	Closest LUC
ALLUVIAL TERRACES			
Terraces formed by fluvial deposits of alluvium	T	17ha	3w1
HILLSLOPES CUT ACROSS GEOLOGICAL STRUCTURES BY SHALLOW FLOWS & SLIPS			
Rolling, mainly stable surfaces	H1	33ha	5e[2]/6e3
Rolling to moderately steep, mainly inactive surfaces	H2	76ha	6e8
Moderately steep to steep, mainly eroded & eroding surfaces	H3	122ha	7e1
Steep to very steep, mainly eroded & eroding surfaces[1]	H4	86ha	6e8/7e1/7e2
STRUCTURAL BASINS FORMED BY DEEP-SEATED SLUMPS			
Rounded, mainly stable surfaces	S1	42ha	4e2/5e[2]
Hummocky, mainly inactive surfaces	S2	12ha	6e[2]
Broken, mainly eroded & eroding surfaces	S3	7ha	7e[2]
STRUCTURAL BENCHES FORMED BY DEEP-SEATED EARTH FLOWS			
Rounded, mainly stable earthflows	F1	164ha	4e2/5e[2]
Hummocky, mainly inactive surfaces	F2	76ha	6e[2]
Broken, mainly eroded & eroding surfaces	F3	19ha	7e[2]
OTHER LANDFORMS			
Gullies	G	13ha	7e2/8e1
Bluffs - very steep to near vertical, mainly eroding surfaces	B	7ha	8e1

[1] *H4' denotes short slopes, incipient gullies, or surficial channels*

[2] *denotes no equivalent capability unit*

Figure 5.54: Land classification system used in the Ruru farm plan. Redrawn and adapted from Hicks (1995). Original compiled by T. O'Hagan, and presented using hatching rather than colours.

Landform units were initially interpreted and mapped from 1:25,000 scale aerial photography, and correlated against the regional LUC classification (Noble, 1985) to derive equivalent LUC designations. Provisional landform and 'new' LUC units were later checked in detail during a farm visit. Compared against the original 1:10,000 LUC map (prepared for an earlier farm plan), landform boundaries coincided closely with the old LUC units, and there was a similar close match between old and new LUC designations.

Efficiency over the traditional LUC survey system was achieved primarily through a reduction in fieldwork. Rather than the three days estimated for LRI & LUC mapping of a comparable sized farm, the new system took only 1.5 days. Much of this efficiency gain appears to have resulted from the omission of LRI mapping. Despite this, some inventory information could be cross-sourced from the Regional Bulletin (rock type, broad soil type, and slope class), and subsequent assessment modules.

Similarity to the Hopkirk landform classification is broad. While some classes may appear similar (*e.g.* H_n), the Ruru classification includes a greater array of classes not constrained to the soil loss model used for the Hopkirks. Of most note are large areas of land classified according to a type and degree of erosion activity (F_n & S_n). Further, a flexible and readily-repeatable technique was used to identify erosion severity for each of the landform classes. This was termed 'the surface stability assessment', and involved walking a transect across each landform and noting, at every tenth pace, the degree of surface stability, erosion activity, and revegetation. This provided a quantitative empirical measure of past and present erosion, and could also be used to infer the potential for future erosion.

The Ruru land assessment also involved the mapping of water-courses for subsequent environmental assessment, and the preparation of a 'current land use map' to depict vegetation cover and structures as a basis for scenario development. This appears to have been combined with another map of 'farm improvements' (paddock names, boundaries and areas), and presented as a 'present land use map' (Figure 5.55). These supplementary maps were printed as transparencies for overlay onto the landform map.

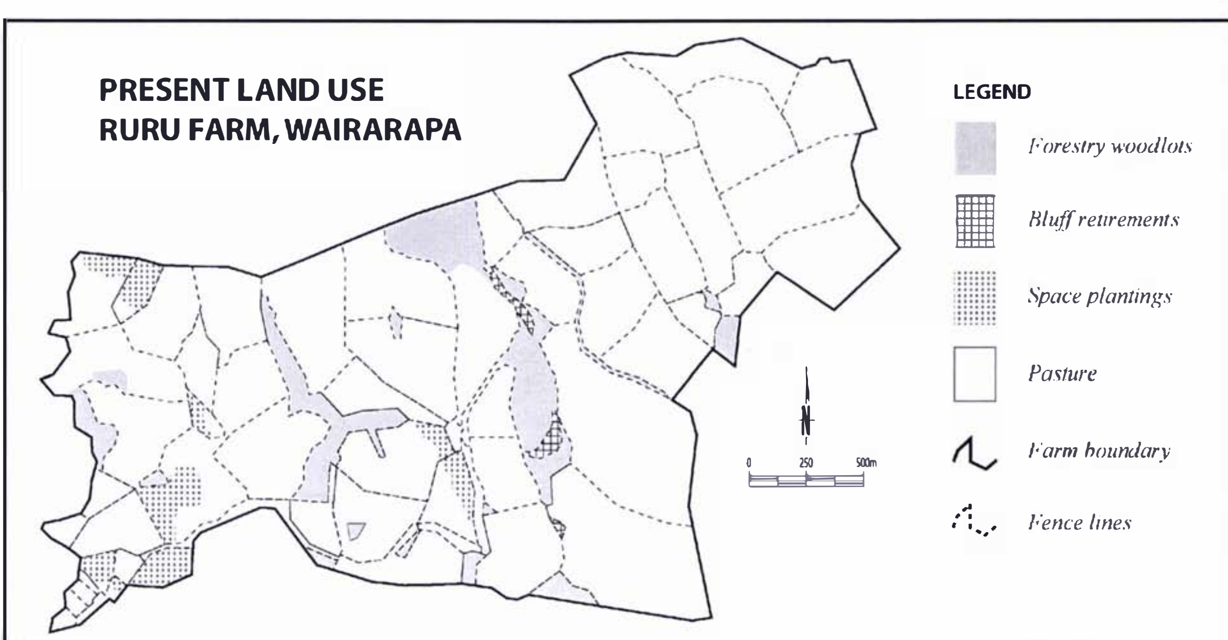


Figure 5.55: 'Present land use map' used in the Ruru pilot farm plan. Redrawn from Hicks (1995). Originally drafted by T. O'Hagan.

The estimated time required to complete the land assessment module for a similarly sized farm was three days. This was comparable to time required for a conventional LRI & LUC type survey. However, this was offset somewhat by the inclusion of additional information (surface stability, surface drainage and location of water courses, and a record of current land use and farm improvements), and the dovetailing with other modules into a comprehensive land evaluation framework.

5.4.2.2.2 Production assessment

The land assessment module provided the basis for evaluating 'levels of production which can be physically sustained on different slopes and soils' (Hicks, 1995, p.26). The purpose of the production assessment module was to attach levels of production to each landform class, according to four land use systems: pastoral grazing; grazing + spaced conservation trees; exotic forestry; and indigenous vegetation (including scrub).

Pasture production of each landform was estimated from local grazing trials, and adjusted according to rainfall, erosion and slope. Pasture under spaced conservation trees was further adjusted to account for shading, nutritional value of poplar leaves, and gains in long-term pasture production attributable to increased soil stability. According to these adjustments, significant reductions in production could be expected on flatter landforms, which decreased to nominal levels on steeper slopes (Table 5.57). Similarly, forestry production was estimated from offsite measures (timber yields and impact of erosion on production), and adjusted to better reflect the farm situation. Production data from indigenous forest could not be sourced, so only estimates of erosion were put forth.

To facilitate easy interpretation, it was recommended that production estimates be expressed as supplementary map keys (Tables 5.57-5.59). It was envisaged that this would allow rapid preliminary evaluation of any production consequences that may arise if land-use on any given landform continued unchanged, or alternatively, if land use was diversified. The supplementary keys would also have value for scenario development.

FORECAST PRODUCTION

	PASTURE (kg DM/ha)	SPACED TREES (kg DM/ha)	FORESTRY (m^3/ha)	REVERSION
T	13,500	8,600	700	?
S1 & F1	12,200	7,800	700	?
S2 & F2	11,400	9,600	539	?
S3 & F3	9,600	9,600	387	?
H1	9,500	6,200	533	?
H2	8,400	7,200	506	?
H3	6,800	7,000	374	?
H4'	5,800	*	383	?
H4	4,500	*	383	?
G	1,200	*	383	?
B	•	•	•	?

• denotes land use is infeasible on specified landform

Figure 5.57: Suggested map key for forecast production under different land uses. (Hicks, 1995).

FORECAST EROSION

	PASTURE	SPACED TREES	FORESTRY	REVERSION
	(as a percent of surface area affected by erosion)			
T	0%	0%	0%	0%
S1 & F1	0-2	0-1	0-<1	0-<1
S2 & F2	0-8	0-3	0-2	0-<1
S3 & F3	15-50	6-20	3-10	1-3
H1	0-15	0-6	0-3	0-1
H2	0-33	0-16	0-8	0-2
H3	17-67	7-27	3-13	1-4
H4'	20-39	*	4-8	1-2
H4	20-53	*	4-11	1-3
G	20-53	*	4-11	1-3
B	*	*	*	*

• denotes land use is infeasible on specified landform

Figure 5.58: Suggested map key for forecast erosion losses under different land uses. (Hicks, 1995).

FORECAST PRODUCTION LOSS

	PASTURE (% of annual production)	SPACED TREES (% of annual production)	FORESTRY (% of standing crop under forest)	REVERSION (% of scub canopy under reversion)
T	0%	0%	0%	0%
S1 & F1	-5	-2	0 to -1	0 to -1
S2 & F2	-11	-4	0 to -2	0 to -1
S3 & F3	-25	-10	-3 to -10	1 to -3
H1	-11	-4	0 to -3	0 to -1
H2	-15	-6	0 to -8	0 to -2
H3	-17	-7	-3 to -13	1 to -4
H4'	-17	*	-8	-2
H4	-36	*	-4 to -11	-1 to -3
G	-36	*	-4 to -11	-1 to -3
B	*	*	*	*

• denotes land use is infeasible on specified landform

Figure 5.59: Suggested map key for forecast production losses under different land uses. (Hicks, 1995).

5.4.2.2.3 Scenario development

Including the status quo, three scenarios were developed and evaluated for Ruru Farm. Scenarios were based on the previous land and production assessments, and also the long term goals of both the owner and manager. Broadly, farm goals focused on maintaining the property as a grazing operation, controlling erosion, and generating supplementary income from forestry. Each scenario also involved the consideration of economic and environmental impacts, both of which would be later evaluated as standalone assessments/modules.

	Status quo	**Moderate change**	**Substantial change**
Grazed	588*ha*	357*ha*	307*ha*
Space-planted & grazed	21*ha*	164*ha*	95*ha*
Woodlots (radiata pine)	62*ha*	146*ha*	265*ha*
Retired from production	3*ha*	7*ha*	7*ha*
Stock units carried	7,742*su*	6,685*su*	5,134*su*
Poles planted	2,100	16,400	9,500
Trees planted	62,000	146,000	265,000

Table 5.19: Changes in production and area for each of the three scenarios proposed for the Ruru pilot farm plan (Hicks, 1995).

The *status quo scenario* involved continued grazing of all areas in pasture, and continued maintenance of existing woodlots (Table 5.19). The *moderate change scenario* would see an expansion of forestry to cover severely unstable parts of the farm, and space planting of the moderately unstable land. For the *substantial change scenario*, space planting would reduce and forestry would again expand to include most of the moderately unstable land.

5.4.2.2.4 Economic assessment

Each scenario was modelled through computer software. Stockpol was used to analyse the economics of changes in grazing patterns, while a spreadsheet model developed by the WRC was used to evaluate forestry enterprise changes. A new model was developed to analyse the economics associated with space planting conservation trees.

The moderate change scenario appeared to offer the most economically viable option for improving whole-farm sustainability. Under the status quo, maintaining existing woodlots would eventually result in significant financial returns, but untreated eroding areas would continue to contribute only a small fraction to grazing returns. The moderate change scenario increased investment costs and carried low initial financial returns, but could eventually result in a 47% increase in income over that obtainable with the status quo option (after 30 years). Not only would initial costs and loss of grazing area be offset, but enterprise diversity would decrease long term risk and a greater proportion of the farm's erosion would be controlled.

The substantial change scenario was financially unviable over the medium term. Although forestry returns would eventually be substantial, the required loss of grazeable area, stock numbers and farm surplus during the first 30 years would make the whole-farm economically unsustainable well before forestry income became available.

5.4.2.2.5 Environmental assessment

The final module involved an environmental assessment of each scenario. Both onsite and offsite environmental impacts were evaluated, including erosion (divided into mass movement and gully/streambank erosion) and annual loading of sediment and nutrient (nitrogen and phosphorous) to waterways (Figure 5.60). Assessment procedure involved the collection of environmental data, firstly from a number of research studies undertaken in the Wellington Region, and secondly from research outside the Region if the local data was inadequate. Data was aggregated and analysed to produce upper and lower thresholds for each environmental factor (minima and maxima). Thresholds were expressed as a degree of environmental impact under various land uses, relative to the degree of impact under a pastoral land use (*e.g.* erosion under pasture = 100%; under space-planting = 17-30%; under forestry = 0-17%; etc.).

The environmental impact of each scenario was evaluated by estimating the area of land, or the length or watercourses, that would experience a change in land cover as a result of land use change. Relative areas and lengths (as percents) were multiplied against thresholds to obtain an estimate of environmental impact. Results are expressed in Figure 5.60, as a percent of pastoral-only environmental impacts (*i.e.* relative to the environmental impacts apparent if Ruru was completely grazed).

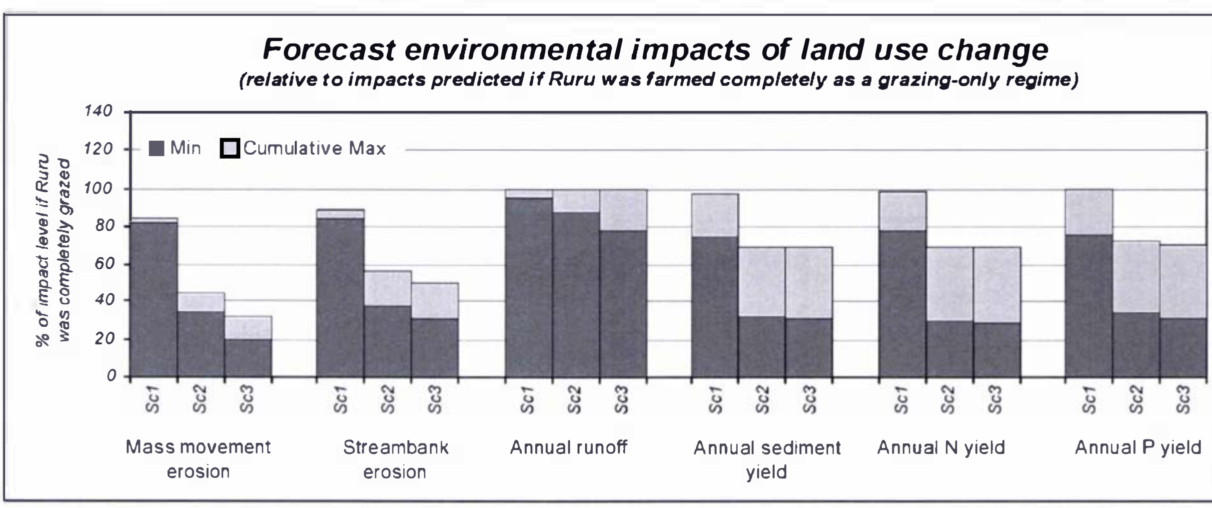


Figure 5.60: Results from the Ruru environmental assessment module. Adapted from Hicks (1995).

According to this environmental assessment, maintaining the status quo could reduce the erosion impact by 12-17%, and reduce sediment and nutrient loads by 8-21%. Future impact of erosion would be halved under the moderate change scenario, with sediment and nutrient loading reduced to 31-68% and 27-71% respectively. Loading reductions would not change significantly for the third scenario, although the impact of erosion was predicted to decrease 50-67%.

The Ruru pilot farm plan and associated Decision Support Package represents the combined development and application of a comprehensive land evaluation framework, designed for individual farms in the Wairarapa hill country. Alongside it's attainable comprehensiveness, the framework achieves a degree of stepwise clarity that sets it apart from other farm planning techniques. This was later refined through trials on a further five farms located near Ruru, and adopted by the WRC as their most detailed form of farm planning for promoting sustainable land use (Chapter 6).

5.4.3 Hawkes Bay 'Whole farm planning'

Hawkes Bay Regional Council developed the concept of *whole farm planning* as a component of their early 1990s Sustainable Land Management Programme (Brown, 1991). This was driven by the Council's newly adopted non-regulatory emphasis afforded under the RMA, coupled with a concern that traditional approaches to farm planning were an 'impracticable use of resources' in the new era of resource management (Manson & Grey, 1994, p.419). Further, while traditional approaches were preferred by some farmers, they 'did not bring about an understanding of environmental management or ownership, or a commitment to the recommendations' (*ibid.*)

Initial development of whole farm planning involved a greater emphasis on collaboration between farmers and Council staff during the preparation phase. However, although this approach proved to be 'the most successful in achieving management changes and works on the ground', it was also considerably more expensive (in terms of staff time) when compared against traditional models (*ibid.*, p.420).

Further development of whole farm planning resulted in the design of a 'training course approach' to plan preparation. This would involve groups of interested farmers being 'tutored' in the preparation of their own respective farm plans through workshops. Claimed benefits were numerous (Figure 5.65), including efficiency gains in terms of Council investment, and effectiveness gains through greater farmer involvement.

Advantages of the 'training course' approach to farm planning

1. *Efficient use of Council's resources*
2. *Problem solving through group discussion*
3. *Creating an understanding of problems & solutions*
4. *Development of realistic plans*
5. *Participant ownership of plans*
6. *Attracting only genuinely interested people*

Figure 5.61: Advantages of the 'training course' approach to farm planning (Manson & Grey, 1994).

A survey was undertaken to identify farm planning topics of interest to sheep and beef farmers (*i.e.* the targeted group of farmers). Topics identified as being the most likely to draw high attendances included farm shelter & amenity planting; matching land use to land capability; and farm forestry. Farm shelter & amenity planting was nominated as the most appropriate topic for a pilot study.

Two Farm Shelter Design Courses were held in Waipawa and Wairoa in mid-1993. Each involved half-day meetings over two consecutive Tuesday afternoons, and a financial contribution from farmers (for costs relating to resources, local hall hire, and guest speakers). The procedure over the two days involved a mix of theoretical and practical sessions, including technical presentations, group discussions, farmer presentations, and assisted design of actual shelter plans. Tracing paper over aerial photographs provided the mapping basis for plans.

All farmers stated they felt confident about implementing the plans they had developed. Six months after the courses, 11 of the 28 participants had completed their plans, while 5 required more information to do so. Other farmers indicated longer implementation time-frames. The approach was deemed a success, and further courses for shelter planning and 'managing the land' (matching land use to land capability) were planned for 1994.

Towards the mid-1990s, the Hawke's Bay Regional Council appears to have made a political shift away from 'whole farm plans'. While some aspects of collaboration may remain in the Council's conventional models (Chapter 6), the 'training course' approach seems to have been displaced by a return to more traditional one-to-one approaches. It is unknown how many whole farm planning training courses were held during the early 1990s, or how many plans resulted from the process.

5.4.4 GWAVAS AND WESTVIEW SUSTAINABLE LAND MANAGEMENT PROJECT

The Sustainable Land Management Project (SLMP) was a three year research study undertaken simultaneously on Westview Farm (963ha) in the Manawatu, and Gwavas Station (1277ha) in the Hawkes Bay. Research objectives were diverse, but strongly orientated towards a community approach for identifying and evaluating a broad interpretation of farm sustainability. Land resource and capability assessments were detailed, and provided the basis for a novel land classification attuned to the practicalities of everyday farming. Production and environmental factors were measured, and combined with the land assessment to identify and evaluate alternative land use options considered more sustainable and socially acceptable.

Although the development of a farm planning technique was not an explicit purpose of the SLMP, several innovations and conclusions would later be refined and developed as the Soils Underpinning Business Success (SUBS) initiative. This programme's unique approach to farm planning is discussed more fully in Chapter 7. Much of the following discussion about the SLMP has been drawn from AgResearch (1998a, 1998b) and Mackay *et al.* (1999).

5.4.4.1 Gwavas and Westview

The two farms selected were previous Meat Research and Development Council (MRDC) Monitor Farms, located within diverse production environments (Figure 5.62). Gwavas Station is considered summer-dry (980 mm/yr), while Westview Farm is winter-wet with a relatively reliable summer rainfall (1200 mm/yr). Geomorphology is also notably different, with Gwavas comprising of a 50:50 split between flat and easy hill country (altitude of 260-380m a.s.l.), and a geology dominated by weakly consolidated sediments (Tertiary), alluvial gravels and loess. Westview extends from recent alluvial terraces adjacent to the Pohangina River (100m a.s.l.); up through older terraces covered with loess, and hill country underlain by mudstones, sandstones and unconsolidated sands; and into the greywacke and argillite dominant steepland of the Ruahine Range (to a height of 500m a.s.l.). Parts of both farms also have inclusions of tephric material, and significant areas of indigenous vegetation.

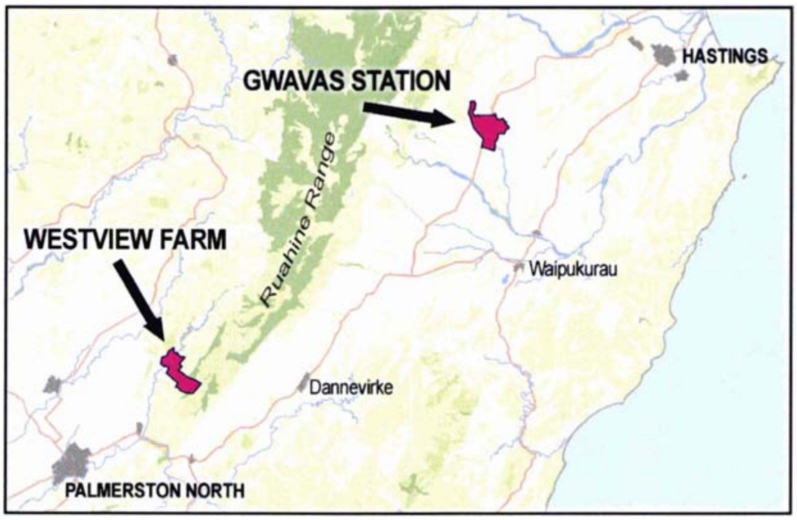


Figure 5.62: Location of Gwavas and Westview properties involved in the SLMP. Property sizes exaggerated.

As previous MRDC Monitor Farms, enterprises for each property had detailed production and performance records for at least four years. Land use systems were diverse, with Gwavas given primarily to sheep and beef breeding/finishing operations (total of 10,900 stock units), including a bull Technosystem (intensive bull finishing system). Approximately 60-65ha were cropped annually, and a small area was planted for production foresty (about 8ha). Westview included 41ha of plantation forestry, and 150ha given to a standalone dairy operation (not considered in the SLMP). The greater area of the property was farmed as sheep, beef and deer breeding/finishing operations (total of 8263 stock units).

5.4.4.2 Project approach

The SLMP had an overarching guiding principal: the inclusion of a broad range of interests to stimulate diverse debate and investigation into farm sustainability, to be balanced against expert knowledge and information. Toward this end, *community groups* were formed around each farm, comprising of farmers, technical specialists (scientists, consultants, regional council officers, technicians), agribusiness representatives (bankers, fertiliser companies), and various interest groups commonly associated with the environmental dimension of sustainability (Maruia Society, Fish & Game Council, Department of Conservation). Groups met four or five times each year. Funding support was provided by the MRDC, Manawatu-Wanganui and Hawkes Bay Regional Councils, while technical, organisational and research support was provided primarily by AgResearch, Landcare Research, and Agriculture New Zealand.

Although somewhat sophisticated and complex, Project objectives and method *relating to farm planning* can be summed as a combination of community- and science-based land evaluation to promote socially acceptable farm sustainability. In essence, this reduced to community group assessments of land, production and environmental impact, and subsequent synthesis and evaluation of alternative land use systems.

5.4.4.2.1 Land assessment

Both farms had detailed assessments of land at a 1:10,000 scale, including the preparation of soil maps and LUC maps (if LRI maps were prepared, they have not been published). Eighteen soils and 11 LUC units were identified for Gwavas, while over 70 soils and 23 LUC units were identified for Westview. Maps were presented to each community group during farm visits, and important characteristics and properties of soils explained through demonstration (Figure 5.63). Alongside other considerations of farm sustainability and land use design, the groups then aggregated soils and LUC units into Land Management Units.

Figure 5.63: Demonstrating and explaining how soils relate to land use at Gwavas, as part of the SLMP (taken from Mackay et al., 1999).

LMU maps for Westview and Gwavas are presented against soil maps to display the basis from which they were derived (Figures 5.64 and 7.65 respectively). Each LMU represents an area of land distinguished either by a dominant soil, or a group of amalgamated soils that exhibit similar properties regarding their management. Hence, although Westview's Upper Hill Country LMU has inclusions of seven distinctly different soils, the dominance of soils with favourable drainage characteristics defines how the LMU is practically managed in a day-to-day farming operation.

Soil information is not the only criterion upon which LMUs are derived. As an integral part of inferring an empirical land management/use classification, many production characteristics must be simultaneously considered (Chapter 3). For LMUs, emphasis is directed at practical management factors, such as existing paddock design, accessibility (*e.g.* a highly versatile piece of land may not be delineated as an LMU if access for cultivation and harvesting machinery is too difficult), stock movement, stock water, area (*i.e.* is an area large enough to be managed as a separate LMU), and so on. Likewise, various land-use suitabilities or vulnerabilities may be considered (*e.g.* an LMU may be delineated because of a characteristically high susceptibility to erosion, thereby requiring specialist soil conservation management), although the framework does not use a ranking system.

Such a strong orientation towards management and production necessitates a flexible framework. Hence, an LMU is not a fixed unit. Rather, by returning to the comparatively static soil map, an LMU map can be periodically updated, refined, or even completely redesigned, in response to the on- and off-site dynamics of modern day farming. In this sense, the LMU framework has been designed principally for use by farmers.

5.4.4.2.2 Production and environmental assessment

A monitoring programme was set-up on both farms 'to establish the potential productive capability and environmental constraints of each LMU to livestock farming' (Mackay *et al.*, 1999, p.27). This combined production and environmental assessments into one, and involved monitoring a broad number of factors that each community group had nominated as being significant to farm sustainability (Table 5.20). The monitoring programme was initiated in the second year, but was not fully implemented because of time and resource constraints.

	FACTORS ASSESSED OR MONITORED		
GWAVAS STATION	• Water quality • Nitrate leaching • Nutrient cycling • Grazing covers • Livestock performance	• Water availability • Wind erosion • Pasture composition • Weed infestation	• Soil compaction • Soil fertility • Pasture growth rates • Livestock production
WESTVIEW FARM	• Surface-water quality • Soil fertility • Pasture growth rates • Livestock performance	• Mass movement erosion • Nutrient cycling • Grazing covers • Pest dynamics	• Soil compaction • Soil biological activity • Livestock production

Table 5.20: Proposed environmental and production factors initially included in the Gwavas and Westview monitoring programme (from Mackay et al., 1999).

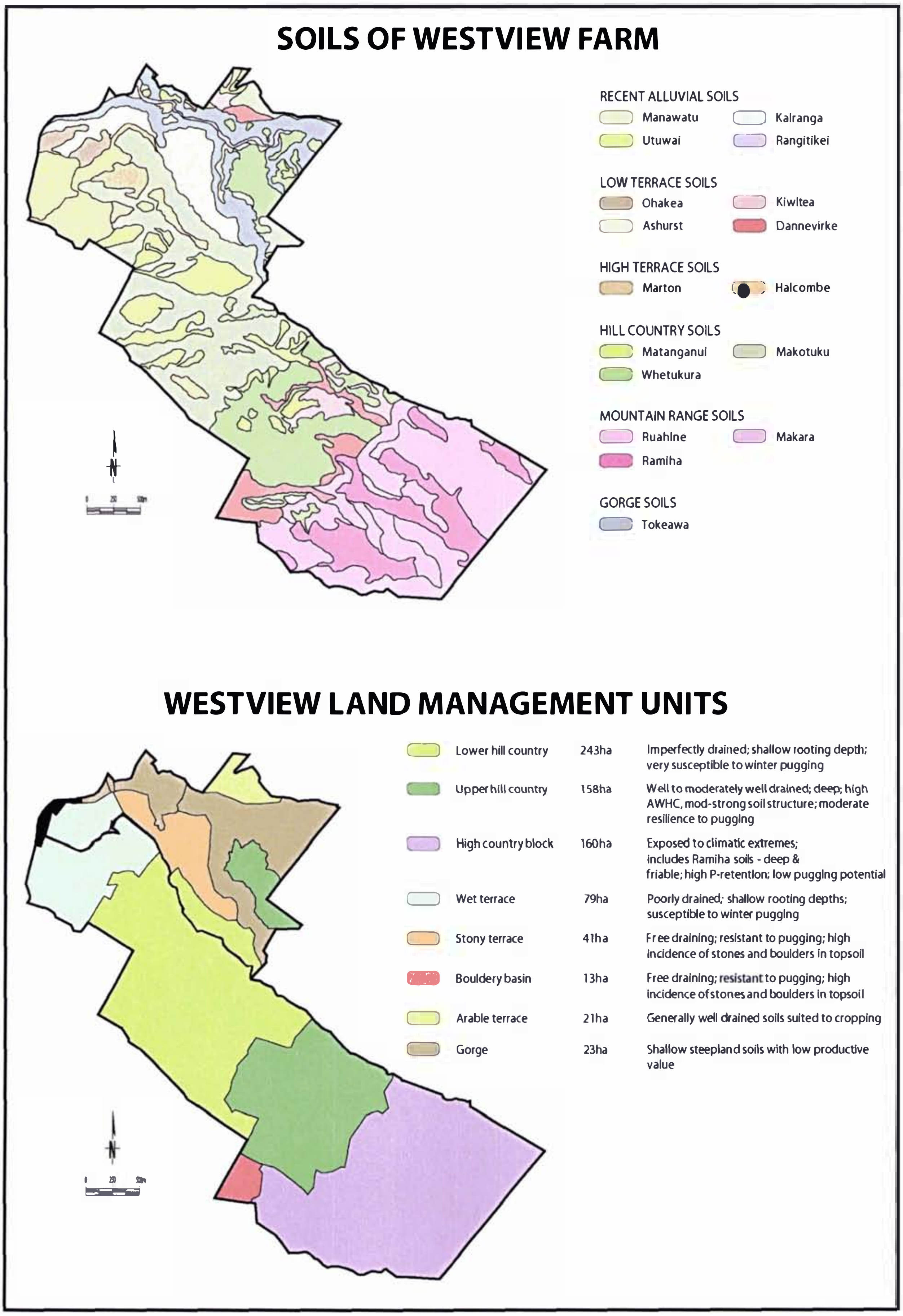


Figure 5.64: Soil map and it's derivative Land Management Unit classification for Westview Farm.

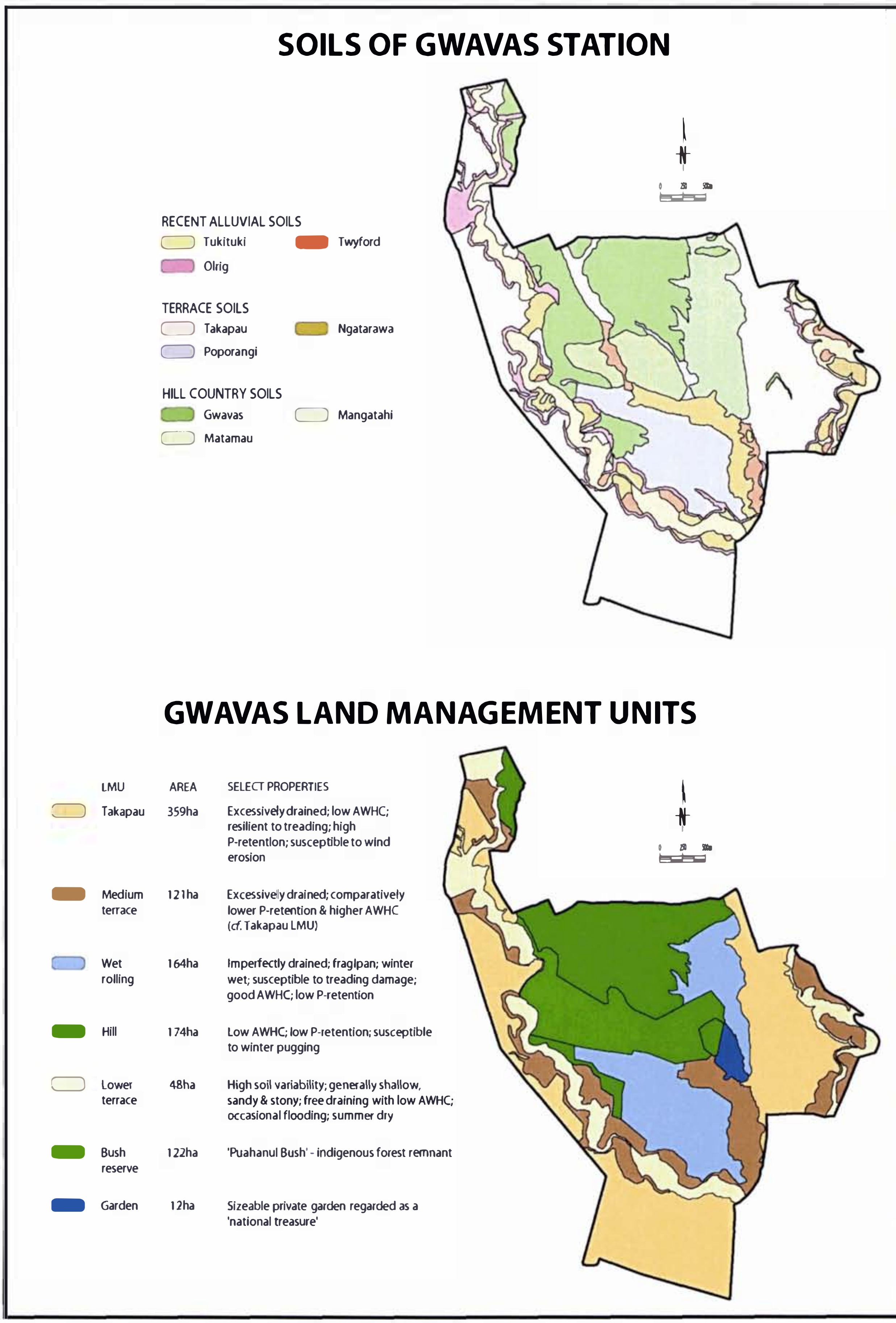


Figure 5.65: Soil map and it's derivative Land Management Unit classification for Gwavas Station.

Results from the monitoring programme were numerous, and the reader is referred to Mackay *et al.* (1999) for a detailed summary. Very briefly and broadly, land use intensification at Gwavas was limited by water availability; water quality was 'reasonable', but improved after flowing through the bush reserve; nitrogen losses under intensive bull beef were low; pugging had been avoided by good management; and farm production would respond favourably to increased fertiliser use. For Westview, surface-water quality was poor (but not always because of the farming operation); soils with impaired drainage were particularly vulnerable to cattle pugging during winter; and both soil fertility and pasture production varied widely across the farm.

Along with other sources of information, results from the monitoring programme were related back to individual LMUs through the community groups. Potential land-use changes were discussed for each LMU, along with requirements and impacts that may associate with any change (Table 5.21). As part of this, a 'landscape management plan' was prepared for Gwavas (to identify and integrate aesthetic values and some animal welfare concerns), and an 'erosion management plan' was prepared for Westview. Results for each LMU were tabulated, and used as a basis for the development and evaluation of alternative land use systems.

	POTENTIAL LAND USE CHANGES		REQUIREMENTS		IMPACTS & CONCERNS	
GWAVAS LMUs						
TAKAPAU	Intensive bulls Intensive beef Cropping Dairy	Deer or sheep Horticulture Viticulture Flower production	Shelter & trees Irrigation	Pasture renewal Riparian fencing	Pests & weeds Wind erosion H_2O quality H_2O availability	Nitrate leaching Bloat Market instability
MED. TERRACE	Intensive beef Dairy Cropping Deer	Sheep Horticulture Viticulture Flower production	Capital fertiliser Conservation tillage Pasture renewal	Shelter & trees Riparian fencing Irrigation	Pests & weeds Wind erosion Effluent Nitrate leaching	Pesticides H_2O availability Financial outlay
WET ROLLING	Beef & sheep Deer Cropping	Forestry Spaced planting	Capital fertiliser Subdivision Pasture renewal Labour	Woodlots Riparian fencing Drainage Stock H_2O	Soil contamination Pests & weeds H_2O quality	Wildlife Landscape Economics
HILL	More intensive sheep, beef or deer	Woodlots forestry Tourism?	Capital fertiliser Increased clover Subdivision	Stock H_2O Staff wages Shelter	Soil fertility Nutrient deficiency Pasture quality	H_2O quantity Shelter Economics H_2O quality
LOW TERRACE	Less intensive sheep & beef	Woodlots Specialty crops	Fertiliser Water Fencing	Weed control Pest control	Wildlife Soil fertility Pasture quality H_2O quantity	H_2O quality Shelter Economics Weeds
BUSH RESERVE	No alternatives suggested		Pest control Weed control		Legal protection Fire	Weeds Pest damage
WESTVIEW LMUs						
LOWER HILL	Sheep only Cattle in summer		Subdivision Drainage Stocking rate Pasture renewal	Shelter Fertiliser Labour Stock H_2O	Soil damage Runoff Erosion	Deer Intensification
UPPER HILL	Sheep & beef Deer		Shelter Fertiliser Labour	Tree plantings Riparian fencing	Compaction Porina (pests)	Weeds H_2O quality
HIGH COUNTRY	Merino flock + strategic cattle	Conventional sheep & beef	Shelter Fertiliser Labour	Tree plantings Fencing	Extreme & vari- able climate Difficult mgt.	Misadventure Access
WET TERRACES	Livestock finishing Feed conservation Cropping	Strategic sheep & cattle Deer	Pasture renewal Shelter Riparian fencing	Irrigation Drainage Fertiliser	H_2O quality Wind erosion Weeds	Economics Animal welfare Soil quality
STONY TERRACE	Intensive sheep & beef	Dairy heifers Cattle wintering	Pasture renewal Shelter	Fertiliser	Soil quality Animal welfare Pasture quality	Economics Stock shelter
BOULDERY BASIN	Pastoral only Livestock finishing	Dairy heifers	Tree planting Riparian mgt.	Fertiliser Fencing	Low wildlife value	H_2O quality Shelter
ARABLE TERRACE	Livestock finishing Cropping	Feed conservation Dairy heifers	Fertiliser Tree plantings		Low biodiversity Landscape	H_2O quality Shelter
GORGE	Retirement Forestry	Shelter	Pest control Native trees	Weed control	Wildlife	Marginal for production

Table 5.21: Summarised potential land use changes for each LMU, as identified by the Gwavas and Westview community groups (adapted from Mackay et al., 1999).

5.4.4.2.3 Scenario development and economic assessment

Identification and evaluation of alternative land-use systems was undertaken by subgroups, who periodically reported back to the main groups for feedback and further debate. The subgroups examined potential land-use changes of each LMU in technical detail, and used this as a basis for the development of enterprise scenarios. These were broadly divided into livestock scenarios, forestry scenarios, and several 'management strategies' including erosion control, shelter, and conservation for biodiversity and aesthetics. However, these were not integrated and economically evaluated together as whole-farm scenarios. Rather, livestock and forestry were evaluated separately and presented as options, while the cost-benefits of management strategies were not evaluated at all (if they were, then they have not been reported).

For Gwavas, a total of six livestock scenarios (including the status quo) were considered in detail, while the Westview subgroup investigated four livestock and four forestry scenarios. All forestry options were economically evaluated using the AEM, while livestock scenarios were refined to four and three for Westview and Gwavas respectively (Table 5.22). The economics of alternative livestock policies were evaluated through Stockpol.

Alternative scenarios for Gwavas were more profitable than the status quo, while only two of the three for Westview were more profitable. Although environmental and social dimensions of farm sustainability were not explicitly included in the economic evaluation, the initial scenario development involved deliberation of these factors as part of the community group process. Hence, all scenarios were considered to have improved and socially acceptable environmental outcomes, and thusly, would be conducive towards improving whole-farm sustainability.

	SHEEP	CATTLE	DEER	CROPPING	GM*
GWAVAS					
STATUS QUO	4060 ewes; 1470 replacements; 120% docking; lambs finished	Finishing 700-900 R2 bulls & steers	None	None	$445/ha
LESS SHEEP MORE CATTLE	3700 ewes; 1080 replacements; 160% docking; finishing lambs	Finishing 920 R1 bulls @ 30 months	None	None	$556/ha
LESS SHEEP, NEW DEER, CROPPING & WINTER CATTLE	3000 ewes; 900 replacements; 160% docking; finishing lambs	Wintering 920 R2 bulls; Dairy grazing during winter	440 breeding hinds; finishing weaners @ 12-18 months	250ha cropping 168ha forage crop	$635/ha
WESTVIEW					
EWES, COWS, HINDS	4600 ewes; 1500 replacements; 115% docking; finishing & store lambs	290 cows; selling weaners as stores	160 breeding hinds	None	$488/ha
EWES, COWS, FINISHING CATTLE, VENISON	3500 ewes; 800 replacements; 130% docking; mix of store lambs & finishing	200 cows; finishing bulls & heifers @ 20 months	Venison production only; 150 weaners finished; no hinds	None	$469/ha
EWES, COWS & YEARLINGS, HINDS & YEARLINGS	2600 ewes; 800 replacements	230 cows; selling bulls & heifers as yearlings	600 deer breeding unit; cross breeds selling yearling stags	None	$509/ha
EWES, COWS, FINISHING DEER & MERINOS	3600 crossbreed ewes; 1100 replacements; 130% docking; 680 merino ewes	140 cows; selling bulls & heifers as yearlings	Venison production only; 150 weaners finished; no hinds	None	$494/ha

*Gross Margin adjusted for any capital investments required by a given scenario

Table 5.22: Livestock scenarios evaluated in detail for Gwavas and Westview farms (from Mackay et al., 1999).

The farm planning technique used during the SLMP was distinguished by it's application through a technically supported community-group process. While information gathering and technical evaluations were undertaken mostly by scientists and specialists, much of the interpretation and decision-making was through the groups. This added a diversity of perspective uncommon to conventional farm planning, allowing farm sustainability to be explored and debated from a number of angles, and ensuring the off-farm social dimension was integrated into any potential land use changes.

Farm plans for Westview and Gwavas were not presented according to the conventional structure of 'report plus maps'. Rather, plans represented the combined knowledge and information gained by the farm managers over the Project's three-year duration (which, if there was ever reason to do so, could be recorded and compiled into a more conventional format). Likewise, these farm plans were not considered as pilots, because the development of a sustainable farm-planning framework was never an explicit objective of the Project.

Despite this, the combined group process and LMU concept were considered worthy of further development, and subsequent extension to the wider farming community. This resulted in another series of research initiatives, designed to 'refine and package the LMU concept... as a technology farmers can use to optimise profitability and resource management'. This would involve the development of 'a low cost approach for preparing LMU maps, upskilling producers in identifying [their] soils... through packaging information and a programme of vocational training' (Mackay *et al.*, 1999, p.17). In effect, this would lead to the development of the Soils Underpinning Business Success program discussed in Chapter 7.

5.4.5 Other North Island Initiatives

Northland, Auckland and Bay of Plenty Regional Councils also developed farm plan initiatives in the 1990s. Bay of Plenty responded to a Federated Farmers proposal in 1993, with the development of *property environmental plans*. These were based on traditional farm plan approaches, but were expanded to integrate a greater range of SLM issues. A two-year pilot programme was instigated, and the model was eventually refined into the Council's contemporary *environmental programmes*. These are discussed in greater detail in the following chapter.

Auckland gradually phased-out farm planning in the early 1990s, but a renewed interest later in the decade resulted in the development of a pilot applied to a 42ha south-Auckland dairy farm. This was loosely based on models then being used by the NSW Soil Conservation Service. The plan involved a description of farm resources and management in a manner similar to traditional models (including a farm-scale LRI assessment and LUC interpretation), but differed by putting forth 'land management suggestions' rather than the more conventional recommendations. Suggestions targeted shelterbelt establishment and management; riparian and wetland management; winter wetness problems associated with soil; and suggestions for improved pasture management. This pilot was not developed further.

Northland piloted *environmental farm plans* in the late 1990s, based on concepts developed within the farm planning model then being used by the Otago Regional Council (AgVantage). Broadly, land capability and land management units were identified collaboratively, and used as a basis for a resource assessment via an environmental checklist. In turn, these provided the basis for developing recommendations and actions according to a timetable, along with a monitoring programme for follow-up. Northland ceased their Environmental farm planning after the preparation of five plans over 1998-1999 (summarised in NorthLAND, 1998).

5.4.6 NELSON PROPERTY PLANS

Nelson City Council developed their concept of property plans as a means to reconcile farmer concerns regarding the Council's proposed Resource Management Plan (RMP) in the late 1990s. In combining regional and territorial responsibilities, the proposed Plan contained a 'formidable' list of implied restrictions applicable to individual farms (Witte, 1999, p.35). Particular concern was expressed for the issue of significant natural areas, and the related question of who pays for the protection of such areas on private land for the public good.

Property plans were nominated as a novel mechanism for alleviating farmer concerns. They have been defined as a "bundle of resource consents' applied for and considered by Council, all at the same time, along with their associated explanations, assessments of effects, and conditions of consent" (NCC, 2000, p.3-14). The principal tenet being, that once a property plan is prepared and agreed to by both the farmer and the Council, no further resource consents would be required under the RMP for the duration of the planning period (Witte, 1999). In effect, a property plan would be tailored to the resource management requirements of individual farms, thereby overriding the blanketing rules and restrictions contained within the RMP (NCC, 1998a).

Although the concept was never applied as a pilot, considerable background effort was invested in the design of the property planning model. Proposed content of a property plan was listed as a set of minimum requirements (Figure 5.66), and structured according to the five principal headings of objectives; resource management information; anticipated development programme; RMP provisions; and a schedule of consents (NCC, 1998b).

A property plan needs to contain:
- adquate resource information
- adequate descriptions of proposed activities
- assessments of proposed activities on natural & cultural values

A property plan needs to specify:
- the activities covered
- conditions to be observed when undertaking works
- the planning period
- circumstances necessitating a review of consents or conditions

A property plan may include a:
- management agreement
- cost sharing contribution
- statement of additional development rights conferred in return for the protection of natural features

Figure 5.66: Content requirements of a NCC property plan (adapted from NCC, 2000).

Resource information was to be assembled, where possible, using existing information sources (*e.g.* NZLRI, DCDB, soil maps, environmental domains, and local survey records). It was anticipated that additional farm surveys would be required to assess ecology, archaeology, water resources, soil erosion, and natural hazards. This would be undertaken by the Council.

The *anticipated development programme* would be designed by the farmer. He or she would describe any foreseen property development for the term of the plan (generally ten years, although this could vary on a farm-by-farm basis). In effect, this would represent a proposal and application for a bundle of resource consents. Relevant developments to consider would include land clearance, earthworks, structures, takes & discharges, and any property subdivision (other than paddock subdivision).

The Council would assess proposed property-development against rules and requirements stated in the RMP. Resulting *RMP provisions* state which rules are relevant to the property plan; the status of any proposed activities (discretionary, permitted, etc.); and standards, terms and conditions relating to any *required* resource consents. In turn, this would provide the basis for a *schedule of consents*, which groups or 'bundles' any *approved* resource consents.

Throughout, the property planning process was designed to be a collaborative undertaking, likely to involve a large number of on-farm meetings between the Council and the farmer concerned. Indeed, it was acknowledged 'that the process is likely to be as important as the final plan itself' (NCC, 1998b, p.3). Similarly, involvement of 'affected parties' (*e.g.* local Iwi and the Dept. of Conservation) would be encouraged, and relevant resource consents would be publicly notified (NCC, 2000).

A number of benefits to both the Council and farmers were claimed for the property planning model (Figure 5.67). Perhaps of most note, is a reduction in the *ad hoc* conventional method of allocating consents, and a degree of assurance and confidence afforded to farmers for long-term property development planning. In terms of shortcomings, a particular difficulty would be the ability of farmers to foresee future property-development needs over a ten-year timeframe (although farmers would still be free to apply for additional consents under normal resource-consent procedures).

Benefits to the Council:
- integrated SLM on a farm-by-farm basis
- Information transfer & consultation with farmers
- refinement of RM information on a farm-by-farm basis
- a mechanism for grants assessment & allocation
- reduced consent processing workloads

Benefits to farmers:
- removes the ad hoc approach to resource consents
- reduces District compliance costs
- may provide additional information of value to the farmer
- Council may contribute to works, rates relief, or permit additional development in return for the protection of significant features

Figure 5.67: Claimed benefits of the NCC property planning model (adapted from NCC, 2000)

As discussed in Chapter 2, NCC's concept of property plans was never piloted. The Nelson farming community became increasingly familiar with resource management under the RMA, such that their support for piloting the property plan model had diminished by mid-2002. Despite this, NCC's property plan model represents a somewhat novel approach to farm planning, distinguished by attempting to integrate both regulatory and non-regulatory mechanisms as a complete package.

5.4.7 Rabbit & Land Management Property Plans

The Rabbit and Land Management (R&LM) Programme was a government funded initiative targeting areas of South Island high-country with severe rabbit problems. As a condition of involvement, each landholder was required to prepare a *property management plan* (R&LM PMP). Although only a small number were prepared, these plans represent an evolution of traditional run plans, particularly as a mechanism to integrate SLM from a pest control perspective.

5.4.7.1 Background

The beginnings of the R&LM Programme are linked with a late 1987 decision by the Government not to release myxomatosis into NZ for the purposes of rabbit control (Parkes, 1995; Bell *et al.*, 1989). As a compensatory measure, the Government commissioned a R&LM Task Force to develop an integrated land management strategy to solve the rabbit problem (R&LM TF, 1988). This Task Force recommended, *inter alia*, that 'the cornerstone of all future rabbit and land management in semi-arid regions should be based on fully integrated property plans developed by the landholders, and land management consultant and a pest control specialist' (*ibid.*, p.vi).

In the following year, the Government announced an intention to invest $16.35m over five years into a Rabbit and Land Management Programme. This Programme would eventually be administered through the Ministry of Agriculture, three regional authorities (Canterbury, Otago and Marlborough), and a special R&LM National Advisory Committee. Over 270,000ha of South Island high country, involving 110 properties, was nominated for inclusion in the Programme (Figure 5.68).

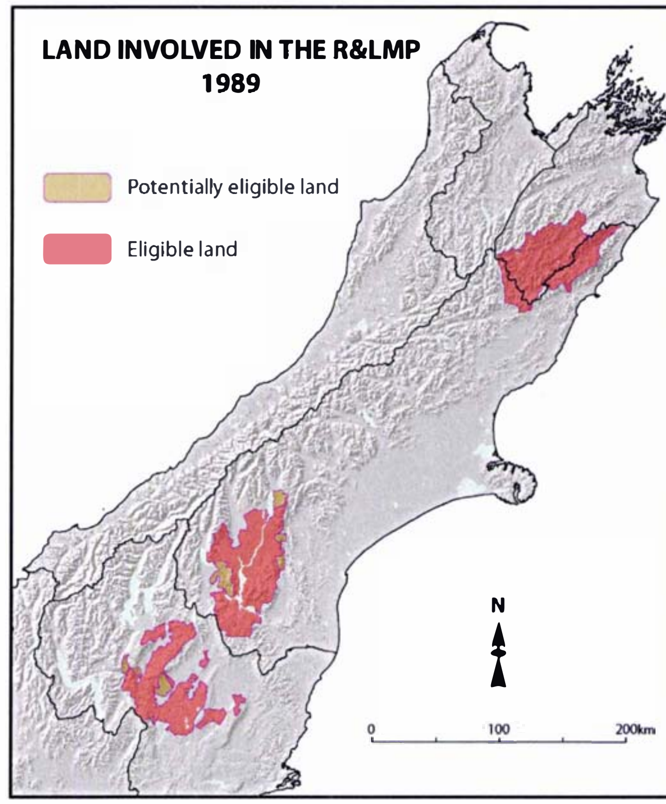


Figure 5.68: Areas of land initially targeted for involvement in the R&LMP (MAF, 1989b).

Marlborough *= 28,190ha as 5 properties*

Otago *= 29,060ha as 53 properties*

Canterbury *= 136,950ha as 37 properties*

Total *= 274,560ha as 110 properties*

Note: 12 properties later decided not to take part in the Programme.

As the 'cornerstone' of the R&LM Programme, all landholders had to prepare a 5-year PMP in order to be eligible for grants. These were backed with a land improvement agreement, which legally bound landholders for 20 years regarding the maintenance of publicly funded capital works (*e.g.* rabbit fencing). Plans were supposed to be prepared collaboratively between regional councils and landholders, and then subject to intermediate approval by Landcorp and/or the Department of Conservation if Crown land was involved (Figure 5.69, overleaf). Regional councils were responsible for obtaining final agreement (signing of LIAs), while MAF retained discretion for final approval (particularly for grants).

Preliminary criteria for PMPs was established at a workshop in March (Bell *et al.*, 1989) and announced to eligible farmers in the first R&LM Newsletter published in June (MAF, 1989a). PMPs for the development of *sustainable land systems* were to include considerations for:

- Rabbit control methods.
- Rabbit harvesting potential.
- Rabbit containment boundaries.
- Timing of control and it's impact on grazing management.
- Other land use potentials.
- Habitat modification and development potential.

Further, run plans prepared by antecedent catchment boards were to be integrated with PMPs where possible. Indeed, MAF (1989b) describe PMPs as an 'addendum' to run plans, while Hunter (1990) states that "soil, land resource inventory and land use capability information will... be used to identify management requirements, land use options and to plan integrated rabbit and land management within 'property plans" (p.16). A 1990 survey identified that 50% of the eligible properties had catchment-board run plans (Baines & Taylor, 1993).

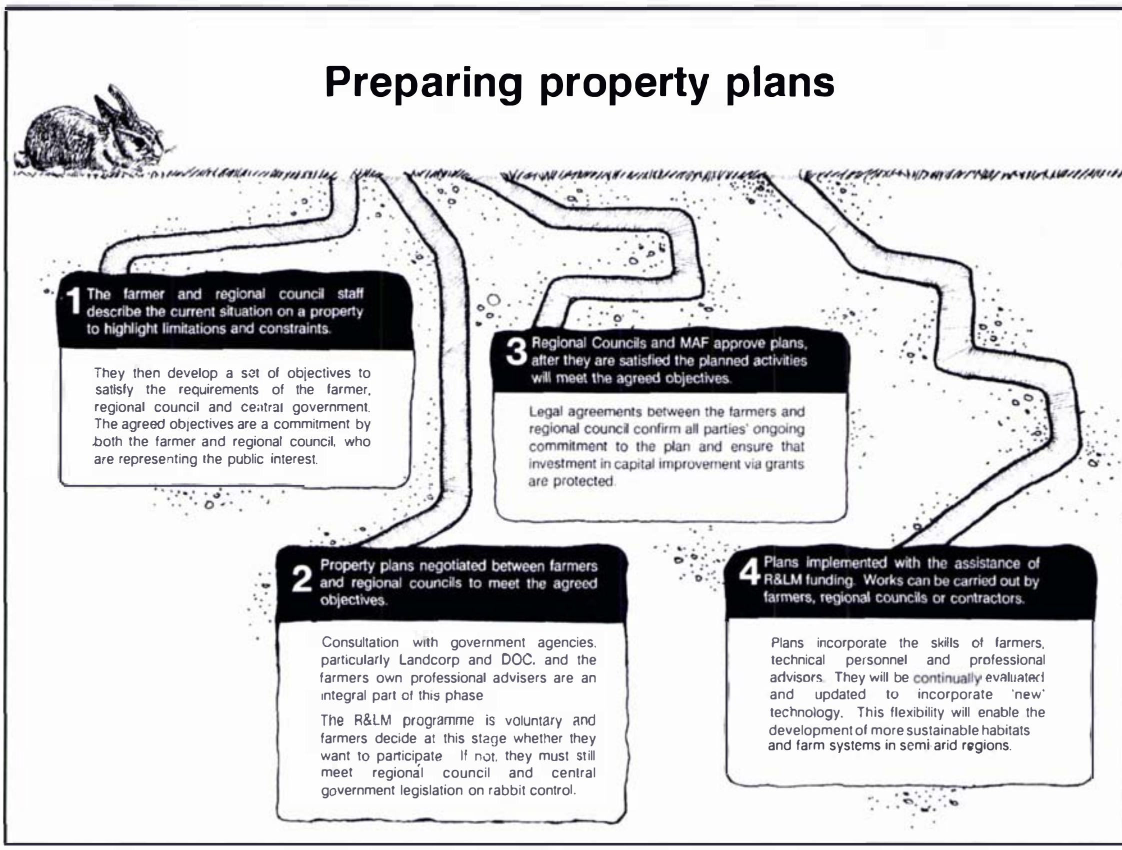


Figure 5.69: Intended process of preparing and approving property management plans (MAF, 1990b)

5.4.7.2 Property Management Plan example

Only a limited number of PMPs were prepared over the duration of the R&LMP. The author has been fortunate to obtain an example for a 4485ha high-country run located near Twizel, which was prepared and completed by Grant Cooper in 1991 (former Land Management Officer with Canterbury RC, now employed by the Manawatu-Wanganui RC). This example demonstrates PMPs as being a comprehensive form of farm planning, and their relational basis with former SWCPs is distinctively apparent.

Aims and objectives of the plan were clearly stated in considerable detail. General aims indicate an emphasis on integrated management and pest control, and they suggest that the philosophical transition between soil conservation's 'wise use' and the emerging 'sustainable use' view was still taking place (see Chapter 1 for a distinction between conservation and sustainability paradigms). General aims of the plan included:

- Achieve the long term protection of the land resource through wise land use and management.
- Coordinate rabbit control with appropriate land management.
- Prevent avoidance of bait- or toxic-shy rabbit populations.
- Achieve a reduction in the long term costs of rabbit control.

Structurally, the plan was divided into thirteen sections (Figure 5.70), many of which demonstrate the SWCP-basis from which PMPs were derived. Key distinctions include the degree of comprehensiveness for all sections (i.e. each was consistently detailed and concise), and the differences expressed in sections 6-9 and the appendices.

1. Summary
2. Introduction
3. The property plan
4. Location/climate
5. Legal description
6. **Present management**
7. **Summary of block worksheets**
8. **R & LM Programme**
9. **Land use conditions and monitoring**
10. Financial summary of programme
11. Land Improvement agreement
12. Acknowledgements
13. **Appendices**

Figure 5.70: Structure of a R&LM PMP

Present management summarised stock numbers and performance, followed by a detailed description of enterprise policies, property development, and grazing management. This included an appended *stock grazing chart* based on Wallace-Ramsay's earlier designs (see Section 5.3.5.2).

The land & issue assessment component of the PMP was based on a Land Inventory/Land Use Capability survey using the 'Waitaki Catchment Commission LUC Unit System' (see Section 5.3.8.3), initially undertaken in 1970 for an earlier farm plan. LI/LUC was presented not only according to a unique LUC classification, but also with soil type and an assessment of soil depletion. The most severely degraded land (through wind erosion and hieracium invasion) was individually highlighted using hatching. The map itself was presented at 1:25,000 on A1 sized paper, using an aerial photo base.

LI/LUC units were aggregated into 'blocks' (essentially land management units), and further assessed using worksheets. The first worksheet focused on describing physical characteristics of each block, including the extent of Hieracium invasion and estimates of stock carrying-capacity (Figure 5.71). The second worksheet summed the present and future rabbit control programme (Figure 5.72); the third evaluated factors limiting various land management options (Figure 5.73); and the final worksheet evaluated the feasibility of different land use options within combined land and rabbit management (Figure 5.74). Worksheets were appended and summed in the report as a *summary of block worksheets*.

Block No/Name	Area (ha)	Rainfall	Soils	Topo-graphy	Vegetation Dominants	% Hieracium	Other Problem Weeds	% Bare Ground	Land Use Capability Description	Fertiliser History	Present Carrying Capacity SU/ha Estimates
Bottom Flat	315	400-450	McKenzie	Flat	Hpi, Fno, Aod, Rac	40%		40	VI poor 5 cm topsoil lost	Native	0.2 to 0.5 Depends if winterewes
			~~Drybread~~ Rolqety	Fan Rolling	Tav, Aod, Rru, Hpi, Fao	10-20%	Briar	40	IV		
				...ting	Hpi + Fno, ...	30%	Bri...				

Figure 5.71: Part example of a R&LM PMP Block Worksheet

Block No/Name	Pest Proneness (Kerr Scale) (Estimates only)	Present Rabbit Infestation Levels McLean Scale as at Feb 91	Poisoning History	Present Poisoning Unit	Poisoning Programme Primary	Poisoning Programme Secondary	Control Programme Other than Poisoning
Bottom Flat	High 100%	2 (3)	2-3 yr GO	Whole property proposed RC 3	Interim GO	Pindone Ground oats	Nightshoot
Substation Bottom ...	Moderate	2	2-3 yr GO	Whole property proposed RC2	"	Pindone	Nightshoot
				Whole prop...			

Figure 5.72: Part example of a R&LM PMP Pest Control Programme Worksheet

Block No/Name	Fencing Quality (stock & rabbit)	Present Block Use	CONSTRAINTS ON: Direct Drilling	Irrigation	OSTD	Tree Pl nting	Fencing	Stock Water	Access	Other
Bottom Flat	Boundary good + rabbit	Autumn grazing	drought eroded soil hieracium	Cost Water right	drought eroded soil hieracium	drought environ-mental powerlines	✓	✓	✓	-

Figure 5.73: Part example of a R&LM PMP assessment of limitations for alternative land management options

Block No/ Name	Possible Options for Block	Preferred Option for Land Use (Landholder and CRC Officer to Complete)	Land Use Within RLM (comments see Appendix III)	Environmental Impact of Land Use	Programme to Achieve Agreed Land Use Option
Bottom Flat	1,2,3,5,6,7,9,10, 11,12,14	1,3,7,10,11,14	1,2,10,7,14	Slight Decrease degradation Change vegetat...	Net fence from hill to boundary net into RC unit ...drill and monitor
			1,10		

Figure 5.74: Part example of a R&LM PMP assessment of land use options within land & rabbit management. Numbers represent a possible 16 various land use options, such as grazing, afforestation, retirement, subdivision, etc.

The PMP's core *Rabbit & Land Management Programme* detailed required rabbit-control measures and physical works (namely paddock subdivision, rabbit fencing, topdressing and pasture reestablishment). Annual works and management programmes were appended, and a Land Management Programme Map was included to show location and implementation schedules by colour-code. Throughout, the emphasis was given to integrated management, although explicit recommendations for management changes were not presented until the section on *land use conditions and monitoring*. This essentially summed land developments, grazing changes and stocking management, against targeted changes in land condition. Another of Wallace-Ramsay's grazing charts was appended to show proposed changes in grazing management (Figure 5.75).

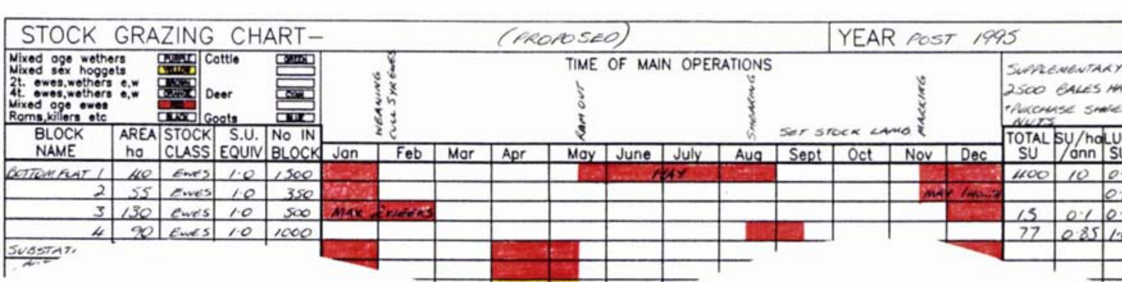


Figure 5.75: Part example of a R&LM PMP grazing chart

Along with worksheets and grazing charts, the appendices also provided detailed breakdowns of costs and technical specifications. Further, although not included with the example viewed, PMPs were also to include 'monitoring maps' (perhaps not included because the method and criteria for monitoring was still being developed). Overall cost for this particular example was ≈$138,000, most of which was subsidised by the regional council and MAF (around 65% subsidy).

5.4.7.3 Application of Property Management Plans

Along with funds management, MAF were responsible for the design of the PMP model. The design was apparently flexible, in that there was 'no magic blueprint for a property plan' (MAF, 1990a, p.1), which resulted in some 'creative' approaches to rabbit and land management (MAF, 1992). A recommendation 'to standardise [the] approach to property plan development' (Baines, 1991, p.10), suggests the PMP model was perhaps too flexible.

It took three years to complete the PMP phase of the R&LM Programme. Ninety-seven of the original 110 landholders had prepared a PMP and signed an LIA by the end of 1992, at a subsidised average cost (regional authorities were allocated an annual grant to prepare PMPs) of $30,000 per property (Baines & Taylor, 1993). After all plans had been completed, it appears that the initial emphasis on PMPs as a tool to integrate and manage rabbit control gradually decreased. As suggested by articles and reports in the R&LM Newsletter series (1989-1995), Landcare groups seem to have gained increasing momentum as a more favourable mechanism.

MAF (1989c) claims farmers were initially favourable towards the idea of PMPs, but later resistance suggests that some did not completely commit themselves to the concept: 'there is still a view... that property plans are simply a bureaucratic nuisance and that once the rabbits are killed it can simply be business as usual' (Morgan Williams, 1991, p.2). In this sense, some farmers viewed the exercise of property management planning 'as a pro-forma one as per the former run plans' (NAC, 1994, p.8).

The 'negative mindset' of some farmers was attributed to PMPs being a compulsory requirement of the Programme (Morgan Williams, 1991; NAC, 1994). Baines (1991) suggests that farmers had been inadequately informed about how PMPs were to function, and recommended that 'immediate steps be taken to further clarify and communicate... the essential features and character of property plans' (p.24). Concerns were also expressed over 'the tardiness of some landholders in meeting their plan objectives' (MAF, 1993, p.4), although it appears that the majority of farmers successfully and agreeably completed their early PMP obligations. Indeed, many had gone further by initiating 'revision and updating of their initial plans' halfway through the Programme (Baines & Taylor, 1993, p.v). Harris (1995) summed difficulties and opportunities associated with PMPs in the final R&MP Newsletter:

> *"Some of the Programme's early problems came about, I believe, because farmers still did not have 'ownership' of their property plans. They should have been involved more in the early stages in 1989 and 1990, surveying and drawing up maps for themselves (along with assistance from regional councils and MAF staff)... if we are to succeed in the hill and high country of New Zealand, I believe that all properties require a modern enhanced farm plan as the framework for sustainable land decisions"*
>
> Harris, 1995, p.8-9

5.4.8 THE NORTH OTAGO SLM GROUP

The North Otago SLM (NOSLaM) Project started in late 1994 as an unassuming collaboration between a group of seven farmers and the Otago Regional Council, over the preparation of soil management guidelines for the northern Otago downlands (Ludemann *et al.*, 1996; Nimmo-Bell, 1999). At completion of the guidelines the group was supposed to disband. However, in recognition that documented guidelines on their own would have little impact on promoting sustainable soil management, the participating farmers unanimously decided to continue the group with a new purpose.

This purpose was expressed as a vision, whereby the group would seek to encourage and coordinate local adoption of SLM systems. Substantial external funding was soon secured for a three-year term (via the Sustainable Management Fund), which was then used to employ a fulltime coordinator for 'promoting the guidelines and working with marketing people' (Ludemann *et al.*, 1996, p.103). At the same time, the group began to expand with the integration of representatives from local range, dairy and vegetable grower community groups.

NOSLaM 'has been an unqualified success' in promoting SLM within the North Otago district (Ross, 2000, p.11), particularly in regard to the Project's 'most important output' of environmental management plans (Nimmo-Bell, 1999, p.57). These have gone through a number of refinements and name changes since 1996 (environmental plans; environmental farm plans; Total Integrated Management System or TIMS plans; Ag-Vantage farm plans), eventually becoming consolidated as *Enviro-Ag* farm plans when ISO14001 status was secured in 2000.

Today, Enviro-Ag farm plans represent a unique application of the farm plan concept. They have 'been developed by farmers for farmers' (Ross, 2000, p.26), as an environmental management system (EMS) backed officially by an internationally recognised environmental standard. They have also recently moved away from being a Council service to farmers, and are now prepared on a commercial basis by independent consultants. As they are still very much in use, the farm planning model underlying these contemporary applications is discussed in more detail in the following chapter.

HISTORICAL SUMMARY

5.4.9 AMERICAN BEGINNINGS

- Farm planning was initiated in early-1930s United States as a tool to control erosion on individual properties.

- Land survey and classification were integral to early farm planning. Efficient procedures actually made widespread application of farm planning possible.

- Initiatives likely to have contributed to the design of land survey/classification systems used in farm planning include the *fractional code method* and the *unit area method*. Likewise, early erosion surveys have been regarded as the 'philosophical predecessors' to land classification systems used in farm planning.

- Four-factor (soil, slope, land use & erosion) land survey systems for farm planning were first used in 1933. A nine class capability classification was developed soon after as a means to link factual survey information to the practicalities of farm management. Classifications and recommended land use practices were derived in collaboration with farmers and specialists, typically on a Conservation District basis.

- Widespread application of the survey and classification system resulted in discrepancies between district and regional classifications. Attempts to promote uniformity resulted in the development of the Land Capability Classification in the 1940s. The Classification was refined to 8 classes, and expanded to a three-tier system including limitation subclasses (1947) and class units (1949). Increasing sophistication in the pursuit of national uniformity would lessen the LCC's flexibility and utility away from its original purpose – the assessment of individual properties for farm planning.

- Rapid and widespread application of the LCC system in the 1950s would conflict with the progress and philosophies of those responsible for surveying and mapping soils. Revision of the LCC in 1961 resulted in the adoption of a four-tier system based on the 'soil mapping unit'.

- A 1940's American farm planning exercise involved four overlapping steps, including a soil conservation survey to collect facts about the land; a land capability classification to determine land use suitabilities; formulation of recommendations concerning appropriate management and conservation treatments; and bringing it all together as the farm conservation plan. Emphasis throughout was on working with the farmer, usability, presentation in an understandable form, and *conservation farming* to simultaneously enhance soil & water conservation and socio-economic goals.

- The format of an early American farm plan would at least involve two maps and a list of recommendations and instructions. Maps would include a combined survey and land capability classification map, alongside a 'land use map' depicting agreed land and land-use modifications.

- Farm sustainability is an implicit feature of early American farm plans, particularly in regard to ideas of land capability and conservation farming. The central idea was to match a socio-economically sustainable system of land use, to the land's inherent and modified ability to sustain that system in a 'wise use' utilitarian context.

5.4.10 LAND SURVEY AND CAPABILITY CLASSIFICATION IN NZ

- Soil conservation was officially recognised in NZ with the passing of the 1941 Soil Conservation & Rivers Control Act, leading to the formation of the national SCRC Council and catchment authorities. Initial efforts to develop a national soil conservation programme were impaired until the late 1940s.

- Various survey and classification systems were applied and evaluated during the 1940s, including erosion surveys, land utilisation surveys, and Cumberland's adaptation of the unit area method.

- The SCRC Council initiated several trial *soil conservation surveys* in the late 1940s and early 1950s, according to the systems then being developed in the US. The Pohangina Conservation Survey used a four-factor inventory and an initial five-class capability classification.

- Rapid development of survey techniques in the US quickly dated NZ's early soil conservation surveys, leading to the official adoption of the US eight-class LCC system in 1952. Delayed development and release of detailed official NZ standards resulted in wide differences in surveys and classifications undertaken between 1952 & 1969.

- Application of soil conservation survey accelerated rapidly through the 1960s, with 7.7-9.3 million hectares having been mapped at catchment and farm scales by 1968. *Provisional national land use capability maps* depicting land capability for NZ at a general scale were presented in 1962 (but not published). The SRCC Council began publishing Land Use Capability Bulletins in 1966.

- Evolution of the US LCC into a 4-tier system in 1961 was not adopted by NZ. This marks a point where NZ's own development of land capability survey and classification diverges markedly from that of the US.

- Official national standards for undertaking Land Resource Inventory (LRI) survey, Land Use Capability (LUC) Classification, and Potential & Recommended Land Use (PRLU) Classification were published in 1969. Prior to this, catchment board conservators had to rely on unofficial publications and interaction with government conservators to maintain standards.

- Systematic mapping of NZ was initiated in 1970 with the *national mapping programme*. Land resource surveys were upgraded or undertaken at a standardised scale of 1:63,360, which would form the basis of three national maps (LUC, 'recommended soil & water management', and erosion) to be presented at a 1:250,000 scale.

- Focus shifted away from the three national maps in 1974, and onto the publication of the underlying inventory data at a 1:63,360 scale. These became the first-edition New Zealand Land Resource Inventory (NZLRI) Worksheets first published in 1975. All 330 Worksheets for NZ coverage were completed by 1979.

- The national survey was undertaken on a regional basis, resulting in regionally distinct classifications. Twelve regions were eventually used, eight of which are represented by published Regional Bulletins. Correlation of the North Island's regional classifications began in 1975 and was completed in 1985.

- A five-yearly revision to update the more dynamic inventory factors of the NZLRI Worksheets (namely erosion, land use and vegetation) was initially envisaged. The first revision (2nd edition Worksheets) involved nationwide conversion from the imperial 1:63,360 to the metric 1:50,000 scale. 1980s political and organisational changes resulted in only 5 of the 12 LUC regions being revised between 1979-1999.

- Today the NZLRI is used mostly as a digital database (as a Land Information System), containing over 100,000 vector polygons that range in area from 7723ha down to 4ha. Some claim the NZLRI is now used more for scientific purposes rather than the planning purpose for which it was originally designed. Limited revisions and updates means the NZLRI is outdated for many parts of the country, particularly in relation to erosion type, erosion extent, and vegetation cover.

5.4.11 HISTORICAL FARM PLANNING IN NZ

- Adoption of farm planning for soil conservation purposes was suggested as part of the SCRC's national soil conservation policy and programme in 1948.

- Principles of conservation farming developed in the US had little relevance to NZ hill country. NZ relevant *conservation farming guidelines* were developed through Soil Conservation Reserves between 1946 and 1955. Guidelines and soil conservation techniques were applied to privately owned 'cooperative demonstration farms' for extension purposes through farm conservation schemes. These schemes were precursory towards *conservation farm plans*.

- Explicit farm plans began to emerge in the late 1940s and early 1950s as pilots undertaken through the SCRC Council, or independently as catchment board initiatives. One of the first was undertaken by the Manawatu Catchment Board and SCRC Council as a component of the 1949-1951 Pohangina Conservation Survey (the Tew's Conservation Farm Plan, 1951). This emphasised principles of US farm planning, particularly the reconciliation of socio-economic goals with soil conservation goals. Land capability was taken directly from the 1:15,840 scale Survey, and used as a basis for a report and 'future land use map'. Subsidised works were a particular feature.

- Conservation farm planning was officially adopted by the SCRC Council in 1956.

- The Manawatu Catchment Board's first official conservation farm plan was prepared in 1956. This included a succinct 7-page report describing farm characteristics, land capability, and a 5yr programme of works. A single map depicted land capability, present land use, and the works programme on a year-by-year basis. Relative to the Tew's example, recommendations concerning production improvements were notably minor.

- Farm plan numbers rose dramatically in the 1960s, eventually totalling 1277 plans nationwide by the end of the decade. Farm plans became the fundamental base unit of soil conservation.

- 1960s techniques for preparing farm plans were significantly different between the North and South Islands. The Otago Catchment Board adhered strongly to US principles, particularly with the preparation of land inventory as an activity separate from land capability classification, and the integrated and participatory manner through-which farm plans were prepared. Waitaki Catchment Commission used similar methods, albeit according to their own unique inventory and classification system. In contrast, directly inferring land capability in the field without a standalone land inventory appears to have become the norm for many North Island catchment authorities.

- Recognised 1960s variations on farm plans included run plans for extensive high country holdings, shelter plans for wind erosion control, and land-use particular variations as orchard and dairy farm-plans.

- Farm plans as the unit of catchment control schemes provided concerted integration of soil and water conservation across large areas. 121 catchment control schemes had been implemented by 1985.

- Conservation farm plans were renamed *Soil and Water Conservation Plans* as a result of an increased emphasis on water management afforded through the 1967 Water and Soil Conservation Act. However, this change in farm planning appears to have been in name only.

- Farm plans represent a communication tool (between farmers, soil conservators, other specialists, and the SCRC Council), and a framework for allocating subsidies. Inclusion of a Land Improvement Agreement bound farmers to a long-term maintenance programme for subsidised works. General subsidy was one-for-one (*e.g.* £1 subsidy for every £1 invested by the farmer), and up to three-for-one for special works. Soil conservation subsidies ceased in 1988.

- Approximately 4731 conservation farm plans had been prepared nationally by 1989. Added to 1326 shelter plans, this represents a total of 6057 farm plans prepared over the 33 year period between 1956 & 1989.

- The general criteria of farm plans changed little through the 1960s to 1980s (due to specifications laid down by the SCRC), although many catchment authorities expressed these criteria according to their own distinctive formats. These range from simple plans reported on three double-sided pieces of loose leaf paper, through to comprehensive and bound reports of 50 pages or more suitable for general publication.

- The general structure for a representative farm plan example involves a physical resource section followed by a conservation works section. This would include a list of recommendations, a 5yr works schedule (reduced to annual programmes), technical specifications, and a financial breakdown of costs and subsidy eligibility. Two maps were included: a property LUC map and a works programme map depicting fence lines and other physical features. Works by year were portrayed by colour coded symbols.

- Otago Catchment Board used a very distinctive farm plan format, involving three maps using aerial photo bases. The third map was a detailed land resource inventory.

5.4.12 FARM PLAN INITIATIVES POST 1991

- Farm planning was no longer an official component of resource management after the late 1980s political and organisational reforms. While some regional authorities retained farm planning, others abandoned the practice altogether. Some 1990s attempts to modernise farm planning according to sustainability principles introduced by the RMA has resulted in a diversity of farm plan models.

- A comprehensive farm planning model for Taranaki hill country was developed and applied between 1990 and 1996. This used a novel land classification based on landforms and previous erosion studies, along with computer modelling and (economic) evaluation of alternative land use scenarios. The Taranaki Regional Council prepared approximately 100 SLM Plans based on this model, but it was phased-out in 1996 due in part to limitations with the classification system.

- Wellington Regional Council developed a comprehensive farm plan model in 1993 as a four-module *decision-support package*. Particular features include: a landform-based classification; linking land productivity with landform classes as a basis for identifying alternative land use scenarios; computer modelling and economic evaluation of scenarios; and an environmental assessment of erosion, runoff and water quality. This model represents one of the most (if not the most) comprehensive and complete land evaluation frameworks used in NZ for assessing the sustainability of pastoral hill-country farms. It is currently used by the WRC for the preparation of Sustainable Land Use Plans.

- Hawkes Bay Regional Council developed their concept of *whole farm planning* in the early 1990s, as a means to reduce costs associated with traditional farm planning, and to improve effectiveness for promoting SLM. Several variations were developed, including a model using a 'training course approach' to the preparatory phase of farm planning. Although early trials appeared to be successful, whole farm planning was discontinued by the Council in the mid-1990s.

- A comprehensive pastoral land-evaluation framework was developed and applied over 1995-1998 as the Gwavas and Westview Sustainable Land Management Project. Principal features include very detailed land assessment through soil and LUC survey; high community input; environmental monitoring; and economic evaluation of alternative land use scenarios through computer software. Although the model was not extended as a discrete form of farm planning, principles were later used as a basis for the Soils Underpinning Business Success programme (which uses group-based approach to land/soil assessment and land use evaluation).

- Auckland briefly experimented with a dairy farm-plan based on a model then being used by the NSW Soil Conservation service. Northland piloted *environmental farm plans* in the late 1990s based on Otago's *Enviro-Ag farm plans*, but discarded them as being inappropriate for the Northland situation at the time. Bay of Plenty developed *property environmental plans* in response to a 1993 Federated Farmers proposal, and have continued to evolve them into their contemporary *environmental programmes* in use today.

- Late 1990s farmer concerns regarding implied restrictions in Nelson City Council's Resource Management Plan, resulted in the design of a farm plan model that packaged both regulatory and non-regulatory considerations for individual properties. In short, a long-term consent process (resulting in 'consent bundles') was integrated with more conventional farm planning models. Subsequent lack of farmer-support resulted in the model being shelved, and no pilot was ever undertaken.

- Rabbit prone high-country landholders in the South Island were required to prepare *property management plans* as a condition of inclusion in the Rabbit & Land Management Programme (1990-1995). Property management plans were based on former soil and water conservation plans, but differed through having a principal focus on long-term rabbit control through integrated management. Ninety-seven plans were prepared.

- Development of a farm plan model far-removed from traditional SWCPs was initiated when the North Otago Sustainable Land Management Group redefined it's purpose in 1996. In collaboration with the Otago Regional Council, this model evolved through a series of 1990s developments, eventually emerging as *Enviro-Ag* farm plans. This model is distinguished through the use of an all-encompassing environmental checklist as a basis for assessment, and the attainment of ISO14001 standards.

SPECIFIC DISCUSSION & CONCLUSIONS

Historical literature frequently describes the ideal conceptual application of traditional farm planning (pre-1988). This commonly involves comprehensive land evaluation of individual properties, including an inventory and capability assessment at the farm scale. However, an idealised procedure may not always be applied in practice, particularly when the process is expedited for reasons of efficiency or competition (*e.g.* in pursuit of Campbell's soil conservation targets). The difference between farm planning theory and practice has implications for the two specific objectives of this chapter.

5.4.13 Farm plans as a source of contemporary resource information

A total of 4731 soil conservation farm plans were prepared between 1956 and 1989, which represents an areal coverage of more than 50% of the land farmed in New Zealand. If each plan was prepared from a basis of land resource survey and/or land capability classification as recommended according to literature and official guidelines, then New Zealand's historical collection of farm plans represents an extensive source of farm-scale land resource information available for contemporary purposes. Unfortunately this can only be true in some cases.

The standard adopted by most catchment authorities for farm plan preparation appears to have involved direct in-the-field inference of land capability without an explicitly standalone assessment and recording of 'facts about the land' as a physical inventory. Hence, most NZ farm plans are based around interpretive land-resource information bias towards soil conservation (*e.g.* LUC), such that the user is required to backwards-interpret in order to obtain meaningful descriptive land resource information (typically through discussion within the report or from regional classifications). Problems with this are fourfold:

- Supporting information for backwards-interpretation can be limiting. Firstly, resource description sections in farm plans vary widely from mechanically brief paragraphs, through to several pages of comprehensive detail. Secondly, for regions without Regional Bulletins, generic supporting information is limited to the brief descriptions of LUC units provided within Worksheet Extended Legends.
- There has been an historical assumption that regionally derived LUC units will correlate well with those found at farm-scales. This is not always the case. As a result, some farm-scale classifications may have been misinterpreted to conform to the rigidity and uniformity of regional classifications.
- Pre-1969 farm plans may not be linked to a regional classification.
- The LUC system may not be understood by those who stand to gain the most benefit from the use of land resource information (farmers).

Otago Catchment Board was the only authority identified to include detailed land resource inventory as a separate component of farm planning. However, even inventory information has it's limitations:

- Only information concerning soil, geology, topography and erosion character remains relevant over long periods of time.
- Soil information may be of dubious quality if not originally collected by a person with strong pedological skills. Inventory soil information was typically inferred from published soil maps, often at scales considerably smaller than the farm-scale. However, this may be less of a limitation for parts of the South Island where landforms are extensive and consistently exhibit soil associations with low spatial variability.

Perhaps the greatest limitation is the accessibility and management of land resource information contained in farm plans. Firstly, most regional councils have archived or stored their historical farm plans away from their day-to-day information management systems. Secondly, some councils have completely discarded their historical farm plans (*e.g.* Taranaki). Thirdly, having extensive spatial information distributed through numerous individual documents makes historical farm-plan information difficult to manage and access readily.

Despite these limitations, it is feasible to suggest that land resource information contained in historical farm plans can be readily updated and/or verified through a contemporary survey. This would reduce the time required for a modern-day land assessment considerably (primary land units have already been delineated, and the general character of land resources has already been described at a broad level).

As a conclusion, historical farm plans in general are likely to have a moderate value as a standalone source of farm-scale land-resource information for contemporary evaluations of farm sustainability. The exception would be farm plans that contain a detailed map and description of land resource inventory. Principal limitations include: a necessity for backwards-interpretation of land capability information; questionable reliability of soil, vegetation and erosion information; and difficulties in readily accessing and using farm-plan land-resource information. The greatest value of historical farm plans would perhaps be as a strong starting point and framework for obtaining (or verifying) more up-to-date and relevant land resource information.

5.4.14 FARM PLANNING AS A LAND EVALUATION FRAMEWORK

From the outset, farm plans were touted as a means of redesigning farming systems according to land capability, towards the dual purpose of improving both resource integrity and farm productivity. An idealised approach to farm planning would include:

- Resource inventorying undertaken by a specialist in collaboration with the farmer, at the farm-scale, and according to a multifactor inventory system.
- Land capability classification inferred from land inventory and land use information, to identify the land's ability to sustain an appropriate system of land use.
- Collaborative design of an integrated and new system of land use that would accommodate farmers' productivity and socio-economic goals; authorities' soil conservation goals; and farmers' ability (as skills & resources) to assimilate and effect any land use changes.

Farm planning was implemented differently in practice by many catchment authorities. A general procedure likely involved direct inference of land capability in-the-field by a specialist (with little farmer input), primarily for assessing a farm's requirements for erosion control. Likewise, the design phase appears to have orientated more towards the specialist identification of erosion control works and discrete land use changes rather than integrated management in many cases. Farmer involvement was relegated to a discussion after the farm plan had been drafted, principally as a means of final refinements before implementation. Further, production improvements could only be recommended if they carried an equal or greater direct benefit towards erosion control, as catchment authorities were not agricultural consultants, and the allocation of subsidies had to be strictly limited to investments for public benefit. At the extreme end of the spectrum, some of the more 'short, sharp and to the point' farm plan examples resembled little more than subsidy approvals for a limited range of erosion control works, with no consideration of integrated management whatsoever.

However, this was not necessarily the norm for all catchment authorities. Otago Catchment Board in particular, strongly supported the original farm planning principles and the complete process, at least throughout the 1960s. Likewise, the comprehensiveness and style of farm planning varied within authorities according to different soil conservators, and the needs of individual farms on a property-by-property basis. This would represent an informal range of farm planning approaches, similar to the idea of a modern-day regional council offering 2-3 types of farm plan formally distinguished by different degrees of comprehensiveness.

Despite the range of practical variations, the core underlying principles of farm planning have essentially remained unchanged throughout the years, even with the seemingly sophisticated modification and evolution of farm planning through the 1990s. Hence, while technological and procedural advances may have improved farm planning in some manner, most farm plan models are still based upon an assessment of farm opportunities and limitations relating to sustainability, followed by the identification and evaluation of land use changes likely to lead to a more sustainable system of farming.

For this reason, historical ideals of farm planning remain as valid today as they were 50-60 years ago. Likewise, it seems reasonable that historical farm plan models can be applied as modern-day land evaluation frameworks (albeit with minor modifications to accommodate contemporary requirements). Indeed, as will be discussed in the following chapter, some contemporary farm-plan models currently being used by regional authorities have changed little in principle, to those used historically in the promotion of soil conservation.

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Chapter 6

CONTEMPORARY FARM PLANNING IN NEW ZEALAND

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6.1.3 Regional Authorites with Alternative Trading Names

Administrative name	**Trading name**
Southland Regional Council (SRC)	*Environment Southland* (ES)
Manawatu-Wanganui Regional Council (MWRC)	*horizons.mw*
Canterbury Regional Council (CRC)	*Environment Canterbury* (ECan)
Waikato Regional Council (Waikato RC)	*Environment Waikato* (EW)
Bay of Plenty Regional Council (BoPRC)	*Environment Bay of Plenty* (EBoP)

INTRODUCTION

Political and organisational adjustments associated with the late-1980s reforms resulted in changes in New Zealand farm planning. With disestablishment of the collective NWASCO administrative body in 1987, farm planning was no longer a requirement of government policy, and national monitoring of farm planning effectively ceased. A high degree of autonomy afforded under the emergent resource management structure, resulted in some regional authorities discontinuing farm planning, while others retained and/or developed their own variations to better accommodate the new challenges of sustainable management.

A renewed interest in farm planning has been expressed in recent years. As will be discussed, a number of councils who discontinued farm planning in the 1980s or 1990s, are now reconsidering the use of farm plans for promoting SLM. Likewise, a number of investigative reports have been commissioned by various interests, which recommend a greater use of farm planning for resource management in the future (*e.g.* Gibbs & Schofield, 1997; Boffa Miskell, 2000a; Blaschke, 2002; Blaschke & Ngapo, 2002[1]).

Since 1987, the evolving trends of New Zealand farm planning have not been monitored on a national basis. With renewed interest in farm planning, this has resulted in a degree of uncertainty regarding the contemporary state of farm planning in this country.

The aim of this study is to review contemporary farm planning in New Zealand through three primary objectives: identify which regional authorities still provide a farm planning service; distinguish differences that may be apparent between contemporary farm plan models; and to briefly review alternative farm planning applications that have been put forth in recent years.

6.2. STUDY FRAMEWORK

Each objective is addressed through it's own section within this chapter. The method for the first objective involved an addendum of farm plan questions to the national survey described in Chapter 2. Survey participants were later contacted a second time with a request for contemporary farm plan examples or templates, which were evaluated against a predefined structure to fulfil the second objective. Methods for these first two objectives are explained more fully within the chapter. Reviewing alternative farm plan applications has been accomplished by obtaining relevant reports from the agencies involved.

Some councils prefer to title their farm plans using a trading name. Five councils have trading names that differ from their official administrative names. To avoid confusion, administrative names have been matched with trading names in the preceding Section 6.1.3.

[1] Blaschke & Ngapo (2002) undertook a Review of NZ Environmental Farm Plans at the same time that this chapter and the preceding chapter were being written. They implemented a survey well after the survey reported in this chapter. Both surveys had similarities. Some survey results reported in this chapter are therefore considered post-dated to those reported by Blaschke & Ngapo. Their report is briefly reviewed as a part of this chapter.

REGIONAL AUTHORITY FARM PLANNING SERVICES 2001/2002

Prior to the 1980 reforms, farm plans represented the principal means of promoting soil and water conservation on individual farms. With the introduction of the Resource Management Act (RMA, 1991), regional authorities were afforded considerable autonomy in how they chose to promote Sustainable Resource Management (SRM) and Sustainable Land Management (SLM) within their own respective jurisdictions. Some Regional Authorities (RAs) opted to discard farm planning as a service, while others retained and/or developed their own farm plan models to better suit regional characteristics and resourcing limitations.

Central Government and some agricultural sectors have recently expressed a renewed interest in farm plans. However, because developments were not monitored through the 1990s, there exists a degree of uncertainty surrounding the state of contemporary farm planning in NZ.

An information gathering exercise was undertaken in conjunction with the RA survey reported in Chapter 2. While being multi-purpose in character, the principal aim of the exercise was to determine which councils currently provide a farm plan service, and to gain some preliminary insight into how farm planning in its various forms is undertaken.

6.3. METHOD

A set of questions pertaining to farm plans was developed and integrated with the questionnaire discussed in Chapter 2 (specific questions included in Appendix II). Briefly, senior land managers from each of NZ's 16 regional authorities were asked these questions in an interview setting, over a 2-3 month period (November 2000 to January 2003). Interviews were taped and later transcribed. Several participants chose to discuss their responses rather than adhering strictly to the questionnaire design.

The questions on farm plans were broken into three parts: questions for *those who do* provide a farm plan service; questions for *those who do not*; and a general section with questions relating to farm plan advantages, disadvantages, and potential design improvements. A further question relating to the measurement of farm plan effectiveness was also included (responses to this are not reported because the author was exploring potential ideas for another study).

6.4. RESULTS

Responses to questions have been categorised for reporting purposes. RAs who do provide a farm plan service are discussed using the following headings: farm plan numbers; investment; demand; farmer involvement; uniqueness; benefits; disadvantages; and improvements. Categories for those who do not provide a farm plan service include: reasons why not; farm plan numbers; residual mapping capability; benefits, disadvantages and improvements. Results are reported by region, beginning with a statement as whether or not a given council provides a farm planning service. These results are relevant only to the 2000/2001 period when the survey was undertaken.

6.4.1 NORTHLAND REGIONAL COUNCIL

Northland Regional Council *does not* offer a traditional farm plan service, although they may be prepared to assist farmers in undertaking their own environmentally orientated farm plans.

NORTHLAND REGIONAL COUNCIL

Reasons why not: The person interviewed (Bob Cathcart) came across as being a strong advocate for farm planning, at least in a traditional soil conservation sense. Post-1991 farm planning initiatives had been piloted (five farm plans had been prepared during 1998-99), but had not been developed further. Reasons for this included a low priority relative to other regional issues and SLM programmes (at the time, water management was particularly topical), and resourcing limitations that restrict the council from offering a detailed and extensively-available farm planning service.

Farm plan numbers: An estimation of approximately 400 Soil & Water Conservation Plans (SWCPs) was given for the number of farm plans prepared before the Government's abolishment of incentive funding (1988). This aligns with the 357 plans reported for 1985 (Miller, 1988), but is well above the 160 plans reported for 1989 (Hughes, 1989).

Farm plan LRI/LUC mapping capability: Two council staff have training in LRI/LUC mapping for farm plan purposes, and a further two are familiar with the mapping system.

Farm plan benefits: One main benefit was described. Farm plans help farmers understand SLM, as it allows SLM issues to be integrated within the whole farm context. In particular, farm plans represent an effective tool for demonstrating that investment in SLM during the short-term is a necessary requirement for long-term financial benefit.

Farm plan disadvantages: Expensive and time consuming.

Improving farm planning: Linking farm plans with Quality Assurance programmes was noted as a means that could potentially increase the demand for a farm planning service. Promises of premiums or favoured supply associated with QA programmes could represent an incentive to have a QA orientated farm plan prepared.

Other: Northland had piloted detailed environmental farm plans loosely based on the Otago Regional Council's model. They found these unsuitable for Northland, due to the expansive scope of issues (including issues other than those relating to SLM) that this model can be used to cover. In short, it was unwieldy for the Northland situation. If a farm plan service did eventuate, preference would be given to specific issue type plans (*e.g.* solely for erosion control), or plans tailored to the SLM issues of individual farms. Likewise, a greater interest in linking farm planning with industry QA programs was expressed, along with an interest in assisting farmers to map and assess their own soil capability.

6.4.2 Auckland Regional Council

Auckland Regional Council *does not* offer a farm plan service, although the person interviewed (Tony Thompson) was very interested in getting one established. Indeed, the author was even approached to design a farm plan model suitable for the Auckland situation (opportunity declined because it came too early in the investigation of farm plans).

Reasons why not: Only two people are employed by ARC specifically in the area of land management. Five to six people was the number considered necessary for an effective farm plan programme (based on traditional models). Existing levels of funding were also noted as limitation for an effective programme. However, as there was a strong interest in adopting a farm plan approach, the main limitation became the identification of a farm planning model that would accommodate the Council's limitations (resourcing) and requirements (effectiveness, regional appropriateness).

Farm plan numbers: The number of farm plans prepared before 1988 was roughly estimated at 400-500 plans. However, this was acknowledged as 'a bit of guess', and is slightly wide of the 290 plans reported in 1989 by Hughes (1989).

Farm plan LRI/LUC mapping capability: Four council staff could possibly have the training and skills necessary for undertaking farm-scale LRI/LUC survey. However, only two could reasonably be redirected into this activity if it ever again it became necessary.

Farm plan benefits: Farm plans were noted as a means to assist landowners in the identification of their farms' particular SLM issues, production capability constraints (in an efficient resource-use sense), and components of their farms that require environmental protection. Further, they represent a way of 'creating better linkages and synergies with rural community', in that a farm plan can be used as a supporting basis for industry-led initiatives such as QA programmes.

Farm plan disadvantages: The main disadvantage was considered to be the long-term commitment required by a council after a farm plan has been prepared. This would include monitoring to ensure compliance, and assistance during various stages of implementation. In this sense, the staffing and financial investment required for a farm plan can go well beyond the initial investment outlay (which is usually high to begin with).

Improving farm planning: A high degree of enthusiasm was expressed for greater farmer input into the farm planning process: 'we want to maximise farmer input, to maximise their ownership of the process'. Elsewhere this was discussed as getting the full benefit from the process, particularly as it relates to increased farmer understanding (of a farmer's own land capabilities and limitations) and the implication for long-term sustainable management of land.

Other: It was also stated that a small number of farm plans had been prepared after the abolishment of subsidy funding. This involved unlooked-for requests from farmers specifically for farm plans. At a 1999 Farm Planning Workshop, it was noted that Auckland had produced '100 Farm Conservation Schemes costing $1000/plan… between 1980 & 1996' (Robinson & Burgess, 1999).

6.4.3 Waikato Regional Council

Waikato *do* provide a farm plan service, loosely categorised into two types. Firstly, traditional farm planning is retained, but quietly relegated to being a 'tool at the bottom of the toolbox'. Secondly, at the time of the interview, the Council appeared to be more interested in the development of group-based models and DIY yourself approaches to farm planning. Farm plan types were described as *environmental farm plans* and *riparian plans*. The people interviewed (Bruce Peploe & Annie Perkins) considered the farm planning process as being more important than the plan itself.

Number of farm plans: The number of farm plans prepared before 1991 was estimated at 500 plans; this closely parallels the combined total of 523 reported for the Waikato and Hauraki CBs in 1989 (Hughes, 1989). Post-1991 farm plan numbers were estimated to be between 50-60 plans. The current rate of farm plans being prepared is less than ten per year, although this may increase if farm plans are used as a component of Project Watershed (a catchment scheme based around the Waikato River involving a two-million dollar investment over two years).

Investment in farm plans: Up to three staff may be involved in farm planning. No singular cost for preparing an individual farm plan was given, although the total cost of the entire farm plan programme (including staff time and resources) was estimated at $80,000 per annum. Investment in farm planning may increase in the future as a component of Project Watershed.

Demand for farm planning: Neither a strong nor weak demand. Future demand may increase as a part of the Project Watershed.

Farmer involvement in the planning process: Farmer involvement in traditional methods of farm planning is low: little or no involvement in LRI/LUC survey & classification; a collaborative degree of involvement in the formulation of recommendations; while implementation is almost wholly left to the farmer ('as much a possible we try and stand back… to encourage farmers to take responsibility'). Waikato RC also have a follow-up programme for monitoring and maintaining works; a large component of the entire farm planning programme is the maintenance of existing plans.

Implicitly, farmer involvement in any group-based or DIY type farm plans would be considerably higher.

Defining characteristics: In regard to traditional farm plans, no features were distinguished as being distinctive or unique to Waikato. However, it was acknowledged that the Council's 'low key' approach may set the programme apart. While farm planning is used, it is not afforded anywhere near the same degree of priority exhibited by some other regional authorities. In council vernacular, farm plans are a tool that reside near the bottom of the proverbial toolbox.

Farm plan benefits: Three benefits were highlighted. Firstly, a farm plan 'actually addresses the needs of individual properties'. In this sense, a farm plan is tailored around farm-particular SLM issues, and according to farmer abilities and objectives. Secondly, the degree of investment in individual farm plans demonstrates that the Council is 'prepared to go a long-way' in helping farmers promote the SLM of their farms.

The third benefit is somewhat more esoteric, in that the process of farm planning can have a greater benefit than the plan itself. Rephrased, implementing plan recommendations may result in specific and tangible environmental outcomes, but it is the insight, understanding and awareness afforded through the preparation process that carries long-term implications towards farmers' ability and willingness to manage land sustainably.

Such intangible outcomes may contribute to farmers identifying and addressing other SLM issues (*i.e.* future issues and issues not covered in the original farm plan), and/or promote integrative SLM solutions as a normal part of farm management. Likewise, the nature of farm plans requires farmers to consider timescales beyond year-to-year farm management.

Farm plan disadvantages: Farm plans may be misperceived by farmers as being a somewhat rigid commitment to the Council. They may 'see it as a contract with no flexibility', and thereby be discouraged from having a farm plan prepared. For this reason, some councils do not require farmers to enter into binding agreements, such that the implementation of a farm plan is wholly voluntary. However, even the most binding agreements are generally negotiable, in recognition that farming situations may change dramatically during the 5-10 year implementation period of a plan.

It was unclear if Waikato RC requires binding agreements from farmers as a component of their farm plans.

Improving farm planning: A greater emphasis on financial analysis was put-forward as one means of improving farm planning, particularly as it relates to integrating monetary costs and benefits into business planning.

Other: At the time of the interview, Waikato RC was 'developing a process of working with groups of farmers... to help them do their own farm plans... where we provide support [including an aerial photo and instructions/information for identifying issues, soils, and 'risk conditions']... and giving them the opportunity to talk about their ideas with other farmers'. It was strongly emphasised that this model was very much in the preliminary stages of development. Similarity to the SUBS programme was acknowledged, but any forthcoming process would be issue-focused rather than resource-focused.

6.4.4 Bay of Plenty Regional Council

Bay of Plenty *do* provide a farm plan service in the form of farm *environmental programmes* (previously known as environmental plans, or environmental property plans). These were strongly endorsed by the person interviewed (Laurie Donald).

Number of farm plans: No figure was given for the number of pre-1991 farm plans prepared, but the Regional Land Management Plan (EBOP, 2002) states that 400 Soil Conservation Property Plans (SCPPs) were prepared between 1970 and 1997. This is well advanced from the 287 reported for 1989 (Hughes, 1989), and may include the 65 environmental programmes prepared since 1992-93. The distinction between SCPPs and environmental programmes was not made (see below). However, approximately 20 programmes are being prepared each year (38 in the last two years), and this rate was considered to be increasing.

Investment in farm plans: Approximately $280,000 was made available for farm environmental programmes in 2001. However, this was difficult to define exactly, because of financial contributions from local district councils (the Council is funded to fulfil some of the district councils' environmental management responsibilities). Five staff are normally involved in the preparation of environmental programmes (four of which are trained or experienced in LRI/LUC survey). An external person had also been contracted to assist.

Demand for farm planning: Strong demand – at the time there was a considerable waiting list for farmers wanting to have environmental programmes prepared, such that, external assistance had been contracted to accommodate some of the demand.

Farmer involvement in the planning process: Although LRI and LUC mapping is not the standard basis for farm environmental programmes (but it may be used for particularly large properties), farmers are involved in an informal land appraisal that precedes the design of a programme (this is discussed in more detail in Section 6.7.17.). Both parties collaborate on the content of a programme, which may involve a second meeting to finalise details. Implementation and maintenance of a programme is wholly the responsibility of the farmer, but this is monitored to ensure implementation does not deviate significantly from the plan/programme.

Defining characteristics: This is also detailed Section 6.7.17. In short, environmental programmes are loosely based on traditional SWCP models but usually without LRI/LUC assessment. They are prepared from a framework template, through which a diverse range of SLM issues can be targeted (including pests, biodiversity, water management and soil conservation). Standalone reports are prepared for each issue; summarised within the programme document; and then included as appendices. The actual programme includes environmental objectives, recommended works, and requirements for works maintenance and monitoring.

Farm plan benefits: It was suggested that farm plans provide an effective means of educating farmers. That is, while a farmer may only read a programme/plan once (and then 'put it in a pile and never read it again'), they do actually read it. Relative to other sources of environmental or SLM information, the impetus to read is afforded through a mix of interest and moral obligation. Interest stems from having the information tailored to, or framed in terms of, the farmer's own property and farming situation. Obligation arises through involvement in the process, and knowing the degree of time and effort that the Council invests in a programme/plan for the farmer's benefit. In contrast, generic information that turns up in the mail may carry little or no interest to a farmer, and he or she will have no moral obligation to read it.

Farm plan disadvantages: Council-internal processing was nominated as the main disadvantage of environmental programmes. Without this, it was estimated a programme could be prepared within a week and finalised well within a month. However, after the initial farm visit, several other parties may be consulted (namely the local district council and the Department of Conservation), drafts must be prepared and checked, and the programme must be approved firstly by senior officials, and then secondly by the councillors. Taken together, this extends the process to a minimum of three months. A farmer's priorities and resolve can change significantly over such a timeframe.

Improving farm planning: No direct suggestions were given on how farm planning could be improved.

Other: Farm production is not examined in any great detail through environmental programmes. The training required to undertake a quality production analysis was considered to be beyond that required by council officers (*i.e.* they are not farm advisors or consultants). Likewise, even with a degree of training, it was considered unlikely that farmers would be receptive to production advice put forward by someone employed by a regional council. Further, the incentive dimension of having a production analysis undertaken has little value in environmental programmes – the Council make available substantial grants for this purpose. Recommendations relating to production are only usually made if they have a direct bearing on environmental outcomes.

It is likely that the Council still prepares traditional soil conservation type farm plans alongside environmental programmes. Hall (1996) states that traditional farm plans were prepared after 1991 as 'Soil Conservation Property Plans', and suggested that environmental plans/programmes would eventually phase out the traditional model. However, SCPPs are described in the Regional Land Management Plan (EBOP, 2002), with policy stating that these plans will continue to be funded alongside environmental programmes. It is unclear as to why the interviewee chose not to distinguish or discuss Soil Conservation Property Plans.

6.4.5 Gisborne District Council

Gisborne District Council *does not* provide a farm plan service. The person interviewed (Trevor Freeman) strongly supported the concept, and suggested that the use of farm plans may be a consideration of the Council in the future.

Reasons why not: Grants as incentives, assistance and compensation were regarded as a necessary component of farm plans for the Gisborne District. Without them, there is little farmer demand for a service, and no guarantee that a plan will result in actual on-the-ground changes (binding agreements between councils and farmers are not usually used in the absence of grants; without them, farmers are only morally obligated to implement a plan). In this sense, the Council's inability or unwillingness to fund a grants scheme represents the main reason why a farm planning service is not provided.

Farm plan numbers: Farm plans as SWCPs ceased when Government funding for subsidies was abolished in 1988. It was confidently stated that 214 of these plans had been prepared before the introduction of the RMA in 1991. This is below previously reported figures of 423 for 1985 (Miller, 1987) and 455 for 1987 (Blaschke et al., 1994), but is inline with the 180 reported in 1989 (Hughes, 1989).

Farm plan LRI/LUC mapping capability: Four staff have the ability to undertake LRI/LUC mapping. All four could be redirected into this activity if it became necessary. However, at the time, two staff had announced intentions to leave the Council.

Farm plan benefits: Three benefits were identified. Firstly, farm plans provide a useful and clear guide to both the farmer and the Council regarding 'what needs to be done' to progress a farm's SLM status. Secondly, a plan based on a detailed LRI/LUC provides a sound indication of land capability. Put another way, it identifies just what a farm's land-resource is actually capable of sustaining, which as argued in Chapter 3, is the fundamental precursor to sustainable land management (*i.e.* the ability of land to sustain must first be identified, if that ability is to be managed responsibly and effectively). Thirdly, farm plans provide a structured mechanism through which financial grants/assistance can be delivered. In this sense, they provide a robust framework for eligibility assessment and grant allocation, necessary for public investment into works on private land.

Farm plan disadvantages: Two main disadvantages were given as they relate to the Gisborne situation, both of which can be categorised as a cost or resourcing constraint. Firstly, it was considered that a LRI/LUC land assessment is an essential basis for farm planning in Gisborne, but such an activity was pointless unless undertaken at a detailed farm-scale (1:5000 to 1:15,840). Such detail for many individual farms translates to a substantial cost in terms of money, staff time, and other resources (*e.g.* aerial photos). Secondly, high cost was also associated with developing a reliable District-wide Land Information System (LIS) that could accurately accommodate farm-scale land resource information. The technical cost for this is presently prohibitive, meaning the Council would have to rely on the traditional but cumbersome method of managing information as separate hardcopies contained in individual plans.

Improving farm planning: One suggestion was put forth on how the traditional farm plan model (as previously used by the East Cape CB) could be improved. The interviewee would like to see a greater inclusion of farm management information afforded through detailed investigation of land capability (*i.e.* more detailed than just LUC). That is, more detailed information concerning stock carrying potentials and capacities, along with a greater consideration of alternative management options. As an example, this could include demonstrating how marginal or unviable some less-capable classes of land may be.

Other: If farm planning was readopted by the GDC, then any new model would likely extend beyond traditional soil conservation to include biodiversity, natural heritage, and other contemporary SLM issues. Alternatively, if greater Council effort is directed at regulating land-use on severely eroding land (as considered by the Council in 2002), then farm plans may be used as a component within any forthcoming regulatory framework (T. Freeman, 21/06/02 *pers. comm.*). This could include policies similar to those recommended by Blaschke *et al.* (1994) and Boffa-Miskell (2000), both of which are discussed in Section 6.10.

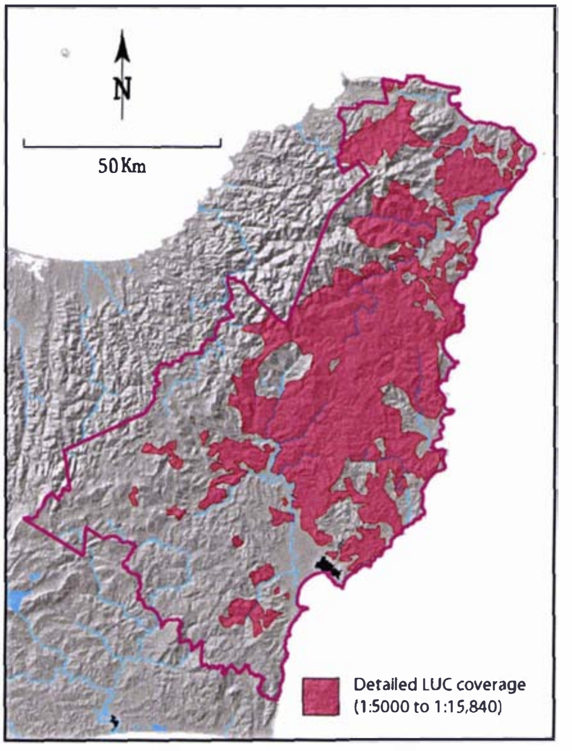

Figure 6.1: Coverage of detailed LUC survey for Gisborne District (adapted from Boffa-Miskell, 2000).

The East Coast Forestry Project was considered apart from the Council's main activities, and was not discussed to any great extent. It was acknowledged that the Project provides a good incentive for land use change, although this is only for Gisborne's most severely erosion-prone land.

Detailed LRI/LUC mapping was strongly supported as a 'major planning tool'. Various catchment surveys and individual farm plans prepared since the early 1950s (beginning with the Poverty Bay catchment authority) can be aggregated to represent detailed LUC coverage across 40-45% of the District (Figure 6.1). Applied to agriculture, this coverage accounts for approximately 70% of the District's pastoral land (Boffa-Miskell, 2000).

6.4.6 HAWKES BAY REGIONAL COUNCIL

Hawkes Bay Regional Council *do* provide a farm plan service. The person interviewed (Garth Eyles) strongly supported the use of farm plans, and is a recognised expert in LRI/LUC survey and farm planning in general.

Number of farm plans: An estimate of 350 was given for the number of farm plans prepared before 1991. This aligns well with the 325 reported for 1985 (Miller, 1988) but is well below the 1989 report of 435 (Hughes, 1989). Early in the 1990s, the HBRC developed and piloted several different farm plan models, but these were later discarded. Occasional plans may have been prepared sporadically through the mid-1990s, but it wasn't until the late 1990s that a farm planning service was officially reinstated. At least 20-25 farm plans have been prepared since 1991. Exact numbers for the early and mid 1990s are uncertain. Under the current regime, approximately 10 plans are being prepared each year.

Investment in farm plans: Two main types of plan were distinguished by their degree of investment. 'Bronze version' plans involve grants of <$10,000 and can be prepared with a relatively low degree of LMO input. The 'gold version' is for grants exceeding $10,000, for which the Council budgets $350/day over ten days. Total cost for a gold version farm plan is therefore approximately $3500. This level of financial investment is unlikely to change in the near future. Farmers are expected to contribute $500 to the cost of preparing a farm plan. The number of staff units allocated to farm planning is approximately 0.6, with the actual responsibility for preparing the plans distributed between two Council staff. Total time required to prepare ***and*** approve a farm plan is usually 20 working days.

Demand for farm planning: Strong demand.

Farmer involvement in the planning process: Farmer involvement is high for a bronze level farm plan, but only moderate for the gold version. A bronze level farm plan may involve a farmer doing a significant component of the plan (he or she is provided with an aerial photo, a stepwise planning template, and instructions), which is later checked and refined by a LMO. In contrast, a gold level farm plan involves the traditional farm visit, a LUC based land assessment, the design of a five year works programme with the farmer, and a non-binding agreement to undertake works on a year by year basis. LMOs will visit each farm that has a farm plan on an annual basis to check if works have been carried out, and to offer further assistance. It was suggested that a greater degree of farmer involvement in the initial design of the works programme would be desirable.

Defining characteristics: Nothing about a Hawkes Bay farm plan was considered unique, as the existing model is based strongly on traditional SWCPs. While some staff may include a broad consideration of SLM issues, they are not encouraged to do so.

Farm plan benefits: A well prepared farm plan conveys a high degree of confidence in it's implementation. That is, recommendations are based on the best information that can reasonably be obtained through detailed land assessments of individual properties. In contrast to other methods, there is a high degree of confidence that farm SLM issues have been identified, assessed (and afforded priority/seriousness), and that the best recommendations have been put forth.

Farm plan disadvantages: Time and cost (time/plan = 10 days; cost/plan = $3,500).

Improving farm planning: Improving the efficiency of the farm plan process was noted as a means to improve farm plans. In particular, the HBRC was attempting to reduce the amount of documentation required for a plan. Further, they were also developing a database to record new LUC units identified at the farm scale, which are not covered by the regional classification.

Other: It was suggested that an LIS would be a desirable method of managing farm plan information. However, as with Gisborne, the technical cost was considered prohibitive, and it was uncertain if historical LUC classifications would conform with the modern day system.

While the implementation of a farm plan is checked on a regular basis, their effectiveness is not monitored. However, at the time, the Council were considering the development of a database that would record the areal percent of an LUC unit treated with soil conservation measures. Progress could then be gauged by comparing the cumulative area of treatments to the total regional area of a given LUC unit.

Hawkes Bay, along with Taranaki, is one of the few councils that organise farm plan workshops for training new LMOs and soil conservators.

6.4.7 MANAWATU-WANGANUI REGIONAL COUNCIL

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Your Regional Council

The Manawatu-Wanganui Regional Council *do* provide a farm plan service, and are currently exploring opportunities for group-based farm planning through the Soils Underpinning Business Success programme. Responses presented below were obtained several months after the initial survey, due to a recording failure in the second half of the interview. The person interviewed (Grant Cooper) favoured the use of farm plans.

Number of farm plans: No estimate was given for the number of farm plans prepared before 1991. Hughes (1989) reported a combined total of 509 plans for both the Rangatikei/Wanganui and Manawatu Catchment Boards in 1989. MWRC did not carry out farm planning between the late 1980s (when subsidies were abolished) and early 1990s, nor were any farm-plan pilots or trials undertaken (other than through involvement in the SLMP). The service was re-established towards the end of 1996. Since this time, approximately 150-160 farm plans have been prepared. Seventy of these have eventuated from the Ohura catchment scheme over the past 4-5 years. The current rate of farm plans being prepared was estimated at 3-4 plans per year (region wide).

Investment in farm plans: A total of ten staff (distributed throughout the Region) have farm planning responsibilities. A single plan generally takes approximately two weeks to prepare, but in exceptional cases may take up to three weeks (Grant, 2000). A two-week plan represents an estimated cost of $4500/plan. Technical approval of a plan is often granted in less than 1-2 days (plans approved/disapproved on a district office basis). The provision of grants involves an application to the regional office after technical approval has been given. Any general grant application backed with a farm plan receive funding priority (if funds are short).

Demand for farm planning: Neither a weak nor strong demand. However, this varies according to district offices, and the degree of emphasis different Land Management Officers (LMOs) place on farm planning. Some district offices have waiting lists.

Farmer involvement in the planning process: Low to moderate. The farm planning process used by the MWRC is strongly based on traditional models: LMO land assessment → discussion with farmer about issues and a works programme → LMO plan drafting and documenting → discussion with farmer about recommendations and implementation → implementation by farmer → annual or biennial checks and updates by LMO. However, it was acknowledged that this varies between LMOs. It was also noted that high farmer involvement in a traditional style of farm planning may be distracting and time consuming; other approaches (*e.g.* SUBS) were considered to be more appropriate for high farmer involvement and action learning.

Defining characteristics: Being based on traditional farm planning, the MWRC model does not exhibit significantly distinctive characteristics. General format includes a resource/issue description section; a works programme; and a series of three maps (paddock/land use, LUC, and works). However, while the main purpose may orientate towards soil conservation, it may also be extended to include pests/weeds, soil structure, and riparian management on a farm by farm basis.

Farm plan benefits: Farm plans were regarded as a means to engage farmers on SLM issues other than just soil erosion. While a farmer may request a plan initially as an aid to control erosion, the farm planning process allows the LMO to identify other SLM issues that may be apparent on a farm; increase farmer awareness and understanding of those issues; and then integrate them into the farm plan and perhaps land management in general.

Farm plan disadvantages: Time and cost (time/plan = 10 days; cost/plan = $4,500)

Improving farm planning: A group approach was nominated as being one potential means of improvement, but only if it is kept separate from traditional farm planning procedures. As experienced with the SUBS programme, a group approach represents a more efficient way for farmers to increase their land capability knowledge. In contrast, attempting to integrate a similar level of education into traditional farm planning models was not considered viable (*i.e.* because it increases time and cost per plan).

It was also suggested that coordinated farm planning on a catchment by catchment basis would also be an improvement.

Other: MWRC farm plans may vary slightly in their content, format and preparation procedure. This is a reflection of the landscape and SLM-issue diversity across the Region, and the autonomy given to district offices regarding the technical approval of plans.

Interest was also expressed in a LIS for linking and managing farm plan information. This has been considered by the Council, but not pursued because of the technical cost; GIS staffing limitations; and a previous reliance on a mapping package that was not amendable to the development of a regional database.

While MWRC's principal approach to farm planning is traditional and comprehensive, a 'DIY farm planning kit' has been developed from the Wanganui office. Briefly, this involves the provision of an aerial photo, instructions, pens, and 'know your land' brochures, which the farmer uses to prepare a rudimentary farm plan. This plan is later checked and refined in collaboration with a LMO. As discussed by Grant (2000), distinguishing features include: low investment of staff time (a plan takes approximately one day of staff time); a three year works programme; required works are assessed on a paddock-by-paddock basis (rather than a LUC basis); and where and when works are carried out is at the discretion of the farmer (*cf.* to targeting high risk LUC units according to Council priorities; this is viewed as an initial means to encourage a soil conservation ethic).

MWRC's policy regarding farm plans may change in the near future. This may be expressed as a reduced emphasis on the promotion of farm planning as a service, although plans will still be prepared if requested. There appears to be an increasing preference for promoting SLM through catchment level schemes, rather than an *ad hoc* farm-by-farm basis. However, this may involve a greater emphasis on DIY farm planning, such as that recommended for the Ohura Catchment (Grant, 2000).

6.4.8 TARANAKI REGIONAL COUNCIL

Taranaki Regional Council (TRC) *do* provide a farm planning service. Indeed, they offer several well-defined *property plans*, including *comprehensive farm plans*, *agroforestry plans*, *conservation plans*, and *riparian plans*. The person interviewed (Dex Knowles) is regarded as one of NZ's leading experts on farm plans (having prepared some of NZ's earliest farm plans, and authored a technical guide on the application of farm planning), and is a strong advocate for their use.

TARANAKI
REGIONAL
COUNCIL

Number of farm plans: Numbers of post-1996 farm plans are given in the TRC Land Management Annual Report (Table 6.1). Approximately 100 property plans are prepared on an annual basis, but this can vary widely. Pre-1991 farm plan numbers are uncertain. According to Hughes (1989), a total of 290 farm plans had been completed by the Taranaki Catchment Commission before government subsidies were abolished. It was stated that approximately 100 'landform plans' had been prepared between 1991-96 according to the model discussed in Chapter 5 (Section 5.4.1).

	Comprehensive	Agro-forestry	Riparian	Conservation	TOTAL
1996 to 1998/99	31	14	120	39	**204**
1998/1999	20	2	54	33	**109**
1999/2000	16	4	62	19	**101**
2000/2001	24	0	88	38	**150**
2001/2002	23	0	61	31	**115**
TOTAL	**114**	**20**	**385**	**160**	**679**

Table 6.1: Summary of TRC farm plan numbers, 1996 to 2002 (TRC, 2002).

Investment in farm plans: No monetary figure for the cost of individual types of farm plans was given. Likewise, no estimate for investment into the property planning programme was forthcoming. However, as property planning is the major method for promoting SLM (see Chapter 2), then it is probable that a high proportion of the $1.2 million annually invested into the Land Management Programme is spent on property planning (directly and indirectly). An estimate of 47-68hrs was later obtained (L. Grant, 2nd April 2003, *per. comm.*) for the preparation of Comprehensive Farm Plans (conservatively this could equate to $2,500 to $3,500 per plan), although this timeframe may be exceeded in practice. At the beginning of 2002, ten staff were responsible for preparing farm plans, along with support from a technical officer specialising in map draughting.

Demand for farm planning: Very strong demand, with a 12 month waiting list of approximately 100 plans. An extra person had been contracted to help reduce the waiting list (who was expected to complete a minimum of 60 riparian plans within 12 months).

Farmer involvement in the planning process: Many of the farm planning processes used are based on traditional models. Essentially, farmers are not involved in LRI/LUC survey and classification; are strongly involved in the development of recommendations; and have only minor assistance from the Council for implementing recommendations, and for carrying out maintenance. However, LMOs will provide follow-up assistance (advice on implementation and maintenance of works), and each plan is monitored on an annual basis (the data collected for monitoring is comprehensive, and serves as a basis for annual planning and reporting).

Defining characteristics: The variety of farm plan types distinguishes the TRC's approach to farm planning. Specific distinctions within each plan type are presented and discussed in Section 6.7. Further, although it was not stated, the lack of a synchronous grants scheme represents another distinguishing feature of TRC's property planning programme.

Farm plan benefits: Farm plans provide a mechanism for identifying and managing site specific SLM issues.

Farm plan disadvantages: The time taken to prepare farm plans, particularly when there is a waiting list. The interviewee would like to see a reduction in the time taken to prepare plans, but in a way that would not unduly compromise plan quality: 'one thing that I'm not prepared to let go of is the standard of the product, and the standard of the service'.

Improving farm planning: Two possible improvements were given as they relate to TRC property plans. Firstly, a grants scheme was considered complementary to farm planning: "we'd be able to assist farmers in adopting land management recommendations more quickly if we could grease the tracks a bit with financial assistance". Secondly, as a response to the time required to prepare farm plans, the Council were actively seeking to accelerate the farm plan process through the development of an LIS (*i.e.* improving farm plan efficiency through information management). At the time of the interview, the Council was considering the purchase of a new GIS, and collaboratively working towards the procurement of detailed orthophotography for the entire Region.

Other: Taranaki has a comprehensive monitoring programme linked with farm planning. Information from farms with plans is collected on an annual basis, entered into a database, and then analysed for monitoring progress relating to SLM (which is then used for annual planning, annual reporting, and five-yearly SoE reporting). The amount of data recorded was described as 'masses of #%&*$! information' that is entered into a 'massive #%&*$! spreadsheet'. Taranaki also organises and runs farm-plan training workshops.

6.4.9 Wellington Regional Council

Wellington *do* provide a farm plan service, divided into *sustainability plans* and *conservation plans* (including *shelter plans* and *hill country erosion plans*). The person interviewed (Dave Cameron) is another well-recognised farm plan expert, and a strong advocate for their use. By continuing farm planning through the 1980s and 1990s, Wellington RC have a longstanding rapport with farmers; considerable farm planning expertise and experience; extensive farm plan coverage; and a consistent history of works and farm plan updates.

Number of farm plans: The total number of farm plans prepared since the mid-1950s was confidently stated as 490 plans. This aligns well with the 454 plans reported in 1989 by Hughes (1989) for the Wairarapa CB (note: approximately 20-30 Wairarapa farm plans would later come under the jurisdiction of the Manawatu-Wanganui RC when catchment boards were abolished). Approximately 60 farm plans have been prepared since 1991 (including 20 shelter plans). Five sustainability plans are being prepared annually (this is a preset limit), while new conservation plans may range from none to five. However, the number of conservation plan updates is considerably higher, as approximately 175-200 plans can be active within any one year (Wellington RC farm plans span a ten year period, as opposed to the traditional five).

Investment in farm plans: Four staff have responsibilities for preparing and maintaining farm plans. A specialist consultant (Doug Hicks) may also be contracted for new LRI/LUC farm-scale assessments, and for the complete preparation of sustainability plans. The approximate cost for preparing a single sustainability plan was estimated at $7,000 to $8,000, with farmers required to make a nominal contribution of $500 for any economic analysis associated with a plan. No singular cost for conservation plans was given, although the Council has committed $600,000 over three years expressly for investment in farm plans.

Demand for farm planning: The demand for conservation plans was not considered relevant – with such a long and uninterrupted history of farm planning, it was felt that the farms that needed farm plans already had a farm plan (and therefore only required updates). However, demand for sustainability plans was strong. This demand was firstly attributed to the limited number of plans that could be prepared in one year (*i.e.* actual demand cannot be accommodated because of high cost), and secondly, it was felt that the production development insight afforded through sustainability plans acted as a strong incentive. Indeed, this was considered an even greater incentive than financial grants, particularly for larger properties seeking the most profitable and environmentally sustainable approach to farm development.

Farmer involvement in the planning process: Procedures for both sustainability and conservation plans are based on traditional models. The farmer will have little or no involvement in LRI/LUC survey and classification; a collaborative involvement in the formulation of recommendations; and perhaps some assistance with works implementation (*e.g.* pole planting). However, implementation is wholly voluntary (*i.e.* there is no binding agreement) and therefore flexible according to yearly fluctuations in the farming environment.

Post-implementation, the Council has a strong and longstanding follow-up program, which is actively used to ensure plans are updated and works are maintained (described as giving the farmer a couple of phone calls or one visit per year, and asking 'how are you getting on?').

Defining characteristics: Two outstanding characteristics are distinctive to the Wellington RC's farm planning programme. The first was stated in the interview, as the previously mentioned high-degree of follow-up after a plan has been prepared. Accordingly, rather than being a once-off solution, Wellington RC farm plans can be considered as being long-term and dynamic solutions.

The second characteristic has been inferred. Uninterrupted provision of farm planning since the 1950s has resulted in an extensive coverage of the Region's farms, to a point where the Council is more involved with the maintenance of traditional farm plans rather than their development (*i.e.* the requirement for completely new conservation plans is very low). With such a consolidated foundation, the Council is now shifting to another level of farm planning through their sustainability plans, involving a more detailed and integrated analysis on a whole-farm basis. In this sense, the Wellington RC has NZ's most established farm planning programme, which is capped-off with one of the most advanced farm plan models (at least for hill country farming).

Farm plan benefits: Two benefits were given: firstly, Wellington RC farm plans represent a means of engaging farmers on a one-to-one basis, and on a level that is both interesting and understandable to both parties. As discussed in the interview, 'the main benefit is the one-to-one relation we have with the land owner… and the amount of information we can get to him across the table'. Paraphrased in a slightly different sense, a farm plan can be a vehicle for site-specific and person-specific education and advocacy.

The second benefit was the effectiveness of farm plans. It was considered that there was a high probability that recommendations would be translated into actual on-the-ground changes, due to the incentive and assistance afforded through grants. This was regarded as 'a very strong driver for getting the work done'.

A final benefit was mentioned later in the interview. Farm plans provide farmers with a long-term perspective of their property, well beyond the year-to-year timeframes usually associated with production management. As such, farm plans provide a means of clarifying the time dimension of SLM, particularly as it relates to continuity.

Farm plan disadvantages: While the Wellington RC has a well-established farm plan programme, the cumulative effect of assisting some farmers throughout the years has resulted in a degree of farmer dependence on the Council for environmental management. That is, some farmers expect and rely on the Council to take a large role in the environmental management of their farms. This may be a symptom of too much assistance, and has long-term implications for ownership and responsibility of farm-related environmental problems. However, it was emphasised that this situation only applies to a minority of farmers.

Improving farm planning: While no suggestions for improving farm planning were put forward, the interviewee strongly supported the whole-farm and integrative character of sustainability plans.

Other: Wellington RC farm plans have been strongly focused on soil conservation, particularly as it relates to hill country erosion and shelterbelt planting on cropping land (and some dairy farms). At the time of the interview, the Council were beginning to explore options for riparian management (and perhaps biodiversity protection). A pilot project had been initiated near Carterton, which was based on a Taranaki RC model of promoting riparian management.

Wellington RC recently completed a review of the format used in their farm plans. Much of the residual content previously required by the now defunct NWASCO was omitted, and has been replaced with a greater emphasis on identifying land use, land-use capability, and requirements for improving the match between use and capability.

The Council undertakes a three-year monitoring programme associated with farm plans. Twenty-five farms from targeted areas are randomly selected every three years (*i.e.* a random but stratified sample), and the relation between treated and untreated LUC units is determined and compared (only targeted LUC units with a high erosion risk are considered). In this way, the Council gains an indication of their progress towards regional erosion control, on a farm basis.

Blaschke (2002b) states that approximately 80% of the Wellington Region's eastern hill country (Wairarapa) is covered by farm plans. In contrast, there are no farm plans for the western part of the Region.

6.4.10 Tasman District Council

Tasman District Council *do* provide a farm planning service as *conservation farm plans*. These are strongly based on traditional SWCPs, and are used almost exclusively for erosion control on hill-country farms. The person interviewed (Colin Michie) favoured the use of farm plans, and is well-versed in their application.

Number of farm plans: Estimating the number of pre-1991 farm plans was difficult because earlier catchment boundaries were significantly different from the Tasman District's modern regional boundary. This was further complicated by the Council's interim transition as part of the Nelson-Marlborough RC in the early 1990s. However, while taking these factors into consideration, the interviewee estimated that 70 to 80 pre-1991 farm plans had been prepared in what is now the Tasman District. A more confident number of 30 new conservation plans was given for the period after 1991. It was also emphasised that a number of earlier plans had been updated, and are therefore still operative. The rate of new farm plans being prepared was less than five per year.

Investment in farm plans: No estimate for the cost of a single farm plan was given. Total financial investment is approximately $10,000 per year. In terms of staff units, around 0.4 of a unit is allocated to the preparation and maintenance of farm plans. This responsibility is delegated to a single staff member.

Demand for farm planning: Weak demand. Apparently there is very little agriculturally-used land within the District that carries a high erosion risk (*cf.* some other districts and regions).

Farmer involvement in the planning process: A traditional approach is used – farmers have little or no involvement in the survey, classification or formulation of recommendations. However, they receive assistance and support for both the implementation and maintenance of recommendations. The TDC also have a follow-up programme in place, to monitor and assist, and to update farm plans if necessary.

Defining characteristics: Somewhat cryptically, the lack of farm planning was noted as a unique feature of TDC's farm planning programme. This was described firstly as the limited demand for farm planning in hill and high country, and secondly, as an unfulfilled and growing potential for multi-issue farm plans tailored to intensive land uses (particularly dairying and orcharding).

Farm plan benefits: Farm plans were considered as a means for improved communication between farmers and the Council. Likewise, they can be used to increase farmer awareness of SLM issues, and for stimulating interest. In this sense, the benefits stated are similar to those reported for Wellington and Manawatu-Wanganui, in that farm plans represent a mechanism for (site-specific) advocacy, education, and communication/interaction.

Farm plan disadvantages: The only disadvantage stated was a disproportionate allocation of resources and advice between farmers. While the Council has an equal responsibility to all the District's farmers, a greater amount of time tends to be invested in farmers who have farm plans.

Improving farm planning: Two possible improvements were given. Firstly, it was suggested that resource management in general could be improved by introducing land assessment into some of the more advanced school syllabuses (*e.g.* 7th Form Geography). Secondly, it was suggested that farm planning could be improved through greater involvement of the farm family. In particular, female partners were perceived as potentially having a greater ability to manage some types of farm information more effectively than their male counterparts. At the time, the TDC was considering an initiative involving farm plans for dairy farms, which would be implemented through the Women's Institution of Federated Farmers.

6.4.11 Nelson City Council

Nelson *does not* provide a farm planning service. However, at the time of the interview, they were developing a *property plan* concept that would later be deferred due to resistance from the farming industry. Both interviewee's (Paul Sheldon & Don Ballagh) described themselves as being 'reserved' about traditional farm plan approaches.

NELSON CITY COUNCIL

Reasons why not: Traditional farm planning was not retained when the Nelson City Council emerged from the dissolution of the Nelson-Marlborough Catchment Board. As a small unitary authority, the Council has had a strong city and district emphasis on resource management. For this reason, there is very little political support for the traditional models of farm planning that tend to associate with catchment and regional resource-management.

Farm plan numbers: Based on local knowledge, a considered estimate of five SWCPs was put forward as the number of farm plans prepared before 1991 (within the current Nelson City Council jurisdiction). These were mostly prepared by the previous Nelson CB, and perhaps to a lesser extent by the Nelson-Marlborough RC. No farm plans have been prepared after 1992.

Farm plan LRI/LUC mapping capability: Two staff have the training and skills necessary for undertaking LRI survey and LUC classification. Both could feasibly undertake this activity today if it was necessary. However, this would be highly unlikely.

Farm plan benefits: For the pre-1989 SWCP model, farm plans represented a way to help farmers undertake SLM-related works that would otherwise be beyond the means of an individual landowner. For more contemporary models, farm plans represent a means to integrate the Council's environmental management skills with farmers' management skills (*i.e.* as a means to assist farmers with environmental management). Farm plans were also recognised as a mechanism to facilitate one-to-one education and advocacy.

Farm plan disadvantages: The effectiveness of farm plans was seen to be strongly linked with the provision of grants. Without grants, the effectiveness of farm plans was much reduced, particularly in terms of motivating farmers to initially request a farm plan, to undertake prescribed works, and then to actually maintain those works. In a similar sense, a low degree of 'buy-in' and ownership was cited as a disadvantage of plans prepared and funded by an outside agency.

Improving farm planning: No suggestions were put forward on how farm planning could be improved.

Other: At the time of the interview, the Council was seeking to develop a concept of *property plans* (see Chapter 5; Section 5.4.6). These are far removed from traditional farm planning models, in that negotiated bundles of consents for an extended period (*e.g.* ten years) form the basis of 'planned' future development and management of a farm's resources. Although the concept has recently been abandoned, Nelson's property plans represent a unique innovation in the way farm planning can be undertaken.

6.4.12 Marlborough District Council

Marlborough District Council *do not* provide a farm planning service. Despite a strong history of water and soil conservation as the Marlborough CB, farm planning and many other land management activities were simply abolished with the formation of the District Council (whose territorial focus was initially greater than its regional focus). It was unclear if the two persons interviewed (Nicki Eade & Ian Shadcock) supported the concept of farm planning.

Reasons why not: Three reasons were given. Firstly, resourcing was noted as a limiting factor: 'its not something we have the staff, money or expertise to do'. Secondly, priority for resourcing has trended towards topical issues concerning lowland intensification and the Marlborough Sounds, rather than soil conservation and hill/high country farming that farm planning has traditionally associated with. Thirdly, pre-1992 approaches to land management were almost completely abolished when the District Council was established. Unitary status was initially skewed heavily towards territorial issues and management approaches, and it is only in the past 3-4 years that a new emphasis on land management has emerged. At the time of the interview, Marlborough was still very much in the development phase of their land management programme.

Farm plan numbers: No estimate for the number of farm plans prepared before 1991 was given. Hughes (1989) reports 110 plans for 1989 (*i.e.* for Marlborough CB), but this is well below the earlier 490 plans reported for 1985 (Miller, 1988). It was uncertain whether any plans had been prepared under the Nelson-Marlborough Regional Council (1989-92), but it was confidently stated that the District Council had not prepared any farm plans.

Farm plan LRI/LUC mapping capability: One staff member possibly has the skills and background necessary for LRI/LUC survey and classification, although it would be highly unlikely that this person could be redirected into this activity if it ever again became necessary. It was also noted that a consultant with the appropriate skills had been considered for refining parts of the Marlborough NZLRI (*i.e.* where more detail was required).

Farm plan benefits: One-to-one contact with farmers was noted as a benefit, particularly as it relates to being a means to facilitate education, increase awareness, and to build relationships.

Farm plan disadvantages: High investment of staff time was highlighted as the main disadvantage.

Improving farm planning: Industry led farm-planning was nominated as a potential improvement over traditional approaches, particularly as it relates to the farm industry and community assuming a greater responsibility for on-farm environmental management.

Other: For the sake of argument, one of the interviewees (Ian Shadcock) challenged the justification of a farm plan service for farmers, relative to the services provided to other industries. Farm planning was discussed as a consultancy type service to farmers, whereby a council undertakes an expensive technical assessment and analysis of part of the farm system, more or less as a free service. It was argued, that because a farm is a business like any other business, it should not receive such special attention. Rather, on-farm environmental management is completely the responsibility of the farmer, and should be accounted for in normal farm management.

As a free service, farm planning can be considered as a form of subsidy similar to financial grants. However, other than regulation and pure advocacy, most council activities relating to the promotion of SLM tend to represent some form of service (*e.g.* provision of information, advice, technical assistance, grants, education & training, works, guidance). These services (including farm planning) are typically justified on the assumption that any resulting benefit to the community will outweigh the benefit to the individual. Likewise, the provision of services epitomises the RMA's principles of partnership and 'working together' to achieve SRM.

6.4.13 West Coast Regional Council

The West Coast Regional Council *do not* provide a farm plan service, nor do they have a significant history of preparing farm plans. The two Council officers interviewed (Trevor James & Rob Thornton) did not suggest any support for farm planning, although farm plans were favourably described as a proactive approach to SLM in a later communiqué. Due to time constraints (arising from a flawed questionnaire design), interviewee's responses to questions concerning farm plans were short and incomplete.

THE WEST COAST
REGIONAL COUNCIL

Reasons why not: Resourcing in terms of financial cost and staffing were cited as the primary reasons for not offering a farm plan service. Further, under the Council's cost recovery policies, it would be difficult to maintain a programme that would require a disproportionately high allocation of services.

Farm plan numbers: No estimate was given for the number of farm plans prepared prior to 1991. Hughes (1989) reported that a modest 22 plans had been prepared by the Westland CB up until 1989. It was confidently stated that no farm plans had been prepared after 1991.

Farm plan LRI/LUC mapping capability: One Council officer has the ability to undertake LRI/LUC survey and classification. It was feasible that this officer could be redirected into this activity, but at the time, it was considered highly unlikely that the Council would ever provide a farm plan service.

Farm plan benefits: None given.

Farm plan disadvantages: None given.

Improving farm planning: No suggestions given.

6.4.14 Canterbury Regional Council

It was stated that Canterbury Regional Council *do not* provide a traditional farm planning service. However, at the time, they had tested the application of a new farm planning model, and had expressed an intention to develop it further. When approached in mid-2002, it was indicated that the Council provides *riparian plans* and *resource care assessment* reports as a precursory form of *property plans*.

Reasons why not: At the time of the interview (November, 2000), farm plans were not used for two reasons. Firstly, the Council was unwilling or unable to support a grants scheme, which was considered necessary for the most effective use of traditional farm planning. Secondly, it was felt that traditional models would be unsuitable for accommodating the broad range of environmental issues now included in resource-care assessments.

Farm plan numbers: Traditional farm planning was officially discontinued in 1991. An estimate of the number of plans prepared prior to 1991 was difficult because the modern regional boundary spans 4 former catchment authorities. It was confidently stated that over 500 plans had been prepared for the North Canterbury CB, but only a 'rough guess' of 1500 was estimated for the entire Region.

Farm plan LRI/LUC mapping capability: Approximately 12 staff throughout the Council have the skills for undertaking LRI/LUC survey. Perhaps four of these could feasibly be redirected into this type of mapping if it ever again became necessary.

Farm plan benefits: Three principal benefits were put forward. Firstly, farm plans are a means to reduce issues to less daunting and more manageable 'bite sized chunks' through five-year works programmes. Secondly, they provide long-term context: 'people can see the outcomes they're trying to achieve… so they get an overall picture of where they are going'. Thirdly, farm plans represent a method of budgeting for sustainable land management.

Farm plan disadvantages: Emphatically stated as a problem of ownership. Having a farm plan prepared by an external agency at little or no cost (to the farmer), does not mean the farmer will assume ownership and responsibility for any stated issues or recommendations. In contrast, ownership is understandably high when farmers develop their own conclusions and priorities for action.

Improving farm planning: Suggestions for improving farm planning were linked with environmental checklists: 'I think the [traditional farm planning process] could be more effective by being more comprehensive… I think the plan itself needs a checklist put in front of it'.

Relative to traditional farm planning, a checklist allows for a broader scope of on-farm issues to be identified by the farmer. Further, in completing the checklist, the farmer is actually acknowledging his/her farm's environmental issues.

Other: As a special exception to Council policy, 25 farm plans had been prepared between 1991 and 1995 as part of the Rabbit & Land Management Programme (R&LMP). Further, with a renewed interest in farm planning in the late 1990s, five property plans had been prepared according to the Enviro-Ag model. As a follow-on, increased application of Canterbury's environmental checklist programme in 2001 was envisaged to precede the collaborative preparation of additional farm plans (which may or may not be according to the Enviro-Ag model). Collaborative preparation is taken to mean the Council will assist farmers in the preparation of their own farm plans.

6.4.15 OTAGO REGIONAL COUNCIL

Otago Regional Council *do* provide a farm plan service, in the form of *Enviro-Ag environmental farm plans*. These differ markedly from traditional models, and can be accredited to ISO14001 standards. The person interviewed (Ian Brown) supported this model of farm planning, and the Council were seeking to promote greater uptake across the Region. However, at the time of the interview, efforts were being directed at fostering the preparation of farm plans through non-Council mechanisms. When contacted 18 months later, it was stated the Council 'no longer offer a farm plan service'; responsibility for preparing Enviro-Ag farm plans has now shifted to the farming industry and community.

Number of farm plans: The number of farm plans prepared before 1991 was optimistically estimated at 700. This is almost double the 334 SWCPs reported for the Otago CB in 1987 (Sutcliffe, 1991) and the 360 reported in 1989 (Hughes, 1989). No estimate for post-1991 soil and water conservation type plans was given (although several would have been prepared as part of the R&LMP). It was confidently stated that approximately 120 environmental farm plans based on the Enviro-Ag model (and its immediate predecessors) had been prepared since 1996, with 15 having been prepared within the 12 month period preceding the interview.

Investment in farm plans: A set maximum of 8hrs is allocated to the preparation of an individual environmental farm plan. In terms of cost, this equates to approximately \$600/plan, although the Council was seeking to reduce this to around \$200/plan (as part of devolving the core responsibility of plan preparation away from Council and into the farming community/industry). At the time, some of the cost was partly offset by charging a nominal fee of \$120 per plan. Annual financial investment in farm planning was given as \$120,000 per year, while the total cost of developing and applying the Enviro-Ag model was estimated at \$300,000. Staff time invested in the farm plan programme equates to one fulltime staff unit distributed between three staff members.

Demand for farm planning: Demand for a farm planning service was described as weak. At the time of the interview, the Council had been developing the Enviro-Ag model with a limited number of farmers, and had only recently begun to promote the programme in a Region-wide context. A strong demand was considered unlikely, even if more resources were invested into the programme: 'I think that even with 10 staff working on farm plans… we would still struggle [to implement a widespread farm plan programme]… because people don't think they need a farm plan'.

Farmer involvement in the planning process: Farmer involvement is high. Briefly, the process begins with local farmers attending a 3hr workshop, at which the Enviro-Ag concept is explained using a case study example and a workshop manual. For farmers who express a further interest, a one-on-one session is arranged to comprehensively assess a farm using a computer database program. The farm planning process broadly involves identifying activities with a related environmental risk; an assessment of the significance of activities/impacts; formulation of a hazard analysis response table (which includes potential solutions/recommendations); and the preparation of an Action Plan. Throughout, the emphasis is on the farmer to work through the process collaboratively, with a Council staff member providing guidance and advice if necessary. This is discussed further in Section 6.7.11.

There is also a follow-up process. Generally, ORC monitored 2-3 farms per year, involving a 2-3hr farm visit to determine what actions had actually been undertaken relative to planned intentions. Monitoring is more intense for those who seek and attain ISO14001 accreditation. This involves an annual visit and audit by a representative from the North Otago Sustainable Land Management group (NOSLaM), and random audits for approximately 20% of accredited farms by a national authority (per year).

Defining characteristics: Enviro-Ag represents a method of farm planning far removed from traditional SWCP type models. Particularly distinguishing features include:

- Development of the Enviro-Ag model has been very much driven by farmers for farmers. It originated from a farm-based SLM group in 1996 (NOSLaM), who were originally 'keen to look at farm plans… but they made it very clear that they wanted a farm plan that means something' (as stated by the interviewee). In this sense, the farm planning process has been kept 'practicable and workable', and includes 'standards agreed to by landowners' (Nimmo~Bell, 1999, p58). Although Council involvement has been strong in the development stage, they are now attempting to foster ownership of the programme back into the farming community.
- In contrast to farm plans that target a small range of predefined SLM issues (*e.g.* erosion, biodiversity, riparian/water quality), the Enviro-Ag model seeks to identify a broad raft of conceivable on-farm environmental considerations (approximately 30-40 activities are recognised as part of an environmental checklist). Once identified, the remainder of the plan is prepared expressly to target the most significantly impactive activities.
- Farmer involvement is consistently high throughout the farm planning process (perhaps higher than any other approach to comprehensive farm planning in NZ). This carries an implication that ownership of any forthcoming solutions or actions will also be high.
- Enviro-Ag farm plans can be used to gain quality assurance to ISO14001 standards. At the time of the interview, four farms had been accredited, and at least another six were awaiting eligibility assessment/auditing.

Farm plan benefits: A key benefit stated for the Enviro-Ag farm plan was the one-to-one interaction, particularly as it relates to site specific education: "it's a very useful education process… sitting down and talking through what's happening on the farm… and even if nothing else eventuates its still a pretty useful exercise in itself". While many plans may inevitably 'end up gathering dust on a shelf', the greater awareness and understanding gained through the collaborative process has implications for long-term and integrative farm management.

Ross (2000) describes the benefits of Enviro-Ag farm planning as increased awareness of on-farm issues; a means to integrate environmental considerations into farm management; and if ISO14001 standards are attained, then a farmer may capture a market advantage.

Farm plan disadvantages: The primary limitation of Enviro-Ag farm plans was stated as the degree of input required by the farmer: 'for the landholder it means a lot of extra work… extra work without any [immediate and tangible benefit]… and there is no direct incentive from Council'.

Another limitation is a low demand for farm plans. As discussed previously, it was noted that many farmers "don't think they need a farm plan". Also, the interviewee expressed reservations of having promoted farm plans in an environmental context rather than a quality assurance context. The farming industry may be less interested in an initiative that carries strong environmental overtones.

Improving farm planning: A greater responsibility from industry was seen to be the key to improving farm planning. Toward this end, the Enviro-Ag model had been developed with industry ownership in mind, and at the time of the interview, ORC intended to train people from outside the Council in the preparation and monitoring of the farm plan model. This would essentially shift the initiative of Enviro-Ag farm planning back onto the farming industry and community. It appears this has taken place, as ORC no longer offer a farm plan service (Ian Brown, 15 July 2002, *per. comm.*).

Other: Enviro-Ag farm plans do not involve the traditional LRI/LUC mapping used by some other councils. Rather, 'we do it in a fairly loose way… we get farmers to… divide their properties into Land Management Units… most farmers have a pretty good idea… then we do the assessment'. LMUs are delineated by the farmer according to differences in physical characteristics and/or management functions of land (ORC & NOSLaM, 2000), and then refined with assistance from a Council officer.

The 'effectiveness' of the Council's farm planning programme was evaluated by Ross (2000). He described the Enviro-Ag as being 'at the leading edge of quality assurance in New Zealand', and as 'a product that effectively promotes sustainable management' (p.2). Three key recommendations emerged from the evaluation: Region-wide promotion; regular follow-up (at six-monthly intervals involving all farmers and previous workshop attendants); and an increased use of local contracting for more cost-effective service delivery.

6.4.16 Southland Regional Council

During the interview it was stated that the Southland Regional Council *do not* provide a farm plan service, at least in the traditional SWCP sense. However, it was later established that they do provide a very streamlined and brief form of farm planning as *riparian management plans*, *erosion control plans*, and *windbreak tree-planting programmes*. The person interviewed (Gary Morgan) strongly supported the concept of farm planning, particularly as it relates to soil and water conservation.

Reasons why not: Two reasons were given. Firstly, a programme offering comprehensive farm plans may no longer be appropriate for Southland. Previous soil conservation works during the catchment board era have resulted in most of the high risk erosion areas being retired and/or planted (wind erosion perhaps being the exception). Likewise, relative to some other regions, Southland does not have a high incidence of serious mass-movement erosion (according to the NZLRI, less than 6% of the region is classed as having a severe or greater erosion potential, none of which apparently occurs within lowland agricultural areas). However, it was acknowledged that a comprehensive farm plan can have a degree of issue utility that extends well beyond just soil conservation.

Time and staffing limitations were cited as the second reason for not offering a comprehensive farm plan service. While resources could be redirected into a farm planning programme, this would come at a cost to other SLM initiatives (namely field days and education programmes). An effective farm planning programme would require a high investment of staff time (*i.e.* 1-2 weeks preparation per plan followed by implementation and monitoring), but would only engage a relatively small number of farmers. In contrast, field days and education programmes involve a larger number of farmers.

Farm plan numbers: The number of farm plans prepared by the Southland Catchment Board before 1991 was confidently stated as 102 plans. This agreeably follows the 86 plans reported in 1989 by Hughes (1989). No comprehensive SWCPs were prepared after 1991. No figures were given for the streamlined versions of riparian, windbreak and erosion plans.

Farm plan LRI/LUC mapping capability: Two staff have LRI/LUC mapping abilities, and it was feasible that both could be redirected into this activity if it ever again became necessary.

Farm plan benefits: One benefit was stated: farmers receive up-to-date and site specific technical information and advice. This includes information and advice concerning land capability and long-term management of a farm.

Farm plan disadvantages: One primary disadvantage was stated: the amount of staff time invested in the preparation and follow-up of a comprehensive farm plan. Rephrased, it is difficult to justify the amount of staff time invested in individual properties.

Improving farm planning: A greater use of technical tools was considered one means of improving the Council's streamlined farm planning activities. Technical tools could include GIS-based draughting and information management through an LIS.

Using farm plans as a mechanism for biodiversity management was also acknowledged. Such plans could be used to identify bush remnants and other natural areas on private land, and provide recommendations concerning their ongoing management or protection.

Other: The SRC will prepare streamlined versions of farm plans for riparian management, the control of mass-movement erosion, and shelterbelt plantings. These are very brief, and can generally be prepared in less than one day. As a generalisation, a plan will identify the problem, state the works required, and outline any specifications (*e.g.* suitable tree species, plant spacing, etc.). The duration of these plans is often less than a year (*i.e.* it is unusual to include a long-term works programme). These are examined in more detail in Section 6.7.

6.5. DISCUSSION AND SUMMARY

6.5.1 WHO PROVIDES A FARM PLAN SERVICE?

At the time of the survey (2000/2001), eight of the sixteen regional authorities provided some form of farm planning service to farmers (Table 6.2). Those who place a strong emphasis on farm planning include Taranaki, Wellington, Bay of Plenty, Hawkes Bay, and Manawatu-Wanganui, while those with a low-key emphasis include Waikato, Tasman and Otago (along with Southland who were later identified as providing occasional and streamlined farm planning services). Otago would eventually move away from the preparation of farm plans in 2002, while Manawatu-Wanganui indicated a possible shift towards a reduced emphasis on farm planning.

For the eight RAs who do not, most suggested that they would like to provide a farm planning service if they had appropriate resourcing. Auckland, Canterbury and Nelson were actively seeking to develop their own farm plan programmes. Resourcing (as staffing and funding) was cited as the most common reason why RAs may not provide a comprehensive farm plan service. Other reasons included political philosophies (Nelson & Marlborough); a perceived need for a complementary grants scheme for farm planning to be effective (Gisborne & Canterbury); priority of a farm planning programme relative to other SLM initiatives or issues (Northland, Marlborough, Southland), and in the case of Auckland, the identification of a regionally appropriate farm planning model that would accommodate resourcing limitations.

COUNCIL	*TYPES OF FARM PLANNING*
Northland	*None*
Auckland	*None*
Waikato	Environmental farm plans Riparian plans
Bay of Plenty	Environmental programmes Soil conservation property plans?
Gisborne	*None*
Hawkes Bay	Erosion control plans (DIY kits) Soil conservation plans
Manawatu-Wanganui	Environmental farm plans DIY farm plan kits
Taranaki	Comprehensive farm plans Agroforestry plans Conservation plans Riparian management plans
Wellington	Sustainable land use plans Shelter plans Hill country erosion plans *Streamland care-plans (developing)*
Tasman	Conservation farm plans
Nelson	*None (but developing property plans)*
Marlborough	*None*
Westcoast	*None*
Canterbury	*None (but developing riparian plans and property plans)*
Otago	Enviro-Ag farm plans (until 2002)
Southland	*None (but occasional & streamlined variations on farm planning)*

Table 6.2: Farm planning services provided by regional authorities 2001.

6.5.2 FARM PLAN NUMBERS

Numbers of farm plans prepared before 1991 has been difficult to establish. There are wide discrepancies between previously reported numbers (*i.e.* Miller, 1988 *cf.* Hughes, 1989); the shift from catchment to regional authorities has complicated the distribution of earlier farm plan numbers; the distinction between preparing and updating a new farm plan is unclear; and few of the interviewees could provide a confident estimate.

Post-1991 farm plan numbers were more readily identified, although this was again complicated by some authorities changing their farm plan type or policy status throughout the 1990s. A conservative and tentative estimate based on interviewee's responses and literature cited in the previous chapter, would be 1200-1450 ***new*** farm plans in their various forms, between 1991 and 2001. Most of these are from Taranaki (100 between 1991-1996 & 679 between 1996-2001).

6.5.3 INVESTMENT IN FARM PLANNING

Regional authority investment in farm planning was expressed in three ways: annual financial cost for the farm planning programme; financial cost per plan; and the number of staff and staff-units involved in the preparation and maintenance of farm plans.

- Annual investment in farm plan programmes was estimated at $10,000 for Tasman; $80,000 for Waikato; $200,000 for Wellington ($600,000 over 3yrs); and $280,000 for the Bay of Plenty.
- Costs for preparing a single comprehensive farm plan were estimated at $3,500 for Hawkes Bay (10 days preparation); $4,500 for Manawatu-Wanganui (14-21 days preparation); and $600 for Otago (eight hours preparation); and perhaps $2,500 to $3,500 for Taranaki's Comprehensive Farm Plans (47-68 hours). Wellington's Sustainable Land Use Plans cost between $7,000 to $8,000. Nominal recovery fees are charged by Wellington ($500), Hawkes Bay ($500) and Otago ($120). Manawatu-Wanganui's DIY farm plan costs approximately $300-$500 per farm (8hrs preparation time). Time required for preparing **and** approving a comprehensive farm plan appears to range from 3-weeks through to 3-months.
- Staff numbers involved in the preparation and maintenance of farm plans includes 5 staff for Bay of Plenty (& perhaps an external consultant); 2 staff for Hawkes Bay (0.6 of a staff unit); ten staff for Manawatu-Wanganui; 10 staff for Taranaki (& perhaps an external contractor); 4 staff for Wellington (& an external consultant); one staff member for Tasman (0.4 of a staff unit); and 3 staff for Otago (equates to 1 staff unit).

6.5.4 DEMAND FOR FARM PLANNING

Otago described farmer demand for farm planning as being weak, due to the targeted development of their model within a defined farming area. Likewise, a weak demand in Tasman was attributed to having a limited area of agricultural land that required further erosion control. Waikato, Manawatu-Wanganui (and perhaps Wellington with their conservation plans) have neither a weak nor strong demand (although it varies intra-regionally for MWRC). Bay of Plenty and Hawkes Bay have a strong demand for farm planning, while Taranaki indicated a very strong demand backed by having a 12-month waiting list for 100 plans. Wellington also has a strong demand for their Sustainable Land Use Plans.

6.5.5 FARM PLAN PROCEDURES AND CHARACTERISTICS

Farm plan characteristics and procedures are discussed in more detail in the following section. General types of farm plans can be differentiated into single-issue vs. multiple issue farm plans, ranging from specifically targeted riparian management, shelter or erosion control plans, through to comprehensive whole-farm evaluations or multiple-issue environmental checklists. Procedures overall are typically based on traditional models, although the degree of farmer involvement also ranges widely. This can be expressed as three principal methods of farm plan preparation:

- Preparation mostly by the RA with a relatively low degree of input from the farmer, who only usually makes a minor contribution as a discussion of the farming situation, and to check the draft recommendations.
- Collaborative preparation, whereby the farmer does a significant share of the work, with support, guidance and final verification by the RA (*e.g.* DIY farm planning kits).
- Group-based preparation where much of the farm plan is prepared collaboratively in a workshop or discussion group setting.

6.5.6 RECOGNISED FARM PLAN BENEFITS

Direct liaison with farmers on a one-to-one basis:

- Engaging farmers at a level that is interesting and understandable to both parties.
- Engaging farmers on SLM issues other than just soil erosion.
- Establishment of long-term working relationships between farmers and authorities, with implications relating to farmer familiarity with council processes and requirements, and reciprocally, council familiarity with the characteristics and requirements of individual farms. There are also implications relating to long-term trust, understanding, and communication between farmers and councils.
- Integration of farmer and council land-management skills for the betterment of whole farm sustainability.
- A vehicle for farmer specific advocacy and education (afforded through interest, moral obligation, involvement, and relationships).

Evaluation of farm-specific land capability, SLM issues & requirements, and farmer capabilities.

- Addresses the actual SLM needs of individual properties.
- Farm plans provide a useful and clear guide to the farmer and council regarding what needs to be done.
- Land capability farm-plans identify the fundamental base upon-which a sustainable farm is defined. They identify, assess, and match the ability of land to sustain a socio-economically sustainable system of land use.

Addresses ability constraints through assistance – strong implications toward integrated and long-term sustainable management of land.

- Farmers receive up-to-date and site-specific technical information and advice.
- Helps farmers understand SLM as it relates to their own farms.
- Encourages farmers to think about the long-term dimension of their farming operation, well beyond the year-to-year focus typically associated with production management.
- Allows farmers to undertake changes and remedial works that would otherwise be beyond their ability as individuals (particularly in relation to grants).
- Reduces issues and required changes to more manageable 'bite-sized chunks'. Helps farmers budget the long-term cost of advancing SLM.

A high degree of potential effectiveness towards addressing on-farm SLM concerns.

- Farm plans (coupled with grants) are an effective means of bringing about actual on-the-ground changes.
- A means of integrating environmental management into everyday farm management.
- A high degree of confidence that a well prepared farm plan has identified, and outlines how to address, the SLM dimension of farm sustainability.

Benefits for council management and promotion of SLM.

- The high degree of council investment into a single farm plan demonstrates that they are prepared to 'go a long way' towards helping farmers.
- Provides a system for assessing a farm's SLM status, and for identifying appropriate changes for improving SLM status. Also provides a structured framework for eligibility assessment and grant allocation.

6.5.7 Recognised disadvantages of farm planning

- Farm planning is generally a time-consuming and expensive activity. This includes both preparation costs, and the long-term costs associated with a follow-up programme. Farm-scale LRI/LUC survey was noted as being a particularly costly component of traditional approaches to farm planning. The substantial investment of time and money into single properties may also represent a disproportionate allocation of council resources for promoting SLM (relative to other SLM programmes that target a wider farming audience).
- The difficulty of managing spatial information collected as part of farm planning. Without a computerised Land Information System, such information must be managed as collections of individual documents.
- A generally long-term commitment after a farm plan has been prepared (for compliance/implementation monitoring; effectiveness monitoring; annual programme follow-up; strategic updates).
- In being a regional authority service, farm plans may be perceived by farmers as having a rigid commitment to implement plan recommendations. Likewise, as a free (or nominal cost) council service, farmer ownership of farm plan recommendations may be low.
- Extended delays in the processing of some farm plans (Bay of Plenty).
- Farm plans may create a degree of farmer-dependence or expectation from councils. Continuous farm planning shifts much of the responsibility of environmental management from farmers onto the council involved. Likewise, farmers may become dependent or expectant on grants for environmental management.
- Farmers may not think they need a farm plan.
- Farm plans that seek to encourage greater farmer ownership through involvement may carry the disadvantage and disincentive of extra work for the farmer.

6.5.8 Potential improvements in farm planning

- Closer links with industry. In particular, linking farm plans with Quality Assurance programmes. Promises of premiums or favoured supply could represent an incentive to have a QA farm plan prepared. It also attributes a farm plan with a utility beyond RAs' purposes of environmental management.
- Greater farmer and family input into the farm planning process.
- Group-based approaches to farm planning provided they are kept separate from more traditional models.
- More detailed assessments of land capability (stocking capabilities, pasture production, etc.) and a greater emphasis on economic analysis.
- More efficient procedures for farm planning, particularly in relation to reduced documentation through computerised information management (*e.g.* via a LIS)
- Inclusion of environmental checklists to cover the full scope of environmental issues that may be evident for a given property.
- Coordinated farm planning on a catchment basis.
- Use of grants as an incentive and a form of assistance (Taranaki).
- Introducing land survey and assessment into school curriculum.

CONTEMPORARY FARM PLAN MODELS

As of March 2003, one of the previously reported eight authorities has ceased preparing farm plans[2], while a further two have adopted some type of farm planning service. Taken together, nine regional authorities now include one or more types of farm plan in their SLM programmes (ten if Otago's promotion of farm planning is included), ranging from simple issue-specific plans through to comprehensive whole-farm evaluations.

Development of farm planning over the past 12-15 years has been undertaken more-or-less independently by individual authorities. Each has had the opportunity to modify or refine the traditional model of farm planning to be better attuned with regional characteristics, requirements (*e.g.* regional SLM issues & resourcing) and political philosophies. While several authorities may provide the same general type of plan (*e.g.* a riparian plan), each may differ in terms of preparation, structure, comprehensiveness and farmer input. Considering the number of authorities and the plans they offer, this could represent approximately 23 different farm plan models currently being applied throughout New Zealand.

The broad aim of this section is to distinguish the differences between these contemporary farm plan models. Specific objectives include describing, summarising and comparing the type and character of New Zealand's modern farm plans.

6.6. METHOD

A request was sent via email in July 2002, to the regional authority representatives who took part in the survey described in Chapter 2. The request was for examples or templates of the types of farm plans that their respective councils provide to farmers. A list of conceivable farm plan types was provided. All of the 16 regional authorities were sent this request, on the basis that some may have recently adopted a farm planning service, or that there may have been some confusion during the 2001/2002 survey as to what actually constitutes a farm plan.

Each farm plan model has been described according to a predefined structure (Table 6.3, overleaf). This provides the basis for a summary and discussion of types and characteristics of farm plans. Three examples are described for the Manawatu-Wanganui RC, due to the intra-regional diversity that apparently exists between regional offices. With farm plan examples (*cf.* templates), farm and farmer details have been omitted to protect privacy.

Using this method to identify design characteristics of farm plan models has limitations. Firstly, examples have been provided through request; it was up to someone else to decide how representative a given farm plan example may be. While the request was for everyday 'run of the mill' examples, in some cases it is possible that 'best' examples were provided. Secondly, only a limited or singular number of examples/templates were examined for each authority. Farm plan types that vary in content or process on a property-to-property basis, may have been inadequately represented.

[2] By mid-2002 Otago Regional Council had ceased preparing Enviro-Ag farm plans. Rather, responsibility for the Enviro-Ag programme has shifted back to the farming community. While the Council no longer prepares these plans, they are still involved in the programme, and are still actively promoting the Enviro-Ag concept.

Thirdly, if not explicitly stated in an example or template, some of the predefined criteria could not be fulfilled (*e.g.* targeted farming & issues, procedure), which to a limited extent has necessitated either a subsequent re-contacting of the council concerned, or making an inference from previous farm plan studies presented in this chapter.

Despite these limitations, this method is considered slightly more objective than simply asking council representatives to describe the character of their councils' farm plans (as was done in the preceding chapter). Likewise, it allows the character of different farm plans can be explored in more detail.

Feature	Description
Example/template examined	Brief description of the farm plan example or template viewed.
Targeted farming	An indication of the primary farming types targeted by the farm plan (in many cases this has been inferred from the content of examples).
Targeted SLM issues	SLM issues or environmental management that the farm plan targets.
Resource/issue assessment	Description of the approach used to assess land resources, land capability, issues and/or SLM status.
Management & land use assessment	Description of other considerations necessary for the preparation of the farm plan (*e.g.* assessments of existing land use, production and practice; identification of farmer goals).
Procedure	Indication of the process involved in preparing the farm plan.
Economic evaluation	Primarily a description of the approach used to design and/or financially evaluate alternative land use options. May also include cost assessments for works & grants.
Plan structure & format	Principal sections and headings contained within the farm plan.
Maps	Description of any map(s) included in the farm plan (if any).
Planning period	Period over which the farm plan is designed to be implemented.
Other	Other considerations of relevance.

Table 6.3: Structure used to examine contemporary farm plans.

6.7. RESULTS

Twenty different farm-plan examples and templates were received (excluding the additional two examples for MWRC). This represents the greater majority of contemporary farm plan models currently being applied in New Zealand. The only models not represented (as far as the author can determine), include Tasman's and Waikato's traditional soil conservation farm plans, and Manawatu-Wanganui's DIY farm planning kit.

Each model is described according to the structure given in Table 6.3 (in a partially abbreviated note form), followed by a summary comparison and discussion.

6.7.1 HBRC Soil Conservation Plan

Example/template examined	• Hawkes Bay Regional Council (HBRC) Soil Conservation Plan completed in February 2003 for a 6000ha hill country farm near Wairoa. Prepared by Simon Stokes, Land Management Officer. Comprehensive 50+ page booklet.
Purpose	• 'The object is to provide sustainable land and water management for the property'. • A means for assessing eligibility for major grants under the Regional Landcare Scheme.
Targeted farming	• Primarily hill country sheep/beef/deer, but the range of issues covered suggests this style of plan could be adapted and applied to dairy or arable.
Targeted SLM issues	• Primarily soil conservation. • Riparian management. • Shelter management. • Conservation areas (natural areas). • Vegetation clearance. • Plant & animal pests. • Matching land use with land capability.

Resource/issue assessment

- **Land Use Capability survey:** Survey scale not given, although the smallest unit mapped is approximately 0.8-1ha. Based on the regional LUC classification, but new units erected at the farm-scale where necessary. Farm LUC classification presented in the main report as a tabulated summary according to Land Management Areas (LMAs), capability features and recommendations (Table 6.4). LMAs appear to be farm-scale LUC suites similar in concept to those used in regional bulletins. Explicit Land Resource Inventory (LRI) survey not included. Detailed breakdown of LUC units provided as an appendix (including effective areas; stocking capacities; and recommended forestry or retirement by area).

LMA	LUC	Area (ha)	Strengths	Limitations	Conditions of use	Recommended land use
Terraces	IIIs3	82	Can be intensitied Free draining	Wind erosion potential Low fertility	Managed riparian Minimal cultivation	Fodder cropping Intensive pastoral
	IIIw3 (new)	133	Can be intensified Versatile	Winter cattle Wetness	Managed riparian Minimise pugging	Fodder cropping Intensive pastoral
Mudstone hill country	VIe4	153	Naturally fertile Semi-intensive capability	Drought prone Soil erosion	Erosion control	Semi intensive Forestry
		36	Can be intensified Naturally fe[illegible]			

Table 6.4: Part example of a table used to summarise LUC by LMA.

- **Soil survey:** Nine soil types and complexes identified. Survey most probably undertaken at the same time and scale as the LUC survey. Soils described using established nomenclature from other surveys (for soil type) where possible. Each soil described in pedological and management detail (Table 6.5).

Soil type	LUC & parent material	Site & slope	Soil profile						Drainage	Other
			Depth	Texture	Structure	Colour	AWHC	Physical mgt.		
Gisborne soil	IIIs3 Tephra over alluvium	Flat terrace	Taupo ash/lapilli to35cm on Waimihia ash/lapilli	0-25cm sandy loam on coarse sandy loam	Mod Nut to weak coarse nut..	Yellow brown	?	High susceptibility to wind erosion High pugging resilience	Well drained	Low nutrient reserves Readily leached High P retention
Atua silt loam	VIe4 – mostly	Rolling to mod [illegible]	>40cm to mudstone	25-40cm silty clay [illegible]	Strongly developed medium nut	Yellow grey	?		Imperfectly [illegible]	Naturally fe[illegible]

Table 6.5: Part example of a table used to summarise soil characteristics.

Resource/issue assessment (con.)	• Geology assessment across the farm was detailed, according to both field-observations and existing geological surveys. • Water resources were qualitatively evaluated in terms of water quality (*e.g.* invertebrate populations, type and presence of algae). • Plant and animal pest status and management requirements were assessed by a pest control officer. • Other specific issues assessed generally as part of the LUC survey.
Management & land use assessment	• Paddock distribution and areas identified and mapped. • Current stocking rates for LUC units estimated. • Potential stocking rates transferred (analogised) from the NZLRI as 'top farmer' carrying capacities. • Difficult to discern the level of collaboration with the farmer(s) involved.
Economic evaluation	• Basic costs of annual works provided. • No detailed production or economic evaluation undertaken.
Procedure	• Strongly orientated towards traditional farm planning – much of the assessment and plan formulation undertaken by the Land Management Officer in consultation with the landholder(s).
Plan structure & format	• **Prelude:** introduction; works programme summary; farm map. • **1. Land resource assessment:** detailed description & explanation of the farm's LUC, soils, geology and water resources. • **2. Land & water resource management:** detailed description & explanation of SLM issues & management requirements; recommendations & specifications for each issue/management feature were tabulated against the area of the farm concerned. • **3. Appendices:** extended explanation of LUC designations and assorted fact sheets concerning different aspects of SLM.
Maps	• High quality maps using an aerial photo base at a 1:40,000 scale (it was acknowledged this was not a 'very user-friendly scale'). • **Farm Layout Map** depicting paddocks with areas, and labelling of significant landscape features (B&W, A3). • **Land Use Capability Map** depicting LUC down to the unit-level (colour coded, A3). • **Soil Map** using a combination of official and self-designated soil classes and types (colour coded, A3). • **Land Resource Management Plan** depicting works and future land use change using colour-coded symbols & fills. Works/changes not colour-coded by year (A3).
Planning period	• Five years; works to be 'discussed & administered' on an annual basis; recommendation given that the plan should be reviewed and updated after five years.
Other	• Recommended that a *Code of Practice for Fertiliser Use* be obtained & followed; *Spreadmark* certified contractors should be used to spread fertiliser (ground spreading); and that users of chemicals should be certified according to *Growsafe* standards. • The farm plan example incorporated some earlier investigations relating to the farm's previous involvement in the Green Project.

6.7.2 HBRC Erosion Control Plan (DIY)

Example/template examined	• HBRC Erosion Control Planning Kit (template). • A kit provided to a farmer contains at least: farm aerial photos (x2 photocopies); Work Sheets (x3); stationary (including coloured pens); and a completed Erosion Control Plan to use as a guiding example.
Purpose	• A DIY kit that allows farmers to identify the spatial extent of erosion; establish how to address that erosion; prioritise erosion control works; and to budget erosion control for a three year period. • A means for assessing eligibility for minor grants under the Regional Landcare Scheme.
Targeted farming	• Hill country farms requiring soil conservation management (particularly those eligible for minor grants through the Regional Landcare Scheme).
Targeted SLM issues	• Hill country erosion.
Resource/issue assessment	• Erosion type and severity identified by the farmer (with assistance from LMO if necessary).
Management & land use assessment	• Spatial layout of paddocks, water courses, and other features mapped by the farmer. • As Worksheets (see below) are prepared by the farmer, objectives and farmer capabilities are integrated by default into the identification of appropriate protection measures, implementation timeframes, and cost estimation.
Procedure	• Emphasis is on farmers preparing their own basic erosion-control farm plan, although a LMO may (on request) spend up to a day assisting with the design of appropriate erosion control measures. • **Map preparation:** farmers delineate paddocks and other landscape features according to a predefined legend and colour-coding system. • **Worksheets:** blank tables are provided as A3 sized Worksheets (Table 6.6), whereby farmers describe erosion characteristics (type & severity) and protection measures (type and quantity) for each paddock. Priority for works is indicated by ascribing a timeframe for implementation (within 3yrs), and farmers are asked to estimate likely costs. An LMO may assist a farmer in filling out Worksheets.

'Erosion Control Plan' Worksheet Farm: [illegible] Prepared: 1/9/97

Hawke's Bay Regional Council

Paddock No	Paddock Name	Erosion (Type and Severity)	Protection Measures (Type and Quantity)	Year	Cost
14	Airstrip	None	Manage to ensure healthy sward present on strip		
15.	Lower Maxwell	Severe gully and slipping in western half of paddock.	Continue willow planting (30) running from the top paddock. Fence-off western half from stock and plant 5 hectares in a mixture of Macrocarpa and gum (E. nitens) woodlot		
16	Top Johns	Severe scouring in creek and [illegible] surrounding faces. Form [illegible]	Build 3 debris dams [illegible] flow up the creek. Space plant [illegible] embankings		

Table 6.6: Part example of an Erosion Control Plan Worksheet.

- An additional page is provided for farmers to describe property and tenure details.
- Completed plans are then submitted to the Council for grants assistance.

Economic evaluation	• Basic and informal estimation of the cost of works by paddock made by the farmer. • No detailed production or economic evaluation undertaken.
Plan structure & format	• Title page and property description. • Farm map. • Worksheets (as many as required) make up the core of the farm plan.
Maps	• Single farm map based on a scanned & printed aerial photo that depicts paddocks and other landscape features; prepared by the farmer using a predefined legend and colour-coding system.
Planning period	• Three years.
Other	• Applications made to the Regional Landcare Scheme for grants assistance will receive priority if they are submitted with a completed Erosion Control Plan.

6.7.3 WRC Streamland Care Plan

Example/template examined	• Wellington Regional Council (WRC) Streamland Care Plan completed in June 2002 for a 117ha dairy farm located near Carterton. Prepared by D. Bell, Conservation Forester. • Concise nine-page document.
Purpose	• 'To meet Dairy industry policies and guidelines for environmental management'. • 'To manage the riparian areas in a way that improves the whole stream environment'. • Grant eligibility assessment and allocation.
Targeted farming	• The example was for dairy farming, but the model used appears to be readily amendable to other farming types.
Targeted SLM issues	• Stream water quality. • Riparian management. • Riparian biodiversity.
Resource/issue assessment	• Uncertain, but probably involving a farm reconnaissance to map watercourses and other relevant features, and to qualitatively assess water quality, and the general condition of waterways and riparian zones.
Management & land use assessment	• As above, but focusing on the identification of management practices necessary for improving water quality and riparian considerations. • Current farm management apparently not assessed to any significant extent, other than that afforded through the inclusion of a brief property description.
Procedure	• Uncertain, but probably orientated towards traditional farm planning approaches – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned.
Economic evaluation	• Basic costs of the first annual programme provided, along with an estimate for the cost of the full programme. • No detailed production or economic evaluation undertaken.

Plan structure & format	• Introduction outlining the purpose, objectives, and structure of the plan, followed by a short property description. • **Waterways on the farm:** Discusses the character and SLM issues associated with the main watercourses flowing through the farm. • **Management practices:** A description of appropriate SLM practices relating to the management of riparian areas and water quality, including fencing, stock crossings and general 'streamland management'. • **Works programme:** Briefly describes and discusses recommendations concerning riparian retirement, fencing and planting. Responsibilities of the parties involved are outlined, followed by an estimation of costs and cost-sharing. Reporting (monitoring) is also briefly discussed. • **Appendix:** Conditions of agreement, along with the actual management agreements to be signed by the farmers involved (which focuses on the exclusion of grazing stock from retired riparian areas).
Maps	• No maps included with the example viewed. • The report referred to the inclusion of a single 'detailed topographical map showing landforms and waterways, the proposed programme, paddocks, soils and other features'.
Planning period	• Not stated. Extended duration of 10 years suggested. • Works programme is refined and implemented on a year-by-year basis. • Implemented works to be assessed annually. • A five-year interim report and works summary may be prepared for the landowner.
Other	• The example Streamland Care Plan viewed, appears to have been prepared as part of a pilot programme (the Riparian Pilot Programme).

6.7.4 WRC Soil & Water Conservation Plan

Example/template examined	• WRC Soil & Water Conservation Plan completed in February 2001 for a 180ha hill-country farm located south of Masterton. Prepared by R. Harrison, Soil Conservator. • Concise seven-page document (and compared with some other SWCPs, rather short and to the point).
Purpose	• To assess and make recommendations concerning erosion control. • Grant eligibility assessment and allocation.
Targeted farming	• Hill country farming.
Targeted SLM issues	• Hill country erosion.
Resource/issue assessment	• **Land Use Capability survey**: Summaries and descriptions of farm LUC were provided in the report, but no survey details or maps were included. Appended LUC descriptions were based on LRI, suggesting either: detailed survey and recording of both farm LRI and LUC; or farm LUC mapping according to regional units, and subsequent backwards-inference of LRI from the regional classification. • As the example viewed is an update on a previous SWCP, it is unlikely that a new LUC survey was undertaken. Rather, a farm assessment/reconnaissance may have been undertaken to check the extent and condition of previous works; to update LUC if necessary; and to identify areas requiring new or additional erosion control measures.

Management & land use assessment	• As above, but focusing on the identification of areas of land and land-use requiring further soil conservation management. • Current farm management apparently not assessed to any significant extent.
Procedure	• Uncertain, but probably orientated towards traditional farm planning approaches – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned.
Economic evaluation	• Basic costs and cost-sharing estimated as a tabulated summary. • No detailed production or economic evaluation undertaken.
Plan structure & format	• **Property description:** Includes legal description & area, location, a very brief discussion on erosion impacts, and a tabulated summary of the farm's LUC classification to the class level (further detail appended, with LUC to the unit level according to the regional classification). • **Conservation programme information:** Very brief overview of on-farm soil conservation issues, followed by future objectives; a tabulated summary of works/progress to date; and estimated works and costs for the term of the programme. • **Programme costs & protocols:** Stated conditions concerning responsibilities, contributions, estimates, and programme implementation. • **Agreement:** Points of agreement between the Council and landowner relating mostly to the implementation and maintenance/management of works. • **Appendix:** Detailed breakdown of farm LUC to the unit level according to the regional classification (each unit is discussed according to it's LRI).
Maps	• No maps included with the example viewed. • The example suggested that a Land Use Capability Map and a Works Programme Map would be included.
Planning period	• Ten years.
Other	• The example viewed appears to represent an update on an earlier Soil and Water Conservation Plan.

6.7.5 WRC Shelter Plan

Example/template examined	• WRC Shelter Plan completed in February 2002 for a 172ha finishing farm located near Masterton. Prepared by Don Bell, Conservation Forester. • Concise ten-page document.
Purpose	• Protect arable soils from wind erosion. • Provide farm animals with shelter & shade. • Enhance areas of existing native vegetation and/or wetland habitats. • Grant eligibility assessment and allocation.
Targeted farming	• Lowland intensive farming (arable, finishing, mixed arable, dairy).
Targeted SLM issues	• Wind erosion. • Animal health & well-being (shelter & shade). • On-farm natural areas and biodiversity.

Resource/issue assessment	• Uncertain, but probably involving a farm reconnaissance to map or verify previous soil surveys; to map paddock layout and other relevant features; and to assess the status of targeted SLM issues.
Management & land use assessment	• As above, but focusing on the identification of areas and management requirements for enhancing shelter, shade, soil conservation, amenity values, and biodiversity. • Current farm management apparently not assessed to any significant extent, other than that afforded through the inclusion of a brief property description.
Procedure	• Uncertain, but probably orientated towards traditional farm planning approaches – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned.
Economic evaluation	• Basic costs and cost-sharing estimated as a tabulated summary (detailed for the first annual programme). • No detailed production or economic evaluation undertaken.
Plan structure & format	• Summary & introduction outlining the purpose, objectives, and structure of the plan, followed by a brief property description. • **Soils:** A discussion of the two predominant soil types found on the farm, with a particular emphasis on soil characteristics and limitations towards shelter plantings and their management (appropriate tree species, profile rooting limitations, etc.). • **Programme objectives:** Summary of revised objectives, followed by a discussion of recommendations and technical specifications for stock shelter, erosion control, natural area enhancement, viticulture, and shade/amenity plantings. • Works programme, including a brief listing of works/activities as objectives for the first year, followed by a listing of broad objectives to be covered over plan's 10yr term. Reporting to include yearly recording, assessment, and updates/refinements of annual programmes, and perhaps an interim report & works summary after 5yrs. Cost estimates and cost-sharing presented as a table. • **Appendix:** Conditions of agreement, and a tailored management agreement.
Maps	• No maps included with the example viewed. • The report referred to the inclusion of a single 'detailed topographical map showing progress to date, the proposed programme, paddocks, soils and other features'.
Planning period	• Ten years.
Other	• The example viewed represents a review and update of an earlier shelter plan that was not implemented.

6.7.6 WRC SUSTAINABLE LAND USE PLAN

Example/template examined	• WRC Sustainable Land Use (SLU) Plan approved in December 2001 for a 620ha coastal hill-country farm located east of Masterton. Prepared by R. Harrison, Soil Conservator. • Concise and detailed 22-page booklet. • Represents the working application of the Ruru pilot model detailed in the preceding chapter.

Purpose	• To address long-term sustainable use of land through the design and evaluation of strategies that integrate environmental, production and socio-economic factors of hill-country farming. • Grant eligibility assessment and allocation.
Targeted farming	• Hill country farming.
Targeted SLM issues	• Erosion and related sedimentation were the principal issues considered in the example viewed. • As a complete decision support package (and as suggested by the Ruru example), it is probable that this model is used to address a broad range of SLM issues (*e.g.* riparian management, on-farm natural areas) according to the needs of individual properties.
Resource/issue assessment	• Detailed resource survey according to the landform survey/classification s stem previously described for Ruru Farm (differing slightly with the inclusion of a supplementary range of farm-particular landform classes). • Survey undertaken by a contracted private consultant (Doug Hicks). • Landform classes correlated to equivalent LUC units contained in the regional LUC classification; new LUC units identified and classed at the farm level, and a note made that they have no equivalent under the existing regional classification; further resource detail on farm LUC provided as an appendix (describing soil, slope and rock-type). • Vegetation cover also assessed during the landform survey, and recorded as *present land use.* • The status of SLM issues (particularly erosion) is also assessed as part of the landform survey.
Management & land use assessment	• Existing land-use identified as vegetation covers during the landform survey. • Likely to include the draughting of a current land use map showing relevant natural and physical features (*e.g.* fence lines). • Other land use/management considerations described include propert history, production & enterprise summar , and the extent and character of tree plantings. • Farm goals identified in succinct detail through consultation with the farmers involved, and used as *decision criteria* guiding the design and evaluation of *land use change*. • Production estimates for three land uses (pasture; pasture/space plantings; pine forestry) derived for each landform unit by local analogy (*e.g.* from local pasture production trial data). • Landform classes are qualitatively assessed in terms of their suitability/appropriateness for different land use categories (grazing; grazing + conservation; woodlots; woodlots + conservation). • A preferred land use scenario is designed, evaluated and briefly compared against the status quo.
Procedure	• Land assessment undertaken by a contracted private consultant. • Likely to orientate towards traditional farm planning approaches – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned. • However, as the model is strongly dependent on farmer input (particularly with production information and farmer goals), the degree of consultation (and therefore farmer contribution & involvement) must be relatively high when compared against the Council's other farm plan models. • Overall, the process can be described as a comprehensive land evaluation, beginning with assessments of land, issues, production & land use, followed by a production and financial evaluation of a preferred land use scenario.

Economic evaluation

- Comprehensive economic evaluation of a favoured land-use scenario through the Agro-Estate Forestry (AEM) model, and perhaps Stockpol.
- Financial summaries include a cashflow analysis over 30-years, and an expenditure schedule for the first 10-years. Appended financial analysis reports extend out to 70 and 100 years.

Plan structure & format

- Introduction noting the redundancy of the former SWCP, along with a general overview of the purpose and advantages of a SLU Plan.
- **Physical description:** Standard property details (location, area, legal description) supplemented with a *property history*, and a graphical summary of *present land use* (as vegetation cover).
- **Farm production:** Description of enterprise types, including a listed summary of stock types, numbers, performance and stock rate (changes in stocking rate over seven-years presented graphically). Also includes a description and summary of existing woodlots and space-planted conservation trees.
- **Land assessment:** Presents a listed summary of each landform class found on the farm, tabulated against a description, area, and equivalent LUC classification. Also includes tabulated summaries of estimated production from different land use categories according to landform, and an inference of land use suitability/appropriateness for each landform.
- **Land use change:** This section reports on the design and evaluation of a favoured land use scenario, including a summary of farmer goals, a description of the scenario and it's predicted outcomes, and a tabulated summary of annual works and their location.

Plan structure & format (con.)

- **Cash flow analysis:** Tabulated analysis report summarising costs, cost-sharing, opportunity costs (foregone grazing revenue), and farm financial surplus by year, over a 30-year period.
- **Programme estimates:** Tabulated summary of works and expenditure by year, for ten-years.
- Report concludes with a summary of *regional protocols* (general conditions & responsibilities); an *agreement* detailing specific conditions and responsibilities; and the Council's *recommendation* for approval.
- **Appendices:** Summary of farm LUC tabulated against rock-type, landform, slope and soil, along with spreadsheet-printouts detailing each works programme, and a graphical summary of predicted farm surplus extrapolated to 2095.

Maps

- No maps included with the example viewed.
- The previously discussed Ruru example would suggest the equivalent inclusion of a present land use map; a landform map; and a works programme map. Maps may also include detailed keys relating to forecast erosion, production and production loss, and may be presented as overlays on an aerial photography base.

Planning period

- The works programme was based on a ten-year planning period.
- Financial returns, ongoing investments and maintenance were modelled over a 30-year timeframe.
- *Predicted farm surplus* was modelled over a 100-year timeframe.

Other

- The Sustainable Land Use Plan replaced a SWCP that the property was previously operating under.
- Sustainable Land Use Plans carry a 10% 'regional contribution premium' above the rate used for SWCPs.

6.7.7 ES Riparian Management Plan

Example/template examined	• Environment Southland (ES) Riparian Management Plan completed in July 2002 for a sheep & dairy grazing farm located near Winton. Prepared by B. Tikkisetty, Land Sustainability Officer. • Brief 4-page document.
Purpose	• Implicitly the retirement/fencing, planting and management of on-farm riparian zones to enhance waterway quality, habitat and related values (*e.g.* aesthetics). • Grant eligibility assessment and allocation.
Targeted farming	• The example was for sheep and dairy grazing, but the model appears to be amendable for application to any lowland intensive farming type (*e.g.* arable, finishing, mixed arable, dairy).
Targeted SLM issues	• Retirement and stock-fencing of riparian areas. • Planting and managing riparian areas.
Resource/issue assessment	• Uncertain, but probably involving a farm reconnaissance to examine the layout and condition of farm watercourses.
Management & land use assessment	• As above, but focusing on the identification of management practices necessary for improving water quality and riparian considerations. • Current farm management not assessed to any significant extent.
Procedure	• Uncertain, but probably orientated towards traditional farm planning approaches – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned.
Economic evaluation	• Basic costs of recommended works. • No detailed production or economic evaluation undertaken.
Plan structure & format	• Mechanically brief description of location, topography & soils and other property details, including an explanation of the targeted issues. • Works recommendations discussed by watercourse, including choice of riparian vegetation species and where they are to be planted. This is followed by specifications for fencing and tree spacing. • Tabulated estimation of the cost of works. • Management recommendations concerning nursery sources, weed control and seedling establishment, and an encouragement to use native plants.
Maps	• Basic map derived from scanned & reprinted NZMS260 topographical map. Watercourses highlighted and labelled according to works sequence (Job 1, Job 2, etc.).
Planning period	• Not stated. Suggested timeframe is 1-4 years, possibly divided into biennial works-schedules.

6.7.8 ES Windbreak Tree-Planting Programme

Example/template examined	• ES Windbreak Tree Planting Programme completed in May 2000 for a dairy farm located near Lumsden. Prepared by G. Morgan, senior Land Sustainability Officer. • Ten-page document. Handwritten.
Purpose	• The control of wind erosion. • Other reasons given for tree planting included stock shelter, minimising the desiccation effects of wind on pasture, and for the protection and enhancement of riparian margins. • Grant eligibility assessment and allocation.
Targeted farming	• Lowland intensive farming types (*e.g.* arable, finishing, mixed arable, dairy).
Targeted SLM issues	• Wind erosion. • Stock health & well-being (shade & shelter). • Riparian management also included.
Resource/issue assessment	• Uncertain, but probably involving a farm reconnaissance to examine the layout of existing fence-lines and tree plantings. • Soil distribution and character may also have been assessed, or at least verified from previous resource surveys.
Management & land use assessment	• As above, with a focus on identifying where to site shelterbelts and what tree-species would be most appropriate for the sites being considered. • Current farm management not assessed to any significant extent.
Procedure	• Uncertain, but probably orientated towards traditional farm planning approaches – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned.
Economic evaluation	• Basic costs of recommended works. • No detailed production or economic evaluation undertaken.
Plan structure & format	• **Topography & soils:** General description of farm topography, and detailed soil type descriptions (particularly in terms of soil characteristics and their implication for farm management and tree planting). • **Reasons for tree planting:** List of pros to justify the planting of trees on farmland. • **Recommended species & specifications:** Discussion of potentially suitable tree species & their management. • **Windbreak specification by job:** A series of preformatted specification sheets for each individual 'job' or windbreak. Includes diagrams showing front and side views of a proposed shelterbelt; prevailing wind direction; and plant spacing. Also includes a discussion on tree species, and an outline of a works programme (as the steps required to establish a shelterbelt). An additional specification sheet included as a plan for amenity plantings around the dairy shed. • **Tree numbers & cost estimate:** Summary of trees to be planted for each job, and an estimate of overall cost of establishment.
Maps	• Aerial photo presented at 1:17750, and used as a base for indicating the location and distances of shelterbelt plantings (hand-drawn symbols, lines and labels).
Planning period	• Not stated. Suggested works could probably be completed within one year.

6.7.9 EW ENVIRONMENTAL FARM PLAN (DIY)

Example/template examined	• Environment Waikato (EW) Environmental Farm Planning booklet (EW, 1999). • Well thought-out booklet of ten pages describing how a farmer can go about preparing their own Environmental Farm Plan by following 3-5 steps.
Purpose	• A DIY farm planning framework for farmers to assess and plan the sustainable use of their land and water resources. Emphasis is on integrating or reconciling socio-economic and environmental goals.
Targeted farming	• Examples given in the booklet suggest hill country farming is targeted, although the model appears flexible and amendable to most farming types.
Targeted SLM issues	• Unspecified but flexible. It is up to the farmer to identify what he or she considers to be an environmental problem/issue.
Resource/issue assessment	• The farmer depicts the location of natural and physical features onto an aerial photo, and then describes topography, soils, waterways, wetlands, native bush, and any other significant areas to the best of his or her ability (*i.e.* consolidating what is known). • The farmer is encouraged to assess 'every ridge, valley and waterway for current and potential land management problems' (*e.g.* slips, reduced pasture production, stream sedimentation, weed infestation, etc.).
Management & land use assessment	• Spatial layout of paddocks, lanes and other physical features mapped by the farmer. • The farmer is asked to detail farming goals, stock types & numbers, and to describe current land use and management. • In being prepared by the farmer, goals & abilities are integrated by default.
Procedure	• Three steps are recommended for the preparation of a farm plan, and a further two relating to catchment planning and grants. • Step 1: Assess what you are starting with. This is a 'kitchen table' exercise, whereby the farmer maps natural & physical features onto an aerial photo, and describes property details, resources, and land use. • Step 2: Issue assessment. This begins with an 'in-the-field' exercise to identify the location and character of environmental 'problem areas'. These are marked on the map, and examined according to an issue analysis table (see below). • Step 3: Work Plan development. Involves the design of a works programme including a statement for each 'solution' previously identified (*i.e.* the required works, treatment or activity), an estimation of materials and cost, and an indication of when works/activities will be implemented. • Step 4: Recommendation that local farmers should convene together, ultimately to form a Landcare group and subsequent development of a catchment plan. • Step 5: Recommendation that any forthcoming care-group makes an appliction to the Council for funding support.
Plan structure & format	• Suggested structure of a DIY Environmental Farm Plan would likely follow the first three steps described in the booklet. • **General information:** Essentially a description of the farm, including tenure, location, farmer goals, resources (topography, soils, waterways, wetlands, etc.), land use and management details. • **Problems, causes and solutions:** Simple issue analysis tables; each *problem* is listed as a statement, and described in terms of it's *cause*, any *possible solutions*, and any forseen or likely *outcomes*. • **Work plan:** Tabulated summary of planned works, resources (materials & costs), and a five-year works schedule.

Economic evaluation

- Basic costs of recommended works.
- No detailed production or economic evaluation recommended.

Maps

- Single farm map based on an aerial photo, which depicts the current state of the farm (paddocks, existing plantings, watercourses, etc.), and by using similar but slightly different symbology, proposed improvements can also be depicted (Figure 6.2).

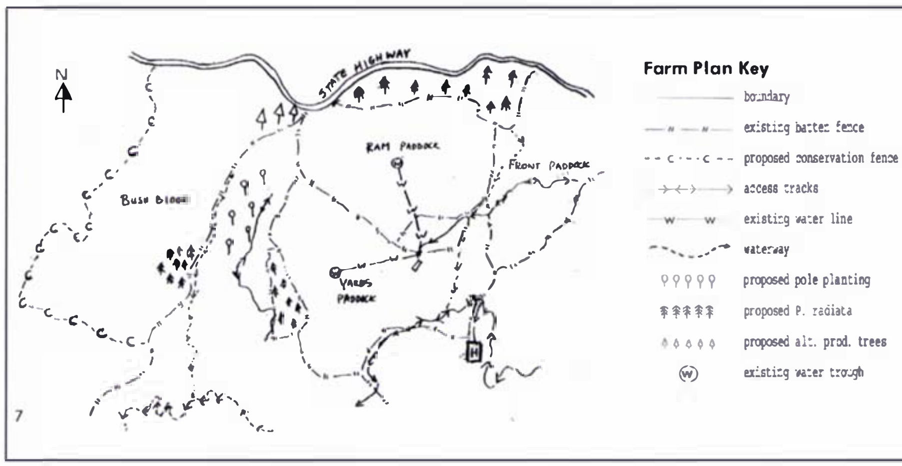

Figure 6.2: Example map for a EW DIY Environmental Farm Plan (adapted from EW, 1999).

Planning period

- Five years, although a recommendation is given to consider longer-term activities in the Work Plan.

6.7.10 EW Riparian Management Plan (DIY)

Example/template examined

- EW's application form for Clean Streams Funding, which apparently doubles as a template for a DIY Riparian Management Plan.
- Four-page application form with two-pages of appended Worksheet templates. Provided to farmers as a package that includes detailed supporting documentation (*e.g.* the Clean Streams booklet – Legg, 2002), and either an aerial photo or part topographical map to identify riparian/wetland areas and waterways.

Purpose

- In being a funding application form, the default purpose is to assess grant eligibility.
- A means for farmers to formally assess the status of on-farm riparian/wetland areas, and to prepare a structured & considered programme of works, ultimately towards the dual purpose of demonstrating grants-eligibility to the Council, and enhancing riparian/wetland management.

Targeted farming

- Principally dairy, but applicable to any type of farming eligible for assistance in riparian management.

Targeted SLM issues

- Riparian-margin and/or wetland management.
- Streambank erosion.
- Quality and health of riparian-margins and watercourses (inc. biodiversity, amenity).

Resource/issue assessment

- Undertaken by farmer. General questions are given within the application form, which provide the basis for a simple assessment of riparian/wetland related erosion, watercourse/wetland characteristics, existing vegetation, and topography of the surrounding landscape.

Management & land use assessment	• No recommendations concerning management & land use assessment, other than activities with a direct bearing on riparian/wetland management (*e.g.* stock access, existing retirement fencing). • In being prepared by the farmer, goals and abilities are integrated into the plan by default.
Procedure	• Farmer supplied with a Clean Streams package (application form, supporting documentation, and base map). • Mapping, assessment and planning undertaken by the farmer (see plan structure below), although Council staff will provide assistance if requested. • Completed riparian plan (map and application form) submitted to the Council for funding approval.
Economic evaluation	• Basic cost estimates of nominated works. • No detailed production or economic evaluation recommended.
Plan structure & format	• Application form with preset sections, fields and check boxes. • **1. Description of property:** Farmers are asked to indicate ownership, legal description and area, along appending a copy of the Certificate of Title. • **2. General description of project:** In the first part, farmers are asked to briefly describe project objectives, and state how retired/fenced areas are to be managed. They are also required to indicate involvement with other environmental initiatives, and highlight any significant cultural and recreational values associated with riparian/wetland areas. In the second part, they indicate the biophysical character of the areas involved, including questions relating to stock access, existing vegetation, and erosion. • **3. Proposed works:** Worksheets are included for detailing a programme of works, which is summarised within the main application according to *proposed fencing*, *proposed planting* and *other* (*e.g.* troughs & water pipe). Supporting documentation provide examples, options, generic recommendations, and specifications. • **4. Maintenance agreement:** A simple agreement to be signed by both parties for grants <$10,000. Grants >$10,000 require a more formal and binding agreement as a covenant. • An additional two sections are provided for Council purposes (funding sources and project approval).
Maps	• Aerial photo or part topographical map provided, upon which the farmer indicates the location of watercourses, wetlands and other relevant features, along with the proposed works. Once plans are finalised and approved, a GIS map is prepared by the Council from the farmer's original map.
Planning period	• At the discretion of the farmer. No preset timeframe stated by the Council, other than a possible 10-year limit to fit within the duration of the Clean Streams project.
Other	• An additional and ulterior purpose is suggested through the combination of grants application and farm planning. That is, the form can be interpreted as a somewhat convert means for the Council to encourage a structured consideration and formal planning of riparian/wetland management. • 'Clean Streams' is a 10yr project committing $10 million to 'encourage & support farmer efforts to reduce the impacts of farming on waterways'. • Detailed options, generic recommendations, and technical specifications for riparian/wetland management, are provided through supporting information (including Legg, 2002; and EW, 2002).

6.7.11 OTAGO ENVIRO-AG FARM PLAN

Example/template examined	• Enviro-Ag Farm Plan completed May 1999 for a dairy farm located near Oamaru. Prepared by the Otago Regional Council according to standards & procedures agreed to by the North Otago Sustainable Land Management Group. Detailed 30-page booklet. • The Enviro-Ag Workshop Manual (ORC & NOSLaM, 2000). Comprehensive 40-page document detailing the Enviro-Ag farm planning process.
Purpose	• To encourage the adoption of sustainable land management practices through farm planning (Council's purpose stated by Ross, 2000). • To promote the marketing potential of farms, backed by sound environmental practices (NOSLaM's purpose stated by Ross, 2000). • For the farm plan itself, the inferred purpose is to help farmers recognise & record a range of conceivable SLM & environmental issues particular to their own farms, such that an environmental management programme can be designed, implemented and monitored, towards the dual purpose of addressing issues and (from a marketing perspective) to actually demonstrate and prove that farm goods & services are produced from an environmentally-responsible system of production.
Targeted farming	• Most types of farming, particularly dairy, sheep & beef, and arable/cropping.
Targeted SLM issues	• Soil quality (*e.g.* erosion, pugging). • Quality & quantity of water resources. • Air quality. • Waste management (*e.g.* effluent). • Natural features & landscapes. • Biodiversity. • Weeds & animal pests. • Animal welfare. • Essentially any conceivable environmental issue that can be associated with farming.
Resource/issue assessment	• Basic resource assessment; farmers are asked to identify Land Management Units onto an aerial photo, and describe them in terms of physical characteristics (topography, soil type, vegetation, etc.) and management differences (*e.g.* fertiliser history, effluent application, grazing management, etc.). • Environmental issues are assessed in considerably more detail (see *procedure* below).
Management & land use assessment	• Farmers are asked to describe enterprise characteristics and management practices as a background to the farm plan. • Considerable opportunity given for stating goals and objectives, including general goals (personal, financial, management, and environmental goals), general environmental objectives as policy statements, and specific environmental objectives as part of the Hazard Analysis Response Table. • In being prepared by the farmer, management and land use considerations are also defaulted into the final plan.
Economic evaluation	• Basic annual costs estimated for fencing and planting. • No detailed production or economic evaluation recommended.
Procedure	• Begins with an group workshop to introduce and explain the Enviro-Ag farm planning process, followed by farmers working through the Workshop Manual and farm plan template (including a database model), either independently or with assistance from a coordinator. The coordinator may help finalise a plan.

Procedure (con).

- The Workshop Manual provides a flowchart of the method used to prepare an Enviro-Ag Farm Plan. This differs slightly in places from the steps recommended in the text.

  Step 1: Document existing management practices already used, which contribute to environmental improvement.

  Step 2: Record background information (property description, current land use and management, planned land development).

  Step 3: Delineate Land Management Units.

  Step 4: State the farm's environmental policies (derived from a preformatted template).

  Step 5: Assess past, present & future *activities* (out to 5yrs) that carry a potential environmental impact. A comprehensive *master list* is provided (≈70 listed activities). Farmers indicate activities/impacts particular to their own farms using a corresponding checklist.

  Step 6: Noted activities are qualitatively evaluated in terms of their significance (as *risk of occurrence* and *consequences of an impact*) using a computer model. Results are summarised as tables (Table 6.7). This exercise establishes environmental management priorities (*i.e.* activities with the greatest and least potential impact for a given farm).

Activity	*Impact*	*LMU name*	*I want it*	*Public interest*	*Environmental*	*Financial*	*Compulsory*	*Likeli-hood*	*Conse-quence*	*Use in HAR Table*
Waste mgt – disposal of dead stock	Water contamination	Point source	☐	☐	☑	☐	☑	3.33	2.00	☑
Waste mgt – silage wrap & other plastic disposal	Rubbish build up & visual pollution	Point source	☑	☐	☐	☐	☐	2.50	0.00	☑
Managing DDT residues in soils	Food safety	A	☐	☐	☐	☑	☐	0.28	3.00	☐
Silage leachate	Water contamination	A	☐	☐	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 6.7: Part example of an Enviro-Ag 'significance assessment' summary.

  Step 7: Development of a Hazard Analysis & Response (HAR) Table, whereby significant activities are analysed according to five factors (Table 6.8), towards identifying the most appropriate management response.

Activity	Impact	Objective	Operational controls (BMPs)	Monitoring	Corrective action
Agrichemical storage & handling	Soil & water contamination; health hazard LMU: Point source	Take all practical steps to avoid soil & water contamination	Store chemicals in secure facility Prepare safe handling & storage procedures	Record steps taken to avoid accidents	Seal shed floor
Waste mgt – dead stock	Water contamination LMU: Point source	Dispose of dead stock in a way that avoids water contamination	Minimise cow deaths to <%l Do not site offal pits in sensitive areas	Record offal pit location on farm map Record instances of water in offal pit	Establish alternative disposal facilities...
Earthworks – reconstruction of border dykes	Loss of topsoil LMU: A & B	Minimise loss of topsoil during reconstruction process	Use only experienced contractors Prepare procedures [illegible]	Record of contractor used & assessment [illegible]	Change contractor & write

Table 6.8: Part example of an Enviro-Ag 'Hazard Analysis & Response Table'.

Procedure (con).	**Step 8**: Preparation of an Environmental Enhancement Plan. This involves farmers listing and describing current or potential works & activities (mostly physical works like planting, fencing, retiring land, etc.) that convey environmental benefits. **Step 9**: Design of an Action Plan, whereby everything is brought together as a categorised summary stating required actions/works, timeframes, locations and an estimate of cost. Actions are categorised into management adjustments; procedures & monitoring systems; and physical works. Specific actions are taken directly from the HAR Table. **Step 10**: Monitoring and auditing. A farmer may choose to implement and monitor their plan without external involvement. Alternatively, he or she may submit to an audit undertaken by the NOSLaM Group (to gain a form of local accreditation), or enter into the NOSLaM ISO 14001 accreditation scheme (to pursue internationally recognised accreditation standards).
Plan structure & format	• **Property description:** Standard description (tenure, location etc.) along with a brief indication of climate, topography and soil types. • **Production/performance data & targets:** Brief summary of stock type and numbers; cropping activities; existing woodlots and conservation plantings. • **Management practices**: States operations. • **Goals & aspirations**: Short statements for the farmer's personal goals, financial goals, management goals, and environmental goals. • **Land management units**: The Workshop Manual recommends a LMU map, but the example farm-plan used photographs to portray each of the property's LMUs. • **Environmental policies**: Tailored farm policy statements based on a preformatted draft set of environmental policies (one policy for each of the targeted issues). • **Activity checklist**: Full list of targeted environmental activities; those with relevance to the farm are checked. • **Summary of significant activities**: Database printout describing the environmental significance (and priority for action) of relevant activities. • **Hazard analysis response tables**: Tabulated summary by significant activity, detailing impacts and responses. • **Environmental enhancement plan**: Summary of current and potential works for improving environmental management. • **Action plan**: Summary of actions and works identified from previous steps. Includes an implementation and cost schedule. • **Detailed assessment of significant activities** (appendix).
Maps	• A Land Management Unit Map using an aerial photo base is recommended. Farmers are asked to delineate areas of land distinguished by differences in physical characteristics and/or management functions. The example provided suggests the map will be digitised and scaled at some point.
Planning period	• The suggested timeframe is five-years.
Other	• This is a very comprehensive farm planning model, even without detailed land resource assessment and economic evaluation. The process is somewhat complicated, and therefore carries a risk that a farmer may lose focus and perspective as he or she works through the detail ("can't see the forest for the trees" dilemma). • Much of the farm planning is undertaken by the farmer(s) concerned. This represents a sizeable commitment and workload. It also has implications towards a high farmer-ownership of outcomes, and understanding of issues.

6.7.12 ECan Riparian Plan

Example/template examined

- Environment Canterbury (ECan) Riparian Plan completed September 2001 for a dairy farm located near Temuka. Prepared by A. Lambourne, ECan Resource Care Team member. Comprehensive fourteen-page booklet.

Purpose

- To plan riparian management for the prevention of waterway pollution; to provide habitat for stream wildlife; control stream bank erosion; and to improve biodiversity.

Targeted farming

- Lowland intensive farming (arable, finishing, mixed arable, dairy).

Targeted SLM issues

- Waterway pollution
- Habitat of stream wildlife.
- Streambank erosion.
- Riparian biodiversity.

Resource/issue assessment

- Uncertain, but likely to have involved a farm reconnaissance to map and assess the location and condition of waterways and riparian areas.

Management & land use assessment

- As above, but focusing on the identification of riparian management needs.
- Current farm management apparently not assessed to any significant extent.

Procedure

- Uncertain, but possibly orientated towards traditional farm planning approaches – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned.

Economic evaluation

- Basic annual costs estimated for fencing and planting.
- No detailed farm production or economic evaluation undertaken.

Plan structure & format

- **Property description:** Location, location map, tenure & legal description followed by a brief discussion of current *land use management* (although this was mostly a discussion of the condition of existing riparian margins and waterways).
- **Riparian management:** Brief discussion of riparian management principles and benefits.
- **Riparian management plan**: States the objectives of the Plan, and discusses issues, specifications and schedules according to recommended works (willow removal & control; fencing/retirement; and riparian planting). Riparian planting is described in detail as the *planting plan*, which details planting design and a schedule of works by riparian section (Table 6.9). Specifications are given for species selection, site preparation, method of planting, maintenance and timing of operations.
- A worksheet is appended for the farmer to record his or her progress.

Section A		Cost per year
Length of section	270m each side	
Width	5m	
All zones plants	1080	
Low access plants	540	$2025
New fencing required	Left bank	
Planting	Left & right bank	

Section B		Cost per year
Length of section	450m each side	
Width	5m	
All zones plants	3600	
[illegible]	Left & [illegible]	

Table 6.9: Part example of an ECan Riparian Plan planting schedule.

Maps	• Location map using a scanned portion of a NZMS260 topographical map. • Proposed Works Plan map based on an aerial photo at a 1:13,700 scale. Features include riverbeds, areas to be fenced and planted, and labelled areas by individual works programmes. Solid fills used (rather than transparent fills or hatches).
Planning period	• Two years.
Other	• This particular example was distinguished from most other farm plans through a notably high inclusion of photos and explanatory diagrams.

6.7.13 ECAN RESOURCE CARE ASSESSMENT

Example/template examined	• ECan Resource Care Assessment prepared June 2001 for a 250ha sheep & beef farm near Mt. Somers. Prepared by A. Lambourne, ECan Resource Care Team member. Detailed 13-page booklet. • Environmental Checklist questionnaire. Detailed 23-page series of checklist-based questions. • ECan Resource Care Assessments provide the basis for an Action Plan. They can also be used to develop a more comprehensive property plan, or an Enviro-Ag type farm-plan.
Purpose	• 'The Environmental Checklist and Action Plan aim to reinforce [farmers'] current sustainable land management and identify areas where improvement could be made to achieve sustainable land management'.
Targeted farming	• Amendable to most types of farming.
Targeted SLM issues	• Efficient water use. • Surface water issues. • Issues relating to groundwater & bores. • Soil health. • Erosion & sedimentation. • Vegetation, native flora, fauna & biodiversity. • Landscapes & heritage issues. • Mammal pests. • Plant pests. • Chemicals, residues & petroleum products. • Waste management. • Air pollution from smoke, dust, odours and spray drift. • Markets & environmental care. • Essentially any conceivable environmental issue that can be associated with farming.
Resource/issue assessment	• Brief description of land and water resources provided as part of the property description. No farm reconnaissance or survey apparently undertaken or recommended. • Land & water resources are assessed alongside other farm features and issues through the Environmental Checklist questionnaire (see below). This is a 'kitchen table' rather than an 'in-the-field' exercise.
Management & land use assessment	• Although not part of the Checklist, a brief summary of stock and farm management is included in the property description. • Current farm management not assessed or described to any significant extent. However, much can be inferred from the Assessment summary.

Procedure

- Environmental Checklist questionnaire filled out by the farmer and a report summary prepared by the Council. ECan staff assist throughout the process if required, particularly if the farmer wishes to pursue a more comprehensive type of farm plan.
- For the Checklist, farmers work through sixteen issue categories (the targeted issues above) involving forty-eight compound questions. Each question is answered firstly with a simple *yes* or *no*, and then by ticking and describing the farm's use of 'good practices' from a list (Table 6.10).

1. Do you milk dairy cows (please tick)	No	Yes

Dairy sheds can use large amounts of water

Good practices include	Notes	Yes
- Pre-wetting yards before milking to make cleaning easier		
- Scraping effluent from the yard before hosing down		
- Wet the yard 5-10 minutes before washing it down		
- Using the minimum amount of water for yard cleaning		

Table 6.10: Part example of an Environmental Checklist question.

- With Council assistance, a series of issues are identified and summarised from the Assessment. These are prioritised by the farmer, and used as a basis for an Action Plan. Using a worksheet, farmers state what they are going to do, what resources they need to do it, an estimate of cost, and a proposed timeframe.

Economic evaluation

- Basic costs estimated as part of the Action Plan.
- No detailed production or economic evaluation undertaken.

Plan structure & format

- **Introduction:** Overview and benefits of the Assessment.
- **Property & management summary:** Brief property description of farm land (area, topography, soils, vegetation, climate); water resources & mgt; and stock & land mgt.
- **Resource management assessment summary**: Summary of Checklist responses for land resources, water resources, air resources, financial resources, and social resources.
- **Resource monitoring summary**: Summary of resource monitoring undertaken on the property.
- **Resource care summary**: Overall summary as a discussion for the property's resource care status and management.
- **Issues identified**: List of issues identified from the Assessment, which the farmer is asked to prioritise.
- **Action plan**: Worksheet used by the farmer to state actions/works, resources needed, costs and timeframe.

Maps

- Location map using a scanned portion of a NZMS260 topographical map.
- No other maps included.

Planning period

- Indefinite – stated that the Checklist was designed to be used by the farmer at regular intervals, but no defined planning horizon was explicitly recommended.

Other

- The ECan Resource Care Assessment was developed from principles used in the Enviro-Ag model.
- Farmer input and workload is likely to be high, but less than that required for an Enviro-Ag farm plan. Likewise, the Assessment has a more readily understandable procedure, and therefore carries less chance of confusion or diminished perspective/focus. However, in fairness to the Enviro-Ag model, the ECan Assessment does not seek or attain the same standard of evaluation.

6.7.14 MWRC ENVIRONMENTAL PLAN: EXAMPLE 1

Example/template examined

- Manawatu-Wanganui Regional Council (MWRC) Environmental Plan completed March 1998 for a 943ha sand-country property that farms sheep & beef, located near Turakina. Prepared by L. Grant, Soil Conservator.
- Comprehensive 70-page booklet.
- Represents a MWRC farm plan example from the Region's Wanganui office (MWRC farm plans exhibit a degree of variation between different offices). Can also be regarded as an agroforestry-focused type of farm plan.

Purpose

- Implied purpose is an assessment of the farm, it's resources and it's SLM issues, towards the design and evaluation of options for improved sustainable land use.

Targeted farming

- Primarily sand and/or hill country farming.

Targeted SLM issues

- Primarily soil erosion (unstable or drifting sand dunes).
- Matching land use with land capability.
- Shelterbelt, forestry and grazing management.
- Plant and animal pests.
- Other issues suggested by LUC descriptions and recommendations include water quality, and the management of natural areas & riparian margins.

Resource/issue assessment

- **Land Use Capability survey:** Survey scale not given. LUC units designated according to the regional classification (*i.e.* no new LUC units particular to the farm identified).
- Explicit LRI survey not presented (and probably not undertaken), although detailed descriptions of resource characteristics are given for each LUC unit. Likewise, detailed discussion of topography, vegetation, geology, soils and erosion is provided as part of the preliminary farm description. This was likely to have been derived from a combination of survey, published information, and the regional LUC classification.
- LUC units are categorised according to regional suites for discussion. Each is detailed according to it's resource characteristics; management and soil conservation requirements; and production potentials.
- Principal SLM issues assessed as part of the LUC survey.
- The status of animal and plant pests assessed by a Council pest control officer.
- Farm LUC units further classified according to four classes of 'management requirements' (Table 6.11) including standard farm mgt; conservation mgt; impactive mgt (where management cannot counteract environmental impact); and impractical mgt (management that is not feasible because of severe physical limitations). LUC units requiring *conservation management* were tabulated against recommended conservation techniques and management options, and a summary of why particular land uses are impactive or impractical was given for particular LUC units.

Topographical location (suite)	LUC unit	Management Required to Sustain Use					
		Protection	Plantation forestry	Low intensity grazing	High intensity grazing	Cropping	Horticulture
Sand plain	IIIw4	Conservation	Impactive	Conservation	Conservation	Conservation	Conservation
	IVe10	Conservation	Standard	Conservation	Conservation	Conservation	Conservation
	VIIIw1	Conservation	Impractical	Impractical	Impractical	Impractical	Impractical
Sand dunes	VIe24	Conservation	Conservation	Conservation	Impactive	Impractical	Impractical
	VIIe15	Conservation	Conservation	Impactive	Impractical	Impractical	Impractical
Marine terrace	IIs2	Conservation	Impactive	Conservation	Conservation	Conservation	Conservation
	IIIs1	Conservation	Standard	Standard			Conservation
	[illegible]	Conservation	Conservation				

Table 6.11: Part example of a Sustainable Land Use classification (types of management required to sustain soil under different land uses).

Management & land use assessment	• Forestry is assessed in detail, as the targeted means of addressing the most erosion-prone LUC units. The assessment includes an account of existing forestry; design of an afforestation programme; and a production & economic evaluation through the Agroforestry-Estate Model. • The grazing enterprise is also assessed in detail, towards the purpose of maintaining or enhancing whole-farm pasture production levels, to account for a loss of pastoral area to recommended forestry.
Procedure	• Orientated towards traditional farm planning approaches – much of the assessment and plan formulation undertaken by a Council officer in consultation with the farmer(s) concerned. • LUC survey and classification, followed by Sustainable Land Use classification, and then an evaluation of land use and management options.
Economic evaluation	• Proposed afforestation programme evaluated through the Agroforestry-Estate Model. Outputs include a summary of area planted by year; change in livestock units carried; cashflow; and labour requirements.
Plan structure & format	• **Summary.** • **Resources:** Standard property description (area, tenure, topography, location, etc.) and overview of the farm's geology, soils and erosion status. • **Land use capability classification**: Detailed discussion of farm LUC units according regional suite categories. • **Sustainable land use**: Classification of LUC units according to four 'management requirements' classes (management required to sustain soil under various land uses). • **Plantation forestry**: Summary of existing forestry, followed by recommendations concerning suitable LUC units for new forestry; conservation management requirements for those units under forestry; appropriate tree species; pinus radiata regime (forestry programme); and a breakdown of costs and materials, along with an estimate of logging yields. Integrated grazing also discussed. • **Livestock management**: Statement of farmer goals, followed by a summary of current stock policy. Recommendations are given for increasing pasture production from non-forestry LUC units (to account for pasture production lost to new forestry), and targeted stocking capacities. Considerable discussion is also given to possible regrassing options and fertiliser application. • **Agroforestry assessment**: Summary of Agro-Estate Model outputs, and discussion on market fluctuations and programme implementation. • **Shelter belts**: Design of a shelterbelt programme, including discussion of shelterbelt principals, designs, costs, suitable species, and technical specifications. • **Plant pests** and the **Rabbit Calicivirus:** Design of a pest control programme, including a summary of on-farm plant pests, along recommendations and management specifications. A special section given to discussion concerning the collection, storage, release and management of the rabbit calicivirus. • **Appendices:** Detail on the Agro-Estate modelling, including a list of assumptions, data output sheets, and an explanation of terms used in the output sheets.
Maps	• A series of five maps, including: Existing Layout & Forestry; Land Use Capability Map; Priority Areas for Afforestation map; Practical Afforestation Plan map; and Recommended Shelterbelt Locations map (that also summarises existing & planned forestry). • Each map presented at a 1:28,500 scale on A4 sized paper. Quality GIS-generated maps displayed as colour-coded thematics (*i.e.* no aerial photo). Each map displayed with paddocks and fence-lines.

Planning period	• Uncertain. A works programme was given for a 32-year period (*i.e.* a forestry rotation for p. radiata), although *priority works* were recommended for the first three-years, and the establishment of the afforestation programme could be accomplished within two-years. Costs were estimated for eight years (up until the 2nd thinning), while scenario modelling was undertaken over a 67 year timeframe.
Other	• Recommended soil erosion measures focused firstly on afforestation of the most erosion-prone LUC units, and secondly on grazing management and shelterbelts. For this reason, this particular example is more readily likened to an agroforestry plan that exhibits a fine line between production and conservation interests (although production improvements are justified by linked conservation improvements). • The plan is a clear example of assisting the farmer to adjust the system of land use in a way that allows types of land use to be better matched to types of land capability (as compared to a plan that recommends works only).

6.7.15 MWRC Environmental Plan: Example 2

Example/template examined	• MWRC Environmental Plan completed April 2003 for a 326ha sheep & beef farm located in hill-country east of Pahiatua. Prepared by G. McLaren, Land Management Officer (Soils). • Detailed 25-page booklet. • Represents a MWRC farm plan example from the Region's Dannevirke office.
Purpose	• The general goal is sustainable farming (environmentally & economically), with the stated aim of the plan being 'to reduce the occurrence of soil erosion and to establish more trees on the property'.
Targeted farming	• Hill country farming.
Targeted SLM issues	• Primarily soil erosion control. • Soil structure damage (pugging and compaction). • Animal pests.
Resource/issue assessment	• **Land Resource Inventory survey:** Farm-particular LRI identified, presented and explained. Survey scale not given. • **Land Use Capability survey/interpretation:** LUC likely to have been interpreted in-the-field as a combined LRI/LUC survey. All LUC units designated according to the regional classification (*i.e.* no new LUC units particular to the farm were identified). • SLM issues assessed as part of LRI/LUC survey.
Management & land use assessment	• Current land use not assessed, other than a delineation of subdivision and farm features (although LRI vegetation-cover provides an indication of land use). Existing management and enterprise policies also not assessed. Recommended changes to land use or management were directly orientated towards targeted SLM issues.
Procedure	• Orientated towards traditional farm planning approaches – much of the assessment and plan formulation undertaken by a Council officer in consultation with the farmer(s) concerned.
Economic evaluation	• Basic costs and cost-sharing estimated as part of the five-year Works Programme. • No detailed economic evaluation undertaken.

Plan structure & format	• **Introduction and objectives:** Brief overview of the Council, Environmental Plans, and objectives of the example plan. • **Physical description:** Description of location, climate, geology & topography, landforms, and catchment. Detailed description of each LUC unit, including full Land Resource Inventory and recommended soil conservation measures. Description of soils by landform (adapted from existing publications), and a detailed breakdown of each targeted SLM issue. A brief comment is made concerning previous soil conservation works. • **Soil conservation programme**: Recommendations and discussion concerning soil erosion control, with particular emphasis on pole planting and gully retirement. Five-year Works Programme presented as a table (works by paddock), followed by an Annual Works Programme with an estimation of costs and cost-sharing. • **Appendices**: Mostly technical specifications and information sheets concerning *poplars & willows*; *native plant selection for retired areas*; and *animal pests*. Also includes a detailed description of the LRI coding system.
Maps	• A series of three GIS-generated maps presented on A4 sized paper without a scale. Includes a Paddock Map (showing paddock names & fencelines); Land Use Capability Map (showing LUC units; LRI; fences; and waterways); and Works Programme Map (showing colour-coded works by year; paddocks & watercourses).
Planning period	• Five years.
Other	• Environmental Plan based on a classical farm plan format. Distinctive in that it explicitly includes an LRI survey. • Photos were used to describe individual LUC units.

6.7.16 MWRC Environmental Plan: Example 3

Example/template examined	• MWRC Environmental Plan completed September 2002 for a 493ha sheep & beef farm located in hill-country near the east coast of northern Wairarapa. Prepared by G. Cooper, Area Land Manager. • Detailed 35-page booklet. • Represents a MWRC farm plan example from the Region's Dannevirke office.
Purpose	• Stated objectives include managing the property 'according to its capability to sustain production'; to control erosion; and to plant trees for conservation, shelter, shade and aesthetics.
Targeted farming	• Hill country farming.
Targeted SLM issues	• Primarily soil erosion control. • Soil structure damage (pugging and compaction). • Plant & animal pests. • Water quality and riparian management. • Drought management. • Additional *sustainability issues* were identified and described according to individual LUC units, including both production and environmental issues.

Resource/issue assessment

- **Land Inventory (LI) survey:** Farm-particular LI identified in notable detail (Figure 6.3), presented and explained. Survey scale not given (but the smallest unit was 1.5ha in area). Inventory based mostly on LRI but with a personalised coding system.

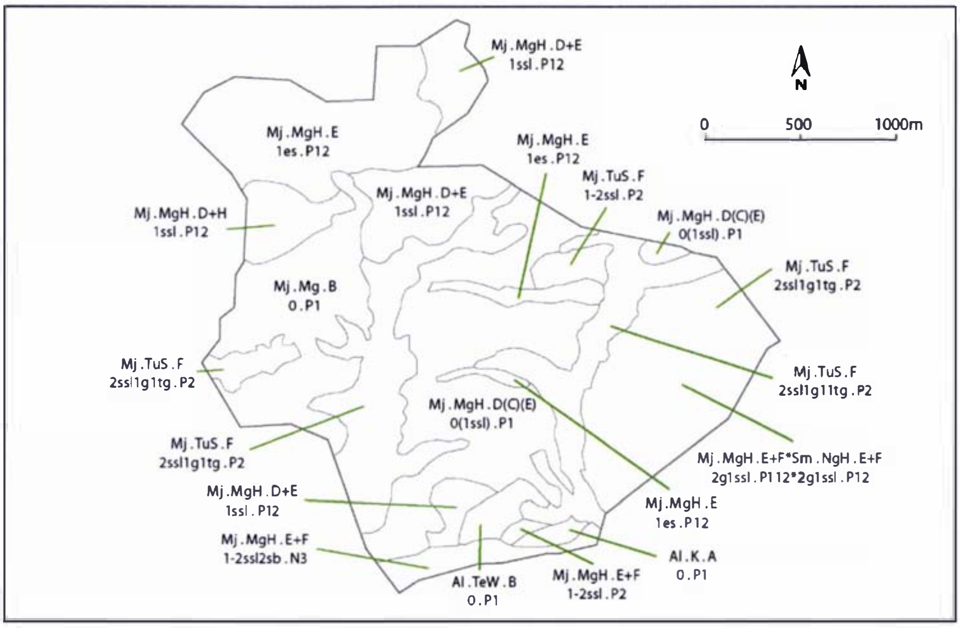

Figure 6.3: Example of an Environmental Plan (Dannevirke) Land Inventory Map.

- **Land Use Capability survey/interpretation:** LUC likely to have been interpreted in-the-field as a combined LRI/LUC survey. All LUC units designated according to the regional classification (*i.e.* no new LUC units particular to the farm identified).
- SLM issues assessed as part of LI/LUC survey. Issues particular to individual LUC units were listed.
- A degree of soil assessment (as part of the LI/LUC survey) was undertaken by verifying published soil information with profile examinations (on the property).

Management & land use assessment

- Current land use not assessed, other than a delineation of subdivision and farm features (although LRI vegetation-cover provides an indication of land use). A brief description of property management is provided (stock policies and numbers). Recommended changes to land use or management were directly orientated towards targeted SLM issues.

Procedure

- Orientated towards traditional farm planning approaches – much of the assessment and plan formulation was undertaken by a Council officer in consultation with the farmer(s) concerned.

Economic evaluation

- Basic costs and cost-sharing were estimated as part of the five-year Works Programme.
- No detailed economic evaluation undertaken.

Plan structure & format

- **Introduction** and **objectives:** Brief overview of the Council, Environmental Plans, and objectives of the example plan.
- **Physical description:** Includes a general farm description, climate and geology. Soils are discussed in detail, derived from both published information and survey information. Erosion is detailed according to erosion type. LUC units are presented and discussed (emphasis is on inventory description, limitations, sustainability issues, and production potentials), followed by plant & animal pests, and a brief summary of stock policies and numbers.
- **Sustainability issues**: Detailed discussion on targeted SLM issues, including appropriate conservation-management recommendations.

Plan structure & format (con).

- **Sustainability issues**: Detailed discussion on targeted SLM issues, including appropriate conservation-management recommendations.
- **Soil conservation works programme**: Summary of previous works; recommended new programme discussed by works; and a tabulated Annual Works Programme.
- **Monitoring**: Suggestions were put forth regarding monitoring, on the basis of that investment of public monies into private land requires proof of more sustainable land use. Types of monitoring could include financial, soil, pest, and effectiveness of works monitoring.
- **Appendices**: Detailed works-programme and costs; specifications & costs for protection afforestation; information on poplar and willow management; and a description of the Land Resource coding system. Also included a tabulated summary of soil properties (Table 6.12).

Soil & symbol	Topography	Parent material	Profile description	Drainage	Erosion LUC	Strengths	Weaknesses
Soils on Terraces							
Kairanga K	Flat medium terrace	Alluvium	20-30cm dark greyish brown silt loam on pale olive grey clay loam with mottles	Imperfect to poor	Streambank IIwl	- fertile - high summer AWHC - Cropping potential with drainage	- Occasional flooding - Potential for winter pugging
Te Wharau Te W	High terrace remnants with slight slopes	Alluvium & colluvium	Not recorded	Imperfect	Nil IIIw1	- Moderate fertility - Readily drained	- Exposed (high terrace) - Potential for winter pugging
Soils of rolling and hilly land							
Mangatea clay loam	Undulating to rolling	Jointed mudstone	20-30cm greyish brown clay loam on light brown	Imperfect	Slight	- Moderately high	- Winter wet

Table 6.12: Part example of soil descriptions provided in the Environmental Plan.

Maps

- Series of five GIS-generated maps presented on A4 sized paper at a 1:25,000 scale. Includes a Location & Subdivision Map (paddock map showing waterways and lanes); LUC Map; Land Inventory Map; Planting Map (showing forestry woodlots); and Works Programme Map (showing colour-coded works by year; paddocks & watercourses).

Planning period

- Five years.

Other

- As with the other Dannevirke Environmental Plan example, photos were used to describe individual LUC units, and the inclusion of a Land Resource survey distinguished the resource assessment.

6.7.17 EnvBoP Environmental Programme

Example/template examined

- Environment Bay of Plenty's (EnvBoP) template used as the basis for preparing an Environmental Programme (EP).
- Represents a preset design structure as a 33-page word processing form.
- The person(s) preparing an EP inserts appropriate descriptions within fields provided.

Purpose

- 'A programme for the protection of indigenous biodiversity and soil & water values'.
- 'A mechanism whereby public support is given to private landowners seeking to protect indigenous biodiversity and/or address soil & water conservation issues on their property'.

Targeted farming

- Applicable to most types of farming; targeted issues suggest an emphasis on both dairy and hill-country farming types.

Targeted SLM issues

- Soil & water conservation.
- Indigenous biodiversity.
- Plant & animal pests.
- Generally any environmental issue that can be categorised under the three headings given above (including effluent disposal, water quality, soil contamination, etc.).

Resource/issue assessment

- Discipline-particular Council staff undertake their own assessments independently, and submit them as reports to be appended to the final Programme. This is done as collaboratively as possible, with each report being summarised as a section within the main Programme document. Pest officers and land-management officers will visit the property together (if practicable).
- A Land Use Capability survey will be undertaken, particularly for large farms with erosion being a principal SLM issue.

Management & land use assessment

- Explicitly assessed as *current property management*. The degree of assessment is proportional to farm-particular SLM issues, and how closely they link to the land-use system of management and production.

Procedure

- Farmer applies → application & farm assessed → programme designed → farmer agrees then signs → Council agrees then signs → approved Programme can then be registered against the property title.
- Undertaken wholly by Council staff in consultation with the farmer. This is considered a necessary approach, because the Programme will effectively become a legally binding document.

Economic evaluation

- Only works-costs are estimated, including a breakdown of 'cost sharing' between the stakeholders involved.
- No detailed production or farm economic evaluation is undertaken. EBoP have a clear policy emphasising environmental protection for community benefit, over farmer gains through increased land productivity.

Plan structure & format

- **Summary:** programme, costs, and legal agreement.
- **1. Background & Environmental Concerns:** Details and summary reports on *property description* (including overviews of physical characteristics, farm management, and the status of targeted issues), and *environmental concerns* expressed by the farmer, the Council, and perhaps other interested agencies (namely local district councils and the Dept. of Conservation). The detail behind summary reports are included as appended full reports.
- **2. Programme & Estimated Costs:** Begins by presenting the objectives of a given EP, followed by a tabulated *initial works* schedule outlining areas, activities (works), and costs on a yearly basis for five years (Table 6.13). Initial works are those eligible for grants assistance. This is followed by a *maintenance programme*, which details follow-up works and maintenance-requirements that the farmer is responsible for implementing or upholding. *Monitoring* is undertaken on a biennial basis by the Council, and on an informal basis by the landholder (as a condition of maintenance). A section is also provided for *general property management recommendations*, presumably to discuss integrated management and/or non-assisted works and activities.

	Activity	Unit	Quantity	Rate	Cost	Cost Share		
						EnvBOP	WBOP DC	Local Share
Area	Year 1							
	Year 1 - Total							
	Year 2							
	Year 2 - Total							
	Year 3							

Table 6.13: Format of an initial-works schedule used in an EP.

- **3. Responsibilities:** Conditions of agreement, including a form whereby the farmer involved commits to the execution of a Memorandum of Encumbrance. A MoE was described as the mechanism that allows a Programme to be attached to the property title, thereby making the Programme a legally binding document.
- **Maps & Plans**
- **Appendices**: EP definition; detailed property description; detailed reports for targeted issues; technical specifications; and relevant information sheets.

Maps

- Not viewed, but described as being based on colour aerial photos that depict the type and location of works. These are GIS-generated maps to a standard suitable for inclusion as a legal document.

Planning period

- EPs are designed to span a 5yr period, after which they will be reviewed to determine if further works are necessary. A proviso is given that a Programme may also be reviewed within the 5yr period, if 'any significant new environmental threat is identified'.
- EPs are also used for other timeframes – they can span one year or several years, but they are reviewed on a five-yearly basis (L. Donald, 28 May 2003, *pers. comm.*).

Other

- Environmental Programmes are designed to accommodate a diversity of contributions from stakeholders who have an environmental management interest regarding privately owned land (namely the landholder, EnvBoP, local district councils, the Dept. of Conservation, and anyone else willing to provide assistance).

6.7.18 TRC RIPARIAN MANAGEMENT PLAN

Example/template examined	• Taranaki Regional Council (TRC) Riparian Management Plan completed January 2003 for a dairy farm located near Inglewood. Brief 12-page collation of documents, including a covering letter, works schedule and cost calculators (as tables), and map. • *The TRC's Land Management Annual Report (TRC, 2002) also outlines Riparian Management Plans.*
Purpose	• To promote good riparian management by setting out recommendations for the retirement or revegetation of land along the banks of watercourses, towards the ultimate purpose of enhancing the water quality on the Ring Plain (an expanse of mostly flat land extending concentrically from Mt. Egmont).
Targeted farming	• Primarily lowland intensive farming on the Ring Plain (dairy farming), although Riparian Management Plans may occasionally be applied in other parts of the Region.
Targeted SLM issues	• Ultimately the water quality of streams and rivers flowing through the Ring Plain. • Other issues implicitly accounted for include streambank erosion, riparian biodiversity, and in-stream habitat.
Resource/issue assessment	• Uncertain, but likely to have involved a farm reconnaissance to map and assess the location and condition of waterways and riparian areas.
Management & land use assessment	• As above, but focusing on the identification of riparian management needs. • Current farm management apparently not assessed to any significant extent.
Procedure	• Likely to follow the traditional 'technical assistance' approach – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned (see TRC Comprehensive Farm Plans).
Economic evaluation	• No production or economic evaluation of the farm undertaken. • A structure for estimating the cost of works is provided, but it is up to the farmer to make the actual estimates. This is achieved by presenting the physical dimensions of required works by river/stream section (*e.g.* planting densities, fence lengths), which the farmer can input into tabular calculators (for fencing, plants, labour and spraying) to estimate total costs for any given section.
Plan structure & format	• **Cover letter**: Essentially represents a summary of the Plan's main features. • **Annual implementation table; cost calculators; plant species selector**: These are presented together as tables on the back of the A3 map. The annual implementation table indicates recommended months during which particular operations (*e.g.* plant ordering, release spraying, etc.) should be undertaken. Cost calculators provide a framework for estimating works cost by riparian section. The plant species selector tabulates recommended riparian plant species against regional climatic zones, and riparian 'planting zones' (defined by their distance away from the watercourse). • **Recommended works table**: This represents the bulk of collated documents, and tabulates existing and proposed features by riparian section. Features include existing fencing and vegetation; proposed retirement/fencing; and proposed planting separated into planting zones for exotic and native species. Additional columns are also provided for summarising any shelterbelt requirements.
Maps	• Laminated high quality A3-sized map depicting colour-coded features (watercourses, existing fences & vegetation, lanes) and proposed works. Riparian areas broken into 'sections' labelled numerically. Detailed colour orthophoto used as a base map. Includes all standard map components (scale, scale bar, north arrow, legend).

Planning period	• No explicit timeframe given. While an 'annual implementation' table is provided to show the timing of various operations, it appears that the application of the plan is completely at the discretion of the farmer.
Other	• An earlier example of a TRC Riparian Management Plan (1993) uses a more comprehensive booklet format, similar in structure to traditional farm plan models.

6.7.19 TRC CONSERVATION FARM PLANS

Example/template examined	• Conservation Farm Plan completed December 2002 for 'wetland enhancement' of a 100ha dairy farm located in NW coastal Taranaki. • Ten-page booklet prepared by L. Hall, Land Management Officer. • *The TRC's Land Management Annual Report (TRC, 2002) also outlines Conservation Farm Plans.*
Purpose	• General: Conservation Farm Plans 'are prepared primarily for properties with individual site-specific soil or water conservation problems that do not require long term input and planning' (TRC, 2002, p.2). Examples include shelterbelts, sand drift controls, and wetland enhancement. • Wetland enhancement example: To address issues relating to the protection and enhancement of a significant wetland. Essentially a plan to outline works required to protect and enhance wetland function (nutrient & sediment filtering; flood buffering; habitat & biodiversity; and aesthetic value).
Targeted farming	• The suggestion is that Conservation Farm Plans can be applied to any type of farm with a singular or readily addressable SLM issue (the issue does not warrant the same degree of investigation and planning required by issues addressed through Comprehensive Farm Plans).
Targeted SLM issues	• Wetland enhancement. • Shelterbelts. • Sand-drift controls. • Minor land-stabilisation requirements
Resource/issue assessment	• Likely to be similar to that used in the preparation of a Riparian Management Plan (*i.e.* a farm reconnaissance to map and assess the wetland area). Other types of Farm Conservation Plans would also likely follow a similar process (because detailed resource/issue assessments would begin to define more comprehensive plans).
Management & land use assessment	• As above, but focusing on the identification of wetland management needs. • Current farm management apparently not assessed to any significant extent, although a section heading is given for 'Land use/management'.
Procedure	• Likely to follow the traditional 'technical assistance' approach – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned (see TRC Comprehensive Farm Plans).
Economic evaluation	• Basic annual costs estimated for fencing and planting. • No detailed farm production or economic evaluation undertaken.

Plan structure & format	• **Introduction:** Brief justification and explanation of the Conservation Farm Plan, including objectives. • **Description of property:** Brief four-part description of farm location, tenure, land use/management (very brief), and a discussion of topography & soils. This also includes a location map and photos of the wetland areas. • **Wetlands**: Brief justification for wetland protection. • **Wetland enhancement proposal**: Detailed description of proposed works, including discussion of works specifications, recommended plant species, and pest/weed management. Detailed costs estimated by riparian section. • **Implementation**: Presentation of a table showing annual timing of key operations, and a table of 'monitoring statistics' (not explained). • **Conclusion**: Brief summary of desired outcomes.
Maps	• Single A3-sized map similar to that included in the Riparian Management Plan (high quality; standard map components; colour orthophoto; colour-coded existing and proposed works, plantings and fences).
Planning period	• As with the Riparian Management Plan, no explicit timeframe given (although an 'annual implementation' table is provided), suggesting that the application of the plan is at the discretion of the farmer.

6.7.20 TRC AGRO-FORESTRY PLAN

Example/template examined	• TRC Agro-Forestry Plan completed October 2002 for a 640ha hill country farm located in North Taranaki. Prepared by J. Loveridge, Land Management Officer. • Detailed 15-page booklet plus appendices. • *TRC (2002) also outlines Agro-Forestry Farm Plans.*
Purpose	• General: To identify land capability, and to investigate viable forestry options that maintain or enhance land capability. • Very specific objectives were included in the example plan: ► To provide suitable erosion control on actively eroding steep to very steep slopes. ► To retire land that is continually reverting to scrub. ► To provide an alternative farm enterprise. ► To use trees to mask the odour of vermiculture compost.
Targeted farming	• Primarily hill country farms, although they may be applied in other parts of the Region if necessary.
Targeted SLM issues	• Ultimately soil erosion through demonstrating production benefits through afforestation.
Resource/issue assessment	• Although part of the stated general purpose of the example plan was to 'identify land capability of the property', there is no evidence to suggest that a LRI/LUC survey was undertaken. Rather, existing vegetation was surveyed and presented as a map, while only brief discussion was provided for topography, climate and erosion. A discussion on lithology and soils was only slightly more detailed.

Management & land use assessment	• Current farm management apparently not assessed to any significant extent. The software package used to model agro-forestry can function without detailed actual farm management information.
Procedure	• Likely to follow the traditional 'technical assistance' approach – much of the assessment and plan formulation undertaken by Council staff in consultation with the farmer(s) concerned (see TRC Comprehensive Farm Plans).
Economic evaluation	• Proposed afforestation programme evaluated through the Agroforestry-Estate Model. Outputs include a summary of area planted by year; change in livestock units carried; cashflow; and labour requirements.
Plan structure & format	• **Introduction:** Brief justification and explanation of the Agro-Forestry Farm Plan, including the general aim. • **Description of property:** Property description (tenure, location) followed by a discussion of farm topography, geology and soils, climate, and erosion (the degree of generalisation suggests this information was obtained from existing sources and not farm survey). Vegetation is discussed in more detail, and is supported by a map of existing vegetation. • **Agro-Forestry**: Outlines specific forestry related objectives, and discusses the farm's existing forestry status. • **Agro-Forestry Assessment**: Overview of the Agroforestry Estate Model (AEM) and selection of suitable forestry species, followed by a detailed breakdown of AEM assumptions and design of a forestry strategy. Includes a map of proposed afforestation. • **Agro-Forestry assessment results summary**: Presentation and discussion of modelling results as they relate to changes in cashflow, labour, and economic viability. • **Joint venture evaluation**: A brief summary of a slightly different model based on multiple investors. • **Conclusion**: Brief summary of potential outcomes. • **Appendices**: Detailed spreadsheet reports generated from the AEM.
Maps	• Two A3-sized maps depicting existing vegetation and the proposed forestry strategy. The same type of map used in other TRC farm plans (high quality; standard map components; colour orthophoto), but with colour-coded vegetation categories.
Planning period	• No explicit planning horizon given, suggesting implementation is at the discretion of the farmer. AEM modelling was for a 28yr rotation, whereby the majority of planting would take place in the first eight-years.

6.7.21 TRC Comprehensive Farm Plan

Example/template examined	• The TRC apply very consistent farm plan models, which has allowed two different Comprehensive Farm Plans to be assessed together. • Example 1: Comprehensive Farm Plan completed April 2003 for a 2760ha coastal farm near Waitotara (Southern Taranaki), which combines sheep, beef and dairy enterprises. Detailed 23 page booklet prepared by J. Loveridge, Land Management Officer. • Example 2: Comprehensive Farm Plan completed July 2003 for 450ha hill country sheep & beef farm located near Stratford. Detailed 25 page booklet (+ appendicies) prepared by M. Littlewood, Land Management Officer. • *TRC (2002) also outlines Comprehensive Farm Plans.*
Purpose	• 'To look at all aspects of a farming operation... to address management practices that protect soil and water resources while maximising the productive capability of the property' (TRC, 2002, p.1). 'Wise' (utilitarian) land use is emphasised.
Targeted farming	• Sheep/beef/deer farms located in Taranaki's eastern hill country.
Targeted SLM issues	• Matching land use with land capability. • Both of the example plans viewed had a strong primary emphasis on soil erosion (including shelterbelt planting), and a lesser secondary emphasis on other environmental issues (namely riparian, wetland and biodiversity management).
Resource/issue assessment	• A combination of both LRI and LUC survey. The five LRI factors are recorded in the field, and then inputted into the TRC's Land Information System. LUC may be directly inferred in the field, or later by interpreting the LRI data. LRI information as a map or according to the five factor code is not presented in farm plans. Rather, LRI factors are discussed independently. LUC is tabulated in farm plans to display total and effective area of individual units. This also includes farm-particular extended legends.
Management & land use assessment	• Farm management is assessed in detail. This includes a description of farm enterprises; farmer objectives; production & performance statistics; and general land management units are erected to explain general patterns of grazing and land use.
Procedure	• Preliminary discussion with farmer regarding the farm system, stocking rates, and farm objectives. This followed by the LMO undertaking a LUC survey of the property, and subsequent in-office preparation of maps, the farm plan document, and formulation of recommendations. The completed farm plan is then either sent or hand delivered to the farmer. The farmer is given two-weeks to consider the plan, after which he/she will again be contacted for further discussion (L. Grant, 2nd April 2003, *per. comm.*).
Economic evaluation	• No detailed economic evaluation of production undertaken. However, existing carrying capacity is compared to potential carrying capacity, and suggestions are given for realising potentials in way that does not compromise land integrity. Works costs are not estimated.
Maps	• Alongside a clear location map, each Comprehensive Farm Plan includes: ► Vegetation and Paddock Map (existing land use). ► Land Use Capability Map. ► Recommended Works Map (showing proposed pole planting, afforestation, scrub control, land retirement, shelterbelts, or wetland establishment). • Maps conformed to the same high standard evidenced in the TRC's other farm plans (colour orthophoto; standard map features; A3 size; colour-coded keys). • One example also included a map depicting legal descriptions and cadastral parcels. Both presented landscape photographs to describe particular LUC units, with one going further by obliquely delineating LUC units onto the photographs themselves.

Plan structure & format

- **Introduction**:
- **Description of property**:
  - ► Subheadings: Tenure & legal description; location; geology & topography; lithology & soils; climate; vegetation; erosion; farm management; grazing management.
  - ► Features: Land resource information appears to have been obtained through existing sources and farm survey; vegetation-cover areas are tabulated against LUC units; farm enterprises & management is discussed in detail, and include farmer objectives and production performance statistics.
- **Land Use Capability**:
  - ► Subheadings: Land resource inventory & capability survey; summary of LUC; description of LUC; recommendations for areas suited to forestry; general soil conservation measures for all areas.
  - ► Features: detailed explanation of the LUC Classification; tabulated summaries & photos of LUC units; farm-particular extended legend (Table 6.14); generic recommendations for forestry areas and soil conservation measures.

LUC unit	Where found on property	Rock type	Soil type	Slope (degrees)	Dominant ve etation types	Present erosion	Potential erosion	Potential stock carrying capacity	Radiata pine site index	Soil conservation measures
Ic3	Flat terraces	Deep andestic tephra (ash)	Egmont black loam	0-7°	Moderate to high producing pasture.	Nil	Nil	20-25 su/ha	29-32m	Shelterbelts are beneficial for pasture production and animal health.
IIw2	Alluvial river terraces.	Alluvium	Kairanga silt loam and clay loam.	0-7°	Moderate producing pasture.	Nil	Slight stream bank	19-25 su/ha	33-35m	Maintain any existing drainage. Avoid pugging soil.
IIIw4	Flat sand plains	Windblown sands	Himitangi sand	0-3°	Low to medium producing pasture. Rushes.	Nil	Nil	15-18 su/ha	30-33m	Management of this unit should always be related to adjacent areas. Fence off this unit from surrounding dune ridges if significant enough to allow differential grazing management to realise the full production potential of this unit without causing severe

Table 6.14: Part example of an extended legend included in a TRC Comprehensive Farm Plan.

- **Grazing potential**:
  - ► Subheadings: Stock carrying capacity; analysis of stock carrying capacity.
  - ► Features: Essentially a comparison between existing and potential (derived from the NZLRI) stock carrying capacities, with suggestions on how some potentials can be realised.
- **Proposed works programme**:
  - ► Subheadings: Summary of priority works; soil conservation recommendations; discussion of recommended works.
  - ► Features: Recommended works are prioritised and discussed in detail. A distinguishing feature is a lack of tabulated works and costs schedules common to traditional farm plans.
- **(Supporting information)**: May include generic fact sheets. This may be appended if it is a large section.
- **Conclusion**: Summary of potential outcomes if works are implemented.
- **(Appendices)**: One example included exerts from the regional plan; a glossary; and a soil test report.

Planning period

- As with other TRC farm plans, it appears that implementation timeframes are at the discretion of the farmer. For Comprehensive Farm Plans, 'landholders are encouraged to implement measures… on a progressive basis as finances permit'.

6.8. DISCUSSION & SUMMARY

The purpose of this study has been to describe and compare key features of contemporary farm plan models. Twenty-one different models from nine regional authorities have been examined and described according to a predefined framework. Key features have been summarised into categories presented in Table 6.15 overleaf. These and other features (*i.e.* those not readily categorised) are compared and discussed below.

6.8.1 PRINCIPAL FARMING TYPES TARGETED

Of the twenty-one farm plan models reviewed, 14 target hill country farming (12 if two MWRC examples are excluded) and at least 10 are applicable to lowland intensive farming (namely dairy, arable and finishing farms). For hill country alone, 10 of the 14 can be considered specific to this type of farming (*i.e.* farm plans designed and used expressly for hill country farming), with the remaining four being generically applicable to most types of farming (Enviro-Ag; ECan Resource Assessments; EnvBoP Environmental Programmes; & TRC Conservation Farm Plans). Enviro-Ag and ECan Resource Assessments are also used to target high country farming. Of the 10 models used for lowland intensive farming, five are orientated towards riparian management; two towards shelterbelts and the control of wind erosion; with the remainder being the same four generic models that can be used to target multiple issues for different farming types.

Of the nine regional authorities represented, Environment Southland was the only council without a farm plan model expressly targeting hill country farming. Conversely, most of the nine councils have some type of farm plan directly targeting lowland intensive farming (as either riparian, shelter or multiple issue farm plans), although Hawkes Bay and Manawatu-Wanganui do not. Hence, it can be stated that lowland-intensive and hill-country pastoral farming are both reasonably well represented by farm plan models in NZ, although there is a slight bias towards hill country (possibly due to the historical focus of traditional farm planning). While this bias is considerably more pronounced with the actual application of farm planning (see Section 6.9), the ongoing emergence of lowland-intensive farm plan models over the past decade (particularly riparian plans) suggests the historical hill-country emphasis may be gradually decreasing.

6.8.2 PRINCIPAL ISSUES TARGETED

Eight of the farm plan models (including all MWRC examples but excluding shelter plans) target soil conservation as the primary issue, five of which also consider secondary issues to varying degrees (particularly riparian/wetland management, biodiversity, shelter, pests and soil health). A further two examples focus on shelter and related issues (*e.g.* animal welfare, biodiversity), while five of the models expressly target riparian management as a primary issue. The remainder were either flexible in the issues they targeted, or multi-issue in character. Notably flexible plans included EW's DIY Environmental Farm Plan (the farmer determines which issues are to be targeted) and TRC's Conservation Farm Plans, whereby the primary issue is determined by the situation (*i.e.* depending on the farm, the model can be used to target wetland enhancement, dune stabilisation, shelterbelts, or other issues that require relatively minor works). Multi-issue farm plans include Canterbury's and Enviro-Ag's environmental checklists (which account for almost all conceivable on-farm environmental issues), and EnvBoP's Environmental Programmes. EnvBoP's programmes are distinctive in that they expressly target three primary issues (soil & water conservation; biodiversity; pests), under which an even greater range of secondary issues are accommodated on a farm-by-farm basis.

Table 6.15: Categorical summary of key features common to contemporary farm plans.

	Principal farming type targeted	Principal issues	Issue scope & focus	Document comprehensive-ness	Preparation emphasis	Resource/issue evaluation	Production/ economic analysis	Maps (excluding location maps)	Planning period
HBRC Soil Conservation Plan	Hill country pastoral	Soil conservation + some secondary issues	Primary + secondary issues	Very comprehensive	Council preparation	Very detailed resource & issue assessment through LUC/soil survey & evaluation	Consideration of carrying capacities	x4 high quality photo-based maps for existing land use, LUC, soils, & planned works	Five years
HBRC DIY Erosion Control Plan	Hill country pastoral	Soil conservation	Primary issue	Brief	DIY farmer preparation	Simple issue assessment by farmer	None	Basic map prepared by farmer using predefined framework & photocopied photo. Includes existing features & planned works.	Three years
WRC Streamland Care Plan	Dairy farming (+other lowland intensive)	Riparian management	Primary issue	Moderately comprehensive	Uncertain	Uncertain	None	Single map depicting existing features & planned works	Ten years
WRC Soil & Water Conservation Plan	Hill country pastoral	Soil conservation	Primary issue	Moderately comprehensive	Council preparation	Detailed issue & resource assessment through LUC survey	None	Possibly two maps - LUC & works	Ten years
WRC Shelter Plan	Lowland intensive farming	Shelter +some secondary issues	Primary + secondary issues	Moderately comprehensive	Council preparation	Onsite issue assessment by council officer	None	Single map depicting existing features & planned works	Ten years
WRC Sustainable Land Use Plan	Hill country pastoral	Soil conservation + some secondary issues	Primary + secondary issues	Comprehensive	Council preparation	Very detailed resource & issue assessment through contracted landform survey & evaluation	Comprehensive analysis	Possibly three maps - existing land use; landforms; & planned works	Ten years
ES Riparian Management Plan	Dairy farming (+other lowland intensive)	Riparian management	Primary issue	Brief	Council preparation	Onsite issue assessment by council officer	None	Single map depicting existing features & planned works NZMS260 topographical map base	Unspecified
ES Windbreak Tree-Planting Programme	Lowland intensive farming	Shelter +some secondary issues	Primary + secondary issues	Moderately comprehensive	Council preparation	Onsite issue assessment by council officer	None	Single low quality photo-based map depicting planned works.	Unspecified
EW Environmental Farm Plan (DIY)	Unspecified but likely to be hill country pastoral	Flexible (dependent on the farmer)	Flexible (dependent on the farmer)	Flexible (dependent on the farmer)	DIY farmer preparation	Moderately detailed issue assessment by farmer using a predefined framework	None	Basic map prepared by farmer using predefined framework & photocopied photo. Includes existing & planned features.	Five years
EW Riparian Management Plan (DIY)	Dairy farming (+other lowland intensive)	Riparian management	Primary issue	Brief	DIY farmer preparation	Simple issue assessment by farmer	None	Basic map prepared by farmer using predefined framework & photocopied photo. Includes existing & planned features.	Unspecified
Otago Enviro-Ag Farm Plan	Hill & high country pastoral and lowland intensive	Very broad range of conceivable SLM issues	Multiple issues	Very comprehensive	Combination of group & DIY farmer prep with expert assistance	Brief resource assessment and very detailed issue assessment according to a checklist framework	None	Recommended that the farmer uses an aerial photo to delineate Land Management Units. Map may be digitised	Five years
ECan Riparian Plan	Dairy farming (+other lowland intensive)	Riparian management	Primary issue	Comprehensive	Uncertain	Uncertain	None	Single photo-based map depicting existing features & planned works	Two years
ECan Resource Assessment	Hill & high country pastoral and lowland intensive	Very broad range of conceivable SLM issues	Multiple issues	Very comprehensive	Combination of DIY farmer prep with council assistance	Brief resource assessment and very detailed issue assessment according to a checklist framework	None	No map	Flexible
MWRC Environmental Plan No.1	Sand & hill country pastoral farming	Soil conservation + some secondary issues	Primary + secondary issues	Very comprehensive	Council preparation	Very detailed resource & issue assessment through LUC survey & evaluation	Comprehensive analysis	x5 high quality thematic maps (existing land use & forestry, LUC, priority afforestation, practical afforestation, & shelterbelts)	Unspecified
MWRC Environmental Plan No.2	Hill country pastoral	Soil conservation + some secondary issues	Primary + secondary issues	Comprehensive	Council preparation	Detailed resource & issue assessment through land inventory and LUC survey & evaluation	None	x3 quality thematic maps for existing land use; LUC (incl LRI); and planned works	Five years
MWRC Environmental Plan No.3	Hill country pastoral	Soil conservation + some secondary issues	Primary + secondary issues	Comprehensive	Council preparation	Detailed resource & issue assessment through land inventory and LUC survey & evaluation	None	x5 high quality thematic maps for existing land use, LUC, Land Inventory; planned planting; & planned works	Five years
EBoP Environmental Programme	Hill country pastoral & lowland intensive	Soil & water conservation, biodiversity, pests	Multiple issues	Very comprehensive	Council preparation	Detailed onsite issue assessments by council officers. May include LUC survey	None	High quality photo-based map(s). Include at least a planned works map.	Generally 5yrs but flexible
TRC Riparian Mgt Plan	Dairy farming (+other lowland intensive)	Riparian management	Primary issue	Brief	Council preparation	Onsite issue assessment by council officer	None	Single high quality orthophoto-based map depicting existing features and planned works. Laminated	Unspecified
TRC Conservation Farm Plan	Hill country pastoral & lowland intensive	Flexible	Primary issue determined by situation	Moderately comprehensive	Council preparation	Onsite issue assessment by council officer	None	Single high quality orthophoto-based map depicting existing features and planned works	Unspecified
TRC Agroforestry Farm Plan	Hill country pastoral	Soil conservation via afforestation	Primary issue	Comprehensive	Council preparation	Onsite issue assessment by council officer	Comprehensive analysis	x2 high quality orthophoto-based maps for existing land use and planned works	Unspecified
TRC Comprehensive Farm Plan	Hill country pastoral	Soil conservation + some secondary issues	Primary + secondary issues	Comprehensive	Council preparation	Detailed resource & issue assessment through LUC survey & evaluation	Detailed evaluation of carrying capacities	x3 high quality orthophoto-based maps for existing land use, LUC, & planned works	Unspecified

Several models also focused on 'matching land use with land capability' as an issue, either explicitly (TRC, HBRC, MWRC) or implicitly (WRC). These models orientated towards hill country and traditional principles of soil conservation. Each was characterised by a detailed assessment of land capability, and in most cases, an evaluation of farming options according to 'wise use' principles (such as demonstrating production gains to offset costs of soil conservation).

6.8.3 FARM PLAN FORMAT AND COMPREHENSIVENESS

Farm plans appear to range widely in their degree of comprehensiveness. Riparian plans appear to be the most brief, particularly those available from Southland, Waikato, and Taranaki Regional Councils. Likewise, DIY farm plans appear to be characteristically brief (HBRC Erosion Control Plan & EW Riparian Mgt. Plan), although the comprehensiveness of EW's Environmental Farm Plan is dependent on the farmer.

Towards the other extreme, five of the models were categorised as being very comprehensive; six as comprehensive; and five as being moderately comprehensive (using a relative scale based on number of pages). HBRC's Soil Conservation Plan and the first example of a MWRC Environmental Plan were notably comprehensive, due in part to very detailed resource assessments and descriptions. Environmental checklist-based plans are comprehensive by default, as they seek to accommodate such a wide breadth of environmental issues. Similarly, EnvBoP's environmental programmes are very comprehensive because they attempt meaningful and detailed evaluations of multiple issues.

The upside of comprehensive farm plans is that they provide considerable on-site information to the farmer, and generally suggest that issues have been investigated in detail and the best recommendations have been put forth (although this is not always the case). The downside is the time and cost to the council, and the threat of information overload to the farmer, or outright disinterest in reading such an information-laden document. Similarly, unless a farm plan has particularly clear objectives and structure, there is a risk that the original purpose of the plan is subdued ("can't see the forest for the trees").

This is a distinctive dilemma for councils seeking to upgrade traditional farm plans to better accommodate contemporary SLM issues. In short, meaningful and detailed evaluations of multiple issues can result in comprehensive farm plans (this includes erosion control plans that also target 'matching land capability with land use' or agroforestry). Council's have attempted to accommodate this dilemma in four main ways:

1. The inclusion of secondary issues: While many of the models had a primary focus (namely riparian management, shelter, or soil conservation) they also included a consideration of secondary issues (particularly in relation to biodiversity, pests, wetlands, and soil health). The degree of secondary-issue assessment and description was generally much less than afforded to the primary issue. Hence, secondary issues may not be assessed to a (comparatively) meaningful degree, and may be perceived as being relatively unimportant – if a council doesn't emphasize a given issue, why should the farmer?

2. Having a range of 'primary issue' models: Rather than attempting to capture multiple issues in a single plan, a series of different farm plans can be used. This is particularly apparent with Wellington and Taranaki, who both have a series of plans specifically for riparian management; erosion control; and 'matching land use to land capability'. Taranaki goes one step further with their Conservation Farm Plans, which essentially represent a generic framework for tackling any primary issue not accounted for by other plans.

3. Conciseness: This should be the ultimate aim of any farm plan, whereby the information content is condensed to a level of relevance and detail without becoming too generalised. Some of the comprehensive examples from Wellington, Taranaki and Manawatu-Wanganui were particularly notable in their level of conciseness. Similarly, while an actual example from Bay of Plenty was not viewed, the template suggests that Environmental Programmes seek to maximise conciseness in the main report by appending the detail of individual issue assessments.

4. Environmental checklists: Enviro-Ag and ECan's Resource Assessments are the only two models that consistently seek to accommodate almost all on-farm environmental issues. This is achieved firstly by using a checklist as means to quickly assess which issues are relevant to the farm, and secondly by prioritising which issues are considered most important. The most significant issues can then be assessed in more detail if necessary. However, assessing significant issues individually to a standard comparable to other farm plan models is unlikely, as the initial process of identifying and prioritising issues is very time consuming in itself (particularly with Enviro-Ag).

The structural layout of contemporary farms also varies widely, and can therefore be difficult to categorise in any meaningful way. However, apart from the most basic examples, farm plans generally appear to include four fundamental components, and most will include one or two auxiliary components (Table 6.16).

COMPONENT	IMPORTANCE	DESCRIPTION
Farm description	Fundamental	Almost universally includes location, tenure, legal description, farm areas, climate, and perhaps a description of existing farm management and enterprises. If not accounted for elsewhere, this component is also likely to include physical descriptions of land (particularly topography, geology, soils, vegetation, hydrology, etc.).
Resource assessment & description	Auxiliary	Typically describes the results from a farm resource survey (land inventory, soils, sometimes vegetation, or direct inference of LUC) and subsequent interpretations. Current farm issues are assessed, and somewhat uniquely, potential issues (e.g. susceptibility to erosion) and production opportunities can be credibly evaluated. Generally limited to farm plans that focus on soil conservation and 'matching land use to land capability'.
Production assessment & description	Auxiliary	Detailed descriptions of farm enterprises, management and production performance necessary for evaluating alternative land use/management options.
Issue assessment & description	Fundamental	Some part of a farm plan will outline the character of the issues it aims to address. This often describes issues identified through resource survey, or some other form of onsite assessment (particularly for the assessment of wetlands, potential shelterbelts and riparian areas). This component may also involve a justifying explanation as to why the issue should be addressed.
Evaluation of use/management options	Auxiliary	Whole-farm scenario modelling of any production and economic effects associated with changes to improve resources or the environment. Tends to be limited to farm plans that focus on 'matching land use with land capability'.
Design of a works programme or action plan	Fundamental	This is essentially the fundamental part of any farm plan. While other components can be discarded (as with some of the briefer models), this component cannot. It will generally outline the when, how, and how-much of works and actions needed to address particular issues. Long-term programmes (5-10yrs) are usually reduced to annual works programmes.
Maps	Fundamental	All but one of the farm plans examined included a map. Single maps for less comprehensive plans tend to depict both existing features and planned works together. Comprehensive plans tend to have a series of maps for existing land use; land resources and/or capability; and recommended works. For the latter maps, the best examples depict both where and when (on an annual basis) works should be implemented.
Follow-up programme	Auxiliary	Some farm plans will outline a monitoring programme, responsibilities of the farmer, and responsibilities and/or future intentions of the council. This also includes management agreements, binding or otherwise.

Table 6.16: Fundamental components (in bold) and auxiliary components of contemporary farm plans.

6.8.4 PREPARATION EMPHASIS AND PROCEDURES

Fourteen of the twenty-one plans examined appeared to have been prepared by a council officer as a technical service for farmers. The remainder had a farmer-focused preparation, either as complete DIY packages or checklist-based issue assessments (both of which could involve council assistance if required). The preparation of Enviro-Ag environmental plans is initiated through a workshop process (this may also be a feature of ECan's and EW's farm plans).

Few reliable comments can be made about actual preparation procedures, as this feature has been mostly inferred. However, as the majority are prepared by council officers as a technical service, it is likely most follow a traditional procedure (farm visit to assess & discuss; office draughting of plan; deliver to farmer & discuss). The exceptions are the plans with a farmer-focused preparation, as these (by their nature) are required to include a systematic explanation of the process.

6.8.5 RESOURCE AND ISSUE ASSESSMENT/EVALUATION

Methods of issue assessment can be categorised into three. Firstly, a council officer may undertake a farm visit to examine the site, define the issue, and begin formulating possible recommendations. Such assessments appear to be characteristic of less comprehensive farm plans, or primary issue plans that don't warrant a full-scale farm survey (particularly for wetland, riparian, and shelterbelt management). It is implicit that criteria are used in these assessments, although it was not clear if councils use predefined criteria (*i.e.* an assessment framework) or rely on the subjective criteria of individual officers (*i.e.* based on their professional judgement alone).

Secondly, assessments may be undertaken by the farmer (with or without council assistance) according to a predefined framework, such as those evident with DIY kits and environmental checklists. In doing so, much of the preparation effort and cost is shifted away from the council and onto farmers. Successful quality assessments are largely dependent on the willingness of farmers to take on extra work, their assessment skill, and their ability or willingness to be objective. In part, these factors may be offset by clear instructions and guidance from council officers.

Thirdly, a farm survey may be undertaken to describe resources and evaluate issues according to a recognised survey framework. This is generally confined to farm plans that seek to 'match land use with land capability', with the most common framework being the LUC survey. This is consistently used by TRC, WRC, MWRC, and occasionally by EnvBoP (for large properties with erosion problems). Such surveys tend to be characterised by direct inference of LUC in the field. However, MWRC examples from the Dannevirke office included detailed land resource inventories, and the HBRC Soil Conservation Plan was distinctive in that it included a farm soil survey. TRC Comprehensive Farm Plans also involve standalone LRI surveys, but these are not explicitly reported to the farmer. WRC SLU Plans are perhaps the most distinctive, in that they are based on a contracted survey according to the specialised landform classification described in Chapter 5 (Section 5.4).

The relation between resource assessment and issue assessment through farm survey is vague. Issues can be directly identified and assessed in the field, or inferred as potential issues from resource characteristics and properties (*e.g.* qualitative estimates of pugging vulnerability, erosion susceptibility, leaching potential or runoff potential). Further, compound issues intertwined with land use and management can be evaluated by identifying land capability, to be used as a basis for designing improved options for land use.

6.8.6 PRODUCTION AND ECONOMIC ANALYSIS

Only three of the farm plans examined had undertaken a production/economic analysis (WRC SLU Plan; TRC Agro-Forestry Plan; & MWHC Environmental Farm Plan No. 1), although a further two included a consideration of improved production by realising carrying capacity potentials (HBRC Soil Conservation Plan & TRC Comprehensive Farm Plan). TRC and WRC appear to be the only two councils who consistently undertake comprehensive analyses (*i.e.* they have farm models designed expressly to accommodate such analyses), while WRC alone have the only model that credibly evaluates both forestry ***and*** stock production/economics. However, it is conceivable that any farm plan model, particularly those that focus on 'matching land use to land capability', could readily integrate a production/economic analysis if it was deemed particularly necessary for a given farm.

Limited use of comprehensive analyses can perhaps be attributed to associated increases in farm plan preparation time and costs, plan comprehensiveness, and the somewhat contentious issue of a council providing an agricultural service likely to result in production and financial gains to individual farmers. On the positive side, such analyses can be used to demonstrate how the costs of environmental management can be offset by production gains, thereby acting as an incentive. Perhaps more importantly, the farmer is shown how to reconcile and integrate these two (often antagonistic) factors, which is the essence of sustainable farming.

6.8.7 FARM MAPS

Maps appear to be a fundamental component of farm plans, with only one of the examples examined not including or recommending a farm map (ECan's Resource Assessments). Less comprehensive plans tend to use a single farm map to depict existing natural features (watercourses, vegetation, wetlands, etc.) and physical features (fences, lanes, etc.), together with any planned works (retirement areas, fencing, space planting etc.). More comprehensive plans tend to separate existing features from planned works by using two maps, while those that involve a resource survey will include a further one (*e.g.* for LUC) or two maps (*e.g.* for LRI and LUC).

A well designed works map will depict both ***where*** different works are required (using characterising symbols and hatching to convey the type of works), and ***when*** works are to be implemented on an annual basis (using colour coding). If all other farm plan components were discarded, then it is feasible to suggest that a well designed works map could be used on its own to successfully implement a works programme. In this sense, a works map is the most important map. However, in a slightly different sense, a resource map has a utility and importance that extends well beyond the initial works programme, as it provides a continual basis for designing future works programmes, and can ideally represent a source of information useful for other farm management purposes. Such maps also demonstrate that a technical and scientific (albeit empirical) assessment has been undertaken, and therefore ideally convey a high degree of confidence in the robustness and justification of any forthcoming recommendations. Unfortunately the common practice of directly inferring LUC in the field may detract from this confidence, as this represents a wholly subjective process that is not backed up by the presentation of descriptive information (*i.e.* land inventory as data or 'facts about the land').

The quality of examined maps was generally proportional to plan comprehensiveness. Less-comprehensive plans tended to be based on photocopied aerial photos or topographical maps, sometimes without an adequate scale or key. Many of the comprehensive examples used detailed aerial photos as base maps, with Taranaki having colour orthophotos for all their maps. MWRC appear to prefer thematic maps only (*i.e.* without a base map), relying on the inclusion of features (watercourses, paddock boundaries) to provide a degree of visual reference. Higher quality maps appear to have been GIS generated, allowing for the consistent calculation of areas and distances.

6.8.8 PLANNING PERIOD

Planning periods assigned to farm plans vary between one-year and an unspecified number of years. The general timeframe appears to be around five-years (the same as pre-1988 SWCPs), although this ranges from single-year programmes (mostly for riparian plans) through to WRC's standard 10-years for all their plans. The two agro-forestry plans examined had unspecified timeframes, due perhaps to their long-term nature (+30yrs). Other farm plans examined appear to have either forgotten to include an explicit timeframe, or it was omitted for strategic reasons. This may be the case for Taranaki, who consistently fail to suggest any timeframe in any of their plans. Rather, it is at the discretion of the farmer to decide when and what parts of a plan will be implemented.

OTHER RECENT DEVELOPMENTS IN FARM PLANNING

Independent development of farm planning under the RMA by individual authorities has resulted in the diversity and creativity of farm planning currently being applied in New Zealand. This development continues, as different interests seek to refine and adapt farm planning to better-accommodate modern-day resource management needs. Of particular note, is a recent emphasis on farm planning for managing dairy sector environmental impacts; the use of farm plans as a basis for farm-tailored regulation; farm plans for on-farm protection of natural areas; and the rapid growth of various Quality Assurance Programmes (QAPs) and Environmental Management Systems (EMSs) that exhibit a strong farm plan component.

The aim of this section is to briefly review these initiatives, to further highlight the innovative development of farm plan models, and to provide an insight into potential future application of farm planning. The first initiative is discussed in slightly more detail because it involves an underlying survey with a purpose similar to other studies reported in this chapter.

6.9. MFE REVIEW & FARM PLANNING FOR THE DAIRY INDUSTRY

In May 2002, resource management authorities and the dairy industry committed themselves to the *Clean Streams Accord*. In partial response to this 'ground-breaking agreement' (NZE, 2002, p.1), the Ministry for the Environment became interested in *environmental farm plans* as a potential mechanism for 'effective industry self-regulation', particularly as it relates to reducing water-quality impacts attributed to dairy farming (Blaschke & Ngapo, 2002, p.7). Soon after the agreement was announced, MfE commissioned a Review to 'provide a national overview of the use and implementation of environmental farm plans in NZ', and to 'discuss issues associated with potential uses of farm plan mechanisms for environmental management in the dairy sector' (*ibid.*). Much of the Review's focus overlaps with the studies presented in this chapter, and the preceding chapter.

Environmental farm plans were defined as 'any type of single-property based farm-plan that has a significant environmental component', whereby *farm plan* is a 'generic term used to describe any type of planning undertaken on a farm' (*ibid.*, p.10). This differs slightly from the terminology used in the preceding chapter, in that *farm plans* have been historically prepared by resource management authorities, and are therefore environmentally focused by default. However, as the term has evolved to include industry-led QA and EMS initiatives, it is perhaps now more pertinent to distinguish farm-plan sub-categories more clearly (to be discussed).

The Review also details various types of farm plans, along with giving an historical account of farm plan development. The core of the report is based around a nationwide survey, whereby all of NZ's regional authorities were contacted by phone to establish whether or not they provide a farm plan service; for those who did, a follow-up postal questionnaire was used to obtain detail on the characteristics of farm planning programmes.

In contrast to previous results reported in this chapter, Auckland RC now indicates that they do provide a farm planning service (although the characteristics of this service were not clear), while Tasman DC apparently no-longer undertake farm planning. Other differences in results are minor, and can perhaps be attributed firstly to the development of farm plan programmes (approximately a year separates the two surveys), and secondly to the qualitative nature of the studies.

A select range of relevant results from Blaschke & Ngapo's survey are presented in Table 6.17. From this they concluded that most councils still target farm planning on 'drystock' (interpreted here as sheep, beef and deer farming) and hill country farming types, although Taranaki, Waikato and Bay of Plenty were considered exceptions. Similarly, most farm plans tend to target traditional RM issues (soil conservation, water quality, pest management), although more recent issues (*e.g.* biodiversity, natural heritage, protection of significant natural features) were also rated highly. Most councils also had some form of agreement and monitoring programme associated with their farm plans.

RAs with farm plans	Traditionally targeted farming types[1]	Issues not targeted[3]	Council/farmer agreement	Monitoring
Auckland	Drystock[2]; vegetable cropping	13	Indirect (Trees for Survival)	Indirect (regional monitoring)
Waikato	Drystock[2]; dairy	7, 8, 9, 10, 11, 13, 14, 15, 16, 17	Binding & non-binding agreements	Compliance monitoring
Bay of Plenty	Drystock[2]; any rural property	7, 8, 9, 10, 11, 113, 14, 15, 16	Binding agreement	Compliance monitoring
Hawkes Bay	Drystock[2]	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	None	None
Taranaki	Drystock[2]; dairy; mixed cropping; any rural property	3, 7, 8, 9, 10, 12, 13, 14, 16	Binding agreement if grants are involved	Compliance & effectiveness monitoring
Manawatu-Wanganui	Drystock[2]; mixed cropping	8, 9, 10, 11	None	Effectiveness monitoring
Wellington	Drystock[2]; dairy; mixed cropping	3, 6, 7, 8, 9, 10, 11, 14, 16	Non-binding agreement	Compliance & effectiveness monitoring
Canterbury	Any rural property	13, 17	Agreement if grants are involved	Some monitoring
Otago	-	13, 17	None (or indirectly through QE II)	None (audits through NOSLaM)
Southland	Mixed cropping; any rural property	3, 12, 13	Non-binding agreement	Compliance monitoring

[1] *Targeted farming is described as 'types of farm where property plans have been traditionally carried out'.*
[2] *It is assumed that 'drystock' farming is meant to include all types of sheep, beef and deer farming. In practice, however, a drystock enterprise has no breeding component (hence 'dry' stock).*
[3] *Key for issues **not** targeted:*

1 Erosion control; tree planting; protection of riparian areas, wetlands, bush remnants and other significant natural areas

2 Control of farm runoff	*6 Pest animals*	*10 Effluent disposal*	*14 Fertiliser*
3 Water supply	*7 Chemicals*	*11 Landscape or heritage values*	*15 Soils*
4 Water quality	*8 Farm dumps*	*12 Other biodiversity management*	*16 Nutrients*
5 Pest plants	*9 Offal pits*	*13 Animal welfare*	*17 Land or soil capability*

Table 6.17: Select results adapted from Blaschke & Ngapo's (2002) national survey of farm planning.

Considerable discussion was also given to the effectiveness of farm plans, based mainly on the opinions of regional council representatives, and a brief review of studies concerning the benefits of soil conservation and riparian management. The principal conclusion was that 'environmental farm plans are an effective method of achieving good environmental outcomes in a non-regulatory way' (p.2). Farm planning relating to QA and EMS was also discussed (see Section 6.14), along with a brief account of farm planning in Australia.

6.9.1 SUITABILITY OF ENVIRONMENTAL FARM PLANS FOR THE DAIRY INDUSTRY

The underlying theme of the Review was to discuss the suitability of farm plans as a mechanism for promoting environmental management in the dairy industry. Three contemporary farm-plan models were nominated as being suitable or amendable towards dairy farming – Taranaki riparian plans; Bay of Plenty environmental programmes; and a new model then being developed by Waikato RC. Riparian plans by Wellington, Southland and Canterbury were not included, nor were the environmental-checklist type plans currently available in Otago and Canterbury. Traditional soil conservation models were considered unsuitable (due to a general focus on hill-country and erosion), although it was acknowledged that they may be applicable in some situations (*e.g.* dairy farming in rolling hill-country). As discussed in the previous chapter, traditional farm planning has rarely been associated with the dairy industry, although historical examples do exist (see Section 5.3.5.3).

An alternative model was suggested for the dairy industry, as a 'one-stop shop model' based on eleven core criteria (Figure 6.4). An even more comprehensive model would include animal welfare, water supply, waste management, energy supply, and more-detailed evaluations of biodiversity protection and pest management. Further, economic evaluations were considered necessary to link environmental planning with business planning. While the difficulty of including all these factors was acknowledged, even a farm plan limited to the eleven core-criteria would be a time consuming and costly exercise. At present, the only contemporary farm-plan model that could come close to accommodating the listed criteria, was considered to be Bay of Plenty's environmental programme.

CORE CRITERIA

- Soils and/or Land Use Capability assessment
- Soil management
- Control of runoff
- Riparian protection and management
- Water quality
- Irrigation management (if applicable)
- Use of chemicals
- Disposal of effluent
- Protection of significant indigenous habitats from grazing
- Control of pests that affect farm production
- Nutrient and fertiliser management

Figure 6.4: Suggested core criteria for dairy farm environmental planning (Blaschke & Ngapo, 2002).

Farm plans were considered as one option (but not the only option) for promoting better environmental management in the dairy industry. Farm plans on their own were unlikely to be well-received by dairy farmers, due to a complex of factors (such as the physical nature of dairy farms, ownership structures, a strong production emphasis, and the historical relation between RM authorities and dairy farmers). Integrated financial planning and strong links with industry-driven initiatives (*e.g. Market Focused*) were considered as two possibilities for improving dairy-farmer interest in farm plans.

The Review also endorsed the Australian model of Property Management Planning (PISA, 1997), particularly as it relates to whole-farm integrated planning (*i.e.* a balanced and detailed emphasis on both business and environmental planning), strong institutional support, and an integral involvement with Landcare groups. Likewise, linking farm planning with regional authorities' increasing support of resource care-groups in NZ was considered potentially beneficial in terms of collective ownership of catchment-scale projects, and as a means for councils to make the best use of their limited resources.

In recognition of the lack of central government involvement in farm planning since 1988 (the exception being the R&LMP), the Review concluded with a recommendation that a greater emphasis on national support and monitoring was desirable, along with a more-rigorous follow-up investigation in 2004-2005 aimed at 'producing a best practices guide to farm planning', and evaluating the potential of more-formally integrating farm plans as an official RM mechanism (p.47).

6.10. PROMOTING SLM IN GISBORNE HILL COUNTRY

Farm plans are generally regarded as mechanisms for promoting voluntary change in resource management (Blascke & Ngapo, 2002). Apart from Nelson's property plan initiative, few farm-plan models seek to integrate the regulatory dimension of resource management. In a recent policy evaluation for Gisborne District Council (Boffa Miskell, 2000a), mandatory farm plans were recommended as a potential mechanism for promoting sustainable land use practices in the District's most severely eroding hill country.

The policy evaluation was commissioned by the Ministry for the Environment. It's purpose was 'to review and evaluate the principal practical options for eliminating unsustainable land use practices on eroding land in the Gisborne District' (*ibid.* p.1), with a view that some recommendations may be incorporated into Council's Combined Regional Land and District Plan. A number of policy options were evaluated, many of which included a farm plan basis.

Farm planning was defined as 'the purposeful area-specific planning of farm activities over a whole farm (or contiguous groups of farms), in order to achieve specific objectives for the farm(s)' (*ibid.* p.48). This is similar to Blascke & Ngapo's (2002) definition, in that the generic term *farm plan* can be used to encompass not only environmental planning, but all other conceivable types of planning undertaken on individual properties (business planning, land development planning, etc.).

A general framework was proposed (as the foundation of any forthcoming farm plan models), based on eight criteria considered applicable to the Gisborne District (Figure 6.5). This suggests a preference for a comprehensive single-issue farm plan, extending beyond stand-alone erosion-control recommendations to integrate soil conservation with production management. At least three *principal policy options* were put forth as structured and functional farm plan models.

SUGGESTED STRUCTURE FOR A GISBORNE FARM PLAN

1. Basis of LUC mapping, whereby LUC units are aggregated into categories.
2. Identification of 'sustainable stock carrying capacities' and forestry site indices according to LUC unit.
3. Identification of areas that need to be retired from pastoral use as:
   - Commercial or conservation forestry
   - Protection forestry
   - Protection conservation
4. Identification of 'severely erodible hill country' that requires conservation measures for continued pastoral use:
   - Space planting
   - Gully planting
   - Other measures
5. Implementation plan (including eligibility for funding through the East Coast Forestry Project).
6. Resource requirements (fencing, planting, labour, etc.).
7. Recommendations to increase profitability/production of remaining pastoral areas, possibly including financial analysis.
8. Integration of all criteria given above into a single combined productive and environmental farm plan.

Figure 6.5: Suggested structure for a Gisborne farm plan (adapted from Boffa Miskell, 2000a).

To begin with, farm plans were nominated as a principal policy option for a renewed emphasis on the non-regulatory promotion of sustainable management. That is, a recommendation was given to reconsider non-regulatory options ahead of any new regulatory options, to allow a reasonable time period for the evaluation of related factors (effectiveness of the East Coast Forestry Project; a proposed hill country strategy; and technical/legal considerations relating to regulatory options). For farm planning, this would translate to the 'reactivation' of a service according to traditional and typical models (*i.e.* a free or subsidised service provided to farmers by the Council, whereby all dimensions of the farm plan are voluntary).

If non-regulatory measures proved to be ineffective, then a recommendation was given to phase in regulatory options. Transitory farm plans (from being voluntary to mandatory) were recommended as the most feasible regulatory option for controlling erosion on severely eroding hill country (Figure 6.6). These would initially be voluntary during a transition period, but to be fully effective it was considered that they may need to become a mandatory requirement covered by a rule in the Regional Land & District Plan.

RECOMMENDED POLICY APPROACHES FOR SEVERELY ERODING HILL COUNTRY

1. **Recommended policy approach for eroding land unsuitable for grazing**

   Desired outcome: Retirement or afforestation (with conditional harvesting) of the District's most severely eroding hill country (LUC VIII & some VII; 'targeted' land under the East Coast Forestry Project). Represents a fragmented and scattered 44,000 hectares.

   Recommended approach: Encouraging farmers to apply for ECFP subsidy through farm plans, with support & promotion by GDC. Ultimately farm plans could become mandatory for farms with 30-60% of total property-area having targeted land. Includes a recommended 10-20 year voluntary-to-mandatory transition period, along with the inclusion of 'significant' promotion and advocacy.

2. **Recommended policy approach for land requiring conservation farming**

   Desired outcome: Sustainable use of the District's severely eroding hill country that can continue to be used for pastoral grazing subject to an erosion control and management programme. May also include farms with pockets of eroding land unsuitable for grazing. Represents a fragmented and scattered 150,000 hectares.

   Recommended approach: Farm planning to ensure each farm applies erosion control & management that is appropriate to the needs of that farm. Ultimately farm plans could become mandatory, although this would depend on the achievement of predefined targets under an initial voluntary regime. A monitoring programme would be necessary to gauge whether or not targets are being met. Farm planning would be backed with education, incentives and other implementation assistance.

Figure 6.6: Recommended policy approaches for Gisborne's severely eroding hill country (adapted from Boffa Miskell, 2000a)

As a regional/district plan rule, continued pastoral use of severely eroding hill country would become conditional on the preparation and implementation of a farm plan. That is, farm plans would be a non-negotiable requirement for farmers with properties containing severely eroding land. Likewise, contents of a farm plan would state specifically how parts of the farm must be managed. Resistance to having a plan prepared, or failing to adequately implement a plan, would theoretically expose the farmer to potential prosecution under the RMA. However, at the time of writing, the Gisborne District Council had yet to suggest the adoption of any form of statutory farm planning. While they may still be considering such an option, they would need to obtain legal and technical opinion on what is essentially a unique application of the RMA (and farm planning). Likewise, strong justification would be necessary to pass any related rule through the public consultation process and Section 32 analysis.

6.11. MANAGING ON-FARM NATURAL AREAS

A wide variety of terms and phrases are used to describe the management or protection of on-farm natural areas (Blaschke, 2002). As discussed in Chapter 2, such areas are generally taken to include the unfarmed flora & fauna and their associated habitats (natural ecosystems) located on farm land. In practical terms, this may include wetlands, dunelands, tussock land, scrubland, shrubland, coastland, herb-fields, indigenous forest remnants, aquatic and riparian zones, and virtually any other significant natural area with a low value towards conventional production agriculture, but a high intrinsic, cultural, aesthetic, or conservation value.

Values, along with property rights, renders the protection/management of on-farm natural areas as a somewhat contentious issue. Farmers retain general management control over the majority of on-farm natural areas, while those seeking protection or active management may have considerably less control (if any). Hence, a farmer may choose to manage (or not manage at all) a natural area in a manner that may conflict with those who value such areas highly in a non-utilitarian way.

Farm plans have been endorsed as a mechanism for promoting sustainable management of on-farm natural areas (Boffa Miskell, 2000b; Kneebone *et al.*, 2000; MAC, 2000; Davis & Cocklin, 2001; Blaschke, 2002; Blaschke & Ngapo, 2002). Such plans could wholly target at the issue (single issue plans), or as recommended by Blaschke & Ngapo (2002), integrated as a component in multiple-issue farm plans.

Presently no regional authority uses a farm plan model that singularly targets the management of on-farm natural areas (although riparian plans and TRC's Comprehensive Farm Plans could be considered exceptions). However, as indicated by Blaschke & Ngapo (2002), all of the ten regional councils with a farm plan service apparently afford a high priority to the consideration of this issue during farm plan preparation. Indeed, as discussed in the previous section, most farm plan models are readily amendable to the inclusion of any alternative issues on a farm-by-farm basis. Typically, however, the protection/management of on-farm natural areas is likely to receive secondary or incidental consideration relative to primary issues, particularly with the application of more traditional farm plan models.

Key exceptions include Bay of Plenty environmental programmes, and in a slightly different way, the checklist-based farm plans of Canterbury and Otago (and perhaps Nelson property plans if they were ever implemented). Canterbury's environmental checklist includes three specific questions of relevance, while the Enviro-Ag 'master list' indirectly associates the management of on-farm natural areas with farm activities. EnvBoP's Environmental Programmes are touted as the most befitting (Blaschke, 2002; Blaschke & Ngapo, 2002), as they are expressly designed to target *indigenous biodiversity* (and the related management of *plant & animal pests*) as a primary farm plan component. Various examples of riparian plans could also be interpreted as targeting a specific part of on-farm natural area management, particularly with plans that explicitly seek to protect, enhance or restore natural riparian and aquatic ecosystems.

Interest and effort towards protecting or managing on-farm natural areas appears to be gradually increasing in New Zealand. If farm planning continues to evolve in tandem, then it is likely that other farm plan models will emerge with a primary emphasis on the issue of on-farm natural areas. Blaschke (2002) recommends a more direct intervention, as a critical review of contemporary farm plans (as they relate to the on-farm natural areas issue) as a basis for future development or guidance of 'farm plans for biodiversity-friendly farming and forestry' (p.44).

6.12. AGRICULTURAL IMPACTS ON WATER QUALITY

Although Blaschke & Ngapo (2002) link into the issue of 'agricultural impacts on water-quality' from a dairy farming perspective, an earlier review undertaken by Gibbs & Schofield (1997) looked at the issue from multiple farming perspectives. This earlier review was undertaken to provide RM authorities with background information on policy approaches considered suitable for reducing water-quality impacts associated with agricultural runoff. Farm plans were nominated as one of several 'main methods' for promoting voluntary adoption of appropriate land management practices.

Farm plans were classically defined as a guide for farmers 'to manage their properties on an environmentally sustainable basis', and as "statements of intent… developed around the farmers' goals, with the objective of adopting sustainable land management practices" (*ibid.* p.22). A generic six-step model was put forward for the preparation of a farm plan (Figure 6.7), and Bay of Plenty's former *environmental plans* and Taranaki's riparian plans were discussed as examples. It was claimed that farm plans induce voluntary change through farmers having to distinguish the 'important relationship between goals and resources' (p.23), thereby apparently motivating them to change through increased awareness.

1. Prepare a 'property inventory to indicate the state of on-farm resources (incl. water quality).
2. Identify personal goals, and goals for the farm.
3. Identify problems - what is constraining the farmer from achieving his/her goals?
4. Identify options - such as better resource use.
5. Prepare an implementation schedule.
6. Formulate a means to evaluate and monitor progress.

Figure 6.7: Suggested steps for the preparation of a farm plan (Gibbs & Schofield, 1997).

6.13. FARM PLANS AS A SOURCE OF INFORMATION & INVOLVMENT OF CENTRAL GOVERNMENT

Bradshaw & Williams (1998) interviewed North Island hill country farmers to identify information and communication needs to assist in the adoption of sustainable land management (a study commissioned by MAF and MfE). Farm plans were identified as a source of 'good site-specific information that could encourage and assist [farmers] to adopt more long term farming practices' (p.25). In particular, the farm plan process (including the site visit and subsequent one-to-one discussions) was regarded as means for farmers to gain an increased understanding of their land resources, and an opportunity to discuss (and perhaps debate) practical options for sustainable land management.

Many of the farmers involved in the study considered that their regional councils (Taranaki, Manawatu-Wanganui, Wellington, Hawkes Bay and Gisborne) were returning to pre-1991 approaches to soil conservation, including farm planning, free local advice, and incentives (in most cases). Having reviewed farm plan development over this period, the author agrees that this trend occurred, although Wellington is a prominent exception. Along with more recent increases in the use of incentives (Chapter 2) and a renewed emphasis on whole-catchment based approaches, it appears the trend is continuing (albeit with a focus on multiple issues other than just soil and water conservation).

The study recommended that central government provide greater support for farm planning initiatives. In regard to soil conservation, this was later taken-up by MfE and MAF in their draft *Hill Country Action Plan* (MfE & MAF, 1999). This Plan represents an ambitious but commendable intention to tackle New Zealand's ongoing erosion problem in a 'serious' and meaningful manner. The stated vision of the Plan was for 'all hill country land to be managed within its capability to withstand erosion by 2050' (p.6). A timetable and set of actions was put forward to achieve this vision.

Farm plans were acknowledged as a voluntary mechanism linked to education and information provision, and were described as 'a well recognised means of initiating and implementing soil conservation' (p.16). Five possible methods were put forward to encourage the uptake and adoption of farm plans, some of which are quite novel (Figure 6.8). A particular emphasis was to encourage a greater involvement from industry, such as advocating to banks and insurance companies the 'desirability of farmers having an environmental farm plan which demonstrates how they propose to manage the environmental aspects of their farm business' (p.18). Quality assurance systems were also to be promoted, and the suggestion was made that consultants and other experts should have a greater involvement in farm planning processes to 'ensure that environmental information is integrated with the production system, and that the benefits of land use change are highlighted as far as possible' (p.21-22).

Methods for encouraging farm plan uptake

1. Provide rates relief for a farm plan
2. Have a consultant help prepare the plan
3. Recognise farm plans in the farm valuation process
4. Provide subsides for farm plan works
5. Recognise accredited or otherwise certified registered farm plans for marketing or market access purposes

Figure 6.8: Methods for encouraging farm plan uptake (MfE & MAF, 1999).

This would involve the design and application of a constituent *communications plan* (*i.e.* a sub-plan within the Action Plan), with its own aim of 'motivating farmers… to incorporate land use capability information into their farm planning' (p.21). Implementation would involve supporting regional authorities' in their farm plan initiatives, and would extend beyond soil erosion to include the promotion of biodiversity and riparian management.

Although representing a meaningful and focused response to the national erosion problem, the Action Plan was never formalised into government policy. Rather, political priorities appear to have shifted across onto the issues of water quality and biodiversity, thereby continuing the Government's post-1988 'hands-off' and *ad hoc* approach to the national coordination of soil conservation activities.

6.14. INDUSTRY-LED FARM PLANNING

Monitoring the standards of goods & services as a means to provide an assurance of quality to customers is a long-standing feature of industrialised society (Morriss *et al.*, 1998). In New Zealand, this concept has increasingly been applied to farming systems since the 1980s, ultimately as a way of demonstrating product ***and*** production quality towards the protection or enhancement of market access. Various frameworks have been developed for different agricultural sectors, which are generically referred to as Quality Assurance Programmes (QAPs) or Environmental Management Systems (EMSs). An EMS is differentiated by focusing on market access threats arising from environmental impacts associated with the farm system or process of production.

Morriss *et al.* (1998) regard an EMS framework as having five structural elements (Figure 6.9). Many of these elements suggest a strong similarity with environmental farm plans, although key differences are apparent. Firstly, an EMS emphasises a continuous planning cycle, which is less evident with some types of environmental farm planning (*i.e.* farm planning without a strong and consistent monitoring and follow-up programme). Secondly, environmental farm planning is driven by resource management for the public good (under the RMA), while an EMS is generally driven by industry good and individual benefit. Thirdly, with an EMS there is no need to dissociate environmental planning from other types of farm planning. This is particularly evident with comprehensive EMSs that exhibit an unbiased emphasis on both business and environmental planning (*e.g.* Australian Property Management Planning, Ontario Farm Plans).

CONTENT OF AN EMS

1. Environmental policy.
2. Planning.
3. Implementation & operation.
4. Checking & corrective action.
5. Management review.

Figure 6.9: General content of an EMS (Morriss et al., 1998).

Blaschke & Ngapo (2002) list nine various QAP and EMS models, and discuss several as they relate to environmental farm planning. Excluding the Enviro-Ag programme (which has been discussed), those with the greatest relevance to conventional pastoral farming and farm planning are briefly discussed below. For more detailed discussion the reader is referred to Blaschke & Ngapo (2002). Additionally, New Zealand's growing organics industry also have their own distinctive range of QAPs and EMSs, some of which accommodate pastoral farming through farm-plan based evaluation and accreditation processes. As an example, to attain *BIO-GRO New Zealand* organic certification for livestock farming, a farmer is required to prepare a Livestock Plan and a Soil Management Plan (Bio-Gro, 2001).

Market Focused is the dairy industry's supported EMS. It comprises two modules, although the second module is not yet available. Module One is described as a 'starting point' for better environmental management (according to industry policy and guidelines), and involves a farmer working through a 33-page folder more-or-less independently, to evaluate ten on-farm environmental issues according to predefined templates. A preference for self auditing is suggested, although the Module is designed for third party audits if necessary. Preparation of a farm map is recommended (depicting effluent, fertiliser, pest control, and chemical use patterns), although the example given is crude, and does not suggest planned works or changes. Blaschke & Ngapo (2002) recommend a greater emphasis on developing the mapping component to improve the package. Module Two is claimed to be a more critical and comprehensive identification and analysis of individual farm environmental issues that can be used to gain full international accreditation status.

The ***Deer QA On-Farm Programme*** is part of the deer industry's greater quality assurance programme. The greater programme emphasises quality assurance throughout the entire 'pasture to plate' chain. The on-farm component stipulates standards strongly orientated towards animal health & welfare, food safety and public perception (as suggested by NZGIB, 1998). Environmental management appears to be underrepresented, although the industry is investing in research towards the development of an environmentally orientated *Landcare Manual* (Paterson, 2002a). A likely recommendation will be for the mapping of deer farms according to 'land use risks'. These would be inferred by the farmer into zones of low, medium and high environmental risk, and linked with 'best management practices' in an accompanying Land Management Plan (Paterson, 2002b). As of mid-2002, approximately 44% of deer farmers were registered and accredited within the On-Farm Programme (Loza, 2002).

The meat and wool sector's ***Green Project*** was initiated in 2001 as a 3-year pilot, aimed at developing a minimum voluntary standard for 'sustainable production' on sheep, beef, deer and goat farms (Mackay *et al.*, 2002). Fifty North Island farmers have so far collaborated, each of which developed their own QAP based on an Animal Management Plan (stock management, health & welfare plan developed in conjunction with a veterinarian), Land and Environment Management Plan (essentially an EMS developed in conjunction with an 'industry professional' such as a regional council officer), and a Social Responsibility Plan (staff training, involvement in the local community, etc.). Third-party accreditation is based on farmers demonstrating progress towards achieving standards/objectives, and international accreditation is currently being sought through Standards New Zealand.

The Land and Environment Management (LEM) plan is a standalone environmental farm plan in its own right, and is prepared according to principals common to the Soils Underpinning Business Success programme (see next chapter). This includes an acknowledged 'land resource specialist' assisting the farmer in the preparation of a land resource map (based on soils and Land Use Capability); the identification of distinguishing land qualities, in conjunction with an evaluation of land use opportunities and limitations (via SWOT analysis); and the preparation of a time-bound and measurable 'action plan' (essentially a schedule and works programme). This entire plan is subject to approval by the land resource specialist. Accreditation is based on the farmer making significant progress towards achieving a combination of predefined standards for major issues, and farm-particular standards for less contentious issues (Table 6.18). Standards also define minimum entry standards.

ISSUES	*PROGRESS STANDARDS*	*ENTRY STANDARDS*
Soil health		
∴ Erosion	50% in 5yrs; 80% in 10yrs; 100% in 15yrs	10%
∴ Chemical use	Farm-by-farm	Test
∴ Nutrient balance; contaminated sites; physical health	Farm-by-farm	Farm-by-farm
Water Quality		
∴ Stream protection	50% in 5yrs; 80% in 10yrs; 100% in 15yrs	10%
∴ Non-point contamination	50% in 5yrs; 80% in 10yrs; 100% in 15yrs	10%
∴ Water supply; fertiliser use; point source contamination	Farm-by-farm	Farm-by-farm
Animal welfare		
∴ Shade & shelter	50% in 5yrs; 80% in 10yrs; 100% in 15yrs	10%
Forage		
∴ Pests; legume content; chemical use	Farm-by-farm	Farm-by-farm
Biodiversity		
∴ Indigenous flora & fauna	50% in 5yrs; 80% in 10yrs; 100% in 15yrs	10%
∴ Wetlands; vista	Farm-by-farm	Farm-by-farm
Biosecurity		
∴ Animal pests; plant pests; TB	Farm-by-farm	Farm-by-farm
Greenhouse gases		
∴ Budget	Farm-by-farm	Farm-by-farm

Table 6.18: Green Project entry and accreditation standards (adapted from Mackay et al., 2002).

On a national basis, essentially all agricultural sectors are now represented by a their own respective QAP/EMS models, although many are still being developed or have limited support from the farmers they target. Lack of widespread support (and in some cases a lack of official support from industry) may be attributed to the common reasons why farmers continue to resist environmentally related initiatives (see Rauniyar & Parker, 1998; Rhodes *et al.*, 2000), or it may be linked with the following EMS-particular difficulties:

1. Adoption of a meaningful EMS requires an initial investment of time and money, followed by a long term commitment and ongoing investment (monitoring, reviews and perhaps auditing). The level of commitment and investment can be considerable, particularly if it detracts from other farming activities, or represents an increased farmer workload.

2. In major agricultural sectors (namely meat and dairy), there may be little guarantee that adoption of an EMS will result in increased returns through premiums or preferred supply. Either actual market restrictions don't yet exist (although the threat of such restrictions may be long standing); restrictions are minor; appropriately discerning markets are currently too small; or in combination with these factors, processing and marketing companies may exhibit limited support of EMSs. While the potential benefits of EMS may be high, in some sectors they have yet to be fully expressed.

3. In being an exercise of monitoring and recording, an EMS tends to involve a comparatively high rate of paper-work, office time, and/or data entry (*cf.* to not having an EMS). As many farmers tend to exhibit informal rather than formal management styles (see Chapter 3), the possibility of having to spend more 'time in the office' may discourage some farmers.

4. Proactive and successful application of EMSs demonstrates that farmers can account for environmental impact and achieve SLM without assistance from central and local government. Arguments that farmers are faced with 'constraints' or 'impediments' become redundant. Authorities may use this as a justification for imposing greater widespread controls on resource management ***before*** the market benefits of EMSs are fully realised.

Despite these difficulties, EMSs are recognised as having one key advantage over environmental farm plans. They are designed for industry good, which is a feature that is more likely to encourage farmer buy-in and ownership of environmental management. For this reason, several regional authorities endorse stronger links between environmental farm plans and EMS initiatives (see Section 6.5.8), and many are involved in the development or application of EMS models. Indeed, Otago RC has been instrumental in the development of EMS-based Enviro-Ag farm plans, while development of the meat sector's *Green Project* has relied on support and contribution from several North Island councils. Further, some councils are now acknowledging EMSs and QAPs in their regional plans (*e.g.* Otago and Bay of Plenty).

Following the existing trends of increased market and public control over land-based production systems, it is feasible to suggest that demand for both EMS and environmental farm plans will increase in the future. With greater links between industry and RM authorities, it is possible that both will be increasingly applied as integrated or complementary models (it makes little sense for a farm to have two or more non-integrated plans/programmes with overlapping purposes). One option is for councils to undertake the assessment and planning of farm resource management as a component of an EMS (*i.e.* essentially the preparation of an environmental farm plan according to a complementary model), similar in concept to the LEM plan used in the Green Project.

GENERAL DISCUSSION & CONCLUSIONS

In its broadest sense, farm planning describes the managerial activity of formulating a program for a definite course of action. In resource management terms, it is commonly used to describe an activity undertaken primarily by council officers, almost invariably for the purpose of promoting sustainable or environmental management on a farm-by-farm basis. The resultant 'farm plan' represents a documented assessment of one or many farm-specific SLM issues, and will generally put forth recommended actions and works considered necessary for addressing those issues over an extended period.

6.15. FARM PLANNING CATEGORIES

While the description given above may hold true for traditional farm plans, significant advances in the design and application of farm planning over the past 12-15 years has resulted in the emergence of a wide variety of farm plan models, such that the distinction of what constitutes a 'farm plan' has become less clear. At least four upper-hierarchy categories can now be distinguished, although it is acknowledged that many overlap:

1. **Business plans & farm policy**: This category simply acknowledges that farm planning is a fundamental component of farm management, and can be undertaken without necessarily emphasizing environmental considerations (*e.g.* business planning and budgeting, land or farm improvement planning, production or enterprise planning, and the design of policies relating to stock, fertiliser, feed budgeting, etc.).

2. **Environmental farm plans**: Any type of farm planning undertaken with an emphasis on environmental management, most commonly undertaken by, or in collaboration with, a regional authority. Types of environmental farm plans are discussed below.

3. **Whole-farm plans**: A form of farm planning that seeks to attain an equal emphasis on business, production and environmental planning. While being widely applied on a consistent basis overseas (namely in Australia and Canada), true whole-farm planning is quite rare in New Zealand. Some of the pilot farm plans described in the preceding chapter may fall into this category. Likewise, environmental farm plans that seek to 'match land use with land capability' sometimes claim this distinction, but in being council-prepared plans they are constrained to an environmental emphasis by default.

4. **Quality Assurance Programmes and Environmental Management Systems**: While QAPs and EMSs may span other categories, they are distinguished as industry-driven initiatives based on predefined product and production standards, and continual monitoring to demonstrate that those standards are achieved.

6.16. ENVIRONMENTAL FARM PLANS

The focus of this chapter has been on environmental farm planning undertaken by regional authorities. For the period between 2001/2002, eight of New Zealand's 16 regional authorities provided some form of environmental farm planning service to farmers. For the eight who did not, most suggested that they would like to provide a farm planning service if they had appropriate resourcing, and at least three councils were looking to develop their own farm plan programmes. By early 2003, one council had devolved their farm planning programme to independent interests (but continued to promote it), and another two had adopted some type of farm planning service.

The principal disadvantage and reason for not having a farm planning service is a high investment of staff time (which can range from one day through to three weeks) and monetary cost (ranging from $600-$7000/plan). Other disadvantages are numerous, but these appear to be offset somewhat by a broad range of advantages, particularly in regard to one-to-one interaction between farmers and council staff, and an individual property focus that allows farm-particular SLM issues and situations to be assessed and accommodated on a farm-by-farm basis.

Prior to 1988, farm plans were more-or-less prepared according to a standardised model required by a national administrative body. Since this period, around 1200-1450 new environmental farm plans have been prepared in New Zealand (this does not include ongoing updates of pre-1991 farm plans), generally without any significant national coordination or guidance. This has allowed the independent development of a possible 23 council-particular environmental farm plan models, either as refinements to traditional models, or as completely new designs and approaches.

Environmental farm plans are differentiated by the type of issue they target (riparian, conservation, etc.); their issue scope (primary, primary + secondary, or multiple issue plans); targeted farming type, degree of comprehensiveness, structural framework and content (traditional, checklist-based, multi-report, single component); method of issue assessment (by farmer, council on-site assessment, council farm survey & evaluation); and the manner in which they are prepared (DIY, workshop/groups, traditional technical service). Any combination of these factors can be used to categorise or classify modern farm plans into general types[3], but a more consistent method would be to choose a single factor. Using issue scope as an example:

1. **Primary issue farm plans**: Environmental farm plans that target singular SLM issues. Examples include riparian plans (or riparian management plans, wetland enhancement plans), soil conservation plans (or erosion control plans), and shelterbelt or windbreak plans. Primary issue plans may indirectly or implicitly accommodate closely related issues.
2. **Primary + secondary issue farm plans**: Plans that emphasize a primary issue (typically soil erosion), along with a secondary consideration of other issues (*i.e.* not to the same depth or degree of evaluation), such as biodiversity, pests, wetlands or soil health.
3. **Multiple issue farm plans**: Plans that give a balanced emphasis to more than one issue. Examples include EnvBoP's Environmental Programmes, ECan's Resource Assessments, and Enviro-Ag. Environmental Programmes are in a subclass of their own, while the other two are characterised as environmental checklists.

Environmental farm planning in New Zealand still appears to orientate towards traditional approaches, with a particular emphasis on soil conservation, hill country farming, and plan preparation by a council officer as a technical service. However, this orientation appears to be gradually decreasing. Today, all but two of the nine councils have a farm plan model that can accommodate lowland-intensive farming types (shelter plans, riparian plans, and/or land use independent/generic plans), and at least three councils provide one or more 'Do It Yourself' types of farm plans (including Manawatu-Wanganui). Likewise, many farm plan programmes are seeking to accommodate a greater range of contemporary SLM issues, although this has the potential to result in overtly comprehensive farm plans. Councils have sought to accommodate overt comprehensiveness by evaluating many issues on a secondary basis (*i.e.* not to the same degree as the primary issue); having a series of farm plan models for singular issues; seeking improved conciseness; and through the use of environmental checklists.

[3] As an example, Blaschke & Ngapo (2002) use a combination of factors to describe general types of environmental farm plan. They categorise farm plans as traditional farm plans (based on traditional issues and farm planning methods); soil-based environmental farm plans (describing farm plans that use soil survey as a basis for issue assessment & evaluation); forestry-orientated environmental farm plans (based on a predefined framework); riparian plans (issue based); and comprehensive farm plans (defined by their high degree of comprehensiveness).

Most comprehensive farm plans include at least four fundamental components: a farm description; an issue assessment & description; a programme of works or actions; and one or more maps. While the works programme and map is ultimately the most important (it defines the 'plan' part of 'farm plan'), other components are important for justifying and demonstrating the rationale behind any forthcoming recommendations.

Methods of evaluating on-farm SLM issues include farmer assessments; council officer on-site assessments; and council officer farm resource surveys. Subjective on-site assessments appear to dominate, particularly in regard to moderately comprehensive farm plans (riparian, shelterbelts, etc.). Only three councils regularly undertake farm surveys. In being empirically scientific, such surveys should convey a comparatively high degree of confidence in any forthcoming recommendations. Further, in describing resource characteristics, a survey can be used to credibly infer issue risks and potentials (see Chapter 3). While this feature is still very much confined to the identification of erosion susceptibility and production potentials (namely as site indexes and carrying capacities), there is considerable scope to account for the potentials of other SLM issues (*e.g.* pugging vulnerability, leaching potential, runoff potential).

Another opportunity for farm planning is the development of complementary Land Information Systems, particularly as they relate to monitoring/recording, expediting the farm planning process, and more effective information management. Several regional authorities expressed an interest in developing an LIS, but were constrained by the cost of necessary technology. TRC is the only authority consistently using a LIS for farm planning. While extensive coverage of farm-scale LRI/LUC may exist in New Zealand, the limited development of LISs means that much of this resource information is not easily accessed, which inhibits its value and utility as a collective information source.

Taking a long term view, farm planning is likely to become more widespread and diverse in New Zealand if existing trends continue. Likewise, the interest of central government in farm plans appears to be growing, but to date their involvement continues to be very indirect. Future developments in farm planning are likely to include a greater emphasis on lowland-intensive farming types and a wider breadth of SLM issues. It would also make sense for environmental farm plans to evolve in a way that is complementary to the growth of QAPs and EMSs.

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Chapter 7

EVALUATION OF THE SOILS UNDERPINNING BUSINESS SUCCESS PROGRAMME

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INTRODUCTION

Soils Underpinning Business Success (SUBS) is an education programme that aims to assist farmers in the collection and use of soil information, ultimately to help progress farm sustainability (i.e. in economic **and** environmental terms). The programme was first piloted in 1998 as a research project, and has since been applied by eleven different farmer groups distributed throughout the lower North Island (along with being partially included in several other extension initiatives). It has been designed specifically to overcome constraints to a greater use of land resource information in farm management, with a balanced emphasis on improved production and environmental outcomes (Mackay, 1999a; McIntosh *et al.*, 1999; Mackay *et al.*, 2000a; Mackay *et al.*, 2000b).

The SUBS programme is continually evolving. Part of this stems from the diversity exhibited by different farmer groups (*e.g.* group differences in farming situations, environments, farmer expectations and abilities), which necessitates subtle variations and adaptations each time the programme is applied. Likewise, in being a recent and somewhat novel initiative (*cf.* traditional methods of collecting and using soil information), new procedures, tools, and ideas are continually being advanced and tested through application.

Along with development, promoting the wider extension of SUBS has been constrained by general difficulties that seem to characterise sustainability orientated education programmes. Difficulties include: intangible outcomes that are too difficult to measure; extended time-lags between application and results (latency); and the difficulty of crediting any given farm management change to a single factor or influence (*i.e.* there are often factors unrelated to a programme that will induce or influence change).

This study has two related purposes. Firstly, it seeks to identify opportunities for improving the content and application of the SUBS programme, and secondly, to gauge the effectiveness of SUBS in terms of recognised benefits, outcomes, and ongoing farmer development. While some of these considerations have been included in previous studies, none have sought a single collective response from the majority of farmers who have been involved in the SUBS programme to date (as of August 2003).

This chapter provides a brief background review to the evolution and application of SUBS, and reports on a mail survey that targeted all farmers who have been through the SUBS programme.

REVIEW: SOILS UNDERPINNING BUSINESS SUCCESS

SUBS is an education programme that aims to assist farmers in the collection and use of soil information as it applies to their own respective farms. It was initiated as a pilot project in 1998, and has since expanded as a package with clearly defined objectives; a practical land evaluation framework designed for NZ farming conditions; and a stepwise process whereby scientists and other specialists guide a group of farmers through a series of survey, evaluation, and planning modules.

7.2. ORIGINS & DEVELOPMENT

The conceptual basis of SUBS originated from the Sustainable Land Management Project (SLMP). This research study ran over three-years, and used a community group approach to explore sustainable land management issues as they applied to two contrasting sheep and beef farms (see Chapter 5; Section 5.5.4). The collection and use of land-resource (LR) information to promote farm sustainability was a particular feature, and resulted in two critical study outcomes that would eventually inspire the SUBS programme:

1. Constraints to a greater use of LR information in farm decision-making were formally recognised as part of the study's key findings. Constraints included: the high cost of collecting new LR information; a need to upskill farmers about their property's soils; and a need to package soil information in an understandable and useable form (Mackay *et al.*, 1999c; Rhodes *et al.*, 1999).

2. The concept of Land Management Units (LMUs) was developed as 'a method for collecting and interpreting land resource information on a paddock-scale, in a form that can be used by farmers for decision-making' (Mackay *et al.*, 1999c, p.8).

The LMU concept was suggested as a means to overcome many of the constraints, and was thus deemed important for further development and extension. Initial uncertainty as to how this could be achieved[1] was resolved through a pilot project in 1998, whereby the feasibility of individual farmers producing and using their own soil maps was tested (Mackay, 1999a; Mackay, 1999b; Rhodes *et al.*, 1999; Mackay *et al.*, 2000). This involved a group of eight farmers, an agricultural consultant, soil specialists, and land-use experts, working together over a 12-month period as the *Dannevirke Land Resource Assessment Group*.

Interim results were positive (Rhodes *et al.*, 1999), and paved the way for the establishment of a second group in late 1999 (McIntosh *et al.*, 1999). The *Wanganui SUBS Group* was an offshoot from the *Wanganui Hill Country SLM Group* (an unrelated initiative), involving nine farmers over a similar 12-month period. This was the first time the title 'Soils Underpinning Business Success' was used to describe the programme as a complete education and training package.

[1] Two student groups explored some of the options for extension and development as part of a 300 level capstone paper in 1998 (Redward *et al*, 1998; Brown *et al.*, 1998).

Whereas the Dannevirke group is credited with developing the SUBS package, it is through the Wanganui group that SUBS was refined (Mackay *et al.*, 2000) and vindicated as a credible programme (*i.e.* the second group demonstrated that the complete process could be successfully repeated with a new group from a different farming environment). Part of this refinement involved the establishment of clear objectives (Figure 7.1).

After two-years of testing and refinement, coupled with increasing interest from farmers and SLM concerned organisations (*e.g.* regional authorities), the SUBS programme entered into an extension phase. This is marked by the Manawatu-Wanganui Regional Council adopting and incorporating SUBS into its SLM programme (on a preliminary basis); the involvement of Wellington Regional Council; and the procurement of substantial funding to support a further 8-10 new groups. Collectively, these are known as the *Southern North Island Soils Awareness Groups* (SNISA Groups).

OBJECTIVES OF SUBS

The objective of the SUBS package is to provide the landowner with skills to:

- Describe & map the soils of their farm.
- Link the properties of the soils to their behaviour and responses to management.
- Catalogue the strengths & weaknesses of soils and identify opportunities.
- Assess the contribution each soil makes to the farm business.
- Assess the current use of resources, including the current match of enterprises with the soil resources on-farm.
- Determine in a more structured way, the use of capital (e.g. fertiliser, drainage, etc.).

Figure 7.1: Objectives of the SUBS programme (McIntosh et al., 2000).

As of August 2003, a total of seven SNISA Groups have been completed, and a further three are currently in operation (Table 7.1). Not shown are a further 2-3 east coast SUBS groups initiated from Dannevirke, and other programmes that have used and adapted SUBS principles. Group sizes were intentionally increased to test optimal levels of farmer-to-trainer ratios, although some of the smaller group sizes shown in Table 7.1 reflect a variable degree of interest from different farming areas and types of land use. Optimal group size is now generally accepted as 8-10 farmers per programme. A preliminary extension manual has also been developed, initially in response to an expression of interest from the Auckland Regional Council (Chapter 8).

SUBS group name	Operational date	Group size*	Primary purpose
Dannevirke Land Resource Assessment Group	1998-1999	8	*Development & refinement*
Wanganui SUBS Group	1999-2000	9	
Sand Country SUBS Group	2001-2002	10	*Application & extension*
Taihape Hill Country SUBS Group	2001-2002	13	
Tararua (Hill Country) SUBS Group	2001-2002	11	
Tararua Dairy SUBS Group	2002-2003	8	
Manawatu Dairy SUBS Group	2002-2003	5	
Raetihi SUBS Group	2002-2003	8	
Taumarunui SUBS Group	2002-2003	6	
Northern Wairarapa Hill Country SUBS Group	2002-	?	
Southern Wairarapa Hill Country SUBS Group	2002-	?	
Wairarapa Plains SUBS Group	2002-	?	

* Number of farmers included in a group. Taken from contact lists provided by group organisers.

Table 7.1: SUBS groups between 1998 & 2003.

7.3. THE PACKAGE & PROGRAMME

Chapter 8 describes the mechanics of the SUBS programme in detail as *A Guide to the Application of Soils Underpinning Business Success* (Section 8.9). Three of the structural and procedural characteristics of SUBS are summarised here to provide the reader with a perfunctory background.

7.3.1.1 Group makeup and roles

A SUBS group is made-up of several farmers as trainees (ideally between 8-10 farmers), and at least three specialists who provide training and group facilitation according to their respective disciplines. Specialists include:

Land resource expert: Usually a pedologist who attends the first six meetings, and is responsible for training farmers in soil mapping and soil description.

Farm management consultant: Usually a commercial consultant who provides advice on farm production and management, and demonstrates the economic impact of any production/management change associated with the land evaluation component of the programme. May be responsible for group organisation and facilitation.

Regional council officer: Primary role is to provide advice and training on sustainable land management and environmental management. May be responsible for group organisation and facilitation, and usually provides complementary support to the land resource expert (particularly between meetings).

Earlier groups also included a 'land use scientist' with skills in agronomy, pedology, land evaluation, and farm management. Overall responsibility for group coordination and facilitation has alternated between the consultant and the regional council officer.

7.3.1.2 Programme and meeting structure

A SUBS programme is run over one complete year, with meetings held once-per-month on different farm properties. This equates to a standard number of twelve meetings, to allow all properties to be visited (8-10 meetings); at least one property to be visited twice for a field day; and 1-2 meetings for a preliminary set-up or post-programme follow-up (which may be held at a more convenient location such as a community hall).

The first meeting may involve an introduction and overview of the entire programme. The final meeting represents a field day, whereby the SUBS farmers demonstrate to the wider farming community what they have learned and gained from the programme (the underlying purpose is to stimulate new interest in forming another SUBS group). The meetings in-between follow a predefined structure of progress reporting, technical presentation, and a combined farm tour with field exercises.

Progress reporting: Individual farmers give a brief report to the group at the start of each meeting, to explain how they have progressed since the previous meeting, and to outline any difficulties that may have been encountered. Trainers can offer advice or encouragement, and may choose to recover previous material if there is a common difficulty.

Technical presentation: A specialist will present the main training theme of a meeting. This may involve an outline of principles (*e.g.* landscape evolution, soil formation), and an introduction of the related land evaluation step (as a module) that will later be demonstrated and reinforced with an in-the-field example.

Farm tour: A tour of the farm to expose the group's farmers to different soils and alternative methods of using or managing similar soils; to undertake in-the-field demonstrations; and to promote land use/management discussion, debate, and professional input from farmers.

Each farmer is expected to apply what they learn to their own respective properties, in-between meetings. This is sometimes expressed as *set tasks*, to ensure all farmers progress at the same rate (*i.e.* farmers should collectively finish a given module before moving onto the next).

7.3.1.3 Land evaluation framework and training modules

Steps used in the SUBS land evaluation framework are suggested by the underlying objectives (previous Figure 7.1), which can be reinterpreted as *survey → interpretation → modelling & planning* (*i.e.* comprehensive land evaluation). Within the SUBS programme, the framework has been described as having three 'phases' (Figure 7.2), and occasionally with a fourth phase to represent the field-day (*e.g.* McIntosh *et al.*, 1999). Each phase has its own respective training modules.

Phase 1: Made up of three modules (landform mapping module; soil mapping module; and a soil description module). Farmers are guided through the mapping of preliminary units (based on landform, parent material and topography), which are then refined into soil units through instruction on soil-landscape relations and soil-profile description. Farmers are provided with detailed aerial photos (1:5,000 to 1:10,000), and draft maps are digitised to provide distance & area information, and to improve final map presentation.

Phase 2: A 'strengths & weaknesses' module allows the first phase to blend into the second. This involves farmers preparing a list of positive and negative attributes (as they relate to production) for each soil. In turn, soils that have similar strengths & weaknesses are grouped and then considered against practical management factors (*e.g.* unit size, infrastructure, strategic value, access, etc.) to derive Land Management Units (LMUs). This LMU module also involves farmers compiling a list of land use/management opportunities and constraints for each LMU identified. The collective experience & expertise of the entire group is utilised during this phase.

Phase 3: This phase includes optional or demonstration modules concerning enterprise evaluation and planning, and may be tailored to suit the requirements of individual groups. A demonstration is usually preferred, as this phase begins to overlap with commercial production-analysis and planning. Past demonstrations have focused on identifying and modelling alternative 'whole-farm' scenarios (based on LMUs), and an evaluation of economic feasibility. The group collectively agrees on which farm will undergo the evaluation – other farmers are encouraged to engage an external service provider (independently) for the same purpose.

Figure 7.2: Three phases of land evaluation used in the SUBS programme (adapted from Mackay, 1999a & McIntosh et al., 1999).

7.4. OUTCOMES & PROGRAMME EFFECTIVENESS

Effectiveness is determined by a given programme's original purpose – if the purpose is achieved, then the programme can be deemed effective (it has successfully effected the desired outcome). SUBS has very clear objectives that relate closely to the modular steps used within its land evaluation framework. Hence, to be effective, farmers simply need to have completed each step in the programme. This has happened with the majority of SUBS farmers, which means that SUBS is an effective training programme.

However, SUBS has an implicit purpose to promote farm sustainability. This is suggested in most related publications, which in various ways emphasize the importance of reconciling a need for increased farm profitability, against a need for greater environmental accountability (usually emphasised as a background justification for the SUBS programme).

Whether or not SUBS has actually promoted farm sustainability is difficult to evaluate. Not only is it difficult to separate the influence of SUBS from other day-to-day farm management influences (particularly with the 12-month duration), but there may be an extended period of latency between learning and application, and a delay between any application and the final result. Put simply, change takes time, particularly if it involves a significant paradigm shift, and/or a redesign of the farming system. These and other problems are common to many other sustainability orientated programmes in general (Nimmo-Bell, 1999).

Despite these problems, there is considerable supporting evidence to show that SUBS has contributed to or initiated improvements in farm sustainability, or induced changes that may eventually lead to improvements. These have been expressed as various benefits, strengths, and 'intangible outcomes' associated with the programme (Figure 7.3).

- A way to shortcut experiences.
- A more factual & objective way of knowing land capability.
- Greater awareness & understanding of soils & their behaviour.
- Increased appreciation of previously devalued areas & environmentally vulnerable areas.
- Increased confidence in making decisions concerning land.
- Broader appreciation & understanding of environmental issues.
- More receptive to (alternative) land use & issues.
- Enduring & transferable skills.
- Increased ability to use other farm management tools (*e.g.* nutrient budget software).
- Wider appreciation of some land use/management options for refined performance.
- Enabled focusing & prioritisation of inputs.
- Able to communicate with land resource professionals on a common level.

Figure 7.3: Benefits associated with the SUBS programme (rephrased from Mackay, 1999a; Mackay et al., 2000a & 2000b).

Most of these benefits have been expressed by farmers themselves, often during or directly after participation in a SUBS programme. Hence, they may not adequately reflect any longer-term benefits, and it is possible that an element of peer pressure may have influenced farmer responses (*e.g.* feeling obliged to respond positively in the presence of the trainers and other farmers). Farmers may respond differently outside of a group setting, and after a reasonable period of reflection.

SUBS SURVEY QUESTIONNAIRE

A mail survey questionnaire was used to target all farmers who had completed the SUBS programme as of August 2003. At least three other SUBS groups were operational at this time, but were not included because the farmers had not completed their programmes, nor had they had same amount of time to reflect on implementation and outcomes of the programme (relative to farmers who had completed the full SUBS programme).

Purpose of the study was to gauge farmer satisfaction with the SUBS process, and to identify outcomes that farmers themselves attribute to the programme. An indication of farmer satisfaction is important for future application and development of SUBS, particularly as it relates to positive stimulation (enjoyment) helpful for maintaining interest and commitment throughout a programme, and contentment that farmers' original reasons for becoming involved in the programme were fulfilled. Degree of farmer satisfaction or dissatisfaction can contribute to decisions regarding the future expansion of the programme. If farmers have been distinctively dissatisfied, then the continuation of limited programmes may be advisable to allow further refining the SUBS package. Conversely, high satisfaction indicates the that the package is suitable for wider application. Degree of satisfaction with different components of the programme can also be used to identify how the package can be improved.

Outcomes attributable to the programme have been evaluated previously (Mackay, 1999a; Mackay et al., 2000a & 2000b), but either during or directly after a SUBs programme. Elements of group peer-pressure may have had an influence on responses (*e.g.* fœling obliged to respond positively in the presence of trainers and peers), and longer-term outcomes may not have become apparent until the programme had been finished for a longer duration. Additionally, published accounts of outcomes attributed to SUBS technically apply only to the group that was being reported (unless otherwise stated), rather than all SUBS farmers as a collective sample.

It is therefore proposed that an improved indication of SUBS outcomes can be achieved through an evaluation undertaken outside the group setting, after a longer period of reflection, and through the inclusion of all post-SUBS farmers together at one time. As with farmer satisfaction, a clearer indication of what farmers got out of SUBS is important for the future development of the programme. It is also necessary for gauging effectiveness, which is critical for identifying the success of a given programme, and whether there is sufficient justification to merit its continuation (Patton, 1982).

7.5. METHOD

Familiarity with the SUBS programme was used in the design of a mail survey questionnaire targeting all farmers who completed the SUBS programme as of August 1st 2003 (9 of the 12 groups = 78 farmers). An appreciation of the SUBS process was gained through initial interviews with two of the core trainers (Drs A. Mackay and A. Palmer); passive involvement with two SUBS groups (Taihape Hill Country and Tararua SUBS Groups); and active participation as a trainer in a third group (Tararua Dairy SUBS Group).

Familiarity was helpful in designing relevant questions. Initially, a total of 106 questions were developed according to six categories (see below). Editing and elimination through comparison against recognised guidelines of mail survey questionnaire design (Erdos, 1983; de Vaus, 1995; Mangione, 1995; Leedy, 1997), resulted in a refinement down to 84 questions, then 63 questions. Refinement was important for ensuring a sound design, and for minimising the amount of time required of participants. This not only reduced costs slightly, but it was felt that a short questionnaire would encourage a greater response rate. Similarly, questions were designed to be as easy to answer as possible, to minimise the amount of time required for a complete questionnaire response.

Questions are ordered into six general categories (actual questions are presented as Appendix V), including:

Involvement in SUBS: Which group was the respondent involved with, and did they complete the programme?

General information: Background information concerning farm and farmer demographics. These questions were designed to be brief, impersonal, and easy to answer. Identifying 'the type of farmer' involved with SUBS was not an objective of this study.

Application of the SUBS programme: Questions designed to elicit if farmers were satisfied with the content and application of their respective programmes (thereby providing an insight into if and how the programme may be improved).

Benefits of SUBS: Mostly single scale questions whereby a respondent indicates how strongly he or she agrees or disagrees with a statement. Statements were taken from recognised benefits of the SUBS programme[2].

Was SUBS worthwhile?: A limited number of questions designed to indicate if farmers received any practical worth from their involvement with SUBS.

Beyond SUBS: Questions concerning independent farmer development or application of SUBS-related skills after the programme had completed.

7.5.1 CHOICE OF SURVEY METHOD

Reasons for choosing mail survey over phone or interview-based survey are both practical and technical, and have been derived from Erdos (1983) and Mangione (1995). Reasons include:

1. *The research sample is widely distributed geographically.* Each SUBS group was held in separate farming communities, fragmented across an estimated area of one million hectares (area between Wanganui, Takapau, Levin, Maowhango, and Pongaroa).

2. *The research budget was modest.* This study was funded by the author independently, who at the time definitely did not have a budget to cover toll calls or extensive travelling costs for phone or interview surveys.

3. *The research would benefit if participants had time to think about their answers.* A key component of the study is to encourage participants to reflect on their experiences with the SUBS programme, particularly in regard to thinking about outcomes, as these can be difficult to identify and isolate from other influences and experiences.

4. *Concise responses.* Interview responses can be unstructured, extended, and time consuming to analyse (Chapter 2). Closed questions used in mail survey are relatively quick and easy to collate and analyse. Similarly, open mail survey questions are constrained by the respondent's willingness to explain in writing (*cf.* unconstrained phone or interview responses). However, see limitations (Section 7.1.5).

5. *Participants had a moderate to high investment in the topic.* All farmers had an interest in SUBS because they had been through the programme. The author's familiarity with SUBS, coupled with previously published reports, indicated the level of interest was likely to be high. Mail surveys are particularly suitable when interest levels are high, as the likelihood of a positive response rate is also high (Mangione, 1995).

6. *The research would benefit if participants had privacy in answering.* While not critical, privacy and partial anonymity were considered important for encouraging open and honest responses.

7. *Reduction in interviewer bias.* Involvement with previous SUBS groups had influenced the author's views regarding the programme. Such views may have been inadvertently transferred during an interview or phone survey (*e.g.* by tone of voice). Mail survey permitted somewhat more clinical preparation and delivery of the questionnaire.

8. *Mail survey is more convenient for the participants.* Engaging farmers by phone is often limited to inconvenient times of lunch and dinner, and interviews are difficult to organise around the active out-of-doors nature of farming. Mail survey has the advantage of farmers responding when it is most convenient for them.

7.5.1.1 Choice of question types

Types of questions included in the mail survey are classed as 'open-end and closed' and 'scaled and un-scaled' questions. Closed questions involve a limited range of predefined answer choices (e.g. yes/no, checkboxes), and carry the advantage of being quick to answer and easy to collate. Disadvantages include: a risk that important categories may be omitted; questions may be leading; checklists inspire 'laziness' and a tendency for limited consideration; and the introduction of bias if categories suggest a common theme (Erdos, 1983). In contrast, open-ended questions invite the respondent to compose their own answers in writing, which requires comparatively more time and thought, but presents greater difficulties for interpretation and collation. Further disadvantages include: the risk of incomplete or null answers; unclear handwriting; and effective responses are dependent on the interest of the respondent in the subject matter, and the education and literacy of the group surveyed (Erdos, 1983; Mangione, 1995).

A combination of open-end and closed questions were used in the questionnaire. Closed questions were used when the conceivable range of potential answers were small (*e.g.* yes/no/maybe) or could be categorised (*e.g.* decade categories for years of farming experience). Alternatively, an optional 'other' category was provided with a 'please explain' request, for questions that may involve unpredictable responses but don't justify a fully open question (*e.g.* reasons for not attending all SUBS meetings). Open-questions were reserved for situations likely to have a wide variation in potential responses (*e.g.* what were your original reasons for becoming involved with SUBS?).

Scaled questions are a special kind of closed question type, whereby categories exhibit relative divisions of increasing or decreasing scale. LIKERT scale questions are used mostly in the questionnaire, distinguished as having five relative orders of 'agreement' and 'disagreement', with a 'neither agree nor disagree' in the middle for respondents who are unsure or unwilling to make a polarised statement. Five-order LIKERT questions are used because there was no reason in this survey to use greater than five orders, and using less than five does not provide an adequate degree of separation for interpreting meaning from the responses.

Along with strengths and weaknesses of other types of closed questions, those based on the LIKERT scale carry the additional advantage of consistent and uniform responses (for easy collation), but also the additional disadvantage of monotony and repetition that leads to 'laziness'.

7.5.2 SURVEY TESTING

The questionnaire was tested by two farmers known the to author, who had completed full SUBS programmes. Initial phone contact was used to engage the farmers, who were then mailed the full questionnaires. Apart form the phone call, implementation of the questionnaire to the two farmers was treated as a formal survey. No additional documentation was provided, and farmers were not asked to make comment while making a response. Farmers were re-contacted three days after sending the questionnaire (both had completed filling it in), and were asked if they had experienced any difficulties or misunderstandings. Prompts derived from survey design guidelines (Leedy, 1997) were used to ensure the testers were asked questions relating to known difficulties of questionnaires and mail surveys.

Required changes were minor. The two farmers found the questions clear and easy to understand, and quick to complete. Exceptions were Questions 26 & 57, which required structural changes to improve clarity. Estimates of time required to complete the questionnaire were given as five minutes for a quick and brief response, and fifteen minutes if the respondent chose to fully reply and explain open questions.

7.5.3 SURVEY IMPLEMENTATION AND MONITORING

The duration of the survey was set at one month (Aug to Sept, 2003) to allow a reasonable amount of time for farmers to reply. Contact details were obtained from organisers and trainers (farmers submit their contact details at the beginning of a new SUBS programme for correspondence purposes). These were entered into a database, which was subsequently used to automatically generate letter and envelope forms. Prepaid return-envelopes were included with the questionnaires (again to encourage a positive response). Introductory letters were not used before sending out the mail questionnaire. While such letters are acknowledged as an effective method of gaining a higher response rate (Fowler, 1993), the cost was too excessive relative to an already low budget.

The survey was implemented on August 11th 2003. While this coincided with the beginning stages of lambing and calving for some farmers, it also represents a period when farmers are least likely to be away on holiday. Further, it represents a compromise between the author's intended date of thesis submission, and having to wait until several SUBS groups had completed.

Follow-up letters were sent out to farmers who had not replied after two weeks. Without an adequate follow-up procedure, the rate of return for a mail survey is likely to be less than 50% (Heberlein & Baumgartner, 1978; Fowler, 1993). A final phone call was also originally planned, but this was later deemed to be an additional and unnecessary cost due to an acceptable return rate (after three weeks).

7.5.4 DATA COLLATION AND ANALYSIS

The rate of questionnaire return was tracked by codes – each answer sheet had a unique code that was ticked off as each questionnaire was returned. Codes could be referenced to the original contact details for questionnaires not returned, thereby allowing the selective use of follow-up letters. This provided a 'partial anonymity', in that only the names of those who did not return a completed questionnaire were looked up. Monitoring the rate of return was undertaken using an Excel spreadsheet.

Actual responses were coded and collated into a database (dbase format), using an evaluation version of *WISCO Survey Power* (WISCO Computing; V4.20). This is a small but useful software application for designing, recording and analysing survey type questions. Responses to structured questions were entered through forms particular to individual questions (Figure 7.4), to be automatically coded and recorded in a database. This eventuated as a quick and easy method of clearly and consistently recording a reasonably large number of question responses as coded data.

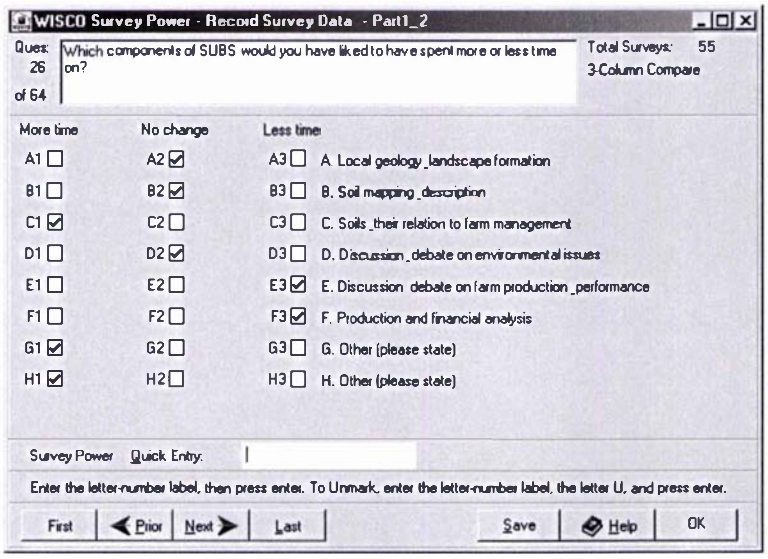

Figure 7.4: Example of a question form used to record responses in WISCO Survey Power software.

Coded responses were exported as a spreadsheet for analysis in Excel and SPSS for Windows. While *WISCO Survey Power* has an analysis function, this is limited to basic statistics and cross tabulation. Excel was used to generate descriptive statistics, cross tabulations (using the comparatively more versatile pivot tables), and a limited range of bivariate analysis (mostly simple T-Tests). SPSS for Windows was partly used for exploratory purposes (*e.g.* identifying distribution patterns), and cross tabulation with 'goodness of fit' statistics (Pearson's Chi-Square).

Semi-structured open-ended questions were recorded as text in a Word document. Similar responses within each question were grouped into general categories. This allowed all the text responses to be reported in a concise manner, and provided a degree of insight into trends and common themes expressed by different farmers. Semi-structured questions were mostly used without any leading prompts, and in cases where responses were likely to exhibit wide variation (*e.g.* what were your original reasons for becoming involved with SUBS?).

7.5.4.1 Presentation of results

Results are reported according to individual questions and question groups (groups bring together sequential questions with a similar theme, such as experience and qualifications). Responses are presented as tables and graphs, or are explained in the text. Bar graphs are used extensively where interpretation is aided by graphics, particularly with scaled questions, multiple response questions, and questions with comparable response categories.

7.5.5 ETHICAL CONSIDERATIONS

No special ethical considerations have been identified for the study. Massey University ethical and instructional requirements for mail surveys have been adhered to, and explained in the cover letter or questionnaire title page (Appendix V). The survey was discussed with members of Massey University's Ethics Committee, and no formal ethics approval was required. Questions were intentionally designed to be impersonal, and only absolutely relevant to the SUBS programme. All returned questionnaires were destroyed three-months after responses had been collated and entered into a database.

7.5.6 LIMITATIONS AND DIFFICULTIES

- Opportunities for statistical analysis. Limited time was available for design of the questionnaire, relative to the amount of time invested in the rest of the thesis. Additional literature review was required for a more sophisticated questionnaire design to take advantage of statistical techniques, and it wasn't until the analysis phase that opportunities for using these techniques became clear (e.g. ANOVA, cross tabulation of intentionally bias and reverse bias questions).

- Absence of a control group. A control group may have been useful for comparing SUBS farmers to the rest of the farming community. However, this could only be achieved if the control groups were established at the same time that each SUBS group was established.

- Trade-off between bias questions and easily understood questions. In several cases, farmer-jargon was used to summarise concepts that are otherwise difficult to convey clearly and concisely in a short question statement. While farmers readily understand their jargon, its use in this survey may have introduced some bias. As an example, use of the phrase 'touchy-feely programmes' to describe soft systems approaches conveys negative connotations (thereby introducing bias), but it has universal meaning to farmers.

- General introduction of bias. The author's familiarity with the SUBS programme may have introduced some additional bias into the questionnaire. However, a degree of bias is unavoidable in all surveys (de Vaus, 1995), and survey questions were checked and approved by other people less familiar with the programme.

- A portion of farmers had moved farm since being in the SUBS programme, and the questionnaire could not be delivered.

- Reluctance towards the survey. The mail survey targeted all farmers who originally signed up to participate in the SUBS programme. However, a small number didn't attend any meetings, or dropped out early in the programme. These farmers may have had less interest or 'investment' in SUBS, and may therefore have been more reluctant to respond.

- Ineffectiveness of mail as a way of enlisting cooperation. Survey recipients were under no obligation to fill in a survey that arrives unannounced in the morning mail. Such surveys engender no rapport or moral obligation to participate. However, it was envisaged this problem would be offset by farmers having a high interest and 'investment' in the SUBS programme.

- A key limitation of mail surveys is the absence of an interviewer (Fowler, 1993), particularly as it relates to being able to explain questions, provide prompts, ask detailed questions, use multi-methods of data collection (*e.g.* use of visual cues), and extract relevant information that may otherwise not be provided in a mail survey.

7.6. RESULTS

7.6.1 SURVEY RESPONSE

The response rate was reasonably steady, with 36 questionnaires being returned in the first three weeks, followed by a further 21 after the follow-up letter. Total number of replies was 62 (from a possible 78), although five of these were returned without answered questions (Table 7.2). The effective *response rate* (73%) falls within the upper 60-75% range typically achieved with mail survey (Dillman, 1978). Almost half of those who responded-positively were interested in receiving a summary of the survey's results (47%).

	Count	Percent
Potential number of responses	**78**	**100%**
Actual number of replies	**62**	**79%**
'Return to sender' (unknown or incorrect address)	(3)	4%
Replied but declined to participate	(2)	3%
Effective total response	**57**	**73%**

Table 7.2: Number of survey responses.

Twenty-percent of the farmers exercised their right to selectively answer questions, meaning 32 of the 56 responses are incomplete data sets (this affects the number of useable responses to individual questions, and any related sampling error). There may also be a degree of uneven representation created by the relative contributions from different SUBS groups (Table 7.3). Almost half the total response has come from the first three groups, and representation from individual groups ranges from 100% (Taumarunui) down to 44% (less than half of the Wanganui group responded). Despite this, any forthcoming results are considered to be representative of all farmers who have completed the SUBS programme, as the effective response rate was high, and all the farmers have essentially been through the same core SUBS procedure (irrespective of the group they were involved with).

	Initial group size *(N = 78)*	**Response from individual groups** *(n = 57)*		**Contribution to total response (%)** *(n = 57)*
		Count	**Percent**	
Taihape Hill Country SUBS Group	13	10	77%	18%
Tararua (Hill Country) SUBS Group	11	9	82%	16%
Dannevirke Land Resource Assessment Group	8	7	88%	12%
Tararua Dairy SUBS Group	8	6	75%	11%
Sand Country SUBS Group	10	6	60%	11%
Taumarunui SUBS Group	6	6	100%	11%
Raetihi SUBS Group	8	5	63%	9%
Wanganui SUBS Group	9	4	44%	7%
Manawatu Dairy SUBS Group	5	4	80%	7%

Table 7.3: Levels of survey participation by SUBS groups (ranked by contribution to total response).

7.6.2 PARTIAL INVOLVEMENT

Those who did not fully complete the SUBS programme may have been less inclined to participate in the survey (and may therefore be underrepresented). For the 57 responses received, 49 farmers indicated that they had completed the full programme (86%). For those who had not (8 farmers), their degree of involvement ranged between three to ten meetings (see Appendix VI for detail).

Reasons for discontinuing with the programme are listed as text responses in Appendix VI. There does not appear to be any single overriding or collective reason as to why the eight farmers decided not to continue with SUBS (most vary according to individual & unique circumstances). Rephrased, the reasons include:

- Illness.
- Planned sale of the farm.
- Other commitments.
- Changed jobs.
- Involved with too many other programmes.
- Difficulties associated with the application of the programme.
- Satisfied with current knowledge of his farm's soils.
- SUBS was considered unsuitable for his situation – it would be impractical to divide a large hill country property into units.

7.6.3 SAMPLE CHARACTERISTICS

7.6.3.1 Land use types and areas (Q6& 8)

The sample was dominated by hill country sheep & beef land-use types (65% of responses), followed by dairy (18%), intensive non-dairy (11%) (*e.g.* mixed cropping, fattening, drystock), and an assorted range of 'other' land use types (7%) (Table 7.4). Representation of these land-uses aligns closely with regional equivalents[3], suggesting that in terms of land use types, SUBS farmers are not too dissimilar from other farmers in the Manawatu-Wanganui Region.

	Number of farms	Percent	Regional equivalent[3]	Difference
Dairy	10	18%	20%	2%
Intensive	6	11%	7%	-4%
Sheep & beef	37	65%	68%	3%
Other	4	7%	5%	-2%
Totals	**57**	**100%**	**100%**	

Table 7.4: Land use types.

Average farm size was consistently greater than lower North Island (LNI) equivalents[4]. Average area by farming type was 137 ha for dairy (*LNI equivalent = 85 ha*); 664 ha for intensive non-dairy (*LNI equivalent = 393 ha*); 627 ha for hill country sheep/beef/deer (*LNI equivalent* = 550 ha); and 719 ha for the 'other' land use category. Hence, SUBS farmers appear to farm larger-than-average properties relative to their lower North Island counterparts. The collective area for all the farms involved was over 30,000 ha, with an average farm size of 552 ha (standard deviation or *sd* = 452 ha). This varied widely between 61 ha and 2200 ha, and did not follow a normal distribution.

7.6.3.2 Ownership & management (Q7)

The majority own and manage their own properties (95%) (includes partnerships), with only two managers indicating an alternative ownership arrangement (farm owned by someone else; combined ownership but not a partnership). A third was a farm employee without ownership or comparative management responsibilities.

[3] Manawatu-Wanganui Regional equivalents calculated from the 2002 Agricultural Production Survey (data accessible from www.maf.gov.nz).

[4] Lower North Island equivalents taken from MAF (2002). 'Manawatu/Rangitikei Intensive' is reinterpreted here as 'intensive non-dairy'.

7.6.3.3 Topographical makeup & diversity (Q9)

Respondents indicated their farm's topographical makeup by area, according to four *categories* (flat, undulating, hill, steepland). A total of twelve *combinations* were apparent (Table 7.5). The most common combinations include: 'Flat + undulating + hill + steep' (19 farms); 'flat + undulating + hill' (14 farms); and 'flat' (8 farms) (see Appendix VI for detail). The number of categories per combination have been used to construct a classification for topographical diversity. It appears that the majority of SUBS farmers manage properties characterised by moderate to very high topographical diversity (83%).

No. categories/ combination	Topography combinations *(total of 12 combinations)*	Topographical diversity	Count *(n = 57)*	Percent (%)
1	[Flat only] [Hill only].	Low	10	18%
2	[Flat + hill] [Flat + steep] [Flat + undulating] [Hill + steep] [Undulating + hill]	Moderate	10	18%
3	[Flat + hill + steep] [Flat + undulating + hill] [Flat + undulating + steep] [Undulating + hill + steep]	High	18	32%
4	[Flat + undulating + hill + steep]	Very high	19	33%

Table 7.5: Topographical diversity of farms involved in the SUBS programme.

7.6.3.4 Production characteristics (Q10-12)

Fifty of the 57 farmers provided information on stocking rates (7 chose not to respond), as either cows/ha (dairy) or stock units (su) per hectare. Average stocking rates included: dairy at 3.5 cows/ha (*LNI equivalent = 2.6 cows/ha*); intensive non-dairy at 12 su/ha (*LNI equivalent = 12.7 su/ha*); hill country sheep/beef/deer at 11 su/ha (*LNI equivalent = 9.6 su/ha*); and 'other' at 12 su/ha. SUBS farmers appear to have higher than average stocking rates (for dairy and sheep/beef/deer), although intensive non-dairy farmers have rates comparable to their lower North Island counterparts.

Fifty-five farmers provided their stocking ratios: five had a deer component (ranging from 2% to 40% of total stock units); ten had 100% cattle (all dairy farms); and 33 farms had sheep & cattle only. The single most common response (mode) for the latter category was 70:30:00 (10 out of 33 farms), with an evenly increasing range of 35:65:00 up to 85:15:00 (see Appendix VI).

Farmers were also asked to rate their farming performance (Figure 7.5). Three choose not to respond. The majority considered themselves to be *above average* (54%), followed by *average* (30%), and *well above average* 'top farmers' (15%). None considered themselves to be *below average*, although one thought his farming performance was *well below average*.

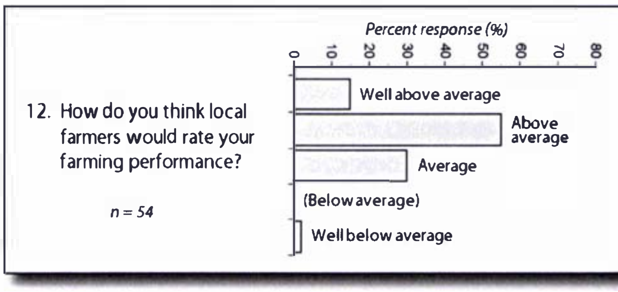

Figure 7.5: Farmers' rating of their farming performance.

'Performance' was not defined: farmers were free to define performance on their own terms (*e.g.* as profit; EFS; productivity; environmental performance; etc.), and farmer modesty (or overt optimism) may have influenced responses. Objective performance measures were not included in the survey because they represent sensitive information that some farmers may not wish to impart (which may have influenced the survey rate of return).

7.6.3.5 Farming experience & tertiary qualification (Q13-15)

The majority of respondents had been farming for between 20 to 30 years (Figure 7.6), with 48% having greater than 24 years experience (average = 24yrs; *sd* = 9.2 yrs). One respondent had less than a year's experience, while the most seasoned had been farming for 45 years.

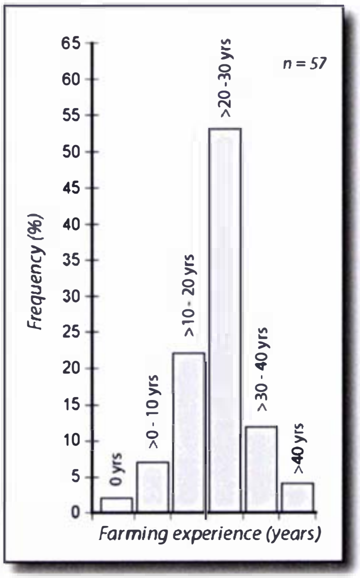

Figure 7.6: Farming experience.

Of the 56 respondents who had farming for more than a year, 16 had gained less than half their experience from the farm currently being managed (28.5%); 15 had gained the majority of their experience from the current farm (26.5%); and 25 had gained all their experience from the same farm (45%). The average for 'experience gained on current farm' was 17 years (*sd* = 9 yrs).

'Farming experience' and 'experience gained on current farm' both approximated normal distributions. Hence, the SUBS programme has involved farmers with an evenly distributed range of experience levels, which is likely to represent a balanced cross-section of farmers in general. Unfortunately industry averages could not be sourced to confirm this (*e.g.* via a one sample T-Test).

Well over the half of the respondents (56%) indicated that they had a tertiary qualification (post-school qualifications that include 'higher learning' and nationally accredited vocational qualifications, but excluding adult education secondary-qualifications). This is considerably higher than the 23% of people employed in agriculture, forestry and fisheries with a post-school qualification (Stats NZ, 2003), and similar figures ranging from 15% to 30% reported for other studies (*e.g.* Moore, 1990; Rauniyar & Parker, 1998). Twelve had a university degree (21%); 14 have diplomas (25%); and six had 'other' qualifications including a doctorate and a masterate (see Appendix VI for detail). It appears that SUBS farmers are generally more qualified than other farmers (in terms of post-school qualifications).

7.6.4 APPLICATION OF SUBS

7.6.4.1 Groups & meetings (Q16-23)

Almost all the respondents considered the size of their respective groups to be 'about right' (87% of 55 responses – 2 did not respond). Two farmers thought their groups to be 'too large' (both from the Taihape group), while five thought their groups were 'too small' (2 responses from the Manawatu group and 3 from the Taumarunui group).

Attendance at SUBS meetings appears to be consistently high (Figure 7.7), with 51 farmers (from 56 responses) attending all or most meetings (91%). For the 37 who missed one or more meetings, 'work commitments' was cited as the most common reason (30 responses), followed by personal commitments (9 responses), and three indicated that they became disinterested in the programme.

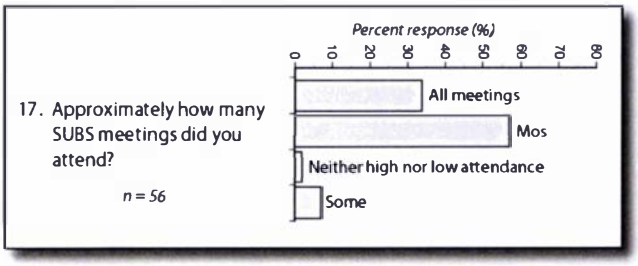

Figure 7.7: Attendance at SUBS meetings.

Unique reasons for missing meetings include: illness; funeral attendance; inappropriate timing of meetings (including conflicts with picking-up children from school); not receiving notification of a meeting; and one respondent had joined a group after several meetings had passed.

Eight out of 56 farmers indicated that they did not host a SUBS meeting on their farm (one chose not to respond). Four of these were from the Taihape group, and the other three were from the Wanganui, Sand County, and Taumarunui SUBS Groups.

The majority of respondents agreed that the late-morning start of most meetings was appropriate (53 of 56 responses or 95%). One indicated that this allowed sufficient travelling time (travelling distances were considerable in some cases), and to ensure important or necessary farm tasks could be completed before departing. Three considered the timing of meetings to be inappropriate: one Taihape couple highlighted a conflict between school times and the late-afternoon finishing of some meetings, while two Taumarunui group members did not agree with the early start-time of some meetings (*e.g.* 9.00-9.30am). These times were unique to the Taumarunui group, and reflected an attempt by the trainers to reduce their own travelling times. A different respondent suggested meeting times should be longer, to provide more time for late-arrivals (when long travelling distances were involved), and to allow for more social time before and after each meeting.

SUBS is designed to be a 12-month programme, although in some cases there was a suggestion that one or two groups finished well within this period. Forty-eight agreed that the 12-month duration was appropriate, with three commenting that it permitted sufficient time to visit all the properties, and to complete all the set tasks without undue pressure. It also allowed the groups to observe and discuss the seasonal behaviour of different soils (with feedback from the pedologist). Three farmers choose not to respond to this question, while another six considered the 12-month duration as being either:

- Too long (3 responses). Reasons included: excessively repetitious in parts; lost momentum; & too drawn-out to maintain interest.
- Too short (2 responses). One replied that he had just started 'to get to grips' with the programme.
- Inconvenient (1 response) because it continued through busy parts of the farming calendar.

7.6.4.2 SUBS activities (Q24-30)

The question concerning the amount of time farmers spent on SUBS activities outside of meetings was unfortunately flawed. While stating that only the *total time* should be considered, there was some confusion with intermittent times (*i.e.* time spent on activities between each meeting rather than the total time). This may have been caused through the use of predefined categories (although an open-ended category was included). Hence, responses are not reported, as it is uncertain whether they consistently represent total time or intermittent times. This is unfortunate because the question could have indicated how much effort was invested by individuals, which would have been important for comparisons against responses relating to farmer satisfaction and individual outcomes.

Over half of the respondents (55% of 56 responses) had special assistance with their soil mapping outside of meetings (from either a pedologist or a regional council officer). This service was usually reserved for those who initially find the soil mapping component of SUBS particularly difficult. Rates of special assistance were particularly high for the Wanganui (x4 farmers), Taihape (x5 farmers), Raetihi (x5 farmers), and Taumarunui (x6 farmers) groups.

Respondents appear to be reasonably satisfied with the degree of emphasis given to different components of SUBS (Figure 7.8), as suggested by a consistently high 'no change' response (61% of total responses) relative to the 'more time' and 'less time' responses (accounting for 33% and 6% of total responses respectively).

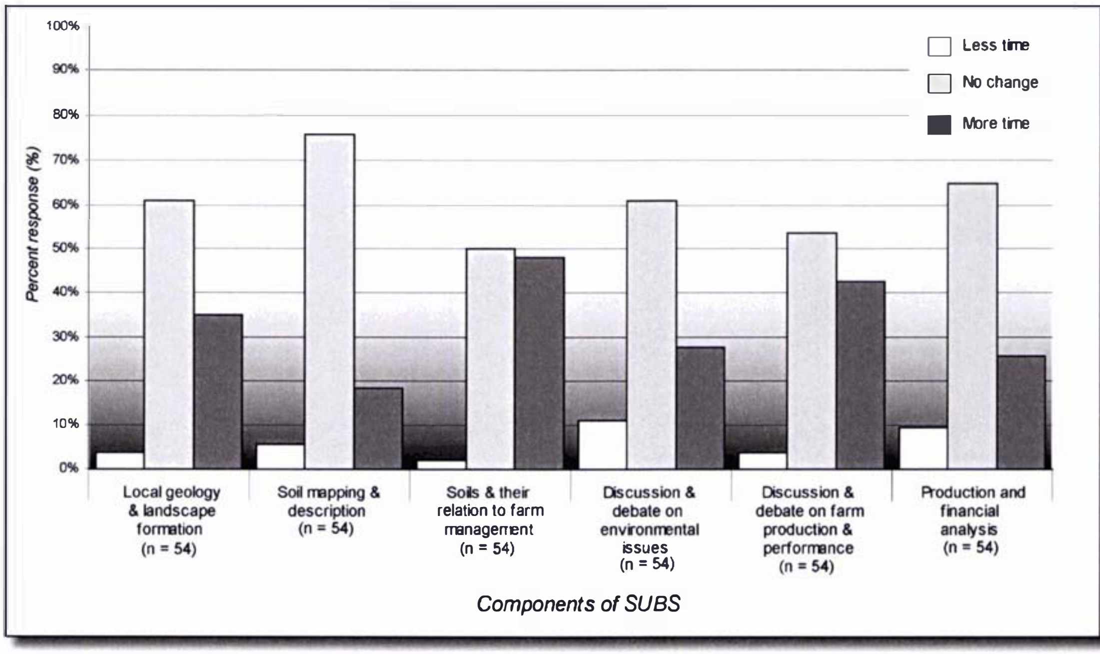

Figure 7.8: Preferred degree of emphasis on different components of SUBS.

A preference for less time is low across all six categories, suggesting the mix of components used in SUBS has been appropriate for the majority of SUBS farmers. Similarly, the number of responses for 'more time' are consistently twofold or greater than the number of 'less time' responses for each component. Differences between the two (i.e. 'more time' minus 'less time') can be ranked and compared against the 'no change' category to indicate which components could receive more or less emphasis in future programmes (Figure 7.9).

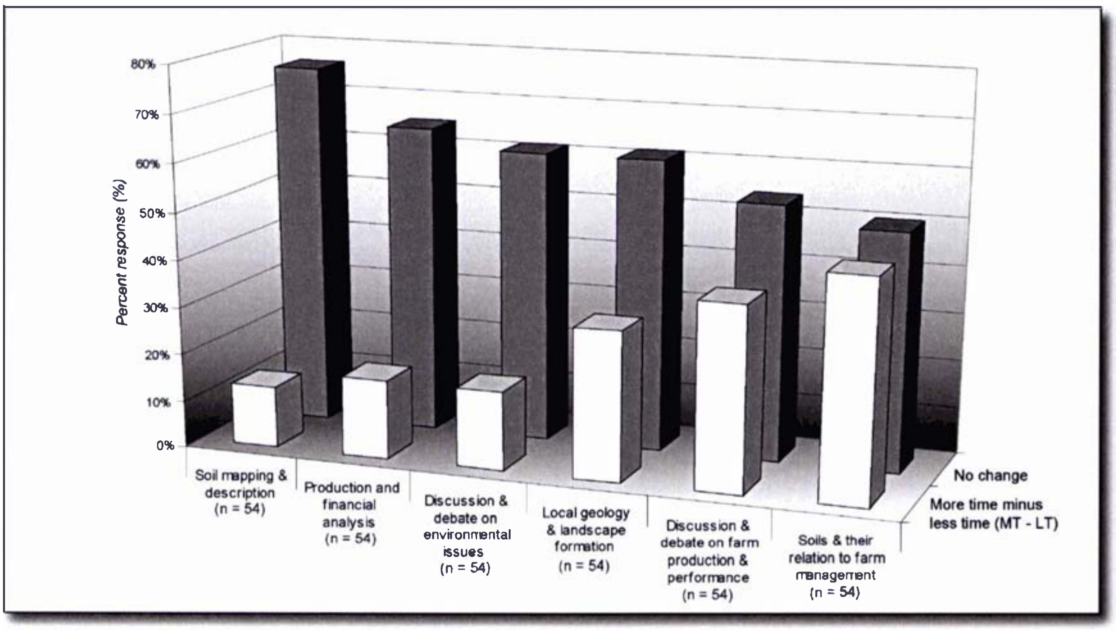

Figure 7.9: Ranked degree of preferred emphasis on different components of SUBS.

The top three components that could be targeted with greater emphasis in future programmes include: soils and their relation to farm management; discussion and debate on farm production & performance; and local geology and landscape formation. Conversely, the high relative rate of 'no change' for the remaining three components suggests they are currently emphasised to an appropriate degree.

Six respondents indicated they would have liked to have spent more time on components not listed in the questionnaire. Other components included the exploration of:

- Land Management Units in more detail.
- How other farmers manage their soils.
- Additional tools for post-SUBS applications.
- Alternative land use options in greater and broader detail (*e.g.* relative suitabilities for pasture, cropping, horticulture, etc.) (x3 responses). Greater consideration of climate variables.

Less than 20% of the respondents considered the soil mapping component of SUBS to be difficult (Figure 7.10). A greater percent had comparatively more difficulty with soil profile description (Figure 7.11), with 39% considering it to be difficult or very difficult (almost a twofold difference). There was no meaningful relation between levels of difficulty and farmers who received special soil mapping assistance (Appendix VI for detail). This may be because the questionnaire did not seek to distinguish between levels of difficulty experienced before and after a farmer received special assistance. Presumably, special assistance should lessen the difficulty of soil mapping and description (this was also suggested by two unprompted comments).

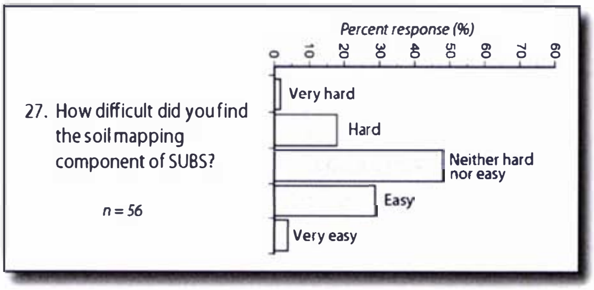

Figure 7.10: Soil mapping difficulty.

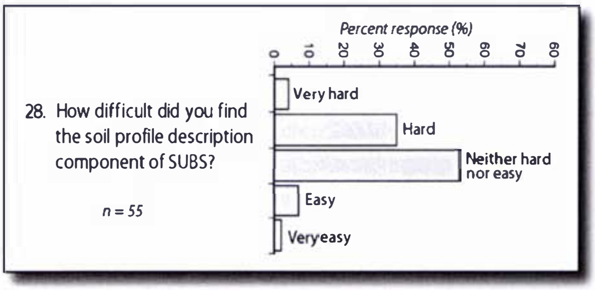

Figure 7.11: Soil profile description difficulty.

Forty-six of 54 farmers (three chose not to respond) indicated that the technical aspects of SUBS were adequately explained during meetings (85%), and 49 found the written instructions for mapping and describing soils to be adequate (91%). A small percent considered either the technical explanations or instructions to be inadequate (6% & 4% respectively), and several were unsure (9% & 6%). Several unprompted comments to this question are reinterpreted as suggestions for improving SUBS.

7.6.4.3 Suggestions for improving SUBS (Q31)

Twenty-one of the 57 respondents answered Question 31 with either suggestions or comments. Some answers were not directly relevant to the question. Relevant responses have been interpreted into common categories for reporting. Farmers suggestions on how SUBS could be improved include:

- Restricting the amount of time allocated to progress reporting (1 response). Some sessions have involved up to an hour or more, which is perhaps too long for maintaining interest & enthusiasm.
- Quicker turnaround with map digitising (1 response). In some cases, the period between submitting a draft map and receiving the final digitised version involved a duration of several months.

- Standardising one-to-one soil survey assistance as part of the SUBS programme (2 responses). All farmers should be visited individually by a specialist early in the programme, to assist with soil mapping and description, and to ensure a minimum standard of survey quality.
- Improved facilitation & timing of meetings (1 response).
- Improved notes and module structure (2 responses). Notes should cover topics discussed during each meeting. Module instructions and objectives require greater clarity & consistency, and additional resource material could be made available (*e.g.* references to publications on local geology & landscape formation).
- Less repetition of topic material during the final few meetings (1 response).
- Improved explanation and demonstration of soil profile description (2 responses). Procedures could be explained in more detail indoors, including a comparison of two or more excavated profile samples (particularly in regard to the determination of soil texture and colour). As it stands, groups sometimes have to visit several properties before experiencing and learning the degree of diversity a given soil attribute may exhibit.
- Supporting information and tools for use after the programme has completed (1 response).
- More time and detail on physical land evaluation (1 response), including a greater and more objective consideration of strengths & weaknesses (*e.g.* water holding capacity, nutrient dynamics), and a broader exploration of land use suitabilities (beyond conventional uses).
- Greater emphasis on how to realise LMU potentials (2 responses), including more time discussing and debating implications towards farm management, and consideration of alternative management options (e.g. optimising fertility levels, planting trees, selecting suitable tree species).

7.6.5 Benefits of SUBS

Questions 32 to 44 involved respondents indicating how strongly they agree or disagree with statements concerning the claimed benefits of SUBS. Fifty-six farmers responded consistently (only one chose not to respond to any of the 13 questions), except for questions 41 & 42 (which had 55 responses each). Results are presented as Figures 7.12 through 7.24.

Responses to all thirteen statements were dominated by positive agreement (as 'agree' or 'strongly agree'), with non-positive responses (neutral, 'disagree' or 'strongly disagree') accounting for only 15% of the total response. Positive to non-positive ratios ranged between to 59:41 and 96:04 (*i.e.* 96% of responses were positive: 4% were non-positive) for individual statements. The percent of positive response for each statement is presented in brackets with a '+' symbol.

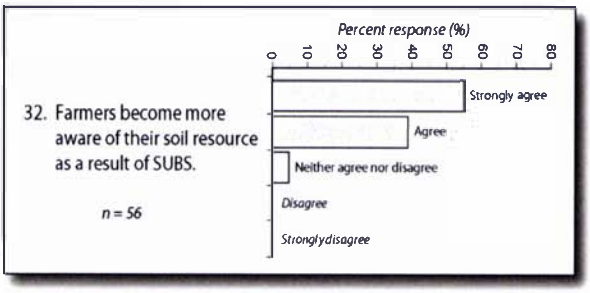

Figure 7.12: Greater awareness benefit (+95%).

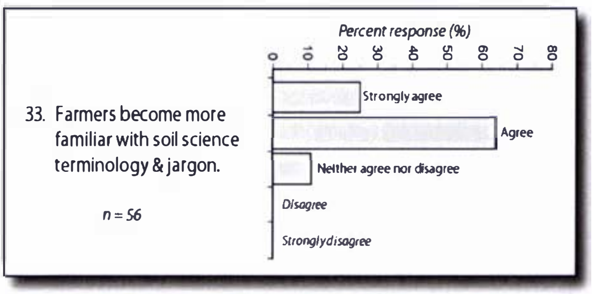

Figure 7.13: Familiarity with jargon benefit (+89%).

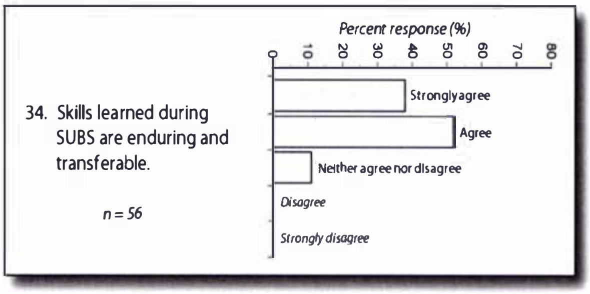

Figure 7.14: Transferable skills benefit (+89%).

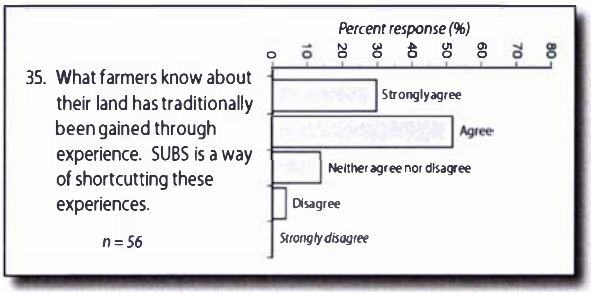

Figure 7.15: Shortcutting experiences benefit (+82%).

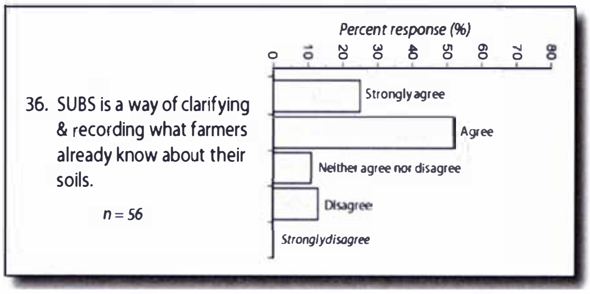

Figure 7.16: Clarifying & recording benefit (+77%).

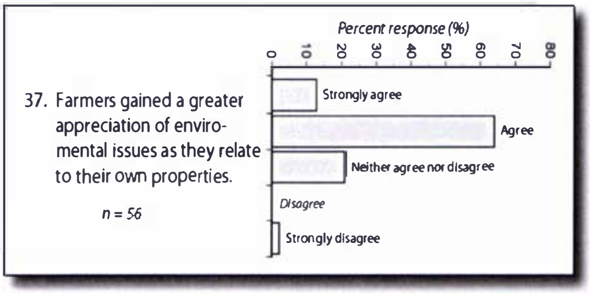

Figure 7.17: Environmental issues benefit (+77%).

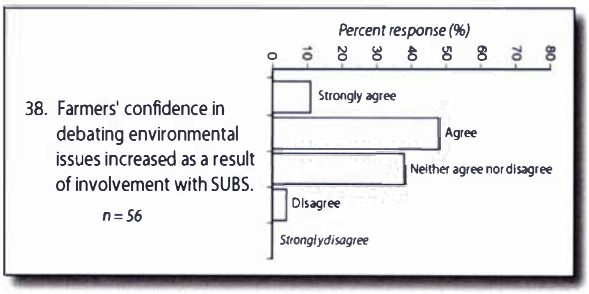

Figure 7.18: Debating issues benefit (+59%).

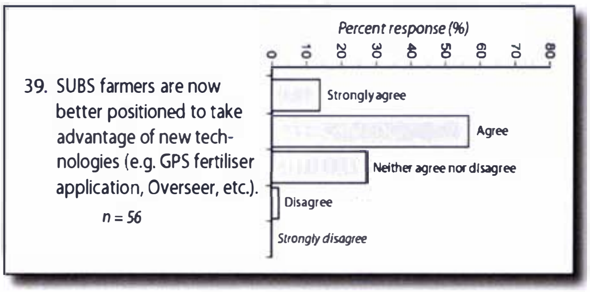

Figure 7.19: New technology benefit (+71%).

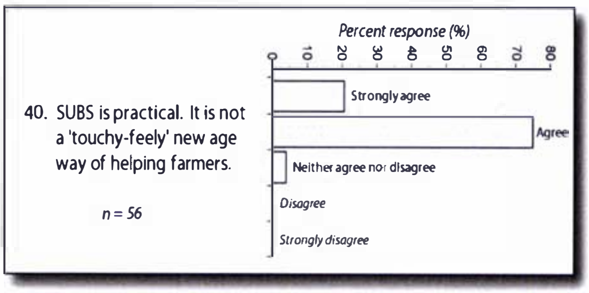

Figure 7.20: Practical application benefit (+96%).

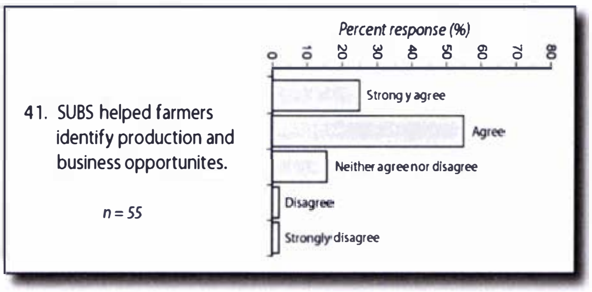

Figure 7.21: Business opportunity benefit (+80%).

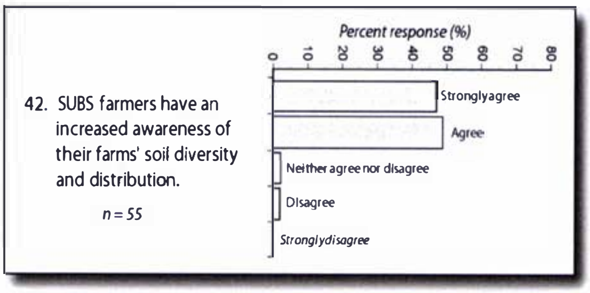

Figure 7.22: Soil awareness benefit (+96%).

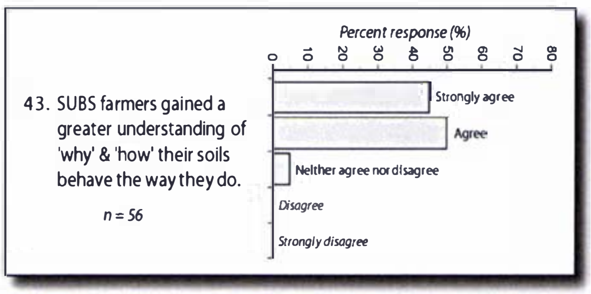

Figure 7.23: Soil understanding benefit (+95%).

Wholly negative responses ('disagree' or 'strongly disagree') were negligible, mostly ranging from 2% to 4% for individual statements. The standout exception was a 13% disagreement with 'SUBS is a way of clarifying & recording what farmers already know about their soils' (Figure 7.16). An unprompted comment suggested that farmers are not particularly aware of their soils (because soils are an indirect component of production systems).

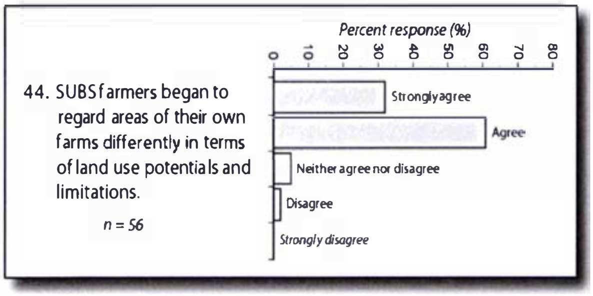

Figure 7.24: New perspectives benefit (+93%).

However, the proportion of respondents disagreeing with the statement was small. Overall, the consistently high positive response indicates the majority of farmers (across all nine SUBS groups) agree that the programme conveys a number of benefits to their ability as farm managers, and sustainable farming in general.

7.6.5.1 Other benefits (Q45)

Respondents were also invited to describe any other benefits that they may associate with the SUBS programme (through an open-ended question). Almost half chose to respond (49% of 57), with each commenting on one or more additional benefits. Most could be grouped into categories according to five common themes:

- **Interaction as a benefit**: Nine respondents considered the opportunity to interact with specialists and other like-minded farmers to be a benefit of the programme. This was also described as networking, 'improved knowledge-network availability', and meeting other farmers with similar motivation and interests. Interacting with specialists was described as 'a big advantage' and 'absolutely invaluable', particularly in regard to specialists who are less likely to be engaged in other situations (*e.g.* pedologist & agricultural scientists).
- **Improved confidence in decision-making**: Four stated that SUBS had improved their ability to make farm management decisions. This included increased confidence to explore alternative land use options (2 responses), along with confidence gained by affirming 'gut feelings' (1 response) and by allowing 'decisions to be informed' (1 response) with less of a reliance on 'guess-work or hit & miss' (trial & error).
- **Benefits relating to farm expansion or purchase**: In addition to the four responses above, a further eight stated or suggested that skills learned during SUBS could assist with decisions concerning land purchase. Such skills can 'make a land purchase decision easier' (1 response); are useful for identifying complementary land for farm expansion (2 responses); and generally allow for more informed decisions when the purchase of new or unfamiliar land is being considered (5 responses).
- **Farm management benefits**: Only three claimed benefits relating directly to farm management, all of which involved more efficient planning or application of fertiliser.
- **Greater understanding & appreciation of the land resource and related environment**: Eight respondents considered the insight gained about local landscape evolution and character to be a benefit of the programme. This included a greater understanding of local geology and landscape formation (3 responses); gaining a 'big picture' appreciation of local soil & geological variation (1 response); and simply 'learning more about the type of country we are farming' (1 response). A further three stated or suggested a general improvement in soil knowledge as a benefit.

Several unique benefits were also stated, including 'visiting other farms to check them out'; receiving a 'good farm map to keep'; and another 'big picture' insight into the three-way relation between landscapes, seasons/climate, and market fluctuations. One respondent claimed a particularly unusual (and worrying) benefit: "Met some hot new chicks. Met some hot new guys. Spied some hot & interesting new farm animals. Buggery, there's this feeling coming over me".

7.6.5.2 *Disadvantages (Q46)*

Respondents were also given the opportunity to indicate any disadvantages that they may associate with SUBS. Fourteen made comments, but six of these stated that they couldn't associate any disadvantages with the programme. The remainder (eight responses) indicated disadvantages that were mostly unrelated to each other:

- Excessive distances between farms. One respondent stated that the location of farms involved in a dairy SUBS group 'covered too wide an area'.
- Some SUBS meetings clashed with other extension initiatives, such as field days, discussion groups, and monitor farm meetings (1 response).
- Attendance at meetings and effective application of the programme required a significant investment of time from farmers (2 responses).
- Sometimes the full complement of trainers or specialists were not present at particular meetings (1 response). This could be vexing if a farmer had been saving a question to ask, or required specialist assistance.
- The month duration between meetings required a review (at the start of each meeting), as 'one tended to forget what was said'. Trying to absorb all that was taught or demonstrated within the relatively short duration of a few meetings was difficult (1 response).
- The manner in which farmers apply SUBS procedures is too flexible (1 response). Essentially it is up to individual farmers to decide how rigorously they apply SUBS to their own farms, which in turn has a strong influence on the quality of the final result. There is scope for improving the rigour of individual applications through the development of more concise instructions and guidelines.
- A loss of competitive advantage. One respondent suggested that his advantage of already having a sound soil knowledge was lessened as SUBS farmers became more aware of the potentials and values of their own soils.

7.6.6 WAS SUBS WORTHWHILE?

7.6.6.1 *Fulfilment of original reasons for becoming involved in SUBS (Q47-48)*

A total of 55 respondents indicated whether or not their original reasons for becoming involved with SUBS had been fulfilled (2 chose not to respond). The greater majority responded in the affirmative (67%); a third specified that their original reasons had only been partly fulfilled (31%); and one farmer indicated that his reasons had not been fulfilled at all (2%). Fifty-one farmers took the time to describe their original reasons. Multiple reasons given by individual respondents have been separated as 'cases', and all have been categorised according to common themes. Categorical reasons why respondents originally became involved with SUBS include:

- **To refresh what had been learned at university** (3 cases).
- **General interest and curiosity** (13 cases): Two respondents became involved simply because they were curious; four became interested through favourable reviews of the programme (from other farmers and newspaper articles); six became involved because they were invited by a group organiser; and one indicated that his involvement stemmed from an existing role with a local monitor farm.
- **To learn something new or different** (28 cases): Seventeen became involved expressly to learn more about soils in general; eight stated their involvement was to learn more about soils **and** how they relate to land use; and three were looking to gain new or alternative information about the land they farm. Similarly, one stated that his reason for involvement was because SUBS looks at farm management and enterprise from an unconventional perspective (*e.g. cf.* production-intensification orientated monitor farms).

- **To improve farm production, management and/or farm sustainability** (15 cases): Seven respondents were interested in examining their farms (from a soils perspective) towards the purpose of improved farm management and/production. A further eight cited similar reasons, but with an explicit purpose of either balancing environmental and production pursuits (3 cases), or promoting farm sustainability (3 cases). Similarly, one respondent stated his involvement was because of the 'SUBS strategy' (the implicit purpose of SUBS is to promote farm sustainability by simultaneously improving productivity and reducing undesirable environmental impact).

7.6.6.2 Monetary worth (Q48)

A total of 50 various responses were given for the question: 'In hindsight, how much money would pay for involvement in programme like SUBS?'. However, only 32 provided a monetary value ('bugger all' does not qualify), with the remainder making comments. Eleven responded with an unprompted question-mark ('?'), which possibly suggests that placing a monetary value on SUBS is difficult.

Monetary estimates ranged from $0.00 up to $2,000, with most falling within non-equidistant categories (Table 7.6). The most common value (mode) was $500; the average value was $530 ($sd$ = $460); and the trimmed mean was $450 ($sd$ = $460) (*i.e.* the average calculated without the most extreme values). Over 55% of the estimated values fell between $200-$500, with 40% ranging between $250 and $500.

Common categories	Count	Percent (*n = 32*)
≤$100	5	16%
$200	5	16%
$250	4	13%
$500	9	28%
$800	1	3%
$1,000	6	19%
>$1,000	2	6%
Total response	**32**	

Table 7.6: Common categories reported for monetary value.

Two stated that they wouldn't have paid for their involvement in SUBS, one of whom suggested the programme should be sponsored entirely by the regional council and fertiliser companies. At the other extreme, one respondent would only invest $2000 if the programme had been 'done properly', and had been personalised for individual farms.

7.6.6.3 Influence on farm operation (Q50-51)

At the end of a SUBS programme, farmer members are asked to nominate three tasks they would endeavour to implement after the programme had finished. The survey invited respondents to indicate how many of these self-set tasks had been implemented. Twenty-nine replied (28 chose not to respond): five had implemented none (17%); a similar five had implemented one task (17%); eleven had implemented two tasks (38%); and eight had implemented three tasks (28%).

One respondent couldn't remember what his self-set tasks were, and three stated or suggested that they were still working towards full implementation. Seven had never been asked to nominate three tasks (mostly from earlier SUBS groups; the self-set tasks component may have been introduced at a later date).

Rather than asking what the self-set tasks were, respondents were invited to describe if and how SUBS has influenced their farm management. Nine did not respond, and ten indicated that their management had not been influenced to any great degree (although four of these stated that SUBS had affirmed or confirmed the soundness of their existing management). A total of 38 responses (66% of a possible 57) described one or more changes in farm management attributed to involvement in the SUBS programme.

The greatest number of SUBS-related management changes reported by a single respondent was five. Singular management changes have been extracted from individual responses (as 'cases'), and all have been grouped into categories with a common theme. SUBS has had the following categorical influences on farm management:

- **Adjustments to stock management** (23 cases): Twenty respondents stated they had made actual stock management changes (as a result of SUBS), and a further three suggested they had made changes. All cases referred to changes that sought to minimise treading damage to vulnerable soils (a suggested exception was that one farmer had 'a different view' of grazing lambs on dusty soils after prolonged dry periods). Seven involved a major change in stock policy, including a diversification away from intensive bull beef (1 case); reduced numbers of cattle wintered on-farm (2 cases); and adjustments towards lighter stock classes (4 cases) including a 20% reduction in cattle stock units. The balance (16 cases) involved management changes only, and included: strategic grazing of cattle during critical periods (6 cases); grazing rotation adjustments (longer-term reallocation of where different stock types and classes graze) (6 cases); and four respondents made general comments about managing vulnerable soils when necessary.
- **Cropping & pasture renewal changes** (7 cases): Four respondents indicated a shift away from conventional cultivation to conservation tillage (presumably to reduce soil degradation); three had planted crops in different areas because of what they had found out about the soils; and one had initiated a regrassing programme as a result of SUBS.
- **Retirement, marginal area diversification, & tree planting** (8 cases): Three indicated they had planted more forestry (one of which also adjusted his poplar planting programme for soil conservation); two were planting (or had planted) more trees for soil conservation and/or shade; one had limited the grazing of steepland to sheep only; another was considering 'retirement or land use change of fragile areas'; and two were exploring non-grass grazing options (including forage willow).
- **Effluent disposal changes** (2 cases): One dairy farmer suggested that changes had been made to the way he managed the disposal of effluent to land. Another clearly that major changes had been made, including the purchase of a new effluent irrigator (with an even application spread); the expansion of effluent storage capacity (to extend the potential for deferred irrigation); and a change in irrigation patterns according to soils (a shift away from soils with impaired drainage onto freer draining soils with a greater capacity for absorbing both water and nutrients).
- **Land & farm development** (15 cases): Includes fencing changes such as re-fencing to contour, subdividing according to soil types, and fencing-off waterways (5 cases); the exploration & application of new drainage systems (4 cases); and changes to fertiliser policy (6 cases). Fertiliser policy changes included: new sampling transects (for soil testing) that better align with individual soil types (2 cases); adjustments in the type of fertilisers used, and the timing of applications (2 cases); and refocusing or prioritising fertiliser inputs into more productive areas (2 cases).
- **Managing land according to land types** (11 cases): In addition to the two cases given above for prioritising fertiliser inputs, a further seven indicated that they had selectively intensified parts of their farms according to soils or LMUs (commonly described as a concentration or focus of effort, spending, & inputs), and four had adjusted management policies to capitalise on the complementarity between different areas.
- **Changed farms** (1 case): One respondent strongly suggested that SUBS had influenced his decision to relocate to a new farm with a climate and soil more suited to his farming goals.

7.6.7 BEYOND SUBS

7.6.7.1 Application & development of SUBS skills (Q52-56)

Forty-four percent of farmers indicated that they had sought new information (concerning soils or related management) as a result of their involvement with SUBS (Figure 7.25) (three chose not to respond). Eighteen percent had further refined their soil maps or profile descriptions after their SUBS programmes had completed (two chose not to respond), and a slightly larger number had modified their LMU maps (28%) (four chose not to respond or made a comment). Two did not know what an LMU map was; one claimed he or she had yet to receive an LMU map; and another commented that a digital version had not been supplied as part of the programme.

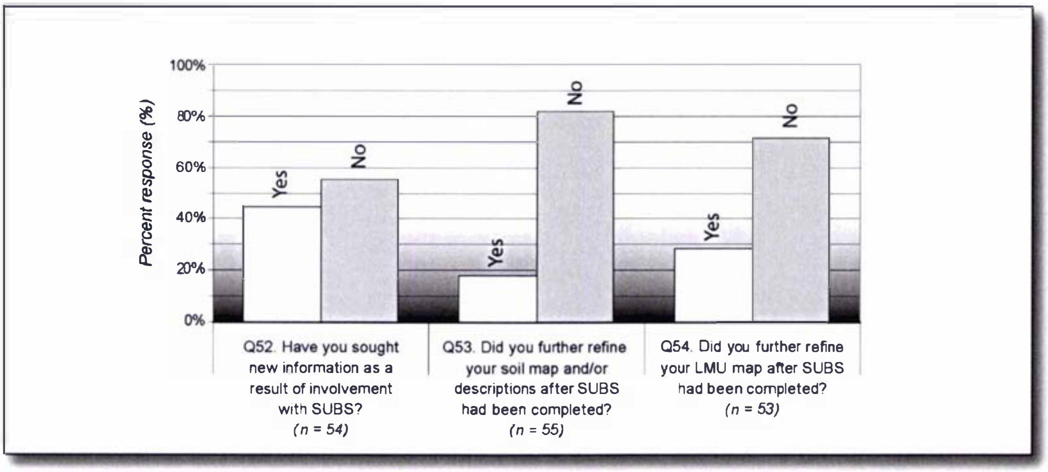

Figure 7.25: Responses to questions 52 to 54.

Over half the respondents indicated that they had applied their SUBS skills outside the programme (29 of 53 responses, or 55%). Those who answered in the affirmative were asked to describe how they had applied their skills (all 29 responded). As with other open-ended questions, multiple responses have been reduced to individual cases, and categorised according to common themes. Categorical applications of SUBS skills beyond the initial programme have included:

- **Evaluating land for purchase** (17 cases): A reasonably large number of respondents indicated that they had applied their SUBS skills to evaluate land for purchase. Five involved the actual purchase of land, while 12 cases involved either exploratory examinations of interest, or failed bids after the decision to purchase had been made (at least two cases). Two stated they were looking to buy land according to predefined soil criteria (to complement the existing operations), and another two stated that soil assessment had allowed them to identify potentials for high production that would have otherwise been masked by rank low-quality grasses and low soil fertility.

- **Evaluating land for lease** (4 cases): Four indicated that they had used SUBS skills to evaluate land for potential lease (particularly for identifying soils that would be complementary to the existing operation).

- **When visiting farms** (5 cases): Two stated that they had used their SUBS skills when visiting other farms in general, and three stated or suggested their skills had been used to make a contribution to other farmer groups (*e.g.* during discussion group visits).

- **Evaluating alternative components of existing operation** (3 cases): Three farmers indicated they had applied their skills to other parts of their farming operation not considered during the SUBS programme, including the application of SUBS principles to other properties (other than the home farm), and assessing new management opportunities.

7.6.7.2 Communication & extension (Q57-60)

Only 9 from 49 responses (18%) indicated that they had independently engaged a service provider as a result of being involved with SUBS (seven engaged a regional council officer, and two engaged a farm management consultant). However, over half (58% of 55 responses) had used their soil or LMU maps to explain something to a service provider (Figure 7.26).

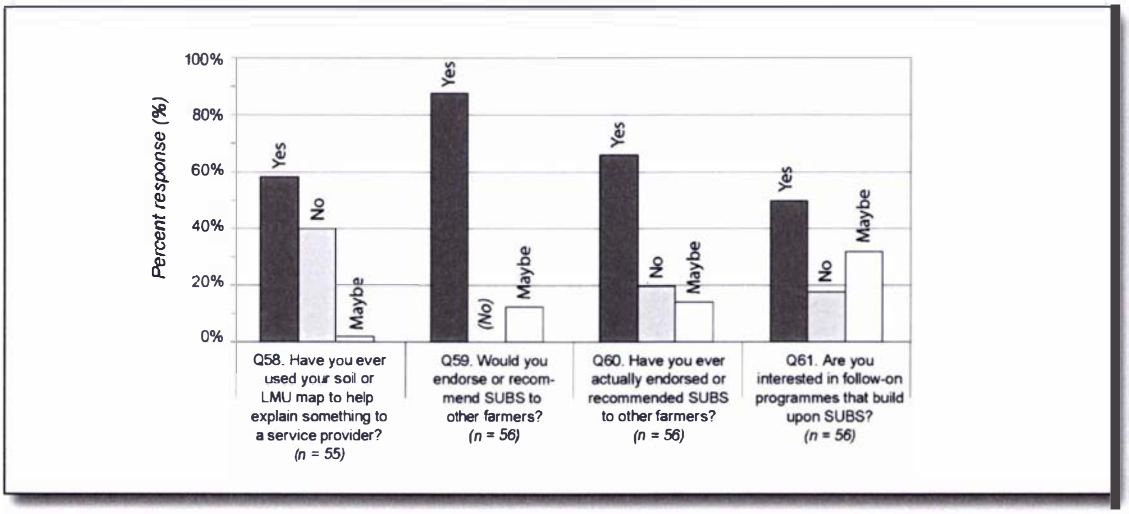

Figure 7.26: Responses to questions 58 to 61.

A total of 56 farmers responded to questions 59 to 61 (one chose not to respond). Many were prepared to endorse or recommend SUBS to other farmers (87.5%), and a large number had already done so (66%). A proportion might make such recommendations or endorsements (12.5%). No respondent opted to indicate that they definitely wouldn't endorse or recommend SUBS to other farmers. These high levels suggest that SUBS farmers consistently believe that the programme has practical worth to other farmers.

7.6.7.3 Follow-on programmes (Q61-62)

Fifty percent of respondents indicated that they would be interested in follow-on programmes that built upon SUBS; 32% indicated that they might be interested; and 18% indicated a definite disinterest (previous Figure 7.26). Those who expressed a definite or possible interest (*i.e.* the 82% majority) were invited to suggest and describe potential follow-on programme topics. Twenty-eight respondents made one or more suggestions. These have been separated as cases and grouped according to common themes. Categorical topics of most interest include:

- **Exploring opportunities & alternative land uses** (7 cases): Seven respondents nominated further land-evaluation topics relating to scenario optimisation (1 case); land use and/or crop suitability evaluations (2 cases); and general evaluations to identify 'best and alternative' land use options (4 cases).
- **Soil fertility & fertilisers** (7 cases): Three respondents were particularly interested in topics concerning soil processes and how they relate to the use of fertiliser (*e.g.* trace elements, optimal nutrient levels, function of 'alternative' fertilisers). The remainder were interested in soil fertility and fertilisers in a less specific way.
- **Tree planting & erosion control** (5 cases). One was interested in options for erosion control of sand country, while four expressed an interest in a tree planting/species topic related to both amenity and soil conservation purposes.

- **Pasture species** (4 cases): Four nominated 'pasture species' as a topic, particularly in terms of evaluating species suitability for different areas of land.
- **Continuing previous themes** (4 cases): Suggestions included continuing SUBS on a wider-scale (*e.g.* greater interaction with other SUBS groups; field trips to contrasting areas); obtaining more detailed information on soil attributes; and exploring LMUs and in more detail. Similarly, one simply stated 'fine tuning what we started'.
- **Water management** (2 cases): One respondent nominated the storage and reticulation of water as a topic, while another suggested a programme focusing on relations between soil water, irrigation, and nutrient balances.
- **Unique topics** (7 cases): Singular topics that could not be readily categorised include: linking with quality assurance programmes; sustainable farming; soil quality; geology; plant/soil interactions; animal health; and modifying soil qualities (*e.g.* overcoming soil limitations, 'sustainable' methods of developing land).

One respondent indicated that a five-hour meeting had been held specifically to identify topics suitable for follow-on programmes: "the general agreement was that no one specific topic could be gone into as there is no one 'magic bullet'. Available future topics included animal health tied in with fertiliser, genetics and management".

7.6.7.4 Additional comments (Q63)

Survey participants were invited to make additional comments about any aspect of the SUBS programme. Twenty-one comments were received. Most are unique, so the reader is referred to Appendix VI for the full list. Sixteen expressed one or more positive comments, such as: 'very worthwhile project'; 'extremely useful & interesting'; 'awesome concept'; 'extremely valuable'; 'learned a lot'; and 'it was very well run & I did enjoy it'. Several other comments touched on features of the programme not directly targeted in the questionnaire, including:

- A monetary estimate on how SUBS has influenced farming returns: '… it would be about $15,000 on the home farm, and… SUBS helped make the decision to buy another block which can earn many thousands through complementary land use'.
- A suggestion that the type and quality of service would need to change if farmers were to pay for involvement in the programme (*e.g.* increased quality of information, a greater focus on each individual farm).
- One farmer predicted that interest in SUBS will gradually decline if only the 'more motivated than average farmers' are targeted for inclusion. He also stated that the combined participation of farmers and outside 'experts' was pivotal to his enjoyment of the programme.
- A suggestion that the January to July period (6-7 month duration) was a more convenient time for running dairy SUBS programmes.

DISCUSSION

Nine SUBS groups have completed as of August 2003, involving 78 farmers from across the Manawatu-Wanganui Region. Seventy-three percent of these farmers participated in this study, which provides a sufficiently representative set of results for making encompassing statements about 'SUBS farmers' and the SUBS programme in general terms.

A small number (8) indicated they had not completed their respective SUBS programmes. There was no single overriding or collective reason as to why these farmers decided to continue. Likewise, most reasons were unrelated to the SUBS programme itself, and did not therefore provide any insight into how the programme could be improved to maintain involvement. An exception arose with unavoidable and compounding difficulties experienced with the establishment of a group in the Taumarunui area, including extensive travelling distances, small group size, and variable attendance by some group members. It would be difficult to ensure all of these problems were not repeated with other remotely located groups, although some improvements could be made with programme content and application (to be discussed).

7.6.8 Characteristics of farmers involved with SUBS

SUBS farmers manage larger-than-average properties relative to their lower North Island counterparts. Hill country sheep/beef/deer has been the most common land-use type, although representation of different land uses (diversity) has been proportionally similar to that evident at the regional level. Stocking rates were generally well above industry averages for dairy and hill-country sheep/beef/deer farms, and comparable for intensive non-dairy land uses. Most farmers had between 20-30 years of farming experience, although the range of experience levels was evenly represented. SUBS farmers also appear to have attained a considerably higher degree of tertiary education relative to other farmers.

7.6.8.1 Above average farmers

Characteristics described above suggest that SUBS has involved an 'above average' selection of the farming community. This is supported by farmers' own opinions about their farming performance (almost 70% rated their performance 'above average' or 'well above average'). This may reflect organisers intentionally targeting 'top farmers' for inclusion, or a more random response from the farming community that reflects known 'top farmer' tendencies and traits. Top farmers are generally progressive, innovative, entrepreneurial, and may exhibit a willingness or receptiveness to the consideration and adoption of new technologies (Russell *et al.*, 1989; Morris *et al.*, 1995).

The implications are twofold. Firstly, by design or chance, SUBS is well positioned for extension into the wider farming community according to principles defined by the traditional 'technology transfer model'. That is, the majority of farmers will gradually adopt the new ideas and innovations generated or (initially) adopted by the top few farmers. If this model is valid[5], then the high proportion of SUBS farmers who have recommended or endorsed the programme to other farmers (or who would be prepared to do so)[6], suggests an effective and unmanaged extension process is already in place.

[5] Debate regarding the validity of the 'technology transfer model' is longstanding (*e.g.* Roling, 1988; Russell *et al.*,1989; & Morris *et al.*, 1995).

[6] Results from this study indicate that most SUBS farmers are prepared to recommend or endorse the programme to other farmers (88%), and many have already done so (60%).

Secondly, the high involvement of 'above average' farmers has implications regarding the programme's past and future effectiveness. Rephrased, the past success of SUBS may be attributable to the 'above average' abilities, motivation and receptiveness of the farmers themselves. As the programme is extended into the wider farming community, it may become increasingly difficult to generate or maintain previous levels of interest, commitment, and overall effective application of the programme.

7.6.8.2 Farm ownership & management

Almost all SUBS farmers own and manage their own properties. As key decision-makers with direct control over substantial land holdings, they ultimately determine how their land will be used, and how that use is adjusted to ensure farm sustainability (SUBS can therefore potentially have a direct impact on land use). However, up-and-coming new farmers and potential land owners are notably underrepresented (cadets, farm workers, some share-farmers), despite typifying a group that is least likely to have a strong knowledge of land gained by virtue of experience. SUBS could have a particular value to those considering their first land purchase, and for helping inexperienced managers avoid expensive land use mistakes (in both economic & environmental terms). A greater representation could be realised by ensuring a proportion of young farmers are included in each new group, or by developing the programme into a practical vocational qualification and/or a young farmer training course.

7.6.9 PROGRAMME APPLICATION & IMPROVEMENT

7.6.9.1 Programme structure

Most SUBS groups were of an agreeable size, although a small proportion indicated their group size to be either too large or too small. In each case, the number of farmers making up a group was outside the 8-10 farmers now considered to be optimal. Hence, there is little reason to suggest that the optimal group size should be changed.

Few insights were gained from the apparently high levels of attendance at SUBS meetings. Most of those who missed one or more meetings did so because of work commitments or personal reasons. A small minority cited reasons relating to the programme itself, some of which may be addressed with a general improvement in content and application (to be discussed).

The standard meeting time (late morning start, late afternoon finish) appears to have been agreeable with most farmers, perhaps as it allows sufficient travelling time between farms and an opportunity to complete necessary farming tasks. However, late afternoon finishes do not align well with school times, which could influence the simultaneous attendance of farming partners (*i.e.* both the key decision-makers). It is uncertain how this problem could be resolved, as the majority of farmers find the standard time agreeable, and some farmers have already expressed a strong dissatisfaction on occasions when earlier start times have been tried.

Similarly, few farmers considered the 12-month duration of the programme to be inappropriate. This duration ensures at least one meeting is held on each farm (in most cases), and it provides sufficient time between meetings for application and reflection. However, a small proportion of farmers indicated that the later stages became repetitious and unfocused, or the duration was inconvenient because it ran through busy parts of the farming calendar. The first problem relates to effective application of the programme (rather than its structural design), and will be discussed in the following section (Section 7.6.9.2).

The second problem is well recognised. Shorter programme durations have been considered, but attempting to cram the full programme into a 6-8 month period (or less) would increase the pressure, workload and conunitment required from farmers. As most farmers appear to prefer the pace afforded under the 12-month duration, an accelerated pace may have an undesirable impact on maintaining levels of involvement.

A possible alternative is dividing the programme into two parts, with each part being applied at times of the year that are most convenient for farmers (*e.g.* the January to July period for dairy farmers). This could involve one part focusing on soil mapping and description, and the second involving the use of soil information in farm management and planning. This would essentially make SUBS a two-year programme (with a long gap in-between). However, some farmers may not want a delay, or may lose interest if they have to wait to finish the programme. Conversely, some may consider that the greater convenience outweighs any disadvantages, which provides sufficient reason to at least suggest the option to new groups (to test their response).

7.6.9.2 Programme content

It appears that farmers are reasonably satisfied with the content of the SUBS programme, with most indicating a 'no change' preference for six key components. This suggests the current emphasis on different components is appropriate, and should therefore remain unchanged. However, only small differences between 'no change' and a preferred increased emphasis were apparent for three components. More focus on these components in future programmes may help promote interest levels. The three components that could receive a greater focus include:

1. Soils and their relation to farm management.
2. Discussion and debate on farm production & performance.
3. Local geology and landscape formation.

Additionally, the range of alternative topics suggested by farmers relate mostly to a more in-depth exploration of existing components, particularly in regard to evaluations of crop suitabilities (including pasture & tree species), and alternative land use options. This interest also featured highly in responses to other open-ended questions (*e.g.* responses concerning suggested improvements, disadvantages, and follow-on programmes), suggesting it is an area that should also receive greater consideration.

7.6.9.3 Programme application

Most farmers appear to have been generally content with how different parts of the programme were applied. However, there were a number of standout concerns apparent throughout the results section the author considers worthy of further discussion.

7.6.9.3.1 Soil mapping & assistance

While most farmers had little difficulty with soil mapping, a reasonable number found it challenging. Reasons for the difference are unclear. Degree of ease may reflect a combination of good instruction, basic application (*cf.* professional soil survey) and personal ability. Likewise, it may also suggest transitional differences between perceiving the landscape in production terms, and reinterpreting what is seen in terms of landscape evolution, soil formation, and soil distribution.

Minor improvements in the ease (and possibly the quality) of soil mapping could be achieved with clearer instructions (to be discussed). In addition, some farmers suggested that individual assistance outside of meetings should become a standard part of the programme. This would make soil mapping easier, quicker (unfinished soil maps can be an impediment to the smooth progression of the programme), and may go some way towards ensuring a high and consistent quality of mapping for all farmers (to be discussed). However, individual visits by specialists are expensive, and may detract from the personal insight, satisfaction and understanding, that a farmer may gain through unassisted mapping (knowing that assistance is forthcoming may lessen motivation for a farmer to undertake and complete soil mapping independently). It is for these reasons that the status quo (of assisting only when absolutely necessary) should be retained.

7.6.9.3.2 Soil profile description

Soil profile description was generally considered more difficult than soil mapping. Some farmers had never previously examined a soil profile in detail, and the method used to assess profile attributes is somewhat technical. Further, in being an empirical method, a degree of calibration through experience is required for effective application (*e.g.* for being able to distinguish clay from silt textures).

As with soil mapping, ease and quality of soil profile description could be improved with clearer instructions (discussed below). Further, a suggestion was made that a greater degree of explanation was required, along with a possible adjustment in the way the topic is demonstrated and taught. This could include an indoor examination and comparison of two or more soil profiles, and standardising examples that demonstrate the range of forms and variations that different soil attributes exhibit (particularly with texture and structure). Emphasis should be on farmers applying soil description techniques themselves, and comparing results against the known standards. The downside would be the amount of preparation time required by the pedologist, although this may be offset by faster progression of the programme, and possibly an improved quality in farmers' soil profile descriptions.

7.6.9.3.3 Application standards for farmers

Application standards can vary widely between different farmers, as there are few mechanisms in place to ensure a consistent degree of quality. The author has observed SUBS soil maps that would rival the efforts of a professional pedologist, through to soil maps that have less value (in terms of quality and utility) than soil information derived from the New Zealand Land Resource Inventory (a 1:50,000 scale national inventory containing soil information of questionable value).

One respondent described this problem as farmers having too much flexibility in their application, and recommended greater clarity and tighter definition of instructions as a solution. Similarly, another suggested he would only pay for involvement (hypothetically) if a high quality standard could be ensured. At the greatest extreme, variable standards of quality could detract from the programme's credibility and growing reputation. Individual farm visits could be used to overcome this problem (for assurance purposes), although this carries its own set of problems (discussed previously). Determining how a consistent quality standard can be maintained deserves further investigation.

7.6.9.3.4 Notes and instructions

While the majority of farmers indicated that the written instructions for mapping and describing soils were adequate, a small number believed the programme could be improved by refining topic notes and instructions. Such refinements carry a potential for expediting the programme (via clarity of purpose and instruction); introducing a greater consistency in quality (discussed above); and for improving the overall degree of training (*i.e.* some farmers may learn more).

7.6.9.3.5 Progress reporting

One farmer was dissatisfied with the amount of time sometimes allocated to progress reporting. While progress reporting and related cross-examination are critically important to an effective programme, extended durations can be somewhat tedious and drawn-out. Retaining the optimal 8-10 farmer group size, coupled with a duration restriction of 20-30 minutes (around 3-4 minutes per report), could improve this part of meetings. However, it is acknowledged that reporting times may have to vary, particularly during the early stages of the programme.

7.6.9.3.6 Lost momentum and focus

Several farmers implied a loss of focus towards the end of some programmes, expressed as lost momentum, repetition, and being too drawn-out to maintain interest. This may be due to compounding reasons, such as variable rates of attendance (from some farmers and trainers); delays in completing tasks and submitting draft maps; a reciprocal delay in completing and returning digitised maps; and possibly a lack of meeting organisation and planning from the trainers (*e.g.* reasons may compound to make it difficult to plan for the next meeting).

Other suggestions made in this Discussion may contribute to improved rates of attendance, and smoother progression of the programme. In addition, a tentative suggestion is made for improved organisation and planning from the trainers, including the clear and strategic definition of roles, responsibilities and programme structure when a new group is initiated, along with formally setting aside a brief period of planning (trainers only) at the end of each meeting, to tactically organise the topic and structure of the next successive meeting.

7.6.10 BENEFITS OF THE PROGRAMME

Agreement with 'benefit statements' previously made about the SUBS programme was exceptionally and consistently high. This implies that farmers strongly believe that the programme has been beneficial to not only their ability as farm managers, but also to their farming operations (implied by the collective range of topics used in each statement). This is also supported by a range of new benefits that farmers associated with the programme, including:

- Greater understanding & appreciation of the land resource and related environment.
- Improved confidence in decision-making.
- Benefits relating to farm management.
- Interaction with specialists and other 'like-minded farmers'.
- Assists land purchase decisions.

While being a wholly qualitative result, the high degree of farmer support affirms that the SUBS programme conveys a number of constructive benefits relating to the ability of farm managers and sustainable farming in general.

7.6.11 OUTCOMES AND EFFECTIVENESS

Farmers individual expectations of SUBS have generally been fulfilled. These are categorically summed as reasons for originally becoming involved in the programme. Ordered by dominant response, they include:

- To learn something new or different.
- To improve farm production, management, and/or farm sustainability.
- General interest and curiosity.
- To refresh what had been learned at university.

The first two reasons align closely with the purpose of the SUBS programme: firstly, to assist farmers in the collection and use of soil information (which aligns with many responses in the 'to learn something new or different' category); and secondly (and implicitly), to promote farm sustainability. As these categories account for almost 75% of response cases, there is a strong suggestion that the SUBS programme has effectively fulfilled its original purpose (at least in an overall and general way).

This is also supported by the high rate of farmers actually completing the programme (whereby finishing the programme's tasks and modules is sufficient to indicate that SUBS has effectively fulfilled it's training purpose), and the programme's apparent and surprisingly high impact on farm management and land use. This includes over 80% of 28 respondents indicating that they had implemented one or more of their nominated self-set tasks (not all farmers had been asked to nominate such tasks), and the high number of often substantial changes made to farming operations. Sixty-six percent of the total response indicated they had made one or more changes, which translates to approximately 67 various cases of individual changes (*i.e.* there could be more than one change indicated by a single response). Categorical changes farmers attributed to their involvement with SUBS include:

- Adjustments to stock management (23 cases).
- Land & farm development changes (fertiliser, fencing & drainage) (15 cases).
- Managing land according to land types (11 cases).
- Changed farms (1 case).
- Cropping & pasture renewal changes (7 cases).
- Land retirement; marginal area diversification; & tree planting (8 cases).
- Effluent disposal to land changes (2 cases).

Evaluating the effectiveness of farmer extension/training programmes in terms of outcomes is inherently difficult. However, as these changes have been linked to SUBS by the farmers themselves, there is a strong suggestion that SUBS has positively resulted in meaningful land-use and management changes as they relate to farm sustainability. Hence, from a qualitative perspective, SUBS has effectively promoted farm sustainability on a rather extensive scale (farms covering a total of 30,000 hectares have been involved in the programme).

7.6.11.1 Additional outcomes

A reasonable number of farmers had sought new information as a result of SUBS (information concerning soils or their related management), and a small number had independently engaged a service provider (mostly regional council officers). Over half had used their soil or LMU maps to explain something to a service provider, which highlights the communication value of such resources. Further, a proportion had also independently refined their soil maps, soil descriptions, and LMU maps. This suggests SUBS has had an enduring influence on some farmers, particularly in regard to further development of information resources; a greater general interest in soils; and the independent application and development of learned skills.

This is more clearly evident with actual examples of post-SUBS applications. Over half described one or more applications, with the majority indicating that their SUBS skills had been used to evaluate land for potential purchase or lease (72% of 29 responses). One respondent even suggested that SUBS had influenced his decision to sell his farm and purchase a new property with a climate and soils better suited to his farming goals. Such a high unprompted response suggests that being able to evaluate land for purchase/lease is a key outcome of SUBS, particularly if it gives farmers a commercial advantage over and above other farmers.

Few alternative applications were identified ('when visiting other farms' and 'evaluating other components of the existing operation'), although it is reasonable to expect that the influence of SUBS will be less recognisable overtime (as it becomes just another skill) and with day-to-day farm management decisions.

7.6.11.2 Programme value

The overall response suggests that most, if not all, farmers consider the SUBS programme to be a very worthwhile and useful exercise. This was suspected during survey design (from earlier feedback), so a question asking respondents to place a monetary value on the programme was incorporated. Money can be used to clarify values (in many but not all cases), thereby indicating the realistic worth of a programme in commercial terms.

Slightly over half responded to this question, with the general consensus being that SUBS was worth around $250-$500 per farmer.

One farmer suggested the programme should be funded entirely by fertiliser companies and regional councils. However, fertiliser companies may or may not benefit from involvement, and regional councils are faced with an historical dilemma regarding community-good investments versus individual farmer gains. Considering that SUBS provides farmers with free access to industry specialists; explicitly targets farm production (albeit from a sustainability perspective); and involves a consultant undertaking one or more production analyses, then there is valid reason as to why a small amount of money should be charged for farmers' involvement.

To put this in perspective, a $250-$500 contribution from farmers is relatively small when compared against the overall cost. For a group size of 8-10 farmers, the money available for an entire programme equates to $2000-$2500 for the lower contribution, and $4000-$5000 for the upper contribution. The cost of having three specialists involved in the programme can easily equate to $10,000 alone (12 meetings; 3 specialists; 6hrs per meeting; a modest $50/hr; does not include other costs such as travel, map digitising, preparation before meetings, miscellaneous resources). While this is not strictly accurate (some specialists are not involved throughout the entire programme), it does highlight a $250-$500 contribution as being almost nominal.

Unfortunately standardising such a fee may put off many farmers from becoming involved with future programmes. Likewise, expectations are likely to increase if farmers are paying for involvement. As an example, one farmer stated he would only make a financial contribution if the programme was 'done properly' and personalised to individual farms. At present, SUBS still requires a degree of refinement before a consistent quality and result can be guaranteed. Hence, a fee should not be charged unless future demand for SUBS increases, and only after the programme has been refined in terms of commercial robustness.

7.6.12 FOLLOW-ON PROGRAMMES

Over 80% of respondents expressed a possible or definite interest in follow-on programmes that built upon SUBS. Such a positive response may suggest that SUBS has stimulated a greater interest in land evaluation and related themes. Alternatively, it may simply reflect an openness to new ideas and learning that one may expect of 'top farmers'. A third option is a combination of both, as suggested by the balance between topics for follow-on programmes (nominated by farmers). Categorical topics include:

- Exploring opportunities & alternative land uses (7 cases).
- Soil fertility & fertilisers (7 cases).
- Tree planting & erosion control (5 cases).
- Pasture species (4 cases).
- Continuing previous themes (4 cases).
- Water management (2 cases).

Several of these categories can be regarded as traditional extension topics (albeit with a soil or sustainable land management thread), with only two new categories directly linked to the SUBS programme. Further, farmers themselves have concluded that there is no singular or preferred topic for a follow-on programme, which is supported by a similar lack of preference evident with the categorical topics given above. Hence, despite the positive response, the strong overlap with traditional topics currently featuring in many other extension programmes (*e.g.* monitor farms, pasture & crop field days), and the absence of support for a singular topic, largely negates any strong justification for a SUBS-particular follow-on programme.

CONCLUSIONS & SUGGESTIONS

- SUBS farmers generally represent an 'above average' cross-section of the farming community. This may generate future interest in SUBS according to the 'transfer of technology' extension model. It may also limit the success of future applications if differences in farmer ability, motivation and commitment become apparent.

- Young up-and-coming farmers who don't own land are notably underrepresented in SUBS groups. There is an opportunity for greater inclusion in future groups, or the development of SUBS-based qualifications or training courses.

- Any future difficulties in the application of SUBS may be offset with improvements. Suggestions for future groups include:
  - Maintaining the optimal group size at 8-10 farmers.
  - Retaining the standard meeting time (late morning start; late afternoon finish), although this may limit some farming partners from attending meetings at the same time.
  - Exploring the feasibility of a twin 6-month programme duration, whereby the existing programme is divided in two, with each part being applied separately at times of the year that are most convenient for farmers.
  - Maintaining the current emphasis on different components of the programme, although an increased emphasis on the following components could promote greater interest: soils and their relation to farm management; discussion and debate on farm production & performance; local geology and landscape formation; and more detailed evaluations of crop suitabilities (inc. pasture & trees) and land use options.
  - Keeping the current policy of case-by-case soil mapping assistance (involving a special farm visit), to avoid additional expense and to maintain the various benefits that farmers gain through unassisted mapping.
  - Adopting an alternative training method for soil profile description, involving indoor comparisons between different soil profiles, and calibration exercises involving examples of soil attribute variability (particularly for soil texture and structure).
  - Identifying and examining options for improved quality standards (for ensuring consistent results and to protect the programme's credibility).
  - Improved notes and instructions for key topics, particularly soil mapping and soil profile description. Refinements could include greater clarity and tighter definition of instructions, and carry a potential for expediting the programme; more effective training; and possibly an improved consistency in quality.
  - Restricting the progress reporting component of meetings to 20-30 minutes (to avoid tedium and boredom).
  - Improved programme and meeting organisation, including trainers strategically defining their roles when a new group is initiated, and planning the structure and topic of successive meetings on a tactical basis.

- SUBS farmers strongly believe that the programme has been beneficial to their ability as farm managers, and to the sustainability of their farming operations.

- SUBS has effectively fulfilled its training purpose. In qualitative terms, the programme has also successfully fulfilled its implicit purpose of promoting farm sustainability, as evidenced by a high rate of actual land-use and management changes farmers attribute to their involvement in the programme.

- SUBS has also had an enduring impact on farmers' abilities, as many developed and applied their SUBS skills after their programmes had completed. A particularly popular post-SUBS application appears to be the assessment of land for potential lease or purchase.

- There is strong justification for charging farmers a fee for their involvement in SUBS. A suggested amount based on farmers monetary value of the programme is $250-$500. Such a fee should not be charged unless demand for the programme is high, and a consistently high quality can be guaranteed.

- Considerable support for post-SUBS follow-on programmes is evident, but the justification is largely negated by an absence of support for a singular preferred topic, and a strong overlap with topics currently covered by other extension initiatives.

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Chapter 8

SOIL DESCRIPTION AND MAPPING TOOLS

TABLE OF CONTENTS

8.1.1 LIST OF FIGURES

INTRODUCTION

Land resource (LR) information can be used to communicate, demonstrate, and plan farm sustainability in a rational and reliable manner, through the process of land evaluation (Chapter 3). Existing sources of LR information in New Zealand are for the most part inappropriate for these purposes (Chapter 4), which means that farmers interested in furthering farm sustainability through land evaluation can only do so by collecting new LR information particular to their own respective properties (at a scale and quality appropriate to their farm management).

One affordable method of collecting new farm-particular LR information is through farmer-assisted surveys such as Soils Underpinning Business Success programme (SUBS). This particular programme has allowed farmers to not only map and describe their farms' soil resources, but also to integrate the resulting information into farm management and planning (Chapter 7).

Despite the success of SUBS, many of the participating farmers have found the process of soil survey to be particularly challenging. Not only are they required to adjust their perception of the landscape for soil mapping, but they are also required to learn the somewhat technical steps of soil survey method (*e.g.* soil profile description). While the majority have achieved this in a commendable manner, it was felt that the challenge of learning soil survey could be made easier and more expedient through the development of training and support materials.

Many high-quality tools and materials are available for teaching and aiding the process of soil survey. Some examples include soil description handbooks (*e.g.* Milne *et al.*, 1995), soil mapping guidelines (*e.g.* Cutler, 1977), and the Munsell Soil Colour Charts (Munsell Colour Company, 1996) for describing soil colour. However, many of these resources have been developed for professional or scientific applications, and are unsuitable for farmers who may not have the time or inclination to learn the full and technical complement of soil survey method. Further, some of these resources are particularly expensive (*e.g.* colour charts), and not all have been developed for application in NZ's unique soil-forming environments.

The original aim of this chapter was to produce low-cost soil description & mapping tools for the SUBS programme. However, after examining existing soil survey training material, it was decided to expand beyond SUBS to develop tools and resources for anyone interested in undertaking soil survey (particularly students).

8.1.2 METHOD

An initial scooping exercise to identify the types of training resources applicable to SUBS was undertaken by examining the limited material used by early SUBS groups, and by interviewing two trainers involved in the programme (a pedologist and land-use scientist). This was followed by the design of a draft manual (in early 2001) that outlined how a SUBS programme can be organised and applied, and included stepwise instructions on soil mapping and soil description. The manual (included in this chapter) provided a preliminary basis for developing additional resources. The author has also been successively involved in three different SUBS groups. This allowed first-hand observation and experience of the types of training resources required, and in some cases the application and testing of resources with the benefit of direct feedback.

Considerable efforts have also been invested in reviewing various soil description and survey handbooks from New Zealand, Australia, Europe, and the United States. These have been particularly useful for identifying alternative methods of estimating key soil attributes as part of a soil-profile description exercise.

Designing new soil mapping and description resources was achieved through specialist graphics and pre-press software from the Adobe suite (Illustrator 10, Acrobat 4, InDesign 1.5, Photoshop 6). The actual methods used within these programs are not reported, as they are commonplace in most graphics and pre-press applications. A total of three different resources have been designed:

- *Colour Chart Booklet.*
- *Soil Description Laminates.*
- *A Guide to the Application of Soils Underpinning Business Success.*

This chapter outlines how each of the resources were developed, and their current stage of development (as of October 2003). Results are presented as example extracts. This represents a necessary compromise between the requirement of a self-contained thesis (as per university guidelines), and the publication of three separate resources (two booklets and one set of laminates). To accommodate the digital size of the numerous graphics, this chapter has been prepared in a pre-press application rather than the more conventional word processing programs (it may therefore appear to be formatted slightly differently from other chapters).

COLOUR CHART BOOKLET

Soil colour is one of several key attributes included in most, if not all, recommended procedures for describing soil profiles. Colour may represent a readily observed distinction between different soils (important for soil mapping and some soil classifications), and can be used as an indicator of soil qualities (*e.g.* drainage status, soil organic matter content in certain cases, degree of weathering, subsoil aeration, leaching).

The standard method for describing soil colour is according to the Munsell Colour System. This is based on colours that can be perceived by the human eye (*cf.* mathematically constructed colour models such as RGB, CMYK, HSL, and L*a*b), ordered into charts of HUE (as a circular sequence of primary colours), VALUE (as a scale of decreasing brightness or luminosity), and CHROMA (as an increasing scale of colour depth or saturation). Examples are provided in Section 8.2, and more detailed explanations are available from the two principal soil colour booklets currently available – the *Munsell Soil Colour Charts* (Munsell Colour Company, 1996), and the *Standard Soil Colour Charts* (Fujihara Industry Company, 1967).

Accurately reproducing colour is an extraordinarily difficult, technical and expensive undertaking. It is for this reason that very few companies are capable of producing soil colour booklets, and those who do must charge high prices in order to recover costs (as of June 2001, the *Munsell Soil Colour Charts* booklet is retailed at around NZ$250-$300 per booklet). These costs prohibit the use of commercial colour booklets in the SUBS programme.

Alongside a high cost, colour booklets have known to deteriorate rapidly under field conditions and repetitive use. Bindings disintegrate; colour squares become unglued; charts become smeared and discoloured (with soil); and the colour squares fade with age and exposure to sunlight (*i.e.* they change colour!). Their small size and regular in-the-field use means they are also prone to being misplaced and lost. Hence, practicing pedologists and training institutions may have to purchase a number of successive replacements over short durations.

Another lesser limitation is the range of colours a booklet may include. Colours are usually selected according to soil colours commonly found in the country that the booklet most closely associates with. The *Munsell Soil Colour Charts* (United States) include a range of colours different from those found in the *Standard Soil Colour Charts* (Japan). Certain high chroma colours found in some NZ soils are not represented in these commercial resources.

The aim of this project is to develop a low-cost soil colour booklet for describing the range of colours found in NZ soils. Fulfilling this aim would allow budding soil surveyors greater access to soil colour charts (which is important for SUBS and university courses with many students), and would overcome booklet-longevity concerns by making regular replacements affordable.

8.2. APPROACH

The approach used to develop a soil colour booklet relies on four principles. Firstly, colour cannot be determined accurately in-the-field because lighting environments cannot be controlled. Colour is a function of reflection, which in turn is influenced by the type of light (*e.g.* sunlight *vs.* florescent light), lighting angle (*e.g.* time of day), reflection from other objectives, soil sample albedo (reflection intensity), and light intensity (*e.g.* full sunlight *vs.* clouded sunlight). Hence, the high accuracy of commercial colour charts is excessive and unnecessary when used in lighting conditions found outdoors.

Secondly, SUBS farmers and university students being introduced to soil survey do not need to attain high standards of colour accuracy, particularly when soil classification is not the intended endpoint. SUBS farmers do not focus on soil classification, and students can move onto commercial colour charts when they are capable of consolidating learned principles and methods of soil colour description.

Thirdly, Munsell colours can be measured quantitatively according to the L*a*b colour model developed to represent international standards for colour measurement put forth by the *Commission Internationale d'Eclairage* (CIE) in 1931. This model is designed to be *device independent* (it creates consistent colour irrespective of the type or brand of printer, computer, scanner, or monitor). If the L*a*b values for Munsell colours are known, then they can be reproduced through a device that uses the L*a*b colour model.

Fourthly, printing press technology has advanced rapidly in recent years. Reproducing colour to a high standard of quality and accuracy is now affordable.

8.2.1.1 Design

Adobe InDesign (version 1.5) was selected to design the booklet, primarily because it is a graphics application that uses the L*a*b colour model. The layout design is similar to that found in commercial colour booklets (to maintain consistency, and because layout options for the Munsell colour system are rather limited), with an emphasis on large colour squares and a minimum number of pages. A total of 12 charts were designed (for 12 hues), with each chart containing an average of 36 colour squares (the total number of colour squares for the entire booklet is 427).

8.2.1.2 Determining colour values

L*a*b values for Munsell colours were eventually obtained through a freely downloadable colour conversion tool (Figure 8.1). While other methods for determining the required values exist (charts, tables and formulas), the colour conversion application eventuated as a quick and easy method of generating the L*a*b values of interest (*i.e.* for the select range of Munsell colours used for soil description). Munsell notation is inputted as hue, value and chroma (the input fields on the left of Figure 8.1), and values for different colour models are returned. Also included is the entire range of Munsell colours presented as RGB charts (not shown).

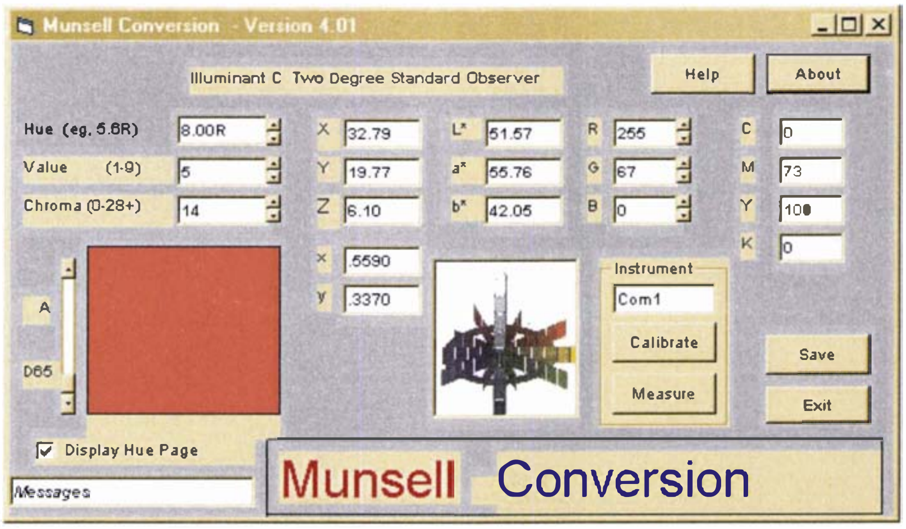


Figure 8.1: Colour conversion software from GretagMacbeth (www.gretagmacbeth.com).

Individual L*a*b colour values derived from the conversion tool were manually inputted as graphic fills for each of the 427 colour squares. The range of Munsell colours included were derived from commercial soil colour charts (the colours for which were originally chosen by pedologists and colour experts working together), and an additional chart has been included for a select range of high chroma colours to represent the vibrant orange mottling found in some NZ soils. High chroma colours were selected from the greater Munsell Book of Colour (Munsell Colour Company, 1999).

8.2.1.3 Printing press output

Original output was naively planned to be through a desktop printer. However, after testing several high-quality printers (inkjet, laser and thermal dye printers), this idea was discarded due to inconsistent output (surprisingly this was often from the same printer), poor colour reproduction, and a potential high cost for producing a sizeable number of copies. The wide variation in colour reproduction is caused by the way a graphics colour-model is translated into the CMYK model used by printers (so called 'ripping'). Further, different printers may use slightly different CMYK models.

A commercial printing company was approached to evaluate the feasibility of output through a printing press. Somewhat surprisingly, the company was very enthusiastic about the project, and were prepared to offer a substantial discount if permission was given for entering the printed booklet in an industry competition for printing excellence. To the company, the booklet represented an opportunity for demonstrating professional excellence concerning the accurate reproduction of colour.

Costs were quoted at $5259 for 500 copies ($10.52/booklet) and $6449 for 1000 copies ($6.45/booklet). Five-hundred copies is the minimum number the printery required to justify a printing run. If colours could not be reproduced to the required standard, then $365 would be charged for proofing (essentially just the cost of ink and paper). However, the company were very confident that the colours could be reproduced to high standards using process colours only (*i.e.* not including spot colours created by independent ink manufacture). While 'ripping' would involve problems similar to those experienced with desktop printers (but to a lesser degree), colours generated by the printing press post-ripping could be manipulated according to very fine tolerances.

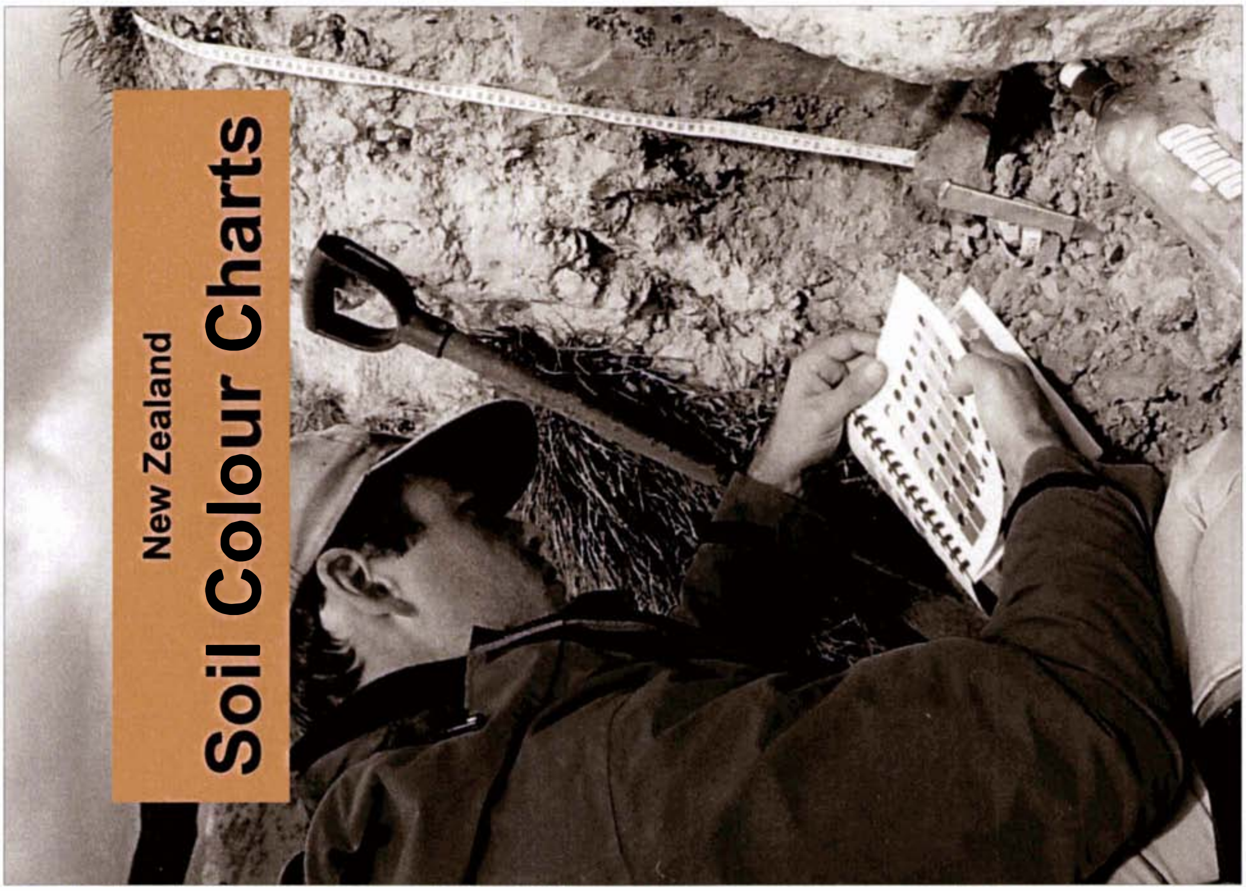
8.3. RESULTS

Three prototype booklets were constructed, each building on the former until the author, Massey University pedologists, and the printing company were satisfied with the final content and format. Specifications include: 15 double sided pages; 12 colour charts; 427 colour squares; A5 page size (148 x 210mm); masking card (one side black, the other grey); wire bound; pocket on the inside of the back cover; and each colour chart punched with a die for viewing a soil sample beneath a given colour square.

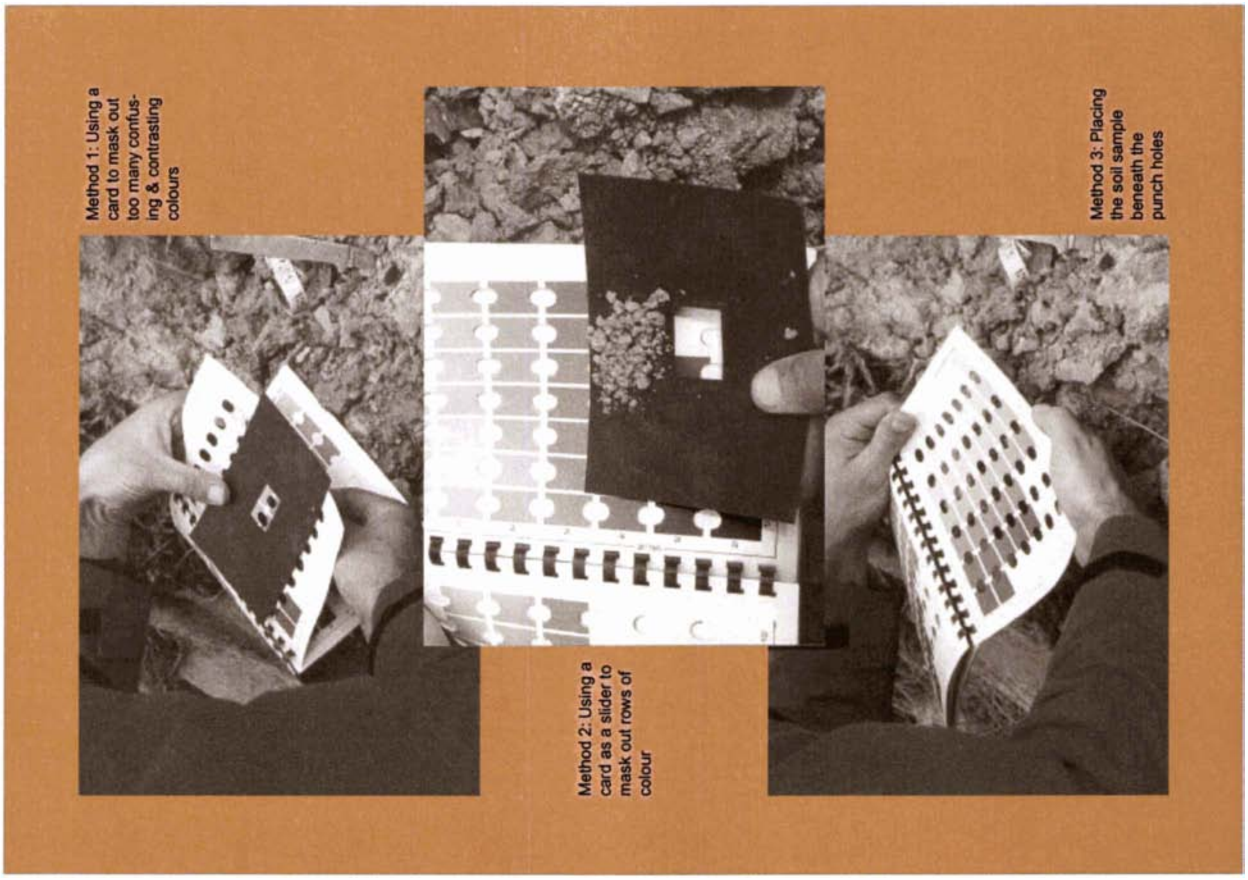
Special waterproof paper and ink were not deemed necessary because of the high water-repellence achieved by normal press printing (similar to a glossy magazine), and the overall low cost of a booklet (meaning any replacement would be affordable). Envisaged retail for a single booklet would be between $10-$20 depending on the customer, which is significantly more affordable than the NZ $300 charged for commercial equivalents.

The Soil Colour Booklet is presented in the following pages as a succession of extracts reduced by 80% and 40%. **Reproduced colours are likely to be very inaccurate – they will not be the Munsell colours that the associated notations and referencing system suggest**. Some graphical reinterpretation errors are also apparent, such as lines appearing where they shouldn't.

Front cover



Back cover



Acknowledgements

This booklet has been made possible through the technical expertise provided by K&M Print, Palmerston North, NZ (www.kmprint.co.nz), and input from Dr . Alan Palmer and Prof. Vince Neall (pedologists at Massey University, NZ). Commercial resources have been used as reference colour standards for checking final colour reproduction accuracy (Revised Standard Soil Color Charts, Munsell Soil Color Charts, Munsell Book of Color). Photos by T. Anthony.

Prepared by A.K. Manderson, 2001

Bibliographic Reference

Manderson, A.K. (2001). New Zealand Soil Colour Charts. *Institute of Natural Resources - Massey University, Soil & Earth Sciences Occasional Publication No.2.* ISSN 1175-4966

Introduction

This booklet represents an affordable and easily replaceable tool for those interested in describing soil colour in the field. It is designed to be quick and easy to use, and aims to account for a slightly increased range of soil colours not usually found in conventional soil colour charts.

To describe soil colour using this booklet, the reader must be familiar with the Munsell Color System. For those who are not, a brief procedure is provided below. A more comprehensive review is included as the accompanying *Describing soil colour according to the Munsell System.*

Procedure for describing soil colour

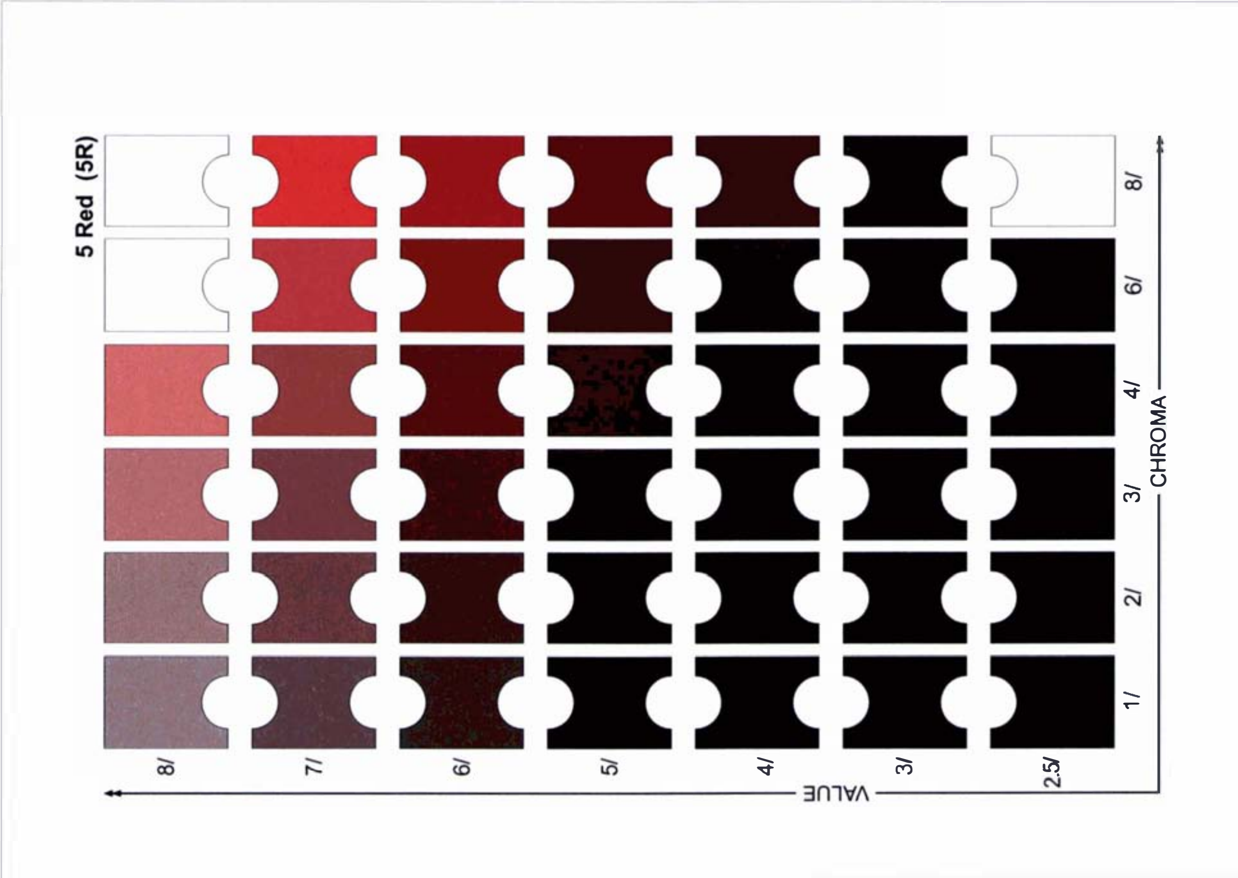
1. Take a small sample of moist soil (about the size of a 50c peice) and observe the most dominant soil colour.
2. Leaf through the booklet to identify the page or pages the soil colour is likely to appear in. This is considerably easier if the user has taken the time to familiarise themselves with the layout of the booklet and the structure of the Munsell Color System.
3. Position yourself so the sunlight is coming over your shoulder. Use the methods presented on the back cover to move the soil sample around the page until the closest possible match is obtained. **Rarely will colours match perfectly**.
4. When the closest colour has been identified, record it both using the Munsell notation (example below) and it's common name.

Munsell Notation:	**HUE / VALUE / CHROMA**
Example:	5YR/5/2 denotes a colour with a *5 Yellow Red* hue, a value of *5*, and a chroma of *2*.
Common Name:	5YR/5/2 = reddish grey

This booklet avoids the traditional high cost of conventional soil colour charts through using recent advances in printing technology. It is recommended that the booklet only be used in lighting conditions commonly experienced outdoors. *Munsell Soil Color Charts*, the *Munsell Book of Color*, or the *Revised Standard Soil Color Charts* are recommended in situations where lighting standards can be more tightly controlled and defined.

Any feedback about this booklet is welcomed. The idea is to develop an affordable and robust tool that can be used to more adequately describe the range of soil colours apparent in New Zealand soil-forming environments. Please direct any feedback to:

A.K. Manderson (PhD Candidate),
Institute of Natural Resources (Soils),
Massey University, Private Bag 11 222, Palmerston North
New Zealand



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CHROMA
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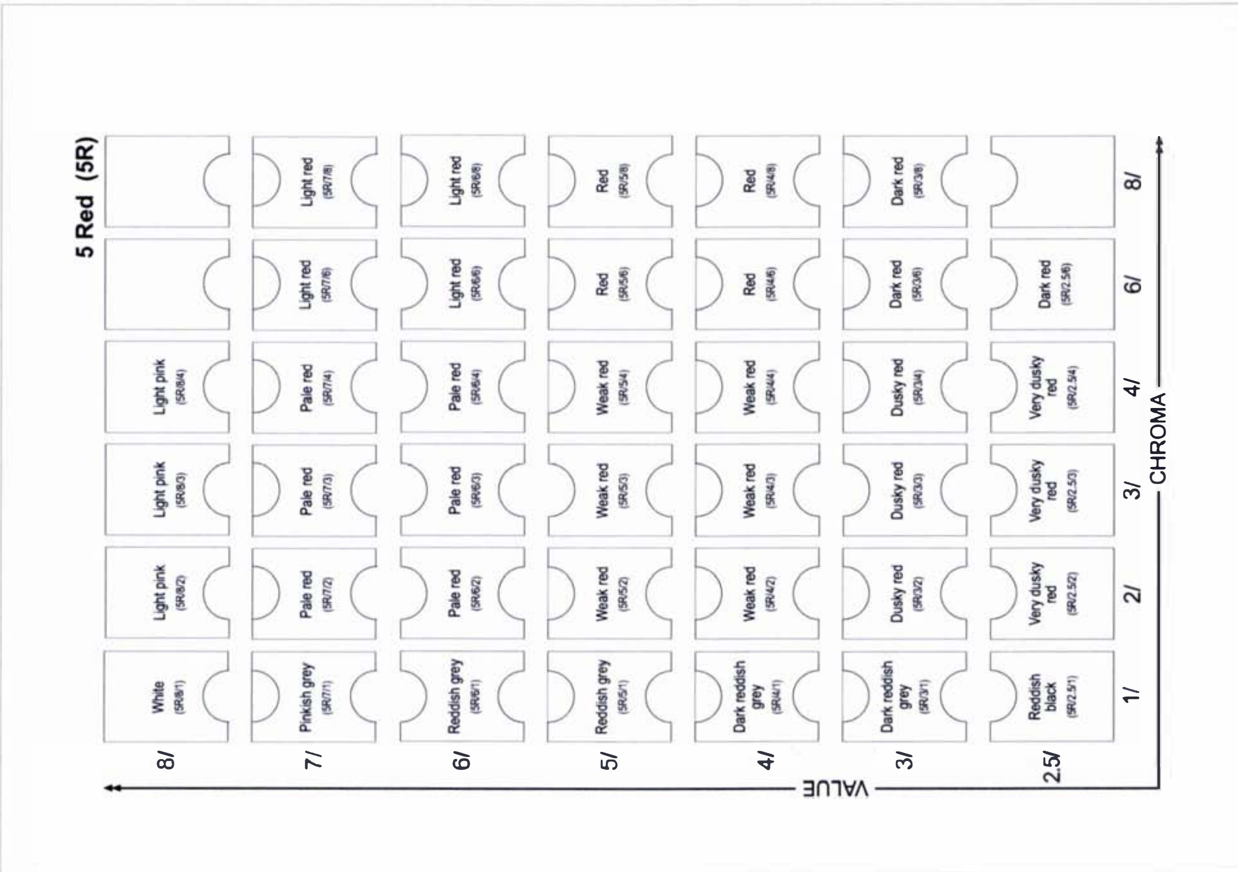

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VALUE
CHROMA
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Light pink
Light pink
7/
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Pale red
Pale red
Pale red
Light red
Light red
6/
Reddish grey
Pale red
Pale red
Pale red
Light red
Light red
5/
Reddish grey
Weak red
Weak red
Weak red
Red
Red
4/
Dark reddish grey
Weak red
Weak red
Weak red
Red
Red
3/
Dark reddish grey
Dusky red
Dusky red
Dusky red
Dark red
Dark red
2.5/
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Very dusky red
Very dusky red
Dark red
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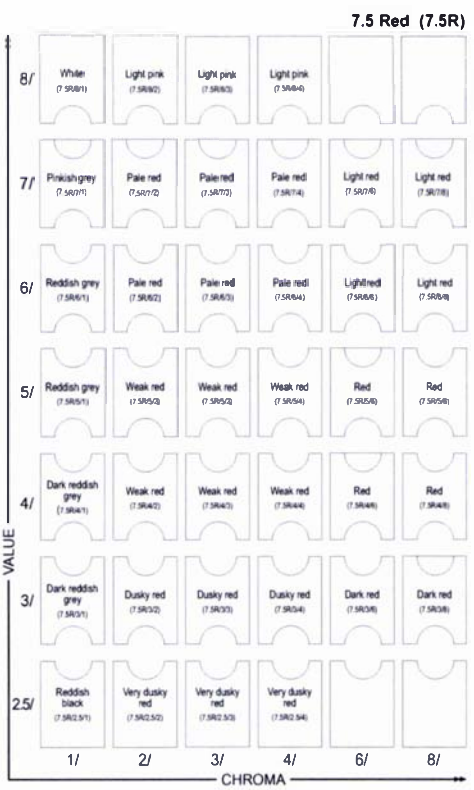

7.5 Red (7.5R)
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White
Light pink
Light pink
Light pink
Pinkish grey
Pale red
Pale red
Pale red
Light red
Light red
Reddish grey
Pale red
Pale red
Pale red
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Light red
Reddish grey
Weak red
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Red
Dark reddish grey
Weak red
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Weak red
Red
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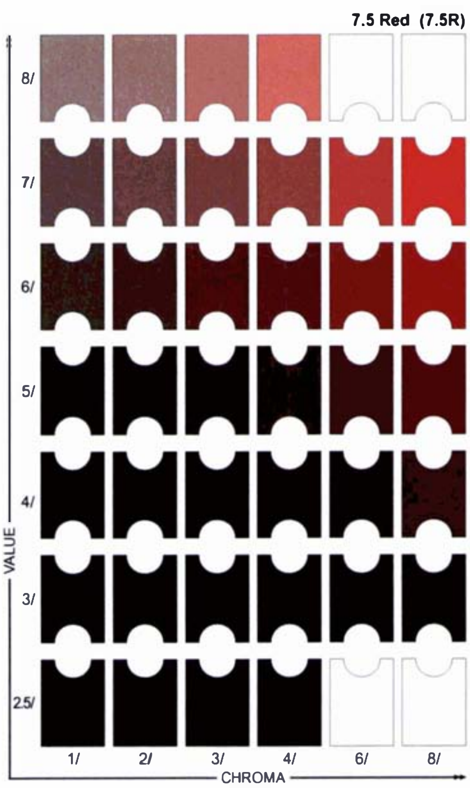
Very dusky red
Very dusky red



7.5 Red (7.5R)
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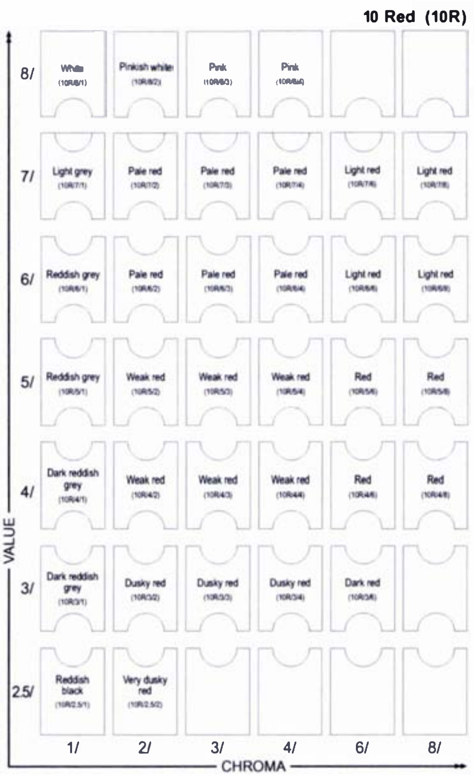

10 Red (10R)
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CHROMA
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White
Pinkish white
Pink
Pink
Light grey
Pale red
Pale red
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Light red
Light red
Reddish grey
Pale red
Pale red
Pale red
Light red
Light red
Reddish grey
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Red
Red
Dark reddish grey
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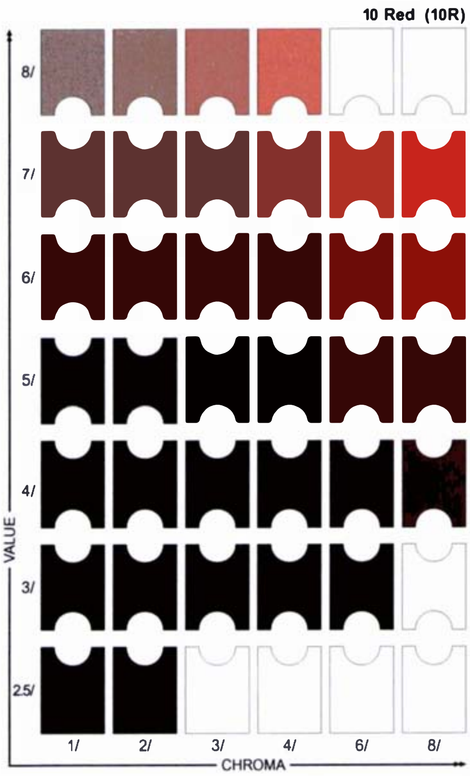
Very dusky red



10 Red (10R)
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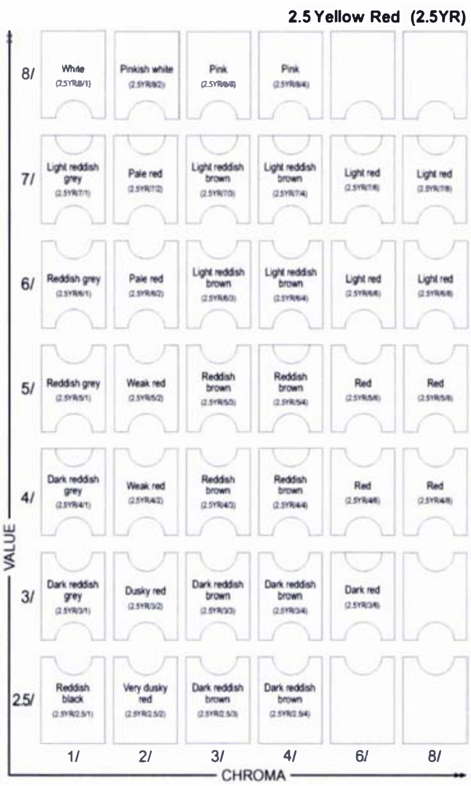
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Light reddish grey
Pale red
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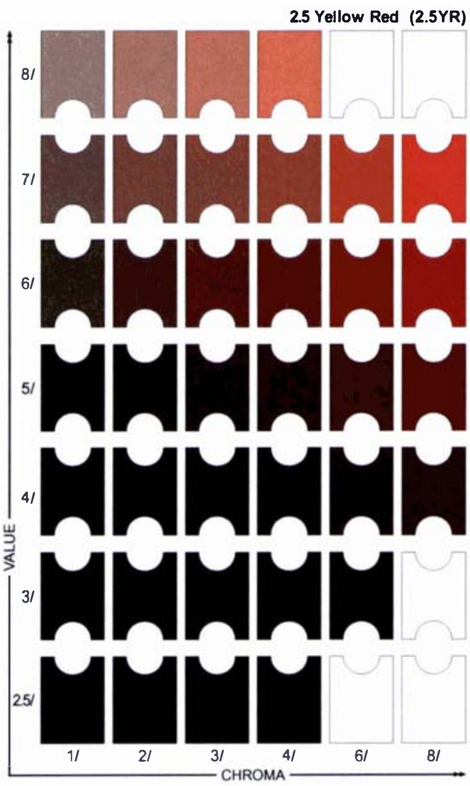
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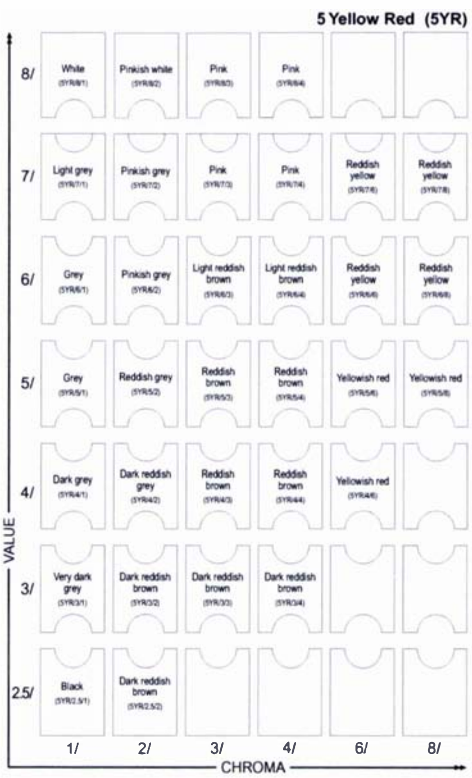
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Pink
Reddish yellow
Reddish yellow
Grey
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Light reddish brown
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Reddish yellow
Grey
Reddish grey
Reddish brown
Reddish brown
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Yellowish red
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Yellowish red
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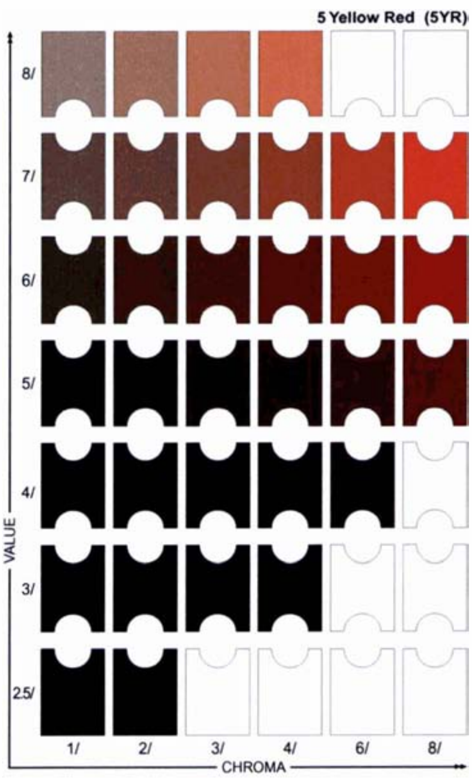
CHROMA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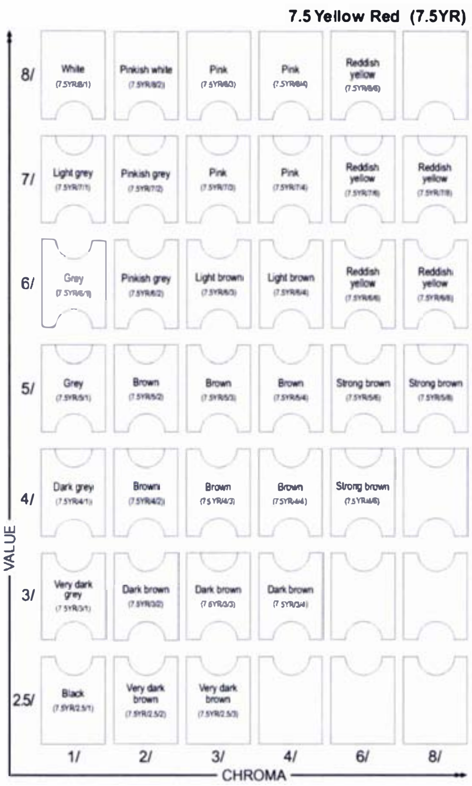
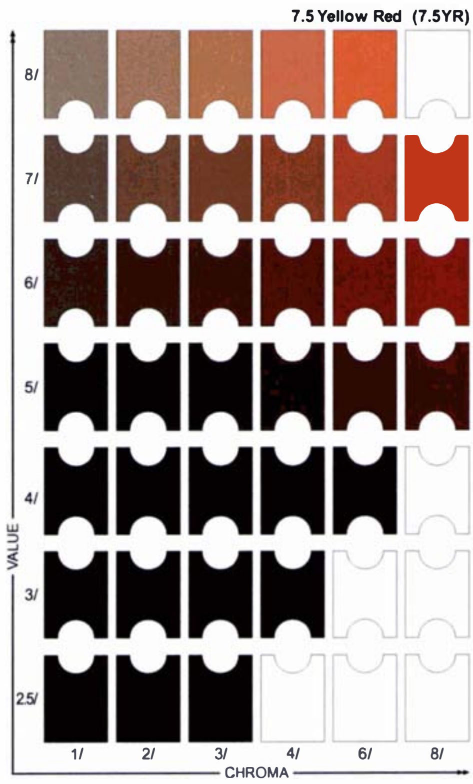
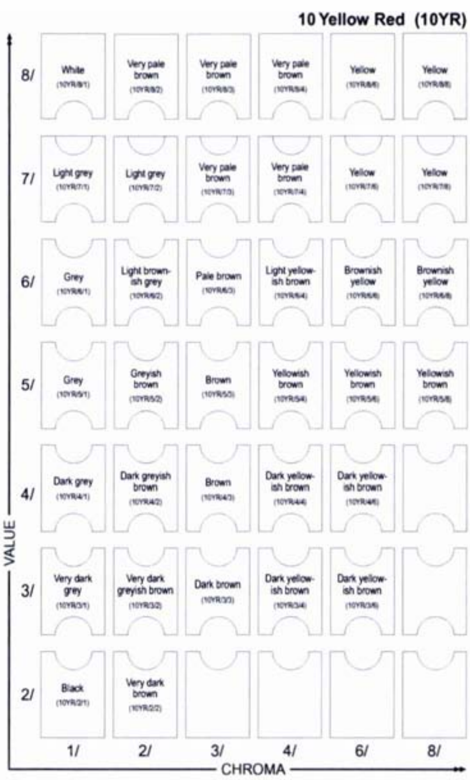
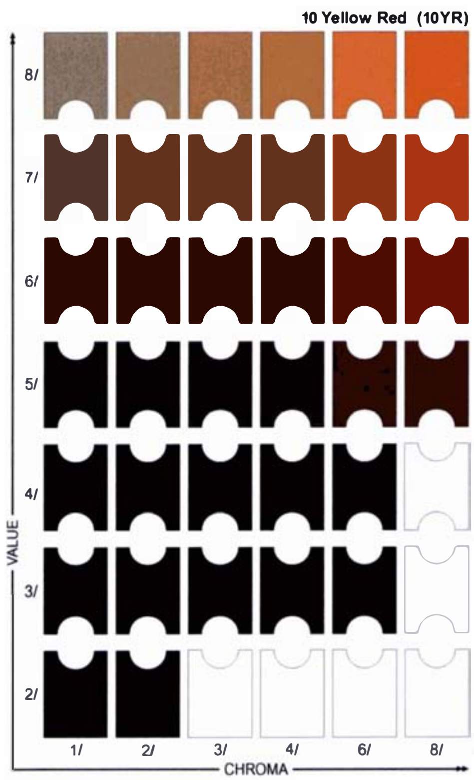
CHROMA


7.5 Yellow Red (7.5YR)
8/
White (7.5YR/8/1)
Pinkish white (7.5YR/8/2)
Pink (7.5YR/8/3)
Pink (7.5YR/8/4)
Reddish yellow (7.5YR/8/6)
7/
Light grey (7.5YR/7/1)
Pinkish grey (7.5YR/7/2)
Pink (7.5YR/7/3)
Pink (7.5YR/7/4)
Reddish yellow (7.5YR/7/6)
Reddish yellow (7.5YR/7/8)
6/
Grey (7.5YR/6/1)
Pinkish grey (7.5YR/6/2)
Light brown (7.5YR/6/3)
Light brown (7.5YR/6/4)
Reddish yellow (7.5YR/6/6)
Reddish yellow (7.5YR/6/8)
5/
Grey (7.5YR/5/1)
Brown (7.5YR/5/2)
Brown (7.5YR/5/3)
Brown (7.5YR/5/4)
Strong brown (7.5YR/5/6)
Strong brown (7.5YR/5/8)
4/
Dark grey (7.5YR/4/1)
Brown (7.5YR/4/2)
Brown (7.5 YR/4/3)
Brown (7.5YR/4/4)
Strong brown (7.5YR/4/6)
3/
Very dark grey (7.5YR/3/1)
Dark brown (7.5YR/3/2)
Dark brown (7.6YR/3/3)
Dark brown (7.5YR/3/4)
2.5/
Black (7.5YR/2.5/1)
Very dark brown (7.5YR/2.5/2)
Very dark brown (7.5YR/2.5/3)
1/
2/
3/
4/
6/
8/
VALUE
CHROMA


7.5 Yellow Red (7.5YR)
8/
7/
6/
5/
4/
3/
2.5/
1/
2/
3/
4/
6/
8/
VALUE
CHROMA


10 Yellow Red (10YR)
8/
White (10YR/8/1)
Very pale brown (10YR/8/2)
Very pale brown (10YR/8/3)
Very pale brown (10YR/8/4)
Yellow (10YR/8/6)
Yellow (10YR/8/8)
7/
Light grey (10YR/7/1)
Light grey (10YR/7/2)
Very pale brown (10YR/7/3)
Very pale brown (10YR/7/4)
Yellow (10YR/7/6)
Yellow (10YR/7/8)
6/
Grey (10YR/6/1)
Light brownish grey (10YR/6/2)
Pale brown (10YR/6/3)
Light yellowish brown (10YR/6/4)
Brownish yellow (10YR/6/6)
Brownish yellow (10YR/6/8)
5/
Grey (10YR/5/1)
Greyish brown (10YR/5/2)
Brown (10YR/5/3)
Yellowish brown (10YR/5/4)
Yellowish brown (10YR/5/6)
Yellowish brown (10YR/5/8)
4/
Dark grey (10YR/4/1)
Dark greyish brown (10YR/4/2)
Brown (10YR/4/3)
Dark yellowish brown (10YR/4/4)
Dark yellowish brown (10YR/4/6)
3/
Very dark grey (10YR/3/1)
Very dark greyish brown (10YR/3/2)
Dark brown (10YR/3/3)
Dark yellowish brown (10YR/3/4)
Dark yellowish brown (10YR/3/6)
2/
Black (10YR/2/1)
Very dark brown (10YR/2/2)
1/
2/
3/
4/
6/
8/
VALUE
CHROMA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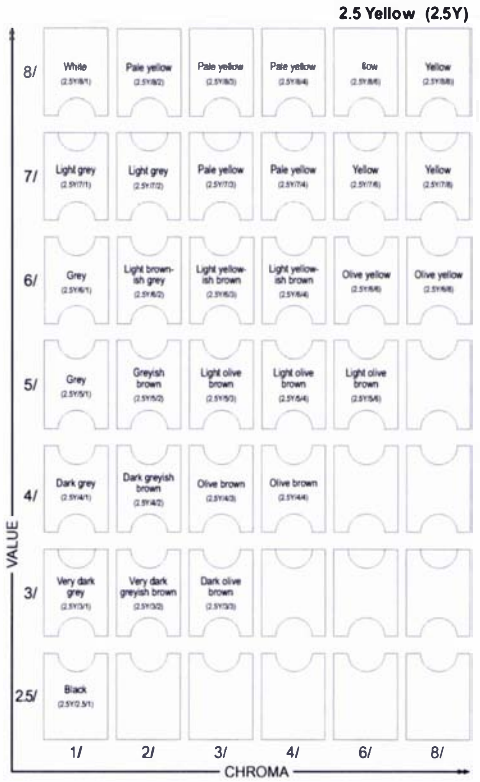
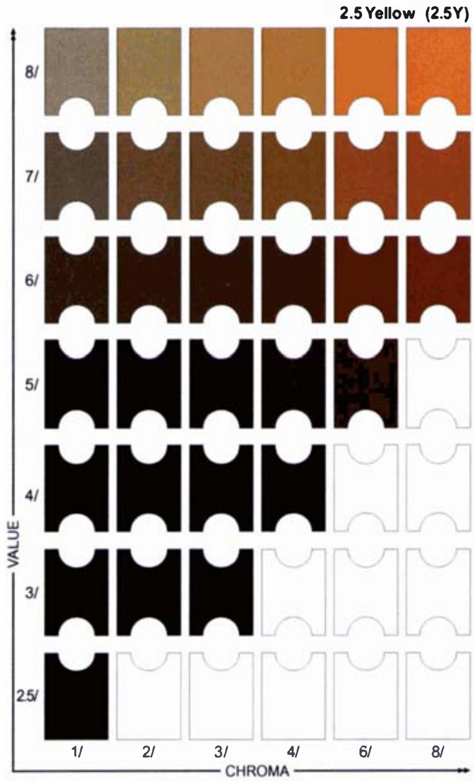
8/
7/
6/
5/
4/
3/
2/
1/
2/
3/
4/
6/
8/
VALUE
CHROMA


2.5 Yellow (2.5Y)
8/
White
Pale yellow
Pale yellow
Pale yellow
llow
Yellow
7/
Light grey
Light grey
Pale yellow
Pale yellow
Yellow
Yellow
6/
Grey
Light brown-ish grey
Light yellow-ish brown
Light yellow-ish brown
Olive yellow
Olive yellow
5/
Grey
Greyish brown
Light olive brown
Light olive brown
Light olive brown
4/
Dark grey
Dark greyish brown
Olive brown
Olive brown
3/
Very dark grey
Very dark greyish brown
Dark olive brown
2.5/
Black
1/
2/
3/
4/
6/
8/
CHROMA
VALUE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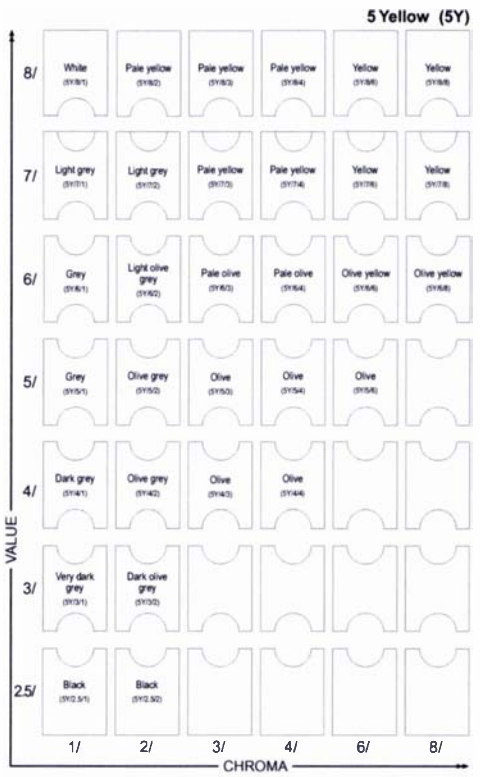
8/
7/
6/
5/
4/
3/
2.5/
1/
2/
3/
4/
6/
8/
CHROMA
VALUE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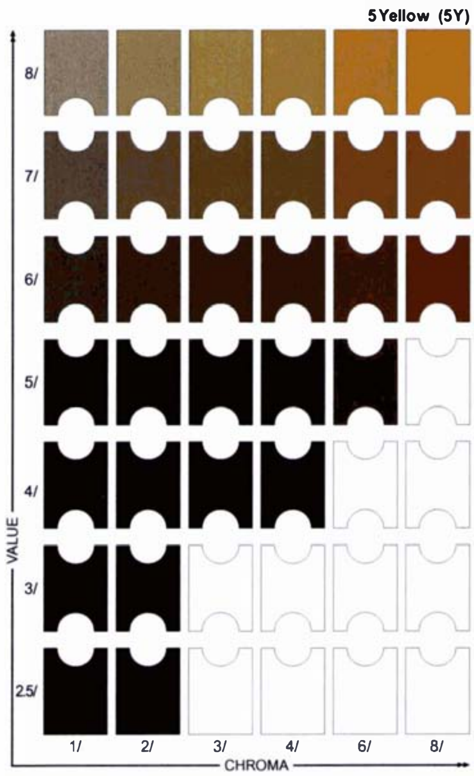
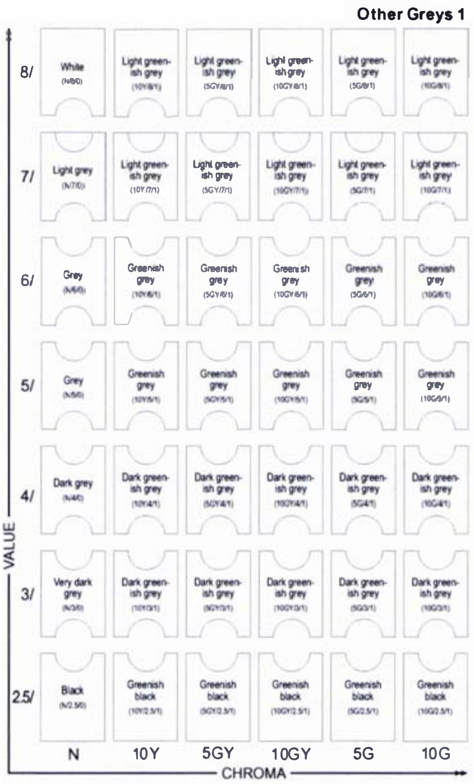
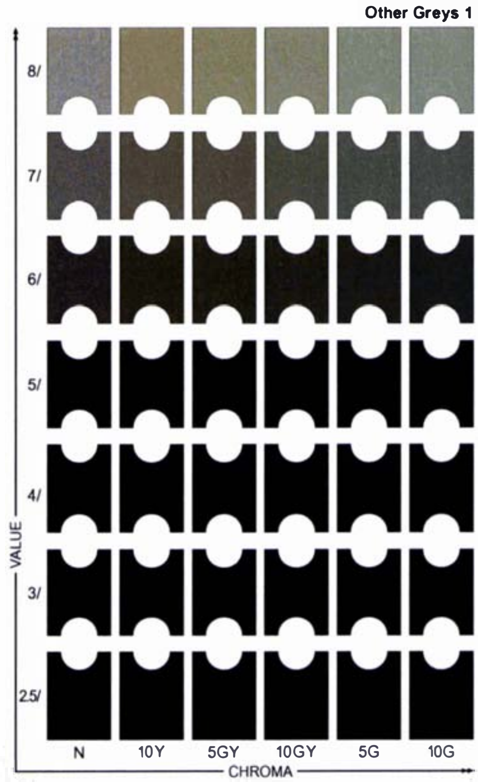
8/
White
Pale yellow
Pale yellow
Pale yellow
Yellow
Yellow
7/
Light grey
Light grey
Pale yellow
Pale yellow
Yellow
Yellow
6/
Grey
Light olive grey
Pale olive
Pale olive
Olive yellow
Olive yellow
5/
Grey
Olive grey
Olive
Olive
Olive
4/
Dark grey
Olive grey
Olive
Olive
3/
Very dark grey
Dark olive grey
2.5/
Black
Black
1/
2/
3/
4/
6/
8/
CHROMA
VALUE


5 Yellow (5Y)
8/
7/
6/
5/
4/
3/
2.5/
1/
2/
3/
4/
6/
8/
CHROMA
VALUE


Other Greys 1
8/
White (N/8/0)
Light greenish grey (10Y/8/1)
Light greenish grey (5GY/8/1)
Light greenish grey (10GY/8/1)
Light greenish grey (5G/8/1)
Light greenish grey (10G/8/1)
7/
Light grey (N/7/0)
Light greenish grey (10Y/7/1)
Light greenish grey (5GY/7/1)
Light greenish grey (10GY/7/1)
Light greenish grey (5G/7/1)
Light greenish grey (10G/7/1)
6/
Grey (N/6/0)
Greenish grey (10Y/6/1)
Greenish grey (5GY/6/1)
Greenish grey (10GY/6/1)
Greenish grey (5G/6/1)
Greenish grey (10G/6/1)
5/
Grey (N/5/0)
Greenish grey (10Y/5/1)
Greenish grey (5GY/5/1)
Greenish grey (10GY/5/1)
Greenish grey (5G/5/1)
Greenish grey (10G/5/1)
4/
Dark grey (N/4/0)
Dark greenish grey (10Y/4/1)
Dark greenish grey (5GY/4/1)
Dark greenish grey (10GY/4/1)
Dark greenish grey (5G/4/1)
Dark greenish grey (10G/4/1)
3/
Very dark grey (N/3/0)
Dark greenish grey (10Y/3/1)
Dark greenish grey (5GY/3/1)
Dark greenish grey (10GY/3/1)
Dark greenish grey (5G/3/1)
Dark greenish grey (10G/3/1)
2.5/
Black (N/2.5/0)
Greenish black (10Y/2.5/1)
Greenish black (5GY/2.5/1)
Greenish black (10GY/2.5/1)
Greenish black (5G/2.5/1)
Greenish black (10G/2.5/1)
N
10Y
5GY
10GY
5G
10G
VALUE
CHROMA


Other Greys 1
8/
7/
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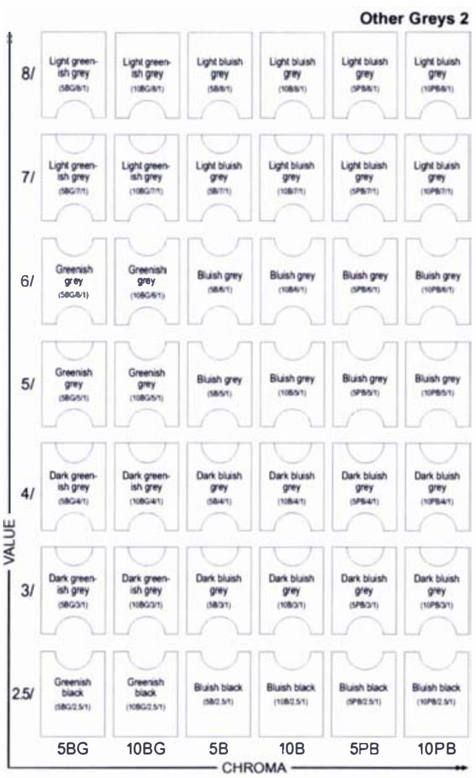
5/
4/
3/
2.5/
VALUE
N
10Y
5GY
10GY
5G
10G
CHROMA


Other Greys 2
8/
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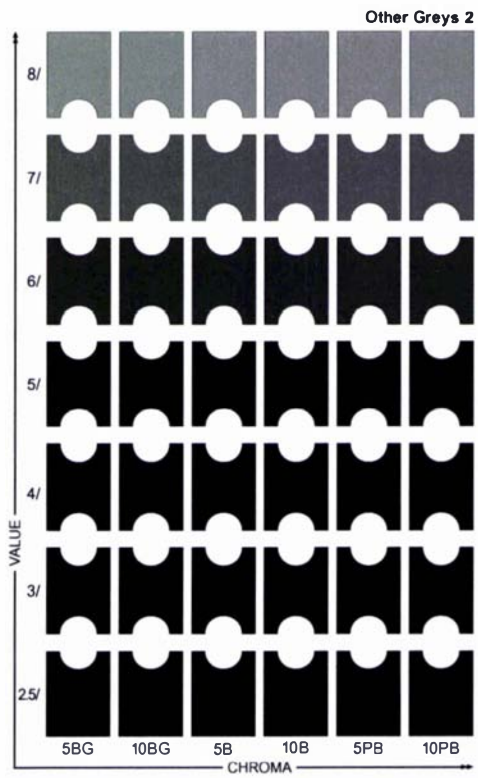
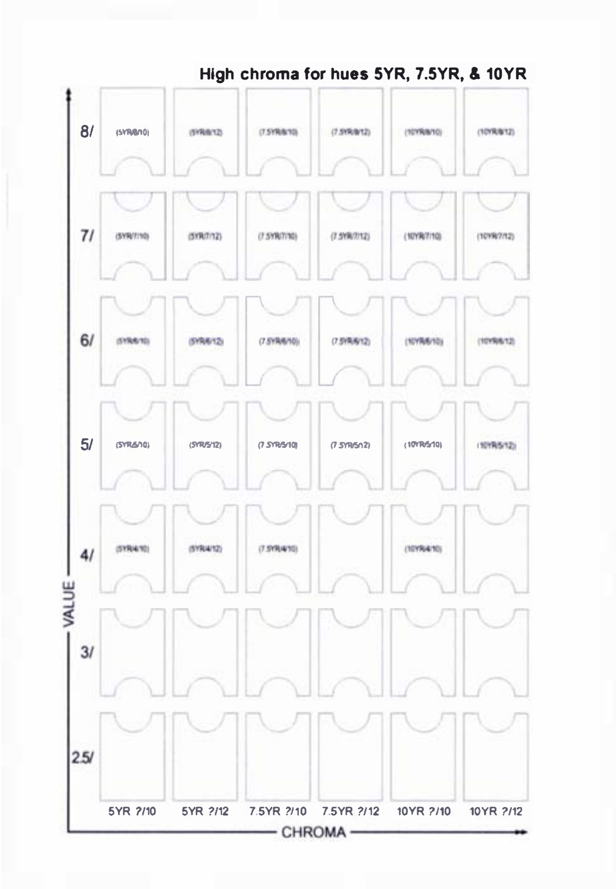
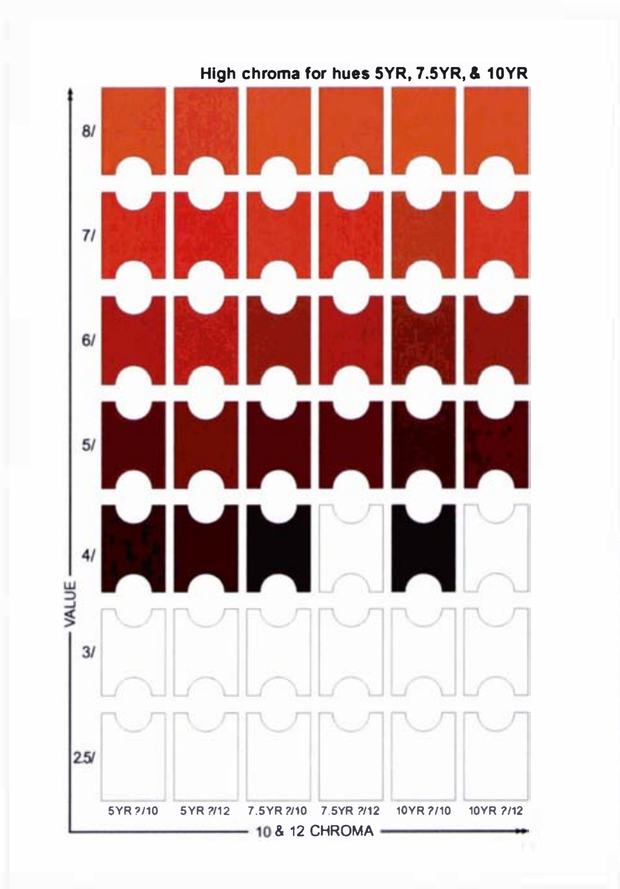
Light greenish grey (10BG/8/1)
Light bluish grey (5B/8/1)
Light bluish grey (10B/8/1)
Light bluish grey (5PB/8/1)
Light bluish grey (10PB/8/1)
7/
Light greenish grey (5BG/7/1)
Light greenish grey (10BG/7/1)
Light bluish grey (5B/7/1)
Light bluish grey (10B/7/1)
Light bluish grey (5PB/7/1)
Light bluish grey (10PB/7/1)
6/
Greenish grey (5BG/6/1)
Greenish grey (10BG/6/1)
Bluish grey (5B/6/1)
Bluish grey (10B/6/1)
Bluish grey (5PB/6/1)
Bluish grey (10PB/6/1)
5/
Greenish grey (5BG/5/1)
Greenish grey (10BG/5/1)
Bluish grey (5B/5/1)
Bluish grey (10B/5/1)
Bluish grey (5PB/5/1)
Bluish grey (10PB/5/1)
4/
Dark greenish grey (5BG/4/1)
Dark greenish grey (10BG/4/1)
Dark bluish grey (5B/4/1)
Dark bluish grey (10B/4/1)
Dark bluish grey (5PB/4/1)
Dark bluish grey (10PB/4/1)
3/
Dark greenish grey (5BG/3/1)
Dark greenish grey (10BG/3/1)
Dark bluish grey (5B/3/1)
Dark bluish grey (10B/3/1)
Dark bluish grey (5PB/3/1)
Dark bluish grey (10PB/3/1)
2.5/
Greenish black (5BG/2.5/1)
Greenish black (10BG/2.5/1)
Bluish black (5B/2.5/1)
Bluish black (10B/2.5/1)
Bluish black (5PB/2.5/1)
Bluish black (10PB/2.5/1)
5BG
10BG
5B
10B
5PB
10PB
VALUE
CHROMA


Other Greys 2
8/
7/
6/
5/
4/
3/
2.5/
VALUE
5BG
10BG
5B
10B
5PB
10PB
CHROMA





8.4. CURRENT STATUS

As of October 2003, the Colour Chart Booklet has not been printed. In nearing the end of his PhD term, the author can no longer afford to invest the $5259 required for press printing. Likewise, sponsorship through advertising could not be secured without an actual example of the finished product (necessary for demonstrating that the Munsell colours can be reproduced at a reasonable accuracy using the described method).

The project will be abandoned unless some other party is prepared to invest in the final cost of production.

SOIL DESCRIPTION LAMINATES

Soil description is one of the two main components of soil survey (the other being soil mapping). It typically involves the selection of a soil site; a description of the surrounding soil-forming environment (topography, vegetation, climatic factors, *etc.*); and a soil profile description that focuses on a set of readily measurable soil attributes by soil horizon (*i.e.* in-the-field & mostly empirical measures of soil colour, texture, structure, drainage, strength, consistence, *etc.*). Brief soil descriptions may be undertaken at the start of a soil survey for calibration and familiarisation purposes, or during the survey as a detailed method of observation for soil mapping (*cf.* auger observations). Comprehensive descriptions are undertaken at the end of a survey for representative soils, to provide a permanent record and a basis for soil classification.

Detailed explanations and instructions for undertaking soil description are provided in soil survey manuals (*e.g.* USDA, 1952; Taylor & Pohlen, 1962; Gunn *et al.*, 1988), while standards and less detailed instructions may be included as separate field guides (*e.g.* McDonald *et al.*, 1984; Milne *et al.*, 1995). These tend to be scientific publications with detailed and technical specifications for describing a large number of soil attributes in a rigorous manner (which is necessary for reliable and consistent soil classification). Using such guides can be daunting and unwieldy to a novice, particularly during an actual soil description exercise (when he or she is trying to reference between many different pages with soiled hands, while at the same time taking samples and recording results). Further, undertaking a complete soil description according to such guidelines can be time consuming, and may involve up to a day for a single soil in some cases.

It is unlikely that farmers involved in the Soils Underpinning Business Success (SUBS) programme would be willing to invest a large amount of time describing soils. Likewise, because soil classification is not the intended endpoint of SUBS, the range of attributes and degree of scientific rigour provided by published guidelines is unnecessary. For students and professional soil surveyors (who are familiar with soil description methods), often all that is required is occasional prompts or summaries of particularly difficult guideline steps.

This project aims to develop a set of soil description guidelines to assist both farmers and students with in-the-field determination of key soil attributes. Such a resource would allow SUBS farmers to attain a greater degree of quality and consistency in their soil descriptions (with a minimal investment of time), while students and others would have available an aid for expediting the soil description process.

8.5. APPROACH

Only soil attributes that most closely relate to soil mapping in NZ were considered for inclusion. A total of seven primary attributes were selected after consultation with Massey University pedologists and reference to several soil description handbooks. Attributes include: soil colour; texture (eleven classes); structure (degree of development, ped form, & ped size); mottle characteristics (abundance, colour, size, contrast, boundary sharpness); horizon boundaries (shape & sharpness); drainage (five classes); and soil consistence (friability, plasticity, stickiness).

Methods and specifications for assessing each attribute were derived from soil description publications, many of which repeat the same or slightly modified method without an original reference. Particular use was made of Molloy (1988); Neall & Palmer (1996); McLaren & Cameron (1996); and Milne *et al.* (1995). Flowcharts were modified to conform with the selected layout and format (see below), and instructions were reworded to minimise scientific jargon and to promote understanding from a wider audience. Student versions were designed to include additional guidelines concerning soil classification, while farmer versions include recommendations on soil mapping and a 'profile description checklist'.

A single set of soil description resources was purposely limited to three double-sided A4 pages (210 x 297mm) to maximise in-the-field manageability and use, and to keep production costs to a minimum. Layout and graphic design was undertaken using Adobe's Illustrator 10, Photoshop 6, and InDesign 1.5 applications. Each page was laminated to improve durability, and to overcome in-the-field usage problems associated with soiling and wetness.

Producing affordable and consistent soil colour charts was particularly challenging. As an interim measure during the development of the Soil Colour Booklet, a simple set of RGB charts were created using graphics functions of Microsoft Word. While these charts were initially created for demonstration purposes only, they were subsequently used by a SUBS group in the absence of published colour charts (published charts were too expensive – see Section 8.2).

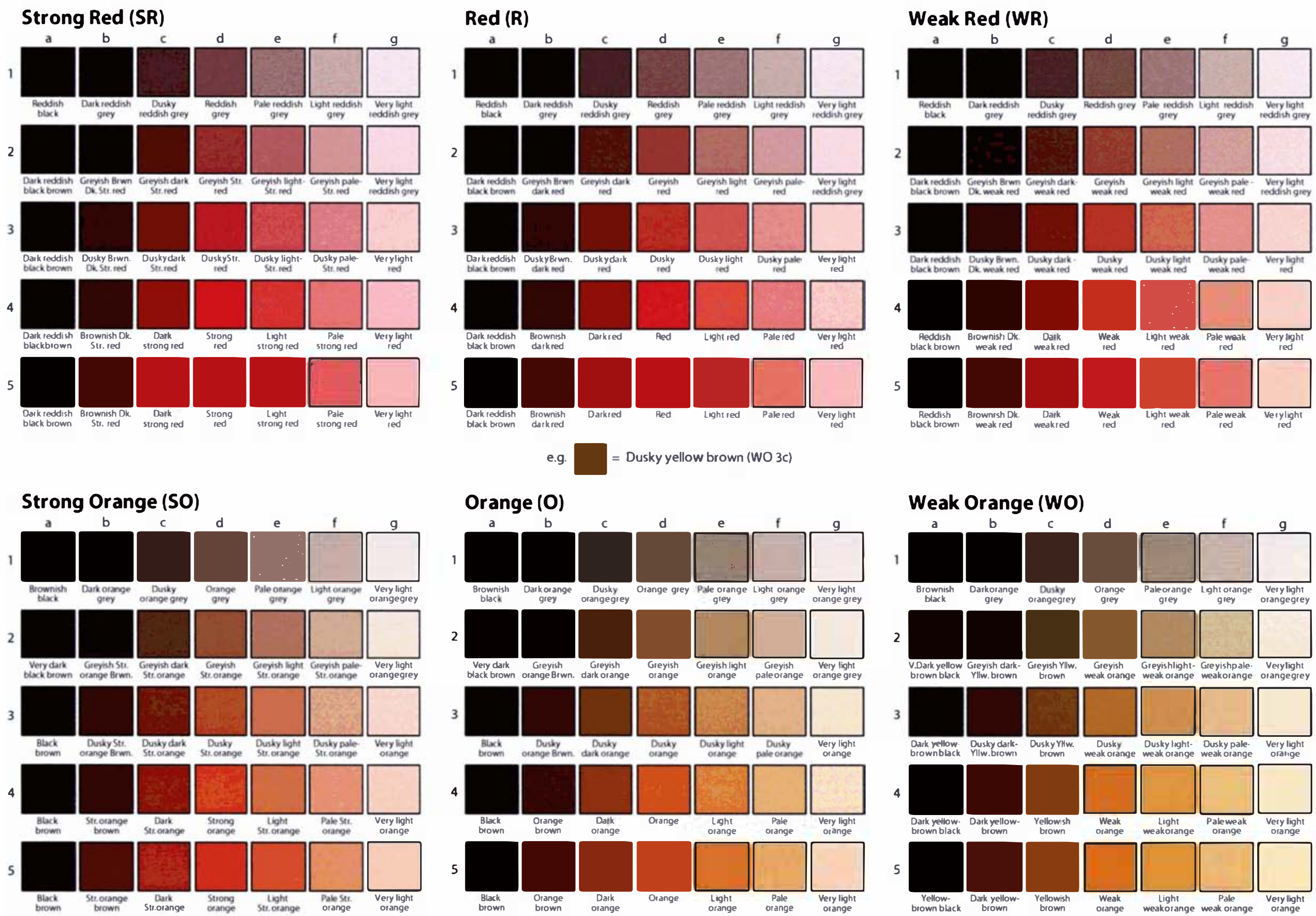
The RGB charts proved to be adequate, and highlighted Munsell colours as being unnecessary for acquiring a consistent colour distinction between different soils – farmers were primarily concerned with mapping different soils as they occur on their own farms, rather than classifying their soils according to standards laid down in soil classification taxonomies. Munsell colours were unnecessary because colour comparisons and correlations were not being made with any soils that occur outside a given farm. Further, if soil classification was a desired endpoint, then a soil colour identified from an RGB chart could be correlated with its Munsell equivalent in most cases (by comparing the two different charts). The RGB charts were later imported into a graphics application and refined, which included the assignation of colour names considered to be more attune to those in common usage.

8.6. RESULTS

The most recent set of soil description resources is presented in the following pages. They have been reduced 80% and some graphic translation errors are apparent (mainly as lines that do not appear in postscript versions). One version has been designed for SUBS farmers, and another for students (differentiated by one page only – both pages are presented here).

Colour separation for the RGB colour charts is likely to be poor, as this thesis is to be outputted through a commercial laser printer. Such printers tend to saturate colour, and therefore have limited colour separation capabilities. Quality colour separation can be achieved through inkjet and specialist laser printers.

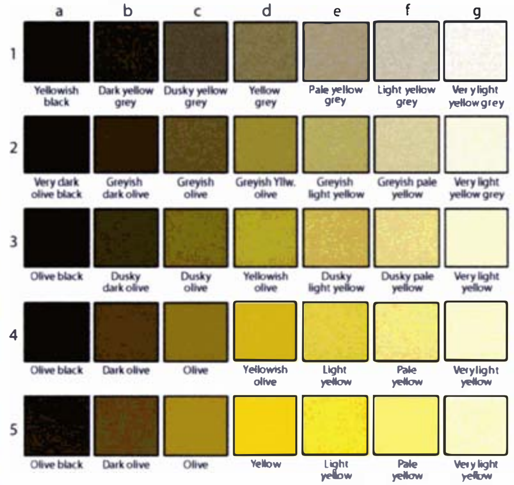
RGB Colour Charts - Page 1.



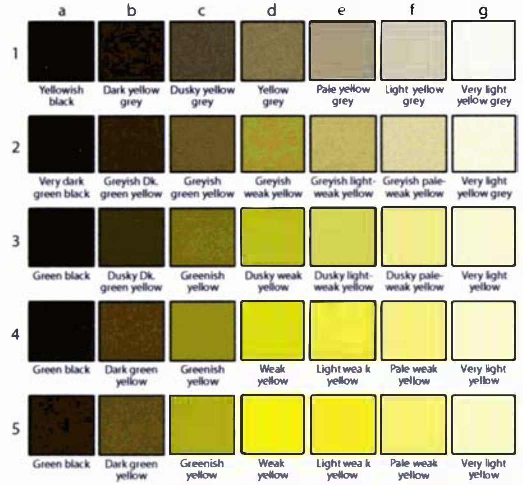
RGB Colour Charts - Page 2.

Strong Yellow (SY)

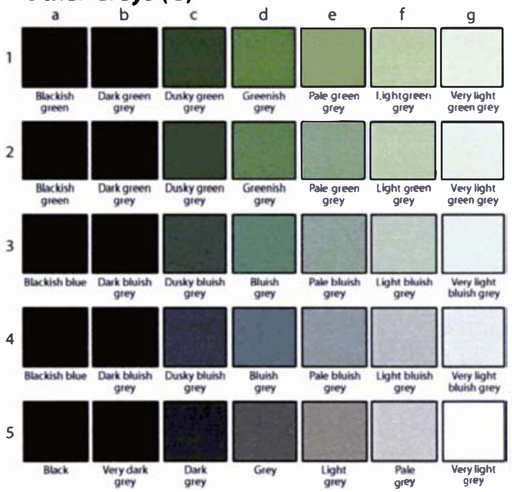
Yellow (Y)



Weak Yellow (WY)



Other Greys (G)



Procedure for determining soil colour

1. Take a small sample of moist soil (about the size of a 50c piece) and place it on the surface of the laminated charts.
2. Place your back to the sun so the light is shining over your shoulder.
3. Look very closely at the sample to determine any hint of primary colour (red, brown, orange, etc.). Focus on extreme or dominant colours only. If necessary, up-to two dominant colours can be described for a single horizon or mottle.
4. Move the soil sample around over the different colour charts until the best possible colour match can be obtained. **Rarely will colours match perfectly**, so only aim for getting a reasonably close match. Please also note that colours found in Most NZ soils are likely to fall within the *Strong Orange*, *Orange*, *Weak Orange*, and *Strong Yellow* colour charts.
5. Some people find this procedure easier using a mask, which helps minimise the distraction of having too many similar colours close to each other. To make a mask, simply cut a 2.5cm x 2.5cm square aperture from a half-page sized piece of card. To use, place the soil sample on the card next to the aperture, and move around the colour charts (viewing each colour through the aperture).
6. When the closest reasonable colour match has been identified, record it firstly by the colour name (e.g. *dark olive yellow*), and secondly by the reference code (e.g. *SY 4b*). Structure for the reference code is: colour group (e.g. *Strong Orange*, *Orange*, etc.), row (*1*,*2*,*3*, etc.), and then column (*a*,*b*,*c*, etc.).

Example:  *= dark olive yellow (SY 4b)*

Charts_version10.pdf   Prepared using HSL colour model   A.K.Manderson, 2002

Guidelines for Describing Soil Attributes - Page 1a (Student Version).

Soil description checklist

1

Site description checklist

a) **Location** (map grid reference, district location, distance & direction from a significant town)
b) **Topography** (slope, elevation, aspect, & dominant landform)
c) **Vegetation** (past vegetation species if known, present vegetation species within the site locale)
d) **Parent material or geology**

2

Profile description checklist

a) **Horizon**
- Depth
- Master & subordinate horizon designations
- Horizon colour(s)
- Horizon boundary transition shape
- Horizon boundary transition sharpness

b) **Horizon mottling**
- Mottle colour(s)
- Mottle abundance
- Mottle contrast
- Mottle size
- Mottle boundary transition sharpness

c) **Horizon texture**

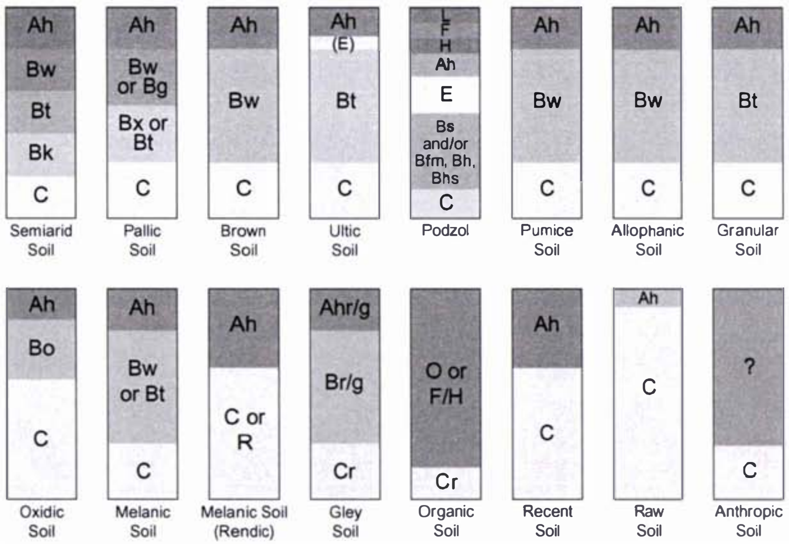
d) **Horizon structure**
- Degree of development
- Ped shape
- Ped size

e) **Horizon consistence**
- Plasticity and/or
- Friability and/or
- Stickiness

f) **Drainage**

g) **Miscellaneous**
- Horizon root abundance
- Stoniness (%)
- Stone size

Representative profiles



Representative profiles redrawn from McLaren & Cameron (1996)

Master horizons

1

Organic horizons

O Organic horizon accumulated under waterlogged conditions (eg. peat). O-horizons are further classified according to the degree of decomposition:

Of	*Fibric horizon.*	Contains large amounts of well preserved fibre.
Om	*Mesic horizon*	Exhibits an intermediate degree of decomposition
Oh	*Humic horizon.*	Well decomposed - orginal structures of organic material are unrecogniable.

L Fresh litter deposited during the previous annual cycle onto a mineral soil, and exhibiting little visual decomposition.

F Partly decomposed vegetation accumulated under moist & (predominantly) aerobic conditions on a mineral soil.

H Well decomposed vegetation accumulated under moist & (predominantly) aerobic conditions, often mixed with mineral matter. Generally, original plant structures cannot be distinguished.

2

Mineral horizons

A Mineral horizon formed at the surface (topsoil) or below an organic horizon, and characterised by incorporation of humified organic matter. Incorporation is through biological activity or cultivation (cf. translocation). A-horizons are generally browner, blacker, or darker than the underlying subsoil.

A/B Transitional horizon between topsoil and subsoil. Commonly a worm-mixed horizon found in soils under grassland.

E Subsurface mineral horizon (below H, O, or A horizon) from which clay, iron, aluminium or organic matter have been eluviated to the underlying horizon (e.g. leached), leaving behind an horizon pale in colour (whitish or pale grey) and with relatively coarser texture (E = Eluvial).

B Mineral horizon without readily distinguishable rock structure (i.e. well weathered), normally underlying A or E horizons, and has one or more of the following characteristics:

An illuvial concentration	*An accumulation of clay, iron, aluminium, or humus (on their own or in combination) in a B horizon through illuviation processes.*
Sesquioxide coatings	*Sesquioxides that have remained within the horizon as coatings, attributing the horizon with a relatively higher chroma or degree of reddishness.*
An alteration of material	*Alteration of the original material that has formed silicate clay or liberated oxides (or both), and which leads to ped formation (granular, blocky, or prismatic).*
Carbonate removal	*Evidence of solution and removal of carbonates.*

B/C Transitional horizon between B & C (i.e. an horizon with mixed materials from both B & C horizons).

C Unconsolidated or weakly consolidated mineral horizons traditionally refered as soil 'parent material'. Usually exhibiting some degree of modification by weathering but minimal biological activity. C-horizons are designated where the horizon does not meet the requirements of A, E, or B horizons.

R Hard bedrock that is impractical to dig with a spade, and is largely an impediment to downward root development.

Common subordinate horizons

h Accumulation of organic matter in mineral horizons (e.g. Ah, Bh). Should not be used where A-horizon has undergone cultivation.

p A-horizon where organic matter has been incorporated through tillage or fertiliser/manure induced biological activity.

w B-horizon exhibiting evidence of alteration or weathering *in situ*, under well aerated conditions (e.g. changes in colour, clay content, or structure).

s Relatively bright (high chroma) B-horizon resulting from the accumulation of sesquioxides.

t Accumulation of clay usually from upper horizons, normally apparent as clay coatings on ped surfaces.

q Accumulation of secondary silica within an horizon.

b Buried horizon (e.g. buried topsoil).

g Horizon with significant mottling. Oxidized (reddish/yellowish) colours tend to be more prevailant than reduced (greyish) coloured mottles.

r Intensely gleyed horizon of predominanty greyish colours, usually with only little mottling evident.

m Continuously cemented horizon. Used in conjunction with an additional suffix to qualify the cementing material.

c Accumulation of discrete concretions. Used in conjunction with a suffix that indicates the concreting material.

x Compact but uncemented horizon (i.e. fragipan). Compacted material breaks up when wetted.

Prepared from Neall & Palmer; McLaren & Cameron (1996), Milne et al. (1991), and Molloy (1980)

Prepared by A Manderson 2001

Guidelines for Describing Soil Attributes - Page 1b (Farmer Version).

Soil mapping tips

- Soil mapping typically involves two phases. Firstly, a quick reconnaissance map of the whole farm, where the major soil units are identified and drafted onto an aerial photo. This can include brief cursory profile descriptions of obvious soil types. The purpose is to get a good overview without becoming bogged down in detail, and to become familiar with soil mapping procedure. Secondly, a more detailed survey is undertaken (if necessary), consciously targeting areas suitable for more intensive mapping (e.g. high value or complicated areas of land). This second phase usually includes doing detailed profile descriptions of the farm's main soil types.

- A significant change in just one of the following soil-forming factors may indicate a change to a different soil type:
  - A change in slope, aspect, or general landform type
  - A change in the underlying rock or parent material
  - A major change in temperature or rainfall between two different areas
  - A major change in the historical native vegetation cover (e.g. from Rimu to Beech dominated forest), or perhaps a noticeable and persistent occurrence of a particular weed in a localised area

- Mapping flatter areas of land that have similar parent materials can be difficult because visual clues are less obvious. Closer investigation of the following soil factors can be helpful:
  - Changes in soil drainage status (e.g. greyness of the subsoil)
  - Changes in soil texture (e.g. alluvial soils can exhibit major textural changes over short distances)
  - Significant changes in topsoil or whole-soil depth
  - Very minor changes in slope or elevation (i.e. that can only usually be seen from a distance)

- Changes in areas of lightness/darkness on aerial photos can sometimes indicate the extent of a soil type. Black & white aerial photos are perhaps best for this, particularly if they were taken over the summer period (with more droughty soils showing up as light areas). Likewise, comparison between historical aerial photos can also be helpful.

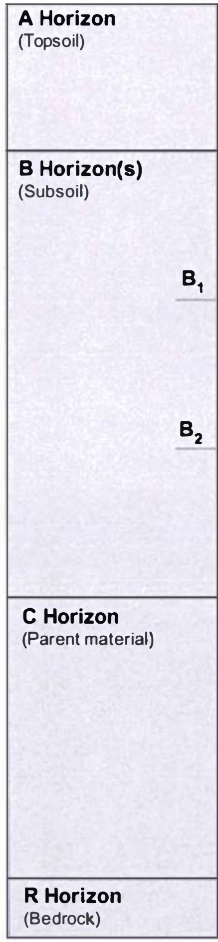
- Sometimes it can be difficult deciding where to draw a boundary line between two different soil types (usually one soil will grade into another over a distance of several meters). If no subtle changes in the land surface are apparent, then often the soil-mapper has to make a judgement (i.e. 'best guess') as to where the boundary line should be.

- Deciding how detailed the soil map should be can be a problem (e.g. is it worth mapping a very small area of a given soil type?). As a general rule, higher-value areas of land should be mapped more intensely than lower value areas. Also, sometimes it's easiest just to map the soil (no matter how small a unit it is), and decide later on whether or not it is worth including in the final map.

- Occasionally two different soils may occur together as a complex or association, and must be mapped as one soil unit. If this is done, a ballpark estimate of the dominance of each soil should be included (e.g. 40% is soil type A: 60% is soil type B), and each soil should have an individual profile description done.

- A site chosen for a soil profile description should represent the entire soil type/unit as best as possible. Again, this may require a 'best guess'.

Profile description checklist



For a reasonably comprehensive soil description, describe **each horizon** in terms of:

1. Horizon thickness (depth) ______
2. Horizon boundaries __________
2. Horizon colour ____________
3. Presence of mottles?
   - Abundance ______________
   - Colour ________________
4. Texture ________________
5. Structure
   - Degree of development ______
   - Ped shape or form _________
   - Ped size ______________
6. Consistence* ______________

* optional

Also record:

1. Topsoil depth ______________
2. Total soil depth ____________ *(to the base of the C horizon)*
3. Drainage class ____________
4. An estimate of stoniness (%) ____

Prepared by A.Manderson 2001

Guidelines for Describing Soil Attributes - Page 2.

Soil Consistence

1 Friability (moist soil consistence)

This test can only be used with a moist soil. Start by taking a sample of soil in your hand and gradually apply increasing crushing pressure.

Noncoherent - soil does not hold together at all	Loose
Soil crushes under very gentle pressure but coheres when pressed together	Very friable
Soil crushes easily under gentle pressure between thumb & forefinger, and coheres when pressed together	Friable
Soil crushes under moderate pressure between thumb & forefinger but resistance is distinctly noticiable	Firm
Soil crushes under strong pressure; barely crushable between thumb & forefinger	Very firm
Soil crushes only under very strong pressure; cannot be crushed between thumb & forefinger	Extremely firm

2 Plasticity (wet soil consistence)

Form a soil 'ribbon' as outlined in the texture flow chart (about half the size of your index finger). Try to roll the soil into a 50mm x 3mm 'worm' in the palm of your hand.

A 50mm x 3mm worm cannot be formed	Nonplastic
A cracked and slightly disjointed worm forms; soil material easily deformable	Slightly plastic
Wire formable; moderate pressure required for deformation of soil material	Plastic
Wire formable; much pressure required for deformation of soil material	Very plastic

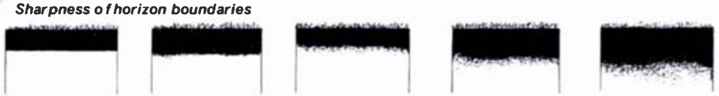
3 Stickiness (wetted soil consistence)

Press some wetted soil material between thumb and forefinger and note it's stickiness

After release of pressure, practically no soil material adheres to thumb or finger	Non sticky
Soil adheres to thumb & finger, but comes off cleanly. Soil is not appreciably stretched when digits are separated	Slightly sticky
Soil adheres to both thumb & finger, & tends to stretch somewhat & pull apart rather than pulling free from digits	Sticky
Soil adheres strongly to both thumb & finger, and is decidely stretched when they are separated	Very sticky

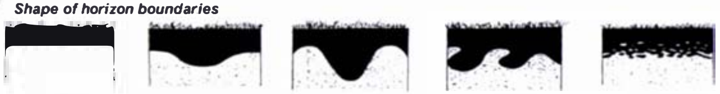
Horizon Boundaries

1 Sharpness of horizon boundaries



Sharp – Almost a line between horizons (transition zone ≤ 0.5cm)
Abrubt – Transition zone between 0.5cm - 2cm thick
Distinct – Transition zone between 2cm - 5cm thick
Indistinct – Transition zone between 5cm - 10cm thick
Diffuse – Transition zone ≥ 10cm thick

2 Shape of horizon boundaries



Smooth – Nearly a plane between horizons
Wavy – With undulations wider than they are deep
Irregular – With pockets deeper than they are wide
Convolute – With irregular pockets that curve back on themselves
Occluded – Transition zone where horizons are mixed (e.g. by earthworms)

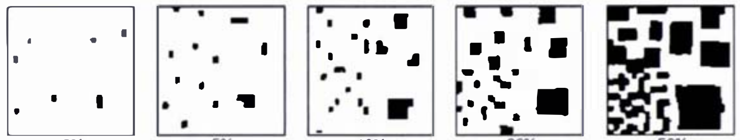
Prepared from Neall & Palmer, McLaren & Cameron (1996); and Milne et al. (1991)

Mottle characteristics

1 Mottle abundance

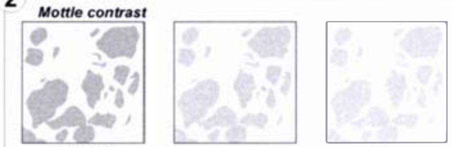
Use the diagrams below to estimate the percent of mottling for each horizon (Nb: each quarter of any one square has the same amount of black). Use the following terms to record abundance.

Few: Mottles occupy less than 2% of the horizon
Many: Mottles occupy 2-20% of the horizon
Abundant: Mottles occupy more than 20% of the horizon surface, and are set in a definite matrix
Profuse: Mottles occupy almost the whole of the horizon surface, and there is no clear matrix colour



2% 5% 10% 20% 50%

2 Mottle contrast



Prominent – The mottles are conspicuous, & mottling is one of the outstanding features of the horizon
Distinct – Although not striking, the mottles are readily seen. Horizon colour is easily distinguished from mottle colour
Faint – Indistinct mottles evident only on close examination. Difficult to distinguish horizon colour from mottle colour

3 Mottle size

Fine: Less than 5mm
Medium: 5-15mm
Coarse: Greater than 15mm

4 Boundary sharpness

Sharp: Knife-edge colour transition
Clear: 2mm transition zone
Diffuse: Transition zone >2mm

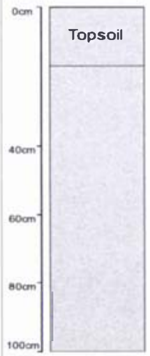
Drainage Classes

Detailed method

Depth from surface (cm)	Abundance of grey mottles	Abundance of reddish mottles	Drainage class
10-30cm	50-100 %		Poorly drained
<30cm	1-49 %	≥ 2 %	Imperfectly drained
30-60cm	50-100 %		
30-60cm	none	≥ 2 %	Moderately well drained
60-90cm	50-100 %		
0-90cm	none	< 2 %	Well drained

Very poorly drained *soils have organic enriched topsoils and grey colours within 10cm depth from the surface.* ***Excessively drained*** *(droughtly) soils may be steep, very porous, or both. Shallow hill soils may be excessively drained.*

Quick method based on grey mottles



Very poorly drained	Organic enriched topsoils and majority of subsoil is greyish
Poorly drained	Significant grey mottling right up to the base of the topsoil
Imperfectly drained	Significant grey mottles present only below 40cm depth
Moderately well drained	Significant grey mottles present only below 60cm depth
Well drained	Significant grey mottles only occur below 80cm, or don't occur at all

*Significant grey mottling is ≥ 2% - see Mottle abundance above

Drainage classes from A. Palmer

Prepared by A Manderson 2001

Texture flow chart

1 Place a finger sized sample of soil in your palm. Pick out any roots or coarse grit. Add water dropwise and knead the soil to break down all aggregates. Soil is at the proper consistency when plastic and moldable, like moist putty or plasticine. Form the soil into a ball.

Add dry soil to soak up water

Does the soil remain in a ball when squeezed? NO → Is the soil too dry? (YES → Add dry soil to soak up water) NO → Is the soil too wet? (YES → Add dry soil to soak up water) NO → **SAND**

YES

2 Place the ball of soil between thumb and forefinger. Gently push the soil with the thumb, squeezing it upward into a ribbon (figure 1). Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.

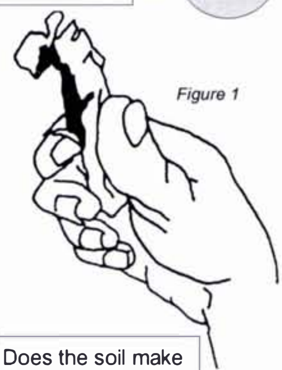


Figure 1

NB: This ribbon can also be used to evaluate soil plasticity

Does the soil form a ribbon? NO → **LOAMY SAND**

YES

Does the soil make a weak ribbon less than 2.5cm long before breaking? NO → Does the soil make a medium ribbon 2.5-5cm long before breaking? NO → Does the soil make a strong ribbon 5cm or longer before breaking?

YES YES YES

Figure 2

3 Excessively wet a small pinch of soil in your palm to form a slurry. Either rub the slurry between thumb and forefinger, or rub it directly in the palm of your hand (figure 2).

Does the soil feel very gritty? YES → **SANDY LOAM**
NO
Does the soil feel very smooth? YES → **SILT LOAM**
NO
Neither grittiness nor smoothness dominates YES → **LOAM**

Does the soil feel very gritty? YES → **SANDY CLAY LOAM**
NO
Does the soil feel very smooth? YES → **SILTY CLAY LOAM**
NO
Neither grittiness nor smoothness dominates YES → **CLAY LOAM**

Does the soil feel very gritty? YES → **SANDY CLAY**
NO
Does the soil feel very smooth? YES → **SILTY CLAY**
NO
Neither grittiness nor smoothness dominates YES → **CLAY**

Alternative method

Feel & sound	***Consistence***	***Soil texture***
Gritty & rasping sound	Cannot be moulded into a cohesive ball	**Sand**
Gritty & rasping sound	Will almost mould into a ball but disintegrates when pressed flat	**Loamy sand**
Slight gritiness, faint rasping sound	Moulds into a cohesive ball which fissures when pressed flat	**Sandy loam**
Smooth silky or soapy feel, no gritiness	Ball is firmer but fissures when pressed. Won't form a wire doughnut without fracturing	**Silt loam**
Very smooth, slightly sticky to sticky	Ball deforms without fissuring. Will form a wire doughnut without fracturing	**Clay loam**
Very smooth, sticky to very sticky	Ball is firmer with a marked resistance to moulding (very plastic)	**Clay**

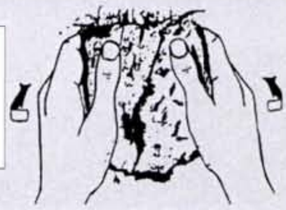
Flowchart adapted from Thein *"Alternative method" adapted from McLaren & Cameron, 1996, and Neall & Palmer* *Prepared by A. Manderson 2001*

Guidelines for Describing Soil Attributes - Page 3.

Structure flow chart

1 Distinguishing structure

1. Take a soil sod. Break it open using gentle hand pressure exposing a natural cleavage plane. Observe the number of distinctive peds and the degree of ped separation.
2. Disturb the soil more and observe the proportions of whole and broken aggregates, and unaggregated material. Move onto part 2.



2 Degree of development

Observe the disturbed soil

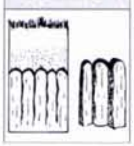
- **Is there any observable aggregation?** (are individual texture grains bound together as some sort of structure?)
  - NO → **Structureless**
  - YES → **Are there few distinguishable peds initially, and when disturbed the following mixture is apparent:** - a **few** entire peds - **many** broken peds - **much** unagregated material?
    - YES → **Weakly developed**
    - NO → **Are the peds evident but not prominent initially, and when disturbed the following mixture is apparent:** - **many** entire peds - **some** broken peds - **little** unagregated material?
      - YES → **Moderately developed**
      - NO → **Are there many prominent peds weakly adhering to one another, and when disturbed the following mixture is apparent:** - **mainly** entire peds - **few** broken peds - **little** or **no** unagregated material?
        - YES → **Strongly developed**

3 Ped shape or form

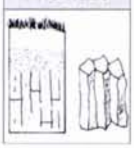
Isolate an individual ped and observe its general form

- **Is it rectangular with length approx ≥2 times width?**
  - YES → *Rectangular* → Does the ped have a rounded cap or top?
    - YES → *Columnar*
    - NO → *Prismatic*
  - NO → **Is it cube-like in form or makes up part of a cube?**
    - YES → *Blocklike* → Does the block have sharp angular edges interlocking tightly?
      - YES → *Blocky*
      - NO → *Nutty*
    - NO → **Is it flattened and layered in form?**
      - YES → *Platelike* → *Platey*
      - NO → **Is the form generally small & rounded?**
        - YES → *Spheroidlike* → Do the shapes look porous like a breadcrumb?
          - YES → *Crumb*
          - NO → *Granular*

Columnar

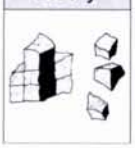


Prismatic

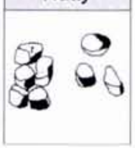


These structures are found only in the subsoil. Columnar structures are less common than prismatic ones

Blocky



Nutty



Blocky structures are particularly common in clay to clay-loam textured subsoils of humid regions

Platey

Platey structures may occur in any part of the profile

Crumb

Granular

These structures are characteristic of topsoils under grass in humid and subhumid regions

4 Ped size

Measure diameter of blocky, nutty, crumb and granular peds. Measure thickness of columnar, prismatic and platey peds.

Columnar & Prismatic	Blocky & Nutty	Platey	Crumb & Granular
<10mm = very fine	<5mm = very fine	<1mm = very thin	<1mm = very fine
10-20mm = fine	5-10mm = fine	1-2mm = thin	1-2mm = fine
20-50mm = medium	10-20mm = medium	2-5mm = medium	2-5mm = medium
50-100mm = coarse	20-50mm = coarse	5-10mm = thick	*5-10mm = coarse
>100mm = very coarse	>50mm = very coarse	>10mm = very thick	*>10mm = very coarse
			* *Granular only*

Flowchart adapted from W. Climo *Ped shape pictures taken from McLaren & Cameron (1996)* *Prepared by A. Manderson 2001*

Guidelines for Describing Soil Attributes - Page 4.

8.7. APPLICATION & CURRENT STATUS

Approximately eight prototypes have been developed and tested through application (as of October 2003). Production, testing and refinement has been intermittent, but at least 60 sets have been produced and used by students, and around 120 sets have been used in SUBS and related programmes. Cost per set is around $10 (including laminating), but this depends on the number produced and the method of colour printing.

There has been little feedback on the student versions. Farmer feedback has mainly been positive, with suggestions for a reduced range of colours on the RGB charts (because there are too many similar colours), and support documentation to provide a more detailed explanation of soil description steps. As a result, a further prototype is now being developed as a single page of RGB charts (Figure 8.2).

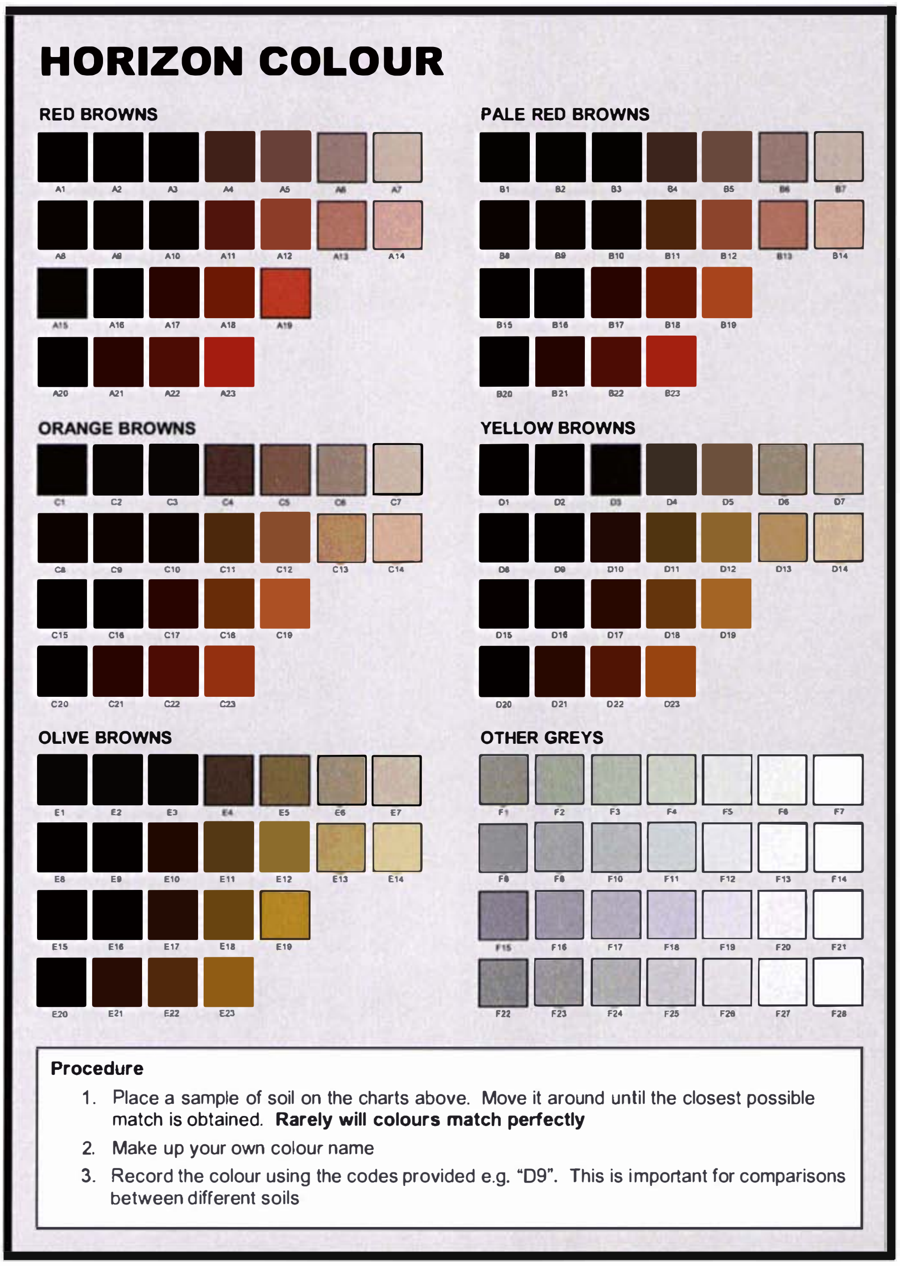


Figure 8.2: Recent prototype for RGB colour charts (single page).

A GUIDE TO THE APPLICATION OF SOILS UNDERPINNING BUSINESS SUCCESS

By the end of 2000, only two farmer groups had been through the Soils Underpinning Business Success programme. These groups relied on experience and guidance provided by specialists who had been involved with the SUBS programme from the outset. There was little written material outlining the programme's stepwise application; this limited the wider extension of SUBS.

In late 2000, the Auckland Regional Council expressed an interest in adapting the programme for use in the Auckland Region. As this Region is located some distance away from the Manawatu-Wanganui Region (where the SUBS programme was being developed), it would have been impractical for the existing (small) group of SUBS trainers to be directly involved. An extension manual was needed, whereby new SUBS trainers could learn to apply the programme independently.

This section reports on the design of a provisional guide for the application of the Soils Underpinning Business Success programme, tailored in part for application in the Auckland Region.

8.8. APPROACH

Published information concerning the SUBS programme was limited when this project was started (late 2000). Information included conference notes (Mackay, 1999), assorted funding applications, and final reports for the Dannevirke Land Resource Assessment Group (Mackay *et al.*, 2000) and the Wanganui SUBS Group (McIntosh *et al.*, 2000). These publications describe the SUBS process in general terms (*cf.* the stepwise mechanics of application), and could only be used to design a basic structure for the manual.

Specific detail was obtained through four interviews with two SUBS trainers (Drs. A. Mackay & A. Palmer). The first two interviews involved a list of questions derived from a review of the aforementioned publications. Responses provided enough detail to begin preparing the manual in earnest. However, information gaps became apparent as the manual progressed, necessitating follow-up interviews for clarification and specific information.

No special graphics applications were used to design the manual – most of the preparation was undertaken using Microsoft's word-processing software (Word), although ESRI's ArcView 3.1 was used to prepare a 'rock type' map of the Auckland Region (derived from the NZLRI database).

8.9. RESULTS

Specifications of the resulting manual include: A4 page size; 60 pages; appended soil description laminates (previously described in Section 8.6); and a *Rock Types of the Auckland Region* booklet (A5; 44 pages; rock-type map; and descriptions of NZLRI rock types found in the Auckland Region summarised from Lynn & Crippen, 1991). The manual is divided into three parts, including: a background overview of the SUBS programme (outlining seven core modules); stepwise instructions on how a programme can be adapted and applied; and module notes to form the basis of handout material.

To conserve space, only the most relevant parts of the manual are presented in the following pages. These have been reduced by 60%, but font size has been enlarged by 20%. The *Rock Types of the Auckland Region* booklet is not presented here, because it is a summary of an existing publication rather than an original work.

A GUIDE TO THE APPLICATION OF

"SOILS UNDERPINNING BUSINESS SUCCESS"

SECTION 1: BACKGROUND ON SUBS

SECTION 2: SETTING-UP & APPLYING A SUBS PROGRAMME

SECTION 3: MODULE NOTES & OTHER HANDOUT MATERIAL

SECTION 4: APPENDIX

CONTENTS

INTRODUCTION

Soils Underpinning Business Success (SUBS) is a package that combines a land evaluation framework with a group-based training programme. Through it, farmers themselves are enabled to evaluate the inherent physical capabilities of their own land, thereby allowing the identification of management opportunities that are both more financial viable and more 'environmentally' sustainable.

This manual is being prepared in response to increasing interest in SUBS from both farmers and land management focused organisations. It includes a background on the SUBS package, an outline and discussion on how to set up and apply a SUBS programme, and a set of module notes used to complement the training programme. It's intended as a guide for anyone interested in applying the SUBS package.

SUBS in a Nutshell

SUBS is a 12-month group-based programme that enables farm managers to apply a five-step land evaluation framework to their own properties. It involves establishing a group made up of 8-10 farmers and at least three specialists (a consultant, regional council officer, and an applied 'land resource specialist'), who work together through a set of five core modules.

Modules are delivered during a series of half-day meetings held on the properties of farmers, and represent the combined input of the specialists, the farmers (as feedback), and the module notes included in this manual. Meetings take place once per month, and follow a general structure of 'progress reporting', module introduction, and field exercises involving hands-on demonstrations and discussion. The final meeting represents a field day with an emphasis on farmers disseminating what they've learned to the wider farming community, and a purpose to interest other farmers in forming a new SUBS group.

Between meetings farmers undertake set tasks. Through completing these tasks, farmers map and describe their property's physical land resources (namely landforms, rock types and soils), identify inherent strengths and weaknesses for each soil type, and then combine it all together with existing farm policies and infrastructure to produce a set of practical Land Management Units.

LMUs represent areas of land with different attributes and limitations, and form the basis for identifying and evaluating more sustainable approaches to management.

With a standard SUBS programme, tasks are complete when each farmer has an LMU map, and each has committed to undertaking three activities that will progress the sustainability status of their farms. There is considerable scope for building on the standard programme, particularly through the development of additional modules. To demonstrate this, example modules on 'designing & evaluating management options' and 'farm improvement planning' have been integrated into the 'how to apply a SUBS programme' section of this manual.

SECTION 1

BACKGROUND ON SUBS

The SUBS package
LMU framework
Group-based training programme
Group field day

THE SUBS PACKAGE

The core SUBS package is made up of a five-step land evaluation framework applied by farmers through a 12-month long group-based training programme. Each group is made up of 8-10 farmers, a programme facilitator, a farm consultant, and at least one 'land resource specialist' with an excellent knowledge of the geology, soils, landforms, and the region's land uses.

Training is 'on-farm', and involves the group working through at least the five core steps (as modules) of the LMU Framework. Please note there is considerable scope for including new themes (as additional modules) that are not included as part of the core SUBS package. Two example modules have been included with this manual to show how this can be achieved.

An LMU approach to land evaluation

LAND EVALUATION

Land evaluation is a general term describing the process of assessing land for a given kind of use. Good land evaluations are based on identifying what the land is capable of sustainably producing. This may be in terms of identifying land suitability of a single land use or enterprise policy; identifying land versatility for a range of different land uses or enterprise policies; or identifying land vulnerability or susceptibility to particular land management practices.

Effective and meaningful land evaluations are complicated in that they require quality information usually obtained by specialists with knowledge and skills that cross-span a number of different disciplines. Specialists often use a framework to simplify the process somewhat, with a good framework involving three tightly merging but distinguishable phases.

Phase 1
Identifying & describing land-resource characteristics

Phase 2
Evaluating land resource characteristics against land use requirements.

Phase 3
Integrating capability information into existing management

The complexity of land evaluations has traditionally restricted their widespread application in New Zealand. A small number have been developed and applied for high value land uses (e.g. orcharding), or for very specific purposes such as soil conservation (e.g. LRI/LUC framework). In most cases, evaluations have often involved a high investment (particularly at the individual farm level), and in some cases, uncertainty regarding the ability of the end-user to fully appreciate the implications of any recommendations.

LMU Framework

The LMU framework has been developed to cover a broad range of NZ land uses, including those which may be considered 'low value' (relative to high-value land uses). The framework is comprehensive in that it spans a process from survey to application, and it is particularly suited for use at the farm and paddock scale. It also retains a high degree of quality and integrity assured by the involvement of specialists, who bring their individual skills and knowledge to the fore at different parts of the framework.

However, the key strength is that farmers are shown how to apply the framework to their own properties by themselves. This not only substantially reduces cost, but it also carries the additional benefit that farmers are able to incorporate their own knowledge and experiences into the evaluation. When this is complemented with the specialists' input, farmers become more familiar with their lands' inherent capabilities, and are then better positioned to understand why they should progress the different aspects of SLM, and how they can go about doing it.

Farmers can apply the LMU framework themselves because of the training and support provided by the specialists, and because the framework has been simplified as a series of easy to learn steps referred to as modules. Each module represents the specialists' collective input during training days, which is complemented and reinforced through a series of module notes. The five 'core' modules are given on the next page, and a further two optional modules are included to demonstrate how additional themes can be added.

Module 1 - Landforms & Rock Types: Geomorphology of a farm largely defines how the land is or can be used at the broad scale, and it is relatively easy to distinguish and describe. Farmers are shown how to map dominant landforms onto aerial photos and describe them in terms of rock type, slope, erosion, vegetation, and other characterizing features.

Module 2 – Soil Description: Soil is the single most important resource in farm production because it represents the interface between the underlying biophysical base (which defines inherent land capability) and the overlying practices of farm management. Farmers are shown how to describe key characteristics of soil profiles, and they're expected to apply this by describing the soils associated with their farm's landforms.

Module 3 – Soil Mapping: This module demonstrates to farmers how soils can be mapped, by modifying the landform map. Farmers are given a demonstration in soil mapping, and the module notes include a completed example of a soil map.

Module 4 – Soil Strengths & Weaknesses: This is a brief module concerned with showing farmers how to interpret whether or not soil properties are strengths or weaknesses for sustainable production (i.e. linking identified soil characteristics to their behaviour under a given land use). It largely involves giving examples in the field, and a demonstration exercise where the whole group identifies strengths and weaknesses for one particular farm.

Module 5 – Land Management Units: Soil and landform information is considered alongside existing farm infrastructure and farm policies to produce a set of practical LMUs. Each LMU represents an area of a farm with its own defining land use limitations and opportunities for sustained production.

Module 6 – Designing and Evaluating Management Options: This optional module is concerned with showing farmers how to capitalize on the opportunities of each LMU while at the same time avoiding or overcoming any limitations that may be present. It involves each farmer using their LMUs to design at least two alternative production policy scenarios, and then evaluate them both against the current production policy (i.e. the status quo) using computer software. The result is the identification of the management changes or refinements needed to progress the farm toward more sustainable land management.

Module 7 – Farm Improvement Planning: This module is also optional. It involves taking the management refinements/changes identified in Module 6 and integrating them into farm planning as production or development targets.

Modules are delivered on the properties of farmer group members, in a series of half-day meetings (training days). The first five-meetings/training days usually correspond with the introduction of the first five modules (but not necessarily – see Section 2).

Farmers complete certain tasks on their own farms before moving onto each successive module. At the completion of all core modules, each farmer has prepared a soil map with soil descriptions, and an LMU map with a list of unit strengths and weaknesses. With the additional optional modules, other outputs include at least two policy scenarios more sustainable than the status quo, and ideally a plan outlining what management refinements are needed and how to implement them. It is worth emphasizing that farmers produce these outputs themselves.

In terms of outcomes, farmers involved with previous SUBS groups have emerged with a greater understanding of how and why their land behaves as it does under particular land uses and management (i.e./e.g. farmers gain explanations for the land behaviours they've experienced in the past), increased confidence to make management changes, a greater ability to communicate with outside interests on land resources and effects of management, and an ongoing interest in progressing sustainable land management.

These outputs and outcomes are achievable only because farmers complete the LMU-based land evaluation themselves. In most other cases, land evaluation typically involves the high financial outlay associated with having to pay appropriately qualified professionals to undertake data collection surveys and interpretive analyses. This is rarely cost effective, and the full benefits are largely dependant on how well the results are communicated, and how well the land user is able to understand their implications. It's easily argued that showing farmers 'how to do it themselves' is more affordable and potentially more effective way of progressing toward SLM.

Group-based training programme

At first glance, training farmers in what has traditionally been the domain of land evaluation experts may seem somewhat ambitious. However, as previous SUBS studies have shown, it can readily be achieved through the combined use of module notes, a group approach, and on-farm training-days involving progress reports, technical presentations, demonstrations, and practical field exercises.

MODULE NOTES

Module notes represent only a very small part of the training programme. Each is a brief summary of how to undertake certain aspects of an LMU land evaluation, including examples. They are not standalone explanations of applying the framework and cannot be used as such. Rather, they are designed only to complement and reinforce what takes place at the training days. Module notes are introduced one at a time on the appropriate training days.

GROUP APPROACH

The benefits of using a group approach to learning and progressing SLM are well recognised in New Zealand, particularly with environmentally orientated 'care' groups and production focused farm discussion groups. How effective these groups are is largely dependent on how well they orientate towards farmers' needs; how well they maintain member interest; how well organized they are; and how clear the purpose of the group is. SUBS achieves all these requirements.

Each SUBS group is made up of a 8-10 farmers and a minimum of three specialists. One farmer is elected to represent farmer interests within the group, and has the infrequently called-upon roles of treasurer (depending on funding arrangements) spokesperson, and perhaps mediator. Specialists include a regional council representative, a farm business consultant, and at least one land-resource expert familiar with the landforms, geology and soils found in the district of interest.

The specialists have a broad range of roles relating to group management, training, and technical support in the areas they represent.

Regional council representative: In terms of group management, the role of the council representative is 'programme coordinator'. They are responsible for organizing each training day, providing module notes, and coordinating the set-up and progress of the overall programme. In a professional context they also have the role of providing technical support and advice for soil conservation, water quality, and other council related considerations (e.g. information on consents and compliance). They are also usually capable of assisting with the identification and description of region-specific land resources.

Farm business consultant: The consultant is responsible for facilitating the training days. This includes opening and closing each meeting, and ensuring the day runs to plan. He or she also provides technical advice throughout the programme, and is responsible for undertaking at least one detailed economic analysis of a farm, which is used to demonstrate how information on soils can be integrated into management (referred to as the 'demonstration farm').

Land resource specialist(s): Ideally only one land resource specialist is required. However, they need to be highly skilled and versatile, with expertise in identifying and describing a region's landforms, geology, and particularly soils. They also need a good understanding of agricultural land uses, or experience with applying land evaluation frameworks. Their responsibility is to take charge of training up to the point of producing LMU maps (when the responsibility shifts to the consultant). These versatile land resource experts exist, but they can be difficult to track down. If such an individual is unavailable, then more than one land resource specialist is required. Previous SUBS groups have used an applied geologist and an applied pedologist, which have also been assisted by a biophysical scientist and a regional council land management officer.

The group structure is the key to making SUBS affordable and functional. Specialists contribute not only their group management skills gained from the organisations and disciplines they represent, but they also contribute their professional technical abilities and knowledge that may otherwise be unavailable or unaffordable to individual farmers.

The group structure also cancels out any strong 'production-emphasis' views that a consultant may have, against any strong 'environmental' views that a regional council officer may have. Bringing these specialists together allows farmers to consider both views simultaneously.

The group approach also contributes to the effectiveness of the learning process itself. This includes the transfer of local knowledge as farmers interact and expose each other to their different views on SLM, and their experiences with how land within the group's district behaves under different land uses, management practices, and production policies. Farmers are also able to support each other if difficulties are encountered with learning about and applying the LMU framework. Also, because each is required to regularly present their progress to the group, there is an element of peer pressure to complete set tasks.

Farmers determine the pace of the training programme, and decide what aspects of the LMU framework require more or less coverage. Pace will vary between groups, because each is influenced by differences in the complexity of the farms involved, what is happening down on the farm at any given point of the year, the ability of specialists to communicate and train farmers, and conversely, the ability of farmers to learn. SUBS integrates this need for flexibility through a 'round table' type discussion held at the beginning of each training day.

ON-FARM TRAINING DAYS

Training days are held on the properties of farmer group members. This provides a comfortable and interactive learning environment. It also provides a means for farmers to actually see in detail how similar and different types of land respond and behave under different types of use, management practices, and farm policies.

Each core SUBS package involves a total of 10 half-day meetings (training days) held over a period of 10 months (one training day per month). Each training day takes an afternoon (from 1pm to 5pm). Please note that outside this manual, training days are referred to as 'meetings' to avoid any possible stigma associated with terms like education, training and learning.

Meetings follow a general predetermined structure of progress report, technical presentation, and field demonstrations.

Progress reports: Progress reporting begins on the second training day, and involves each farmer making a brief and informal report to the group. This includes stating if the previous meeting's tasks have been completed; what was achieved through undertaking the tasks; and any difficulties the farmer may have experienced. After a quick summation from each farmer, the group discusses how any difficulties can be overcome, and whether the day's programme needs to be adjusted to revisit previous material.

Technical presentations: The first 5 training days involve technical presentations to introduce each of the 5 core modules. This generally involves a 30-minute presentation by the appropriate specialist on the most technical aspect of the module. Each presentation concludes with an explanation of the module and its relevance; what is expected of farmers; and what aspects are going to be demonstrated out in the field later in the day.

Field exercises: Field exercises are an integral part of each training day. The first six are an opportunity to get outside where actual examples can be used to explain the modules further. The group usually walks or drives (whichever is most appropriate) much of the farm, stopping at certain points so the specialists can practically demonstrate how to undertake module tasks. These tasks are usually interactive, and farmers are continually encouraged to practice their developing skills. The last two field exercises are used to reinforce what has been learned, and to give enough time for all farmers to complete evaluations of their own farms.

Each meeting concludes with a summary of the day, and the reinforcement of set tasks (which farmers should endeavour to complete before the next meeting).

Learning Processes

SUBS is rather diverse in terms of learning processes. They are somewhat difficult to define, so they've been reduced to the following headings for brief discussion.

Explanation, demonstration and doing: The combination of technical presentation, practical field exercises and the application of what is learned by each farmer to their own farms represents the base upon which the SUBS training programme is built.

Incremental training: The somewhat technical LMU framework is reduced to five easy to learn modules. Each module builds on the previous one, and each introduces principles contained in the next successive module.

Module notes: These notes provide stepwise instructions to some of the more technical aspects of each module. They can also be used as a reference for what is taught at the training days. Clear examples of what farmers are expected to achieve are also included.

Feed-forward/feed-back learning loop: Specialists 'feed-forward' technical information and instructions. Farmers go away to apply what they have learned, and if there are any difficulties these are 'fed-back' through the progress reports. In doing so, the group can decide what areas need to be covered in more or less detail. Feed-back and feed-forward is also made more successful as farmers gradually learn the 'land resource jargon' (which is intentionally restricted only to that which is absolutely necessary) and start to communicate in terms the whole group readily understands.

Reaffirmation: Farmers consolidate what is taught at the training days as they apply it to their own properties. This is consolidated further through farm visits, as farmers are encouraged to practice their developing skills within landscapes they are not familiar with.

Sharing of local knowledge: Discussion within groups and visiting different properties allows members to consider how similar and different types of land behave and respond under different land uses, management practices, and farm policies. Learning a common jargon facilitates the sharing of local knowledge.

Recalibrating 'internal yardsticks': Everyone has their own internal yardstick that determines how significant or important we consider something to be. As an example, a council officer who's seen many examples of erosion may have a different view of how serious a farm's erosion is, relative to the farmer who probably hasn't been exposed to anywhere near as many examples.

Visiting different farms, having their farms visited, and the group discussion, all contribute to adjusting internal yardsticks. Through visiting each farm and having their own properties visited, farmers are exposed to different situations and views that they can relate back to their own farm and management. The likely outcome is that farmers will come away from SUBS with a better ability to make sound management decisions.

Reflection & clarification: The month between meetings gives ample time for farmers to reflect on what they've learned and how it applies to their own properties. They are also encouraged to reflect on what they already know about their land capability (as strengths & weaknesses), along with having to formally consider and define how they manage their land (Module 5).

Group Field day

Each SUBS programme concludes with a field day. This day is organized and run by everyone in the group, and usually takes place on the demonstration farm that has undergone the full economic analysis. In preparing for the day, members are encouraged to reflect on what they've achieved through their involvement with SUBS. Each member is also expected to bring along a carload of curious people to expose a wider audience to the practical benefits of SUBS. The objective is to interest other farmers in the programme, and get them committed to forming a new SUBS group.

SECTION 2

SETTING-UP & APPLYING A SUBS PROGRAMME

SETTING-UP A PROGRAMME

SUBS is based on taking 10 farmers through a standard 12 month programme. This period allows for meetings to be hosted on each farm, and for the demonstration farm to be revisited at the end of the programme. It also gives farmers a full month to complete module tasks between meetings.

Farmers will vary in the amount of time they are willing to commit. This is accounted for by having buffer of three final meetings where no new material is introduced. These buffer meetings allow the SUBS programme to be delivered at a rate determined by the farmers.

The following table outlines the standard 12-month SUBS programme. This forms the basis of most of the discussion and description outlined in this section of the manual. The programme is flexible both in terms of when the modules are introduced, and in terms of incorporating additional themes. Optional Modules 6 & 7 have been included to demonstrate additional themes. Examples of alternative timeframes are presented in the Appendix.

Standard program structure (10 farmers/12 months)

Month	*Meeting*	*Main theme*	*Venue*
Month 1	Introduction	Forming a group	
Month 2	Meeting 1	Module 1: Landforms & Rock Types	Farm 1
Month 3	Meeting 2	Module 2: Soil Description	Farm 2
Month 4	Meeting 3	*Module 3: Soil Mapping*	Farm 3
Month 5	Meeting 4	Module 4: Soil Strengths & Weaknesses	Farm 4
Month 6	Meeting 5	Module 5: Land Management Units	Farm 5
Month 7	Meeting 6	*Module 6: Designing & Evaluating Options**	Farm 6
Month 8	Meeting 7	*Module 7: Farm Improvement Planning**	Farm 7
Month 9	Meeting 8	General round-up	Farm 8
Month 10	Meeting 9	General round-up	Farm 9
Month 11	Meeting 10	General round-up & field day preparation	Farm 10
Month 12	Field day	Field day	Demonstration farm

* Optional modules

PROGRAMME SUMMARY

The following summary is for a 12 month programme involving visits to 10 farms. Please note it integrates optional Modules 6 & 7.

Meeting 1 – Farm 1

- Introductions, programme outline, and other preliminaries
- Presentation and introduction to Module 1: Landforms & Rock types (resources include ring binders, module notes, aerial photos and field kit)
- Farm tour to assist with Module 1
- In-the-field demonstrations on mapping and describing landforms & rock types

Meeting 2 – Farm 2

- Each farmer reports back on progress in mapping and describing landforms. Progress is discussed
- Presentation and introduction to Module 2: Soil Description (resources include module notes and soil description field kit)
- Farm tour to examine progress, address any difficulties and share experiences
- In-the-field demonstrations on how to describe soil profiles

Meeting 3 – Farm 3

- Progress report on completed landform maps
- Progress report on five completed soil descriptions. Progress discussed
- Presentation and introduction to Module 3: Soil mapping (resources include module notes)
- Farm tour to examine progress, address any difficulties, and discuss opportunities and limitations
- In-the-field demonstrations on soil description repeated. Demonstration on soil mapping

Meeting 4 – Farm 4

- Progress report and discussion on soil mapping and soil description
- Presentation and introduction to Module 4: Strengths & Weaknesses (resources include module notes)
- Farm tour to examine progress, address any difficulties, and discuss opportunities and limitations
- Demonstrations on soil description and mapping revisited if necessary
- Identifying strengths & weaknesses exercise
- Nomination of one farm for demonstrating the use of soil information for farm planning

Meeting 5 – Farm 5

- Progress report on completed (draft) soil maps and the listed strengths & weaknesses of each soil. Progress discussed
- Presentation and introduction to Module 5: Land Management Units (resources include module notes)
- Introduction to developing & evaluating scenarios (resources include laptop & spreadsheet model)
- Farm tour to examine progress, address any difficulties, and discuss opportunities and limitations
- Aggregating soils into Land Management Units exercise

Meeting 6 – Farm 6

- Progress report on designing LMU's and listing opportunities and limitations of each unit. Progress discussed
- Presentation and introduction to Module 6: Designing & Evaluating Management Options (Stage 1) (resources include module notes and software)
- Consultant's progress report on base modelling the demonstration farm
- Farm tour to examine progress, address any difficulties, and discuss opportunities and limitations
- Exercise on developing & evaluating alternative scenarios (Stage 2 of Module 6)

Meeting 7 – Farm 7

- Progress report on completed draft LMU maps and listed opportunities and limitations. Progress discussed
- Session 1 on scenario modelling. Includes consultant's progress report on modelling the demonstration farm; farmers' progress reports on developing scenarios; and modelling of four farmers' scenarios in front of the group
- Farm tour to examine progress, address any difficulties, and discuss opportunities and limitations
- Introduction to optional Module 7: Farm Planning

Meeting 8 – Farm 8

- Completed LMU maps handed in for digitising
- Progress report on developing scenarios
- Session 2 on scenario modelling. Consultant gives final report on the analysis of the demonstration farm and farmers' scenarios modelled in front of the group
- Farm tour to examine progress, address any difficulties, and discuss opportunities and limitations
- Farm planning exercise – development of a simple farm plan for the demonstration farm

Meeting 9 – Farm 9

- Digitised LMU maps handed back and discussed
- Final progress report on the most feasible scenarios
- Progress report and discussion on potential viable changes
- Farm tour to examine progress, address any difficulties, and discuss opportunities and limitations

Meeting 10 – Farm 10

- Presentation by each farmer to the group
- Specialist's review
- Planning of field day

Field day – Demonstration Farm

- Welcome & introduction to the day
- Overview of SUBS by farmers
- Soil identification and description demonstration (two sites) by farmers and LR specialist
- Designing options presentation by host-farmer and consultant
- Group summary and discussion
- Drinks

PRELIMINARY SETUP

Prior to the first true meeting of a SUBS group, a number of preliminary tasks need to be undertaken by the programme organizer. These include: identifying and engaging the specialists needed; organizing the 'introductory meeting' through which the SUBS group will be formed; bringing together the specialists for a 'training session' if its deemed necessary; and then setting up the first meeting to ensure things get off to a good start.

Finding Suitable Specialists

Specialists include a regional council officer, a farm business consultant, and at least one applied 'land resource specialist'. These three are the minimum required to ensure the SUBS framework is applied effectively. Just how effectively largely depends on the quality of the specialists.

Regional council representatives should have a close affiliation with land management (eg soil conservators, land management officers) with experience or training in identifying land resources particular to the location of interest. They should also have group management skills, and an ability to communicate effectively with farmers.

Each region will have a range of farm business consultants who can be approached for inclusion with SUBS. A consultant would need confident communication & facilitation skills to operate within a group, and have sufficient technical ability to evaluate and discuss a range of farming enterprises and management techniques. Ideally, he or she would also have a background or at least an interest in the soils and geology of the region, and an expert ability to use farm-production analysis software.

Involving a suitable land resource expert may be more difficult. Ideally this specialist will have training or experience in both applied geology and pedology, and a satisfactory ability to communicate with farmers on a level somewhere between technical and non-condescending. Being 'applied' means the specialist has both the technical training, and the experience to use their knowledge and skills outside research in a practical 'down on the farm' way. Such a specialist should be very familiar with the landforms, geology and soils of the region of interest, and have an appreciation of a broad range of regional land uses. Universities, research institutes, and certain resource management consultants may be able to provide these specialists.

It's quite probable that a multi-skilled land resource specialist can not be found. Previous SUBS programmes have overcome this by using three specialists. An applied geologist, an applied pedologist, and an earth science orientated agronomist. This is more expensive, but having two specialists has implications regarding the effectiveness of the learning process. Another option under consideration is upskilling regional council officers in soil description and mapping. This is a feasible option if the officer has a strong background in soil conservation; use of the LRI/LUC framework; and experience in identifying local rock types.

Early commitment of specialists for involvement in a SUBS group means they can be informed about the process in more detail at the introductory meeting, and also they can explore their roles further in the training session.

Any potential specialist interested in being involved should also be encouraged to contact their counterparts who have already gone through a SUBS programme, to get a better idea of what their role would involve.

The Introductory Meeting

An 'introductory meeting' has been used in the establishment of previous SUBS groups. It allows interested farmers to come together and find out more about the package, with the explicit purpose of getting eight to ten of them committed to forming a group. It is thought only one initial 'introductory meeting' is needed for an area because subsequent groups are formed through the SUBS programme itself.

WHO TO INVITE

With previous SUBS programmes, some of the interested farmers were invited through RC officers (two types of farmer were targeted – progressive farmers and those with whom they had an issue), while others came from an existing MRDC monitor farm programme (Dannevirke) and the 'Wanganui Hill Country Sustainable Land Management Group'.

Invited farmers should represent a range of land use & business types. Past SUBS group members have included dairy, sheep & beef, cropping, and farmers with strong interests in forestry. These diverse groups are encouraged over those representing a single land use, to introduce a wider breadth of interest, views, and problem solving abilities. Similarly, past SUBS groups have stated that members from a wider swath of a district are more preferable and beneficial than groups made up of members located in immediate neighbouring vicinities.

Ideally about 20-25 farmers should be invited to attend the introductory meeting. In addition, the meeting is also an opportunity to more fully introduce the specialists to the SUBS process. While it may seem presumptuous to engage the specialists before farmers have formed a group, it is necessary for making effective use of time and resources (see 'training session' below).

What Happens at the Meeting

The meeting itself is essentially an opportunity for the whole SUBS package to be explained to get farmers interested enough to sign up. This is probably best done by someone familiar with the use of SUBS, such as Alec Mackay, Alan Palmer or Tony Rhodes, who would then be able to give a presentation at the meeting on the practical benefits of being involved. In the past this meeting has taken place in the evening at various locations, such as council offices or the local pub. Farmers from previous SUBS groups could also be invited to these meetings.

The presentation on SUBS dominates most of the meeting. Toward the end, farmers are asked if they would like to be included in a SUBS programme. Essentially, getting farmers to sign up is where the meeting ends, although there is opportunity for the programme organizer to obtain farm location details from each new member (for the purpose of obtaining aerial photographs), and to nominate a farmer to host the first meeting. It's recommended the organizer have on hand topographical maps on which farmers can point out their properties.

The Training Session

A short 'training session' is recommended on the same day as the Introductory Meeting. This session is for the specialists only, with Alec Mackay, Alan Palmer or Tony Rhodes taking each of the specialists through their expected roles and responsibilities, and transferring any particular considerations they may have experienced through applying the SUBS package in the past.

Organising the first meeting

Organizing the first meeting is usually the responsibility of the regional council representative. Tasks include follow-up phone calls and reminder letters, along with preparing resource materials needed on the day.

Follow-up Phone Calls

Follow-up phone calls are made to each member of the group about a week after the Introductory Meeting. These calls allow the facilitator to confirm the venue, date and attendance of the First Meeting. They're also an opportunity to clarify problems that may be experienced by the council officer with identifying the appropriate aerial photographs. A phone call to the land resource specialist(s) is also a polite reminder that he or she should be thinking about the presentation on landforms and rock types to be given at the first meeting.

Reminder Letters

Reminder letters are sent out to farmers and specialists about one week before the First Meeting. They represent a formal reminder of venue and date, and should include a programme and a map depicting where the meeting is being held (see examples). Letters to the specialists can be used to formally confirm their roles on the day. The letter to the land resource specialist(s) should also include a request for a summary of what he/she intends to present at the first meeting.

There is also an opportunity to confirm the correct aerial photos have been selected. This involves copying the appropriate aerial photo and including it in the letter to the farmer concerned. Not only would this lower the risk of turning-up on the day with the wrong aerial photos, but it also gives farmers a chance to start thinking about where their fence lines run on the photo.

Organizing Resources

To help group members manage the new information that will be presented to them, it is recommended each is supplied with a hard-cover ring binder. The intent is that this is brought along to each meeting, so it can be used to house both members' notes and handout material from the modules.

Handouts should also be prepared. Each farmer receives a summary of the whole SUBS programme, a copy the notes on Module 1, and a brief summary (1-2 pages) of the land resource specialist's presentation (see below). Farmers are also supplied with the laminated sheet on landforms and rock types, and the protractor gizmo for measuring slope.

OTHER TASKS

Before the First Meeting the land resource specialist is required to put together a presentation on the region's geomorphology and evolution (max. 40mins), and forward a 1-2 page summary to the facilitator so they can be copied and offered as handouts to group members on the day of the First Meeting.

If it is practical and convenient, the land resource specialist may want to organize a preliminary visit to the first farm so he/she can become familiarized with the geology and landscape the group is going to encounter. If this is not possible, the specialist may be able to infer what rock types and landforms may be present, off LRI Worksheets, geology maps, or soil maps. How much farmers learn on the day is partially dependent on how quickly the land resource specialist can attune himself or herself to what soils and rock types may be present.

MEETING ONE

Meeting one is described in some detail because it involves themes repeated on successive training days. Meeting one runs for about 4hrs (1pm-5pm), beginning with sorting out group management details before moving onto Module 1. A presentation on the region's geo-topography is given, and farmers are introduced to how they can go about mapping and describing their farms' landforms and characteristics. Approximately half the time is spent inside and half outside.

What's covered in the meeting

Meeting one follows the general structure given in the programme below. It usually begins with a brief welcome and overview of the day by either the RC officer or, more preferably, by the consultant. This is because, relative to the other specialists, the consultant has key involvement throughout the entire programme, so it's particularly important they build up a strong relation early on. The welcome and overview need only take five minutes maximum.

Where possible, the indoors part of the meeting is best conducted by arranging seating in a circle such as around a table. This allows a natural flow for the next part of the meeting – introductions. Starting with the consultant, members introduce themselves by giving a little bit of background. For specialists this can include information about their profession and about their role within the group. Farmer members can background their farm briefly and perhaps why they decided to get involved.

Suggested program for Meeting One:

Time	*Activity*
1.00pm	Preliminaries Welcome & quick overview of the meeting Introductions Election of a group representative
1.30pm	Module 1: Landforms & Geology of the region Quick overview of the module Presentation on geo-topographical evolution and key rock types Introduction to the field exercise
2.30pm	Afternoon tea (general discussion)
2.45pm	Field exercise: Landforms & Geology
4.45pm	Meeting close

Introductions need only take about ten minutes, as there will be opportunity for more interaction between members out in the field. The last part of the preliminaries is the quasi-election of a member to the role of 'group representative'.

Preferably this should be a farmer, as the responsibilities include representing farmer interests within the group, acting as a mediator between individuals (if needed), and depending on funding, the role also includes acting as treasurer (in some cases farmers are more eligible for certain funding grants). Generally the role doesn't involve much effort, and it's usually filled by a farmer with a background in committees and community groups – such as a chairperson of a local trust or board.

Module 1: Landforms & Geology of the Auckland Region

The preliminaries need only take 20-30 minutes before the meeting leads into the first module of the LMU framework. This begins with a presentation held inside by the land resource specialist. A possible structure for this includes: a quick overview of the module; a brief mention of what farmers have to do and what they will achieve; a 'lecture' on the geo-topographical evolution of the local landscape, including detail on dominating landforms and key rock types; perhaps a slide show; and finishing with an introduction to what's going to happen during the field exercise.

The lecture is prepared by the land resource specialist himself or herself, and shouldn't be longer than about 40-50 minutes maximum duration. The shorter the better – there's only so long a person can endure a technical presentation. There's also an opportunity during the field exercise to more clearly highlight key ideas through example. It is also extremely important to minimize the use of jargon or technical nomenclature unless it's absolutely necessary, or unless terms are going to be developed in subsequent parts of the programme.

One final point on the landform specialist's role is that, at every opportunity, he/or she should endeavour to explain why it is important for farmers to recognise the different types of geology and landform – how can it be related to land use and what does it mean to the management of the farm. Right from the outset it has to be made relevant (this is a reoccurring theme throughout the programme).

Within the lecture there's also the opportunity to include a slideshow. This has been used in previous SUBS groups, although it depends on relevance and the availability of appropriate slides. Just before the break, the field exercise can be introduced. This includes an overview of what's going to happen, and what farmers should be looking for when they get out there.

Afternoon Tea

Anyone would need a break after listening to a technical specialist for half an hour or so. With previous SUBS groups, afternoon tea has been the responsibility of the RC officer to organize. In some cases the host-farmer has been willing and able to provide it, but where this is not possible it is recommended the RC officer brings it along with them.

Field Exercise: Landforms & Geology

The purpose of the field exercise is to get the group outside where actual examples can be used to explain landform and rock types, and to introduce the principles of survey and land-resource mapping. The idea is to give farmer members the skills they will need to map and describe the major landforms and rock types of their own properties.

Out in the field the group walks or drives (which ever is most appropriate) part of the farm, initially led by the host-farmer who should be encouraged to give an overview of his/her enterprise. With prompting from the specialists, the group stops at places of interest – such as track cuttings and vantage points – where characteristics of landform and rock type can be investigated and explained.

As noted by Alan Palmer (pedologist & geologist), the land resource specialist needs to take every opportunity to look at appropriate examples, and to make sure they constructively make use of the limited time to show farmers the relevance of recognizing what's there and what it means to farm management. Because the specialist may not have been to the property before, he/or she has to be very observant and quickly 'key in' to the farm's geology (and soils) as quickly as possible.

At one or two vantage points, farmers are given a demonstration on how to distinguish landforms and delineate them onto aerial photographs. At the same time, a worksheet on landform units may be introduced. It's intended purpose is to help distinguish and describe landform units for mapping, although it is up to the individual farmer whether or not he/she finds it useful enough to apply. At another point on the property, farmers are given a demonstration on how to measure slope using a simple protractor and a bit of string (protractor gizmo). At all stages farmers are encouraged to 'get involved' with these demonstrations.

Each specialist is encouraged to introduce aspects of other modules during the field exercise. While moving around the farm each specialist should be looking for opportunities to use their expertise: the LR specialist can highlight distinguishing soils and their properties from road and track cuttings; the regional council officer can turn the group's focus onto environmental management; while the consultant can discuss aspects of the farmer's policy and management.

Meeting Close

The meeting close takes place with the group returning to the shed or where-ever the meeting started from, and having a summary of the day given by the consultant or RC officer. Farmers have the opportunity to ask any outstanding questions. It also allows the date and venue for the next meeting to be set (someone will volunteer or get volunteered when the topic is brought up), and is also a good time to give farmers their aerial photographs.

The final task of the meeting is to reaffirm the tasks farmers are required to complete before the next meeting. Each farmer will be expected to give a progress report on these tasks at the start of the second meeting.

Resource materials for meeting one

Resource materials include the appropriate number of copies of the SUBS programme outline, module notes, presentation notes, a ring binder for each group member, an 'in-the field kit', and an aerial photo copy onto-which landforms will be mapped.

Copied notes: Each specialist receives a manual, so copies of the notes need only be prepared for farmer group members. This includes copies of the programme outline on pages 20-21, module notes included at the end of this manual, and the 1-2 page summary of the LR specialist's presentation.

Ring binder: Farmers receive a ring binder, which they gradually build-up with notes and handouts as the programme unfolds.

'In-the field kit': This includes a protractor gizmo for measuring slope; laminated notes on describing landforms; and a field guide booklet on common rock types. This kit is returned to the council at the end of the SUBS programme.

Aerial photographs: Each farmer receives at least one A3 sized black & white copy of an aerial photo that depicts their farm, ideally at a 1:10,000 scale or larger (i.e. more detailed). Property location details are obtained at the introductory meeting by asking farmers to point out their farms on 1:50,000 scale topographical maps. Copies are prepared by photocopying or scanning the appropriate aerial photos held by the regional council.

Copied maps need to be of sufficient quality to enable precise identification of fence lines and landscape features. This is not usually a problem when copying black and white photos. However, with colour some photocopiers cannot adequately produce a high quality black & white output. In this case it may be necessary to scan the photo as 'grayscale' (at a resolution of 50-75 dpi), and print it off through a high definition printer.

If only one photo copy is being produced per farmer, then it will need to be laminated and supplied with a special chinagraph pencil. Some people dislike using laminates for mapping, so it may be better to supply a number of photo copies so farmers can use normal soft lead pencils (e.g. 2B, 4B). Three copies are recommended in this case.

Farmer tasks to be completed for the next meeting

Between meetings 1 & 2, farmers are expected to have made significant progress toward breaking up key areas of their farm according to landform and rock type, and drawn these areas as units onto the aerial photo copy. Each unit should also be described in terms of the most relevant characteristics as outlined in the Module 1 notes.

Organising meeting Two

The date and venue for Meeting Two is established at the 'meeting close'. The programme organizer then has the responsibilities of preparing the Module 2 notes, sending out reminder letters two weeks before the meeting (again including date and venue confirmation, the day's programme, and a directions map if necessary), and it may be beneficial to discuss the day with the farmer hosting the meeting.

Fielding Inquiries

Farmers are encouraged to contact some of the specialists (particularly the RC officer and perhaps the LR specialist) between meetings as they encounter problems fulfilling their tasks or seek additional clarification. This is part of the learning process, so it's important the specialists take the time to assist when possible. With previous groups, the RC officer has undertaken farm visits to assist with 'getting started' on the first mapping exercise.

Meeting Two

Progress reporting begins in Meeting Two, and farmers are introduced to the second module on soil description. The day follows a similar programme structure to the previous meeting, although more time is made available for demonstrations in the field.

What's Covered in the Meeting

From Meeting Two onwards, preliminaries are taken up primarily by a 'round table' discussion where each farmer reports back on his or her progress. For this particular meeting, each farmer is expected to show the group how their landform maps are progressing, and be able to discuss them in terms of rock types and other landform characteristics.

These progress reports often stimulate discussion around the table, and provide the opportunity for each farmer to ask specific questions of any specialist. Overtime, the act of presenting begins to manifest itself as increased confidence and ability of farmers to talk about/communicate their farms' land characteristics to the specialists, who in turn begin to find it easier to communicate back to farmers in the technical manner they are accustomed to.

Suggested program for Meeting Two:

Time	*Activity*
1.00pm	Preliminaries Welcome & quick overview of the meeting Progress report
1.30pm	Module 2: Soil Description Quick overview of the module Short presentation on identifying soils & their characteristics Introduction to the field exercise
2.00pm	Afternoon tea (general discussion)
2.15pm	Field exercise: Soil description Farm tour Soil profile description demonstrations
4.45pm	Meeting close

The other main benefit of progress reporting is group peer pressure. While most of the farmers will have completed the tasks set for them, there's always the possibility that one or two haven't. When their lack of commitment is exposed to the whole group, they tend to get 'all sheepish' because they've got little or nothing to present or talk about, and there's peer pressure for them to 'get their act together'.

The first progress report will probably be quite short – perhaps about 2 to 5 minutes with each farmer and about 20-55 minutes in total (it varies between groups). This part of the meeting also includes 'housework', such as what's going on with funding and the like, and a brief overview of what the day is going to involve. Then it's straight into Module 2.

Module 2: Soil Description

This module is concerned with showing farmers how to identify different soils within the landscape, and how to describe those soils in terms of several key characteristics: horizon depth & colour; mottle colour & abundance; soil texture (sand, silt & clay); and structural characteristics like aggregate type and degree of development. Stepwise instructions and flow diagrams are included as a set of three laminated sheets, and each characteristic and how to describe it is explained in more detail in the module notes.

The LR specialist gives a brief presentation on how to describe soils after the progress report. This is kept short so more time can be spent in the field doing demonstrations.

Field Exercise: Soil Description

Out in the field, the farmer-host overviews his or her enterprise, and the group provides feedback. Specifically, the LR specialist is required to broadly distinguish some of the dominating soils on the farm, and demonstrate how to describe profiles using at least two of the most contrasting soil types.

Toward the end of the tour, a suitable site is selected where farmers can do a soil description themselves. Members pair-off and dig themselves a pit. The LR specialist then takes them through the description process, step by step, to allow everyone to get some initial hands-on experience.

Again, the day is summarized at the 'meeting close', and farmers leave with a series of tasks to complete before the next meeting.

Resource Materials for Meeting Two

Only the laminated field sheets and copies of the Module Two notes are supplied to farmers. For the field exercise, at least five spades need to be sourced from somewhere (farmers bring their own?) and there needs to be about the same number of water bottles available for assisting with the textural analysis.

Farmer Tasks to be Completed for the Next Meeting

Farmers are expected to have competed their landform maps for Meeting 3, and described at least five soil profiles. The five profile sites should be marked on the landform map also.

Organizing Meeting Three

Venue and date for Meeting Three is established at the 'meeting close'. Notes for Module 3 will need to be copied, and reminder letters sent out two weeks before the day.

Meeting three largely covers the soil description module again, because previous SUBS groups have found this part of the process somewhat difficult. It's quite probable that the LR specialist and RC officer will have to field a number of inquiries as farmers encounter these difficulties.

Meeting Three

At Meeting Three, farmers are expected to have completed their landform maps. During the progress report, each farmer uses the map to show the sites of five completed soil description, which he or she then talks about. The indoors part of the meeting is largely taken up by the ensuring discussion – previous groups have found the process of soil description difficult. The onus is on the LR specialist to revisit previous material, and to answer any questions.

Module 3 is introduced before any field activities. Principles of soil mapping are covered, and the idea of soil strengths and weaknesses introduced. Outside, the group tours the new farm, and the session on soil description is repeated. A demonstration on soil mapping is given from a vantage point, and examples of strengths and weaknesses of soils are inferred and explained.

At Meeting 4, farmers are expected to have made significant progress in mapping and describing their own farms' soils. Please note that Meeting 4 can also be used as a 'catch up' meeting, postponing the introduction of Module 4 until Meeting 5 (see note on page 39).

Suggested program for Meeting Three:

Time	*Activity*
1.00pm	Preliminaries Welcome & quick overview of the meeting Progress report Discussion
1.45pm	Module 3: Soil Mapping Quick overview of soil mapping
2.00pm	Afternoon tea (general discussion)
2.15pm	Field exercise: Soil description Farm tour Soil description session repeated Demonstration of soil mapping Examples of strengths & weaknesses
4.45pm	Meeting close

Meeting Four

Each farmer reports back on progress in mapping and describing their farms' soils. By now they should be reasonably confident in soil description, and have mapped a significant area of their properties. If not, then it may be necessary to revisit material and demonstrations given in previous meetings.

Progress reporting again takes about 45 minutes. Module 4 is briefly introduced, and then the group moves outside for a general tour of the property, with the focus being on repeating demonstrations and highlighting examples of strengths and weaknesses.

The field exercise ends earlier than previous meetings, to allow an in-depth explanation of the strengths and weaknesses concept. The whole group is expected to contribute to the identification of the strengths and weaknesses of the host farm's soils (as a demonstration).

The meeting closes with the usual summary, discussion of tasks to be completed before the next meeting, and determination of where and when for Meeting 5. It also includes the nomination of a farm that will be taken through a full production analysis by the consultant, as a demonstration of how land resource information can be used in farm planning.

Suggested program for Meeting Four:

Time	*Activity*
1.00pm	Preliminaries Progress report & discussion
1.45pm	Module 4: Soil Strengths & Weaknesses Quick overview of soil strengths & weaknesses
2.00pm	Afternoon tea (general discussion)
2.15pm	Field exercise: Strengths & weaknesses Farm tour Demonstrations on soil description and mapping repeated if necessary Examples of strengths & weaknesses
4.00pm	Exercise on soil strengths & weaknesses
4.45pm	Meeting close Demonstration farm nominated

MEETING FIVE

Meeting Five's progress report is intentionally kept short so more time is available to cover Land Management Units. By now farmers should have completed a draft soil map with descriptions, and a list of strengths and weaknesses for each soil.

Presenting Module 5 involves an overview of criteria used to aggregate soils information with existing farm infrastructure and management, to produce a set of LMU's. A spreadsheet model is also introduced, which will be used in the next meeting to design policy options. The consultant collects details for modelling the demonstration farm's existing production and policies through appropriate software (e.g. Stockpol, AEM, DairyWin, etc.). He or she is required to present and explain this base modelling at the next meeting.

The group tours the farm to observe & discuss soils and management, with a particular focus on determining how the farm may be broken into LMU's. Demonstrations from previous meetings can also be revisited if necessary.

Back inside, the group applies the LMU design criteria using the demonstration farm as an example. The idea is to give farmers a bit of initial experience in applying the design criteria, while at the same time keeping the whole group familiar with the ongoing analysis of the demonstration farm.

Suggested program for Meeting Five:

Time	*Activity*
1.00pm	Preliminaries Progress report & discussion
1.30pm	Module 5: Land Management Units Overview of Land Management Units Introduction to policy evaluation software
2.00pm	Afternoon tea (general discussion)
2.15pm	Field exercise: Land Management Units Farm tour (focus is on how the farm can be broken into LMU's)
3.45pm	Exercise on aggregating soils into Land Management Units
4.45pm	Meeting close

A brief note on the standard programme...

The programme being outlined in this manual diverges from the standard SUBS programme, in that:

1. Meetings 1-5 do not necessarily correspond with the introduction of modules 1-5 in practice. Exactly when each module is introduced depends on the progress of the group (determined at each 'progress report'). As such, a difficult module like Soil Description may be adjusted to cover two whole meetings, with the introduction of Module 3 being delayed to Meeting 4. 'Buffer meetings' at the end of the programme are included to absorb these sorts of extensions.

2. With the standard SUBS programme, farmer tasks essentially end when Module 5 has been completed, and each farmer has a digitised map of their farms' LMU's. From this point, farmers have to come up with three activities they will commit to undertaking as a result of being involved with SUBS. The rest of the meetings are given to farm tours (demonstrations & exercises are repeated, and farmers continuously practice their developing skills and learn more about a wider range of soils and their behaviour), and the 'use of land resource information in planning' demonstration being undertaken by the consultant.

There is considerable scope to build on the standard SUBS programme, by introducing additional themes with the purpose of bringing a little more complete closure to the end of a SUBS programme. This is explored in this manual by introducing two new modules – Designing Management Options and Farm Planning. These modules are a natural extension of existing SUBS themes, so they can be readily integrated into a SUBS programme.

MEETING SIX

Farmers are expected to have made significant progress toward designing LMU's, and to have listed limitations and opportunities for each unit. In the past, some farmers have zealously defined a large number of small LMU's. Such farmers need to be guided back to a practicable and workable number of units.

The consultant introduces (optional) Module 6, and outlines how farmers go about drawing up the base model of their farm's existing production and policies. The demonstration farm is used as an example, and the consultant shows how he or she developed the farm's base model using a purposely designed spreadsheet model, and then how it was refined using comprehensive computer software like Stockpol, Agro Estate Forestry Model (AEM), DairyWin, etc. The next stage of the module – developing and evaluating scenarios – is covered after the field exercise.

By now the field exercise has shifted from in-the-field demonstrations, to discussion of opportunities and limitations for sustainable production. The group still discusses soils, but less in a 'learning how to do' manner and more in a 'practicing what has been learnt' sort of way.

Suggested program for Meeting Six:

Time	*Activity*
1.00pm	Preliminaries Progress report & discussion
1.30pm	Module 6: Designing & Evaluating Management Options Overview of the module Introduction to developing base models Report & discussion on base modelling of the demonstration farm
2.00pm	Afternoon tea (general discussion)
2.15pm	Field exercise Farm tour
3.45pm	Exercise on developing & evaluating alternative scenarios
4.45pm	Meeting close

Back inside, the consultant facilitates the group's development of at least two alternative production/policy scenarios for the demonstration farm, with an emphasis on explaining how each farmer goes about developing their own alternative scenarios. The idea is to identify options that would simultaneously progress the profitability of the business, the quality of the underlying land resource, and progress the farms' contribution to improving the status of the wider environment.

During the exercise, the consultant will be using a purposely-designed spreadsheet model to give a quick and broad evaluation of any possible scenarios as the group develops them. After the meeting, he or she will model the demonstration farm's scenarios through more comprehensive software and present the results at the next meeting.

How farmers develop and evaluate alternative scenarios for their own properties can vary. Some may have experience using comprehensive software, and are capable of doing a detailed analysis. Some may just have a computer, so the spreadsheet model can be given to them and they can do a broad analysis. Others have to develop scenarios in the traditional way, and develop and refine them via the spreadsheet model at the next meeting with group input.

This part of the programme begins to lean towards production economics, even though the scenarios represent changes that will progress the biophysical aspect. To maintain a balanced approach within the SUBS programme, the scenarios are only evaluated crudely through the spreadsheet model (apart from the demonstration farm). If a farmer wants a more detailed evaluation and refinement of scenarios, then he or she should be encouraged to engage the consultant (or any other consultant) outside the normal SUBS programme.

The development and evaluation of possible scenarios has only meant to be a way of showing farmers what broad options they have for progressing the sustainability of their business, and an indication of how they can go about doing it. Another way of putting this is that farmers get an idea of how they can progress the biophysical aspect without having to impair the financial viability of their business.

MEETING SEVEN

Farmers briefly report back on the development of LMU's. By now they would have ideally produced a complete draft LMU map and a list of opportunities and limitations for each unit. However, it's more likely they will need to be refined that little bit extra before being ready to be submitted for digitising at the next meeting.

Progress reporting extends into a session on scenario modelling. The consultant makes a report on how the analysis of the demonstration farm is progressing, and the group provides feedback. This leads onto each farmer reporting their progress in developing scenarios for their own farms. Four of the farmers have their scenarios modelled by the consultant in front of the group, so they can be examined and discussed (the other five farmers have their scenarios modelled at the next meeting).

After the scenario modelling the group tours the host farm looking at and describing soils and landforms, and discussing various options they farmer may have. Back inside, the group is briefly introduced to optional Module 7. This is covered in more detail in the following meeting.

Suggested program for Meeting Seven:

Time	*Activity*
1.00pm	Preliminaries Progress report on LMU's Discussion
1.20pm	Scenario modelling session 1 Consultant's progress report on modelling the demonstration farm Farmers' progress report on developing their scenarios Modelling of farmers' scenarios using the spreadsheet module
2.45pm	Afternoon tea (general discussion)
3.00pm	Field exercise Farm tour
4.30pm	*Introduction to Module 7: Farm Improvement Planning* *Overview of the module*
4.45pm	Meeting close

MEETING EIGHT

Final copies of each farmer's LMU map are handed-in for digitising. This may be briefly discussed before farmers report back on their progress in developing scenarios.

This leads into the second session on modelling, where the consultant gives his or her final report on the demonstration-farm analysis. Then he or she takes the group through the modelling of the scenarios developed by the five farmers who were not covered in the previous session.

Again, the group takes a tour of the farm. By now, this has the added advantage of breaking up the head-scratching analysis work.

The later part of the meeting is given to explaining Module 7 in more detail. The group is shown how to prepare 'farm improvement plans' (that largely omit the financial budgeting side of things and concentrate on development and improvements), with the consultant & RC officer facilitating the development of a plan for the demonstration farm. At the end of the meeting, farmers are asked to draw up a list of feasible changes they would consider making, which would progress their farms' sustainability (both in terms of production and conservation/environmental management).

Suggested program for Meeting Eight:

Time	*Activity*
1.00pm	Preliminaries Progress report on scenario development (farmers) LMU maps handed in for digitising
1.20pm	Scenario modelling session 2 Consultant's final report on the demonstration farm analysis Modelling of farmers' scenarios using the spreadsheet module
2.45pm	Afternoon tea (general discussion)
3.00pm	Field exercise Farm tour
4.30pm	*Farm Planning exercise* *Development of a simple plan for the demonstration farm*
4.45pm	Meeting close

MEETING NINE

No new themes are introduced from Meeting 9 onwards, which gives more time for discussion and reaffirmation. Digitised maps are handed back at the start of the meeting, and are explained and discussed if necessary. Each farmer will report back on their most promising scenarios, and outline the changes that they consider potentially viable for progressing their farms' sustainability. These can be discussed in some detail, in terms of how feasible they are, what are their likely impacts, and what is required to turn them into reality through the 5 planning steps of Module 7.

This discussion is broken up by the second-to-last farm tour, which takes up all the later part of the meeting. At the end of the day, farmers are asked to identify three activities they will commit to initiating over the next 12 months as a result of being involved with the SUBS programme.

Suggested program for Meeting Nine:

Time	*Activity*
1.00pm	Progress reporting & group discussion Digitised LMU maps handed back and discussed Final report on scenario development Progress report on listing potential changes
2.45pm	Afternoon tea (general discussion)
3.00pm	Field exercise Farm tour
4.45pm	Meeting close

MEETING TEN

Each farmer gives a short presentation to the group. This is not meant to be formal in anyway, and each farmer can talk for up to 10 minutes if necessary. Each farmer can review their LMU maps, highlighting dominating soil features and the most distinguishing opportunities and limitations they identified. This follows with a brief summary of their most promising scenarios, and concludes with an outline of the three activities they intend to undertake over the next 12 months.

After the field exercise, each member of the group gives a short review of what they got out of being part of the programme (someone records this). This is an opportunity to ask for feedback from the group on how the SUBS programme can be improved or refined.

The field day is planned at the meeting close. The programme organizer outlines what needs to happen on the day, and then the whole group decides what each person's role and 'message' will be. Farmers are expected to pair up to cover part of the field day programme.

Each member of the group is also expected to bring along a carload of people who might have an interest in SUBS. For farmers, this not only means their immediate peers, but also people like their bank manager or fertilizer representative. Specialists are also expected to bring along a carload of peers.

Suggested program for Meeting Ten:

Time	*Activity*
1.00pm	Group presentation session Farmers' presentations
2.00pm	Afternoon tea (general discussion)
2.45pm	Field exercise Farm tour
4.00pm	Feedback
4.30pm	Meeting close Planning of field day

FIELD DAY

The field day has two purposes. Firstly, as a field day, it's a means for the group to extend a message to neighbouring farmers and the wider farming community (namely the importance of having a sound understanding of soils and their potential uses), and secondly, to get another group of farmers interested enough to start a new SUBS programme.

A particular feature of SUBS field days is that its one group of farmers extending or transferring information to another group of farmers - the onus is on the group's farmer members to run the day themselves, with a pair of farmers being responsible for any one part of the day. The specialists are largely relegated to a support role.

The 'day' is actually an afternoon, broken into four general parts: introduction and overview; out in-the-field explanation and demonstration; an inside presentation on the farm's options; and a general summary and 'knees up' at the end of the day.

Suggested program for the field day:

Time	*Activity*
1.30pm	Welcome & introduction to SUBS Introduction to the day 'What we got out of SUBS' Review of the SUBS programme
2.00pm	Soil description demonstration and comparison Site 1: Presentation on geology, soils & landforms; soil description exercise; relevance of soil strengths & weaknesses Site 2: Soil description exercise; designing LMU's
3.30pm	Afternoon tea (general discussion)
3.45pm	Designing options presentation Host-farmer's overview Presentation on the economic analysis
4.25pm	Group summary 'What we are going to do now' Conclusion
5.00pm	Field day officially finishes (drinks) Drinks & forming of a new group?

The day begins at a central point (e.g. a woolshed or farm sheds) with a welcome and brief overview of the programme given by the programme organizer, and then follows with two farmers explaining what they got out of being involved with SUBS – what they learned about their farms and how they benefited. This leads onto another two farmers outlining just what SUBS is and how it works. The specialists should be ready to 'prompt' the farmers if necessary, or fill in any aspects they may have missed at the end.

After these preliminaries have finished, everyone moves out to the first of two demonstration sites. These sites represent two contrasting soils (and hence, two different LMUs), and ideally, should also be vantage points for viewing a large area of the farm (if not, then vantage points will have to be stopped at before, between, or after visiting sites). At the first vantage, the LR specialist provides a setting for the geology and landforms of the farm, and the host-farmer gives a brief overview of his or her enterprise.

At the first site, 2 farmers use pre-dug holes to explain the process of soil description. The LR specialist needs to be prepared to offer support if they have difficulty, and again fill in anything that the farmers may overlook. This follows with a quick explanation of what soil strengths and weaknesses are. At the second site, a different 2 farmers again demonstrate how to describe the soil, and then outline particular strengths and weaknesses. From this site or from a suitable vantage, a brief presentation is given on the design of LMUs.

After visiting the two sites, everyone returns to the central point where the day started for afternoon tea. After this, the consultant and host-farmer give a presentation on the economic analysis, including an overview of the existing farm business (including farmer objectives), and an explanation of the two most likely scenarios and how they were modelled.

A group summary is held after this, with each farmer briefly talking about what they got out of being involved with SUBS, and stating the three activities they're going to undertake over the next 12 months. The day concludes with a summary given by the programme organizer, and an invitation for farmers to sign-up to forming a new SUBS group.

ADDING THEMES

The introduction of new themes into previous SUBS programmes has essentially ended at Meeting Six. Likewise, setting farmer tasks has finished with the completion of the LMU map and each farmer stating the three activities they intend to undertake. They were not asked to develop their own scenarios or their own farm plans. Rather, they were only shown how they might go about it through the demonstration farm example.

Consequently, outside the 'core' SUBS package, the modules on 'Designing Management Options' and 'Farm Planning' are completely optional. Even with their omission, any programme would still retain the original integrity of the SUBS package. They are only included in this manual to give an example of how additional themes can be readily linked onto the SUBS programme, to extend the utility of the package into specific areas.

Specialists and farmers from previous SUBS groups have both expressed an interest in building on the base SUBS package. Perhaps the inclusion of the modules on designing options and farm planning would be the next logical step, although there is considerable scope to include just about anything that might be of interest to farmers.

However, only one or two possible themes can be integrated with the existing package – more than this and the programme becomes too rushed. Off course, outside the 12-month programme, the addition of extra themes is limited only by how long farmer interest can be maintained.

SECTION 3

MODULE NOTES & HANDOUT MATERIAL

Module 1: Landforms & rock types
Module 2: Soil description
Module 3: Soil mapping
Module 4: Soil Strengths & Weaknesses
Module 5: Land Management Units

MODULE ONE

LANDFORMS & ROCK TYPES

THIS MODULE INCLUDES NOTES ON:

1. WHAT YOU WILL NEED TO MAP YOUR FARM'S LANDFORMS
2. HOW TO MAP LANDFORMS
3. LANDFORM CHARACTERISTICS WORTH DESCRIBING
4. AN EXAMPLE OF A COMPLETED LANDFORM MAP AND WORKSHEET

Mapping Landforms & Rock Types

During the first meeting, you will be shown how to map landforms and describe them along the lines of 'important landform characteristics'. This module and the laminated field notes are included just in-case you need some reminding or reference when you're out there mapping and describing your own farm's landforms and characteristics.

LANDFORM MAPPING FIELD NOTES

The laminated notes are a brief summary of the eight landform characteristics detailed in the following pages. Characteristics considered important include:

- Landform type
- Topography & slope (and aspect)
- Rock type
- Vegetation
- Degree of erosion
- Flooding potential
- Improvements/developments
- Current land use

The field notes are only meant to be a quick reference if you find you need a bit of prompting. They are not meant to be prescriptive – if you come up with a better term to describe, say, a particular landform, then use it. The idea is to describe landforms in a way the whole group will be able to relate to.

Some of the characteristics include a 'code' for quicker recording. Again, it's up to you whether you use this. For some characteristics it's actually just as quick writing out the whole term.

PROCEDURE FOR MAPPING LANDFORMS

Before going outside to map landforms, take five minutes to sit down with your aerial photo and consider what sorts of landforms make up your farm. Examples of possible landforms are included in the laminated field notes, and are explained in detail in the following pages. Lightly pencil landforms onto the photo as units, and then draw up a worksheet for describing the characteristics of each unit (see example on page xyz).

There are two things to do outside. Firstly, find vantage points to get a broad perspective of each landform you've lightly pencilled in. This may be a high point, a long flat, or for a really wide perspective you may want to jump the fence and find a vantage on your neighbour's farm. From a distance, it's easier to distinguish landforms, measure the overall slope, and to more accurately estimate the degree of erosion. Note down these characteristics for the units/landforms you're looking at, and adjust the lines on your map as necessary.

The second thing to do is to get up close and wander around inside each landform unit you've drawn. This gives a better perspective for describing characteristics like rock type, vegetation, etc. When all the characteristics have been recorded, come up with a name that best describes the landform unit.

At the next meeting you can present and talk about your maps to the group. This meeting is also an opportunity to bring-up any problems you may have encountered, and to discuss how different farmers with the same or similar landforms might manage or use them differently.

Important Landform Characteristics

The following descriptions have been adapted from various sources, including the NZLRI system and the Soil Description Handbook (Milne *et al.*, 1995).

1. LANDFORM TYPE

Record the landform type that most closely describes the unit you're looking at. If it's a large area within hill country, you might like to describe it in terms of 'hillform' (ridge, spur, side slope, etc.) and the shape of any slopes (concave, convex, straight or 'many sub-slopes').

Hill or hill country (HC): A hill has a slope ranging from 12^0 - 28^0. Steeper than this and it's a mountain. If the half the unit is covered in 'hills' then it's defined as hill country.

Plain (P): Any extensive flat or gently undulating area of land that cannot be defined as floodplain (FP), sand plain (SP), or terrace (T). A plain may include a few hills, gullies, depressions, etc., and it may have a distinct and extensive tilt or slope (i.e. 'tilting plain').

Floodplain (FP): River flats that may be subject to occasional flooding

Sand plain (SP): An extensive area of sand-covered plain between sand dunes.

Terrace (T): An elevated flat/gently undulating area of land. This may be elevated just beyond the reach of a river (river terrace) or terraces may be found right up in the hills (very old terraces). They are usually distinguishable by having a steep drop-off at the terrace edge.

Fan (F): Where a river or stream comes out of the hills and deposits a fan shaped mound of alluvium.

Gorge (G): A predominantly steep-sided (slope >25^0), wide, and deep (>10m) channel usually formed by a river or large stream.

Gully system (GS): A small gorge – mostly steep-sided but not as wide or as deep (<10m). Usually associates with the water-runoff systems of hill country.

Valley (V): A long and wide U or V shaped landform between mountains or hills.

Dune or dune country (DC): A hill made of sand. Dune country is many hills made of sand.

Summit area (SA): A reasonably broad area of hilltop that gradually rises to a rounded apex.

Ridge top (RT): Either a hilltop that doesn't form a conical type of summit, or the elongated top of a spur. Usually flat, but can include a long slope less than 12^0. Usually only broad ridge tops are large enough to be mapped.

Spur (S): A landform that extends out and down from the main hill. Spurs are usually separated by gully systems, and start from ridge tops.

Side slope (SS): Either a hill side, or the side of a spur. If large enough, side slopes with northerly or southerly aspects are often drawn as landform units.

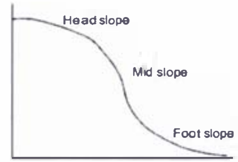
Head slope (HS): The upper most part of a slope. Only feasible to map where the hills are quite large and the slopes are long.

Mid slope (MS): The middle part of a long slope.

Foot slope (FS): The bottom or 'toe' of a long slope.

Cliff (CF): A slope greater than 55^0 and usually denuded of vegetation.

Valley floor (VF): Where the flattish bottom part of a valley is too narrow to call a floodplain, but is large enough to map as a landform unit.



Swamp or bog (SW): An area of land that's always heavily saturated with water. If it associates with pooled water it's a swamp – if it doesn't then it's a bog.

2. Topography & slope

Measure slope using the protractor gizmo. Stand far enough away from the slope so you get a good perspective of the whole slope – from top to bottom. Use the protractor gizmo by holding it at arm's length, and aligning the bottom edge with the general angle of the slope of interest. Once aligned, work out the number of degrees between the 90^0 mark and where the string crosses the protractor. It may seem a bit rough and ready, but measuring slope this way is just as effective as using a special $250 device.

Straight slopes are easy to measure. For convex, concave, and 'many sub-slope' slopes, its best just to take an overall average as best you can (this is easiest from a distance). Where there are two obviously different angles on a slope, measure the steepest and the least steep angles and express them as a range (e.g. $20^0 – 24^0$).

3. Rock type

A map and description of the rock types likely to be found in your region are included as a booklet. Please note the map is not accurate at the farm scale. It's only included to give a general idea of the rock types that may be present in your immediate district. If you have local names for the rock types then use them – provided you're confident everyone in the group will know what you're talking about.

4. Vegetation

Vegetation is fairly self-explanatory. The idea is to describe the most characteristic vegetation of the landform unit. This may simply be *'medium quality hill country pasture'* as an example. However, this doesn't really tell people very much – a better example might also include; *'space planted poplars on the less stable slopes, quite dense rushes on the foot slopes, and the whole unit has very little clover, a high proportion of browntop, and can break out badly in thistles after a dry spell'*. The level of detail is completely dependant on how much you want to clarify in your own head.

5. Erosion

Most erosion within a unit is fairly easy to identify – just compare any erosion types you see with the pictures and descriptions included in the rock-types handbook. Describing erosion seriousness is a little more difficult, however. To do this you need to consider all the following factors at once, and make a judgment on how much impact you think the rate of erosion is having on the long-term production potential of your farm (and downstream water quality). These factors include:

- Depth of erosion
- Rate of erosion
- Age of erosion
- Land value and/or productivity
- Steepness/slope
- How naturally fertile and how easily weathered the underlying rock type is
- Erosion type
- Area affected
- Potential area that may be affected in a worst-case scenario (e.g. tropical cyclone)

Don't be too concerned if you find judging a unit's erosion severity difficult. The group will help out when they visit your farm. In particular, ask the geologist/pedologist and regional council officer, as these people have probably experienced numerous examples of erosion across many farms, and should be readily able to offer a considered opinion on erosion seriousness.

6. Other characteristics

Record anything else that may describe the particular character of your landform units. Please note that soils are covered in some detail in module 2. However, you might want to note general soil characteristics like natural drainage, natural fertility, how droughty it is, etc. Other characteristics to consider include:

Flooding potential: Estimate how often the unit is affected by flooding.

Improvements: List any developments or improvements. In particular, mention if the unit has been artificially drained; if its been intensively fenced or not; and what its fertilizer history over the past three years has been.

Past & present land use: State how the land has been used in the recent past, and/or how it's currently used.

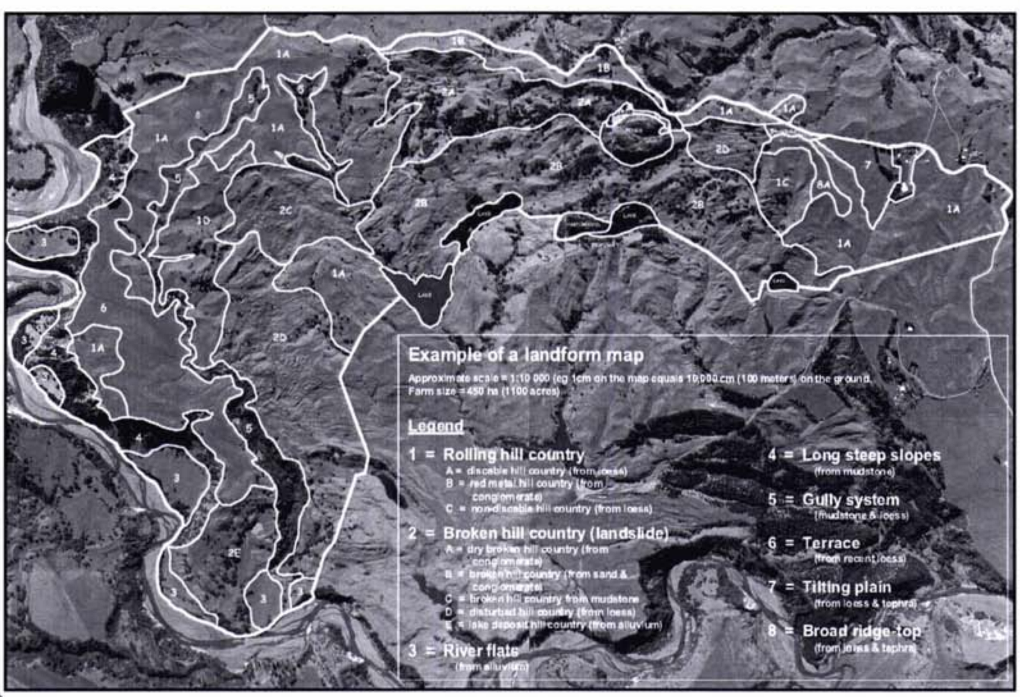
Finish off by giving each of your landform units a name. Usually a name will combine landform type, rock type, and perhaps topography.

7. EXAMPLE A

Example description of landform units

Unit No.	Landform	Slope	Topography	Rock type	Vegetation	Erosion	Other	*Landform name*
1A	Hill country with short convex slopes	15	Rolling	Ash + loess	Medium quality HP with some scattered kanuka	Negligible slip	Made up of hills & basins. The hillier bits tend to be drier less fertile, & there's one or two slips. Sheep & beef only but am thinking about deer	*Discable hill country (from loess)*
1B	Hill country with short convex slopes	15-18	Strongly rolling	Conglomerate	Low quality HP & some kanuka	Slight sheet & potential for severe if overgrazed when dry	Dry faces in red metal country. Very shallow soil & [illegible] out early. Only ever been used to graze sheep & cows.	*Red metal hill country (from conglomerate)*
1C	Hill country with long straight slopes	20	Strongly rolling	Loess (but some limestone outcrops)	Low quality HP & some kanuka	Slight slip & potential for moderate slip erosion	Pretty much the same as Unit 1A but forms straighter & steeper slopes. Sheltered - good lambing paddock. Only used for sheep & beef	*Non-discable hill country (from loess)*
2A	Broken hill country with short convex slopes	16	Rolling	Conglomerate with patches of loess	Low quality HP & some kanuka	Slight sheet & potential for severe if overgrazed when dry	Like Unit 1B but part of the landslide. Not discable because of very disturbed surface	*Broken hill country from conglomerate*
3	Riverflats	0-5	Gently undulating	Fine alluvium	High quality HP	none	Very fertile & grows good grass all year. Problem with access, so has only been used for sheep & cows	*Riverflats from alluvium*
4	Very long straight & steep slopes	28	Steep	Massive mudstone	Low quality HP & native scrub	Moderate slip with potential for extreme	Only parts are grazed - wintering the rams & emergency summer ewe feed. Too steep	*Long steep slopes from mudstone*
5	Gully system	24-25	Moderately steep	Loess. Some mudstone on slip faces	Low quality HP & big patch of kanuka	Slight slip & potential for moderate	Used only for sheep & beef. Have had problems estabilishing poplars in the past	*Gully system from mudstone & loess*
6	Terrace	0	Flat land	Ash & loess	High quality HP	None under pasture but potential for moderate wind erosion if cultivated	Can dry out in summer. Grass grub problem. Best land on the farm. Used for fodder cropping, hay, lamb fattening, intensive bull beef, etc	*Terrace (from recent loess)*
7	Tilting plain	10	Rolling land	Ash & loess	High quality HP	none	Used mainly for the studs & lambing. Cultivated once but very wet all year round	*Tilting plain from loess & tephra*

7. EXAMPLE B



MODULE TWO

SOIL DESCRIPTION

THIS MODULE INCLUDES NOTES ON:

5. WHAT YOU WILL NEED TO DESCRIBE YOUR FARM'S SOILS
6. HOW TO SELECT A SUITABLE SITE FOR DESCRIBING A SOIL PROFILE
7. AN OUTLINE OF KEY SOIL CHARACTERISTICS
8. LAMINATED FIELD NOTES THAT DESCRIBE THE PROCEDURES FOR DESCRIBING KEY CHARACTERISTICS
9. AN INTRODUCTION TO SOIL STRENGTHS & WEAKNESSES FOR PRODUCTION
10. AN EXAMPLE OF A COMPLETED SOIL DESCRIPTION

Soil description kit

In addition to these notes, the following items will help with the description of soils:

- Landform map, clipboard and clips, pencils, eraser, etc
- Note paper for recording soil descriptions
- A spade!
- Pocket knife
- A water bottle to help identify soil texture.

Procedure for describing soils

At this stage aim to do one soil profile description for each landform unit previously mapped. Pick a site that characterizes the whole unit as best as possible. This site is likely to represent the most dominating soil within that particular unit. Record the site on your landform map (e.g. site 1, site 2, etc.).

Either dig a fresh soil pit (about the depth and size of a post hole) or spade-back an exposure such as a track cutting or slip edge. If an exposure is used, then it is often beneficial to familiarize yourself with what that particular soil looks like when moist by digging a pit nearby.

Carefully 'shave-back' the profile face using the edge of the spade or a pocket knife. Have a good hard look to distinguish each horizon/layer of soil (see notes on horizons overleaf). On a piece of paper draw up a 'profile description table' (see the examples at the end of this module) and record the site, horizon name, and the depth of each horizon.

'Soil characteristics' of most interest include horizons, mottling, texture, and structure. Definitions are included on the following pages. Procedures for describing characteristics are included as laminated field notes. It's recommended that one characteristic be described at a time (e.g. describe texture in horizon A, then texture in horizon B_1, etc.) rather than trying to do all the characteristics at once for single horizons.

Consider the strengths and weaknesses of each soil as you describe it. That is, how do the soil characteristics you're describing relate to management and production. How to infer strengths and weaknesses is introduced briefly in this module, and is covered in more detail as Module 3. The idea is to start thinking about them now, while you're head down/bum-up in a soil profile pit.

Aim to have at least 5 to 6 soil profile descriptions completed by Meeting 3 so you can talk about them to the group. Additional demonstrations on how to describe soils will also be given at this meeting, and the third module – soil mapping and strengths/weaknesses – will be introduced.

Key soil characteristics to describe

Horizons – depth & colour

Horizons are different layers in the soil. They can be different in terms of soil colour, texture or structure. Key points on soil horizons include:

- The majority of NZ soils have at least one A, B & C horizon: A horizon = topsoil; B horizon = subsoil; C horizon = parent material or underlying rock type
- Occasionally a soil may have no B horizon such as a very recent alluvial soil that has not had time to develop
- Boundaries between horizons may be distinct and obvious, or they may be diffuse and difficult to distinguish.

Depth is simply the thickness of any given profile. Generally, the deeper the soil (particularly the topsoil) the more fertile the soil (relative to soils from similar rock types).

Colour is a fundamental property of soil that can indicate presence of organic matter, drainage and the nature and age of the parent material. It is also important for making distinctions between different soil types. 'Horizon colour' refers to the overall or prevailing colour that is most apparent across the face of the horizon being described. Colour Charts are included to help distinguish soil colour.

Mottles – Colour & Abundance

Mottles are discrete patches of colour within the overall 'horizon colour' scheme. They form in small patches where minerals precipitate out of soil-water (red, brown & orange mottles) or in small areas where there is no oxygen (grey mottles). Usually they are an indicator of a seasonally fluctuating water table or poor aeration/water logging. Their abundance and colour have implications regarding drainage and water movement within the profile. Laminated charts are provided to help determine mottle colour and abundance. Refer to the following table to determine how mottling relates to describing the internal drainage status of a soil.

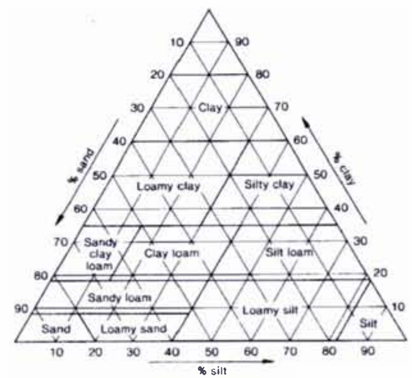
Table: Internal soil drainage classes

Depth from surface (cm)	*Abundance of grey mottles*	*Abundance of reddish mottles*	*Drainage class*
10-30 cm	50-100 %		Poorly drained
<30 cm	**1-49 %**	**≥2 %**	**Imperfectly drained**
30-60 cm	50-100 %		
30-60 cm	none	≥2 %	Moderately well drained
60-90 cm	50-100 %		
0-90 cm	none	<2 %	Well drained

Texture (sand, silt or clay)

Texture refers to the overall dominance of sand, silt or clay within an horizon. It's a very important property affecting a soil's ability to drain, to hold water for plants, to hold onto nutrients, and to provide oxygen within the soil profile. A laminated flowchart is provided to distinguish the textural name for soils (see diagram below).

Texture can also refer to the size and abundance of stones. Stoniness affects water holding ability and land versatility for cultivation.



Structure

Soil sand, silt, clay, minerals, and organic matter all interact together to form distinct soil structures known as 'aggregates' or 'peds'. Peds can be grouped into types according to their shape (e.g. 'blocky', 'granular', 'prismatic', etc). How distinctive peds are is dependent on the degree of structural development (ranges from 'structureless' to 'strongly developed'). Ped type and degree of development have important implications for the physical fertility of soils, and are strongly related to aeration, resistance to compaction/pugging, drainage, water holding capacity, etc. Laminated flowcharts are provided to help determine ped type and degree of development.

A note on soil strengths & weaknesses

SUBS is about teasing out your farm's unique mix of strengths and weaknesses that arise from the interaction between the soils, rock types, slopes, vegetation, and other land factors particular to your farm. A strength is a positive land-characteristic that can be an opportunity and an advantage to production. A weakness is a negative land-characteristic that can limit or lessen production.

Strengths and weaknesses can be related to soils, landforms and how the landscape has been modified for production. All three are covered in more detail in Module 3. The first – soil strengths & weaknesses - are being introduced here to encourage you to think about them when you're actually out there describing soil profiles. A few brief examples include (more in Module 3):

Possible soil strengths	Possible soil weaknesses
Freely drained	Poorly drained
Deep topsoil	Shallow topsoil
Good soil-moisture holding ability	Poor soil-moisture retaining ability
High natural fertility	Low natural fertility
Good soil structure	Poor soil structure
Balanced soil texture (e.g. loam)	Imbalanced soil texture (excessively dominated by sand or clay)
High resistance to compaction/pugging	Susceptible to compaction/pugging
	High water table
	Presence of a pan
	Excessive stoniness

As you move around your farm mapping and describing soils, consider what the strengths and weaknesses of each soil are. Also, it's likely you'll pick up on various strengths and weaknesses through talking with other group members, and by seeing how similar land is managed differently as you visit each farmer's property.

You'll also be asked to consider broader strengths and weaknesses relating to landforms and landuse in Module 3, which will be used to develop Land Management Units in Module 4. A Land Management Unit represents a practical amalgamation of land with similar strengths and weaknesses for more effective management.

EXAMPLE C

Example soil profile descriptions

Landform Unit: Terrace Unit (Unit 6)

Soil name or unit: Terrace soil (S4)

Horizon name	Horizon (thickness & colour)	Mottles (colour & abundance)	Texture	Structure (degree of development & ped type)	Other
A	20cm & dark red brown (RB3b)	none	sandy loam	well developed nut structure	Lots of grassgrub, very droughty in summer, very dusty when cultivated particularly along the shelter belt, many holes dug by bulls
B	35cm & dusky red brown (RB3c)	none	sandy loam	moderately developed coarse nut structure	Strengths: freely drained, good natural fertility, very resistant to pugging when wet
C	dusky orange yellow (OY3d)	none	sand grading down to coarse gravels	no structure	Weaknesses: droughty in dry summers/low water retaining ability, prone to wind erosion when cultivated

Landform Unit: Mostly Unit 1A (Discable hill country from loess)

Soil name or unit: Hill soil from loess (S1a)

Horizon name	Horizon (thickness & colour)	Mottles (colour & abundance)	Texture	Structure (degree of development & ped type)	Other
A	15-20cm & dark orange grey (O/Y1c)	none	sandy clay loam	weakly developed fine nut structure	Some fine pumice in A horizon, small bright orange (O5d) concretions of iron in wetter areas, some charcoal in A horizon. B2 is a pan and only appears in some parts of the paddock
B1	20cm & pale orange yellow (O/Y3f)	many (4%) yellow (Y/B4d) mottles	sandy clay loam	weakly developed nut structure	
B2	35cm & dusky red brown (RB3c)	none	sandy clay	structureless	Strengths: moderate natural fertility
C	35cm & dusky red brown (RB3c)	none	sandy clay (loess)	moderately well developed prismatic structure	Weaknesses: very prone to pugging when wet, low water holding ability - tends to dry out early in summer, clay pan

MODULE THREE

SOIL MAPPING

THIS MODULE INCLUDES NOTES ON:

Soil mapping considerations

You've already described what is likely to be the most dominating soils within each landform unit. These are referred to as reference soils. From here, aim to identify any other significant soils that may be present within each unit.

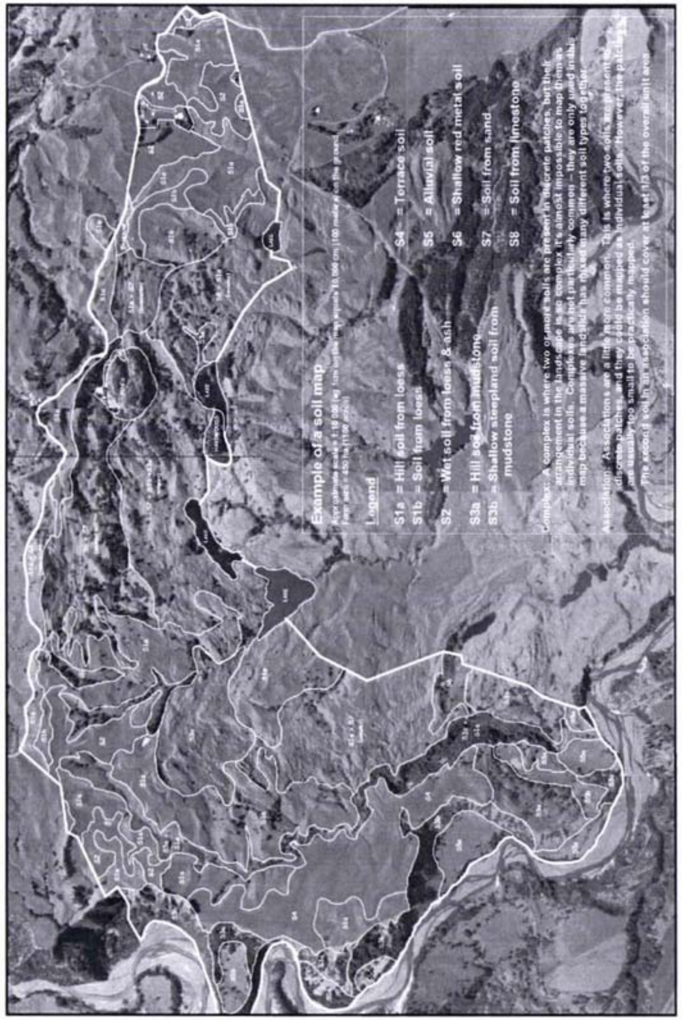
Using each reference soil as a starting point, look for changes in the landscape (within the unit) that may suggest a change in soil type. This might be a slight change in slope, elevation, aspect, rock type, or even a change in vegetation like the presence or absence of rushes.

Dig pilot holes where you suspect there's a change in soil type – just deep enough to get a quick view of the upper profile. If it looks like a different soil, dig additional pilot holes to gauge if the soil covers a significant area – that is, is the area significant enough to be worth mapping? What a 'significant area' is will vary between people, because it depends on the type and intensity of land use being considered. If in doubt, don't map anything smaller than ¼ of a hectare. And if it is a significant area, then you'll need to do a profile description.

Record newly identified soils on your landform/soil map. Where to draw a line between two soils is always a problem. Very rarely does one soil just stop and the other starts. Rather, there's likely to be a gradual intergrading between soils over several meters. Exactly where you draw the line isn't really all that important – the important bit is having identified a significant area of a different soil type in the first place.

Move around the farm examining each unit in turn. Again, be on the lookout for strengths and weaknesses. If possible, aim to have the soil map completed by Meeting 4 so the group can start on developing Land Management Units. An example of a completed soil map is included in this module.

EXAMPLE D



MODULE FOUR

STRENGTHS & WEAKNESSES

THIS MODULE INCLUDES NOTES ON:

13. AN EXPLAINATION OF STRENGTHS & WEAKNESSES

14. EXAMPLES

Strengths & Weaknesses

In practical terms, a soil strength is a potential production advantage while a soil weakness is often an inadvertently overlooked production disadvantage. Production can be sustainably lifted by firstly recognizing each soil's particular strengths and weaknesses, and secondly by integrating them into farm management to simultaneously capitalize on the advantages and avoid or overcome the disadvantages.

Examples are included over the page. Please note these are only examples and they may or may not relate to your particular property. Identifying strengths and weaknesses is not a clear or stepwise process because every farm is uniquely different from its neighbor. Every farm in NZ has its own particular combination of land resources (e.g. soils, slopes, rock type, vegetation, etc.) that interact with the slight differences in climate and weather, to present different strengths and weaknesses that are particular to individual farms.

There's a number of ways to identify your farm's strengths and weaknesses. Firstly, by examining your farm's combination of land resources in detail, you'll be clarifying the strengths and weaknesses you already know about by relating them to specific landforms or soil characteristics. Secondly, by describing soils you can identify characteristics that indicate new strengths or weaknesses that you weren't aware of. Thirdly, you'll be able to use the experiences of other group members just by talking with them and visiting their farms.

By visiting different farms you get to see, compare, and talk about soils that are likely to be the same or similar to your own. Farmer members may use and manage these soils differently than you (e.g. different fertiliser policy, pasture species, crops, stock policies, grazing rotations, etc.), and they may have experienced responses and behaviors that you haven't experienced on your own soil types. It follows that they may be aware of some strengths & weaknesses relevant to your land.

Likewise, use the experience of the council representative, consultant and pedologist. It's likely they've seen a wide range of soils and associated management from across the whole region, and they may be particularly skilled in relating strengths and weaknesses to management opportunities. A good pedologist will also be skilled in identifying soil characteristics and relating them to possible strengths and weaknesses. Take advantage of these specialists when they visit your farm.

Hopefully you've had the chance to consider soil strengths and weaknesses as you described soil profiles. For this module, make a detailed list of all related strengths and weaknesses for each soil, including those that relate to landform (e.g. slope stability, warm/cold aspect) and land development (e.g. improved level of fertility through fertilizers, intensively subdivided, poor stock access to water). Examples are included overleaf. Your list and the soil map will be used in Module 5 to group soils and management factors to produce a practical set of Land Management Units for your farm.

Key points to consider when identifying strengths & weaknesses:

- A strength or weakness can be broad and obvious – like steep slopes, southern or northern aspects, very poor drainage, etc – or it can be specific and subtle – such as poor aeration indicated by the presence of grey mottles in the upper profile (which can negatively influence plant production).
- What is defined as a strength or weakness depends on the land use being considered. The broader the land uses you consider, the more strengths and weaknesses —and perhaps production opportunities – will be identified.
- A single soil characteristic can be either a strength or weakness (e.g. stoniness). But its more likely that one or more characteristics need to be considered together to indicate a strength or weakness.
- This is why the following examples may or may not relate to your farm. They are only included to give you an idea of what strengths and weaknesses are. They relate mostly to pastoral landuse.

Examples of possible strengths		Examples of possible weaknesses	
Freely drained	Naturally sheltered	Poorly drained	Hot dry aspect
Deep topsoil	Warm aspect	Shallow topsoil	Wet cold aspect
Good soil-moisture holding ability	Stable (not susceptible to erosion)	Poor soil-moisture retaining ability	Freely draining & close to a water course
High natural fertility	New pasture	Low natural fertility	Susceptible to drought
Good soil structure	Good pasture quality	Poor soil structure	Susceptible to erosion
Balanced soil texture (e.g. loam)	Well sheltered by trees	Imbalanced soil texture (excessively dominated by sand or clay)	Susceptible to flooding
High resistance to compaction/pugging	Artificially drained	Susceptible to compaction/pugging	Low quality pasture
Well aerated	Low in insect pests	High water table	High in insect pests
Good P, K & S levels	Low in weeds	Presence of a pan	High in weeds
Good pH	Good stock access to water	High nutrient leaching	Poor stock access to water
Flat land	Good machinery access	Excessive stoniness	Poor access for machinery
		Excessively steep	
		Very exposed	

EXAMPLE E

Example of strengths & weaknesses

Soil No.	Soil name	Strengths		Weaknesses	
		Soil specific	Related strengths	Soil specific	Related strengths
S1A	Hill soil from loess	Reasonably high K & S levels;	Mostly discable;	Occassional duripan at depth; mottles indicate poor winter drainage; high clay content - very dense soil; low to medium water holding ability; only moderate P levels; potential for pugging in winter	
S1B	Soil from loess				
S2	Wet soil from loess and ash				
S3a	Hill soil from mudstone				
S3b	Shallow steepland soil from mudstone				
S4	Terrace soil				

MODULE FIVE

LAND MANAGEMENT UNITS

THIS MODULE INCLUDES NOTES ON:

15. HOW TO GROUP YOUR FARM'S SOILS INTO LAND MANAGEMENT UNITS
16. AN EXAMPLE OF A COMPLETED LMU MAP AND LMU DESCRIPTION SHEET

Land Management Units

Land Management Units are what you get when you combine land resource information (on soils & landforms) with management factors like existing fence lines, accessibility (stock & machinery), water reticulation, and other developments or improvements that may be present. They can either represent a refined version of the existing production system, or they can be designed to include major adjustments in land use policies (e.g. diversification or a change in stock policy).

The idea of LMU's is to break up your farm into smaller pieces (sort of 'sub-farms) for easier and more focused management. Each unit will be rather unique in terms of land resource combinations and improvements, so it follows that each unit will need a slightly different management approach (or policy) to get the most out of it.

This is certainly not a new idea – you probably already manage paddocks or sets of paddocks according to pasture production and landform – like these paddocks are used each year for lambing, these ones are always used to winter hoggets, and so on. Through designing LMU's you'll not only be clarifying the existing system, but you'll also be refining it to capitalize on production opportunities identified from each unit's strengths and weaknesses. For those who want a little more, LMU's can also be designed to include any significant policy changes that would more fully take advantage of any identified opportunities.

This module outlines how to go about designing Land Management Units using an eleven-step checklist. An example LMU map and its unit descriptions are also included.

Designing Land Management Units

By now you should have a map of your farm's soils and a list of strengths and weaknesses. The next step is to group similar soils into areas that are big enough to be managed as a separate unit, and then consider if these units really could be managed differently in practice. You can either do this all at once (according to the LMU checklist), or break it down to the following two steps:

1. **Grouping similar soils**: If you've large areas of soils already, you can probably move straight onto the next step. If not, then you'll have to look hard at both the characteristics and strengths & weaknesses of each soil type, and start grouping the similar ones. At this stage completely ignore things like existing fence lines and other 'improvements'.

Through this process you might end up with several large areas of soils distinguished by the strengths and weaknesses that have the greatest impact on production – like topsoil depth, texture, drainage, susceptibility to pugging, water holding ability, and fertility. Aim to group your soils into about 6-10 potential units.

2. **Assessing practicality**: Use the LMU design checklist (starting from criterion No. 2) to evaluate the practical feasibility of each of your grouped soils. Give particular attention to how closely the existing fence lines match soil boundaries – where possible, use fence lines for the borders of your developing LMU's (but not necessarily).

You probably won't be able to design the best possible LMU's at the first attempt – either redo the two steps, or put the whole thing aside for a while and try again in a few days. It's quite likely you'll come up with new ideas as you work around your farm, and visit the other group farmers' properties.

After you've designed a set of LMU's you're happy with, summarize each unit's most distinguishing features according to what soils are present, strengths and weaknesses, and the most suitable types of land use (this can be both existing and potential types of land use). An example of one of these LMU summary sheets is included with these notes.

Checklist for designining LMU's

1. **Soil characteristics**:
2. **Area**:
3. **Aspect**:
4. **Slope**:
5. **Accessibility**:
6. **Versatility**:
7. **Fragility**:
8. **Strategic importance**:
9. **Vegetation cover**:
10. **Shade & shelter**:
11. **Stage of development or improvement**:
12. **Suitability for use**:

EXAMPLE F

Example of an LMU summary sheet

Land Management Unit	Dominant soil types	Strengths	Weaknesses	Uses
1. Easy hill unit				
2. Rugged hill unit				
3. Broken hill unit				
4. Red metal unit				
5. Bullock unit				
6. Terrace unit				
7. Gully unit				
8. Steepland unit				
9. Riverflats unit				

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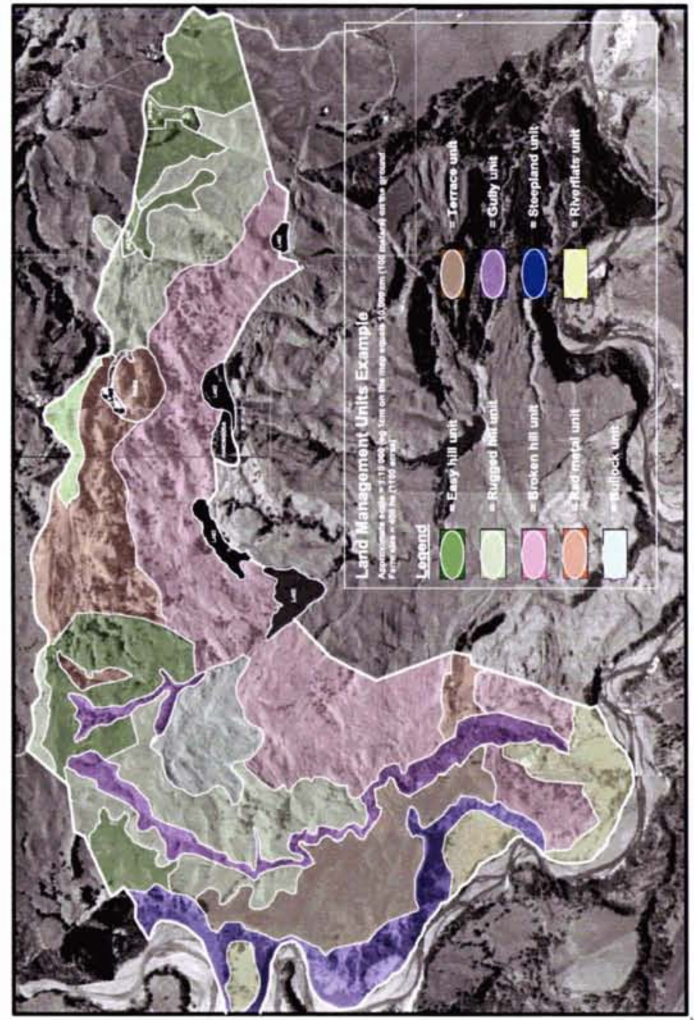
EXAMPLE G



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8.10. CURRENT STATUS

The manual was prepared in late 2000, at the beginning of the author's doctoral term. It has not been updated since. The SUBS programme has evolved significantly since this period, particularly in terms of different land use groups (*e.g.* dairy farming), and application by a wider number of trainers who were not involved in the original programme. Hence, the version presented here is somewhat dated, and there is considerable reason for revising the manual. An alternative approach to any future manual could include separate booklets aimed at the two key audiences – farmers and trainers – with a particular emphasis on improving descriptions and examples for the most difficult modules. Possible booklet titles include:

- *Identifying Farm Geology, Landforms & Erosion.*
- *Farm Soil Mapping – A Practical Introduction* (including soil description).
- *A Soils Perspective on Farm Planning.*
- *A Guide to the Application of Soils Underpinning Business Success* (a much revised and concise version without module notes).

However, use of the original manual has been limited, which may negate any further development. A copy was delivered to the Auckland Regional Council in early 2001. While feedback was positive, the Council has not yet developed or applied a programme for the Auckland Region (as of October 2003), and are unlikely to do so.

END NOTE

A considerable amount of personal time and money have been invested in developing the resources presented in this chapter. Despite this, they essentially become 'public domain' on release of this thesis, and are therefore freely available to anyone interested in soil description and/or furthering the application of the SUBS programme. Printable versions have been included on CD-Rom as Appendix 7. Please note that the colour charts have been converted to RGB, and are therefore unsuitable for printing (if true Munsell colours are the desired result).

For the original InDesign files, please contact the author through Alan Palmer at Massey University, Palmerston North, New Zealand.

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Chapter 9

FUTURE DIRECTIONS

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INTRODUCTION

The challenges of farm sustainability are difficult to summarise. One might describe the problem as a legitimate want or need for farmers to improve their socio-economic well-being (to remain on par with the rest of society), most often fulfilled by intensifying their land use systems. Intensification beyond the capacity of land is often implicated with environmental degradation, leading to perceptions of farmers as irresponsible land stewards, which in-turn leads to calls for greater intervention in how farmers choose to use and manage their land.

In defence, farmers may assert they have traditional land use rights; the evidence implicating agriculture's contribution to degradation is sparse and generalised; future technology will solve the problem; off-farm environmental management is someone else's responsibility; and in pointing-out the substantial contribution of agriculture to NZ's well-being, some may be suggesting that a degree of degradation is a necessary compromise for social and economic development.

While the validity of these arguments is still very much open to debate, they presently appear to be strong enough to protect farmers' existing high-degree of independence in how they choose to use and manage their land. However, evidence supporting agriculture's contribution to environmental degradation continues to accumulate, and farmers' traditional property rights are gradually deteriorating as society's view of land ownership evolves (*e.g.* farmers' contemporary property rights are considerably less than they were 25 years ago, and it is likely they will continue to decrease over the next 25 years). Similarly, affluent markets and consumers are more discerning than before, both in terms of product quality and the manner in which it is produced.

These conditions provide sufficient justification for a proactive response from the farming community (including, but not solely referring to, the agricultural industry), if farmers wish to retain their current autonomy in how they decide to use and manage their land. From a political perspective, an active self-led response is also desirable if farmers wish to retain or build the strong political representation needed to ensure agricultural interests are equitably promoted and defended at the national level.

The collection and use of land resource (LR) information through more-formal approaches of land evaluation, represents an opportunity for NZ farmers to proactively achieve and demonstrate farm sustainability. Previous chapters have examined this thesis, focusing mainly on how sustainability can be interpreted; sources of LR information; it's integration into land use design and management; and how it has been used at farm-scales to promote wise or sustainable land use in historical and contemporary terms. Key findings are summarised in this chapter. These are then used as a basis for discussing future opportunities towards a greater use of LR information and land evaluation in NZ farming.

SUMMARY & KEY FINDINGS

1. Much of the ambiguity and confusion surrounding the meaning of sustainability can be removed through systems theory, which allows the concept to be abstractly defined as *the ability of one or many systems to sustain one or many systems over a period of time.* Practical use of this definition can be achieved through derivative criteria, whereby different interpretations can be clarified by stating:

    - The *'what'* of sustainability, which describes the central system of interest (*e.g.* a pastoral system).

    - The *'why'* of sustainability. This represents the purpose of the central system of interest (*e.g.* a pastoral system contributes to sustaining animal production).

    - The *'how'* of sustainability, which describes the mechanisms and resources sustaining the system of interest (*e.g.* a pastoral system is sustained by sunlight, water, nutrient inputs, etc.).

    - The *'who'* of sustainability. This is a recognition that people have increasing control over the sustainability of systems (*e.g.* modifying and managing natural systems), and that their worldviews will influence decisions concerning what is sustained, how it is sustained, and why it is sustained (*e.g.* pastoral systems are managed according to the different management philosophies of individual farmers).

    - The *'for how long'* of sustainability. This is a recognition that no system can be eternally sustainable, and that many managed systems need only be sustainable for an absolute period (*e.g.* diversification away from livestock production negates the need for a sustainable pastoral system).

    - The *hierarchical tier* that describes the level of generality relevant to a given definition of sustainability.

2. A farm represents the interaction and management of many complex and dynamic subsystems. Farm sustainability is achieved when all objectives, obligations, and requirements for each system are fulfilled in a reconciliatory way. Maintaining farm sustainability is dependent on the ability of management to adjust to change, particularly as it relates to continually refining or redesigning land use in a way that generates a profit without compromising land integrity and environmental quality.

3. Ongoing soil, water and biodiversity problems linked with agriculture demonstrate that the reconciliation of farm sustainability is a difficult proposition. This difficulty will increase as the farming environment becomes more complex, dynamic, and demanding.

4. New Zealand's 16 regional authorities are responsible for ensuring the sustainable use and management of farmland. An examination of policy instruments confirms that the autonomy afforded under the Resource Management Act (1991) has resulted in major differences in how each authority is endeavouring to fulfil these sustainable land management (SLM) responsibilities.

    - Most regional authorities emphasise a non-regulatory approach to SLM, but rely on regulation as a backstop when other methods fail. Authorities who emphasise a regulatory approach do so because of limited resources, underdeveloped programmes, or particularly difficult SLM issues. Unitary councils tend to skew towards regulatory approaches.

- Future emphasis may shift to a greater use of regulation if non-regulatory approaches prove to be ineffective over the next 10-15 years. The implication for farmers is to voluntarily and proactively progress SLM on their own farms, or be forced to do so in the future.

- Substantial SLM assistance for farmers is currently available from most regional authorities (as grants, services, advice, and information), and is likely to increase in some areas. These opportunities for improving SLM may not always be available, particularly if a long-term shift to regulation eventuates.

5. Generating and using *land resource information* (LR information) through *land evaluation* represents a methodical and effective means of communicating, demonstrating, and planning farm sustainability. LR-information describes the character and capability of natural and physical resources as they vary across the landscape, while land evaluation is the decision-making process of assessing the fitness of land for a given purpose or use. Farm-scale land evaluation provides a framework for identifying and systematically evaluating alternative land-use options in terms of potential economic performance and possible environmental impacts.

6. Farmers apparent predisposition for informal decision-making means that most rely on their 'knowledge of the land' and informal methods of land-evaluation when making decisions concerning land-use and management. While informal methods are important to successful farming, it is generally accepted that traditional approaches to farm management need to become more formal, strategic, knowledge intensive, and information rich, to better accommodate the modern challenges of sustainable agriculture.

7. A key constraint to more-formal approaches to land evaluation is the availability of appropriate LR information. A critical evaluation of NZ's map collections and databases concludes that reliable and relevant LR information for farm management purposes cannot be obtained from existing sources. Most sources are unsuitable because of limited geographical coverage, inappropriate scales, and a limited relevance to modern farming needs. Farmers interested in using LR information for farm management purposes can only do so if they collect new information.

8. A survey of NZ organisations and consultants who specialise in the collection and provision of LR information indicates that a wide variety of commercial services and resources are available to farmers interested in collecting new LR information. Price and quality varies, so it is advisable that farmers assess alternative options before making an investment. A complete exercise resulting in professional soil and paddock maps could cost a farmer up to $7000. This cost can be reduced substantially through either having a regional authority 'farm plan' prepared, or through assisted soil survey programmes.

9. A detailed review of historical literature shows that regional authorities and their antecedent catchment boards have long recognised the value of farm-scale LR information and land evaluation for promoting wise and sustainable land use. This recognition is expressed as an evolving 'farm plan' model of land inventory survey, land capability classification, and integrative land-use planning for individual properties.

   - Farm planning was originally developed in the 1930s by the US Soil Conservation Service as a means to promote *conservation farming*. Underlying principles and objectives are similar to those of sustainable farming, differentiated by a focus on soil erosion as a singular environmental problem.

- Widespread application of farm planning was achieved through a system of recording inventory and evaluating *land capability*, which came to be known as the Land Capability Classification (LCC). Land capability is synonymous with 'land sustainability' (the ability of land to sustain).

- NZ's official efforts to promote soil conservation began in the early 1940s. After testing an eclectic range of land survey and classification systems, the American LCC was adopted in 1952, and was gradually refined over a 17-year period into NZ's own Land Use Capability (LUC) system. Similarly, *conservation farm planning* was officially adopted in 1956 after the development of *conservation farming guidelines* and the application of several pilot examples.

- Various adaptations of conservation farm plans emerged between 1956 and 1989, including run plans, shelter plans, orchard plans, and farm plans for dairy farms. The Soil and Water Conservation Plan (SWCP) title was adopted in 1967 to acknowledge growing water quality problems. Official standards ensured the basic content of farm plans remained consistent between catchment boards, although formatting and informational detail varied widely. Few catchment boards adhered to the original philosophy of farm planning, particularly in regard to the full recording of land resource inventory in-the-field, and the balanced consideration of environmental and production goals through integrative land use planning.

- Approximately 4730 farm plans representing 50% of NZ's total farmland were prepared before NZ's reform of resource management administration in 1989. Factors limiting these historical plans as a contemporary source of LR information include: a necessity for backwards interpretation of land capability; questionable reliability of soil, vegetation and erosion information; and difficulties in readily accessing farm-plan information. Principles underlying the traditional farm plan model are still suitable for most contemporary land evaluation purposes, although methods may require updating to accommodate contemporary environmental issues.

- Late 1980s reforms resulted in some regional authorities discontinuing the practice of farm planning, while others experimented with new or refined models to better accommodate issues and challenges introduced by the Resource Management Act (1991). Notable developments include group processes, computer aided evaluations, the integration of regulatory requirements, and new systems of assessing land capability.

10. Absence of a national monitoring programme has resulted in a degree of uncertainty regarding the contemporary state of farm planning in NZ. A 2001-2002 interview survey identified that eight regional authorities had a farm planning programme; a further three were looking to develop programmes; and most of the remainder would like to develop programmes if they could afford to do so. Approximately 1200-1450 new farm plans had been prepared since 1989. The number of authorities with a farm planning programme had increased to ten by 2003, which means that the majority of NZ farmers have access to some form of farm planning service.

11. A critical evaluation of contemporary examples shows that the independent development of regional authority farm planning during the 1990s has resulted in a diversity of at least 23 different farm plan models. Only five models involve the combined collection of farm-particular LR information, land evaluation, and integrative land-use planning. Farmers interested in obtaining new LR information through a contemporary farm plan can only do so if they reside in the Wellington, Manawatu-Wanganui, Hawkes Bay, or Taranaki Regions.

12. The Soils Underpinning Business Success programme (SUBS) aims to assist farmers in the collection, interpretation and use of LR information, ultimately to help promote farm sustainability. A survey-based evaluation indicates that SUBS farmers attribute substantial land-use and management change to the programme, and are in strong agreement that participation has been beneficial to their abilities as farm managers and the sustainability of their farming operations. Suggestions are given for improving future applications of the programme.

9.0. SUMMARY COMMENT

NZ's state of LR information and it's use at meaningful scales is somewhat under-realised at present. This may in part be attributable to the 1980s reforms, whereby national progress in surveying and land evaluation were essentially marginalised with a shift away from land sciences. While there appears to be a recent resurgence of interest in regional and national initiatives, NZ's advancement in survey and land evaluation over the past 10-20 years has not kept pace with many other developed nations. This is despite being a country that is still dependent on land-based industries, and one which is faced with an increasing degree of land related problems and land-use competition, at a time of significant intensification by all sectors of the agricultural industry.

However, the situation is not completely bleak. Advances in land evaluation and survey are generally transferable irrespective of where they have been developed (with adaptations), and recent initiatives concerning soil and climate surveys in NZ demonstrates that at least some are attempting to realise the potential of LR information and land evaluation. Further, a few particularly tenacious regional authorities have advanced farm-scale survey and land evaluation for environmental purposes, through retaining and modernising the practice of farm planning. Some private companies are also developing various nutrient-loss farm plans based on process models. Taken together, these and other developments may suggest that a reinstatement of a coordinated national survey and land evaluation programme may not be an unduly difficult or unrealistic proposition.

OPPORTUNITIES FOR FUTURE CONSIDERATION

NZ's somewhat limited use of LR information and land evaluation creates a considerable number of opportunities and considerations for future development. Two of the most important include the identification of options for improving existing sources of LR information, and defining the type and quality of LR information needed for present and future purposes. Any developments would also benefit from a national coordinating strategy for LR information collection, management, promotion and distribution.

9.1. IMPROVING EXISTING SOURCES OF LR INFORMATION

Reliable and relevant LR information for individual farms at appropriate scales cannot be sourced from NZ's existing public map collections and databases (Chapter 4). Opportunities for resolving this problem include a revised national collection of LR information; regional collation and information collection projects; survey partnerships; a central LR information management and distribution organisation; and technological solutions for the rapid and extensive collection of LR information. Many of these options are interchangeable at different scales of decision-making (national, regional, etc.).

9.1.1 A REVISED NATIONAL COLLECTION OF LR INFORMATION?

Government funded initiatives are perhaps the most obvious option for updating and improving LR information sources. State projects have traditionally been NZ's greatest single contributor to map collections and databases, as the gathering of new information can be justified as an investment for the public good. Many older surveys had an underlying purpose of promoting agricultural development, soil conservation, and rational land use planning, ultimately for national interests. More recent government-funded initiatives have focused on sustainable development at regional or district levels, or to provide information for national environmental monitoring.

Unfortunately these initiatives will be largely ineffectual in the promotion of sustainable resource management, and will probably have limited influence on any economic development. This is simply because the information is inappropriate for application at levels where the majority of land-use decisions are made. Any land holder who bases land-use decisions on information that imprecisely or incorrectly describes land at the farm scale, is taking a considerable risk with the future success and soundness of his or her enterprise. Likewise, it is dubious if such information can be used reliably by regional authorities to help plan SLM at a meaningful scale, or to monitor environmental trends of individual properties.

A new or updated national inventory would have merit if it contained reliable LR information relevant to NZ's modern-day needs. Unfortunately such an initiative is currently unlikely, as the government appears to be content with it's existing sources LR information (despite the limitations). Further, any new project involving the intensive collection of LR information would need to address the following problems:

1. The collection and provision of farm-scale LR information may be perceived as an unwise investment of public money, because such information can be used for individual gain. This is a redundant argument, as the Government is interested in farmers making business gains, thereby contributing to the type of development that is actively promoted and funded by the Ministry for Economic Development. A greater use of LR information in farm decision-making represents an opportunity for promoting both economic development and sustainable resource management in a complementary manner.

2. It is uncertain if NZ has the human-resource capability to undertake an extensive land resource survey based on conventional methods. This capability has been greatly reduced since the late 1980s, such that NZ now has few practicing professionals available to undertake land and soil surveys. Exact numbers are unknown. However, the recent Topoclimate South project has demonstrated that an effective team of surveyors can be gathered and trained at reasonably short notice.

3. The neutrality of descriptive LR information (as observed & measured data) is a proverbial double-edged sword for farmers. From one perspective, farmers can use such information to promote farm sustainability. From another, authorities and other external interests can use the same information to examine whether or not land is being managed sustainably. Likewise, if the information is available, then there may be a greater expectation on farmers to demonstrate or defend the environmental soundness of their farming operations. As these considerations may translate into greater compliance costs and increased workloads, some farmers may be opposed to the collection of new LR information.

4. Effective application of soil and land surveys has traditionally relied on the goodwill of land-holders for access to farmland. This access may be denied by farmers who do not support a LR information collection exercise.

5. The investment required for intensive land resource surveys at farm scales would be substantial, and possibly prohibitive on a nationwide basis. However, while there are no estimates currently available (due in part to some of the other problems described here), it is possible that the cost may be comparable to many previous government initiatives that have failed to progress a widespread shift in sustainable land management.

6. There is no guarantee that farmers will actually make use of new LR information. Land users in the past have exhibited an indifference to the use of LR information in land-use design and farm management. In part this is due to the unavailability of appropriate LR information, but it also extends to the ability and inclination of farmers to make use of such information. Any new initiative would need to account for this problem, if the ultimate desired endpoint is a substantial improvement in SLM and sustainable farming.

7. There is uncertainty regarding the types of information that should be collected. This includes the historical argument regarding the comparative merits of soil and land inventory survey; the type and generality of interpretive information that is most needed by land users; and the types of land attributes and qualities that should be recorded during a survey. This problem may be partly offset by developing a core of high-quality information based on land resources and attributes that exhibit the least temporal variation (discussed further in Section 9.1).

8. There is also a degree of uncertainty regarding the most appropriate scale or resolution at which LR information should be collected. While detailed resolutions are desirable, they tend to equate with a high investment of time and money. Further, the level of detail required can vary with land use intensity, and may change over-time as use becomes more intensive. Coordinated soil mapping in Australia seeks to overcome some of these problems by surveying at different scales according to land use intensity (discussed further in Section 9.1).

While there are options for addressing the problems listed above, the probability of a government funded initiative for the national collection of LR information is presently very low. Despite this, the promise of economic development and sustainable resource management that could arise from a greater use of LR information in farm decision-making, should provide sufficient justification for examining this opportunity in more detail. This could take the form of a national review, possibly towards the development of a national coordinating strategy.

9.1.2 Regional opportunities

Regional authorities have a responsibility under the Resource Management Act (RMA, 1991) to monitor the State of the Environment (SoE), and to promote the sustainable management of land. Fulfilling both responsibilities is aided by LR information at appropriate scales (*i.e.* scales at which land is managed and monitored). While monitoring at farm-scales may presently be beyond the capabilities of many authorities, LR information can be used to describe the state of land; monitor critical response limits (thresholds); and to map trends in land condition. However, the greater contemporary value of LR information is being able to infer land capability, as the 'ability of land' must first be known before SLM can be achieved (how can land be managed sustainably if we don't know what land is capable of sustaining?).

As discussed in Chapter 6, the value of farm-scale LR information has long been recognised by regional authorities and their antecedent catchment boards. Unfortunately much of the information is contained in farm plans for individual properties, rather than as a single collective database or map collection. While the attribute information may be general, the spatial-distribution information concerning landscape units provides a strong starting point for more detailed databases. Hence, there is an opportunity for regional authorities to aggregate and update farm-plan LR information into singular Land Information System (LIS) databases. Various techniques are available, but all would involve a reasonable investment of time and money. For this reason, it is suggested that a pilot be developed with a regional authority with a strong background in farm planning, with a view of developing an LIS to identify the most efficient technique.

Another opportunity is for regional authorities to employ their own land or soil survey specialists for a defined term of 2-3 years. The primary purpose of such a specialist would be to work towards regional coverage of LR information at farm scales, firstly by aggregating and updating existing information sources, and secondly through survey to fill in the gaps. Provided surveys are undertaken using methods and scales appropriate for different land uses and intensities, then such an arrangement could eventuate as being considerably less expensive than commissioning the services of an established surveying organisation.

The third regional opportunity is already being realised in part, but the information being produced can only be used at farm-scales in a general way. These are often termed as *regional development projects*, supported by central and regional government, and in some cases by commercial interests. Unfortunately there is often considerable hype and promise behind such projects, which never seems to be fully realised. This may reflect information collection at inappropriate scales (*i.e.* at scales too small for land use decision-making), and an assumption that the resulting information can and will be used by those who make the most land use decisions.

Considering the large investments made in regional development projects, there is considerable opportunity for greater effectiveness through improved information collection, use and promotion. This extends well beyond improved information collection, across onto a principal focus of encouraging and demonstrating how the information can actually be used to aid successful and sound decision-making.

Field days and demonstration farms are conventional options for promoting the use of information. However, as a survey for the collection of farm-scale information involves visits to individual properties, there is unrealised opportunity to engage each land manager on a one-to-one basis during the survey itself. This would allow for not only a reciprocal exchange of information, but also the direct linking of LR information to land use and management. Such an exchange may also stimulate a deeper interest in the use of LR information, thereby encouraging attendance and participation in additional extension initiatives.

9.1.3 SURVEY PARTNERSHIPS

The field of resource management has benefited greatly from various partnership techniques formalised in recent years. Such techniques relate to community groups, issue groups, action learning, experiential learning and participatory approaches, all of which seek to more actively engage stakeholders in problem solving processes that have traditionally been the domain of 'experts'. While some techniques may have gained a reputation as being overtly 'soft' and socially uncomfortable for some people, many carry substantial benefits in promoting awareness, understanding and ownership of resource management problems.

There is an opportunity to integrate partnership techniques into future survey programmes, as a means to address the traditional disuse of LR information in farm management decision-making. Pragmatic techniques could be used to not only promote the effectiveness of any new survey initiative (in terms of extension and adoption), but may also represent a more efficient distribution of monetary and human resources (depending on the techniques used). Four interchangeable options are suggested here, including:

1. The widespread promotion of programmes such as Soils Underpinning Business Success, with a general aim of assisting farmers with the collection and use of LR information particular to their own farms. The benefits and successes of SUBS are numerous (Chapter 7), such that the programme's wider extension represents an opportunity for promoting farm sustainability through a greater use of LR information in farm decision-making. However, because such programmes need only attain information quality standards acceptable to the individual farmers concerned, additional verification and amendment by a professional soil surveyor would be required if SUBS soil maps were to be integrated as a singular map collection or database.

2. A variant on the SUBS programme, whereby a group of neighbouring farmers are assisted in the collection and use of LR information for their own properties, but with a secondary purpose of aggregating individual maps into a collective and spatially continuous database. This could be a suitable option for small catchments, particularly if an auxiliary focus on addressing catchment-scale resource management issues was a desired outcome. However, such an option would require agreement and commitment from all neighbouring farmers (although non-participating farms could be mapped separately), along with a greater input from a professional soil surveyor to ensure quality standards, and perhaps to classify soils against recognised taxonomies.

3. A traditional LR information collection exercise, which involves voluntary financial contributions from farmers in return for farm-individual soil maps. A monetary contribution ensures a vested interest, but the success of any such programme is dependent on farmers' demand of farm-scale LR information relative to what they are willing to pay. Evidence exists that some farmers may be willing to make an investment[1]. The actual demand for farm-scale LR information could be confirmed through a simple marketing study.

4. A traditional LR information collection exercise funded by central and/or regional government, but with the parallel and integrated application of an extension programme. Such a programme could involve initial consultations with farmers to discuss land use and soil distribution as interpreted by the farmer; the farmer tagging-along during the survey; specialised and localised field-days after 10-20 farms have been mapped; or the adaptation of SUBS to be run in conjunction with a professional soil mapping exercise. While these considerations make the job of a professional surveyor more difficult and lengthy, they are preferable to the traditional 'adding on' of an extension programme after the survey has completed.

[1] Chapter 7 demonstrated that most SUBS farmers were prepared to place a monetary value on the programme. There are also organisations currently selling 'farm soil maps' (from the 1:50,000 scale NZ Land Resource Inventory), and a number of farmers have independently contracted soil surveys over the past two years (as reported in rural newspapers). These considerations suggest a farmer demand for LR information exists.

9.1.4 A NATIONAL LR INFORMATION MANAGEMENT & DISTRIBUTION CENTRE

Obtaining LR information from existing sources can be difficult. Either it is unclear to potential users what information is actually available, or it may be uncertain from whom it can be obtained[2]. Further, existing sources of soil and land information appear to be used more for scientific rather than planning purposes (Chapter 5), as the organisation responsible for maintaining the information is a Crown Research Institute. The organisation does not appear to actively pursue or promote the greater use of LR information by individual land users (this is not their responsibility).

The suggestion for establishing a national centre for managing and distributing LR information is not new (Chapter 5). Such a centre could represent a colloquial 'one-stop-shop' for all forms of publicly owned and funded spatial information, without necessarily being directly involved in the collection and maintenance of such information. This is akin to a dynamic library that takes advantage of technologies in database management, geographic information systems, and digital communications. A particular focus could also be on the promotion and demonstration of initiatives involving a greater use of LR information in land use decision-making (*i.e.* an extension function).

9.1.5 TECHNOLOGICAL OPPORTUNITIES

Technological options for the collection, use and management of LR information continue to evolve in terms of efficacy and feasibility. From one perspective, it may be argued that the task of collecting LR information should be put aside until technology has progressed to a point that allows for the rapid, affordable and reliable collection of information at detailed resolutions. However, it may also be argued that it is irresponsible and risky to rely on a technological solution when it is unknown when or if it can be developed. The compromise is to make use of technologies alongside traditional methodologies, while making allowances to accommodate future opportunities that may arise through technological development. Some of the contemporary technologies with value towards LR information collection, management and use include:

1. Automated mapping through remote sensing, whereby aerial or satellite sensors are used to capture various spectrums of energy (as sound or radiation) that is reflected, emitted, or bounced-off landscape objects. Most applications record landscape covers, although some of the more expensive can be used for mapping topography and subsurface features. Present limitations include the dynamic nature of land covers (thereby necessitating frequent updates); the general low resolution of satellite imagery and it's susceptibility to cloud cover; expense; an auxiliary need for calibration or verification ('ground truthing'); and the typically large digital datasets that are generated for either extensive areas or detailed resolutions.

2. Automated mapping from ground instruments, such as the EM38 sensor that measures the electrical conductivity of soil, and Real Time Kinematic Global Positioning Systems (RTK GPS) that measure surface topography at vertical and horizontal precisions of around ±10mm. The EM38 is presently limited to use on easy terrain, but may offer an alternative means of determining soil boundaries in some cases, and estimating the spatial variability of some soil attributes.

[2] As a casual interest, the author regularly asks farmers 'where would you go to get soil information about your farm?'. The most common response is "don't know", followed by 'the regional council'. Rarely do farmers indicate Landcare Research as an option, despite being the organisation responsible for overseeing NZ's soil information resources.

3. Automated landscape classification, whereby predefined rules are applied to digital data to group areas of land that exhibit similar features. A common application is land classification according to rules that group similar slope, aspect, and elevation features derived from a Digital Elevation Models (DEMs). A more sophisticated application is the LENZ database described in Chapter 4. Similarly, process models can be used to derive classifications, such as those commercially used to categorise land according to its susceptibility for nutrient runoff and leaching. Like any form of landscape classification, the quality of the result is dependent on the quality of the original data, and how adequately the rules describe real-world processes.

4. Whole-farm landscape modelling based on the aggregation and integration of various process models. While some advances have been made with catchment scale modelling in NZ, there is a largely unrealised opportunity for developing intelligent applications that seek to spatially model (and therefore predict) key production and environmental parameters of individual properties, in a whole-farm manner. In this sense, NZ agriculture has yet to fully push the boundaries of what may be achieved by maximising the use of existing spatial technologies alongside our understanding of biophysical processes (Section 9.2).

9.2. MODERN LR INFORMATION CONSIDERATIONS

While a number of opportunities for collecting or generating new LR information may exist, there is a degree of debate regarding the type and form of information that would best meet our modern and future needs.

9.2.1 SOIL VERSUS LAND INVENTORY INFORMATION

Debate regarding the relative merits of soil survey and land-resource inventory (LRI) is longstanding. It is difficult to identify the cause of this debate when these merits are examined from a first principles perspective. That is, a LRI survey implemented according to the original design involves the delineation of an inventory unit where any significant change occurs in either rock type, slope, vegetation, erosion or **soil**. Hence, the correct application of LRI survey should integrate a soil survey from either published sources (if available at appropriate scales), or through conventional soil survey method. In doing so correctly, the result would be an inventory that allows the soil unit to be extracted and aggregated as a standalone soil map comparable to that obtainable through conventional soil survey.

Unfortunately this principle has often been overlooked or ignored during the application of LRI survey in NZ. Either surveyors have had limited pedological skills, or published soil maps at appropriate scales have not been available. While the omission of conventional soil survey methods has contributed greatly to the rapid and extensive application of LRI survey, the inclusion of an often inadequately defined soil unit has antagonised some soil survey practitioners. A particular concern is that information-users may be unaware of the limitations, and may therefore assume that the soil unit has been defined with the same degree of confidence and rigour as that obtained through conventional soil survey. Likewise, there is an implication that all the inventory factors have been defined to an equal standard of reliability.

A correctly implemented LRI survey has roughly the same merit as a conventional soil survey, as they both provide the same general type of information (inventory factors are usually described as part of the 'soil forming environment' of a soil description). Likewise, with today's increasing use of GIS to record spatial information and resource attributes, an historical advantage of inventory map-codes for conveying key information quickly is largely redundant. Hence, both soil and (correctly implemented) land-inventory survey are equally valid for modern day purposes.

A possible exception involves exploiting the traditional misuse of LRI survey intentionally. The greatest limitation of soil survey and correctly implemented LRI survey is that they require a considerable investment of time and money, particularly at large scales across extensive areas. While such investments can be rationalised for intensely used land, the justification weakens when applied to NZ's extensive areas of less-intensive land. A compromise for future survey programmes could be a focus of soil survey for flatter, more intensively used land (where soils are the best indicator of land variability), and land inventory survey with an intentionally reduced standard for the soil unit on the less-flat, and less-intensive areas of NZ (where landscape morphology is a better indicator of land variability). Modern databases provide the means to integrate the two types of information.

9.2.2 SINGLE VERSUS MULTI-PURPOSE SURVEYS AND TYPES OF INFORMATION

The type of information collected is defined by a survey's purpose. Only those land resources and attributes with a direct relevance to fulfilling this overriding purpose should be considered. In doing so, costs are minimised by avoiding the unnecessary collection of irrelevant information, but the resulting information may have limited relevance for other purposes and applications (and may therefore represent an inefficient investment of resources).

The alternative is a multi-purpose survey, whereby there can be a simultaneous demand for many types of information for different purposes. As an example, differences exist for the type of information required for engineering, environmental monitoring, science, and various forms of agriculture and forestry. Some historical surveys have sought to accommodate all conceivable purposes through recording as many different resource attributes as possible (so called 'blunderbuss surveys'). Such surveys can be extraordinarily expensive and drawn-out (if they are ever completed), and can carry the risk of containing information that may never be used.

A compromise involves the collection of core LR information. This idea is suggested by Landcare Research's development of the Soil Fundamental Data Layers (but see limitations; Chapter 4; Section 4.4.8). Ideally a core dataset should record resource-attributes that have relevance to a broad range of purposes; exhibit a low degree of temporal variation to promote relevance longevity (thereby helping to justify the initial investment); and to be collected at a high standard of spatial precision and representation to again promote relevance longevity, and to also provide a reliable basis for updates and the development of auxiliary databases. Dynamic or specific information for individual purposes can then be collected through an augmenting survey.

9.2.3 SCALE AND LAND-USE INTENSITY

Appropriate scales of LR information for decision-making at the farm level have been discussed in Chapter 4. Key points include that survey costs increase with increasingly detailed scales, and scale appropriateness for decision-making is a function of land-use intensity. This is based on the premise that increasingly intensive land-use systems are also 'knowledge intensive', and require more-detailed information to help ensure sound and successful land-use decisions. Ideally, scale should also vary according to the complexity and variability apparent within the landscape (one scale may not be appropriate for all parts of the landscape), or if this is not possible, it should be defined by the part of the landscape that exhibits the greatest variability (*e.g.* in soil survey this may be to the *soil phase* level for scales greater than 1:30,000).

Choosing a scale with an appropriate level of detail for a given cost (as it relates to NZ's diverse landscapes and land-uses) deserves further investigation. One option for large surveys is to use stratified scales. As an example, least-intensive areas of land could be surveyed at a 1:25,000 scale; more intensive areas at a 1:10,000 scale; and the most intensive at 1:5,000.

9.3. A NEW GENERATION OF FARM PLANS?

Prior to the 1980s, NZ's principal environmental issue related to agriculture was soil erosion. Erosion can be readily identified and treated with protective vegetation, but this represents a remedial measure after the damage has been done. A far better solution was to identify areas of *potential erosion*, such that the problem could be treated proactively before damage occurred. Early conservators recognised that erosion is a function of certain key parameters (*e.g.* slope, geology, vegetation cover, soil characteristics), which can be assessed through survey and used to predict erosion potential (as the vulnerability or susceptibility of land to erosion). In NZ, this was achieved through the Land Resource Inventory (LRI) and Land Capability Classification (LUC) system of land evaluation.

While the ability to identify potential erosion was a major advance in early soil conservation, implementing an appropriate pre-emptive treatment was constrained by land ownership and associated property rights. Erosion control was desirable, but farmers were under no obligation to adopt soil conservation practices. This problem was partly resolved through the concept of *farm plans*, whereby the short and long-term cost of erosion treatments were subsidised and/or offset with suggested improvements in farm productivity (at least in principle). In effect, farmers were persuaded to adopt soil conservation practices through the use of LR information and land-evaluation, although this was increasingly overshadowed by the more persuasive use of subsidies.

Today's environmental management is somewhat more challenging. Soil erosion has expanded to include environmental issues relating to soil contamination, soil compaction, nutrient leaching, nutrient runoff, and natural biodiversity. Many of these issues are complexly and obscurely intertwined within our existing systems of intensive land-use and management, and are therefore less amendable to traditional resource management solutions. Those involving 'invisible' and diffuse contributions to offsite contamination are particularly concerning, as they cannot be easily identified on a farm-by-farm basis, and cannot therefore be targeted for promoting (or enforcing) treatment and control. Farmers cannot advance a solution because the problem has yet to be defined as it relates to their own properties. This contrasts greatly against the relative ease of defining erosion problems on a farm-by-farm basis, thereby allowing specific treatments to be designed and recommended for it's control.

NZ may already have the latent capability to collectively identify and address all environmental challenges on an individual farm basis. That is, it is feasible to suggest that an intensive investment of modern science and technology into an individual farm could result in solutions to environmental problems (firstly as they relate to the farm concerned). This is being done in part, but on a somewhat ad-hoc basis that usually involves individual issues (although there are exceptions), and rarely (if ever) through the application of a full complement of science and technology capabilities.

The idea of fully investing science and technology capabilities into individual farms is not new. It was adopted by H.H. Bennett when he assumed responsibility for developing the United States' early soil conservation efforts, at a time when there was no obvious solution to the erosion problem (Chapter 5). Bennett surrounded himself with experts from various disciplines, who initially focused on intensive investigations of individual farms as a team. Results eventuated into practical solutions to be applied across the US (*e.g.* as resource survey, capability classification, farm planning, conservation districts), the success of which inspired other countries to adopt or adapt similar approaches. As an initially daunting environmental issue, it is quite remarkable how Bennett's early ideas have led to the successful control of erosion on an international basis.

Bringing together a contemporary team of NZ specialists with expertise in agricultural and environmental processes could result in the preliminary beginnings of a new generation of farm plans. Considerable scientific advances are continually being made in areas of landscape processes (*e.g.* nutrient dynamics, surface runoff, erosion dynamics, soil compaction), production processes (pasture and animal production), and farm management systems in general. Likewise, the development and application of new land-related technologies continues to advance, particularly in relation to GIS, precision agriculture, process modelling, and methods of spatial analysis.

There is an opportunity to combine these science and technology advances at one time and place, in a way that is similar to the development and integration of process models described for 'whole-farm landscape modelling' (previous Section 9.0.5). The endpoint could be a brief report not too dissimilar to most conventional farm plans (outlining findings, recommendations, and presenting maps), but underpinned by robust investigation, analysis, and information contained in a farm-particular Land Information System (LIS). Such an LIS could include layers of measured and generated information, and the original process models. In this way, the LIS can be supplied to farmers as an addendum to the documented farm plan, and can be updated at predefined intervals (*e.g.* 5 years) or when any significant land use change occurs. The ultimate aim would the design of a generic program that can be used to create an LIS for any farm (*i.e.* robust and reliable models that accept key data parameters).

This ideal of a new generation of farm plans may seem fanciful, but some tentative advances are already being made by fertiliser companies and several science organisations (namely NIWA, Landcare Research, and AgResearch). Regional authorities also continue to make farm planning advances, but few are pursuing the integrated use of process models. Considering that no single coordinated effort has yet been directed at optimising our science and technology capabilities into individual farms, then the opportunity of a new generation of farm plans is unlikely to be realised in the near future.

Despite this, other opportunities exist for refining and improving conventional methods of farm planning while we await the development of new integrative technologies. As with erosion, LR information can be used to indicate potential environmental problems before they occur, particularly in relation to identifying the vulnerability of land to nutrient leaching; nutrient and pathogen risks associated with surface runoff; and seasonal susceptibility of soils to compaction (Chapter 3). The methods of land evaluation involved are not overly technical, but they may require the greater definition of soil types at farm scales, and the measurement of particular soil attributes.

9.4. A NATIONAL REVIEW AND STRATEGY FOR LR INFORMATION

Perhaps the single greatest opportunity regarding LR information and its use, is a clarification of national status and future direction. This is partly rationalised by the potential offered towards economic development **and** sustainable resource management (SRM) in the agricultural sector. Further, in being a somewhat new (or perhaps even novel) option, promoting a greater use of LR information for SRM represents an alternative solution relative to many of the others that have been tried since the RMA was introduced in 1991. Colloquially, it offers an option with a completely different 'flavour' to conventional approaches, which includes a degree of neutrality without the discouraging environmental overtones. From another perspective, LR information and it's use is a largely forgotten option with an historical pedigree in NZ, and one that has continued to receive more attention from some of our overseas counterparts.

This dissertation has explored some of the questions that could be included in a national review, and has touched-upon many others (particularly in this chapter). Critical questions include:

1. Is there a preliminary interest from land users for property-specific LR information?

2. What are the implications towards farm and environmental management arising from the imprecise and unreliable LR information currently being used in land-use decision-making? What is an appropriate quality standard (as spatial accuracy and information reliability) for our present and future LR information needs?

3. Is a revised national collection of LR information feasible? What would it cost? Can the potential benefit for related economic development and sustainable resource management be quantified?

4. What types of descriptive information are suitable for creating a core database of national LR information? What types of land resources should be described, and what attributes should be recorded?

5. What is the most efficient scale(s) for LR information to be used in land-use decision-making?

6. Can improved land evaluation methods be adapted or developed to better accommodate the needs of NZ land-uses (particularly pastoral farming), and the capabilities of NZ farmers? Conversely, what types of interpretive LR information would be relevant for modern-day farming purposes?

7. What solutions to existing land-based problems can be identified by the intensive investment of existing science and technology into individual farm properties?

8. What is the most effective option for promoting the widespread uptake and use of LR information and/or more formal approaches to land evaluation in land-use decision-making? How much would a national programme cost? Can the benefits be measured to quantify programme effectiveness?

9. How can existing and future LR information be managed to promote access, distribution and use by individual land users?

This list is not exhaustive, but it does provide an insight into the type of answers required to clarify NZ's future direction regarding LR information collection, management and use. If a meaningful direction ever eventuates through political support, then answers to these questions could be used as a basis for establishing a robust national strategy. The purpose of such a strategy should include the clarification of responsibilities and the coordination of any forthcoming efforts and initiatives, but the ultimate aim should remain focused on stimulating sustainable development and management from the ground up, through a greater use of LR information in land-use decision-making.

APPENDICES

APPENDIX I

1.1 RECENT HISTORICAL EVENTS CONTRIBUTING TO THE EMERGENCE AND POPULAR RISE OF THE SUSTAINABILITY CONCEPT

1956 The first person dies from mercury released into Minamata Bay, Japan.

1959 Mercury from industrial pollution identified as the cause of widespread poisoning of thousands of local residents near Minamata Bay in Japan.

1961 The World Wildlife Fund (WWF) created at Morges, Switzerland. The WWF, later renamed the World Wide Fund for Nature, became one of the more important non-governmental organisations influencing international wildlife conservation efforts.

1962 ***Silent Spring*** published (Carson, 1962). Regarded as 'an immensely influential book' that is often taken as marking the birth of the modern environmental movement. Carson brought the gross misuse of pesticides to the attention of the wider public. This book stands at the head of, and in many cases has been the inspiration for, the long stream of environmentalist literature which has followed it. It unleashed a flood tide of debate and writing which swiftly extended beyond the issue of pesticides to the whole question of what mankind was doing to the natural environment.

1966 The US Lunar Orbiter takes the first photographs of the earth from near the moon. Such pictures supported emerging views of 'spaceship earth', the 'fragile planet', and eventually ideas of Gaia, the ecosphere, and the biosphere.

1966 ***The Economics of the Coming Spaceship Earth*** published (Boulding, 1966). Highlighted the prevailing economic model as a 'cowboy economy', whereby increasing planes of production are acceptable, on the assumption that resource and waste-receiving reservoirs are unlimited. This was contrasted against the idealistic 'spaceship economy', which operates as a closed system (the biosphere) whereby resources and waste are recycled internally, and is ultimately driven by inputs and outputs of solar energy. This publication is regarded as a forerunner to many environmentally considerate critiques of economic growth that emerged in the early 1970s.

1968 Cadmium pollution identified as the cause of the widespread and highly degenerative 'Itai Itai disease' in Japan.

1968 The Swedish government places an item called 'the human environment' on the agenda of the UN Economic and Social Council, which eventually leads to the 1972 Stockholm Conference.

1969 *Torrey Canyon*, a supertanker carrying 118,000 tons of crude oil ran-aground off Land's End (England), causing massive oil spillage and pollution in the English Channel. Regarded as setting the precedent for disaster-driven [i.e. proverbial 'knee-jerk' reaction] international environmental law.

1969 *Earthrise* photograph taken on the *Apollo 11* mission to the moon – regarded as 'the most potent icon' of the world's growing 'global consciousness'. Used widely to promote the 'fragile planet' views of the global human/nature dualism.

1970 **Earth Day**, 22 April, 1970. Regarded as the 'climatic coming of age of the environment movement' at least in North America. Twenty million people participated, which provoked *Time* magazine to refer to 'the environment' as the issue of the year.

1970 ***The Population Bomb*** published (Ehrlich, 1970). A bestselling book that predicted the decline of mankind due to environmental problems.

1971 ***The Entropy Law & the Economic Process*** published (Georgescu-Roegen, 1971). Related economic systems to fundamental thermodynamic Laws, in that 'the basic nature of the economic process is entropic and that the Entropy Law reigns supreme over this process and over its evolution' (p.263).

1972 ***Blueprint for Survival*** published (Goldsmith *et al*., 1972). Represents the first time the sustainability term appeared as a major literary theme. The book explicitly highlighted the central paradox between unchecked economic growth and limits to growth. Economic growth creates a need for further economic growth, but continued economic growth (according to the models then being applied) would undermine progress and lead to 'the breakdown of society and the irreversible disruption of the life-support systems on this planet, possibly by the end of this century'. A 'steady state' economy was proposed, featuring resource self-sufficiency, energy conservation, resource recycling, low-impact technologies, biotic rights, and a decentralized society focusing more on quality of life rather than material possessions.

1972 ***Limits to Growth*** published (Meadows *et al*., 1972). Used a computer simulation to model and extrapolate the continued growth of five interconnected trends of global concern – industrialisation, population growth, malnutrition, depletion of non-renewable resources, and ecological damage. Despite integrating optimistic contributions from technology & science, modelling suggested that 'the limits of growth... will be reached sometime within the next one hundred years' (p.23). The associated report 'attracted enormous attention, provoked intense debate and became a bestseller in several languages' (Reid, 1996, p.31).

1972 ***The Doomsday Syndrome*** published (Maddox, 1972). Represents one of the first literary challenges that 'sharply questioned the assumptions that underlay the fashionable predications' associated with the popular and alarmist views then being put forward by the new wave of neo-Malthusians (protagonists of 'limits to growth' ideologies).

1972 **The United Nations Conference on the Human Environment** (also known as the Stockholm Conference). Recognised as the first major attempt to bring the international community together to address environmental concerns. Included representatives from 119 nations and 400 NGOs. The Conference is credited with placing environmental problems (particularly pollution) firmly on the international political agenda, and for laying the foundations that lead to the establishment of the United Nations Environment Programme (UNEP). UNEP provides a focus point for international environmental programs, organisation and funding.

1972 The first national Green Party established in New Zealand.

1973 Beginning of the 'oil shocks', whereby steep rises in oil prices highlighted how dependent economies and societies are non-renewable resources.

1973 ***Small is Beautiful: A Study of Economics as if People Mattered*** published (Schumacher, 1973). This book sharply criticises 'over-organised systems' as being socially and environmentally destructive, and notes the failure of traditional economic models to integrate values beyond just economics. Perhaps best known for introducing the term 'appropriate technology', which 'became the catch-phrase of the following decade'. *Small is Beautiful* 'became a rallying cry', & 'gave new impetus to a whole generation of environmental defenders'.

1973 ***The Shallow and the Deep, Long-Range Ecology Movement*** (Naess, 1973) published. Regarded as the beginnings of the 'deep ecology movement' that advocated a major paradigm shift in the human/nature dualism. Deep ecology rejects the anthropocentric view of nature (shallow ecology) in support of Eastern ideas (e.g. Buddhism) that humans are part of nature and have no more right to exploit other species as those other species have to exploit humans.

1974 The first World Conference on Population is held by the UN in Bucharest, Romania.

1974 The World Food Conference is held in Rome, laying the foundations for the creation of the World Food Council and World Food Programme.

1974 **The Cocoyoc Declaration** emerged from an international symposium on the *Pattern of Resource Use, Environment and Development* held in response to unalleviated concerns regarding inter- and intra-national inequalities created by conventional economic models. Emphasis was given to encouraging poorer nations to pursue the goal of self-reliance, along with calling for radical economic, social and political changes that would allow them to do so.

1975 **The Convention on International Trade in Endangered Species** (CITES). An international treaty designed to conserve wildlife, by banning trade in 600 species, and with restrictions on the trade of a further 26,000 other species.

1976 The term 'sustainable' first used in legislation, as a US Federal Statute named the Magnuson Fishery Conservation and Management Act, 1976. Sustainability was used in a 'narrowly ecological' context, to describe the 'maximum sustainable yield' from fishery stocks.

1976 The Sevesso dioxin leak in Italy

1977 The term 'ecodevelopment' first used (Sachs, 1977). Definition of the term is regarded as being precursory towards the emergence of the sustainability term, as it 'provided the rationale for the 1978 UNEP document that marked the first use of the sustainability term in a UN document.

1977 **The Independent Commission on International Development Issues** established (The Brandt Commission). The Commission produced a number of reports (the 'Brandt Reports') that highlighted the failure of encouraging economic growth alone as a means to alleviate disparities between the 'rich North' and the 'poor South'. A strategy aiming to increase aid to the South and reduce the advantages the North was advocated, but received little international support. Despite this, the Commission's publications are regarded as representing a 'transitional stage' in how the international community responded to the 'global crisis'.

1978 The term 'sustainability' first used in a United Nations document – *Review of the Areas: Environment and Development, and Environment Management*. The term was phrased in a context of social equity rather than previous resource-use contexts: Sustainable development means that the needs of present and future generations must be appropriately reconciled.

1978 *Amoco Cadiz* oil spill

1979 ***Gaia: A New Look at Life on Earth*** (Lovelock, 1979) published. Lovelock put forward a controversial hypothesis that the biosphere is a self-regulating entity with the capacity to keep our planet healthy by controlling the chemical and physical environment – that the planet is a single system regulated by homeostasis. His central concern was 'could the stability achieved over eons of geological time be destroyed within a few generations'.

1979 Three Mile Island nuclear incident in Pennsylvania, America.

1979 **The Convention on Long Range Transboundary Air Pollution** (LRTAP) agreed in response to concerns regarding acid rain and air pollution between neighbouring countries (notably the US and Canada; the Scandinavians and UK/France/West Germany).

1979 A World Climate Conference in Geneva concludes that the 'greenhouse effect' demands urgent international action.

1980 ***The World Conservation Strategy*** published (IUCN, 1980). A strategy proposed 'to stimulate a more focused approach to the management of living resources and to provide policy guidance on how this can be carried out'. Credited with promoting national conservation/development strategies, and for giving wide publicity to the idea of sustainable development. Recognised as the document through which 'sustainability' and 'sustainable development' terms came to prominence.

1980 The Global 2000 Report to the President – another 'limits to growth' report differentiated in it's official commissioning by US President Jimmy Carter.

1984 **The World Commission on Environment and Development** (The Brundtland Commission) established to investigate and report on the worsening financial plight of the poorer countries and the increasing suffering of their populations.

1984-88 Series of environmental and environmentally related disasters, including: catastrophic leak of methyl-isocyanate in Bhopal, India – 2,800 killed & tens of thousands injured (1984); widespread flooding in Bangladesh (1984); massive industrial explosions in Brazil and Mexico City (1984); famine in sub-

Saharan Africa (1985); cyclone in Bangladesh (1985); Mexico earthquake (1985); discovery of the 'hole in the ozone layer' above Antarctica (1985): Chernobyl nuclear explosion (1986); the Basle fire & pesticide leak into the Rhine River (1986); renewed famine in Ethiopia (1987); the years 1983, 87, 81, & 88 were four of the hottest years on record globally, contributing to widespread concern regarding climate change (1988).

1986 **The IUCN Ottawa Conference on Conservation & Development**, which emphasised the need to consider solutions to global issues in an integrated context, and highlighted sustainable development as a new paradigm emerging from two closely related paradigms of conservation.

1987 ***Our Common Future*** (WCED, 1987) published (also known as the Brundtland Report) represented three years of investigation toward developing 'long term strategies for achieving sustainable development by 2000' (p. ix). It is regarded as a fundamental text on the then new paradigm of sustainable development, and has received widespread attention, acceptance and critical debate.

1987 **The Montreal Protocol on Substances that Deplete the Ozone Layer**, signed by 24 countries. Described as 'epoch making' because it was the first treaty in which countries agreed to impose significant costs on their economies (in pursuit of a reduction in CFC & ozone depleting agents); and the agreements were made without conclusive scientific information.

1991 The Gulf War and the environmental depredations left by Saddam Hussein.

1991 The 'Antarctic Treaty states' agree on a 50 year moratorium on all mineral-related activity in the Antarctic.

1991 *Caring for the Earth* published by the IUCN, UNEP & WWF as a sequel to the World Conservation Strategy.

1992 **The United Nations Conference on Environment and Development** (also known as the Rio Conference and the first Earth Summit). The Rio Conference was the largest international conference yet held, involving representation by 178 governments and 500 NGOs. Not only did it represent the culmination of months of preparation through which the sustainability concept was widely disseminated throughout the social world, but it also produced five important 'earth summit' agreements. Perhaps of most note is Agenda 21 – the 'action plan' for international sustainable development. Agenda 21 was regarded as the most thorough and ambitious attempt to reconcile development with environmental concerns, and was put forward as the key intergovernmental guiding and reference document concerning sustainable development. The Rio Conference is also regarded as 'the main catalyst' for the popular rise and acceptance of the sustainability concept.

1992 **The United Nations Commission on Sustainable Development** established to implement Agenda 21.

1993-94 Several international Conventions ratified including UNCEDs Biodiversity Convention and Climate Convention, the Treaty on Desertification, and the Convention on the Law of the Sea.

1997 **Earth Summit II** – New York (officially known as the United Nations General Assembly Special Session – UNGASS). Held to assess progress since Rio, with more than 100 presidents, prime ministers and other top officials in attendance. Considerable progress had been made in the establishment of environment ministries and agencies, and the development of environmental policy and legislation. However, the degree to which top-level initiatives were resulting in on-the-ground changes was dubious.

1997 Kyoto Protocol – delegates to the third meeting of the Conference of Parties to the UN Climate Change Convention adopt a landmark agreement to reduce global emissions of greenhouse gases.

2001 Terrorist bombing of the World Trade Centre. Regarded as a 'defining moment in history' that 'jolted many people from their complacency and caused many other to reconsider their priorities'.

2002 **Earth Summit III** – held in Johannesburg. Notable themes include a shift away from sustainable development to just development. The absence of US President Bush was seen as an indicator that sustainability was no longer high on the international political agenda. Progress towards achieving sustainable development continues to prove difficult.

APPENDIX II

1.2 Regional authority questionnaire – Section 1

Confidential // not confidential

Date: ___ / 11 / 00 **Interviewee:** ____________
Council: ___ ____________ **Job title:** ___ ____________

SECTION 1: GENERAL USE OF INSTRUMENTS & EXTENSION METHODS TO ACHIEVE SLM

The questions in Section 1 apply to everything the Council is endeavouring to do to ensure and encourage SLM.

1 Present and future importance of instruments used to effect SLM

a) To what degree does the Council use the listed instruments to effect SLM?

1—2—3—4—5 (Not used, Minor use, Used, Major use, Extensively used)

b) How do you think the Council's use of the listed instruments is likely to change over the next 5-10 years?

1—2—3—4—5 (Considerably less use, No change, Considerably more use)

c) How would you like to see the use of the listed instruments change over the next 5-10 years?

1—2—3—4—5 (Considerably less use, No change, Considerably more use)

General instruments	Answers to question 1(a)	Answers to question 1(b)	Answers to question 1(c)
1. Financial instruments as incentives	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
2. Financial instruments as disincentives	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3. 'Free' technical services as incentives	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
4. Prizes/ awards/ competitions	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
5. Financial instruments as assistance	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
6. Regulation instruments	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
7. Tradeable rights & duties as instruments	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
8. Covenants as instruments	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
9. Management agreements as instruments	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
10. Educational instruments for assistance	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
11. Educational instruments for promoting awareness & encouraging motivation	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

2 Present and future importance of extension/delivery methods used to effect SLM

a) To what degree does the council use the listed extension methods to effect SLM?

1—2—3—4—5 (Not used, Minor use, Used, Major use, Extensively used)

b) How do you think the Council's use of the listed extension methods is likely to change over the next 5-10 years?

1—2—3—4—5 (Considerably less use, No change, Considerably more use)

c) How would you like to see the use of the listed extension methods change over the next 5-10 years?

1—2—3—4—5 (Considerably less use, No change, Considerably more use)

General extension/delivery methods	Answers to question 2(a)	Answers to question 2(b)	Answers to question 2(c)
1. Promotional leaflets or brochures	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
2. Fact sheets or information packages	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3. "Do it yourself" kits	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
4. Farm visits (one to one consultation)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
5. Focus farms	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
6. Field days	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
7. Farmer based discussion groups	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
8. Landcare groups	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
9. Other community groups	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
10. Regular publications (eg Newsletters)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

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1.3 Regional authority questionnaire – Section 2A

SECTION 2: ASSISTANCE PROGRAMS

The questions in Section 2 apply to Council programs that aim to increase farmers' capability toward achieving SLM.

A **Questions for Section 2**

3. What are your Council's five most important SLM assistance programs?
Name and list the programs in the first column of the answers sheet
Feel free to list as many programs as you wish

4. What general types of land use does each program focus on?
From the list below, select the land use or uses that best describes the program's focus
Write the accompanying code(s) in the appropriate column of the answers sheet

Code	Land use type	Code	Land use type
A1	Arable	A4	Dairy
A2	Hill country pastoral	A5	Orchard/ horticulture
A3	High country pastoral	A6	Pastoral lowland (finishing for sheep, beef, deer, other)

5. What environmental issues does each program aim to address, and what is their relative priority?
From the list below, select the environmental issues each program aims to address
Write the accompanying code(s) in the appropriate column of the answers sheet
Rank the three issues that receive greatest priority within each respective program
1 = most priority; 2 = second most priority; 3 = third most priority

Code	Environmental issue	Code	Environmental issue
B1	Water quality decline	B7	Surface soil erosion (eg sheet & wind)
B2	Weeds	B8	Mass movement soil erosion
B3	Pests	B9	Soil compaction
B4	Biodiversity loss	B10	Soil acidification
B5	Wetland decline	B11	Soil contamination
B6	Animal welfare	B12	Pesticide or herbicide use

6. What farmer constraints does each program aim to overcome, and what is their relative importance?
From the list below, select the farmer constraints each program aims to overcome
Write the accompanying code(s) in the appropriate column of the answers sheet
Rank the three most important constraints
1 = most important; 2 = second most important; 3 = third most important

Code	Constraint	Code	Constraint
C1	Awareness of SLM issues	C5	Ability to obtain farm-specific information for decision-making
C2	Motivation to address SLM issues	C6	Ability to use farm-specific information for decision-making
C3	Resource ability to address SLM issues	C7	Motivation to maintain adopted/developed SLM practices
C4	Technical ability to address SLM issues	C8	Ability to maintain adopted/developed SLM practices

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1.4 Regional authority questionnaire – Section 2b

Section 2 continued: Assistance Programs

7. What types of instruments are included in each program, and what is their relative importance?

From the list below, select as many instruments you consider to be part of the program
Write the accompanying code(s) in the appropriate column of the answers sheet
Rank the three instruments that dominate in the program
1 = most dominating; 2 = second most dominating; 3 = third most dominating

Code	Instrument	Code	Instrument
D1	Technical assistance: provision of generic technical information & recognised SLM practices information	D8	Educational service: 'how to' obtain farm-specific information
D2	Technical assistance: obtaining & providing farm-specific technical information	D9	Educational service: 'how to' interpret & integrate SLM related information into farm planning
D3	Technical assistance: assistance with farm planning	D10	Financial assistance
D4	Financial incentives	D11	Regulatory instruments
D5	Financial disincentives	D12	Bargaining instruments
D6	'Free' services as incentives	D13	Collaborative instruments
D7	Prizes / awards / competitions		

8. What types of extension/delivery methods are used for each program, and what is their relative importance?

From the list below, select the extension/delivery methods used for each program
Write the accompanying code(s) in the appropriate column of the answers sheet
Rank the three methods that are most used for each program
1 = most used; 2 = second most used; 3 = third most used

Code	Extension/delivery method	Code	Extension/delivery method
E1	Promotional leaflets or brochures	E9	Field days
E2	Fact sheets or information packages	E10	Farmer based discussion groups
E3	"Do it yourself" kits	E11	Landcare groups
E4	Farm visits (one to one communication)	E12	Other community groups
E5	Focus farms	E13	Regular publications (eg Newsletters)

9. How effective do you consider each program to be?

Put another way: how effectively does each program address the issues and constraints you listed in the previous questions?
Use the criteria below, and circle the appropriate number in the appropriate column of the answers sheet

1	2	3	4	5	6	7	8	9
No desired outcomes effected		Few desired outcomes effected		Neither few nor many desired outcomes effected – too difficult or unclear to judge		Many desired outcomes effected		All desired outcomes effected

Tack-on question: How do you review the effectiveness of each program?

Senior land managers' questionnaire Section 2 Page 3

1.5 Regional Authority Questionnaire – Section 2C

B. **Answers for Section 2**

Name of assistance program	Land use (s)	Issues	Co	nstraints		Instruments		Extension/ delivery methods		Effectiveness
1. Farm Plan program										1 2 3 4 5 6 7 8 9
2.										1 2 3 4 5 6 7 8 9
3.										1 2 3 4 5 6 7 8 9
4.										1 2 3 4 5 6 7 8 9
5.										1 2 3 4 5 6 7 8 9
6.										1 2 3 4 5 6 7 8 9
7.										1 2 3 4 5 6 7 8 9
8.										1 2 3 4 5 6 7 8 9
9.										1 2 3 4 5 6 7 8 9

1.6 Regional authority questionnaire – Section 3A

Section 2: Comprehensive Farm Plans

A | Questions for councils who do offer the Farm Plan service

10. **How many comprehensive Farm Plans does the Council prepare each year?**

0-5 6-10 11-15 16-20 21-25 >25

11. **How much money is budgeted for the Farm Plan service this year?** $ ________

12. **Is this amount likely to *increase or decrease next* year?** increase / decrease

13. **How 'in demand' is the Council's Farm Plan service (do you have a waiting list)?**

1. Very weak demand
2. Weak demand
3. Neither weak nor strong
4. Strong demand
5. Very strong demand

14. **To what degree will a farmer be involved in each stage of a Farm Plan process?**

1	2	3	4	5
No farmer involvement		Equal farmer/ Mgt. Officer *involvement*		No Mgt. Officer *involvement*

1.	Identification and description of land units (eg LRI type mapping)	1 2 3 4 5
2.	Interpretation of land classes (designation of LUC classifications)	1 2 3 4 5
3.	Integration of LUC's into planning (formulation of recommendations)	1 2 3 4 5
4.	Implementing recommendations	1 2 3 4 5
5.	Maintaining implemented recommendations	1 2 3 4 5

15. **How many Council staff are currently directed to prepare Farm Plans?**

0 1 2 3 4 5 >5

16. **What's unique about your Council's Farm Plan service?**

1. ________

2. ________

17. **How many Plans have been prepared within the Region, both prior to 1991 and post 1991?** Pre 1991 ________ Post 1991 ________

B | Questions for councils who don't offer the Farm Plan service

18. **Has the Council ever offered the Farm Plan service?** Yes / Maybe / No

19. **If yes, in what year was the service discontinued?** 19____

20. **How many Plans have been prepared within the Region, both prior to 1991 and post 1991?** Pre 1991 ________ Post 1991 ________

21. **How many Council staff have the appropriate training or experience to undertake LRI/LUC mapping?**

0 1 2 3 4 5 >5

22. **How many appropriately skilled staff could be feasibly redirected to undertake Farm Plan preparation if it became Council policy?**

0 1 2 3 4 5 >5

23. **What are the Council's key reasons for not offering the Farm Plan service?**

1. ________

2. ________

Senior land managers' questionnaire Section 3 Page 5

1.7 REGIONAL AUTHORITY QUESTIONNAIRE – SECTION 3B

SECTION 3 CONTINUED: COMPREHENSIVE FARM PLANS

C	General questions on Farm Plans

24. What do you consider to be the main benefits of a Farm Plan service?

1. ______________________________

2. ______________________________

3. ______________________________

25. What do you consider to be the main disadvantages of a Farm Plan service?

1. ______________________________

2. ______________________________

3. ______________________________

26. How do you think the general Farm Plan process could be improved (how could it be made to be more effective)?

1. ______________________________

2. ______________________________

3. ______________________________

27. How would you go about measuring how successfully a Farm Plan service effects a council's desired SLM outcomes (how do you do it now, or/and how would you do it if it was up to you)?

1. ______________________________

2. ______________________________

3. ______________________________

Thank you very much for taking the time to complete these questions

Now that you know the nature of this questionnaire, do you want the information you have provided to remain confidential:

1. May I name the Council in my write-up? Yes / No
2. May I reference any ideas or information you have given? Yes / No
3. Do you want to review the draft of the report I intend to prepare as a result of this survey? Yes / No

1.8 REGIONAL AUTHORITY QUESTIONNAIRE – INSTRUMENT DESCRIPTIONS A

DEFINITIONS AND EXPLANATION OF INSTRUMENTS

A **Definitions & explanations regarding instruments**

What follows applies both to Section 1: Questions 1a & b, and Section 2: Question 7

An instrument is defined as the means by which a council effects its sustainable land management objectives and policies.

Categories of general instruments used include:

1. **Financial instruments as incentives**: Examples include: *e.g. decreasing rates, waving charges for certain activities, financial grants*
2. **Financial instruments as disincentives**: (discouragement – opposite of motivation) The use of financial instruments to discourage certain activities *e.g. increasing rates, imposing charges for certain activities*
3. **'Free' services as incentives**: Essentially any technical or educational type service councils offer with little or no fees attached. An example is the Farm Plan service offered by some regional councils.
4. **Prizes / awards / competitions**: (motivational) Some regional councils recognise and highlight particular farms or initiatives that achieve a high degree of biophysical sustainability
5. **Financial instruments as assistance**: Dissimilar from 'financial incentives' in that it refers to finances to help farmers achieve SLM (assistance) rather than as a tool to motivate farmers toward SLM (incentive)
6. **Regulatory instruments**: *e.g. resource consents, rules, standards (e.g. water quality), permits etc.*
7. **Bargaining instruments**: These instruments refer to where and when a council may come to an agreement with a land user over some sort of balance between private rights and, usually, regulation. *e.g. Property plans, tradeable rights/duties (i.e. tradeable 'bundles' of certain rights that go hand in hand with certain duties).*
8. **Collaborative instruments**: These instruments refer to where land users are given the opportunity to take steps toward progressing SLM independently. Examples include covenants and 'management agreements' (an agreement with the present landowner to manage land in certain ways – when land changes hands the agreement must be renegotiated) (adapted from Sapsford, 1998, who defines the term under 'voluntary measures' relating to conserving biodiversity).
9. **Technical assistance as an instrument**: This refers to technical information and services relating to SLM that a council may offer. Often services are overlooked as being services because they are free.
   a) Technical service: provision of generic technical information and recognised SLM practices information: This instrument (9a) is the twin of the following instrument (9b). Both refer to the council service of providing technical information (*e.g. info on land resources, land capability, environmental monitoring data, etc.*) and information on recognised SLM practices (*e.g. BMP, recognised soil & water conservation practices, etc.*). This instrument (9a) refers to the generic types of information (i.e. non farm-specific) that a council may offer.
   b) Technical service: obtaining & providing farm-specific technical information: As different land resources vary from region to region, so to do various combinations vary from farm to farm. Some councils offer services such as surveying land resources for the purpose of Farm Plan preparation, or may undertake environmental monitoring of individual farms.
   c) Technical service: assistance with farm planning: Where a farmer may be unable to translate unfamiliar types of information into planning, a council may provide an advisory/consultancy services through which they may assist farmers interpret and integrate information into planning/practice, or in the case of Farm Plans, draw up a complete strategic plan.
   d) Technical service: 'environmental' monitoring: Most councils have the capacity to undertake environmental monitoring. This may be extended to farmers as a service. Likewise, monitoring of Farm Plans may be undertaken.
10. **Education instruments for assistance**: This refers to the use of education to overcome constraints relating to farmer's ability (in terms of knowledge, understanding and skills to address SLM issues). While regional council officers may have the appropriate skills to obtain, interpret, integrate and extend information and practices to farmers as 'technical services', there are issues relating to the depth of assistance that may be offered (re: ownership of outcomes; misuse of public funds), and physical constraints of numbers of officers who can offer such services. As such, a council may prefer to keep the responsibility firmly in the hands of the farmer, and aim to upskill them instead.
    a) Education service: 'how to' obtain farm specific information: Some programs have the intention of upskilling farmers in obtaining land resource information particular to their own properties. Likewise, some councils may encourage farmers to undertake their own environmental monitoring (e.g. assessing soil condition).
    b) Education service: 'how to' interpret & integrate farm-specific information into farm planning: Information on land resources and/or land capability is useless unless it can be interpreted and integrated into farm planning. Some programs aim to upskill farmers in the use of such information.
    c) Education service: 'how to' integrate generic technical information & recognised SLM practices into planning: Most councils offer this service – if they didn't then they'd just be loading farmers with information they can't use.
11. **Educational instruments for promoting awareness and encouraging motivation**: This differs from assistance, in that it refers to efforts to increase farmer understanding and awareness of environmental issues through education. Awareness and understanding are key factors in encouraging farmers to become motivated to change existing practices.

1.9 Regional authority questionnaire – Instrument descriptions B

Definitions and Explanations of Terms Used

B	Explanations and definitions for extension/delivery methods

What follows applies both to Section 1; Questions 2a & 2b, and Section 2; Question 8.

Extension/delivery methods represent the way in which education, advocacy, and advice are implemented. Associates closely with participatory methods of implementing policy.

Categories of general extension/delivery methods used include:

1. **Promotional leaflets or brochures**: Essentially any promotional summary or introduction to a programme or issue. Characterised as being brief, persuasive, and often visually attractive. The classic example is the glossy three-fold brochure.
2. **Fact sheets or information packages**: Generic but usually detailed information to assist farmers in resource management.
3. **"Do it yourself" kits**: Explicitly, these include farm planning kits and self-assessment instructions like the Visual Soil Assessment. Farm planning kits provide the basic tools (e.g. aerial photo, coloured pens) and instructions for preparing an environmentally orientated farm plan. VSA provides instructions for assessing and monitoring soil health.
4. **Consultancy/advisory type service**: The provision of a technical service or advice.
5. **Farm visits (one to one communication)**: Where a council representative will visit a farmer on-farm as a service, to provide information, training, advice or assistance.
6. **Focus farms**: These include long-term farm assessment or monitoring programmes, either organised by a council, or that a council is heavily involved with. They also include whole-farm pilot projects.
7. **Field days**: Meetings where the public are invited to attend; typically on-farm; and often involve reporting on progress, provision of information, and promotion of desired views, behaviours, practices, etc.
8. **Farmer based discussion groups**: Industry organised and facilitated farmer groups that meet on a regular basis.
9. **Landcare groups**: These include only 'landcare' groups – community groups that have formed to address sustainability or environmental issues specifically concerning land.
10. **Other community groups**: These include other 'care' groups, such as stream-care, coast-care, bush-care, etc.
11. **Regular publications**: Any regular report or update published by the council in question. Particularly land specific publications such as Gisborne DCs Conservation Quorum.

APPENDIX III

1.10 LAND USE DERIVED FROM THE NZLRI – METHOD & CRITERIA

The New Zealand Land Resource Inventory uses a five-factor inventory of rock type, soil, slope, erosion and vegetation. Vegetation is categorised according to five primary classes of grassland (P), cropland (L), scrubland (M), forest (N), and weeds/herbs (H), and around 40-45 further subclasses (e.g. P1, P2, etc.). As more than one vegetation type can exist within a given LRI unit, then more than one subclass can be recorded as an inventory code (e.g. P1h3m1). The first subclass recorded indicates the vegetation type that dominates within the unit; a capitalised letter indicates that it dominates >40% of the unit; and an un-capitalised letter indicates <40% dominance.

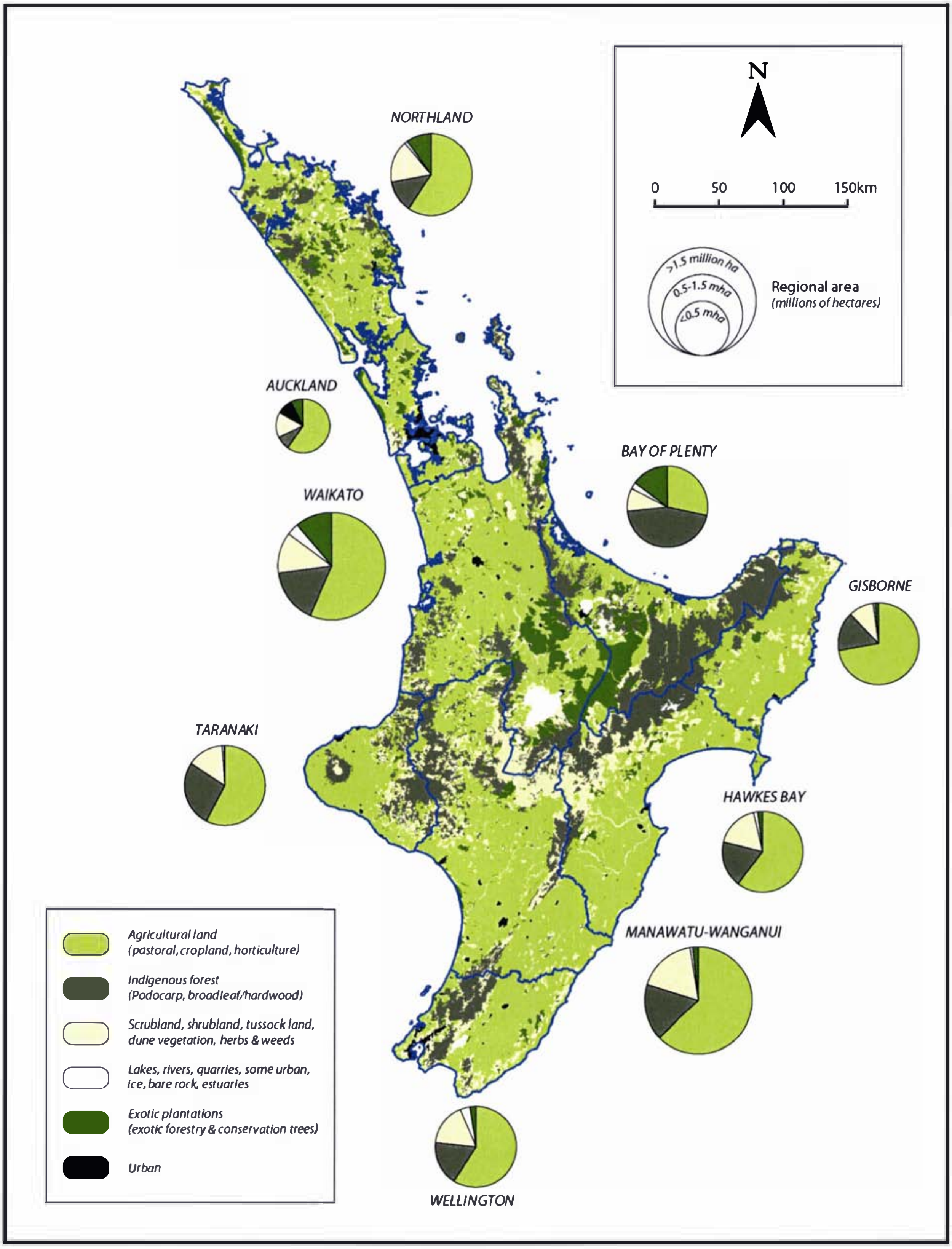
Dominant vegetation classes have been filtered from the digital database version of the NZLRI to derive a crude indication of regional and national land use. Records have been filtered according the vegetation subclass that appears first in the code, and reclassed as nominated land-use categories. Reclassification criteria included:

Land use class	**NZLRI vegetation subclass**
Agricultural land	Unspecified grassland (P), high producing pasture (P1), low producing pasture (P2), crops (L, L1, L3), orchards/vineyards/horticulture (L2, L4)
Indigenous forest	Unspecified forest assoc. (N), coastal forest (N1), kauri (N2), podocarp-hardwood (N3), nothofagus (N4), hardwood (N5), podocarps (N7)
Scrubland, shrubland, tussock land, dune vegetation, herbs & weeds	Scrub (M, M1, M2, M3), fern (M4), subalpine scrub assoc. (M5), native shrub assoc. (M6), brushweeds (M7, M8, M9, M10), matagouri (M11), mangroves (M12), tussock assoc. (P3, P4, P5), sand dune assoc. (P6)
Other	Ice, quarries, lakes, rivers, estuaries, blanks
Urban	Towns
Exotic plantations	Exotic forest (N6), conservation trees (N8)

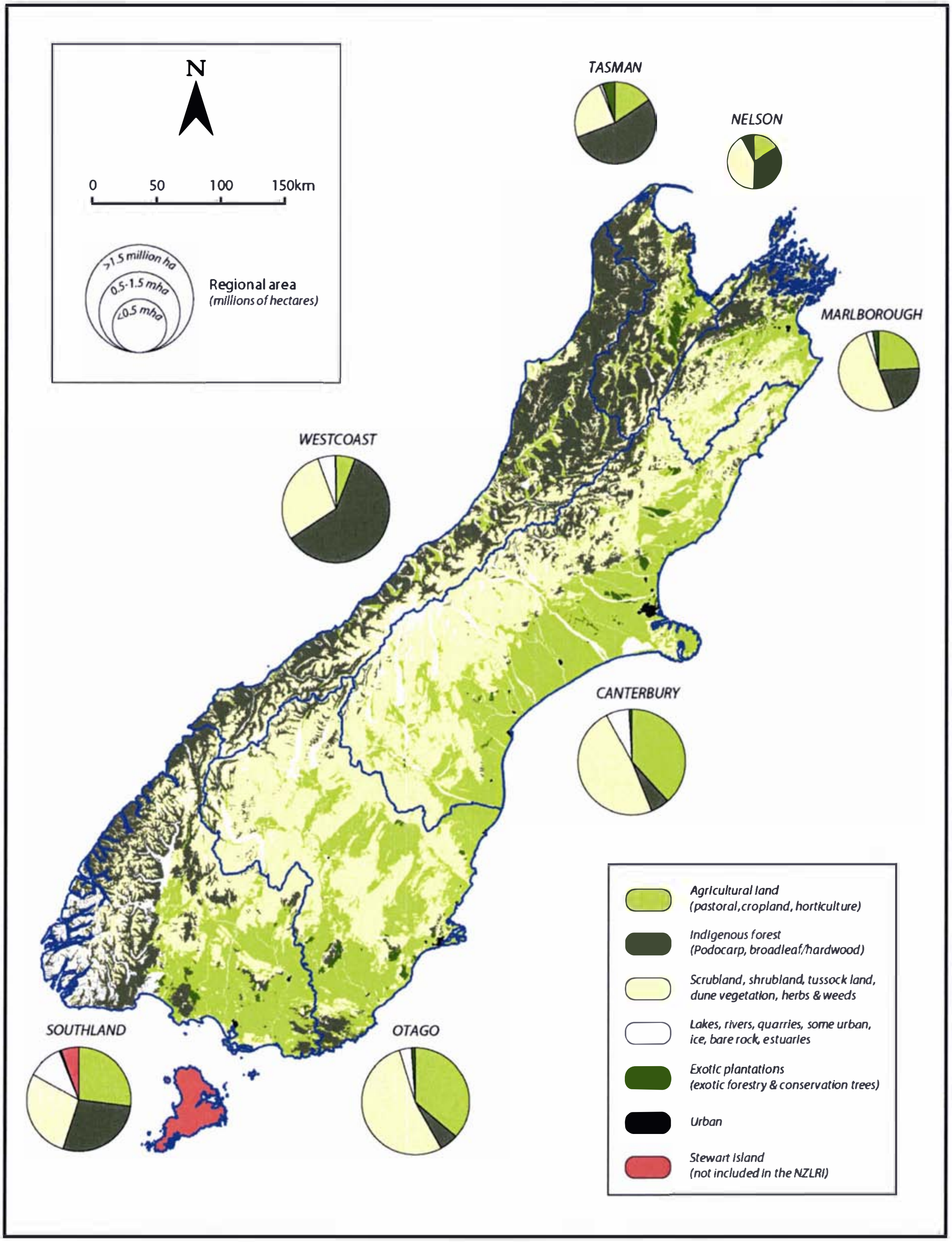
Results are presented as the following two maps. Limitations are major. Firstly, the original data are for vegetation cover, but they are inferred here as being indicative of land use. Two particularly questionable assumptions are: (a) that the grassland types listed are actually used for agriculture; and (b) that tussock land is not used for agriculture. Secondly, the NZLRI is hopelessly out-of-date. First edition maps were completed in 1979, and only five LUC Regions have been updated with second edition survey – North Waikato (1980-84), Northland (1985-90), Wellington (1987-92), Marlborough (1987-92), and Gisborne-Eastcape (1995-99). However, as vegetation is the most dynamic of the five LRI factors, even the second editions have a questionable modern-day reliability (concerning vegetation).

The more recent Landcover Database was not available to the author for casual analysis (acquiring the database would have involved a monetary cost). As such, although land use inferred from the NZLRI has a number of limitations, it was considered an inexpensive means of demonstrating some of the more general land use differences between each region.

1.11 LAND USE DERIVED FROM THE NZLRI – NORTH ISLAND



1.12 Land use derived from the NZLRI – South Island



APPENDIX IV

1.13 QUESTIONNAIRE FOR *SOIL & LAND INVENTORY SURVEY SERVICES* STUDY

Availability of soil mapping services for individual farm properties

Thanks for taking the time to fill out this brief survey. Responses contribute toward increasing farmer awareness of the options they have for obtaining land resource information about their farms. Please base your answers on the following scenario farm:

Scenario farm

- A 500ha sheep & beef farm in hill country that ranges from recent alluvial flats, up through hill country & occasional higher terraces, and a small proportion of steepland at the back of the farm. The farm is geologically underlain by a reasonably diverse sequence of limestone, mudstones, sandstones, and some loosely consolidated sands. There are also occasional inclusions of loess, and there's even a chance that some tephric material may be present.

For a farm with similar attributes located in your own region, how much would you or your organisation estimate (ball park figure) to charge for the following types of large scale (e.g. 1:10 000) farm soil survey

Outcome quality	*Example description*	*Estimated cost*	*Remarks*
Bronze level soil survey	▪ A basic farm map depicting polygons of soil units; perhaps ½ day in the field either mapping or ground-truthing; brief explanation of the soil units identified; moderate confidence in the accuracy of the map	$	
Silver level soil survey	▪ 1 or 2 days in the field; digitised and spatially coordinated map with basic legend; detailed report on the soils identified; moderate to high confidence in the accuracy of the map	$	
Gold level soil survey	▪ Two or more days in the field; digitised and spatially coordinated map with full pedological legend; detailed report including an interpretation of how soil characteristics relate to current and potential land use; high degree of confidence in map accuracy	$	
Platinum level soil survey	▪ As for the gold level, but includes physical and chemical analysis and interpretation of key soil properties	$	

Please return this completed form in the envelope provided

Thanks for your help

Availability of non-council LRI/LUC mapping services for individual farm properties

Thanks for taking the time to fill out this brief survey. Responses contribute toward increasing farmer awareness of the options they have for obtaining land resource information about their farms. Please base your answers on the following scenario farm:

Scenario farm	▪ A 500ha sheep & beef farm in hill country that ranges from recent alluvial flats, up through hill country & occasional higher terraces, and a small proportion of steepland at the back of the farm. The farm is geologically underlain by a reasonably diverse sequence of limestone, mudstones, sandstones, and some loosely consolidated sands. There are also occasional inclusions of loess, and there's even a chance that some tephric material may be present.

For a farm with similar attributes located in your own region, how much would you or your organisation estimate (ball park figure) to charge for the following types of large scale (e.g. 1:10 000) farm LRI/LUC survey

Outcome quality	***Example description***	***Estimated cost***	***Remarks***
Bronze level LUC survey	▪ A basic farm map depicting polygons of LUC units; perhaps ½ day in the field either mapping or ground-truthing; brief explanation of the LUC system & LUC units identified; moderate confidence in the accuracy of the map	$	
Silver level LRI/LUC survey	▪ Mapping of the farm's LRI and LUC; 1 or 2 days in the field; digitised and spatially coordinated map with basic legend; detailed report on the LRI/LUC system & the units identified; moderate to high confidence in the accuracy of the map	$	
Gold level LRI/LUC survey	▪ Mapping of the farm's LRI and LUC; two or more days in the field; digitised and spatially coordinated map with extended LUC legend; detailed report including an interpretation of how the farmer can make more profitable & environmentally less impactive use of his/her land; high degree of confidence in map accuracy	$	
Platinum level LRI/LUC survey	▪ As for the gold level, but also includes the identification & comprehensive evaluation of 2 or 3 alternative land use scenarios that are both more profitable & less environmentally impactive than present	$	

Please return this completed form in the envelope provided

Thanks for your help

APPENDIX V

1.14 Review of Soils Underpinning Business Success Questionnaire

Survey

Review of the SUBS programme

Questionnaire

Important points

1. This questionnaire has been tested by farmers involved with SUBS. They estimated that it can be completed within 5 to 15 minutes.
2. Each question is self-explanatory.
3. Completed questionnaires will be treated with discretion. They will not be shown to anyone other than myself, and they will be destroyed at the completion of the study.
4. Please note that participation would imply that you are giving consent – that it's ok to use your responses in my studies.
5. A general follow-up letter may be sent within two-weeks if the initial return rate is low. If the return rate is reasonable, then the follow-up may be undertaken by phone.
6. You are partly anonymous! The original design was for complete anonymity, but this would mean having to post everyone a follow-up letter. Partial anonymity is achieved through the code at the bottom of the page, which is only referenced to identify questionnaires that are not returned.
7. You are more than welcome to have a copy of the final results. Please complete the enclosed slip and post it back with the questionnaire.
8. If you have any questions, please contact me on (06) 350 5799 (ext. 7164) or by email at A.M.Manderson@massey.ac.nz . Alternatively, my supervisor Dr Alan Palmer can be contacted on (06) 350 5799 (ext. 7746), or through A.S.Palmer@massey.ac.nz .

Reference:

PART 1a: INVOLVEMENT IN SUBS

1. The SUBS programme has now been used by at least 9 groups. Which SUBS group did you sign up with? (please tick one)

- ☐ Dannevirke Land Resource Assessment Group (1998-99)
- ☐ Wanganui SUBS Group (1999-2000)
- ☐ Sand Country SUBS Group (2000-01)
- ☐ Taihape Hill Country SUBS Group (2001-02)
- ☐ Tararua (Hill Country) SUBS Group (2001-02)
- ☐ Tararua Dairy SUBS Group (2002-03)
- ☐ Manawatu Dairy SUBS Group (2002-03)
- ☐ Raetihi SUBS Group (2002-03)
- ☐ Taumarunui SUBS Group (2002-03)

2. Did you complete the SUBS programme? (please tick one)

- ☐ Yes (if yes, please go to Part 2)
- ☐ No (please go to Part 1b below)

PART 1b: PARTIAL INVOLVMENT

3. Did you attend any of the meetings? (please tick one)

- ☐ Yes (if yes, please answer questions 4 & 5)
- ☐ No (if no, please answer question 5)

4. Approximately how many meetings did you attend? __________ meetings

5. What was your main reason for deciding not to continue with SUBS? (please describe)

____

____

____

____

____

____

____

____

____

____

This is essentially the end of the questionnaire for those who did not attend any SUBS meetings. Thank you for your participation. Please return this questionnaire using the self-addressed envelope provided. For those who attended some meetings, several of the remaining questions may be irrelevant.

PART 2: GENERAL INFORMATION

6. What broad category of farming do you most closely associate with? (please tick one)
   - ❑ Arable or mixed cropping
   - ❑ Dairy farming
   - ❑ Hill country sheep, beef, and/or deer
   - ❑ Other (please indicate): ______________________________

7. What is your relation with your home/main farm? (please tick one)
   - ❑ Farm manager & farm owner (includes partnerships)
   - ❑ Farm manager & the farm is owned by someone else
   - ❑ Other (please indicate): ______________________________

8. What is the total area of your home/main farm? __________ hectares

9. As a quick estimate, what area of your home/main farm can be described as:
   a. Flat or gently undulating __________ hectares
   b. Undulating or rolling hill __________ hectares
   c. Hill country __________ hectares
   d. Proverbial tiger country (steepland) __________ hectares

10. What is the normal stocking rate on your home/main farm? __________ su/ha

11. What is the stock unit ratio between sheep, cattle and deer? (*e.g.* 70:30:0) _____ : _____ : _____
    Sheep ***Cattle*** ***Deer***

12. How do you think local farmers would rate your farming performance? (please tick one)
    - ❑ Well above average ('top farmer')
    - ❑ Above average
    - ❑ Average
    - ❑ Below average
    - ❑ Well below average

13. How many years have you been a farmer? __________ years

14. How many of those years have been with the farm you're currently managing? __________ years

15. Do you have a tertiary qualification? (please tick one)
    - ❑ Yes (please name highest): ______________________________
    - ❑ No

PART 3: Application of the SUBS programme

16. Wasthe size of your SUBS group appropriate? (please tick one)

- ❑ Too large (too many people)
- ❑ About right
- ❑ Too small (too few people)
- ❑ Not sure

17. Approximately how many SUBS meetings did you attend? (please tick one)

- ❑ Attended all meetings
- ❑ Attended most meetings
- ❑ Neither high nor low attendance
- ❑ Attended some meetings

18. What were your main reasons for not attending some of the meetings? (tick as many as you like)

- ❑ Work commitments
- ❑ Other commitments (family, annual holiday, etc.)
- ❑ Declining interest
- ❑ Long travelling distances to meetings
- ❑ Bad weather
- ❑ Other ____________________

19. Did you host at least one SUBS meeting on your farm? (please tick one)

- ❑ Yes
- ❑ No

20. Meetings typically involved half a day. Was the time of day appropriate? (please tick one)

- ❑ Yes (please skip to question 22)
- ❑ No

21. Please explain why the time of day was inappropriate:

____

____

____

____

____

____

____

____

22. Most SUBS programmes ran over a period of 12 months. Was this period appropriate? (please tick one)
   - ❑ Yes (please skip to question 24)
   - ❑ No

23. Please explain why the 12 month duration of SUBS was inappropriate:

____
____
____
____
____
____
____
____

24. Approximately how much total time did you spend on SUBS activities outside of the meetings? This includes soil mapping, interpreting strengths & weaknesses, etc. (please tick one)
   - ❑ Up to ½ a day
   - ❑ About 1 day
   - ❑ About 2 days
   - ❑ About 3-5 days
   - ❑ More than five days (please indicate) ____________ days

25. Did either a soil scientist or regional council officer visit your farm specially to help you with your soil mapping? (please tick one)
   - ❑ Yes
   - ❑ No

26. Which components of SUBS would you have liked to have spent more or less time on? (please tick your preference).

	More time	No change	Less time
Local geology and landscape formation	❑	❑	❑
Soil mapping and description	❑	❑	❑
Soils and their relation to farm management	❑	❑	❑
Discussion & debate on environmental issues	❑	❑	❑
Discussion & debate on farm production and performance	❑	❑	❑
Production and financial analysis	❑	❑	❑
Other (please state):	❑	❑	❑
Other (please state):	❑	❑	❑

27. How difficult did you find the **mapping** component of SUBS? (please tick one)

- ☐ Very easy
- ☐ Easy
- ☐ Neither difficult nor easy
- ☐ Difficult
- ☐ Very difficult

28. How difficult did you find the **soil profile description** component of SUBS? (please tick one)

- ☐ Very easy
- ☐ Easy
- ☐ Neither difficult nor easy
- ☐ Difficult
- ☐ Very difficult

29. Were the technical aspects of SUBS (including soil mapping & profile description) adequately explained and demonstrated at the meetings? (please tick one)

- ☐ Yes
- ☐ No
- ☐ Not sure

30. Were the written instructions for mapping and describing soils adequate? (please tick one)

- ☐ Yes
- ☐ No
- ☐ Not sure

31. Do you have any general suggestions on how SUBS could be improved? (please describe):

Please use another sheet of paper if you have a number of suggestions

PART 4: Benefits of SUBS

People involved with SUBS, including farmers, have stated various benefits associated with the programme. Some of these are listed below. Please indicate how strongly you agree or disagree with each statement.

32. Farmers became more aware of their soil resource as a result of SUBS.
    - ❑ Strongly agree
    - ❑ Agree
    - ❑ Neither agree nor disagree
    - ❑ Disagree
    - ❑ Strongly disagree

33. Farmers became more familiar with soil science terminology and jargon as a result of SUBS.
    - ❑ Strongly agree
    - ❑ Agree
    - ❑ Neither agree nor disagree
    - ❑ Disagree
    - ❑ Strongly disagree

34. Skills learned during SUBS are enduring and transferable (they can be used elsewhere at a different time).
    - ❑ Strongly agree
    - ❑ Agree
    - ❑ Neither agree nor disagree
    - ❑ Disagree
    - ❑ Strongly disagree

35. What farmers know about their land resource has traditionally been gained through familiarity and experience. SUBS is a way of shortcutting these experiences.
    - ❑ Strongly agree
    - ❑ Agree
    - ❑ Neither agree nor disagree
    - ❑ Disagree
    - ❑ Strongly disagree

36. SUBS is a way of clarifying and recording what farmers already know about their farms' soils.
    - ❑ Strongly agree
    - ❑ Agree
    - ❑ Neither agree nor disagree
    - ❑ Disagree
    - ❑ Strongly disagree

37. Farmers gained a greater appreciation of environmental issues as they relate to their own properties.
- [ ] Strongly agree
- [ ] Agree
- [ ] Neither agree nor disagree
- [x] Disagree
- [ ] Strongly disagree

38. Farmers' confidence in debating environmental issues increased as a result of involvement with SUBS.
- [ ] Strongly agree
- [ ] Agree
- [x] Neither agree nor disagree
- [ ] Disagree
- [ ] Strongly disagree

39. SUBS farmers are now better positioned to take advantage of new technologies (e.g. Overseer, GPS fertiliser application, etc.).
- [ ] Strongly agree
- [ ] Agree
- [ ] Neither agree nor disagree
- [x] Disagree
- [ ] Strongly disagree

40. SUBS is practical. It is not a 'touchy-feely' new age way of helping farmers.
- [ ] Strongly agree
- [ ] Agree
- [ ] Neither agree nor disagree
- [ ] Disagree
- [ ] Strongly disagree

41. SUBS helped farmers identify production and business opportunities.
- [ ] Strongly agree
- [ ] Agree
- [ ] Neither agree nor disagree
- [ ] Disagree
- [x] Strongly disagree

42. SUBS farmers have an increased awareness of their farms' soil diversity and distribution.
- [ ] Strongly agree
- [ ] Agree
- [ ] Neither agree nor disagree
- [ ] Disagree
- [ ] Strongly disagree

43. SUBS farmers gained a greater understanding of 'why' and 'how' their soils behave the way they do.

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

44. SUBS farmers began to regard areas of their own farms differently in terms of land use potentials and limitations.

- ☐ Strongly agree
- ☐ Agree
- ☐ Neither agree nor disagree
- ☐ Disagree
- ☐ Strongly disagree

45. Were there any other benefits you could associate with SUBS? (please describe).

46. Were there any disadvantages that you could associate with SUBS? (please describe).

PART 5: Was SUBS worthwhile?

47. What were your original reasons for becoming involved with SUBS? What did you originally hope to get out of the programme (please describe).

48. Did the programme fulfil your original reasons for becoming involved with SUBS? (please tick one)
    - ❑ Yes
    - ❑ Partly
    - ❑ No

49. Money is one way of indicating if something has worth. In hindsight, how much money would you pay for involvement in a programme like SUBS? $ ____________

50. At the end of SUBS you were supposed to indicate **three tasks** that you would undertake as a result of being involved with SUBS.
    How many of these tasks have you implemented? ____________

51. Please describe how your farm management has changed as a result of being involved with SUBS:

Please use another sheet of paper if you have a number of changes

PART 6: Beyond SUBS

52. Have you sought new information about soils or related management as a result of being involved with SUBS? (please tick one)

    Yes

    No

53. Did you further refine your **soil map** and/or descriptions after SUBS had been completed? (please tick one)

    Yes

    No

54. Did you further refine your **LMU map** after SUBS had been completed? (please tick one)

    Yes

    No

55. Have you applied your skills learned through SUBS in another situation or context? (please tick one)
    Examples: to examine soils on another farm; land purchase; assessing alternative management options, etc.

    Yes

    No (please skip to question 58)

56. Please explain how you applied your SUBS skills in another situation or context:

    ____

    ____

    ____

    ____

    ____

    ____

    ____

    ____

57. Have you independently engaged a service provider **as a result** of being involved with SUBS? (please tick appropriate response).

    No

    Yes – farm consultant

    Yes – regional council officer

    Yes – other (please state): ____________________________

58. Have you ever used your soil or LMU map to help explain something to a service provider? (*e.g.* fert rep, farm consultant) (please tick one)

    Yes

    Maybe

    No

59. Would you endorse or recommend SUBS to other farmers? (please tick one)

- ☐ Yes
- ☒ Maybe
- ☐ No

60. Have you ever actually endorsed or recommended SUBS to other farmers? (please tick one)

- ☐ Yes
- ☐ Maybe
- ☒ No

61. Are you interested in follow-on programmes that build upon SUBS? (please tick one)

- ☐ Yes
- ☐ Maybe
- ☐ No

62. If you were interested in follow-on programmes, what topics would be of interest? (please list)

63. Do you have any other comments or suggestions you'd like to make about SUBS?

This is the end of the questionnaire.
Thank you for your time and perseverance.
Please return the questionnaire using the self-addressed envelope provided.

APPENDIX VI

1.15 SUBS Questionnaire Responses (tabulated)

Table A1: Partial involvement – farmers who did not complete the SUBS programme (Q3, 4, 5)

	No. of meetings attended	Primary reason for discontinuing
Farmer A	5	Illness.
Farmer B	3	Difficulties associated with application of the programme.
Farmer C	4	Was planning to sell the farm.
Farmer D	10	Considered SUBS unsuitable for his situation – impractical to divide large hill country area into units.
Farmer E	7	Involved with too many other programmes & commitments.
Farmer F	3	Satisfied with his current level of knowledge regarding his farm's soils.
Farmer G	6	Changed jobs.
Farmer H	10	Other commitments.

Table A2: Descriptive statistics for farming categories and areas (Q6,8)

		Hectares (ha)						
	Count	Max	Min	Sum	Mean	StdDev	Error	Regional average
Dairy	10	280	61	1369	137	67	21	85
Intensive	6	2200	121	3983	664	764	312	393
Sheep & beef	37	1600	160	23214	627	384	63	550
Other	4	1440	237	2874	719	585	293	-
All	57	2200	61	31440	552	452	60	-

Table A3: Topographical makeup & landscape diversity (Q9)

Categories			Landscape diversity		
Class	Count	Percent	Class	Count 2	Percent 2
Flat only	8	14%	Low		
Hill only	2	4%	Low	10	18%
Flat + hill	1	2%	Moderate		
Flat + steep	1	2%	Moderate		
Flat + undulating	4	7%	Moderate		
Hill + steep	1	2%	Moderate		
Undulating + hill	3	5%	Moderate	10	18%
Flat + hill + steep	2	4%	High		
Flat + undulating + hill	14	25%	High		
Flat + undulating + steep	1	2%	High		
Undulating + hill + steep	1	2%	High	18	32%
Flat + undulating + hill + steep	19	33%	Very high	19	33%

Table A4: Descriptive statistics for stocking rates (Q10)

	Count	Stocking rate (dairy = cows/ha: non-dairy = su/ha)						Regional average
		Max	Min	Sum	Mean	StdDev	Error	
Dairy	8	4.7	2.6	25	3	0.7	0.2	2.6
Intensive	5	15	10	58	12	2.1	0.9	12.7
Sheep & beef	36	15	7.75	393	11	1.8	0.3	9.6
Other	2	15	9	24	12	4.2	3.0	-

Table A5: Counts of common stocking ratios (Q11)

Common stocking ratios	Crop-ping	Dairy	Other	Sheep beef	Grand Total
No response	1		1		2
00-100-00		10			10
35-65-00				2	2
40-30-30				1	1
40-60-00				2	2
48-52-00	1				1
50-10-40	1				1
50-50-00			3	3	6
53-43-00				1	1
55-45-00			1	1	2
60-40-00			2	4	6
64-36-00				1	1
65-25-10				1	1
65-35-00				1	1
66-34-00				1	1
67-33-00				1	1
68-32-00				1	1
70-30-00				10	10
73-27-00				1	1
74-26-00				1	1
75-25-00				1	1
80-20-00				1	1
82-18-00				1	1
85-15-00				1	1
92-06-02				1	1
Grand Total	3	10	7	36	57

Table A6: Descriptive statistics for farming experience (Q13&14)

	Count	Years					
		Max	Min	Sum	Mean	StdDev	Error
Farming experience	57	45	0	1351	24	9	1.22
Experience on current farm	57	40	0	972	17	9	1.25

Table A7: Cross tabulation between SUBS group & type of tertiary qualification (Q15)

	Degree	Diploma	Other Tqual*	Total Tqual**	Not Tqual**	Total	% of Tqual farmers
DANNEVIRKE	2	3	1	6	1	7	86%
MANAWATU DAIRY	-	-	1	1	3	4	25%
RAETIHI	-	1	-	1	4	5	20%
SAND COUNTRY	1	1	1	3	3	6	50%
TAIHAPE	4	3	1	8	2	10	80%
TARARUA HILL	2	4	-	6	3	9	67%
TARAUA DAIRY	2	1	1	4	2	6	67%
TAUMARUNUI	1		1	2	4	6	33%
WANGANUI		1	-	1	3	4	25%
Grand Total	**12**	**14**	**6**	**32**	**25**	**57**	**56%**

* *'Other' includes x1 Doctorate; x1 Masterate; x1 national certificate; x1 'not stated'; x2 dual responses (qualifications for two people given).*

** *Tqual = Tertiary Qualification (does not include secondary qualifications attained as an adult).*

Table A8: Special help with soil mapping (Q25) by mapping difficulty (Q27) & profile description difficulty (Q28)

Q27*						
Q25	**A**	**B**	**C**	**D**	**E**	**Total**
Asst	1	8	16	**5**	**1**	31
Not Asst	1	7	11	**5**		24
(blank)		1				1
Total	2	16	27	10	1	56

Pearson Chi-Square = 1.120 (df = 4) [5 cells (50%) have expected count <5. Minimum expected count = 0.44].

Asymptotic significance (2-sided) = 0.891

Q28*						
Q25	**A**	**B**	**C**	**D**	**E**	**Total**
Asst	1	2	14	**14**		31
Not Asst		1	15	**5**	**2**	23
(blank)		1				1
Total	1	4	29	19	2	55

Pearson Chi-Square = 6.590 (df = 4) [6 cells (60%) have expected count <5. Minimum expected count = 0.43].

Asymptotic significance (2-sided) = 0.159

** A = Very easy; B = Easy; C = Neither difficult nor easy; D = Difficult; E = Very difficult.*

(Asymp. Sig. for both comparisons is >0.10 meaning it is likely that differences observed in both tables are due to chance variation)

Table A9: Count responses to questions concerning the benefits of SUBS (Q32-44)

	Question response (count)													Total count	Total percent
	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q42	Q43	Q44		
Strongly agree	31	14	21	17	14	7	6	8	12	14	26	25	18	213	29%
Agree	22	36	29	29	29	36	27	32	42	30	27	28	34	401	55%
Neither	3	6	6	8	6	12	21	15	2	9	1	3	3	95	13%
Disagree	0	0	0	2	7	0	2	1	0	1	1	0	1	15	2%
Strongly disagree	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0%
Total response (n)	56	56	56	56	56	56	56	56	56	55	55	56	56	726	100%
Positive responses*	53	50	50	46	43	43	33	40	54	44	53	53	52	614	85%
Non-positive responses**	3	6	6	10	13	13	23	16	2	11	2	3	4	112	15%

** Positive responses = 'strongly agree' + 'agree'*

*** Non-positive responses = neutral response + 'strongly disagree' + 'disagree'*

1.16 SUBS Questionnaire Text Responses

Questions that required a text response are in bold. Questions that did not invite a text response (but comments were made anyway) are in italics.

Question 05: What was your main reason for not deciding to continue with SUBS?
R 3: "Hip replacement – crook. Programme incomplete"."
R 11: "I did not decide not to continue. I was left out of the initial group to my annoyance, and started with the 2nd group which collapsed. I was offered to join in with the 2nd group but found the meeting times were designed to suit payed professionals not farmers, and so missed meetings that started early in the morning… through not getting farm work done beforehand. Also, notice of meetings was often short and sometimes didn't arrive. Having meetings in the busy time of the year also meant I missed some meetings as a result, only one meeting I attended had a scientist attending and I feel I have not 'done' the course to a meaningful level".
R21: "We put the farm on the market at short notice so I decided not to attend any more meetings as I would have been going out of farming. It don't [something something] the finish, I felt I had missed too many meetings to catch up."
R23: "Large property – hill country – impractical to separate classes"
R35: "Too many balls in the air" [involved with other programmes].
R41: "I had a reasonable understanding about soils having lived on a property with diverse soil types. Understanding sand country characteristics and intensive cropping on our silts is a necessity, to be able to make a reasonable return from different soils" [already had a sound understanding; SUBS was unnecessary – but its suggested/implied.
R43: "Changed jobs."
R46: "I was asked to join as I was chairman of the Local Monitor Farm Group. I resigned from that due to other commitments & sometimes I found I couldn't attend land resource meetings days either." [too busy; other commitments].

Question 15: Do you have a tertiary qualification?
R 16: 'nearly qualified accountant' [but he answered 'no' to this question].

Question 16: Was the size of your SUBs group appropriate?
R 43: Answered 'about right' with the comment: "when everyone turned up".

Question 18: What were your main reasons for not attending…?
R 11: In response to other: "not receiving notification, poor timing of meetings"
R27: "Started after the group had started".
R35: Other – "conflicted with school time".

Question 21: Please explain why the time of day was inappropriate?
R 1: [responded in terms of 'the time of day was appropriate] "Need time to get to meeting. Need time to get anything done before going". [meaning travelling distances can be far, and a number of farm jobs need to be done in the morning].
R 5: "busy people".
R 9: "On some occasions at approx. 9-9.30am it was too early because of morning jobs on the farm"
R 11: "early meetings at a busy time of year meant unable to get to meetings because, by the time vital work (*e.g.* feeding out, checking calving stock, etc.) was done, + up to 80minutes travel, meetings would be over by the time I got there"
R14: "The day could be longer. In our group there was up to an hour travel. Socialising with lunch or over a beer is often good value".
R35: "Didn't fit around school children."

Question 23: Please explain why the 12 month duration of SUBS was inappropriate?
R 1: "I thought Taihape's was about 6 months which kept it current – otherwise it gets too long & you loose momentum"
R 3: "Not long enough"
R 9: "It appeared to me to be too long in the middle session of the programme – there was a lot of repetition" [organisation problem?].
R 11: "Meetings continued through busy times" [i.e. busy times of the year].
R22: "I thought it was too long and drawn out. Six months may be better".
R29: "Just a bit too long to maintain interest, given [that farmers have] other commitments."
R31: Responded in terms of the duration being appropriate: "Able to observe climate & seasonal change to soils. Able to get through all the SUBS tasks without being pressured."
R39: "Would have liked it to last longer – just started to get to grips with it when it stopped."
R42: Supported the duration: "It enabled the group to discuss the impact of seasonal variations pertaining at the time."
R47: Supported the duration: "Appropriate time to get around [all the] properties. Full run of seasons useful too."

Question 24: How much time?
R18: Confused with the question [possibly like many others]. "per meeting or total?" And then he responded in terms of "per meeting".
R20: "Approximately ½ day per month = 5-6 days total"
R46: "I didn't as my farm had already been very extensively soil mapped!"

Question 25: Did either a soil scientist or regional council officer visit your farm specially to help with mapping?
R 1: 'very helpful'
R35: "Offered but they never got around to it."
R49: "I went to visit them in town."

Question 26: Which components of subs... more or less time on?
R 1: Other 'I though it would have been useful to look at what other options could we use some of these soils for considering the climate, etc.'
R 10: Other – "how other farmers dealt with their soils".
R 13: Other – "LMUs needed more discussion".
R 16: Other – "Exploring land use options"
R25: "Different soil strengths & weaknesses for pasture, cropping, horticulture, etc."
R55: "Application tools post-SUBS."

Question 27: How difficult did you find the mapping component of SUBS?
R 14: Said it was 'easy' but with a qualifier: "with help from regional council!"
R 17: "My own farm seemed difficult compared to other farms until the tutors changed the way I looked at the hills"
R27: "Soil – but had help".

Question 29: Were the technical aspects...adequately explained...?
R 11: "Maybe I wasn't there".
R 13: "[said yes] – but a bit more time needed – maybe I'm a bit thick!"
R19: "See no.31 for explanation".

Question 31: Do you have any suggestions on how SUBS could be improved?
A: SUGGESTIONS
R 1: "I found the 'show & tell' part of each meeting too long. Where people showed their maps & how they did it"
R 4: "Perhaps soil profiles inside to discuss in more detail".
R 11: "Improved facilitation and timing of meetings"
R 13: "Once LMUs have been identified there needs to be a bit more time spent on discussing the implications on farm management *e.g.* fencing + stock replacements. There just seemed to be a gap for me once I had my map. I look at it now and can follow it, but really not sure if I have changed many things. With a relatively high stocking rate I need all of the farm for stock. I have identified the ash soils and do manage them differently no *e.g.* lighter stocking rate in winter but keep on top of it once it starts to grow in the spring. The people [trainers] were/are excellent – just make sure everybody fully understands. Alan Palmer tended to go a bit quick."
R 15: "More information on strengths & weaknesses of different soil types *e.g.* Water holding capacity; nutrient retention/availability; suitability for different farming practices."
R 16: "The process of farm mapping needs to be sped up. More time needs to be spent on realising the potential of Land Management Units. Eg. Land use options; suitability of plants, trees, etc.; optimum fertility levels, etc.
R 17: "Notes covering topics discussed (I regret not taking my own notes)."
R19: "If on the first or second day we were shown good examples of different soil types and structures (side by side in a display) it would allow us to get a faster understanding of what the difference really looked like rather than waiting to come across it on a farm visit which might be later in the programme or not at all. Because we could not see this overall range of types it made it harder to assess what our soul properties were: i.e. I thought I was making a 'ribbon' until I got on a clay soiled farm and realised my ribbon wasn't such a good one after all. This part of the course could have been shortened.
R38: "A soil scientist or regional council officer should assist <u>all</u> participants with their soil mapping – one on one, on their own farm." [but who pays?].
R39: "Could go longer. Very interesting looking at different soils. Heaps of information to be gained from experts."
R40: "I believe it is essential that a soil scientist assist with the soil mapping (as happened in my case) as it gives confidence that the soil map is accurate and therefore a useful management tool."
R50: "The last 4-5 meetings were a bit repetitive – the first six were really good."
R53: "Quicker turnaround with getting maps (soil & LMU) done or changed/corrected."
R54: "I was unable to attend the first meeting and it may have been given verbally then, but I would have liked an overview of what was to be addressed at each meeting."
R55: "Each section should be a module, with clear instructions & a goal/goals to be achieved before beginning the next module. Ideally all modules should have the same format for text, diagrams, etc. There should be additional resource material included to explain general things such as soil formation/erosion processes, etc. Finally there needs to be an interactive kit for options that farmers can apply post SUBS. We have the 'discovery tool' [i.e. SUBS as it stands]. An ongoing information & application was a little lacking *e.g.* If I have sandstone derived soils, what should I grow to feed my sheep on, instead of the present browntop & Manuka, taking into account that after 50 years this is the status quo?

B: GENERAL COMMENTS
R 9: "A comment would be it takes you guys 3 to 4 years for your degrees & it was hard to come to grips quickly with soils & soil profile description".

R 10: "The defining of colours and the structures was difficult or we were unsure of our descriptions at the start. But once we had a one-on-one discussion with one of the 'experts' it was easier. Generally the information we gained was extremely useful to our operation".
R18: "No. I think an excellent learning environment was created through expertise that was provided and group interaction and we wouldn't change it".
R24: "This was a common sense approach that I believe most farmers could relate to".
R37: "I thought the geographic spread of farms was an important feature of our group. Important to see a range of different soils as helps appreciate strengths/weaknesses of own soils."
R47: "My interest in SUBS was more intellectual curiosity rather than driving for better management or income. So my interest may not be the same as others. I would be interested in more background on geological history."

Question 35: What farmers traditionally know about their land resource has traditionally been gained through familiarity & experience. SUBS is a way of shortcutting these experiences?
R 1: "It is not the way farmers traditionally look at their land. Eg. It is either a wet or dry paddock – not how or why that occurs"

Question 36: SUBS is a way of clarifying & recording what farmers already know about their farms' soils?
R 1: "I don't think that farmers are aware of soils – grass & crops grow on it!"

Question 41: SUBS helped farmers identify production and business opportunities?
R 1: "It could do, but more emphasis needs to be put onto this – particularly business opportunities" [may be referring to alternative land uses?]

Question 45: Were there any other benefits you could associate with SUBS?
R 1: "Access to agricultural scientists & field officers [was] a big advantage. How we will use these soils & where they are on the farm is a long term thing. It will take years in some cases to get some of the benefits of SUBS. I don't think it should be called a 'feel good' exercise for the organisers, however, the benefits are not an easy sell. Therefore I don't think farmers will pay much of an up front fee. The benefits come with doing the course. Two of us suggested the course to our farm discussion group. We'd been t the pasture workshops last year – nearly everyone is planting pasja & no one wanted to talk about their soils!!!!"
R 2: "Hopefully we will keep the information gained and use it if we ever expand the boundaries"
R 3: "Understanding of the geological history which I'd love to have learned more of"
Response 4: "Good farm map to keep"
R 6: "Networking with specialists & like-minded farmers"
R 7: "Yes. Introduced me to soil scientists and improved knowledge network availability"
R 8: "Quickly identifying potential land use when expanding *e.g.* requiring cattle wintering country so we would look for 'argillilic' type soils".
R 10: "Being able to know or have the knowledge to make more decisions without any guess work or hit and miss i.e. knowing hwo something behaves and why it does … enabling decisions to be informed"
R 13: "Meeting you Andrew" [errrk!!].
R 14: "Affirmed gut feelings of land capability. Gave confidence to make positive decisions".
R 15: "Met some hot new chicks. Met some hot new guys. Spied some hot & interesting new farm animals. Buggery, there's this feeling coming over me".
R 16: "Confidence to explore more valuable land use options"
R 17: "I learned a lot about the district's geology. Interacting with group members & tutors."
R18: "It can make a land purchase decision easier. It assists us to target our soil tests and soil applications".
R19: "SUBS gave you the skills to better understand how national, regional and local areas could vary and as such react differently to climatic events and seasons which has an influence on stock marketing and prices".
R27: "Better general knowledge about soils which can help with future farm purchases".
R30: "Finding out about local geology & landscape formation. The other information gained on many different matters through meeting other progressive farmers and professional people at the SUBS monthly meetings."
R32: "Identify land management units. Fertilise parts of the farm differently."
R33: "We were able to meet soil scientists and regional council agronomists [!] who have areas of expertise in many areas. This is absolutely invaluable".
R34: "I would feel some confidence that the programme would allow me to better identify potential advantages & disadvantages in land use on any future purchase or lease of land."
R37: "Meeting other similarly motivated farmers. Other advice from associated 'experts'! Increased ability to recognise SWOT & other 'new' farms [something] 1st time visit. Particularly beneficial with regard to future investment in land."
R45: "Contact with professionals."
R38: "The thing I got out of the programme, was to become more knowledgeable about an aspect of farming that I was probably relatively ignorant of the finer details."
R45: "Meeting a group of people with similar interests."
R47: "General background information on sand country in my case."
R49: "Looking at different soil structure across different properties."
R50: "More knowledge of soils when buying more land."

R51: See question 47: "*A way of learning more about the type of country we are farming. Better use of fertiliser for different parts of the farm. Visiting other farms to check them out.*"
R53: "Appreciate opportunities when getting more land that complements the existing farm."
R55: "In some ways the most valuable benefit of SUBS is to give me a 'big picture' of soils & geology. I was continually amazed at how variable the Taihape district was, and this is just a small part of the New Zealand. The big picture stuff enables me to walk onto a farm or into an area I know nothing about, & with a small amount of information (i.e. rainfall, altitude, aspect) decide whether a particular area will be a 'grass factory' or a 'millstone'. If any of us ever move we may not have the lifetime of experience in our new location.

Question 46: Were there any disadvantages you could associate with SUBS?
R 1: "no".
R 2: "It covered too wide an area – but I appreciate that not all people who indicated they would join did not and they missed out on a very useful project"
R 7: "Yes. It clashed at times (unavoidably) with other opportunities such as discussion group – also production focused and research field days"
R 10: "In our situation with bull farming we knew we were damaging our soils but worse than we thought as it turned out".
R 14: "No".
R 15: "SUBS chicks, guys & farm animals aren't very cooperative".
R22: "I think that the meetings being at least one month or more apart meant that some review was necessary as one tended to forget what was said. This was done at most meetings, trying to absorb all the knowledge of a soil scientist in a few outings is not really possible. Allan Palmer our scientist was very good in explaining things and very thorough in his approach; I thought his time was well worth while.
R30: "None".
R33: "Nil".
R39: "Took time."
R41: Somewhat cryptic response to this question: "teaching other farmers the value of soils that they did not know about!" [note: this farmer indicated he chose not to continue with SUBS because he believed he already had a sound understanding of his farm's soils – competitive advantage?].
R45: "Just finding the time."
R47: "Not really."
R49: "Tutors not available on the day of the meeting."
R50: "No."
R55: "The flexibility, and to some extent, the subjectivity of the 'individual's application of the SUBS process means that the success/failure of the SUBS system is totally dependent on the person apply the process. I feel some rules tightening up the mapping for instance would be good *e.g.* what slope units we used or whether we used them at all was entirely over to us. This is a strength and a weakness. If we had three slope units 0-15, 15-30, >30, we would have some guidance. I think some people who had not thought objectively about them in this way became a little lost in the process."

Question 47: What were your original reasons for becoming involved with SUBS?
R 1: "Mapping soil capabilities and alternative land uses"
R 2: "In being an older person with 2 younger sons running the farm, I felt that understanding the soil structure more would benefit all of us"
R 3: "Fascination with geology"
R 4: "See other sand country. Get expert input into mapping".
R 5: "Wasn't sure – just came along for a look".
R 6: "We were the first group developing from the soils subgroup on the local monitor farm group. So the reason to join the SUBS programme was more of an evolution than a conscious decision. It was more a case of following on interest t the next step".
R 7: "Invitation"
R 8: "To add some practical experience to soils papers I did at Massey. Also to meet some farmers in the area who I could learn from. To be able to differentiate areas of the farm for different management."
R 9: "I had read about SUBS in farming papers and thought it was a good idea. I got out of subs pretty much what I thought I would".
R 10: "To learn about or more about the soil on our farm to understand the way they worked. How other people farmed their soils that were like ours. We were invited to attend and it sounded like the sort of thing we were interested in".
R 11: "I wanted a greater understanding of the soils; the strengths & weaknesses, and management limitations. To know just what soil types we had. To be able to adjust management to enhance production through consideration of how different soils behave".
R 12: "I did it on the recommendation of Lachie Grant. I did it with an open mind hoping to learn a little from other operations".
R 13: "A better understanding of the Taihape soils and how that understanding 'could' benefit my EFS. By and large, I think that has been achieved".
R 14: "To gain a better understanding of the land capabilities".
R 15: "New practical information".
R 16: "Being able to detect soil degradation at an early stage with more intensive cropping and being able to limit potential damage [i.e. land stewardship reasons]. To increase production in a safe and sustainable way."
R 17: "I had a pretty good idea of the course/soil maps etc. from what I had seen in the monitor farms"

R18: "I became interested after being involved in the land resource group of the Poulton monitor farm when I saw what could be achieved by soil mapping a farm. I thought a soil map would be an awesome resource for my farm".
R19: "1. To identify soil properties and from that be able to do a SWOT analysis specific to various areas within the farm and the farm as a whole. 2. To better understand what makes & changes soil properties. 3. To acquire the technical skills and terminology to be able to relate to other people."
R20: "To learn more about soils. Its limitations and opportunities. Strengths & weaknesses."
R22: "To learn a little more about the different types of sands & their fertility".
R23: "Hopeful to become better informed."
R24: "I was asked by A. Mackay after being involved in the local monitor farm and was one of the members of the first group".
R25: "To gain a better knowledge of our soils and their best usage."
R26: "To learn more about soils."
R27: "Rather than join another monitor farm group which tend to focus on intensification – SUBS is coming from another direction".
R29: "To learn more about the soil on my own farm."
R30: "Interested in geology & finding out about different soil types was the original reason. Also the positive feedback from farmers taking part in the first SUBS group in our area".
R31: "How to grow more grass at less cost. How to have a sustainable farming system."
R32: "To map soil differences over the whole farm and to see what or how that should be managed differently."
R33: "Lived with [on the?] land all our lives without knowing much about the soil we rely on."
R34: "Interested in sustainable land management. Hoped to gain an insight into future potential of particular areas & confirm or disprove currently held ideas about different blocks on farm."
R36: "Asked to join. Had nothing to lose. Learn more about soil activities, etc."
R37: "Refresher on some of the material I'd covered at university".
R38: "I became involved with the SUBS group after being invited to attend by T. Rhodes."
R40: "I wished to obtain more knowledge in respect to our farm's soils."
R41: "Learn more about soil characteristics."
R43: "Refresh my knowledge of soils – helps at work. Help with management of important resource on the farm." [recent university graduate].
R44: "To gain an improved knowledge of the relationship between soil type and pastoral use/production and then to create land management units."
R45: "More [to get a greater] understanding of geology & soil chemistry [fertility?]."
R47: "General curiosity [see Q31]. Desire to know more about soils rather than commercial gain. Enjoyed visiting other properties and seeing soils, topography & environment." [this respondent has a PhD.].
R48: "To reaffirm livestock policy issues relating to different areas of the farm, and look at other opportunities thereupon."
R49: "To learn something new about the land & soil we farm on."
R50: "Wanted to learn more about soils as soil is our main resource."
R51: "A way of learning more about the type of country we are farming. Better use of fertiliser for different parts of the farm. Visiting other farms to check them out."
R52: "To gain a better knowledge of soil characteristics on my farm, with a view to increasing production and preventing [land] degradation."
R53: "An understanding of soils. Looking for opportunities on our farm."
R54: "The original reason was that it sounded like a good opportunity to learn more about my farm and what I may be able to do to increase production."
R55: "To understand the soils I farm. To get answers to its problems. To get solutions to its problems."
R56: "Soils underpinning business strategy – the title explains it all".
R57: "We are caretakers of the land for future generations and as such must be able to understand the environment we are looking after. I have a desire to make good money off my property but not at the expense of it becoming unsustainable. SUBS now gives me a balance between the two." [1. Improved understanding; 2. Balancing/reconciling sustainability objectives].

Question 49: How much money would you pay for involvement in a programme like SUBS?
R 5: "Should be sponsored by Council & fertiliser companies"
R 10: "the more we use the information the more benefit we get"
R 11: "Done properly & personalised… $2000".
R 14: Stated $1000 (plus or minus) – "but I was lucky" [suggesting it might be worth less to those who get less out of the programme].
R 15: "Bugger all"
R22: "I would only spend money on something like this if I was contemplating some development work".
R43: "I wouldn't have paid for it."
R48: States '$200' and: "What you are prepared to pay & what you hope to get are always as far apart as possible! When there is choice."

Question 50: At the end of SUBS you were supposed to indicate three tasks… How many have you implemented?
R 1: "its been too dry to implement them"
R 5: "Don't remember this"
R 6: "can't recall that bit"
R 7: "None yet. But they are planned."

R 9: "I don't recall these".
R 11: "Haven't had the opportunity to even hear about the 3 tasks".
R 15: "Programme not quite finished".
R43: "Didn't finish SUBS."
R48: "Don't remember this part of the programme."
R51: "Still planning on [the] three."
R55: "Can't remember what they were!!"

Question 51: Please describe how your farm management has changed as a result of being involved with SUBS?
R 1: "looking a after the 'better soils', & appreciate what I thought were poor soils are [actually] quite good"
R 2: "Making us all aware of the wetter soils so winter pugging is now taken on a new awareness. The real dry areas to be made to work when moisture is there" [avoiding pugging & maximising effort into productive areas at an appropriate time].
R 3: "It hasn't yet, except we are already not carrying cattle on steepland"
R 4: "We have farmed to soil types for a long time already, so [it] just underpinned current thinking"
R 5: "Confirmed conclusions that had already been reached. Have continued with planting, fencing, etc.".
R 6: "More of an appreciation of how animals on wet soils can affect future production. Have planted a lot of poplars since."
R 7: "Adjusted grazing practice as a result of better understanding of soil variety".
R 8: "1. Utilising riverbeds/terraces for growing winter crops *e.g.* kale to hold winter – brought cattle ready for spring. 2. Mole ploughing a lot more land (50ha/yr). 3. Running sheep on previously calf wintering land to reduce damage".
R 9: "I would keep big cattle off my steep country ... would not put any cattle on steeper country over winter. Discovered pumice on my [something] country so would now consider cropping it. My river flats are too wet over winter so wouldn't break feed them with cattle over this period. Have a different view grazing lambs over my easier (dusty) country after prolonged dry periods"
R 10: "We are currently trying to move out of bulls as we were farming them and not farming them in intensive small areas on ash soil types. Wintering heavy cattle on crops so that damage can be kept in one area and easily repaired".
R 12: "We have a 50-50 split with the good Egmont loams in the front and the sand & forestry to the rear. We have become more focussed on the sand and trying to increase production".
R 13: "As stated [previously], the management and understanding of the ash soils. The management of mudstone – keeping cattle off in wet seasons to stop pugging and structure damage. I now understand that sandstone soils/parent material is not just second rate stuff. More and larger use of my stony flats for cattle wintering.
R 14: "1. Identified land management areas. 2. Implemented capital fertiliser program on best land. 3. Concentrated on improving fencing [subdivision]. 4. Regrassing plan. 5. Increased steepland area to forestry."
R 15: "It hasn't but [it] did reinforce present management practices".
R 16: "Some fencing has been altered especially on our top free draining soils. Use of cover crop (mustard). Monitoring or organic matter. Fertility – exploring alternative fertilisers (bacterial activity). Land Management Units are now farmed individually while still complementing each other."
R17: "Conscious of the damage cattle can do and try to minimise".
R18: "I have changed my soil sample areas to suit soil types and further targeted fertiliser applications. I have changed my winter cattle rotations to suit soil types and capabilities. I have changed my tree planting plan (poles & pines) for the next few years according to the information gained".
R19: "1. Been more specific in designating different stock classes to different parts of the farm. 2. Establish more defined break points when stock can be on a particular area. 3. Integrating different parts of the farm to better compliment their strengths & weaknesses. 4. Being aware to fence to soil type, contour & aspect."
R20: "1. Undertaken a drainage programme. 2. Started fencing off streams & rivers. 3. Incorporated some winter lamb finishing on newly cultivated areas in the first winter after cultivation".
R22: "Developed 4ha swampland. Planting more pines."
R23: "Haven't".
R25: "Far more aware of the damage pugging does, so took steps to minimise damage. Planted a winter crop on Otaki soils for better drainage."
R26: "More aware of the need to stand cows off and which areas to use."
R29: "No change".
R30: "More aware of keeping heavy cattle off poorly drained soils during wet periods. Realised that one area of the farm had far greater potential than I had though and have put greater resources into developing that area (soil structure & drainage are not limiting factors in this area)."
R31: "Soil farm & shifted to a new area with a better climate & soil type that suits my farming goals".
R33: "More direct drilling. More fencing. Change in fertiliser policy. More use of nitrogen. Strategic use of phosphate. Drainage. Change in use of tress & types of trees."
R34: "Slight alteration in areas used for wintering heavier cattle".
R35: "Run less cattle through the winter."
R36: "More aware of pasture & structure 'soil'. Advantages & disadvantages."
R37: "Increased awareness of different blocks of the farm and how I might prioritise the spending of additional capital on them."
R39: "Allocation of stock classes to certain areas particular in winter. Lighter stocking in winter – buy in more stock for spring. Greater understanding of winter wet/summer dry with clay soils (watch stocking in the summer). Use of direct drilling on some country."

R40: "I now spread my dairy effluent on the well-drained 'better' soils rather than the poorly drained soils. We avoid feeding the areas of poorly drained soils unless they are as dry as possible to minimise pugging. We have built a much larger effluent pond for deferred effluent spreading during summer and have purchased a 'spitfire' irrigator."
R38: "Particularly in the area of effluent disposal management, the SUBS programme has made me far more aware fo the capabilities and limitations of the soils on my farm."
R41: "It has not."
R44: "Soil testing is now conducted differently with more emphasis on soil type."
R45: "Reduce cattle treading at critical times."
R47: "Very little, but [I am now] more observant of soil characteristics."
R48: "Not much. Some consideration of drainage but cost/benefit may not stack up."
R49: "Keeping heavy cattle off wet soils."
R50: "More aware of getting cattle off wetter country during a wet spell. Looking at doing more drainage."
R51: "Change hogget part of the farm to running single bulls at lambing – improve country for hoggets to enable higher bodyweight. Fertilise better country at a higher rate and use more special blends of fertiliser. Working at improving water supply on easy country."
R52: "Concentration of effort – fertiliser etc. on the better land [appropriate or selective intensification]. Awareness of the need for drainage and subdivision on other areas."
R53: "Can't run many more cattle so now concentrate on sheep. Looking at re-fencing to contour – i.e. fence off creeks. Winter lighter cattle on wetter soils. Looking at mole drainage.
R54: "Instead of treating my farm as one property, I am more inclined to farm my property as several farms to gain as much as I can from the better contour/soils."
R55: "I am looking seriously at 'non-grass' grazing/browsing systems on my erodible steepland on sites where plantation forestry is not an option. Further intensification (i.e. drainage, liming, fertiliser, reticulated water on the 'good areas'. Retirement or land use changes on fragile zones. More fencing of wet vs. dry areas, steep vs flat, etc."
R56: "Using the penetrometer, we monitor wet areas and graze accordingly. Many of the points raised in SUBS we were already managing – but SUBS made us more aware of the damage done to soils and pasture if not monitored carefully enough – leaching, pugging, etc."
R57: "Our high cattle ratio has been changed from 30% sheep 70% cattle to a 50/50 ratio. The steep hils (sidlings) will now only be sheeped. I will now not cultivate pumice flats, but just Roundup and direct frill SR Rye. We will also look at 'forage willow' but may find work load too great to be able to harvest them. Planting 100 more poles for shade & wet areas. Already cut poles and ready to plant. Now have a LMU map which helps with possibilities of increasing Kg production out the gate of different classes of land."

Question 54: Did you further refine your LMU map?
R 15: "my what" [Dannevirke dairy farmer].
R 18: "I have plans to do so".
R25: "Haven't got our maps."
R48: "Never got a digital copy."

Question 55: Have you applied your skills in another context?
R 9: No check box response but states "I would".

Question 56: Please explain how you applied your SUBS skills in another situation or context?
R 3: "Looked carefully at two soil [something, maybe 'structures'], and other land I lease and may purchase".
R 4: "when looking at purchasing land"
R 5: "When viewing lease lands, etc."
R 6: "Purchased another farm"
R 8: "Have been looking at land throughout the North Island from sand country to south Wairarapa to Hawkes Bay. Great sandy country! Have since settled on argillite".
R 9: Indicated that he would in the future "in the case of purchasing more land".
R 10: "we used the skills and knowledge learned to look at another farm, and had the confidence in the potential of the soil to offer a price that was more than acceptable to the vendor. When other purchasers only saw that it had rank grass [rather than seeing] that it could grow huge amounts of grass"
R 13: "Got Lachie Grant in to look at a small farm that was for sale. We went through the principles of SUBS and identified the good soils and poor soils. [It] was amazing that peoples opinion of the farm was that it was a dry farm with shit soils – quite the reverse since investigating it. Miss out [on purchasing the block of land] because the money was too hot... but a good exercise all the same.
R 14: "Soils on another farm"
R 16: "Exploring lease land and also land purchase."
R 17: "Always noting parent material when on other farms & often check a soil sample. Have looked at a farm with the idea of purchase & took careful note of the soils".
R18: "I have recently purchased extra land (neighbour) and was able to compare my LMUs with parts of this farm".
R19: " 1. In assessing alternative policies. 2. When going on another farm to get a fast handle on that farm's SWOT potentials. 3. I belong to the 'land resource group' of the local monitor farm. I am much better able to communicate with scientists and ordinary farmers."
R24: "I am chairman of the carrot monitor farm LEP group".
R27: "Assessing the soils of a farm we were looking at to purchase".

R29: Answered in the negative for Q55 but stated: "but would should the need arise".
R30: "Examined soils on a potential farm purchase."
R31: "Land purchase. Consultation with fertiliser representative."
R33: "Was able to objectively investigate new farm opportunities before purchasing."
R34: "Whilst I have answered no to several questions pertaining to the application of our SUBS programme knowledge, this is mainly due to the recent finish of our group> I would certainly envisage using that knowledge in the future." [Answer to Q63.].
R35: "Involvement with tree fodder group."
R37: "Particularly with regard to land purchase/lease – used more as a basis for establishing what levels of production may be feasible given the various blocks of land. – Slightly more formal in analysis than previously [i.e. applied skills more formally when it became important.]."
R39: "Looking at farms to purchase. Management on certain areas."
R40: "I examined the soils for a possible land purchase."
R41: "Understanding clay based soils" [comment from a sand country farmer].
R44: "Have since moved to another property and used soil sampling techniques [soil description & mapping?] in ascertaining suitability of new block for current venture."
R48: "Positive decision to purchase a property, with the knowledge of the soil properties. Some sandy silt loams which don't pug and some limestone country with great soil structure and natural fertility."
R50: "Looking at soils when purchasing land."
R53: "Consider soil characteristics when on farm discussion group visits. Leased a new farm with complementary soils."
R54: "The SUBS dealt with one of our properties and I will be applying what I learned to the others."
R55: "Driving along the road and looking at road cuttings. On holiday in Queensland the changes in soil with changes in aspect & area are dramatic. Thinking about the potential productivity of sites around NZ that perhaps should never have been farmed and are quickly reverted or already have. Big picture environmental issues i.e. nitrate leaching into lakes in the volcanic plateau."
R56: "We farm 4 other farms – 3 dairy & one drystock – we now monitor all similarly to the main dairy unit."

Question 57: Have you independently engaged a service provider...?
The prior question 55 says skip to Q58 – some people missed filling in question 57.
R39: States that he was already involved with service providers.

Question 58: Have you ever used...to explain to a service provider?
R 14: States 'yes' and then states "often".
R54: "I will though."

*Question **61**: Are you interested in follow programmes that build on SUBS?*
R 18: "If an interesting topic was found".

Question 62: If you were interested in follow on programmes, what topics would be of interest?
R 1: "Pasture species. Alternative crops (*e.g.* South Island land use programmes). Water – storage & reticulation. Trees – stabilisation/amenity."
R 2: "Farming a great range of soil types. Looking at what grasses & clovers could or would suit different areas. Ways to stop sand erosion."
R 4: "Highest net return per soil type, assuming all development, P levels etc are done" [optimising scenarios to identify absolute potentials].
R 8: "Wider area land use – say linking with some other SUBS groups or even spending some time on other county's soil issues & opportunities. Land sustainability."
R 10: "There ahs been a meeting to discuss this. After 5hrs discussion the general agreement was that no one specific topic could be gone into as there is no one 'magic bullet'. Available future topics were animal health tied in with fertiliser, genetics and management".
R 13: "Have been involved with the Wanganui farmers group studying fertiliser usage. Would like to understand the nutrients in the soil better as have been bombarded with [by] mineral selling agents".
R 14: "Better grasses. Refining fertiliser use."
R 15: "Refer to Q.31".
R 16: "Identifying land use options".
R 17: "Fertiliser & soils."
R19: "1. Soil property modification: drainage; cropping techniques; earthworms; plant varieties; etc. 2. Tree planting: matching varieties to specific areas and/or intended purposes. 3. Establishing a paper trail to show that we are following an environmentally friendly and sustainable system for quality i.e. to help with marketing.
R25: "Best and alternative usage for different soils".
R27: "Sustainable farming."
R30: "Appropriate fertiliser and trace-mineral use for maximum sustainable production on various soil types".
R31: "Soil quality. Land use. Open planting vs. pasture. Erosion."
R32: "How soils perform under different management systems and fertiliser regimes."
R34: "Particular pasture/pasture-management or stock types suited to particular soils." [a bit like maize climatic zones for NZ?].

R37: "Geology. Fertiliser. Pasture species to gain more production. Basically I regard SUBS as successfully reinforcing some of the 'stuff' I already knew in one aspect of farming and would be interested in similar programmes covering any other technical area of farming."
R40: "More information on soil water/irrigation/nutrient balancing and monitoring."
R41: "What grows on different soils."
R45: "Planting programmes [erosion]. Plant materials [species]."
R47: "More on plant/soil interactions."
R49: "Fertiliser."
R51: "Fertiliser requirements for different areas of the farm. Gross [???] seed recommendation. Animal health issues."
R54: "Fine tuning what we started."
R55: "We really do need a logical & objective approach to matching soil on the one hand, and land use on the other. There is too much to put in this space so I will include my thoughts on some pages with this report. What I have in mind is a vegetation calculator/selector. Perhaps a little similar to the plant selector of the green project [???] done 3 yrs ago by Landcare?"
R57: "LMUs."

Question 63: Do you have Any other comments or suggestions you'd like to make about SUBS?
R 1: "I thought it was a good programme. I learnt a lot & found other gaps in my agricultural knowledge. It led on to a fertiliser programme that was good in parts".
R 2: "We found SUBS interesting because it looked at farms over a wide area of the Manawatu, and gave some different views on what land could be used for".
R 8: "It has been extremely valuable. Question 49 is how much we would pay, the next question is how much we have benefited & will we estimate we could benefit. In this case it would be about 15,000 on the home farm, & because SUBS helped make the decision to buy another block which can earn many thousands through complementary land use. The programme is very enjoyable."
R 10: "We found this programme extremely useful and interesting and gave us confidence in hat we were doing and with a few minor changes to management we were achieving our goal to work with the environment sustainably and profitably. We have recommended this programme to several other farmers who are on a list for the next group".
R 13: "Not really. The soil structure section is very important so that needs to be fully understood by everybody before moving on to the next topic – maybe a little test?"
R 15: "A good course. Well worth it."
R 18: "Awesome concept".
R19: "If we were paying then I would definitely like to see my suggestions in 3.31 (this questionnaire) implemented [suggests higher standards are required if it was going to be a paid service]".
R22: "I did learn a lot about the different types of sand and their possible uses. I found it very interesting the different ages of the sand and how they change with age. I think it was very well run and I did enjoy it."
R30: "I really enjoyed the SUBS programme".
R31: "My farm was used for the field day. More input from the rest of the group would have been beneficial; perhaps another ½ day visit from the whole group".
R34: "Whilst I have answered no to several questions pertaining to the application of our SUBS programme knowledge, this is mainly due to the recent finish of our group> I would certainly envisage using that knowledge in the future."
R37: "Once again I'd say that the participation of the farmers involved and the outside 'experts' was pivotal to its enjoyment of the programme. I think this was the 2nd programme run in this area and as such tended to attract more motived than average farmers. At some point 'saturation' will occur."
R39: "Very worthwhile project".
R40: "I am grateful that I was able to participate in the Dairy SUBS programme."
R51: "Usually a good day out. Met some very interesting people."
R53: "We are using our SUBS stuff now plus making new soil & LMU maps for the new lease block as part of the monitor farm program which is at our place now. Its good to have that background knowledge, and it has sped up the process of explaining the resource."
R55: "Subs is the discovery tool. We definitely need the application part to be improved and especially the information to choose 'different options from the status quo. In many cases it is all ready out there but not in a form that is digestible to farmers *e.g.* forestry costs & returns are generally not expressed in soil/ha equivalents per year. We need tools either academic or real that allow us to assess the moisture in soil & its effect on production.
R56: "Very good programme – disappointing turn-out from other farmers on our programme. Dairy farmers are probably better able to turn out ot SUBS meetings during the months of January to July."

APPENDIX VII

1.17 PRINTABLE VERSIONS OF RESOURCES DESCRIBED IN CHAPTER 8

How to insert a page break

1. Insert a 'next page' type of break
2. Open footer for editing
3. On the toolbar, switch off 'same as previous'
4. done