THE NEW ZEALAND FEED GRAIN INDUSTRY:

PRODUCTION, MARKETING AND UTILIZATION

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ABSTRACT

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The New Zealand feed grain industry has expanded considerably over the last decade yet to date very little is known about the influence of both the economic and non-economic factors on grain production. Even less has been written about the marketing and utilization of these grains.

One objective of this study was to examine the functions and activities of the many participants in the feed grain industry. A secondary objective was to develop a model of feed grain supply for maize and barley crops which would reveal the reactions of producers to the changing economic and non-economic variables that were prevalent in the marketplace when actual production decisions were made.

From a grain producer's point of view many decisions have to be made. Initially the producer has to decide on one or several production alternatives in which to invest his limited resources. "Will I produce maize this year or will I buy more breeding stock?" is a typical decision that has to be made. There are several non-economic factors influencing production decisions at the farm level such as:

(1) constraints imposed by nature (delayed seeding, etc),

(2) cultural constraints (crop rotations, etc.),

(3) fixed factors involved in agricultural production,

(4) institutional constraints (price for wheat set by the New Zealand Wheat Board),

(5) uncertainty and imperfect knowledge (prices, etc.).

All of the above factors influence production decisions at the farm level.

The New Zealand feed grain industry is made up of many participants starting initially with the producer and his grain merchant. Grain merchants are involved in many activities such as:

(1) the establishment of annual feed grain prices,

(2) the management of the grain contracting system,

(3) the marketing of agricultural inputs and other services to the primary producer,

(4) marketing of feed grains to both the domestic and export markets.

The majority of the feed grains produced in New Zealand are produced under contract to a grain merchant. Approximately 95% of the maize and 80% of the barley acreage is contracted each year at specified prices subject to certain grading standards. In New Zealand there is no "formal" marketplace (such as a commodity exchange) for the establishment of feed grain prices. Prices are negotiated by the producer and his grain merchant on an individual basis with generally the same price quoted for each producer. As acres are contracted and it seems that production will not be sufficient for the expected demand, then a higher contract price is offered which hopefully generates the necessary production that is needed. All contract prices are equalized within a region by the individual grain merchant. Competitive grain merchants set their own prices but again prices tend to equalize within a region. Price differentials between regions generally account for the differing transportation costs of moving the grain from producer to end user.

Another participant in the grain industry is the grain broker. The grain broker brings buyers and sellers together. For example, somebody has grain they want to sell while another needs grain. The grain broker contacts both and without the buyer knowing who the seller is, the sale is negotiated at a mutually agreeable price. Prices fluctuate depending upon supply and demand and the position of the grain (i.e. is it readily deliverable? transportation costs, etc?") The grain broker handles grain sales between merchants and also between merchants and feed manufacturers.

New Zealand grain has primarily two end sources - the domestic or the export market. The domestic market is divided into grain for stock feeding, industrial uses and for human consumption. A major participant at this stage is the feed manufacturer. He performs several important functions in the grain sector:

(1) participates in the establishment of prices,
(2) makes the necessary transport arrangements to move the grain from free-on-rail or ex-silo positions,
(3) manufactures and retails feed grains in bulk and bag form,
(4) provides technical and economic services for end users.

An attempt to quantify some of the relationships within the feed industry was carried out in the form of a supply response model. A simple linear regression model was used. A generalized model took the following form:

$$Q_t^* = a_o + a_i \frac{p_t^g}{p_t^c} - a_2\, p_t^L + a_3 Z_t + a_4 T + a_t$$

where Q_t^* = acreage of grain in period t

p_t^g = price of grain in period t

p_t^c = price of the major competitive grain in the specific region in period t

P^L_t = price of major livestock alternatives in the specific region in period t

Z_t = non-economic factors in period t

T = linear trend variable

e_t = error term

a_o, a_1, a_2, a_3, a_4 = regression coefficients to be estimated.

The analysis was divided into two parts, the North Island and the South Island regions. Each region was estimated for the major feed grains produced. Barley on the South Island and both barley and maize on the North Island. For example in the South Island barley analysis, the model explained 86% of the variations in production with all variables statistically significant at the 1% level. This particular model estimated that for a 10% increase in the price of wool, the area sown to barley would decrease by 5.4%. Similarily, a 10% increase in the barley to wheat price ratio would result in a 25% increase in the area sown to barley.

For maize, one of the estimated equations explained 87% of the variation in maize acreage. The elasticity at the mean was estimated and for a 10% increase in the maize price, the acreage of maize increased by 15%. This was based on 15 years of data.

Several grain marketing alternatives were discussed. These included grain cooperatives, feed grain marketing boards and also making better use of the services of the grain broker. All have merits and of course certain limitations but as the feed grain industry expands there will be increasing pressure for changes within the New Zealand feed grain industry.

This study hopefully has shed some light onto the functions and activities of the major participants in the New Zealand feed grain trade. This is just a starting point. More accurate grain statistics are necessary before any extensive research can be conducted. Hopefully this is an area where government and industry can come together.

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

1.1 INTRODUCTION

Very little is known about the influence of both the economic and non-economic factors on New Zealand maize and barley production. Even less has been written about the marketing and utilization of these grains. Over the last two decades there has been an increasing interest in the cropping sector as an economical alternative to New Zealand's traditional meat, wool, and dairy enterprises. As these cropping activities increased over time, particularly on the North Island, there was a marked expansion of feed grain utilization in the domestic feed industry and the development of an export outlet for feed grains.

The primary aim of this study is to develop a model of feed grain supply which will reveal the reactions of individual producers to the economic and non-economic variables that are prevalent when production decisions are actually implemented. By being able to develop and empirically estimate structural relationships for each feed grain it will be possible to describe at an aggregate and regional level these aspects of feed grain production in New Zealand. These estimated supply structures will then enable assessment of the acreage-price response relationship for the aggregate supply of each feed grain in each cropping season and also will permit the evaluation of the impact of grain policies upon feed grain production and ultimately on feed grain consumption and export. Obviously prices are not the sole determinant of feed grain quantities produced so the proposed model will also take into account how non-economic factors constrain the optimum adjustment of planted acreage. This study will limit itself to only considering two of New Zealand's primary feed grains, that is, maize and barley.

The construction of supply models for maize and barley have the following objectives:

1) to establish the relationship between the acreage harvested and the prices for these grains,

2) to test the hypothesis that the North Island supply of barley is more elastic than the South Island supply,

3) to test the hypothesis that there are lags in acreage adjustment.

The secondary aim of this study is to provide a comprehensive description of the New Zealand feed grain marketing system as it now exists in the domestic and export markets. This will involve an analysis of the functions and activities of the major participants in the marketing process and a description of the utilization of the various feed grains.

1.2 Thesis Guide

This thesis consists of seven chapters. The introductory chapter provides an outline of the objectives for the study and a brief history of the New Zealand cropping sector. The second chapter examines basic production theory and a review of the literature. Chapter 3 highlights some of the factors which influence the decision-making process in the New Zealand grain industry. Chapter 4 offers a description of the functions and activities of the two major participants in the feed grain trade, the grain merchant and the grain broker. Chapter 5 discusses feed grain utilization and the role of the feed manufacturer in the grain trade. Chapter 6 considers the basic feed grain supply models, their statistical properties, and the results from the analysis. The thesis concludes with a summary of the paper and suggestions for possible grain marketing alternatives for the New Zealand grain industry as it exists today.

1.3 Historical Summary of the New Zealand Cropping Sector

The purpose of this section is to outline the historical importance of grain production in New Zealand.

Towards the end of the 19th century the area sown to grain crops was approximately 300,000 hectares. Grain production at that time was a major source of export income for the New Zealand economy. Much of the area was devoted to wheat and oats production with relatively small areas of barley. At this time refrigeration began to appear in the shipping services which opened up entirely new prospects for meat and dairy production in the "colony". Similarly, agricultural research and other technological advances such as better pasture species and the greater use of clovers, enabled higher stocking rates and hence greater production of livestock. This "livestock era" which is typical of New Zealand agriculture today, resulted in significantly reduced grain areas over the first half of the 20th century. In fact, by 1956 the total cropping area of wheat, oats, barley, and maize had decreased to approximately 68,000 hectares. This was during a period of stable prices for meat and wool products when farmers had little interest in grain production.

During the early 1960's, further agricultural research by plant breeders at the Department of Scientific and Industrial Research began to produce higher yielding, stiff-strawed grain varieties. Similarly, a continuous improvement in grassland management over this period allowed farmers to increase their stock-carrying capacity to such an extent that farmers were able to reduce the area of grassland needed to maintain a given number of stock. During the late 1960's, wool and meat prices slumped which encouraged farmers to consider cropping as an economically viable alternative to traditional livestock production patterns. In conjunction with this slump in meat and wool prices, the changing patterns of farm management, specialization and amalgamation of farmlands helped to expand areas of crop production. Better disease and pest control, superior seed varieties due to the seed certification programs, and the introduction of bulk harvesting and handling methods all provided the environment for a strong recovery in cropping.

The geographical production of New Zealand grains (excluding oats, which is traditionally a South Island crop) has remained relatively static on a North Island - South Island basis. Wheat is primarily a South Island crop. Maize production is concentrated on the North Island, while barley is grown extensively on both Islands. Table I indicates the production patterns of grains over the last 15 years on a % distribution between North and South Islands.

Over the period of this analysis, 1954-1955 to 1975-1976, the overall trend in the cropping sector has been one of expanding acreages of all grain crops. Table II illustrates the fluctuating levels of grain production in New Zealand. Total hectares of the major threshed grain crops (wheat, barley, maize, oats) expanded from 73,000 ha. in 1954-55 to an estimated 250,000 ha. in 1975-76. This is an increase of 340% in production over 21 seasons. Individual grains have shown

TABLE I GRAIN PRODUCTION IN NEW ZEALAND: PERCENTAGE DISTRIBUTION BETWEEN NORTH AND SOUTH ISLAND

GRAIN	1960-61	1970-71	1974-75*	1975-76*
Wheat: N.I.	7%	6.6%	4.3%	5.6%
S.I.	93%	93.4%	95.7%	94.4%
Maize: N.I.	100%	96.8%	99.0%	98.6%
S.I.	-	3.2%	1.0%	1.4%
Barley: N.I.	17.4%	29.7%	24.4%	25%
S.I.	82.6%	70.3%	75.6%	75%

SOURCE: New Zealand Department of Statistics, 1962-74.
* Ministry of Agriculture & Fisheries estimates.

CROP SEASON	WHEAT	BARLEY	MAIZE	OATS	TOTAL AREA
1954-55	42084	16865	1276	12612	72837
1955-56	27713	19909	-	17065	-
1956-57	26666	24191	2220	22864	75881
1957-58	33968	26662	2568	12133	75331
1958-59	53789	21700	2676	13764	91929
1959-60	66029	25292	3374	13567	108262
1960-61	75592	26545	2655	17589	122381
1961-62	75890	31208	2972	14036	123606
1962-63	91359	35383	3196	8449	138387
1963-64	82542	38033	3904	10754	135233
1964-65	74451	35223	3919	15691	129284
1965-66	80747	33987	3265	15663	133662
1966-67	93307	37221	4062	9311	142901
1967-68	126653	62778	5873	13955	209259
1968-69	129978	63538	7138	15906	216560
1969-70	108396	56081	8089	21008	193574
1970-71	97528	81378	11982	22141	213029
1971-72	106596	96263	14806	16374	234038
1972-73	107690	73750	12859	15079	209377
1973-74*	72700	81250	17500	18400	189850
1974-75*	59399	118565	24755	21873	224592
1975-76*	107707	96000	32253	13452	249412

Source: New Zealand Year Book, various issues, 1956-74.

*Ministry of Agriculture and Fisheries estimates

TABLE II THRESHED AREAS OF MAJOR GRAINS IN NEW ZEALAND (HECTARES) varying degrees of expansion. Barley area has expanded by 720% while wheat production has increased from very low production levels in the 1956-57 season. Since 1954-55 the wheat area has increased by 250%, yet importation of wheat is still required in most years due to poor yields and grades. The area planted to maize was relatively static up to the 1966-67 season. At that time most production occurred in the Gisborne area. Since 1967-68 maize production has expanded considerably, particularly in the South Auckland and Bay of Plenty area which at present produces approximately 70% of New Zealand's maize. Since 1954-55 maize production in New Zealand has expanded by 2666%. Oats production has fluctuated over the period of this analysis within a range of from 8,000 ha. to 22,000 ha.

Grain production, in terms of its contribution to total gross farming income[1] occupies a relatively minor role in New Zealand's agricultural industry. In fact the cropping sector's contribution to gross farming income has continued to provide a relatively static proportion to total farm income. As a percentage of total gross farming income, the cropping sector's contribution has fluctuated from 5% to 9%. Cropping and dairy production have shown a steady increase in gross farming income while beef, wool, mutton, and lamb have tended to fluctuate considerably.

Over the period of this analysis there have been changes in New Zealand's output of agricultural products with several farming enterprises showing considerable growth in gross farm income. Relative to New Zealand's traditional production of mutton and lamb, wool and dairy products, such agricultural activities as beef, poultry production, and cropping have expanded significantly. It is within this context of diversified agricultural activities that this present analysis on the feed grain sector is undertaken.

1.4 Background Information on Barley and Maize Production in New Zealand.

1.4.1 Barley

This study specifically focuses on an analysis of the New Zealand

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1. Gross farming income is the value of the gross output of farming at the farmgate before any deductions are made for the expenses of farm operation.

feed grain sector where such crops as barley and maize are planted in the spring while wheat is planted in either the autumn or the spring. For wheat, this study considers only that proportion of the annual crop which is utilized as a feed ingredient. The sowing of barley generally occurs through the months of October-November on the North Island and sometimes earlier on the South Island. The harvest of this crop occurs over a six-week period through January and February. In wet years, particularly in the North Island, some of the barley crop must be dried artificially.

Barley has been grown throughout New Zealand for many years with the majority of the crop being produced in the South Island. Since World War II controls have restricted imports of barley to quantities necessary to meet shortages only. During and for some years after World War II a maximum price was fixed by the government for barley with premiums for lines of specified qualities. Grading standards were set initially by the Department of Agriculture acting on the recommendations of the Barley Advisory Committee. When price controls were abolished, the merchant sector took over the function of price establishment for barley. At present the malting company announces its price for barley through the grain merchant's contract growing system. Grading standards are now set by the New Zealand Grain Merchant's Association.

Both two-row and six-row barley varieties are grown in New Zealand yet two-row barley varieties constitute virtually all of the barley crop. This is partly because of the influence of the malting requirements for specific barley qualities which have a low nitrogen content and even germinating properties. Also, two-row barley generally outyields the six-row barley varieties. Table III indicates the varieties produced in the 1971-72 crop year. All varieties mentioned in the table are two-row varieties.

In recent years, particularly since the 1967-68 season, the barley acreage in the Wellington and Hawkes Bay provinces has increased substantially. This grain has been directed primarily for poultry and livestock feeding purposes in the North Island. South Island barley is used primarily for malting purposes and stock feeding. Substantial

TABLE III BARLEY VARIETIES FOR THE 1971-72 CROP YEAR

BARLEY VARIETIES	% OF TOTAL CROP
Carlsberg	21.2%
Kenia	9.3%
Research	8.5%
Zepher	60.4%
Other	.6%
	100.0%

Source: Department of Statistics, Agriculture, 1972 quantities of export barley also originated from the South Island ports. Figure 1 depicts major feed grain acreage in New Zealand over the duration of this analysis (1955-75).

1.4.2 Maize

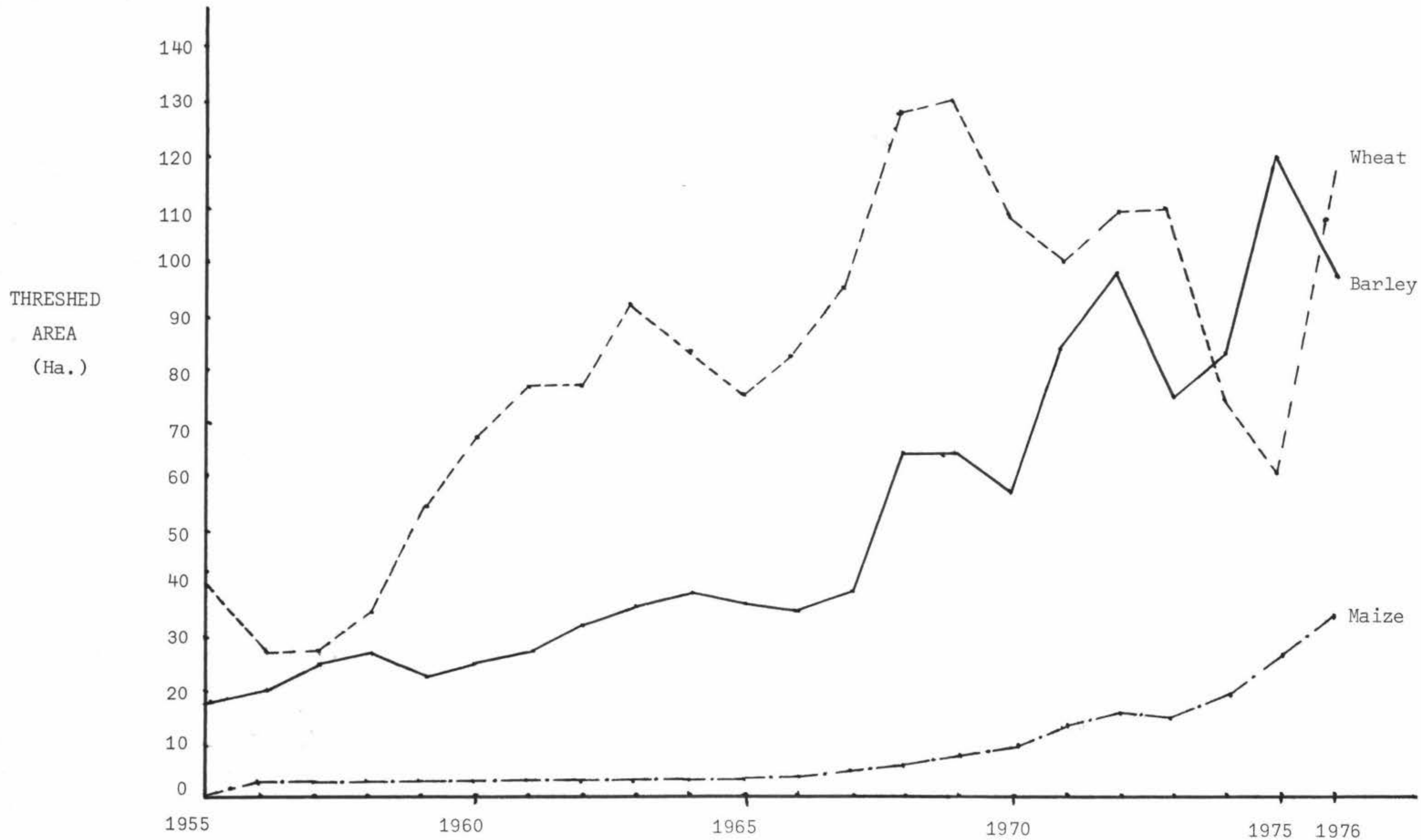
Maize production in New Zealand occurs primarily on the North Island. Maize has been grown in New Zealand for over 75 years, initially in the Gisborne area. Since 1967-68 maize production has expanded dramatically from 6,000 ha. to 32,000 ha. Most of this increase in production has occurred in the South-Auckland and Bay of Plenty provinces which are closer to the major domestic feed markets in Auckland, Tauranga, New Plymouth, and Hamilton. Table IV indicates how maize production on the North Island has expanded on a regional basis.

Table IV NEW ZEALAND REGIONAL MAIZE PRODUCTION: % OF TOTAL CROP

AREA	1961	1966	1971	1974	1975*	1976*
North & South Auckland-Bay of Plenty	21%	9%	43%	62%	65%	69%
East Coast	75%	81%	41%	25%	20%	18%
Hawkes Bay	4%	10%	13%	7%	9%	7%
Taranaki-Wellington	-	-	3%	6%	6%	6%
	100%	100%	100%	100%	100%	100%

Source: Department of Statistics, Agriculture, 1962-74.
*Ministry of Agriculture and Fisheries estimates.

Maize is usually planted in November through early December. Harvest begins in April and concludes in July with the greatest volume of grain reaching the market in June. From harvest all grain must be dried artificially or placed in cribs for natural drying. The merchant sector forward sells approximately 95% of the crop to end users both domestically and on the export market. Maize production is small but it is providing a greater contribution to the total grain area. Production and utilization of maize is concentrated in the North Island.



Source: New Zealand Yearbook, various issues, 1960-1976.

FIGURE 1: Total Area Threshed Grain in New Zealand

CHAPTER II

REVIEW OF THE LITERATURE

2.1 Introduction

A prerequisite for attempting any work on supply analysis is an understanding of the basic principles of production theory and an appreciation for the relevant studies which have been conducted in recent years. Since this study is of a semi-quantitative nature, it is also necessary to choose an appropriate analytical technique which best solves the problems to be researched. This chapter will consider the following aspects: 1) basic production theory, and 2) review of the literature.

2.2 Basic Production Theory

Heady *et al.* (14) state that, "... the production function is the foundation of supply." In *Agricultural Supply Functions*, Heady illustrates the relationship between the Cobb-Douglas production function[1] and the static short-run and long-run supply functions. This section relates the fundamental principles of production theory to the static short-run supply of a commodity. Knowledge of the static supply function is the first step toward understanding the total supply relationship.

It is assumed that a farmer or entrepreneur has a goal of profit maximization under conditions of perfect competition. Under these conditions a special case of a two factor, single product firm will be presented. This analysis is further simplified by considering only the short-run period of production which is "... a period of time sufficiently short to prevent the firm (or farm) from varying the quantities of some of its factor inputs." (24, page 97). Fixed factors of production such as land, buildings, and machinery are ignored in order to simplify the analysis.

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1. Cobb-Douglas production function:

$$p = bL^{k} C^{1-k} U$$

where p = index of total production per year
L = index of labor inputs
C = index of capital inputs
U = error term

The three relevant functions in this analysis are the production function, the cost function, and the profit equation under conditions of perfect competition. The production function is a physical relationship which relates the flow of output, Y, to the flow of inputs, X.

$$Y = f(X)$$

In a two product case, the concept of isoquants relates a constant production of output, Y, to various combinations of two inputs, say X_a and X_b.

$$\text{Output} = Y = f(X_a, X_b) \tag{1}$$

Naylor and Vernon [24] discuss the various properties of isoquants in Chapter 3 of their text (page 97). In Figure 2, Z_1 , Z_2, and Z_3 represent three different levels of output of Y. The slope of a tangent to a point on an isoquant, say Z_2, is the rate at which X_b must be substituted for X_a in such a manner as to maintain a constant level of output. The negative of this slope is the rate of technical substitution (RTS) which is the ratio of the marginal products [2] of X_b and X_a at the tangency point. Thus the slope is equal to:

$$RTS = - \frac{dX_a}{dX_b} = - \frac{MP_b}{MP_a} \tag{2}$$

A firm's variable cost of production is given by the linear equation:

$$C = P_a X_a + P_b X_b$$

where C is the cost of production and (3)

P_a and P_b are the respective prices for X_a and X_b

Input prices can be incorporated into the graphical analysis by introducing isocost lines. Each isocost line shows different combinations of resources that the firm can purchase for a given outlay,

2. The marginal product is the change in output for a unit change in the variable factor of production.

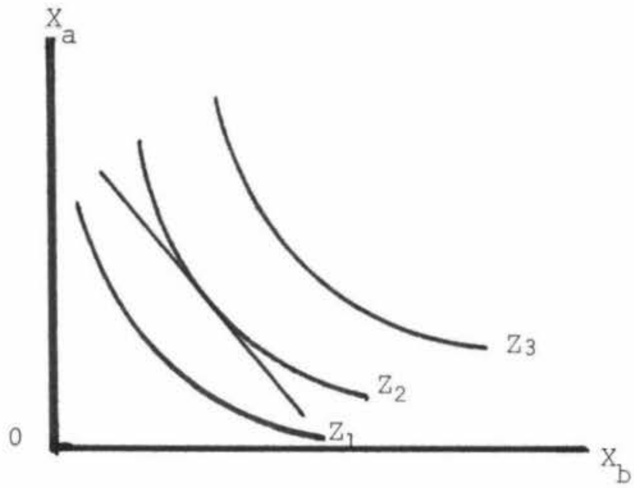

FIGURE 2 Isoquants

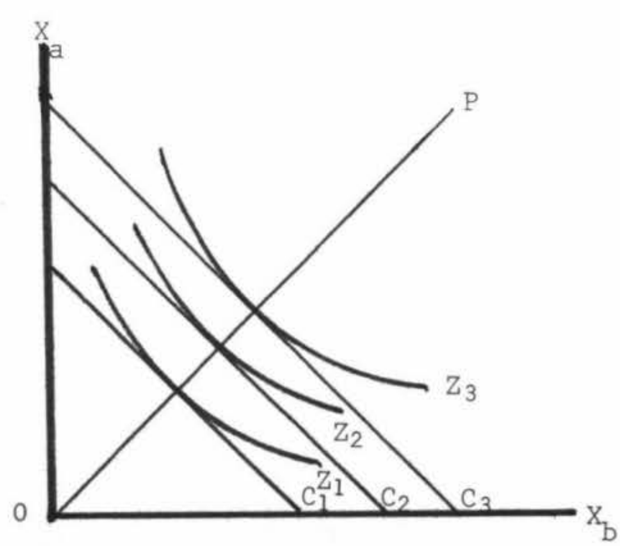

FIGURE 3 Isoquants and Isocost Curves

assuming that prices for the factor inputs are constant. In Figure 3 the isocost lines C_1, C_2, and C_3 each represent the locus of input combinations of X_a and X_b which result in a constant total cost. For example, every combination of inputs X_a and X_b which lies on C_2 are multiplied by their respective prices to yield a total cost of C_2. In Figure 3, the least cost combination of resources which will produce a given output Y are at the point of tangency between isocost and isoquant lines. At this point the slopes are equal and therefore:

$$RTS = -\frac{dX_a}{dX_b} = \frac{P_b}{P_a} = \frac{MP_b}{MP_a} \tag{4}$$

However, it can be shown that at this point of tangency, $\frac{MP_b}{MP_a} = \frac{X_a}{X_b}$.

Hence,

$$\frac{X_a}{X_b} = \frac{P_b}{P_a} \tag{5}$$

The locus of tangency points in Figure 3 gives the expansion path OP. The rational entrepreneur will select only input combinations which lie on his expansion path. From (5) it can be seen that in the short-run the expansion path is given by the linear equation:

$$P_aX_a - P_bX_b = 0 \tag{6}$$

Solving this expansion path for X_a:

$$X_a = f(P_a, P_b, X_b) \tag{7}$$

Substitute (7) into the total cost function (3) to obtain:

$$\text{Cost} = C = f(P_a, P_b, X_b) \tag{8}$$

Substitute (7) into the production function (1) to obtain:

$$\text{Output} = Y = f(P_a, P_b, X_b) \tag{9}$$

Re-arranging equation (9):

$$X_b = f(P_a, P_b, Y) \tag{10}$$

Substitute (10) into equation (8) to obtain cost as a function of output:

$$C = f(P_a, P_b, Y) \tag{11}$$

The derivative of total cost with respect to output gives the marginal cost function (MC):

$$\frac{dC}{dY} = MC = f(P_a, P_b, Y) \tag{12}$$

Under conditions of perfect competition the entrepreneur produces at the output where his marginal cost is equal to the price of the product ($MC = P_y$). Therefore equation (12) can also be written:

$$MC = P_y = f(P_a, P_b, Y) \tag{13}$$

Re-arranging equation (13) to give:

$$\text{Output} = Y = f(P_y, P_a, P_b) \tag{14}$$

The output (Y) is determined by the prices of the two factor inputs P_a and P_b and the price of the product itself (P_y).

Continuing with the assumptions of perfect competition and profit maximization, we can write:

$$\text{maximize profit} = \Pi = P_y Y - P_a X_a + P_b X_b$$

Since total revenue (TR) is the price of the product (P_y) times the output (Y), and total cost (TC) is equal to the price of the input (P_a or P_b) times the amount of the input used (X_a or X_b) then similarily we have:

$$\text{maximize } \Pi = TR - TC$$

Maximum profits occur when:

$$\frac{d\Pi}{dY} = \frac{dTR}{dY} - \frac{dTC}{dY} = 0$$

Since $\frac{dTR}{dy}$ = MR and $\frac{dTC}{dy}$ = MC then similarily:

$$\frac{d\Pi}{dY} = MR - MC = 0 \text{ or when } MR = MC$$

A graphical presentation of the above analysis is depicted in Figure 4. Profit is maximized at output level Z_o when the slopes of the total revenue (TR) and the total cost (TC) lines are equal (i.e. MR = MC) and when the vertical distance between the total revenue (TR) and total cost (TC) is at a maximum. The marginal cost (MC) curve and the marginal revenue (MR) curve are equal at output level Zo. For the perfectly competitive firm, production will occur where the market price for the product is equal to its marginal cost (P = MC). Under the assumption of perfect competition the demand for a product is perfectly elastic and can be depicted for example by P_1 in Figure 5. This horizontal line is the demand curve for the product. All producers face the same demand for their product and the same price. Thus P_1 = Demand curve = MR. If the firm produces at the point where its MC = P then the positively sloping portion of the firm's short-run marginal cost curve represents the competitive firm's short-run supply function. The marginal cost curve shows the amount of output the firm will be willing to supply at various prices. At different prices, say P_1 to P_2 in Figure 5, output changes from Z_1 to Z_2. At P_2 the firm is just breaking even and if the price falls below the average variable cost (AVC) the firm's profit would be greater if it produces no output at all than if it produced a positive output.

The above simplified analysis provides a starting point from which to examine the supply of agricultural products. Further expansion to this analysis will have to take into account the highly competitive nature of the agricultural industry and the many other non-economic factors which greatly influence the amount of a product produced. Alternative production possibilities will be introduced into the analysis in the form of product prices for competitive products. This will be presented in Chapter 6 where several feed grain supply models will be discussed.

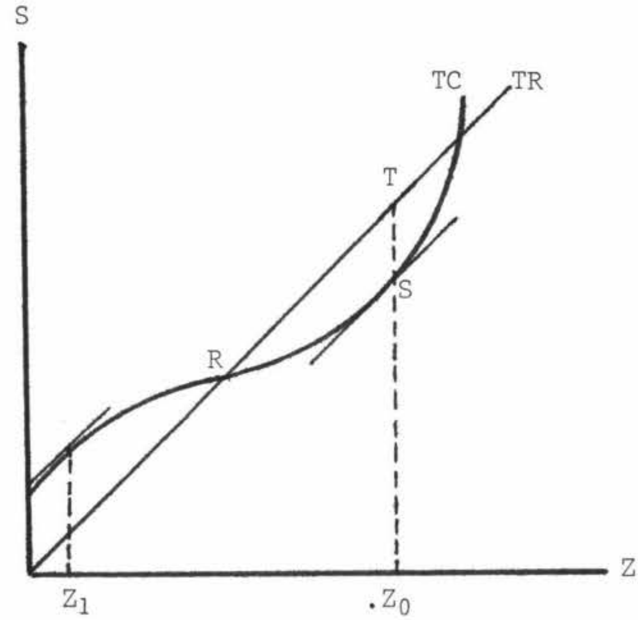

FIGURE 4: Profit maximization for the perfectly competitive firm

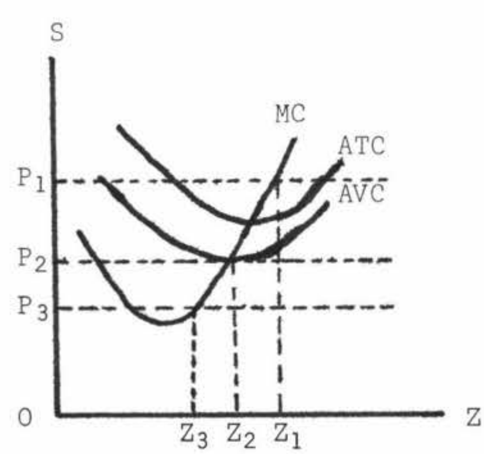

FIGURE 5: Short-run equilibrium for the perfectly competitive firm

2.3 Review of the Literature

Cowling and Gardner (9) classify the various analytical models for estimating agricultural supply relations according to the following characteristics:

1) unit of observation,
2) source of data,
3) period involved,
4) the nature of the model.

The unit of observation refers to whether or not the analysis is at the market, firm, or technical unit level. The source of data distinguishes between either primary data (experimental or survey) or secondary data. The period of analysis defines whether the study is an historical time-series analysis or a cross-sectional study. Finally, the nature of the model classifies these models into either a positive or normative approach. A positive model such as regression describes a model dealing only with matters of fact. A normative model such as a linear programming model deals with ideal situations in that the model is based upon the achievement of a norm or the acceptance of some assumption of the behavior of farmers such as maximum profits.

Nerlove and Bachman (27) suggest two further approaches for classifying the techniques available for supply analysis:

1) the statistical analysis of time series data,
2) the constructive method which involes the derivation of supply functions from basic data and relates this to production functions and individual behavioral relations.

Using both the above classification systems this literature review will examine the following:

1) New Zealand and overseas studies, involving statistical time series analysis.
2) The constructive methods of estimating supply, including linear programming, budgeting, spatial equilibrium analysis, recursive programming, and non-linear approaches.
3) Descriptive studies on feed grain production and marketing.

2.3.1 Econometric Studies of Agricultural Supply

Regression procedures have been by far the most popular methods used in estimating supply relationships. These models are of a positive nature, generally using time-series, secondary data, with most of their application occuring at the market level. Of the studies reviewed, the works of Guise (12), Candler (4), Duloy and Watson (10), Anderson (1), Traill (33), and Colman (8), used single equation, least-square regression procedures to estimate supply relationships. Other time-series work by Houck (19), used a simultaneous equation system to study the United States soybean market.

Regression methods could similarly be applied to cross-sectional data from inter-farm or inter-area surveys to interpret supply response. This cross-sectional data is generally used to estimate the supply structure based on farm firms or technical units. Cross-sectional studies are used to interpret potential responses at a point in time, in contrast to time series analysis which is based on observed changes in responses over several periods. The use of cross-sectional data generally occurs in either two forms; production function studies or in linear programming models.

We turn now to a more detailed analysis of the earlier studies on the grain industry. Candler (4) attempted to develop an econometric model of wheat cropping in New Zealand. He used the acreage harvested each year as the dependent variable. Ten independent variables were considered. These were the price of wheat, fat lambs, wool, oats, barley, white clover seed, rye grass seed, the acreage of red clover, rainfall (number of rainy days in April), and the area of wheat planted in the previous season. Candler considered the use of relative values for independent price variables in his model but chose to specify equations in which the price variables were incorporated into the model at their absolute value. The period of analysis was from 1924-1953.

Candler found that fat lamb prices lagged one year, acreage in red clover lagged one year, and the lagged dependent variable, wheat acreage, as the most significant factors which determined actual wheat acreage in any season. All hypothesized signs were obtained indicating a plausible inverse relationship between wheat acreage and fat lamb prices and red clover acreage (a competitive alternative for land use). A positive co-efficient for wheat acreage lagged by one year was an indication of capital investment continuing into subsequent years from initial investment. This also might represent the general attitude of farmers that once the land has been brought into crop production it should continue to be cropped for several years.

Approximately ten years after Candler's initial work on wheat acreage response models, Guise (12) attempted to explain not only the wheat acreage-price relationship but also the effect of weather on aggregate crop yields. He specified two structurally different time periods for separate estimation: 1917-1941 and 1945-1964. Both Candler and Guise came to the same general conclusions that ... "the earlier period (1917-1941) is unsuitable for econometric analysis because the market structure changed too frequently". (12, p.29)

Guise hypothesized that farmers, as economic maximizers, react independently to the economic conditions of the day. Thus in formulating production plans farmers ... "will be guided by the relative gross margins per acre which the technologically feasible enterprises are expected to yield and will adjust the size of each enterprise in the new season at least partly toward what would represent its long-term equilibrium size if those relative returns were to hold into the indefinate future". (12, p. 16). Guise utilizes gross output per acre data for the explanatory variables in his model. The reason for specifying the data in a gross output rather than a gross margin form was because ..."it was considered impractical, if not impossible, to attempt to obtain data on specific costs related to each enterprise throughout these time periods". (12, p.22). The values of the variables for gross output per acre of crop were calculated by multiplying New Zealand average crop yields by the price available in that season.

Guise criticizes Candler's decision to use absolute price values rather than relative values in the model on the grounds that, ... "this (using absolute values) conflicts with the theoretical requirement that a supply function should be homogeneous of degree zero in prices in a region where all agricultural land is already being farmed and technology is assumed to be constant". (12, p.6). Guise specified his wheat acreage model using area of wheat threshed as the dependent variable, while the independent variables were introduced into the basic model as expected gross output ratios. These gross output ratios all specify gross output per acre of wheat as the numerator. The explanatory variables, incorporated as denominators to the gross output ratios, were as follows: fat lamb price, other crop alternatives such as oats, barley, rye grass, peas and white clover, and gross output per acre when two-tooth ewe replacements were purchased. Actual wheat acreage threshed in the previous year (t-1) and in the year before that (t-2) were also incorporated into the model. Guise assumed that his model was of a linear form making it suitable for estimating the long-run supply for wheat. One of his estimated equations is presented as follows:

$$A_t = -34.691 + 51.63\ X_{1t} + .380A_{t-1} \qquad R^2 = .904$$

$$d = 1.66$$

A_t = acreage of wheat threshed in period t.
X_{1t} = ratio of the wheat price to fat lamb price in period t.
A_{t-1} = acreage of wheat threshed in previous season.

All added variables in Guise's analysis gave regression coefficients with the correct sign on a priori grounds yet only the regression coefficients of the gross output relatives for wheat/rye grass seed and wheat/red clover seed were significant at the 5% level on a one-tailed test.

Guise stated that since in New Zealand all milling wheat is sold at prices established each year by the New Zealand Wheat Board, "... there is little price uncertainty for wheat in this country. Although returns from sheep depend upon export prices, farmers' expectations about future returns tend to adjust very rapidly to the current level of returns." (12, p.32) Guise continues... "such factors as farmers' prejudice, lack of experience with wheat, and satisfactory, if not optimal returns from other enterprises have tended to delay the adjustment of wheat acreage to the optimum long-run level even when suitable equipment for growing wheat was available." (12, p.32). These observations on the behaviour of New Zealand wheat farmers will be helpful in formulating an appropriate acreage response model for the feed grain sector. In some other countries, such as Canada, United States, and Australia, the different industry structures provide a much greater degree of price uncertainty in agricultural production. This has encouraged research into the development of price expectation models which interpret the farmer's responses to future prices. Nerlove (26) gives a concise account of his research in this area.

Duloy and Watson (10) have shown that estimates of supply response relationships can be made at a regional level. They specified equations for four regions in Australia using two different models for comparative purposes: a) a model using absolute but deflated price variables, and b) a distributed lag model using relative price variables. They found that the results obtained from models using absolute price levels were poor in comparison with the results from the distributed lag models incorporating relative price variables.

Duloy and Watson outlined several factors which should be appreciated before supply analysis is undertaken: "a) with a number of production possibilities supply may be expected to be considerably more elastic for products produced with few or no alternatives, b) it is necessary to take into account the production possibilities open to cereal producers in constructing models to estimate supply elasticities, c) because the set of competing products varies among regions it is apparent that gains in efficiency of estimation are obtainable by disaggregating rather than by attempting to estimate an aggregate function." (10, p.29). They also specified two criteria for establishing homogeneous regions for estimation by linear models: a) the regions must be uniform in their response to economic stimuli, b) the region must be unique with respect to their climatic variability.

Duloy and Watson used'acreage of wheat intended to be sown in the season' as their dependent variable. This was based on the assumption that, "farmers' statements of their (planting) intentions bears some constant relationship to what they actually do." (10, p.34). They claimed that intentions data are less subject to short-run climatic influences than are actual sowings. They also assumed that lags in resource adjustment were not present... "the usual barriers to rapid supply adjustment, the availability of suitable land and machinery, did not exist over the period of the study". (10, p. 35). Explanatory variables in the model included lagged wheat acreage and lagged wheat and wool prices. The price variables, particularly the wool prices, required some minor refinements to suit the regions that produced different grades of wool. Sixteen years of data were used to cover the period 1947-48 to 1962-63.

In a study of supply response in the Australian coarse grain industry, Traill (33) suggested that knowledge of the size of wheat quotas in any year could be used to predict the area actually sown to wheat. These acreage predictions could then be used in equations designed to forecast the plantings of coarse grains in the new season.

Simple analytical techniques were used to quantify some of the more important variables influencing the production decisions of coarse grain growers. Traill used area planted to each coarse grain rather than actual production (tonnes) as his dependent variable. Independent variables were generally taken into the equation as ratios of several different product prices. An equation representing total coarse grain production is as follows:

$$Acg_t = 4.968 - .176\, Aw_t + 2.123 \frac{Pcg}{Pw_{t-1}} + .417T \qquad R^2 = .752 \quad d = 1.739$$

where Acg_t = area coarse grains in t

Aw_t = area planted to wheat in t

Pcg_{t-1} = coarse grains in t-1

Pw_{t-1} = price wool in t-1

T = trend variable

Traill concluded that an increase in wheat area by 100 ha. would reduce barley acreage by 20 ha., oats 3 ha., sorgum 6 ha., and maize 0.4 ha. Furthermore his regression results indicated that coarse grain plantings are sensitive to the price of wool.

Anderson (1) attempted to improve on the estimational performance of single equation regression techniques. Using a distributed lag structure which incorporate both geometric and polynomial lag forms, he attempted to model the formulation of these lags for both price expectations and acreage adjustment in the Australian barley industry.

He obtained some success with the geometric lag model but received unsatisfactory results for the polynomial lags. The elasticity estimates obtained from his expectations (price) and adjustment (acreage) model indicates that barley acreage in Australia is quite responsive to the relative prices of barley to wheat, especially in the short-run. The estimated short-run price elasticity of the supply for barley is higher than for wheat, wool, and meat while the long-run elasticity estimate appears to be lower than the other major commodities.

One of his estimated equations from the expectations and adjustment model was:

$$Q_t = -213 + 7.718P_{t-1} + .9341Q_{t-1} - .04738Q_{t-2}$$

$$R^2 = .899$$

$$d = 1.68$$

where Q_t = acreage barley in period t

P_{t-1} = price barley in period t

Q_{t-1} = acreage barley lagged one year

Q_{t-2} = acreage barley lagged two years

Colman's study (8) followed a different approach. Colman estimated at the aggregate level a set of structural relations which explained the functions of the United Kingdom cereal market. The model incorporated a set of cereal supply and demand functions. The cereal supply set incorporated supply response equations for oats, barley, winter wheat, spring wheat, total cereal grain acreage response, and for mixed cereals.

On the demand side, estimates for feed demand, human and industrial demand, seed demand, and import demand were carried out. Also quarterly and annually livestock inventory models were specified in order to identify the factors which determine the numbers of each major class of livestock in the United Kingdom.

Previous feed-livestock models have required simultaneous estimation of equations. In Colman's model, because of the structure of the United Kingdom cereal sector, it was assumed that no price variables need be treated as endogenous.

Houck's (19) work with soybeans involved the specification of a simultaneous system estimated by two-stage least squares and three-stage least squares. Houck examined both soybean supply and demand. On the demand side he hypothesized equations for meal, oil, and whole bean demand for both the domestic and export markets. On the supply side, he estimated supply response equations for six soybean producing regions in the United States and aggregated these to national supply figures. Finally, he specified a market-clearing equation where the demand for soybeans was equated to the supply of soybeans. He introduced several dynamic properties by lagging variables in both the demand and supply equations.

2.3.2 Application of Mathematical Programming to Estimating Agricultural Supply

Mathematical programming models for estimating agricultural supply have been developed for two purposes: a) to estimate production potentials, and b) for the optimum allocation of planned output goals. Basically these models are of a normative nature and use cross-sectional data. The unit of observation could be either at the technical, firm, or market level. Initial models were of a linear form but recent models have been non-linear. One class of non-linear models defined the objective function as a quadratic while retaining linear constraints.

Agricultural economists initially used simple budgeting techniques to estimate supply responses for a commodity or commodity-mix. An improved plan was made up for each farm in a sample and the results were then aggregated to provide indications of regional response and supply functions.

As an extension of this early work, linear programming, with its assumptions about farmer's behaviour imbedded in the objective function, was applied to individual farms for projections of supply possibilities subject to specific constraints such as land, capital, and labor. Not only was this technique useful for planning at the individual farm level but it was also useful for predicting production response at the regional level. Formal optimization models for a region have been constructed to indicate desirable resource use within the region. Several examples of normative studies in agricultural supply will be briefly discussed below:

1) an example of an inter-regional trade model,
2) an application of recursive programming,
3) representative farm models.

In his thesis King (17) specifies a spatial equilibrium model incorporating M different supplying regions $(S_1, S_2, \ldots, S_M)$ and N different destinations $(D_1, D_2, \ldots, D_N)$. His objective was to determine the least cost pattern of production and distribution of grains in New Zealand in terms of a minimum loss of profit from sheep, beef cattle, and dairy farming. Using the technique of linear programming, production restraints and crop producing activities were defined for each region. Feed demand restraints consisting of fixed quantities of each final product were designated for each consuming region. Each producing region was completely contained in a consuming region and production in the particular producing region contributed to supply in that region. The production of feed grains was modelled under assumed cost maximization. Along with the least cost production function, a set of transport activities were incorporated into the model which permitted the movement of commodities to consuming regions with an excess demand. This resulted in an optimal plan specifying regions of least cost production of the commodity and regions to which commodity should be shipped. The model is detailed as follows:

$$\text{MINIMIZE:} \quad Z = \sum_{k=1}^{4} \sum_{i=1}^{8} Y^k_i C^k_i + \sum_{k=1}^{4} \sum_{i=1}^{8} \sum_{j=1}^{8} T^k_{ij} R^k_{ij}$$

where Z = total cost

k = 1,2,3, and 4 are the grain crops (wheat, oats, barley, maize),

i = 1,2,...8 are the production regions in New Zealand,

j = 1,2,...8 are the demand regions,

Y^k_i = production of the kth grain in the ith region,

C^k_i = production costs associated with the production of the kth grain in the ith region,

T^k_{ij} = quantity of the kth grain transported from the ith production region to the jth demand region,

R^k_{ij} = per unit cost of transporting the kth grain from the ith production region to the jth demand region.

King based his analysis on feed grain consumption figures obtained from a Ministry of Agriculture and Fisheries feed grain survey (1968-70). Regional feed grain consumption was analyzed for poultry, pig, sheep, dairy, and beef cattle. By minimizing both production and transport costs for all grains across all producing and consuming regions, the optimal solution from the model indicated a production and distribution advantage for the South Island, particularly Canterbury and Otago. Other policy issues were discussed such as transport subsidies, price premiums for grains and the regionalization of industries.

With recent expansion in the maize industry on the North Island and the subsequent increases in the transporting costs of grains, it is questionable whether these South Island production and distribution advantages still exist.

Recursive programming has been used to analize acreage response and to forecast crop acreages. The theory underlying recursive analysis is that current production decisions depend upon past prices, while current prices depend upon current production in a cobweb pattern. If prices and production prior to year t are known, then predictions can be made on probable production in year t and thus probable prices in year t.

Recursive programming is a synthesis of time series and linear programming techniques. A purely linear programming model differs from recursive programming because the latter "... is capable of predicting the actual behaviour of farm firms, whereas the former is normally designed to estimate an optimal behaviour". (29, p.2). Recursive programming employs the normal programming format by optimizing a linear objective function subject to linear constraints derived from time series data. These linear constraints represent the maximum and minimum bounds on the allowable year-to-year changes in the acreage of a crop from one year to the next. Flexibility constraints were calculated in Sahi and Craddock's (29) study by using upper and lower flexibility coefficients. The coefficients were estimated using multiple regression analysis on time series data over the period 1953-1967. The equation for the flexibility coefficients of a crop was hypothesized to depend upon: crop price, price of a major competitive crop, acreage in the previous year, end of year stocks of the crop, exports of the crop, amount of rainfall in the months of April and May, and a time trend to account for technological change.

The programming portion of the analysis was carried out over the period 1958-1967. In the programming model several limitations were specified for the two producing and four selling activities. These were: two physical resource constraints, an absolute maximum acreage for a region, and marketing quota restraints. The objective function was to maximize the total expected net income for all farmers in a region for the activities included in the model. The economic plan for each crop year was developed through a sequence of optimizing decisions using this programming framework.

Representative farm models have been developed to analyze the regional and also national supply responses for various commodities given changes in the prices for these commodities. These studies are purely normative in nature and merely state what may happen given the basic assumptions in the model. The procedure was to classify all the farms in a region into one of several farm-type groups and to designate a representative (typical) farm for each group. The Meat and Wool Boards' Economic Service has eight classifications for New Zealand sheep and beef farms. (Johnson, 21) Production restraints and activities were specified for each representative farm and an optimal production plan was estimated by linear programming. Next an optimal plan for the group was obtained by multiplying the optimal representative farm plan by the number of farms in the particular group. Finally, the regional totals were the sum of the group totals and the national model was the simple summation of the regional totals.

2.3.3 Review of Feed Grain Studies of a Descriptive Nature

The extensive report prepared by Shepherd (31) covers many aspects of supply and demand considerations in the New Zealand feed grain sector. This study used 1965 as its base period and projected feed requirements for poultry and pig industries to 1970, 1975 and 1980. Taking the pig sector for example, Shepherd began with basic New Zealand income and population projections and related these to projected per capita consumption of meats. He then projected pig meat demand and actual pig numbers which would meet consumers' needs. Finally, he equated pig numbers to pig feed demand and then to acreages of grain required to supply the total feed requirements based on the projection period. Projected feed requirements were scaled to either possible low, intermediate, or possible high feed grain consumption. Shepherd excluded feed exports because at the time of his study New Zealand grain exports consisted of only small sporadic shipments.

The above transformation of necessary feed requirements into feed units and then their allocation into individual feed grains such as wheat, barley, and maize was based on Shepherd's assumption that compound feeds would meet the entire requirements of all types of poultry and pig enterprises. However, in 1965 only 45% of total feeds were commercially prepared in the compound form. Because of this limitation, Shepherd's projections are somewhat lacking. Nevertheless, his work was the first major study on feed requirements in New Zealand. Shepherd suggested that several factors would affect the actual usage of New Zealand feedstuffs in the future: (1) the seasonal supply limitations of certain grains, (2) the long-run relative prices, (3) the nutrient content of feedstuffs, (4) nutrient requirements of various classes of livestock and poultry, and (5) changes in the structure of the pig and poultry industries. Since 1965 there have been many fundamental changes in the New Zealand feed industry. To cite a few, there has been a tremendous expansion in maize production, there has been a development of an export market for feed grains, also an expansion in the broiler-chicken industry and a switch from skim milk feeding of pigs to grain feeding. All these factors have added completely new dimensions to the New Zealand feed grain market since Shepherd's initial work on the subject.

Britton's (3) study of the United Kingdom grain market examined the total marketing system from producer to end user. This study centered around information gathered from an extensive questionnaire sent to all sectors of the grain industry. Analysis of the data involved examining the role of the merchant, storage and transportation, imports and exports, and many other aspects of grain marketing in the United Kingdom.

CHAPTER III

FACTORS AFFECTING DECISIONS TO PRODUCE GRAIN IN NEW ZEALAND

3.1 Introduction

This chapter outlines the major production alternatives in New Zealand agriculture and examines their relative profitabilities. Also included in this chapter is a discussion of the economic and non-economic factors which influence the production decisions made by New Zealand grain farmers. The purpose of this chapter is to gain an appreciation of the environment in which production decisions in the cropping sector are made and this will help in specifying a more appropriate model of feed grain supply.

3.2 Production Alternatives in New Zealand Agriculture

Various constraints such as soil type, climate, and topography tend to determine the feasible range of production alternatives open to New Zealand farmers. Within this feasible range of production choice, as defined by a particular farm location, various cropping and livestock production alternatives are available. Each alternative enterprise has a level of profitability associated with it. Farmers tend to choose from among these alternatives the enterprise or enterprises which maximize their profits. In recent years economic pressures on the New Zealand agricultural sector has greatly influenced the allocation of productive resources to such an extent that the traditional meat, wool, and dairy industries have experienced strong competition for resources from a number of diverse agricultural activities. Notable among these activities has been the expansion of cropping to meet the ever-increasing demand for feed grains. One of the major reasons which has encouraged farmers to switch resources from one enterprise to another has been the variations in the profitability associated with the various production alternatives. For example, gross farm income from meat and wool production in New Zealand has fluctuated extensively over the last two decades while the dairy industry has maintained a steady growth in income and has expanded and progressed considerably.

In order to specify appropriate supply models for maize and barley production, it is necessary that the researcher has an appreciation for the relative profitabilities associated with different production alternatives. It will be helpful to look at recent gross margins per hectare to interpret the situation. Gross margin analysis is a technique which has been developed to find the relative profitabilities of different enterprises. The gross margin per hectare for a production alternative such as barley can be interpreted as an indication of the profit which could be obtained by increasing the output of barley by one hectare in circumstances where it is not necessary to increase the stock of fixed assets. Colman (8p.21) states, "The comparison of gross margins indicates the change in returns which could be achieved by switching land from one use to another where this is technically feasible and where no additional capital is required." For any existing farm structure fixed costs such as interest on land, rates, buildings, and tractor overheads may be excluded from the enterprise decision process in gross margin analysis because these costs have to be met irrespective of whatever enterprise is chosen. Confronted with enterprise alternatives, farmers simply deduct from gross returns the variable costs associated with the production of the crop or livestock alternative. Gross margin analysis only considers economic factors (i.e. other than yields) such as product prices and costs of productive inputs. Non-economic factors such as the farmers crop rotation and his fixed factors of production (fences, special buildings) also directly influence the decision process but are not included in gross margin analysis.

Table V illustrates the relative profitabilities of the major production alternatives in New Zealand agriculture. Caution must be exercised in the use of this table as a means for comparing profitabilities because incorrect conclusions could be drawn. This table gives a general indication of the profitabilities of various agricultural activities in New Zealand and it will be helpful in formulating feed grain supply models.

The information for this table is taken from a gross margin report published by the Palmerston North office of the Ministry of Agriculture

TABLE V AVERAGE GROSS MARGINS FOR VARIOUS PRODUCTION ALTERNATIVES IN THE MANAWATU AND RANGITIKEI DISTRICTS 1975-76

Crops	Yields	$/ha
Mangolds	125 tonnes/ha	656.56
Potatoes	38 tonnes/ha	961.00
Maize	10 tonnes/ha	328.50
Ryegrass seed	900 kg/ha	78.00
Peas	3.3 tonnes/ha	310.00
Wheat	4.7 tonnes/ha	333.25
Barley	4 tonnes/ha	144.85
Lucerne hay	500 bales/ha	515.10
Livestock		
Dairy: Town Supply	6570 litres/ha	459.02
Factory Supply	286 kg milk fat/ha	309.15
Dairy Beef Bulls	5/ha	221.40
Prime Lamb	Buying in @ 20 ewes/ha	140.00
Store Lamb	Breeding 15 ewes/ha	126.70
Beef Breeding	2.5 cows/ha plus replacement	79.88
Prime Beef	5 weaners/ha	278.00

Source: Ministry of Agriculture and Fisheries, Palmerston North Regional Publication No. 23, 1975-76.

and Fisheries for the 1975-76 season. The prices, yields, and costs used in the analysis are for the Manawatu and Rangitikei districts only. They are not totally representative of the New Zealand situation as a whole, yet they identify those enterprises which are the principal competitors of grain crops. The table indicates that wheat gross margins/hectare of \$333.25/ha exceed barley gross margins/hectare of \$144.85/ha by a considerable amount (\$188.40). With production costs for wheat and barley being very similar, the question arises: "Why would farmers grow barley when wheat returns are so much higher?" Obviously product prices and other economic factors are not the sole determinants of quantities produced. Non-economic factors such as different soil types, varying disease susceptibilities of various grains, crop rotations, fixed factors of production and the present farming system on each individual farm, directly and indirectly influence a farmer's decision to produce a grain crop.

Other land use alternatives can similarly be compared using gross margin analysis but care should be taken to analyze these alternatives only within the sphere of an existing farm enterprise.

3.3 Non-economic Factors Influencing Production Decisions

There are many cultural, technical, and institutional factors other than product prices for individual grains which influence feed grain supply in New Zealand. If structural relationships for feed grain supply models are to be specified which permit quantitative measurement and identification of the factors that influence production then it is important that these limiting factors are appreciated. The non-economic factors which limit production of feed grains in any one season are many and varied. Some of these factors are within the individual farmer's control (e.g. crop rotations) while others are beyond the farmer's control (e.g. weather). Some of the more important factors influencing areas of the various grain crops grown in New Zealand are:

1) constraints imposed by nature,
2) cultural (e.g. rotational) constraints,
3) fixed factors involved in agricultural production,
4) institutional constraints,

5) uncertainty and imperfect knowledge.
These aspects will be discussed below.

3.3.1 Constraints Imposed by Nature

For any farm location nature is likely to constrain the set of feasible production alternatives which can be considered. The main natural features which impose limitations upon production are climate, soil type, relief, incidence of disease, and pests. The regional differences in these natural features obviously give rise to feasible crop alternatives, different crop rotations, and typical livestock production patterns. From the outset we must appreciate that these natural features have definite implications for supply analysis since regions with a greater number of production alternatives would be expected to have considerable more enterprise flexibility than regions with fewer alternatives. It is this reasoning which has encouraged modellers of agricultural supply functions to favor the building of disaggregated regional models rather than aggregated models in order to accurately model farmers' supply response behaviour.

The most obvious constraint imposed by nature on the acreages of grain crops in any one season would be the level of rainfall previous to and during the seeding period. It can be hypothesized that for each cropping season farmers formulate an overall production plan for total grain acreage on their farms. This total acreage is then allocated among the individual grains. In exceptionally wet seasons producers substitute one grain for another. Grain farmers are free to substitute among the various grains (wheat, oats, barley, peas and oil seeds) because the mechanical equipment (with some modification) can be used for all these grains. Maize production however requires slightly more specialized equipment. On the South Island wheat is planted in the autumn rather than the spring as winter wheat yields are generally higher and an autumn sown wheat crop can, if necessary, be utilized for grazing purposes during the winter months. With wet weather in the autumn, wheat plantings may be postponed until the following spring. However, if spring weather conditions (August-September) still limit planting, a farmer has the choice of foregoing wheat acreage in favour of another crop (usually barley). Barley is planted later than wheat and makes up for any short-fall in total grain acreage on the farm. Thus weather directly limits wheat acreage and thereby indirectly enhances the acreage sown to barley in any one cropping season.

Weather directly influences the rate of pasture growth and thus the length of the grazing season. This in turn influences the proportions of grains and forages used in supplementary feeding throughout drought periods and the winter months. The amounts of grain used during these months directly influences the production of those grain crops, especially barley and oats, which are diverted to feeding stock. In some seasons, particularly in the North Island, a spring feed shortage sometimes forces farmers to limit or possibly omit their spring wheat crops in favour of maintaining pasture for livestock.Taking wheat, for example, which is planted on the North Island generally during the month of September, in some seasons spring grass growth has not been sufficient to enable farmers to divert pasture lands from livestock production into cropping uses. In this situation farmers often forego wheat plantings in September for barley plantings in October. This is generally the choice because barley as a crop is easy to produce; similar machinery is required for the production of both barley and wheat, the timing of barley sowing fits in well with off-peak labour requirements (after lambing), and the rate of grass growth at this time has almost peaked. Furthermore, a barley crop presents a minimum of marketing problems for the farmer in comparison to his wheat crop. With a wheat crop, farmers are often required to store the grain while with barley the crop is generally sold at harvest to a grain merchant. All of these factors influence a farmer's planting decisions to a certain extent.

3.3.2 Cultural Constraints on Grain Production

It is hypothesized that the influence of crop rotations and other cultural practices limit a farmer's ability to adjust to his desired long-run acreage position. It should be noted at this point that it is very difficult to generalize about the various rotational patterns practiced by all New Zealand grain farmers. These different rotational patterns come about partially because of diverse climatic conditions and in turn, as a result of the development of different livestock and crop production alternatives between the North and South Islands. For example, maize production is concentrated on the North Island while wheat is grown predominantly on the South Island. To attempt to describe all the various rotational patterns within this section would be impossible. All that can be mentioned at this point is that farmers generally do follow rotational programs which could prevent full adjustment to optimum grain acreage in one season. Farmers are quite conscientious about following these rotational patterns which are usually based on long-term land development and pasture improvement programs. To maintain pastures at high levels of production, pasture renewal programs are carried out. To offset these pasture renewal costs, farmers often plant grain crops as a break-crop in the process of preparing land for subsequent pasture. Cash crops also provide a good source of income to the farm, particularly when good yields are achieved. On a commercial basis, maize yields in New Zealand are the highest in the world relative to other grain-producing countries[1] because a combination of better pasture strains, greater usage of clovers, and the control of grassland pests have developed excellent soil textures and high fertility levels.

Crop rotations vary depending on the unique requirements of each grain, the type of farming practiced, the characteristics of the soil, and the use of the land prior to the grain crop contemplated. Disease organisms build up in the soil over time when one grain or related grain crop is grown in successive seasons on the same block of land. A natural method of minimizing the effects of disease build-up in the soil is to rotate crops. Because of these cultural constraints, a grain farmer's production alternatives are further limited when he decides which crop to grow. Barley production has been culturally the least restrictive of the grain crops and this has been probably one of the major reasons for the expansion in barley acreage over the last two decades. Barley can follow practically any rotation and is

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1. "As of 1971-1973 there were 135 nations in which maize was produced in significant amounts. The highest national average yield in the world was 7.2 tonnes/ha. in New Zealand; in the United States it was about 5.8 tonnes/ha." S. Wortman, Scientific America, Volume 235, No. 3, page 37, September 1976.

generally sown towards the end of a rotational pattern. Wheat production on the other hand requires a more fertile soil type than barley and successive crops of wheat present serious disease problems. Claridge (7) discusses in detail various rotations and the soil requirements for the major cropping alternatives. From the above discussion on rotational patterns it can be hypothesized that the area of wheat in the previous year has some influence on barley acreage in the decision period. Justification for this is that a barley crop generally follows wheat production in the rotational system (see Claridge (7), pp. 111-112).

Another cultural constraint on feed grain production is that different grain crops occupy a particular block of land for different periods and lengths of time. Barley and wheat crops occupy an area of land for only a part of the year while maize production because of the time of planting (November-December), occupies the land for nearly a full year. Maize planting is restricted until soil temperatures reach a specific level. Harvesting occurs during May to July (wet season) when at this time little field work can be done to prepare the land for the next crop or new pasture. With wheat and barley production, harvest occurs through January and February leaving ample time to consider an alternative break crop or to plant new grass. Because land used for maize production is required for such a long period of time, farmers hesitate to commit land to maize production. The advantage to growing crops such as wheat and barley is that farmers can maintain their flexibility to produce other alternative crops.

3.3.3 The Influence of Fixed Factors on Agricultural Production

The opportunities for substituting one commodity for another are theoretically great on farms because the same resources (land, labour, and capital) can be used to produce any one of several products. However, in practice producers have only a few alternatives for short-run adjustment to price changes because of specialization and fixed investment. Coleman (8) states that, "Capital fixity in agriculture results in the inability of farmers to quickly adjust their output and input levels in response to price changes". (8, p.50). Farming is characterized by these lagged responses in the production of agricultural products as Guise (12) observed in his work with New Zealand farmers that "... the process of adjusting the sizes of individual enterprises may not be completed in one season since full adjustment could involve capital investment in buildings, machinery, or land, and farmers may lack the necessary finance to undertake this capital investment in the short-run. Full adjustment may also make some part of previous capital investment worthless..." (12, p.17). Thus,for this study on the New Zealand cropping sector, it is hypothesized that fixed factors involved in agricultural production limit a farmer's ability to respond to the economic stimuli (prices for products and inputs) observed in the market place.

Most farm investment funds are provided from farm profits with farm development occuring over a period of years. If there is to be a major change in farm structure in the short-run then farmers will have to obtain funds from financial institutions where interest rates are usually higher or not available compared to funds which have been generated from within the business. Thus short-run, immediated response to alternate production possibilities is limited because of these factors and changes in production usually occur over a period of years.

Edwards (11) states that there are benefits and costs of disposing of capital and to acquiring more of it. He continues, "...an asset may be considered as fixed if the cost incurred in changing the quantity used of a given asset is greater than the benefits derived therefrom". (11, p.749). There is even greater rigidity in changing or expanding enterprises since "... for small product price changes most assets subject to fixity will remain fixed at existing levels and one would expect an inelastic supply response. But for large price increases, it becomes profitable to enlarge the stock of certain assets and the supply curve will be elastic." (11, p.755). For most farmers the decision-making process is so tightly constrained that in the short-run only limited output response to relative changes of input and output prices are likely to occur.

An important characteristic about New Zealand farming systems should be noted at this time. In New Zealand very few farms are devoted solely to cropping. Basically it has been the different climatic conditions which have dictated whether a grain crop can be feasibly produced throughout the different agricultural regions. The New Zealand cropping sector can be broadly divided into two different climatic and marketing areas; the North Island and the South Island. Grain producers in the South Island have very different attitudes towards grain production compared to North Island growers. South Island grain producers are much more committed to grain production and continue to plant grain crops year after year. South Island grain farmers generally own the necessary farm machinery required for grain production and plant acreages on a far greater scale in comparison to their North Island counterparts. Rotational systems are different because of the different variety of crops grown on the South Island (i.e. wheat, barley, oats, rapeseed, linseed, and peas).

On the contrary, cropping to the North Island farmer involves limited capital investments in machinery. The existence of farm machinery contractors, who operate on a regional basis throughout the North Island, enable grain farmers to produce a grain crop with only limited capital involvement. This allows the farmer to move in and out of grain production as economic conditions in the agricultural sector fluctuate and as the non-economic factors (weather and rotation) change. Field sizes are small because farmers are reluctant to dismantle fence lines which are part of the major livestock enterprise. Grain production on the North Island is generally viewed merely as another source of cash income over and above the earnings received from a farmer's main enterprise (traditionally meat, wool, or dairy production). In short, North Island grain farmers are interested in limited capital involvement in the cropping sector and paramount is the earning of cash incomes with the least possible disruption to their main farm enterprise. Stock numbers cannot be adjusted in the short-run and changes generally occur over a period of years. Because of the structure of the North Island grain industry it is hypothesized that the supply of North Island feed grains has a more elastic response than has South Island supply. This hypothesis will be tested in a barley supply model in Chapter 6.

3.3.4 Institutional Influences Upon Grain Production

There are several institutional constraints which have an influence on the production of feed grains. The wheat price set each year by the government indirectly affects farmers' decisions to plant wheat or other grain crops such as barley and maize. A high wheat price encourages farmers to plant greater wheat acreages. Grain merchants must in turn adjust barley and maize prices relative to the wheat price so as to ensure that adequate areas of feed grains are planted.

The New Zealand Wheat Board also sets a price premium on North Island wheat in order to influence regional production decisions. Similarly, on a regional basis, the existence of major food processing companies influence to a certain extent the regional production of grains. These private companies set price levels for various process crops (beans, peas, tomatoes) and in order to encourage the production of necessary feed grains the merchant sector must also take into account the profitability of feed grains relative to these processed crops. This is one of the main reasons for the existence of different regional grain prices.

The establishment of various grading standards could also be termed as an institutional constraint. The existence of these grading standards indirectly influences the production of those crops susceptible to possible down-grading. Particular reference must be made to North Island wheat. Wet climatic conditions often cause wheat crops to sprout in the field and therefore not meet the required milling standards. Similarly, farmers are often asked to store their wheat crop for a period of time before delivery to millers and this involves extra work and added responsibilities which are not found in the marketing of barley and maize. Marketing problems such as these indirectly influence a farmer's decision to grow wheat in successive years.

3.3.5 Uncertainty and Imperfect Knowledge

Colman (8, p.20) states that "... the existence of uncertainty about future conditions causes farmers to adopt conservative strategies in changing their pattern of output". A major source of uncertainty in agricultural production is the lack of knowledge about future prices for products. This describes the grain production situation in such countries as Canada and Australia where prior to sowing crops farmers are only aware of the initial payments for the various grains. Finally payments are issued after all marketing expenses have been met. However, in New Zealand, the most unique characteristic about the grain trade is that the future prices for grains are generally known. The New Zealand Wheat Board announces the wheat price usually in March, several months before winter wheat planting commences. For barley and maize, the pricing situation is slightly different where regional prices at the farm level are decided upon through the activities of the grain merchants' contracting system.

Generally beginning in August, merchants and farmers sign legal contracts to grow specific qualities and quantities of grain.[2] Because of the structure of the New Zealand grain industry, it is assumed that there is little price uncertainty and decisions to grow various grain crops are based on quoted annual prices known before the sowing of the crop. On the other hand, there is price uncertainty associated with the other agricultural enterprises particularly in the meat and wool industries where prices tend to fluctuate considerably. A plausible reason for this lack of price stability and therefore source of uncertainty is the traditional involvement of these industries in the international market place. The grain industry, until recent years has primarily been domestically orientated. Price changes were minimal from year to year until recently when prices have doubled because of the grain industries involvement on the international grain market.

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2. See Chapter 4.

CHAPTER IV

FEED GRAIN MARKETING IN NEW ZEALAND

4.1 Introduction

The aim of this chapter is to provide a comprehensive description of the New Zealand feed grain marketing system. An evaluation of the functions and activities of the major participants involved in the marketing process will provide a better understanding of the industry. This insight is then used to examine both the present situation and the emerging trends in the New Zealand grain industry.

The approach used in gathering this information involved personal interviews with grain merchant executives, grain brokers, and personnel from the Ministry of Agriculture and Fisheries.

4.2 Role of the Grain Merchant Sector

In the previous chapter an examination of the grain producer and the factors which influence his decision-making process were undertaken. In this section, the intent is to focus on the activities and functions of the grain merchant sector. This sector is a vital part of the market, yet at the same time, that area of the total grain market of which the least is known.

The grain marketing process in New Zealand involves the total relationship between four major participants in the feed grain sector: the producer, the grain merchant, the feed manufacturer, and the end user. One of the characteristics of the New Zealand feed grain sector is the existence of a very close association between the farmer and his merchant on the one hand, and the merchant and feed manufacturer on the other. The grain merchants are situated in the middle and rely on both producers and feed manufacturers for their livelihood. As a middleman, the merchant exists under the constant threat that either of his customers will decide to by-pass him.

In analyzing the merchant sector, the following functions and activities will be discussed:

1) the establishment of prices,
2) the management of a grain contracting system,
3) the marketing of agricultural inputs and the provision of advisory services and other services to the primary producer,
4) the marketing of feed grains to the domestic market,
5) the marketing of feed grains to the export market.

4.2.1 Price Establishment

One of the most important functions performed by the merchant sector is the establishment of annual prices for barley and maize subject to pre-determined delivery requirements and specific grading standards. This initial price, which is payable directly to the farmers when the crop is delivered, is the basis on which the grain-contracting system is built. The grain-contracting system will be discussed in the next section.

At the farm gate there is no formal market place for establishing prices. By this is meant that there is no representation of the growers' interest in the negotiation of farm gate prices other than on an individual farmer to merchant basis. In New Zealand there is no commodity exchange or any service to publically communicate current grain prices to the growers. Merchants in general offer the farmer the minimum price which will encourage the production of the necessary domestic and export commitments for the season. Because of the structure of the market place where buyers (grain merchants) are few and sellers (grain producers) are many, a situation exists in which farmers participate merely as price takers. In some grain producing areas farmers have worked together through such farmer organizations as Federated Farmers with the objective in mind of forming a stronger bargaining position for the farmers. By working together, this group hoped to influence the merchants' decisions on farm gate prices. This strategy had limited success in the regions where it was attempted.

Even though a merchant has a strong bargaining position, he is aware that he is only one of several merchants. Furthermore, if the price at the farm gate is not attractive enough, then farmers have the option of simply not producing grain. Because of this, one of the most difficult and time consuming tasks performed by the merchant sector is the establishment of a price at the farm gate which will encourage the farmers to plant the necessary areas which will yield the required amount of feed grains for the new marketing year. Many factors must be considered in this process. General economic conditions in the country and particularly in the agricultural sector naturally influence a farmer's production plans. These conditions also influence the level of feed grains consumed and hence the price to be established. Within the agricultural sector the grain merchant must interpret how these conditions will influence the cropping sector relative to other competing production alternatives such as meat, wool, and dairy production.

Both farmers and merchants are in business for profit. The farmer produces a grain crop to earn a profit on his invested capital in land and machinery. He also expects a reasonable return on his labor input and the associated risks involved in producing a crop. The merchant, on the other hand, hopes to earn a profit for his advisory, managerial, and marketing skills. Also, the more grain a merchant handles, then the better he utilizes his fixed investments in grain handling equipment. Thus, the annual farm gate price established for a particular feed grain such as maize must be set at a profitable level relative to other cropping and livestock activities. If it is not, then the merchant's grain supplies will be insufficient to meet his needs.

When a crop like maize or barley is produced in a surplus situation for the export market as it has been in recent years then it is also important that the domestic price levels for these grains are set with some consideration to the international price levels. For example, if farmers see a high international maize price of say $125/tonne yet receive a price at the farm gate of $83/tonne, they then question the size of the marketing margin and wonder why they do not receive a portion of it. This reference to international grain prices adds another dimension to the price establishment process.

On the other hand, the price must also be set at an economic level to ensure that feed manufacturers will continue to buy, process, and sell similar or expanding quantities of grain to endusers. The feed

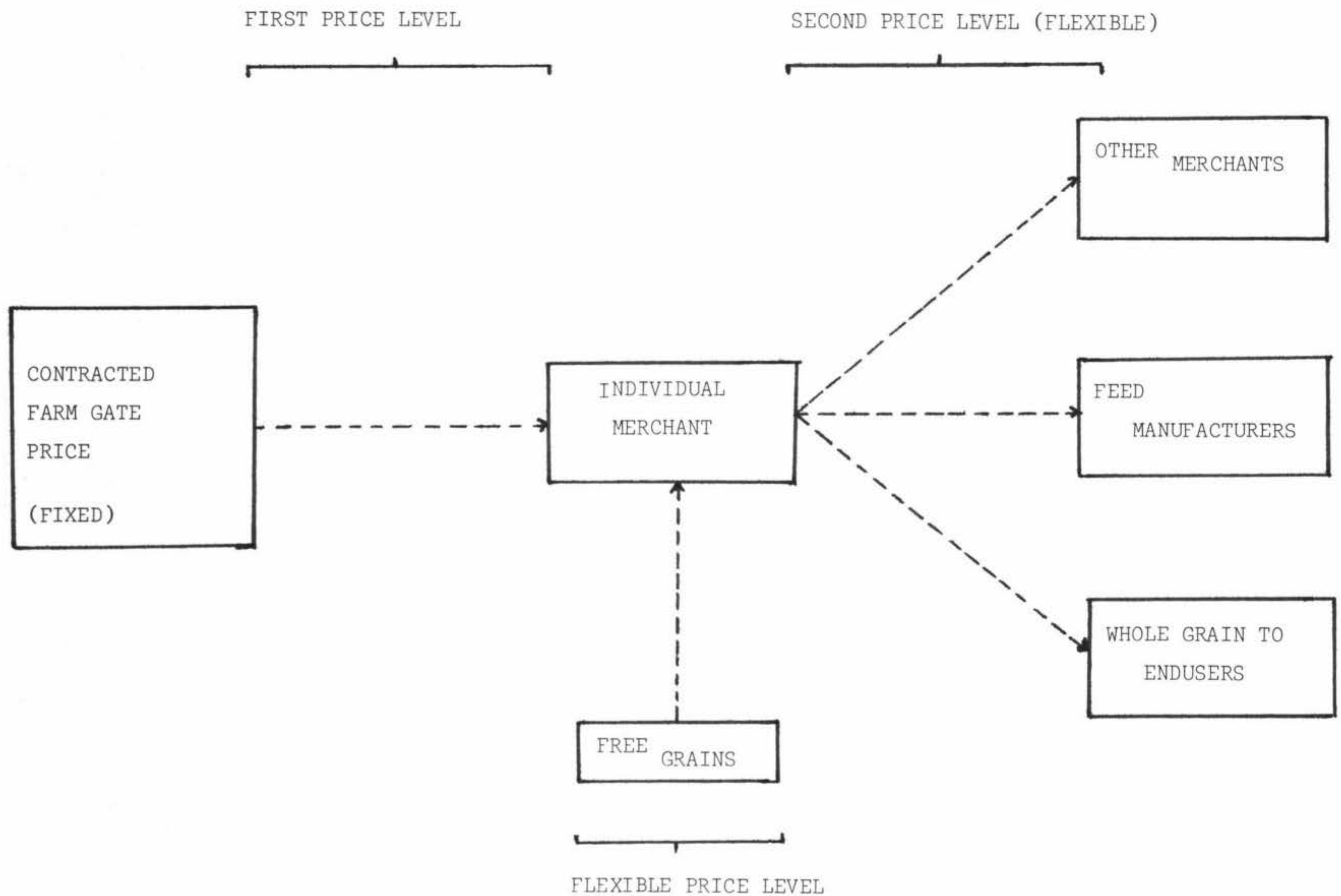

FIGURE 6: Flow of grain through the merchant sector.

manufacturer's pricing objective is for a minimum "free on rail" (F.O.R.) price. Diametrically opposed to this is the farmer's objective for a maximum farm gate price. The merchant attempts to strike a balance between these two interests.

There are several price levels actually established in the trade and Figure 6 attempts to illustrate these. The first price level is the farm gate (contract) price to the grower. This price is fixed before the crop is sown. The second price level is the price to the feed manufacturer, enduser, or other merchant. These prices are flexible in that they reflect storage and interest charges, and the changing supply and demand conditions.

The procedure of establishing the farm gate price has become a traditional function of the merchant sector. The planning of these pricing strategies begins well ahead of the actual sowing of the grain. Annual price decisions come about through a network of market information. Information on domestic and export demand and supply conditions are gathered through informal contacts with other merchants, through feed manufacturers and grain brokers, and from other interested parties. From this contact merchants gain a much wider picture of the current and expected supply and demand situation.

Both the merchant and feed manufacturer discuss their anticipated feed requirements for the new season. From previous experience, the merchants are aware of the local demand for feed within the region. They also assess the demand in the major consuming regions and for the export market. In turn, these demand projections are applied back to the regional areas to determine the acreage which is needed to meet these grain needs. Working within his regional area, a merchant discusses with other merchants various price levels which would provide the necessary incentive for farmers to grow crops. Both economic and non-economic limitations to production are subjectively assessed. Informal discussions are held with individual grain producers to attempt to interpret their response to various price levels.

This process of price establishment occurs over a period of several months, usually from June to August. Towards the later stages of the negotiations, the local merchants have informal meetings to discuss the market situation and eventually establish what the new price will be for the local market. At the same time merchants, especially those companies with national offices, continue to compare inter-regional price levels. Although independent merchants are free to set their local prices at any level they wish, it is generally the case that all merchants set the same price within a region (See Tables VI and VII). In some seasons the price established for contract grain is set too low prior to seeding and not enough area is under production. This forces the grain merchant to raise the farm gate price to encourage more local production to cover his forward grain commitments. In this situation, the merchant will attempt to maintain his position of goodwill in the farming community by re-contracting producers at the new price level. Generally intra-regional prices are similar while inter-regional prices maintain their relativity due to transport differentials to the major grain consuming areas (See Tables VI, VII). Sometimes inter-regional prices are set differently to reflect the unique regional supply and demand conditions. For instance the presence of malting companies, starch companies, and even food processing companies have a direct influence on production and pricing policy within a region.

The planning of these pricing strategies begins well ahead of actual sowing of the grain. It has been generally the practice that as much as 60% of the grain contracted by the merchants from farmers is forward sold in both the domestic and export trade. As the season progresses, merchants further assess their supply needs for the season and relate these commitments to the acreage that they have already contracted. By harvest, approximately 90% of the grain has been forward sold to grain consumers. This forward selling system helps to create stability and confidence within the industry.

The second price level to be established by the merchant sector is the price of grain to the feed manufacturer and other grain enduser (see Figure 6). This price includes a storage charge, the merchant's margin, and in some cases a transport charge depending on the arrangement with the buyer. This second price level is negotiated annually by the merchants and feed manufacturers and strongly reflects the feed manufacturer's

TABLE VI REGIONAL MAIZE PRICES (CONTRACT PRICE):

YEAR	HASTINGS[1]	GISBORNE[2]	MANAWATU[3]	HAMILTON[4]
1962-63	-	$51.16	-	-
1963-64	-	$51.16	-	-
1964-65	-	$49.17	-	-
1965-66	$47.24	$49.17	-	-
1966-67	$53.15	$51.16	-	-
1967-68	$51.18	$51.16	$53.15	$53.15
1968-69	$51.18	$51.16	$53.15	$53.15
1969-70	$45.27	$51.16	$53.15	$50.49
1970-71	$49.20	$51.16	$50.49	$50.49
1971-72	$41.73	$49.17	$49.20	$47.19
1972-73	$45.27	$49.17	$49.20	$47.19
1973-74	$83.00	$80.00	$98.40	$83.00
1974-75	$78.00	$79.00	$97.00	$83.00
1975-76	$78.00	$79.00	$83.00	$83.00

Sources: 1 Hastings: Williams & Kettle Ltd., Grain Merchant.
2 Gisborne: Williams & Kettle Ltd., Grain Merchant.
3 Manawatu: Ministry of Agriculture & Fisheries Palmerston North Regional Office.
4 Hamilton: Ministry of Agriculture & Fisheries Hamilton Regional Office.

TABLE VII REGIONAL CONTRACT BARLEY PRICES:

YEAR	MANAWATU	CANT. MALTING	HAWKE'S BAY 1	HAWKE'S BAY 2	SI FEED
1958-59	$41.90	$39.25	-	-	$30.87
1959-60	$44.10	$39.25	$44.10	-	$30.87
1960-61	$46.30	$39.25	$46.30	-	$35.28
1961-62	$41.90	$39.25	$48.50	-	$35.28
1962-63	$41.90	$39.25	$41.90	-	$37.49
1963-64	$44.10	$39.25	$44.10	$40.00	$35.28
1964-65	$39.69	$39.25	$39.69	$42.00	$35.28
1965-66	$41.90	$39.25	$39.69	$39.00	$34.40
1966-67	$41.90	$41.90	$39.69	$41.00	$34.84
1967-68	$41.90	$41.90	$42.77	$45.00	$37.49
1968-69	$37.49	$40.57	$35.27	$44.00	$37.49
1969-70	$41.90	$40.57	$40.56	$36.00	$37.49
1970-71	$44.10	$40.79	$44.10	$40.00	$35.28
1971-72	$48.50	$43.44	$46.30	$51.00	$39.69
1972-73	$46.30	$45.42	$46.30	$47.00	$35.28
1973-74	$74.97	$56.89	$80.00	$80.00	$66.15
1974-75	$88.00	$92.61	$88.00	$88.00	$79.82
1975-76	$84.00	$92.61	$85.00	$85.00	$74.97

Sources: Manawatu: Mr. N. Watson, Massey University, Palmerston North
Canterbury Malting Barley: Ministry of Agriculture & Fisheries, Christchurch
Hawke's Bay 1: Williams & Kettle Ltd., Grain Merchant, Napier
Hawke's Bay 2: Dalgety New Zealand Ltd., Grain Merchant, Hastings
South Island Feed Barley: Pyne, Gould, Guinness Ltd., Grain Merchant, Christchurch.

position in the market. For example, in discussions with the feed manufacturers it was found that a grain producer price for maize of $83.00/tonne was sold F.O.R. (free-on-rail) to a feed manufacturer at $88.50/tonne. This price difference ($5.50) reflects the merchant's margin for arranging the sale. In this case it is the farmer's responsibility to deliver the grain to the railhead where ownership of the grain is passed on to the feed manufacturer. The manufacturer usually pays for the transport charges to his mill.

A feed manufacturer requires stocks of grain on a spread delivery basis for the entire year. Generally, a major portion of the grain is delivered at harvest but supplies must continue to come forward until the new season's crop appears. Feed manufacturers presently pay $2.25/tonne/month to cover costs of handling, storage, interest on investment for the storage facilities, and interest on the money involved in buying and holding the grain. Most of the storage is handled by the merchant who either arranges storage at the grain drier or at suitable stores on railheads.

Feed manufacturers also require some continuity of supply and therefore purchase their supplies from several merchants. This also ensures that a competitive price is maintained. If any feed manufacturer is able to obtain lower priced feed inputs compared to his competitors, then the feed company can in turn sell their final products for the same price at a greater profit to the company or at a lower price which would undercut their competitors.

As the season progresses, the initial price quoted for a grain begins to reflect the commercial storage charges. If farmers owned their own storage facilities on the farm they could similarily expect to receive these monthly increments up to the time when they eventually sold the grain. The price of grain also will reflect any changes in supply and demand conditions as the season unfolds. The merchant's knowledge of a going price for grain is spread through the market by a sensitive information system. Merchants deal directly with grain brokers, feed manufacturers, and other merchants on a day-to-day basis arranging sales and this day-to-day pricing becomes a complex and sensitive process.

Any merchant endeavouring to obtain an excess margin of profit by paying a lower price to farmers or charging a higher price for grain delivered to the feed manufacturer would soon find that his competitors would take the business from him. There seems to be a certain unwritten understanding in the Trade of what price is a fair one in terms of profit margins. In a study by Bourke (2,p.22) it was found that, "Where merchants operate in a number of areas and sell to a number of buyers located in different regions it is open to them to take higher margins in some areas and lower margins in others while achieving an acceptable average margin in total. "These high or low margins exist primarily because of the transport differentials from the various producing regions to the feed manufacturing centers. In Bourke's analysis it seems that "... a commonly quoted margin taken by merchants may be \$6.00-\$9.00/tonne..." (2, p.22).

4.2.2 Grain Contracting System

The initial price established by the merchant sector for a particular grain is in reality the farm gate price at which the grain is contracted. Under the rules and regulations specified by the Merchant's Federation, a merchant is restricted to contracting only with farmers in his area. On the other hand, in the marketing of the grain, a merchant can sell to other merchants or feed manufacturers in any other part of New Zealand.

This contracting system has been established as a means of stabilizing the feed industry. Now approximately 95% of the maize is purchased from producers on contract while approximately 80% of the barley is handled in a similar fashion. The merchant contracts with farmers for specific grain acreages and an actual grain contract is signed. (Figure 7 is a copy of a typical grain contract). The grain produced is accepted either "free on rail" or "into store" subject to specific grading conditions about moisture content, bushel weight, weed seed and foreign matter, and the requirement that the grain be of a fair average quality (FAQ) for the season. Once the producer price has been established, contracting begins. This contract price is for the delivery of all grain produced on the block of land specified in the contract. The purpose of the

Merchant's Copy

Sale and Purchase Contract   No. 1271

BETWEEN .... **(Seller)**

ADDRESS: ....

AND **(Buyer)**

ADDRESS: ....

....

For the resultant crop of .... Hectares of .... (Variety)

Feed Barley ex harvest for 19 / Season.

at $.................... per tonne of good Whole Feed Barley in bulk F.O.R. .... or Delivered into Store ....

For Grain of the following quality:

Minimum of 21.7 kilograms (48lb) Bushel weight.

Maximum moisture content to be 14% in Bulk.

Weed Seed and foreign matter not to exceed ½% by weight.

Colour to be of average for season.

GENERAL:

Goods purchased F.O.R. or Into Store are at Seller's risk until accepted by Purchaser at destination.

Buyer has right to accept or reject goods tendered which do not comply with the terms of this Contract.

Weights from approved Certified Weighbridge shall be final.

SPECIAL CONDITIONS:

The Buyer undertakes to accept delivery either In Store or On Rail direct from the harvest.

SIGNED: .... Seller. For:

Date ....

K. & M. Ltd. 774

FIGURE 7: Typical grain merchant's contract.

contracting system is to ensure that adequate supplies are available for domestic and export markets. By legally signing a contract that producers will plant and deliver their entire grain crop, a merchant is then able to make forward grain commitments to ensure the smooth flow of grains after harvest to various users.

Producers are not limited to growing grain on contract. They can produce whatever they wish and these grains so produced are called "free grains". The producer accepts the price risk associated with holding his own grains in the hope that market shortages force up the price of grain. These "free grains" make up any short falls in the merchant's requirements as the season progresses. If there is a surplus crop, the producer of "free grains" usually has a difficult time in selling his crop.

The merchant attempts to minimize the risks associated with grain marketing yet annual yield fluctuations very quickly disrupt that fine balance between surplus and shortage. A merchant is placed in a rather awkward position in seasons of poor yields as all grain contracts back to the farmer are contracted on an area basis (hectares) while his forward commitments to the domestic and export market are on a tonne basis. This situation causes the "free grains" to often become valuable commodities resulting in active inter-merchant trading as merchants attempt to cover their forward grain commitments.

4.2.3 Marketing of Agricultural Inputs and Other Services

Besides carrying out the functions of price establishment and managing the grain contracting system, the merchant performs many other necessary functions in the agricultural sector. Grain merchants and stock and station agents market agricultural inputs, provide financial services, establish grading standards, and offer a valuable advisory service to their growers. Other activities such as real estate, auctions, and other services are extensions of their everyday business activity and help to encourage that closer contact between farmer and merchant.

There are several reasons why merchants have broadened their range of trade. The most obvious one is the desire to provide a complete service for the farmer so as to discourage him from dealing with other competitors within the merchant sector. The merchant's trade is of a keenly competitive nature and if a rival firm gained entry to a farm through supplying some item which they did not stock themselves, then the farmer might choose to deal with the rival concerned, not only for that item but also for all other goods and services which the firm offered.

Reciprocal trade between the farmer and merchant builds up a situation of interdependence. The merchant's long-run prosperity depends upon the support of the farming community. By providing a high proportion of the farmer's requirements the merchant can develop and sustain this relationship.

The second reason why merchants become involved over a wide range of trade with the farmer is that margins from handling grain are not excessive. By diversifying the product range, merchants not only diversify the risks involved but simultaneously share the overheads of handling these other items of agricultural trade. By increasing the volume of trade in relation to these overhead costs, unit costs can be lowered and profits increased. Economies arise in the use of labor, business premises, trucks, etc.

The merchant sector plays an important role in the production of New Zealand feed grains. Merchants are involved in the production of high yielding hybrid seeds for maize production. Without the suitable stocks of seed varieties that have been developed for New Zealand conditions, many of the productivity advances would not be available today. Farmers turn to merchants for help of an advisory capacity. Merchants have been instrumental in introducing and expanding cropping, particularly maize, in many regions. Along with this expansion of cropping has been the necessary investment in capital equipment to handle the crops. Merchants have a keen interest in providing up-to-date services for farmers in order that a top quality crop can be produced and in turn marketed through the merchant sector. In the growing of the crop, merchant representatives play a big part in ensuring that fields have been properly cultivated, planted, sprayed for weeds, etc. It is in the merchant's interest to receive a crop which is of a fair average quality for the season because the marketing of that crop is made easier.

The merchant often operates drying, storage, and grain cleaning facilities for farmers so that the crop can be properly prepared for sale. This involves considerable amounts of forward planning in order to accommodate the crop. Often customers require specific grades of grain which require different cleaning and drying instructions. The merchant must process this crop in such a way so as to maintain certain quality standards which are set by the industry.

Another function of the merchant sector is the establishment and maintenance of grading standards. The standard grades for feed grains require that there be a minimum bushel weight, a maximum moisture content, a limit of one-half of a percent of weed seed and foreign matter, and it must be of a fair average color for the season. (See Figure 7). A large part of the merchant's function in the market is to judge the quality of grain and direct it to the outlet for which it is best suited. New Zealand maize has consistently been of a superior quality compared on international feed standards to USA #2 yellow, while barley quality generally fluctuates from season to season. Generally grain is delivered dried, in bulk, subject to the above grades, either free-on-rail or into store.

Because grain merchants realize that the cropping sector is of a seasonal nature, an important function of the grain merchant sector is the provision of credit. Credit is made available because merchants want to maximize their sales of agricultural inputs and also encourage the production of the required quantities of feed grains. If the merchant refused to offer credit facilities, his customers would likely do business elsewhere. The existence of credit facilities for the client farmer influences to some extent the channels through which grain is moved to its final usage. The merchant who extends credit for agricultural inputs can have much greater security if he knows that the farmer will in due course produce and sell through him a satisfactory grain crop. This occurs even where there is no formal agreement to sell grain to the merchant. Merchants are in a unique position to judge the credit worthiness of a farmer and his ability to repay the funds borrowed.

4.2.4 Feed Grain Marketing: Domestic Activities

On the domestic market, the merchant sector has generally followed a policy of buying its total grain commitments from farmers on a contract basis. Discussion in earlier sections indicated that merchants generally buy in bulk F.O.R. or Into Store. At either of these positions the merchant can direct specific quantities of grain to generally three major purchasers: feed manufacturers, whole grain users, and other merchants. It is generally the case that at harvest approximately 90% of the grain has been forward sold to these endusers. Not all grain will be delivered at harvest but a good portion of the crop will be combined with the previous years' grain stocks and held in store until needed. Merchants only resort to buying grain from other merchants when supplies from their farmer customers are not sufficient enough to meet their own commitments. This occurs later on in the season once the grain harvest has been assessed and possible shortages or surpluses in various regions have been determined. An example of this type of transaction would be a purchase by one merchant in Palmerston North from another merchant in Masterton of 30 tonnes of feed wheat delivered to New Plymouth. The reason for this sale was that Palmerston North merchant did not have the available quantities of feed wheat himself to meet his sale commitments, so he had to look elsewhere. The margin for this transaction as noted by the writer was $5.00/tonne.

When selling to feed manufacturers most merchants realize that they are but one of several sellers and they often have to take the prices quoted to them. Alternatively, the merchant could continue to store the grain or possibly sell it to someone else if the price quote from the feed manufacturer was not high enough.

Merchants sell whole grain to local pig and poultry farms for use in home-mixed feeds. These are generally direct sales out of storage by truck to these local endusers. Merchants also contract on behalf of food and industrial companies, maltsters and distillers for specific quantities and qualities of various crops. With barley, the malting company announces the price for malting barley and in turn directs merchant companies to contract individual farmers to grow their requirements. A similar practise is carried out for grain used in the distilling of whiskey and gin. For maize the practice is similar with quantities of grain delivered directly to feed manufacturers, whole grain poultry and pig users, starch companies, distillers, and breakfast food companies.

Merchants and feed manufacturers become involved in some reciprocal trading amongst themselves. The latter purchase raw grain from the merchants to process into pig and poultry meals and other specialized feeds. The merchants in turn sell these processed feeds to their farmer clientele on behalf of the feed manufacturers.

The attached flow charts for maize and barley indicate the merchants activity in directing specific qualities and quantities to various end users. (See Figures 8 & 9).

4.2.5 Feed Grain Marketing: Export Activities

A more recent activity of the grain merchant sector has been the export sales of maize and barley to South-East Asian countries such as Japan, Taiwan, and South Korea. These sales are negotiated by a consortium of merchants. These consortiums possess the necessary expertise to transact these sales through their connections with the leading international grain companies. This consortium concept has many advantages over, for instance, a single merchant's activities or several merchants operating independently. In the consortium, merchants do not attempt to play one company against another. Because of this, a single selling organization for each export contract exists rather than many small parties, which tend to confuse the international buyers. Also, with the merchants represented as a consortium, not only is the available expertise combined, but economic grain cargo lots (10,000-15,000 tonnes) are sold which are more readily acceptable on the world market. The individual merchant companies who have the grain to export are seldom in a position to provide an economic cargo lot. There are problems of locating and moving grain for shipment from the various areas without overstraining local facilities or driving up the local price of grain. This form of cooperation has undoubtedly made possible the export of larger quantities of barley and maize in recent years.

To arrange the sale of the grain, each participating merchant in the consortium contacts his appointed overseas agent who is in contact with one of the major international grain companies, to advise them that there

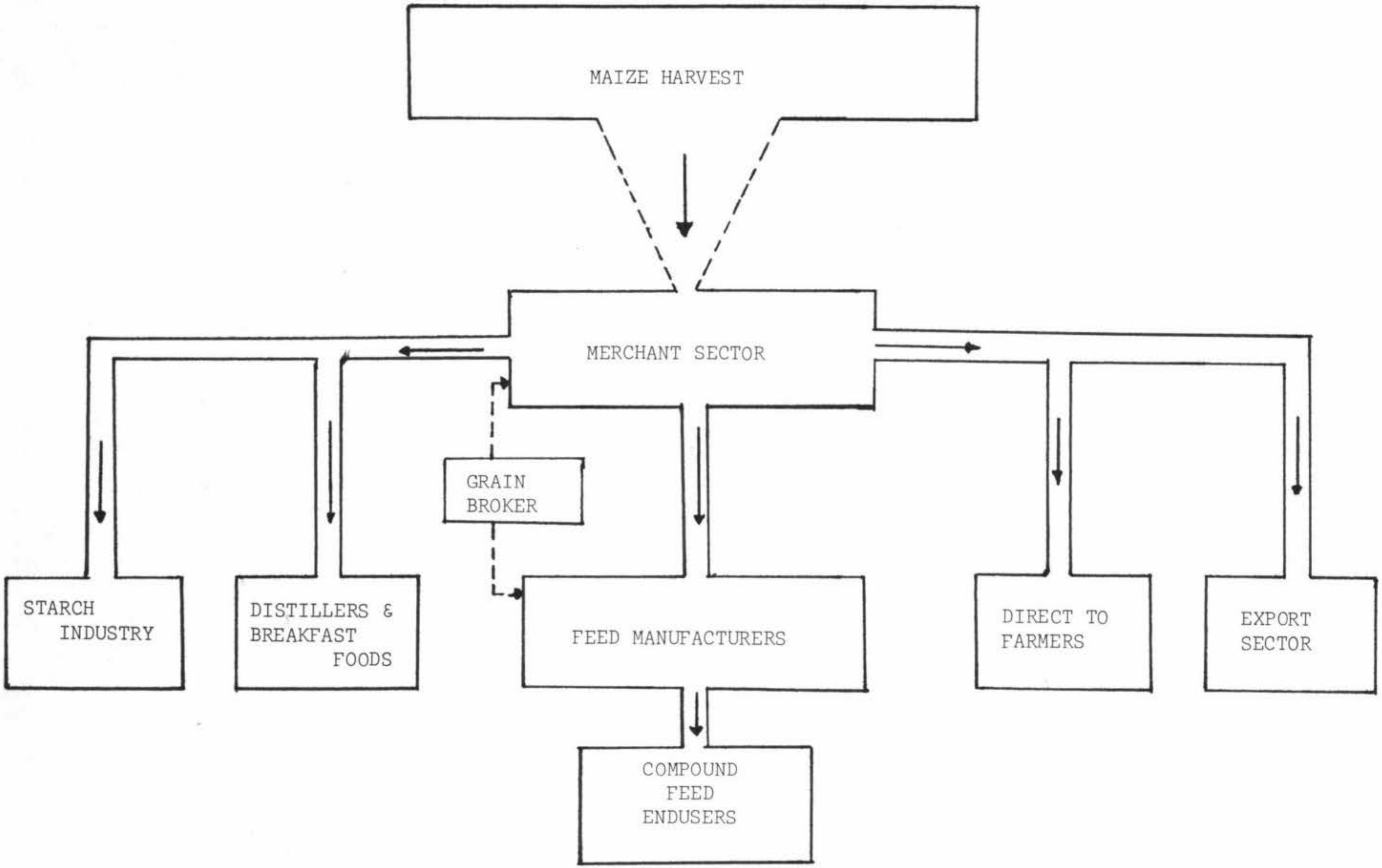

FIGURE 8: Flow chart for maize production, marketing and utilization.

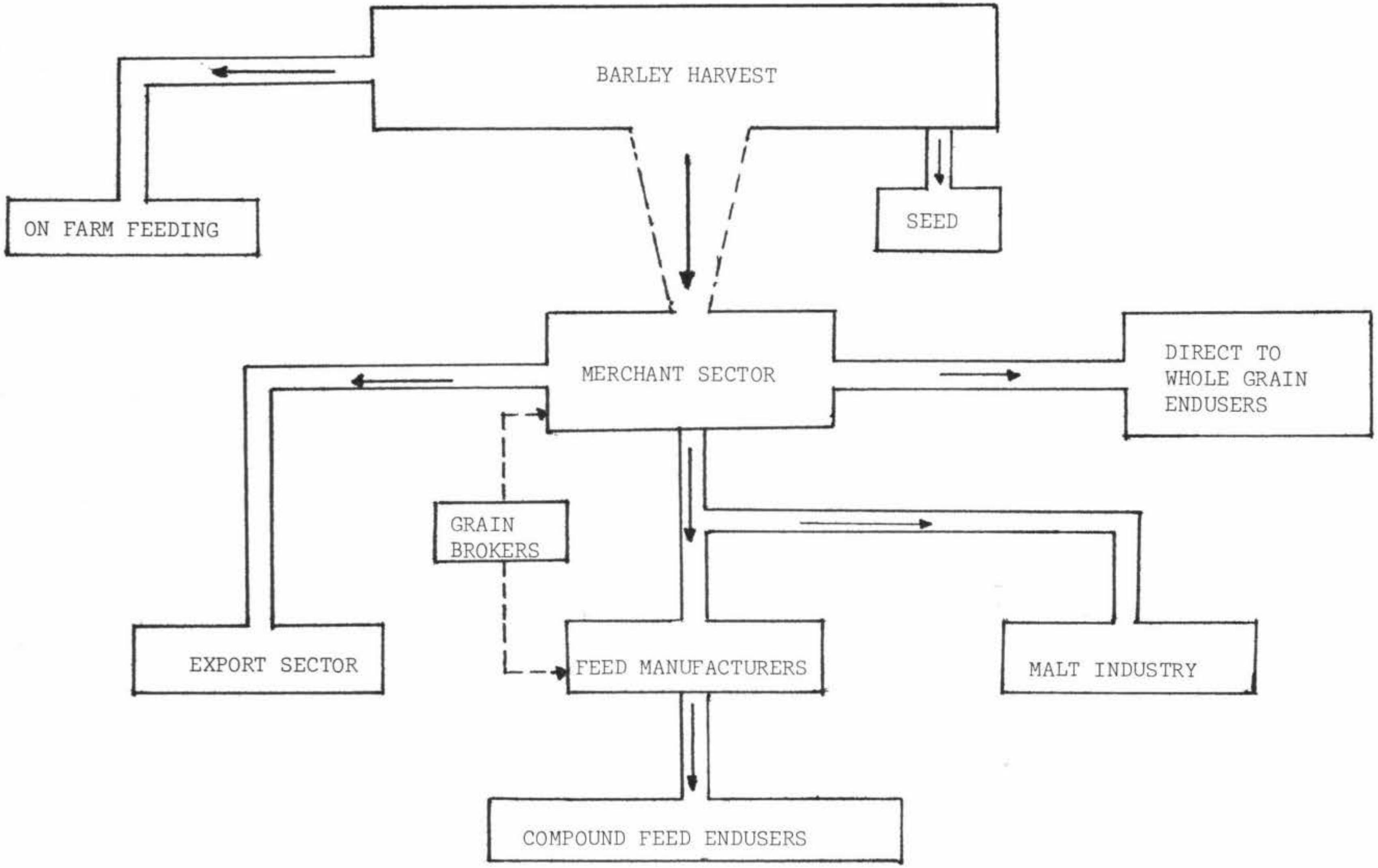

FIGURE 9: Flow chart for Barley: production, marketing and utilization

is a specific quantity and quality for sale. Quotations are obtained from each of the overseas representatives with generally the highest bidder taking the sale. This approach to overseas marketing ensures the highest possible price is chosen on the day and eliminates the possibility of a weak seller deflating the market. The consortium operation has been very successful and represents a united marketing effort to transact the sale for the best possible advantage of the entire grain industry and the New Zealand economy.

Exports of maize to these international grain companies have been sold free-on-board (F.O.B.) ships from Gisborne and Tauranga. The international grain companies generally make all shipping arrangements, leaving New Zealand exporters the task of loading the boats. The loading facilities at the export ports have a very low loading capacity by world standards. Tauranga has recently increased its loading capacity to 5,000 tonnes per fifteen hour working days.

Both an export licence and an export permit are required to export grain from New Zealand. The export licence specifies an overall quantity agreed to with the Government for the year. The export permit gives permission for the export of a specific consignment within the quantities specified by the export licence. Under the export licence system, the Trade (i.e. Merchant's Federation) has had to guarantee to repurchase grain committed for export in the event of a short fall on the domestic market. Usually the export contract with the international buyer has a specific clause which entitles the exporter to overdeliver or underdeliver 10% of the entire cargo due to conditions beyond the exporters control (i.e. low crop yields). The purpose of these export documents is to ensure that domestic feed requirements are provided before any overseas orders are filled.

New Zealand has been able to produce a high quality maize crop relative to other major exporters with the quality being similar to U.S. #2 yellow grade. The New Zealand exporting period is May to July when world values are usually at a peak because of interest and storage cost on old maize crops from the Northern Hemisphere countries. These aspects, and an awareness by New Zealand exporters that they must encourage a stable source of supply, provides encouragement for an expanding New Zealand maize industry. One disadvantage would be New Zealand's geographical location in relation to the export market place. The great distances to the market place force up the cost of landed New Zealand maize. Export licences for 1975-76 season have totalled 61,000 tonnes to date.

Barley exports are handled by consortiums of merchants in a similar fashion. These exports generally originate from the South Island ports of Lyttleton, Timaru, and sometimes Bluff. Similar export arrangements for North Island barley occurred in the 1974-75 season when 15,000 tonnes were exported to Russia. Export licences for the 1975-76 barley crop at this point total 68,000 tonnes. In terms of export earnings the export of barley and maize could contribute from $12-$15 million.

In summary, the merchant sector possesses several distinct advantages in grain marketing activities:

1) they have specialized knowledge in both domestic and export grain marketing,
2) they maintain shared overheads with their other agricultural activities thus ensuring minimum costs for handling grains.

4.3 Changing Structure of the Merchant Sector

Over the duration of this analysis (1954-55 to 1975-76), there have been changes in the structure of the New Zealand feed grain industry. Some of the more obvious changes have been:

1) a decline in the number of individual merchant companies.
2) an expansion of the merchants' activities into the area of feed manufacturing,
3) a tendency for farmers to establish cooperative drying and marketing companies.

As the feed grain industry has gained importance in the New Zealand agricultural sector, there has been ample evidence of examples of horizontal integration [1] within the merchant sector. Because of the need for economies of scale in the handling of grains and other agricultural products, some of the bigger stock and station and grain merchants have

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1 "Horizontal integration occurs when a firm gains control over other firms performing similar activities at the same level in the marketing sequence." (20, p.30)

attempted to extend their market to increase their volume of business. A number of independently owned and operated merchant companies have either closed down or been amalgamated into the structure of these bigger companies. In these takeovers, the newly acquired companies often retain their original names and one could assume that this sort of strategy is followed so as to give the farming community the impression that the company's interests are not as wide-spread as would be obvious on a first glance of the industry. A more plausible assumption would be that generally there is a considerable amount of goodwill associated with a merchant company, and by not changing the name when the company is taken over, patronage is still maintained. The amalgamation of a company into the structure of another organization is a far easier method of extending one's business practise. Other methods are to extend a market by establishing a new company and through price competition and superior service a portion of the region's business is slowly won over. From experience, merchants have stated that it is easier to buy a firm out and to amalgamate it into the company than it is to establish a new company. Often skilled staff are retained along with an immediate volume of trade which can be expanded.

In conjunction with this concentration in the industry there has been further evidence of vertical integration[2] in the merchant sector. Merchants have extended their activities into the feed manufacturing area. However, this is not a significant portion of the merchant's business activity because of the high degree of specialization required in the feed manufacturing sector. The existing feed companies have expanded and improved their facilities to such an extent that some of the merchants have found that it was not economical to maintain their own feed manufacturing plants.

The most significant change within the feed grain sector has been the tendency for farmers to establish grain cooperatives to dry and market their annual crop by omitting the merchant sector. The activities

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2 Vertical integration occurs when a firm combines activities unlike those it currently performs but related to them in the sequence of marketing activities. (20, p.30)

of these grain cooperatives has definitely introduced a further competitive element into the trade. The cooperatives have absorbed the merchants' margins by selling on a small scale direct to feed manufacturers at a lower price than that offered by the merchant. This cooperative movement has been on a limited scale and has only slightly disrupted the present marketing system. However, further competition in sales to feed manufacturers will continue to threaten the merchants' position. This could impair the reciprocal trade between merchant and feed manufacturer and could possibly force the merchant to operate on a lower margin.

The direct impact of grain cooperatives has been very small because the attractions for this type of an organization have been insufficient to draw farmers away from their traditional dependence on the merchant sector. Several reasons for this lack of local support in cooperatives have been:

1) There is a need for large sums of money for capital investment in drying and storage facilities. Associated with these investments are high risks.
2) There is a need for working finance for inputs such as seed, chemicals, and other services to produce the grain. Traditionally this finance has come from the merchant sector. Trading banks generally consider the risks of providing finance to groups of farmers as being too excessive.
3) There is a need for experienced drier operators and marketing personnel. As a cooperative increases in size, it finds it increasingly unsatisfactory to rely on voluntary part-time efforts of its members.
4) Farmers are aware of previous failures with cooperative movements. Even legal involvement of the membership has proven unsuccessful.
5) Farmers are aware of the competitive nature of the grain industry and fear merchant retaliation on members by limiting the availability of agricultural inputs and/or hindering the marketing of their other products.

4.4 Role of the Grain Broker

In New Zealand there are approximately 14 active grain brokers within the grain, seed, and produce marketing sector. These brokers are either individuals or companies who independently perform the necessary function of coordinating buyers and sellers in the market place. These brokers are members of the New Zealand Association of Grain, Seed, and Produce Brokers which maintains the ethics of the brokering system in New Zealand. Any changes in the system must be discussed at a meeting of the Association.

Grain brokers sell grain on commission for a principal. The principal pays the broker a commission generally on a cents/tonne basis. Brokers do not physically handle grain. Their function is to exploit a full and intimate knowledge of the grain market in order to further the interest of his client. He arranges transactions between merchants who have a relative surplus of some grains and merchants who are facing a shortage. Similar arrangements are made with feed manufacturers who are interested in purchasing specific quantities and qualities of grains delivered ex-harvest or on spread delivery for some time in the future. Essentially the sales are of an inter-regional nature but are often of an intra-regional nature.

The grain broker is in contact with all major buyers and sellers throughout New Zealand on a day-to-day basis. He provides supplementary information to the communication system which already exists in the merchant sector. In fact the broker generally has a much wider knowledge of market conditions than the merchant because of this daily contact with the major buyers and sellers. Merchants, on the other hand, tend to be more concerned with regional business activities rather than concentrating on the national grain sector. Nevertheless merchants very quickly become aware of the total market situation. The brain broker's knowledge of and activities in the market place keep the grain market as competitive as possible.

The broker never speculates or takes a position in the market. The ethics established by the Trade limit this sort of activity. Instead, the broker acts as the intermediary between buyer and seller. These grain transactions are generally carried out by telephone. A contract specifying the buyer and seller, the quantity, quality, price, means of payment, place and time of delivery are all noted on the contract. The contract is witnessed and signed by the broker. The broker sends one copy of the contract to the buyer, one to the seller, and keeps a copy for his own reference (See Figure 10).

One of the most important aspects of the brokering business is that in carrying out a grain transaction a grain broker never declares the identity of either the buyer or seller until the deal is completed. In some instances one could be trading grain with the competitor across the street.

Delivery of the grain could be either immediate or at some date in the future. Forward commitments on next year's grain crops are common transactions. These are signed even before the farm gate price has been established and definitely long before the grain is even sown. The grain broker carries out his business with other merchants and with feed manufacturers. Figure 11 indicates the flow of grain enhanced by the brokerage system.

A grain broker acts as an intermediate in the transfer of grain between two merchants. A specific example of this would be a merchant in region "A" purchases a forward commitment of 100 tonnes of bulk barley from another merchant in region "B". The forward purchase was for $98/ tonne delivered ex-harvest 1977 crop. This sale was contracted 3 months before the sowing of the crop.

An example of a merchant selling grain to a feed manufacturer through a broker would be as follows. Because of the grain brokers contact with buyers and sellers in the market place, he becomes aware of specific price quotes that merchants are willing to sell for and price quotes that feed manufacturers are willing to pay for grain supplies. Grain merchant "C" paid $83.00/tonne for feed barley to the farmer and the feed manufacturer agrees to buy at $88.50/tonne. Prices are agreed on and details for the contract are specified. In this instance the merchant received a margin of $5.50/tonne for handling the grain (See Figure 11).

BROKER'S COPY

CONTRACT NOTE

Issued with the approval of the N.Z. Grain, Seed and Produce Merchants' Federation Inc., and under the authority of N.Z. Association of Grain, Seed, and Produce Brokers Inc.

Telephones:
Business:
Private:

Grain, Seed and Produce Broker

For reference quote this number

This serves to confirm the sale between *Date* ....

Buyer ....
and
Seller ....

of the following goods: ....

....

....

....

Price ....

Place of Delivery ....

Time of Delivery ....

Terms: N.Z. Terms, 1973, and Amendments.

***Insurance:** as per instructions contained in the Federation Roll of Members or any amendments or additions thereto.*

Special Conditions ....

....

....

Yours faithfully,

Per ....

Member of N.Z. Association of Grain, Seed & Produce Brokers Inc.

Should there be any error in the above contract, Please advise broker immediately.

FIGURE 10: Typical Grain Broker's Contract.

Previous to the increase in maize production and the expansion of the export trade, the role of the grain broker had tended to diminish over the years. This tendency was possibly accentuated by the process of takeovers and amalgamations among the major grain merchants and feed manufacturers. Because of the small number of buyers in the market place the role of the grain broker became less obvious. Recently, strong interest in the maize industry has helped to increase the role of the grain broker. Greater quantities of grain are now being forward sold and general business activity in the grain industry has increased overall.

The pattern for future trends in the New Zealand grain industry could be centered around the activities of the grain broker. Grain producers could form themselves into groups or cooperatives and sell their grain on the domestic market through the brokerage system. If cooperatives had their own drying and storage facilities they could sell their grain under the same conditions that a merchant must comply to. These producer groups would be expected to face the same marketing risks that merchants face today. All contracts signed would have to be honoured as is presently the case with the merchant companies. This might require the producer groups to purchase grain on the open market in order to make good their previous commitments.

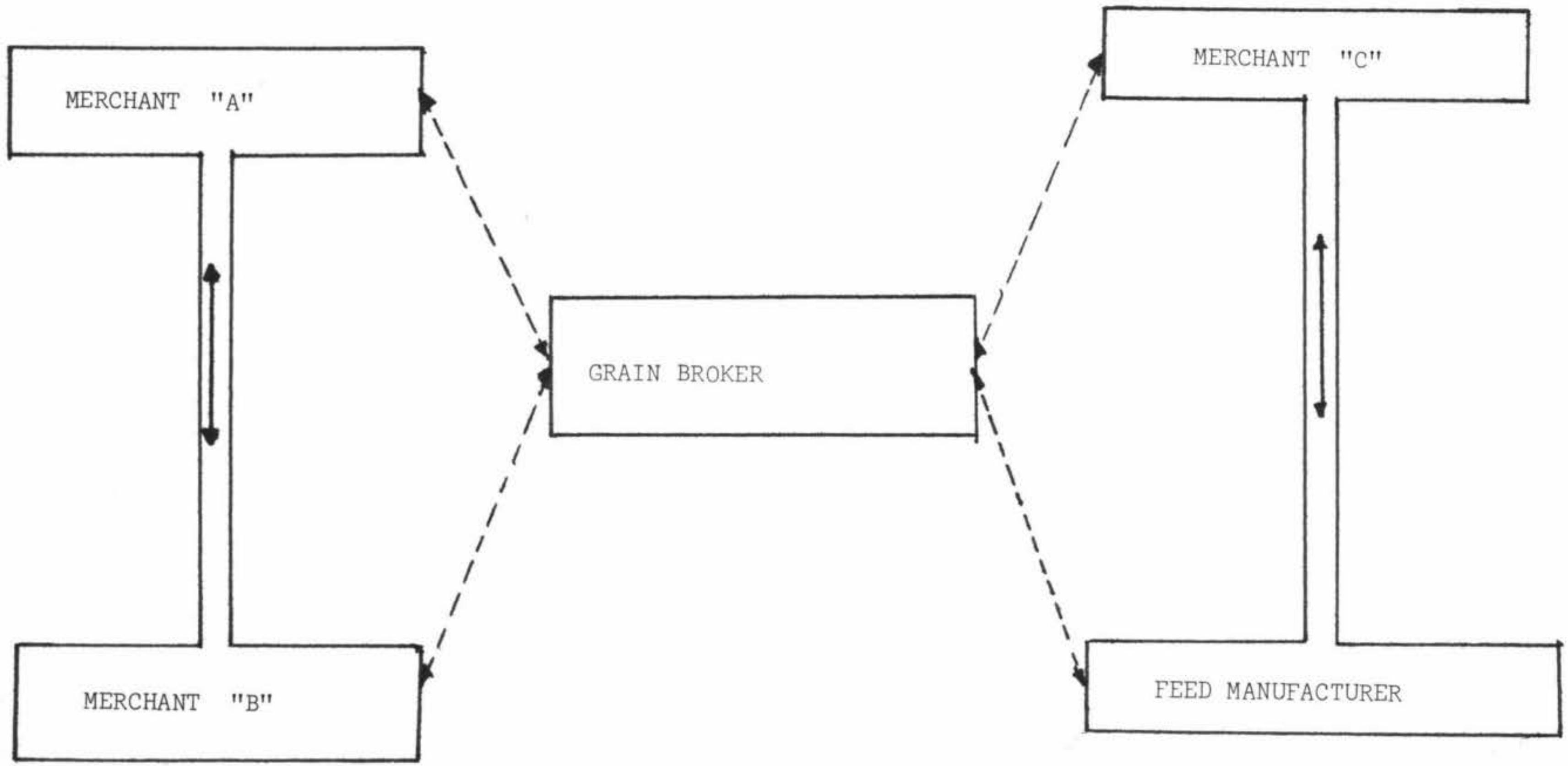

FIGURE 11: The Grain Broker's Position in the Marketplace

CHAPTER V

FEED GRAIN UTILIZATION

5.1 Introduction

Very little information is available on feed grain utilization in New Zealand. The information that is available from both the government and the private grain trade very often differs between the two sources. Because of this lack of accurate information only the major grain consumption trends are discussed in this chapter. This chapter begins with a brief historical review of the New Zealand feed grain industry, analyzes the demand for grain, the structure of the feed manufacturing industry, and concludes by outlining the role of the feed manufacturer in the New Zealand feed grain industry.

5.2 A Brief History of the Feed Grain Industry

New Zealand's agricultural production has traditionally been based on the conversion of forages into saleable products but within the last decade great advances have been made toward greater utilization of feed grains for the production of poultry and other livestock products.

Prior to the mid-1960's New Zealand feed grains found their greatest usage in the laying industry and occasionally for the feeding of sheep and cattle during such stress periods as droughts and winter periods. During this same period New Zealand pig producers predominately fed their animals by-products from the dairy industry because during this period the dairy factories accepted only cream at the factory door with the skim milk being retained on the farm to be fed without any further treatment to both pigs and calves. Dairy farmers naturally tended to be pig producers as they could best utilize the by-products from their dairy enterprises.

In the late 1960's the structure of the dairy industry changed dramatically with farmers tending towards the delivery of whole milk, rather than only the cream, to the dairy factory following the expansion of the bulk collection of milk from dairy farms. The skim milk, instead of being returned to the farmers, was instead pasteurized at the dairy factories, condensed and finally spray-dried into skim milk powder which was then sold primarily as a high-protein animal feed on both the domestic and international markets.

During the transition period between skim milk feeding and the change to grain based feeding there was a period of time where whey was returned from the dairy factory to the pig farmer. This was short-lived because of the greater economic opportunities for the further processing of whey by the dairy companies. Because of these many changes in the dairy industry, the structure of the pig industry was subject to great change. Pig numbers have declined by one-half between 1964 to 1974. Table VIII clearly indicates the dramatic changes in pig numbers in New Zealand.

Even though there has been a drop in total pig numbers over this period the industry is still viable. Pig production in New Zealand has become more of a commercial operation and is moving away from being a side-line activity in mixed farming. The industry today primarily consumes feed grains rather than dairy by-products. With producers now operating on a much larger scale, they tend to prefer process rations rather than unmixed feeds since they are easier to handle and because of the balanced nutritional value of the processed feeds compared to unprocessed feed grains.

In the poultry industry there have been similar trends in the expansion of feed grain utilization. Growth in the laying industry has moved secularly as New Zealand's population and incomes have steadily increased. In recent years the traditional "backyard flock of fowls" has declined in numbers with a trend towards much larger flocks maintained on commercial poultry farms. Once again these commercial farms are primarily using processed feeds supplied by the feed manufacturers.

In the late 1960's a combination of two factors, the establishment of "take-away" chicken shops and higher beef prices, led to the increased consumption of chicken meat. While statistics on the poultry industry are limited, it can be noted that production in the broiler industry during the 1973-74 year alone indicates a rapid growth in this industry. During this period, 1973-74, bird numbers increased from 13 million to 18 million birds.[1] Poultry meat production and the number of eggs handled by licenced distributors are detailed in Table IX. These figures illustrate the rapid growth of the poultry industry.

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1 New Zealand Yearbook 1975, pp. 412-413.

TABLE VIII NEW ZEALAND PIG NUMBERS

YEAR	BREEDING SOWS OVER 1 YEAR	OTHER PIGS	TOTAL PIGS
1963	97039	668986	766025
1964	95179	676271	771450
1965	90048	625960	716008
1966	81678	585227	666905
1967	75910	526785	602695
1968	77412	536765	614177
1969	69223	484165	553388
1970	73204	504721	577925
1971	77431	539752	617183
1971	60162	360463	420625
1972	60319	416670	476989
1973	57633	418209	475842
1974	56576	405150	461726

Note: Figures above the rule are as at January 31 while the figures below the rule are for June 30.

SOURCE: New Zealand Year Book, 1975, pp. 412-413.

TABLE IX NEW ZEALAND POULTRY MEAT PRODUCTION FOR JUNE YEARS AND EGG PRODUCTION

Year	Birds (millions)	Eggs handled by licenced distributors (million dozen)
1962-63	2.8	31.0
1963-64	3.0	33.0
1964-65	4.0	32.7
1965-66	5.0	36.0
1966-67	5.5	38.3
1967-68	5.5	39.4
1968-69	6.5	39.9
1969-70	8.0	45.4
1970-71	10.0	51.0
1971-72	11.0	51.1
1972-73	12.5	50.9
1973-74	18.7	53.4

SOURCE: New Zealand Year Book 1975, pp.412-413.

5.3 Usage of Grains in New Zealand

5.3.1 Food and Industrial Purposes

The demand for grain originates from primarily three areas: grain for food, industrial, and feed purposes. Grain for food and industrial purposes are required as the basic raw material in some manufacturing processes. Their demand is therefore closely associated with the level of final demand for the end product. The substitution between grains for food and industrial purposes is minimal as each grain has its own defined uses for specific end products. In the malting industry certain varietal and quality standards must be met. Maize utilized in the starch industry must be artificially dried under more specific temperatures compared to maize for stock feeding purposes. Because of each of these qualitative requirements grains destined for either food or industrial purposes generally command a higher price than those used in animal feeds.

The existence of separate feed, food, and industrial markets for the different grains illustrates the point that all grains are not necessarily of a homogeneous nature. Maize can be used for many industrial purposes, not all of which are being fully capitalized on in New Zealand. Maize is used in the starch industry for the manufacturing of glucose, dextrose, and starch. Corn oil and animal feeds are obtained as by-products from the starch industry. The uses to which the basic glucose, dextrose, and starch products can be applied are immense. Starch can be used in paper, textile, and adhesive production. Glucose finds uses in jams, preserves, soft drinks, and baking products. Dextrose has applications in the pharmaceutical industry. Maize has further uses in the breakfast food industry along with some quantities of wheat and oats. There is therefore a great potential for further quantities of maize being used in future manufacturing processes in New Zealand.

Large quantities of barley are used in the malting industry. The Canterbury Malting Company in Christchurch annually uses some 60,000-70,000 tonnes of barley for the production of malt. Malting is the process in which grain is germinated under carefully controlled conditions for a specific length of time. It is then dried with the resultant product being malt. It resembles the original grain in appearance but is very different in chemical properties. The principal uses of malt are in the brewing (beer) and distilling industries (gin and whiskey). Maize is also used in distilling (whiskey) but generally in conjunction with barley. Small quantities of barley are diverted to the production of pearled barley for food use.

5.3.2 Grains Used for Stock Feeding

The demand for the various types of feeds obviously depends on the type of animal (either simple stomach or multi-stomach), the purpose of the animal (production or breeding), and the system of production used (pastoral or grain fed). There are three major types of feed for livestock:

1) forage and preserved forage,
2) high-energy feeds (grains),
3) high-protein content feeds (oilseed residues, fish and meat meals).

Although forage is the cheapest form of energy for herbivores, high levels of output per animal are obtainable by substituting some of the bulk forage for concentrated grain. This activity is not a wide-spread practise in New Zealand where production of livestock is based on a pastoral system with grain feeding of livestock only during stress periods. The prime usage of feed grains in New Zealand is in the poultry and pig industries. The recent expansion of these very intensive industries has relied heavily on the concentrated grain-based feeds.

The geographical location of a pig or poultry farm, with its associated climatic and market factors, greatly influences the type of grain which is used and the ability to substitute among the various feed alternatives available. For example, maize in the North Island has largely replaced wheat as a high energy grain feed for egg and broiler production. On the other hand, because of the availability of feed wheat on the South Island, large quantities of wheat are used for high energy poultry and pig rations. In the South Island feed wheat and barley are the two main feed substances while on the North Island, maize, barley, and wheat are generally available in various quantities and are substituted into feed mixes depending on their availability, their relative prices, and the eventual end use (poultry, pig, or other) of the feed. Table X indicates the consumption of feed grains by geographical region. From the Table it can be seen that maize is the prime feed grain on the

TABLE X PERCENTAGE CONSUMPTION OF TYPES OF FEED GRAINS BY REGIONS:1973

	Wheat	Barley	Maize
Auckland	11.8%	10.4%	35.4%
Palmerston North	10.1%	21.7%	29.7%
Hamilton		12.9%	23.2%
Hastings	4.3%	11.6%	11.7%
Other North Island			
Total North Island	26.2%	56.6%	100%
Christchurch	52.8%	31.9%	-
Other South Island	21.0%	11.5%	-
Total South Island	73.8%	43.4%	
	100.0	100.0	100.0

SOURCE: Ministry of Agriculture and Fisheries Feed Grain Survey 1974.

North Island, that wheat dominates the feed market on the South Island, and that barley is consumed in almost equal proportions on the North and South Islands.

The type of grain used by the different classes of livestock in New Zealand are depicted in Table XI.

TABLE XI FEED GRAIN UTILIZATION BY CLASSES OF LIVESTOCK, 1973

Grain:	(percentage consumption)				
	Poultry	Pigs	Dairy	Sheep & Beef	Other
Wheat	78.5%	5.5%	2.3%	4.4%	9.3%
Barley	46%	34%	10%	9%	1%
Maize	67.5%	13%	15%	3.5%	1%

SOURCE: Paper given by Mr. J. Simpson, July 28, 1976, Maize Seminar, Massey University, Palmerston North.

As can be seen from Table XI, in 1973 the poultry industry was the prime consumer of all feed grains. Since the expansion of maize production on the North Island, the usage of South Island feed wheat in the Auckland area has declined to such a level that very little feed wheat was required in the 1975 and 1976 season. North Island self-sufficiency in feed grains has come about primarily because of the high costs of shipping feed grains from the South Island. These higher costs for transporting the grain have pushed the North Island feed prices to such a high level that it has now become economic for North Island farmers to grow feed grains locally. North Island self-sufficiency in feed grain production has altered the structure of the New Zealand poultry industry. When wheat and barley had to be freighted to the North Island to maintain intensive poultry production close to the centres of population, the South Island producers could economically compete with their North Island counter-parts. As transport costs increased, more and more feed was produced locally on the North Island and this was substituted into the feed rations at the expense of South Island feed grains. This trend has continued to the extent that South Island poultry production has declined to such a level that only local demand is satisfied.

More recent figures (1975) on the consumption of stockfeeds are presented in Table XII. Stockfeeds in this Table refer to processed feeds which have been manufactured by a feed company. These figures do not include those grains consumed on farm, nor grains sold through a grain merchant back to farmers for livestock feeding.

TABLE XII CONSUMPTION OF STOCK FEEDS IN NEW ZEALAND (1975)

Distribution	Layer	Broiler	Pig	Stock	Total
North Island	72%	64%	64%	87%	71%
South Island	28%	36%	36%	13%	29%
N.Z. (000 tonnes)	240	80	75	70	465
% of total	52%	17%	16%	15%	100%

SOURCE: Mr. N. Robertson, Northern Roller Mills Group, Auckland, N.Z. 1976.

The North Island is the major consuming region in New Zealand making up 71% of processed stockfeeds consumed. The laying sector of the poultry industry is by far the prime user of processed stockfeeds.

The quantities of total grains used for feeding purposes have increased dramatically over the last decade. Table XIII indicates that wheat usage as a feed grain has declined significantly while barley and notable maize utilization have increased two-fold and four-fold respectively.

TABLE XIII QUANTITIES OF GRAIN FOR LIVESTOCK FEEDS: (000 tonnes)

Year	Wheat	Barley	Maize	Total
1968	75	95	43	213
1969	67	118	70	255
1970	55	144	85	284
1973	50	162	120	332
1975 (est.)	53	185	164	402

SOURCE: Paper given by Mr. J. Simpson, July 28, 1976, Maize Seminar, Massey University.

Grain utilization for all purposes; food, industrial and feed is depicted in Table XIV. These figures are the Ministry of Agriculture and Fisheries' estimates for the 1975-76 season.

TABLE XIV ALTERNATIVE GRAIN USES (1975-76) tonnes

Wheat:	MAF production estimates			426,000
	Utilization:	flour milling	320,000	
		feed and seed	42,000	
		surplus (estimate)	64,000	
			426,000	
Barley:	MAF production estimates			343,000
	Utilization:	feed	149,000	
		malting	73,000	
		distilling	5,000	
		seed	11,000	
		export	68,000	
		surplus (estimate	37,000	
			343,000	
Maize:	MAF production estimates			239,000
	Utilization:	feed	164,000	
		starch	15,000	
		distilling	6,000	
		food	3,000	
		export	58,000	
		shortage	- 7,000	
			246,000	

SOURCE: Paper presented by Mr. J. Simpson, Maize Seminar, Massey Univ. 1976

5.4 Structure of the Feed Manufacturing Industry

The structure of the New Zealand feed manufacturing industry has altered over the years. The overall movement within the industry has been towards a greater concentration of the trade in larger enterprises. The small feed manufacturing firms have either amalgamated with the major national concerns or they have gone out of business. This steady rationalization in the industry is illustrated by the decrease in the number of individual feed manufacturing companies yet at the same time there has been an increase in production and throughout per factory. The feed manufacturing industry at present is made up of basically two groups:

1) a few major firms which combined handle the major portion of the trade (i.e. the national compounders),
2) a number of small regional feed compounders.

Feed manufacturers on the national scale have a strong bargaining position relative to the grain merchant attempting to sell grain and the feed end users requiring animal feedstuffs. The national compounders also have an advantage over the regional compounders in terms of their economies of scale particularly in the buying of raw feed materials and for covering overheads in their marketing operation. Activities such as advertisement, research and development, and the use of up-to-date least cost feed mixes are spread over a far greater turnover relative to the smaller feed manufacturer. Obviously some diseconomies in transport occur with these larger firms. The smaller compounders are able to maintain lower transport costs since they generally buy and sell on a regional basis.

While there has been ample evidence of horizontal integration in the feed manufacturing sector, vertical integration by feed manufacturers is limited. Feed manufacturers have not taken over merchant firms to either purchase their raw materials or to market their processed feeds to farmers. There has been some vertical integration by feed manufacturers through subsidiary companies in the production of broiler chickens and other livestock enterprises. This is generally insignificant at present but may become a common form of integration and rationalization within the industry in the future. Some merchant firms, however, do own their own feed manufacturing businesses. This occurs on a very small scale and is generally on a regional basis.

5.5 Role of the Feed Manufacturer

The feed manufacturer represents the link between the grain merchant and the final processed-feed users. The feed manufacturer performs the following functions in the grain sector:

1) participates in the establishment of prices for the season,
2) makes the necessary transport arrangements for feed grains from the feed merchant to the processing plant,
3) manufactures the feed grains into bulk or bag form,
4) provides technical and economic services for end users,
5) retails the final feed products to end users.

The feed manufacturer indirectly plays a role in the establishment of farm gate prices in the various grain producing regions. Annual price negotiations for maize and barley begin well before sowing of the grain crops. These informal negotiations take place over a period of several months until eventually a price is established. Grain producers, grain merchants, feed manufacturers, and end users all present their respective positions during these informal negotiations as the major participants in the feed grain industry. The feed manufacturer represents the link between feed endusers and the grain merchants. The feed manufacturer's objective is to obtain the lowest possible farm gate feed prices for the endusers so as to enhance the competitiveness of pig and poultry products relative to other meats. This, of course, is balanced by the need to have sufficient grain grown and to set a price to attain this. Feed manufacturers consult their feed endusers, usually pig and poultry producers, to ascertain any additional costs which have occured during the year in the industry. It has been estimated by a grain company executive that feed costs in the poultry industry account for over 70% of the cost of production and therefore any increases in the cost of feeds seriously effects the profitability of the industry and eventually the final prices for poultry and pig meats relative to other meats. Any attempt by feed manufacturers to increase their profits by charging higher feed prices would jeopardize the growth of their industry.

Feed manufacturers informally, through day-to-day business activity, negotiate with the merchants for an annual basic feed price. Regional price levels vary depending on the proximity of the grain producing area to the final feed market. Other feed grain needs are passed on to the merchants who in turn are similarly aware of total grain demand not only for feed grains but for exports and grains for food and industrial demand. Combining these needs, the merchants determine the area needed to produce the necessary grain requirements. Consultation between merchant and grain producer on either an individual basis or through such farm organizations as Federated Farmers provide the merchant with a feasible price for which grain producers would be willing to produce grain crops. The feasible price is established taking into account the prices of alternative production possibilities in the different regions. Two prices which are set unilaterally but which affect feed grain prices are those for malting barley and milling wheat. Also, besides alternative crop or livestock farming returns, the price of export grains must also be considered.

Once the farm gate price is established for the season, for example in the 1976-77 season the Gisborne maize price was initially established at $93.00/tonne while the Waikato price is $90/tonne, the merchants then begin contracting with the individual farmers. Similarly feed manufacturers sign forward grain contracts with merchant companies to purchase quantities of grain. Generally the buying policy is for the feed manufacturers to purchase grains on either an overline basis or a spread delivery basis.

Grain bought on an overline basis refers to grain purchased during harvest. Merchants receive the grain from the grain producers and transported it to rail lines where it is sent to the feed manufacturers. In a normal season feed manufacturers purchase approximately one-third of their grain requirements on an overline basis. The remaining two-thirds of their grain requirements are bought on a spread delivery basis from the end of harvest onwards until the next year's harvest. Spread delivery refers to grain purchased over a period of time (usually monthly requirements) based on a forward contracting system with the merchants. In order to encourage the storing of grain, the feed manufacturer presently pays $2.25/tonne/month to the storer, generally a merchant or stock and station company. Thus, during any season the price to the feed manufacturer increases by this monthly increment from harvest onwards until the grain is finally purchased and delivered.

The second function of the feed manufacturer is to transport grains from the regional areas to the feed companies. The transport arrangements are handled by the feed manufacturer and purchase is made "free-on-rail" during harvest period and "ex-silo" after harvest. Certain grading standards such as moisture content and quality must be met before the grain is accepted by the feed manufacturer. Generally feed manufacturers buy grain supplies from several merchants. This safeguards against any risks associated with a merchant firm not meeting its sales commitments.

The third function of the feed manufacturer is to process the grains and other ingredients into well-balanced feed mixes. Most protein materials for the feed mixes and sometimes even feed grains must be imported into New Zealand to make up the compounded feeds. The larger feed companies utilize computers to formulate the least cost feed mixes for their associated feed mills.

The fourth function of the feed manufacturer is to provide some form of after sales service to their customers. This could involve economic planning or technical services. Technical services such as ration formulation, pre-mixing of feed ingredients, laboratory services, and results from company financed research studies are made available to the companys' customers. Farm advisors are employed by the feed manufacturing company to provide on-farm assistance in matters relating to farm management, stock husbandry, and farm economics.

The final function of the feed manufacturer is to market his processed feeds. Once the feeds have been mixed and prepared for sale, they are sold to endusers in either bulk (90%) or bag (10%) form. There are generally two methods of sale:

1) direct to the enduser which comprises 85% of sales,
2) back to the merchants and from there to be sold to the small scale endusers. This makes up the remaining 15% of feed sales.

The reciprocal nature of the second option has developed out of the traditionally close contact between merchants and manufacturers. Merchants sell unprocessed grain to feed manufacturers and in turn the feed manufacturer markets the processed feeds back through the merchant sector. Feed manufacturers also provide a credit service to those endusers who buy direct from the company.

CHAPTER VI

FEED GRAIN SUPPLY MODEL

6.1 Introduction

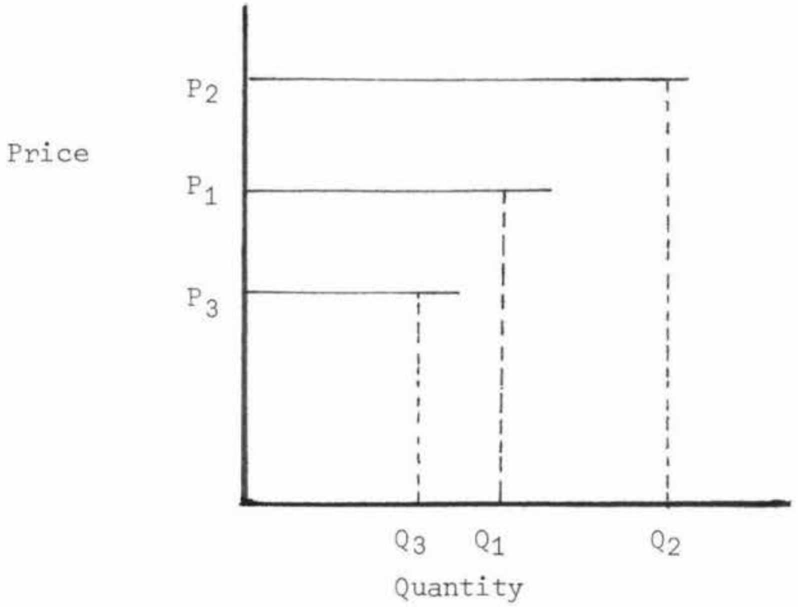
In the previous chapters of this thesis an attempt was made to describe in some detail the production, marketing, and utilization of feed grains in New Zealand. From this understanding attention is now turned to a quantitative interpretation of the industry using simple linear regression models to analyze the regional production of two major feed grains: barley and maize. This chapter will look at the methodology for the analysis of the New Zealand feed grain sector, the actual regional feed grain supply models for the various grains, and the results of the analysis.

6.2 Methodology

While the fundamental foundations of commodity supply are derived from a micro-basis (See Chapter II), a macro-model derived from this micro-economic theory can be hypothesized. The macro-model is then estimated statistically from simple aggregates of the micro-variables (i.e. output levels and prices). The estimated parameters from this model are then used to assess production response to a changing economic environment.

It is hypothesized that the grain industry in New Zealand is characterized by near-perfect competition in the production of feed grains. The justification for this statement is that the industry is made up of a very large number of small grain growers and for each grain type (barley, maize, or wheat) each grower produces a very similar end product (homogeneous products). Grain producers have very little influence over the prices they receive and any change in output by a single producer has no perceived effect on market price levels. Furthermore, in the New Zealand grain industry there is complete freedom of exit from and entry into the industry. Both the grain buyer and producer are knowledgeable about the seasonal market prices for grains. From these observations on the structure of the New Zealand grain industry, it is hypothesized that each grain farmer faces a demand curve for his product that is infinitely elastic (i.e. the demand curve is a horizontal line). In Figure 12 for example, the quoted annual merchant price for a specific region is P_1. All grain farmers within the region are free to choose whether or not they want to produce a grain crop at the price P_1 or alternatively, to produce other feasible agricultural products such as dairy, meat, or wool.

Figure 12 DEMAND CURVE FACING EACH FARMER: PERFECT COMPETITION



At a higher price level, say P_2 farmers respond by producing quantity Q_2 while at a lower price level of P_3 only Q_3 is produced. Thus grain farmers in the New Zealand grain industry are characterized as price takers and can be modelled as a homogeneous group existing in a perfectly competitive environment.

6.3 Lags in Price and Acreage Adjustment

Many authors (27,9,14) have attempted to estimate the relationship between expected prices and observable price variables. These attempts have been prompted primarily because of the different market structures in these countries (notable Canada, USA, and Australia) where initial grain price announcements are made prior to sowing. Farmers under these circumstances can never know what the full price for their grain product will be until the crop year ends and a final price is paid to the grower after all marketing expenses have been accounted for. Several simple models of expectation formation which have been proposed are:

1) the cobweb model,
2) the traditional model of extrapolative expectation,
3) the adaptive expectations model,
4) the rational expectation model.

Nerlove's (26) model, the adaptive expectations model, has found wide use in recent years and states that:

$$P^*_t - P^*_{t-1} = C\,(P_{t-1} - P^*_{t-1}) \qquad 0 \leq C \leq 1$$

where P^*_t = expected price level for the new season,

P^*_{t-1} = expected price level for the previous season,

P_{t-1} = observed price level for the previous season,

C = coefficient of expectation.

This formulation has the economic interpretation that each year farmers revise the price they expect to prevail in the new season in proportion to the error they made in predicting prices in the preceding season.

In the New Zealand grain industry a different situation exists. Price expectations are not paramount in deciding which grain crop to grow because the new season's crop prices are known prior to sowing. Wheat prices are announced by the government through the New Zealand Wheat Board well before the winter wheat crop is planted (usually the price is announced in March). Maize and barley prices are generally available through the merchant's grain contracting system.[1] Thus all

1 Aspects of this contracting system were discussed in Chapter IV.

grain prices are known prior to sowing and farmers' decisions as to which crop to produce are based on the actual prices of grains.

Considering the question of lags in acreage adjustment in New Zealand agriculture, it has been observed that complete adjustment of each farming enterprise in response to changing market conditions is not always feasible in any one season but is spread over several years. Guise, in his economic analysis of the New Zealand wheat industry, states that "...subject to the constraint of total acreage available on individual properties, farmers will adjust the size of each enterprise in the new season at least partly toward its long term equilibrium size, if these relative prices for products were to hold into the indefinite future". (11, p.16). Since most development and investment on farms is approached with a long term plan in mind, in any one season a farmer seldom alters the entire structure of his farm when switching from one productive enterprise to another (i.e. from dairy production to maize cropping). This is due to previous commitments in fixed factors of production (such as specialized machinery and buildings), uncertainty about the future price trends in farming, lack of information and other factors which influence a farmer's decision. Furthermore, the ability to change farm structure in any year may also be affected by certain non-economic factors such as weather conditions and crop rotations. Unfortunately, not all of these factors are quantifiable, and this severely limits the analysis. However, surrogates for these non-quantifiable constraints will be presented and incorporated into the supply model.

Lags in acreage adjustment can be interpreted in the following mathematical form:

$$Q_t - Q_{t-1} = d\,(Q_t^* - Q_{t-1}) \qquad 0 \leq d \leq 1 \qquad (1)$$

where: Q_t = quantity produced in period t

Q_{t-1} = quantity produced in period t-1

Q_t^* = desired quantity in period t

d = coefficient of adjustment

and which reduces to: $Q_t = dQ_t^* + (1-d)\,Q_{t-1}$

This is Nerlove's (26) model of partial adjustment and is appropriate for the present analysis based on the above interpretation of the New Zealand cropping sector. This equation describes the way in which supply adjusts towards the long run equilibrium supply where d represents the proportion of the adjustment towards equilibrium which occurs in one time period. The time necessary to change fixed factors of production is the primary reason for the existence of this parameter.

6.4 The Model

In Chapter 2 (section 2.2) it was shown that the price of a product and the price of inputs required to produce the product are important in determining the amount of a commodity produced. This very simple model can be expanded to incorporate other influencing factors such as the prices of alternative products which the farmer could feasibly produce and other non-economic variables which influence the production of agricultural products.

It is intended in this analysis to formulate a supply response model for two different feed grains, barley and maize. Furthermore, the analysis will concentrate on several broadly defined regions in New Zealand. For barley these include the South Island and North Island regions. For maize, since production is primarily located on the North Island, only a North Island model will be examined. Because of the regional differences in production alternatives the regional models will naturally include different variables. To avoid any misunderstanding of which variables will be included in which model, a generalized model will be presented initially and in the individual sections on each grain for each region there will be a more specific presentation of the model. Therefore, a generalized agricultural supply response model incorporating these variables but omitting input prices because it was impossible to gather data on the specific costs associated with each enterprise throughout the entire time period of the analysis, has the form:

$$Q_t^* = a_o + a_1 \frac{P_t^g}{P_t^c} - a_2 P_t^L + a_3 Z_t + a_4 T + a_t \qquad (2)$$

where Q_t^* = acreage of grain in period t

P_t^g = price of grain in period t

P_t^c = price of the major competitive grain in the specific region in period t

P_t^L = price of major livestock alternatives in the specific region in period t

Z_t = non-economic factors

T = linear trend variable

e_t = error term

a_o, a_1, a_2, a_3, a_4 = regression coefficients to be estimated.

To account for lags in acreage adjustment which were discussed in the previous section (6.3) equation (1) can be substituted into (2) to obtain:

$$Q_t = a_o d + a_1 d \frac{P_t^g}{P_t^c} - a_2 d P_t^L + a_3 d Z_t + a_4 dT + (1-d)Q_{t-1} + de_t \qquad (3)$$

Equation 3 simplifies to a linear model of the following form:

$$Q_t = b_o + b_1 \frac{P_t^g}{P_t^c} - b_2 P_t^L + b_3 Z_t + b_4 T + b_5 Q_{t-1} + b_6 e_t \qquad (4)$$

This equation takes on the form of an auto-regressive, linear regression model. It assumes static price expectations and incomplete acreage adjustment for each crop season. This model will provide some indication of the quantitative relationship between grain prices and grain acreage and implies that variations in grain production are influenced by the prices of alternative production possibilities, non-economic factors, lagged grain production, and technological change.

If the model (4) is estimated by least-squares, it is assumed that the error term (e_t) is independently distributed with a mean of zero and a constant variance.

The effects of lagging the dependent variable (Q_{t-1}) in the regression model results in autocorrelation of the error term and correlation between the lagged dependent variable and the error terms. For example, Q_{t-1} is not independent of e_{t-2} because Q_{t-1} is determined in part by the lagged value Q_{t-2}, which is dependent on e_{t-2}. Thus there is a partial dependence between the lagged dependent variable and the disturbances and this causes the classical least squares estimates to be biased. Assuming that the disturbance term e_t is normally and independently distributed with zero mean and a constant variance, Christ (6) has shown that these least squares estimates are consistent, that their asymptotic variances exist, and that these variances are approximated by the usual ordinary least squares estimates of them.

Turning now to a discussion of the independent variables which make up equation (4), the justification for the inclusion of relative feed grain price variables in the feed grain supply model is based on the hypothesis that farmers make decisions about the planted acreage of individual grains on the basis of the prices of these grains relative to other feasible grain crops. Some grains are naturally closer substitutes to other grains depending upon machinery requirements, time of planting, the feasibility to grow the grain in the region, and other cultural requirements. Similarly, the prices of alternative production possibilities in the livestock industry strongly influence the acreages of grain crops in New Zealand. Depending on the particular grain and region in question, the market prices of pastoral products such as wool, beef, lamb, and dairy products cause wide fluctuations in annual grain acreage.

It is also hypothesized that the acreage of a particular crop in the previous season determines to some extent the acreage in the new crop season. The prime reason for this is that agricultural production has traditionally been more of an adjustment process due to the presence of fixed factors in agricultural production which severely limit immediate acreage response to market prices in the short run. Information lags and non-economic factors such as crop rotations are hypothesized to influence the acreage of other grains planted in the new season.

In estimating the feed grain supply equations several basic economic relationships are expected from the regression coefficients of each estimated equation. From supply theory, one would expect that a positive relationship would exist between price and output. The higher the price of a product, the greater the quantity produced. Also, one expects a negative relationship between the quantity of a particular grain produced and the prices of other competitive grains and/or livestock products. This negative relationship arises because all feasible production alternatives compete for the same farm resources as land, capital, and labor. For example, as wool prices increase, farmers divert more resources into the production of wool. They may buy more stock and thus reduce their grain acreage to accommodate the additional stock numbers. Also, one would expect the sign for the lagged dependent variable to be positive if the assumption is valid that the previous year's acreage of a crop influences current acreage of a crop. For the non-economic factors, particularly the crop rotational effect of barley following wheat[2], one would expect a positive relationship between the production of wheat in period t-1 and the production of barley in period t. The relationship between wheat production in the current period to barley production in the same period[3] is expected to be negative. The more wheat planted in the fall and spring of the new season, the less barley planted in order to maintain grain acreage on the farm.

Because of distinct marketing and climatic differences between the New Zealand grain growing areas, two main production and marketing regions have been broadly defined for estimation purposes. These areas are the North Island and South Island grain growing regions. These regions have been selected according to Duloy and Watson's criteria..."that regions should be uniform in their response to economic stimuli," and..."that the regions be homogeneous with respect to climatic variability". (9,p.31).

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2 See Chapter III, Section 3.3.2. Cultural Constraints on Crop Production.

3 See Chapter III, Section 3.3.1. Constraints Imposed by Nature.

For all regional feed grain models the dependent variable is the actual acreages of each grain harvested in each season. For the more recent years (1973-1976), the data for harvested acreage is the Ministry of Agriculture and Fisheries' estimates of post- harvest acreage. The choice of actual acreage threshed rather than intended acreage was based on the statement by Guise that, "It was considered that there would be very little difference between farmers' intentions and actual realized acreage threshed since it is seldom in New Zealand that climatic conditions prevent either the sowing or harvesting of the crops." (11, p.25).

The basic economic model to be presented in this study is estimated using annual time series data. Grain production in New Zealand is on the basis of one sowing and one harvest per year. Since it has only been in recent years that there has been such a rapid expansion of the feed grain industry, particularly in the North Island, the time series analysis has been limited to only 15 years of data. This is because there is very little reliable data available before this period. The prices for all commodities are estimated at the farm gate level. (See Appendix for data sources).

6.5 Interpretation of the Results

Maintaining the above assumptions about the form of the model and its statistical properties, the regression equations for the two major feed grains were estimated. As previously stated, barley acreage was estimated at the regional level for the South Island and the North Island, while for maize only a North Island model was estimated as very little maize is produced on the South Island. Tables 6.1 to 6.6 detail the results from the regression equations. The estimated regression equations generally supported the hypothesis on which the model had been based. The hypothesized signs for the regression coefficients were achieved except for several cases which will be discussed on an individual basis. The regression coefficients from each equation were all tested for their statistical significance. The procedure is to hypothesize that the regression coefficient is equal to zero. This assumption implies that a variable with a zero coefficient in an equation carries no weight in explaining the variations of the dependent variable. Similarly this can be stated as:

$$Ho : b = o$$

$$Ha : b \neq o$$

where b = regression coefficient.

The student "t" distribution is used for the purpose of either accepting or rejecting this hypothesis. The formula for determining the calculated "t" value is as follows:

$$t = \frac{b}{S_b}$$

where t = calculated "t" value,

b = estimated regression coefficient from regression equation,

S_b = standard error of the estimate.

If the calculated value of "t" is higher than the "t" value in the student "t" distribution, then we reject the null hypothesis (b = o) and conclude that the variable is a statistically significant variable in explaining the variation of the dependent variable.

The R^2 values for each of the estimated equations are also included in the tables. The higher the value of the R^2 then, the greater the variation in the dependent variable is explained by the independent variables incorporated in the model.

One of the objectives of this study was to estimate the supply elasticity. The supply elasticity shows the speed and magnitude of output adjustments in response to changes in produce price. This parameter is especially important for public policy because it measures the ability of farmers to adjust production to changing economic conditions that continually confront them in the fluctuating agricultural sector. The elasticity of supply tends to be highest for commodities that can be produced under a wide range of resource conditions and that have alternatives that are readily substitutable in production. One of the hypotheses of this analysis is that North Island feed grain production has a greater elasticity of supply relative to South Island supply elasticity. Justification for this statement is based on the different structure of the feed grain industries in each region. The North Island feed grain producing region is characterized by a greater choice of production alternatives and a system of machinery contracting that enables farmers to enter and exit from grain production in response to market conditions without being limited by high fixed-asset investment in machinery. Also, because of climatic advantages, alternative production possibilities are more extensive in the North Island relative to South Island production. Since grain production has been a more traditional activity on the South Island, it is expected that the South Island elasticity of supply will be lower than the North Island elasticity of supply.

The elasticities were estimated at the mean values of the explanatory and dependent variables using the following formula:

$$e = b \frac{x}{y}$$

where e = the estimated elasticity,

b = the regression coefficient of the particular explanatory variable,

x = mean value of the explanatory variable,

y = mean value of the dependent variable.

6.5.1 South Island Barley Results

The South Island barley model attempts to specify the most important production alternatives in the region. The two most important crops grown in the South Island are barley and wheat. Thus the price of wheat has an important influence on what the price of barley will be and ultimately on how much barley will be produced. Furthermore, wool and lamb production are recognized as being the major competitive livestock alternatives to cropping in the South Island. Because of this, these two variables are specified separately in the model to test the influence that each have on the quantity of barley produced in a season. Lagged barley acreage is included in the model as an indication that once production of a crop has been initiated into the production base of a farm, the farmer generally continues to crop further acreages in successive years. Finally, a linear trend variable is included to take account of technical change in the grain industry over the fifteen year time period of this study. Thus the regional model for South Island barley production can be illustrated as follows:

Acreage South Island barley = $f(\frac{PB}{PWh}, MLA, AB, T)$

where: PB = price barley,

PWh = Price wheat,

AB = acreage barley from the previous season,

MLA = major livestock alternative,

T = time variable.

Several variations of the above model are specified to note any differences in the significance of the coefficients and possibly to improve the explanatory ability of the model. For all the models the area of South Island barley was specified as the dependent variable. Several independent variables as noted above were specified. Since all important explanatory variables can not be incorporated into one single equation because of a lack of degrees of freedom, several different equations were specified which included these variables. These are presented in Table XV.

The regression equations for South Island barley production generally supported the hypothesis on which the model was based. The coefficients for each independent variable had the correct signs as expected and generally were significant. The significance levels are noted in Table XV. The price ratio of barley to wheat was included as the major cropping alternative. The wheat price was later specified in the model at its absolute value but it resulted in the coefficient becoming insignificant and of the wrong sign. Similarly the absolute values of both the lamb and wool prices were included and in each case the coefficient was significant and had the correct negative sign to indicate a competitive alternative to cropping. For example, in equation number one where all variables are significant at the 1% level, 86% of the variation in South Island barley is explained by the model. Referring to Table XVI for the elasticities at the mean, a 10% increase (decrease) in the barley to wheat-price ratio would result in a 25% increase (decrease) in the area sown to barley. The negative sign for the price of wool is an indication that as the price of wool increases, less barley will be planted as farmers switch resources from barley to wool production. The elasticities at the mean estimated that for a 10%

TABLE XV: SOUTH ISLAND BARLEY RESULTS

Equation	Dependant Variable	Independent Variables	R^2
1	Acreage of Barley	$-81049 + 134555 \frac{PB}{PWh} - 291\ PW + 1.0\ A\ B$ *** *** *** ***	.86
2	Acreage of Barley	$-68477 + 70931 \frac{PB}{PWh} + 36627 \frac{PB}{PW} + .84\ AB$ *** ** *** ***	.86
3	Acreage of Barley	$-69084 + 117325 \frac{PB}{PWh} - 230\ PW + .64\ AB + 1408\ T$ ** *** ** ** *	.87
4	Acreage of Barley	$-57690 + 103573 \frac{PB}{PWh} - 117\ PW + 3326\ T$ ** ** ***	.83
5	Acreage of Barley	$-73354 + 123432 \frac{PB}{PWh} - 645\ PL + 1.0\ AB$ ** *** * ***	.77
6	Acreage of Barley	$-56170 + 108437 \frac{PB}{PWh} - 744\ PL + .36\ AB + 2867\ T$ ** *** ** * ***	.86
7	Acreage of Barley	$-53700 + 108089 \frac{PB}{PW} - 635\ PL + 3878\ T$ ** * ** ***	.86

where for the independent variables:

PB = price barley in period t
PWh = price wheat in period t
AB = acreage barley in period t-1
PW = price wool in period t
PL = price lamb in period t
T = time

and:

*** = 1% level of significance
** = 5% level of significance
* = 10% level of significance

TABLE XVI Estimated Elasticities at the Means: S.I. Barley

Explanatory Variable	Dependent Variable: S.I. Barley Production (equation number) 1	2	3	4	5	6	7
PR. Barley / Pr. Wheat $_t$	+2.5	+1.3	+2.2	+1.9	+2.3	+2.0	+2.0
Pr. Lamb $_t$					-.51	-.58	-.50
Pr. Barley / Pr. Wool $_t$		+.51					
Production Barley $_{t-1}$	+.89	+.75	+.57		+.89	+.32	
Pr. Wool $_t$	-.54		-.43	-.22			

increase (decrease) in the price of wool, the area sown to barley would decrease (increase) by 5.4%. Lagged barley acreage in this equation has a positive coefficient indicating an adjustment process is prevalent in the feed grain production sector and that the previous years acreage of barley has some influence on current production.

Equation number two from Table XV explains approximately 86% of the variations in South Island barley area over the period studied. All variables in this particular equation are significant at least to the 5% level. The equation indicates that barley plantings are sensitive to the price of wheat and wool. The positive sign implies that barley competes with wheat and wool production for available farm resources. From Table XVI the elasticities at the means for the barley to wheat and the barley to wool price ratios in equation number two are estimated to be +1.3 and +.5 respectively. This implies that a 10% increase (decrease) in the barley to wheat price ratio would result in a 13% increase (decrease) in the acreage planted to barley. Similarly, a 10% increase (decrease) in the barley to wool price ratio would result in a 5% increase (decrease) in the acreage planted to barley.

The price of lamb was included as another significant variable in several equations in Table XV. In equations 5, 6, 7, a negative sign for this coefficient was obtained indicating a competitive production possibility to barley production. The elasticities at the mean for equation number 5 indicated that for a 10% increase in the price of lamb, barley acreage would decrease by 5.1%. Similar indications of production response can be drawn from the other equations illustrated in Table XV. Over all equations estimated, a 10% increase in the barley to wheat price ratio produced a 20% increase in the acreage sown to barley. If recommendations were to be made to either government or private grain companies on possible pricing alternatives for South Island barley, one could utilize the above elasticity estimates as an aid to decision making on price levels. Alternatively, to forecast production for the next season, grain merchants could not only utilize one of the above models as an aid in defining annual price levels but also taking into account the influence of alternative products. For example, equation number three, which explains 87% of the variation in South Island barley is as follows:

Acreage of South Island barley =

$$-69084 + 117325 \left(\frac{PB}{PWh}\right)_t - 230\ PW_t + .64\ AB_{t-1} + 1408\ T$$

This equation has been derived from data covering the period up to 1975. To test the accuracy of the model at predicting future grain acreage one can substitute recently published data for the 1976 season into the equation. The 1976 data is as follows:

Price Barley = 92.61/tonne
Price Wheat = 95.48/tonne
Price Wool = 157.1 cents/kg.
Lagged Barley acreage = 89635 ha.
Trend value = 16

Substituting these values into equation three produces a predicted acreage of 65906 ha. while the actual published acreage for South Island barley production is 72095 ha. The predicted value is within 8.5% of the actual level of production. Since the price establishment process for feed grains occurs prior to planting grain merchants are able to observe grain and livestock prices that are presently quoted in the market place. These prices, or possibly a range of prices can then be utilized in the model to derive the desired acreage requirements which the grain merchants feel would meet their market requirements. The benefit of using a model, if the model is theoretically sound, would be its usefulness in providing quantitative estimates to support a grain merchant's subjective opinion on current and future market trends.

6.5.2 North Island Barley Results

It was pointed out in Chapter Three that there were several different aspects between the North Island and the South Island feed industries. Specifically, there are differences in market structure and there is a wider choice of feasible production possibilities on the North Island due to climatic differences. Maize, barley, and wheat can be grown on the North Island yet the area planted to wheat is not extensive because of the higher level of rainfall in the North Island. Wheat is also planted in the Spring on the North Island while in the South Island wheat can be planted in the Fall or Spring. All barley grown in the North Island goes directly into feed uses while on the South Island a sizeable portion of the year's crop is purchased by the malting company. Furthermore, dairy production is pursued on a much wider scale in the North Island thus the price of dairy products could influence the quantity of barley grown.

Because of these regional differences the barley model for the North Island will contain several different variables compared to its South Island counterpart. The basic model is similar. North Island barley area is the dependent variable and the independent variables are the price ratio of the major cropping alternatives, the price of the major livestock alternative and the acreage of barley in the previous year. Similar assumptions about the statistical properties of the model are made for this analysis of the North Island barley production. The variables which make up the model all displayed the expected signs and had coefficients with levels of significance as illustrated in Table XVII. Several different variations of the above basic model are illustrated. The two variables for the major crop alternatives were first the price ratio of barley to maize and secondly the price ratio of barley to wheat. For the major livestock activities, the price of wool, the price of dairy products, the price of beef, and the price of lamb were considered to be the most competitive alternatives to cropping activities. In all cases a negative relationship between the area of barley planted and the prices of these alternative livestock activities was achieved. For example, the model indicates that as wool prices increase the area of barley diminishes.

The elasticities were estimated at the mean and are depicted in Table XVIII. In equation number one the dependent variable was the area of barley under production and the independent variables explained 95% of the variations in barley acreage. The following interpretation can be made about the elasticities. For a 10% increase in the barley/maize price ratio, an 11% increase in barley acreage occurs. Similarly, for a 10% increase in the price of wool, the production of barley would decrease by 6.4%. The coefficient of the time trend was positive which indicated that with all else constant, the barley area would have increased by 1270 ha. annually. Similar interpretations can be applied to the other

TABLE XVII NORTH ISLAND BARLEY RESULTS

Equation	Dependent Variable	Independent Variables	R^2
1	Acreage of N.I. barley	$-6092 + \underset{**}{18492}\,\frac{PB}{PM} - \underset{***}{117}\,PW + \underset{**}{.307}\,AB + \underset{***}{1270}\,T$	.95
2	Acreage of N.I. barley	$\underset{*}{-13519} + \underset{**}{36638}\,\frac{PB}{PM} - \underset{**}{267}\,PD + .204\,AB + \underset{***}{2138}\,T$	.86
3	Acreage of N.I. barley	$2577 + 1752\,\frac{PB}{PM} - 173\,PB + .57\,AB + \underset{**}{1138}\,T$	.78
4	Acreage of N. I. Barley	$3403 + 6946\,\frac{PB}{PM} - \underset{**}{332}\,PL + .25\,AB + \underset{***}{1658}\,T$	.87
5	Acreage of N.I. Barley	$6162 + 2669\,\frac{PB}{PWh} - \underset{***}{106}\,PW + .23\,AB + \underset{***}{1531}\,T$	.91
6	Acreage of N.I. Barley	$7743 + 2563\,\frac{PB}{PWh} - \underset{*}{355}\,PL + .238\,AB + \underset{***}{1754}\,T$	.86

where for the independent variables:

PB = price barley in period t
PM = price maize in period t
AB = acreage barley in period t-1
PW = price wool in period t
T = time
PD = price dairy products in period t
PL = price lamb in period t
PWh = price wheat in period t

and:

*** = 1% level of significance
** = 5% level of significance
* = 10% level of significance

TABLE XVIII ESTIMATED ELASTICITIES AT THE MEAN: NORTH ISLAND BARLEY PRODUCTION

	Dependent Variables: N.I. Barley Production (equation numbers)					
Explanatory Variables	1	2	3	4	5	6
Pr. Barley/Pr. Maize $_t$	+1.1	+2.2	+.10	+.41		
Pr. Barley/Pr. Wheat $_t$					+.14	+.13
Price Wool $_t$	-.64				-.58	
Barley Production $_{t-1}$	+.27	+.18	+.51	+.23	+.20	+.21
Pr. Dairy Products $_t$		-.16				
Price Beef $_t$			-.40			
Price Lamb $_t$				-.76		-.81

equations in Table XVII, but caution must be used in analyzing the results of those equations that have independent variables which are not significant. To test the North Island barley models for their forecasting value 1976 data was substituted into equation number one as follows:

Acreage of N.I. Barley =

$$-6092.8 + 18492.1 \frac{PB}{PM} - 117.8\ PW + .3068\ AB + 1270\ T$$

where the data for the 1976 analysis is as follows:

PB = Price Barley = 84.00/tonne

PM = Price Maize = 79.00/tonne

PW = Price Wool = 157.1 cents/kg.

AB = Lagged Barley acreage = 28930 ha.

T = Trend value = 16

The forecasted value can be obtained by substituting the above data into equation number one to obtain the North Island barley area prediction of 24259 ha. In 1976 the Ministry of Agriculture and Fisheries estimates for North Island Barley production was recorded at 23905 ha. This is within 2% of the actual area planted.

An attempt was made to substantiate the hypothesis that farmers set a pre-season, total acreage limit and attempt to fulfill this limit by decreasing or increasing other grain acreage relative to the acreage foregone in an alternative grain crop. An example would be the substitution of barley acreage for wheat acreage which on the North Island is often restricted because of wet weather in the Spring. Barley is planted approximately one month after wheat when weather conditions are more stable. Thus the expected regression sign for the inclusion of new season wheat acreage into the feed grain model would be a negative relationship, implying that for any shortfall in wheat plantings, barley acreage would make up the difference (i.e. as wheat acreage decreases, barley acreage increases). However, this relationship was not demonstrated by the model in any of the regression equations.

It was not possible to accurately compare North Island and South Island barley elasticities because when absolute barley price variables were used in the equation, the coefficients were consistently of the wrong sign and insignificant. When price ratios were compared it was necessary to use the major cropping alternative in the region. In the North Island maize is the competitive grain crop thus resulting in a barley/maize price ratio for the North Island regional model. For the South Island wheat is the closest competitor to barley thus resulting in a barley/wheat price ratio for the regional model. Because of this lack of similarity between the two regions a true comparison of the elasticities of supply between North and South Island barley production cannot be obtained. Instead, the regions are best analyzed on an individual basis. In general, for a 10% increase in the North Island barley/maize price ratio, barley acreage increased by 17%. For a 10% increase in the South Island barley/wheat price ratio, barley acreage increased by 21%.

6.5.3 North Island Maize Results

The results obtained from the study of North Island maize production are not extensive. Only three equations are presented in Table IXX and these are simplified versions of the original model. Many of the variables which were incorporated into the model had opposite signs than were expected and were generally insignificant. In the equations the Durbin-Watson test for autocorrelation is inconclusive and therefore it cannot be said whether there is positive or negative correlation in the residuals. Equation number one from Table IXX incorporates the price of maize and trend variable. This equation explains 87% of the variation in maize acreage. The elasticity at the mean was estimated and for a 10% increase in the maize price, the acreage of maize increases by 15% (See Table XX). The time variable is positive which indicates an acreage increase of 995 hectares annually, all other factors being constant. When alternative livestock prices were substituted into the model, the expected negative signs were obtained. Unfortunately, the livestock variables (Price Beef and Price Lamb) were not significant even to the 10% level in these equations, so very little can be said about the quantitative influence of these alternative products on maize acreage.

TABLE XIX NORTH ISLAND MAIZE RESULTS

Equation	Dependent Variable	Independent Variables	R^2
1	Acreage of N.I. Maize	-12297 *** + 233 *** PM + 994 *** T	.87
2	Acreage of N.I. Maize	-8164 * + 171 * PM - 82 PBF + 1250 *** T	.86
3	Acreage of N.I. Maize	-11698 *** + 268 *** PM -90 PL + 1066 *** T	.86

where for the independent variables:

PM = price maize in period t
PBF = price beef in period t
PL = price lamb in period t
T = time

and:
*** = 1% level of significance
** = 5% level of significance
* = 10% level of significance

TABLE XX ESTIMATED ELASTICITIES AT THE MEANS: NORTH ISLAND MAIZE PRODUCTION

Explanatory Variables	Dependent Variable: Maize Production (equation numbers) 1	2	3
Price Maize $_t$	+1.5	+1.1	+1.7
Price Beef $_t$		-.34	
Price Lamb $_t$			-.37

6.5.4 Summary

In summary, the regression coefficients indicated that barley plantings were sensitive to the relative prices of grains and particularly to the prices of such livestock products as lamb and wool. A strong upward trend in the planting of feed grains is also prevalent. Although direct comparison of elasticities between North and South Island was not possible, some indication of the quantitative aspects about regional barley production in New Zealand were established. Similarly, the maize industry, which has only gained importance in New Zealand within the last 7 to 10 years, was examined on a quantitative basis. Although the maize results were poor, some indication of the responsiveness of planted acreage to maize prices was established. This initial analysis of the feed grain industry has provided a starting point for any future investigations of the industry.

Chapter VII

7.1 Summary and Conclusions

Up to this point very little has been written about the New Zealand feed grain industry. This study has merely provided an overview of the New Zealand market, its participants, and how they function. This is just the beginning, more work is needed which will zero in on specific aspects of the industry. The supply models have attempt to quantify the relationship between prices and production of the various feed grains. This, again, is a starting point for future quantitative analysis on the feed grain industry.

The main point in studying the New Zealand grain industry as it exists today was to gain some insight into what might happen in the future. Several important aspects have come into focus:

1) There is an urgent need for the grain trade to provide accurate industry statistics on grain prices and eventual end use of feed grains within New Zealand and on the export market.
2) Each individual participant in the marketing chain is mutually dependent on the other participants to make the whole industry function smoothly. Growers, merchants, feed manufacturers, and end users need to work together to create an opportunity in which each can survive in the industry, otherwise production will stagnate.
3) There is a need for continuing flexibility and responsibility within the grain production/marketing process to ensure that adequate supplies are produced in the long term. An example of this would be the proposed maize stabilization pool which was created to siphon off a portion of the excess profits in the better exporting years with the objective in mind of injecting these funds back into the system in the leaner years, thereby hoping to eliminate the effect of excessive price fluctuations.

Several marketing alternatives have been proposed in recent years in response to some of the marketing problems encountered in the New Zealand feed grain industry. To a certain extent the grain industry itself must share some of the blame for even the mere suggestion of changes to the present system.

Several recent occurrences in the feed grain industry are visible indications that not all is well in the market place. Examples of these are situations where producer groups are forming their own grain cooperatives and also wide spread discussion on the formation of a feed grain marketing board. These issues could possibly have been avoided if the grain trade as an association reacted by:

a) better explaining their actions in the marketplace, in particular how producer prices are established on an annual basis.
b) by providing accurate market information on prices and the eventual marketing of feed grains.

As stated earlier this inactivity on behalf of the grain trade in New Zealand has encouraged grain producers to form their own cooperative in order to produce, dry, and market grains direct to endusers. They are, in short, effectively bypassing the grain merchant. The question is asked, "Why would grain producers go to the trouble and expense of trying to dry and market their own grain when up to now the grain merchant has handled that aspect of the business?" The motives behind the producers actions are directly related to the economics of grain drying and marketing, and also to the type of service provided by the grain merchant. Obviously, grain producers don't feel they are being treated fairly and they feel they can receive a better return by processing and marketing their own grain than to have the grain merchant perform these same functions.

In chapter 4 it was pointed out that grain producers in New Zealand rely on their grain merchants for their required inputs and eventual sale of the grain. In New Zealand there is no formal market place for setting grain prices where prices are quoted on a daily basis and where producers can decide to buy or sell as they wish. This could become a serious inadequacy as the New Zealand feed grain industry expands. Some changes will be needed to make the industry function more smoothly. One suggestion would be to more fully utilize the services of the local grain brokers who daily contact merchants and endusers to move grain from the farm to the feed manufacturer. The grain brokers' functions are to bring buyers and sellers together. In any single transaction the buyer and seller do not know who the other party is until the grain broker makes the sale final and delivery slips are made out. Grain producers could pool their grain and approach their local grain broker to sell a shipment of grain at a specified price. It is the brokers' job to find a buyer at that price. If the price is too high, then obviously no sale is made. The producers can maintain that price and continue to store their grain or lower the price until a buyer is found. A system such as this is as close to the free market approach as one could realistically hope for in a market structure the size of the New Zealand grain industry.

Discussions on a feed grain marketing board have been widespread in recent times. One way of approaching this issue would be to initially have a producer vote on whether or not a feed grain board is needed. Voters must naturally be eligible producers of feed grains. Members of the proposed feed grain board should be elected from among growers, industry, and government. The structure of the board could take many forms but a suggestion would be to have the feed grain board keep away from the marketing of the crop directly and leave that to the grain industry. Functions of the board would be to negotiate the terms and conditions of sale within New Zealand but would not influence the prices of feed grains. They could also monitor the price spreads between domestic and export prices and act as the agency to manage the surplus funds as suggested by the proponents of the maize stabilization pool. They could also be the group which would take responsibility for the collection and maintenance of industry statistics. A final function of the board would see them providing an advance payment system to member producers. Such a financial undertaking would need funding from governmental sources. However, a service such as this would free the grain producer from automatically turning to the grain merchant for the necessary farm inputs to grow a crop which has tended to put the merchant in a favourable position to encourage that grain producer to market his crop through the grain company. By allowing the producer to obtain his operating capital from other sources, this in turn could allow the producer to market his grain when he feels the prices are more favourable. There is a need in New Zealand agriculture for more active participation of the trading banks in the agricultural industry to provide financial services to the basic producers as illustrated in the situation referred to above. Solutions to the market problems in the New Zealand feed grain market will not be easily found. Hopefully, this study has shed some light onto some of the basic functions and activities of the major participants in the New Zealand feed grain industry.

APPENDIX A

Year	S.I. Barley Production	S.I. Wheat Production
1955	14850	39298
1956	17941	25894
1957	21350	24689
1958	24233	31856
1959	18729	49937
1960	20882	61419
1961	21685	70952
1962	26773	71120
1963	29219	86128
1964	30989	78051
1965	27436	69239
1966	25669	75629
1967	26836	88498
1968	42870	117903
1969	45434	118716
1970	36437	99095
1971	57183	91074
1972	70272	99667
1973	53838	102267
*1974	63930	68530
*1975	89635	56818

Source: Department of Statistics, Agriculture, 1955-1973.
*Ministry of Agriculture & Fisheries, Cereal Crop estimates.

Year	Barley Production	N.I. Maize Production	N.I. Wheat Production
1961	4860	2656	4642
1962	4436	2973	4272
1963	6165	3196	5233
1964	7044	3818	4492
1965	7787	3900	5214
1966	8318	3249	5118
1967	10386	3043	4811
1968	19916	5822	8753
1969	18112	7045	11262
1970	19652	7905	9301
1971	24198	11597	6458
1972	25991	14806	6929
1973	19912	12858	6964
*1974	17220	17500	4170
*1975	28930	24505	2581

Source: Department of Statistics, Agriculture, 1961-73

*Ministry of Agriculture and Fisheries, Cereal Crop Estimates

GRAIN PRICES $/tonne

Year	S.I. Feed Barley Price*	S.I. Malting Price+	S.I. Wheat Price#
1955	39.25	39.25	42.34
1956	39.25	39.25	42.34
1957	37.04	39.25	42.34
1958	39.25	39.25	42.34
1959	33.08	39.25	49.61
1960	37.49	39.25	49.61
1961	39.25	39.25	49.61
1962	35.28	39.25	49.61
1963	33.96	39.25	49.61
1964	33.96	39.25	49.61
1965	33.08	39.25	49.61
1966	34.40	41.01	53.36
1967	34.40	41.90	53.36
1968	33.08	41.90	53.36
1969	35.28	40.57	53.36
1970	35.28	40.57	53.36
1971	35.28	40.79	53.36
1972	39.69	43.44	55.13
1973	35.28	45.42	56.96
1974	66.15	56.89	59.71
1975	79.82	92.61	91.86

Source: *Pyne Gould, Guinness Ltd., Christchurch, New Zealand company records.

+Canterbury Malting Co., Christchurch, New Zealand company records.

#New Zealand Wheat Board, Annual Reports, 1970-73.

GRAIN PRICES ($/tonne)

Year	N.I. Barley Price*	N.I. Maize Price+	N.I. Wheat Price#
1961	46.30	49.17	56.87
1962	41.90	49.17	56.87
1963	41.90	51.16	56.87
1964	44.10	51.16	56.87
1965	39.69	49.17	56.87
1966	41.90	49.17	60.62
1967	41.90	51.16	60.62
1968	41.90	51.16	60.62
1969	37.49	51.16	60.62
1970	41.90	51.16	60.62
1971	44.10	51.16	60.62
1972	43.50	49.17	62.39
1973	46.30	49.17	64.21
1974	74.94	80.00	66.97
1975	88.00	79.00	99.12

Source: *Hodder & Tolley Ltd., Palmerston North, Company records for contracted grain prices.

+Williams & Kettle Ltd., Gisborne, New Zealand, Company records for contracted grain prices.

#Ministry of Agriculture & Fisheries, Palmerston North Office.

Commodity Prices cents/kilogram

Year	Lamb Prices[1]	Beef Prices[2]
1961	30.80	23.60
1962	23.80	20.30
1963	30.00	20.80
1964	31.61	22.30
1965	32.50	22.90
1966	26.13	29.88
1967	25.80	28.00
1968	29.00	35.70
1969	32.10	37.10
1970	39.13	47.82
1971	34.40	46.90
1972	28.50	45.56
1973	46.10	62.45
1974	58.30	45.64
1975	39.00	25.00

1. Lamb Schedule Price. Prime Lamb 13-16 kilograms.
   Source: New Zealand Meat and Wool Board's Economic Service Annual reports 1961-75.
2. Manufacturing Grade Price, cow beef schedule, 141 kilograms and over.
   Source: New Zealand Meat and Wool Board's Economic Service Annual reports 1961-75.

Commodity Prices cents/kilogram

Year	Dairy Prices[1]	Wool Prices[2]
1961	69.67	74.10
1962	69.67	72.00
1963	67.82	78.70
1964	70.57	101.20
1965	76.80	77.40
1966	82.69	76.50
1967	82.76	64.80
1968	77.11	50.40
1969	71.76	61.90
1970	73.94	56.50
1971	86.28	53.40
1972	121.99	66.50
1973	109.86	144.00
1974	131.58	139.20
1975	128.51	91.70

Source: 1. Price for milkfat in milk at the factory door (cents per kilogram of milkfat).
Source: New Zealand Dairy Board's Annual Reports, 1961-75.

2. Wool Prices: New Zealand average price for greasy wool at auction in cents per kilogram, all qualities.
Source: New Zealand Meat and Wool Board's Economic Service, Annual Reports, 1961-75.

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