A STUDY OF NON-COMMERCIAL DAIRY FARMING SYSTEMS IN THE WESTERN DIVISION OF FIJI

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ABSTRACT

The purpose of this study was to describe the smallholder dairy system(s) in the Western Division of Viti Levu, the largest island of Fiji. The role and contribution of non-commercial dairy cows to the income, nutrition and cultural well-being of Indian families in these systems was assessed.

In common with such dairy systems elsewhere in the developing world there is a dearth of available information on the non-commercial dairy sector of Fiji. A Farming Systems Research (FSR) approach provided the framework for the field survey which was carried out in the Western Division of Fiji over an eight week period from February to March 1991. Nineteen farmers selected at random were interviewed for this study. These farmers together owned a total of 36 non-commercial dairy cows. Information was obtained from these farmers on their farming resources and operations and in particular, on the roles, production and reproductive performance of their cows. Using data from these farms and other limited secondary data which was available, a whole farm budget for a typical farm in the survey area was prepared, identifying the revenue and costs of commercial and subsistence crop enterprises and the two-cow system.

For the 'typical' farm, the total net revenue from the combined crop enterprises (commercial and subsistence) was F$5433/year, with sugar cane providing the main source of income from the farm. The imputed net value of production from the two-cow system was estimated to be about 38% of the net crop revenue.

Per capita consumption for Indian farm families of fat and protein from liquid milk were estimated to be 11.6kg and 10.5kg per year, respectively. Survey results show that liquid milk is a significant source of protein to these families. Farmers reported that if a cow was not owned a reduction in the nutritional welfare, health and income of the family would most likely occur. Longitudinal field studies in these smallholder farming systems are recommended to allow the essential dynamics of the livestock enterprises and the relationships between these enterprises, the cropping systems and the farmers' families to be established..

It is concluded from the field studies that non-commercial dairy cows make a significant contribution to the nutrition and economic and cultural well being of the families which keep them, and that these cows are maintained and produce using resources of low opportunity cost to the farm family.

Key words: smallholder dairy systems, Farming Systems Research, Fiji agriculture, tropical dairy production.

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Personal interest in dairy production systems and developing countries in the tropics initiated this study, firstly focusing upon Africa and later on the Pacific islands of Fiji. A specific goal of the writer was to gain more knowledge on the dairy farming systems of developing countries and to identify past research and development on dairy development especially through the use of FSR. This, in turn, would provide the basis for my long-term goal of development work in third world countries.

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LIST OF ABBREVIATIONS

ALTA	Agricultural Landlord and Tenant Act
AH&P	Animal Health and Production
CP	Crude Protein
EP&S	Economic Planning and Statistics
FCA	Fiji College of Agriculture
FSR	Farming Systems Research
GDP	Gross Domestic Product
MAF	Ministry of Agriculture and Fisheries
MFE	Milk Fat Equivalents
NLTB	Native Land Trust Board
MPI	MInistry of Primary Industries
PNG	Papua New Guinea
RCDC	Rewa Cooperative Dairy Company

1.0 INTRODUCTION

1.1 INTRODUCTION.

Smallholders dominate crop and livestock production throughout developing countries. Some 1.4 billion people, or over a quarter of the human population depend on this form of agriculture for their livelihoods. Smallholder farmers are seldom specialist livestock producers. Rather they keep ruminants and non-ruminants as an adjunct to, but integrated with, their cropping systems.

Ruminants play a special role in smallholder farming systems. They can utilise crops and crop byproducts and pastures which can not otherwise be used, and convert them into products of high nutritional value such as meat and milk. Milk from smallholders' dairy enterprises underpins the protein supplies of many millions of rural families in developing countries. Hrabovszky (1981) reported that 'most of the poorest people in developing countries are in agriculture. Thus, if any major improvement is to be achieved in reducing the gap between the poor and the rich, then the focus will need to on the poor in agriculture.' Given the vital contribution of livestock to these people, research into and subsequent development of their smallholder dairy production systems can be a potent means of ensuring the nutritional wellbeing of them.

The world's cattle population in 1989 was approximately 1.3 billion head (FAO, 1989), of which some 68% were distributed throughout the developing countries (as defined by FAO,1989). The majority of cattle in developing countries are in Asia, South America and Africa, which have 391m, 261m and 185m head respectively. These cattle are predominantly maintained under traditional systems of small-scale mixed cropping and livestock farming. These systems are heterogeneous in character and function with differences being due to factors such as climate, land type and class, cultural influences and econo-political setting.

Throughout Africa, Latin America and Asia some of the traditional smallholder mixed farming systems have been described and assessed. However, there are still a large proportion of small-scale mixed production systems in developing countries which require initial description and analysis, identification of possible on-farm constraints and opportunities for improvements through the adoption of new technologies. Little research has been carried out on these farming systems in the South Pacific region. Nations such as Tonga, Papua New Guinea and the Solomon Islands have received some attention. However, there are still a number of island nations relying upon these smallholders, for crop and livestock production, which remain undescribed and assessed. Smallholder dairy systems have been the subject of even less research endeavours than have smallholder cropping systems.

The modestly resourced study reported in this thesis was undertaken to contribute to the pool of

publicly available knowledge and understanding of these important farming systems. The study was done in the Oceanic developing country of Fiji with the focus on the non-commercial dairy systems of the Western Division of Viti Levu, the largest Fijian island. In 1978, the national cattle population of Fiji was estimated at 247,430 head, of which the dairy cattle population was estimated to be 95,000. A large proportion of the dairy cattle are in the Western Division. There is no commercial production of milk in this Division; and farmers keep dairy cattle mainly for subsistence purposes. Nearly 84% of dairy cattle in Fiji are kept for non-commercial purposes.

The study focusses on the non-commercial production of milk by small-farmers in Fiji. The farming systems approach to research was adopted to fulfil the goals and objectives of this study, as the farmer and farm household will be the target for new technologies and development.

1.2 STUDY OBJECTIVES

The main aims of this study are to describe the smallholder farming system(s) and assess the role and contribution of non-commercial dairy cows to the income, nutrition and cultural well-being of Indian families in the Western Division of Viti Levu.

Two hypotheses were to be tested through the field studies. First, that the smallscale cow herds, typically one or two cows, make a significant contribution to the nutrition and economic and cultural well being of the families which keep them. Second, that these small herds are maintained and produce using resources of low opportunity cost to the farm family. If these two hypotheses can not be rejected, and opportunities can be identified significantly to improve these systems, again of low total resource costs, then the case may be made for the investment of public monies into their future development. While this latter question of public investment is not addressed in this study, opportunities for the improvement of the systems are identified and discussed.

The specific objectives of the study are:

1. To collect, describe and analyse primary and secondary information on the production and contribution of the non-commercial cow to the income, nutrition and cultural well-being of Indian farm families in the Western Division of Fiji;
2. To examine and identify possible problems or constraints on the productivity of non-commercial dairy cows;
3. To assess opportunities for improvements of these systems and to provide recommendations for further research and development on them to the Fijian Government, agricultural researchers, extension personnel and educational institutions.

1.3 STUDY PLAN

The Farming Systems Research (FSR) methodologies provided the framework for the study. A

review of the evolution of FSR, and the key concepts and processes embodied in it are presented in Chapter 2. The descriptive or diagnostic stage of FSR is described in detail, with special reference to this study.

An introduction to Fiji is presented in Chapter 3. The resources of the country are described. An overview of the Fijian economy, effects of land tenure upon agriculture and the main farming systems is presented. Dairy production in Fiji is discussed in two parts; the commercial dairy sector and the non-commercial dairy sector.

Chapter 4 describes the methodology followed in the study, and the procedure used for sampling of the farmer-subjects interviewed, and for the field operations. Comments are offered on the practicalities of undertaking these field studies in Fiji.

The results gained from field studies preformed in the Western Division are presented in Chapter 5. Background information on the farmers surveyed, the production histories of cows owned by surveyed farmers and the husbandry and management of these cattle are reported. The value of non-commercial dairy cow(s) to the farm and family in terms of her monetary worth and nutritional value of milk and milk products to the farm household is estimated and assessed.

The final chapter provides a brief summary of the results gained from this field survey. The methodological issues, implications and recommendations for future research are discussed. Finally, the conclusions to this dissertation are presented.

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

A review of selected literature on Farming Systems Research (FSR) is presented in this chapter. Section 2.2 briefly describes the evolution of FSR, which was mainly a response to the inadequacies of conventional reductionist research methods. Some of the key concepts and processes incorporated into FSR are addressed in Section 2.3.1. A detailed discussion of the initial descriptive or diagnostic stage of FSR, with special reference to the field study in Fiji, is presented in Section 2.3.2.

2.2 EVOLUTION OF THE CONCEPT OF FARMING SYSTEMS RESEARCH

FSR emerged in the post Green-Revolution era in response to the growing concensus that the mainstream, conventional agricultural research and extension institutions were not providing or disseminating technologies widely adopted by small-scale, resource-poor, farmers (Byerlee et. al., 1980; Shand, 1985; Sands, 1986b; Chambers et. al., 1990).

The diagnosis of this problem, as reported by Sands (1986b) and Chambers et. al. (1990), was that agricultural researchers and development planners, the usual generators and disseminators of new technology, had employed a fundamentally 'top-down' approach to technology development. In this traditional or classical agricultural research approach, the priorities were determined by scientists. The scientists generated new technologies on research stations and in laboratories, and these were then transferred through extension services to farmers. Commentators on the agricultural research and development process stressed that agricultural researchers and development planners lacked sufficient first hand understanding or documentation of the management conditions under which smallholder farmers in Third World countries operate.

In response to this situation, FSR proponents argued firstly, that development of relevant and viable technology for small-farmers must be grounded in a full knowledge of the existing farming system and secondly, that technology should be evaluated not solely on the terms of its technical performance, but in terms of its conformity to the goals, needs and socio-economic circumstances of the targeted small-farm system (Sands, 1986b; Shaner et. al., 1982).

FSR has contributed fundamentally to reconsideration of the view of many researchers and developers that smallholder farming systems in the tropics and sub-tropics were static and primitive. It is now more widely realised and accepted that they are complex, dynamic systems

which have evolved in response to particular agro-climatic, ecological and socio-economic conditions (Sands, 1986b).

Smallholder farmers had not been rejecting new technologies, the 'improvements' being provided by the top-down research/extension establishment, out of sheer ignorance, traditionalism or sloth. They had not adopted them because they were pursuing goals and employing criteria for evaluating tecnologies different from those used by agricultural scientists (Sands, 1986b; Simmonds, 1986).

Instead of starting with the knowledge, problems, analysis and priorities of scientists, FSR starts with the knowledge, problems, analysis and priorities of farmers and farm families. Instead of the research station as the main focus of action, it is now the farm. Instead of the scientist as the central experimenter, it is now the farmer, whether woman or man, and other members of the farm family with the involvement of the researcher. Farming systems research is therefore more likely to design technologies that are appropriate and acceptable to small farmers because the FSR approach stresses an understanding of the farming systems and the farmer's environment. (Shaner et. al, 1982)

2.3 KEY CHARACTERISTICS AND PROCESSES OF FSR

Before addressing the procedures involved within the FSR approach, some intrinsic concepts defining FSR are discussed. These are presented in Section 2.3.1., followed by a discussion on the stages of FSR in Section 2.3.2. Aspects relating to this study are also discussed in Section 2.3.2 with respect to the procedures carried out in the field.

2.3.1 Important concepts defining FSR

The basic unit of the FSR approach, as stated by Weinschenck (1989), is the farm-household system comprising of the household, the production system, the off-farm component and the natural resource component.

Farming systems are defined by their physical, biological and socio-economic setting and by the farm families' goals and other attributes, access to resources, choices of production activities (enterprises), and management practices (Shaner et. al., 1982). FSR considers the farmers and their problems in a comprehensive manner using an interdisciplinary approach that complements existing research and development activities, and is iterative, dynamic, and responsive to society (Gilbert et. al., 1980; Shaner et. al, 1982; Sands, 1986b).

The primary objective of FSR is to improve the well-being of individual farming families by increasing the productivity of their farming system, given the constraints imposed by resources and the environment. FSR consists of two thrusts towards increased productivity (Norman & Collinson, 1985; Norman and Gilbert, 1982; Shaner et. al, 1982). Firstly, by the development and dissemination of relevant improved technologies and practices. Secondly, through the implementation of appropriate policy and support systems to create opportunities for improved production systems and to provide conditions conducive to the adoption of technologies already available. However, before improvements can be made the current farming system must be described and understood. This is the aim of the study in Fiji.

Research can be considered to be FSR if it has the following characteristics (Norman and Collinson (1985); Norman and Gilbert, 1982). First, the farm as a whole is viewed in a comprehensive manner with a recognition of the interdependencies and interrelationships within the natural and human environment in which the farming system is operated. Second, the choice of priorities for research reflects initial study of the whole farm. Research on a farm subsystem is legitimate FSR, provided the connections with other subsystems are recognised and taken into account. Third, the evaluation of research results explicitly takes into account linkages between subsystems. These characteristics are consistent with the aims and objectives of this study, since the FSR methodologies provide the framework of this research.

Shaner et. al (1982) reported that FSR researchers may focus on any part of the whole farming system or they may concentrate on a predetermined subsystem. However, both approaches require some study of the whole farming system. The first approach requires an understanding of all subsystems and their interactions, while the second approach demands detailed knowledge only of the selected enterprise and its relationship with the rest of the subsystem. The second approach was adopted for this study in Fiji. The specific enterprise selected was non-commercial dairy cow(s) owned by sugar cane farmers in Votualevu. The aims of this study are such that a description of the whole farming system is necessary before the role and contribution of the non-commercial dairy enterprise to the farm family can be fully assessed.

FSR programs can be classified two ways, as 'upstream' or 'downstream' FSR (Norman and Gilbert, 1982; Shaner et. al, 1982). Upstream (on-station) FSR, also called resource management research, uses a systems approach on an experimental station to provide prototype solutions aimed at alleviating major constraints to agricultural improvement. The information received concerns the technical feasibility of innovations under ceteris paribus conditions which may differ markedly from the conditions on farms in the targeted area. Downstream (on-farm) research has an adaptive orientation and aims at developing and introducing strategies that will improve the productivity of farming systems for target groups of farming families in the short run. It means the testing of technical innovations under the practical conditions of farm and household. On-farm

research and on-station research should be seen as complementary and not competitive. The combination of upstream and downstream research is often considered as FSR. This is currently the most widely used methodology, especially in international agricultural research centres (IARC's) (Doppler, 1989). However, for the purpose of this study, the downstream approach of FSR is considered and discussed in Section 2.3.2.

2.3.2 The main processes involved in on-farm FSR with special reference to the diagnostic stage

The main components of the FSR processes are briefly presented. This is followed by a detailed discussion of the initial diagnostic stage, which is central to this study.

The FSR process can be described in four distinct and linked stages. Figure 2.1 summarises the process (Byerlee et. al., 1980; Shaner et al., 1982; Norman and Collinson, 1985). The stages are:
1) The descriptive or diagnostic stage where the target and research area are selected. This stage seeks to determine the constraints farmers face and to ascertain potential flexibility in the farming system (Steps 1 and 2 from Fig.2.1);
2) The design or planning stage (problem identification and development of a research base) involving the identification of a range of strategies that are considered to be relevant in dealing with the constraints (Step 3: Fig.2.1);
3) The testing stage which involves on-farm research, where the most promising strategies identified are evaluated under local farming conditions (Step 4: Fig.2.1); and,
d) The recommendation and dissemination stage in which the strategies identified and screened during the design and testing stages are implemented (Step 5: Fig.2.1).

The methodology adopted in this study accepts and follows the framework provided in the above procedure, although the main focus is on the first stage. The objective of the initial descriptive or diagnostic stage, as reported by Norman and Collinson (1985), is to select target areas to divide the frame of farming families into target groups as recommendation domains, and to ascertain the major constraints on farming in that area and also the degree of flexibility that exists to modifying the farming systems.

The target area selected for this study was the Votualevu District of the Western Division of Viti Levu. Indian sugar cane farmers in this area were the focus of the field studies because they owned cows for non-commercial dairy production and were known to account for virtually all dairy production in that part of Fiji.

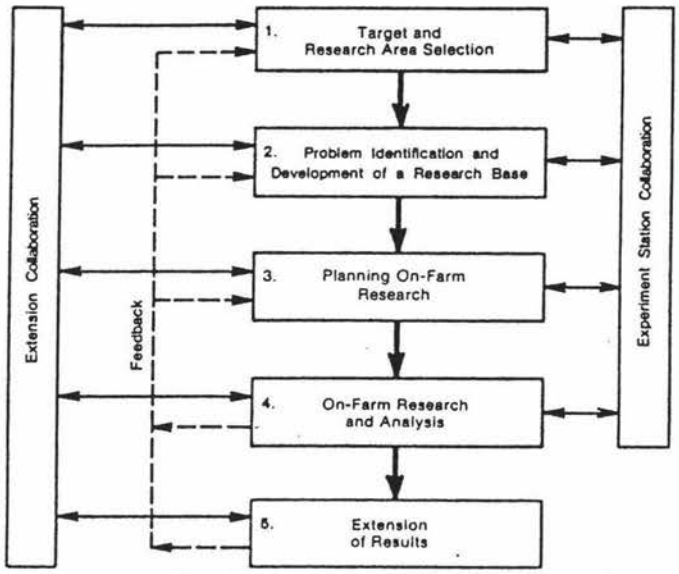


Figure 2.1 The five basic activities of on-farm research in Farming systems research and development.

(Source: Shaner et al., 1982: Figure 3.1)

The next step involved in the FSR process is the identification of problems or constraints in chosen farming systems. Shaner et al. (1982) describes three basic steps taken as part of problem identification. Firstly, the identification of existing farming systems, seeking to understand them and their environment. Secondly, to identify problems and opportunities for improving the system or the environment, or both. Finally, to set priorities for research and implementation. Within these steps there are various parts to the problem identification process, as summarised in Figure 2.2. The objective of this phase of the process is to help the agricultural scientists - who are developing technology for small farmers, and development planners - who are designing projects to transfer the technology, to know the circumstances and needs of their client.

The first preliminary analysis (2a. of Figure 2.2) is based on information obtained during the selection of the target and research areas. At times enough will be known about the problem to go directly to planning research activities. However, more often the interdisciplinary team will need to learn more about the farming systems and the environment of the area. This was the case for the study of non-commercial dairy Indian farmers in Fiji. Since no previous research had been carried out in this area any information was recognised as an advance towards gaining an understanding of the current farming systems adopted in Fiji. A literature review of past animal research on smallholder producers' problems in Sub-Saharan Africa (Richardson, 1990) highlighted potential issues of relevance to the Fiji situation, and enabled the writer to form tentative hypotheses about the nature of the Fijian smallholder dairy systems. The limited resources available for this study prevented a 'standard' FSR field team from being assembled. This important departure from

recommended FSR practice limited the field work to diagnostic activities. This researcher was supported in the field by two Government officials.

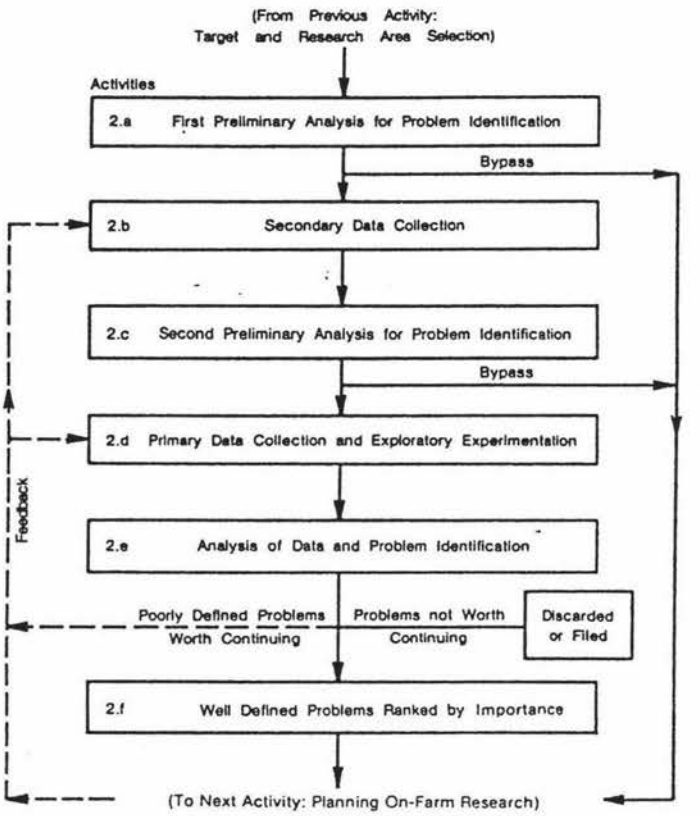


Figure 2.2 A flow chart for the problem identification and development of a research base

(Source: Shaner et al., 1982: Figure 5.1)
Note this figure is an expansion of box 2 in Figure 2.1.

The next step in the FSR process involves the collection and analysis of secondary data (2b. and c.). Full use of secondary information, either published or unpublished, regarding the research area is necessary so that resources are not squandered on 'reinventing the wheel' or time wasted in the field (Byerlee et al., 1980; Gilbert et al., 1980; Sands, 1986a). Collection and analyses in New Zealand of available secondary materials were performed before going to Fiji. Resources at the University of the South Pacific in Suva were also examined throughout the visit. The literature provided a useful background to the field study, however it emphasised the scarcity of information available on the non-commercial dairy sector.

Primary data (2d of Figure 2.2) can be gathered from farmers and from others who have a knowledge of the farmers' circumstances in the target area. The interviews to gather this data may be conducted relatively informally through, for example, conversations between researchers and farmers, or more formally by single and/or multiple interviews using a questionnaire. Sands (1986a) recommended starting with interviews with professionals familiar with the targeted region

such as government officials, extension personnel, merchants dealing with farmer's products and supplies, local agricultural scientists, and political leaders as 'they can often focus attention on key problem areas in the small-farm sector, but their hypotheses should be tested in interviews with farmers.' Discussions were held with Fijian Government officials, agricultural researchers and extension workers prior to and throughout field visitations in Fiji. The conversations highlighted the lack of available information on the non-commercial dairy systems. However, the informal discussions provided useful data for the selection of a target research area for field visits. Although the discussions were useful they did not suggest any 'key' problems areas for further investigation in the field. This was mainly attributed to the lack of knowledge on the production systems.

The exploratory survey, also generally known as a quick, informal, or reconnaissance survey is a method of primary data collection that usually follows secondary data collection (Byerlee et. al., 1980; Shaner et al., 1982). The review of the secondary material should be completed before conducting the field research so that questions framed for field reconnaissance are appropriate. The regional reconnaissance is a critical phase in the research process because it is the period in which problems are initially defined and research priorities established, it is also the first stage of research in the field with farmers. It is also the most vulnerable to funding constraints because the pressure for producing concrete results as quickly as possible is strong (Sands, 1986a). The exploratory survey enables a lot of information (both facts and impressions) to be collected in a short amount of time.

Sands (1986a) also recommends that a descriptive and diagnostic regional reconnaissance should be made by an interdisciplinary team of both technical agricultural scientists and social scientists trained in smallholder agriculture. While a team approach was not possible for this study, the principle is acknowledged as being beneficial.

According to Sands (1986a), the primary goals of regional reconnaissance should be to:

a) initiate dialogue with the farmers so that their needs and priorities are incorporated into the initial stage of the technology development process;
b) develop an overview of the physical, economic, social, and political environment in which the small-farmer operates;
c) describe the major farming systems in the region and develop criteria for dividing them into more or less homogeneous types with similar needs, constraints and areas of flexibility;
d) generate hypotheses of principal constraints to increased productivity for each type.

These goals were adopted by the writer for this study as a guideline for the type of information to be gathered.

Informal methods of primary data collection usually refer to surveys undertaken without the use of questionnaires. The casual nature of the informal method allows the interviews to be conducted in a relaxed and friendly manner. However, there are associated disadvantages with the informal surveys (Shaner et al, 1982). Firstly, data gathered informally have some limitations because rigorous methodologies are not followed. For example, the farmers may have been selected purposively and not randomly, therefore the data can not be subjected to statistical analysis. Another disadvantage is that without the use of a written questionnaire from which to work, interviewers may not ask the same questions of all farmers, nor are they likely to ask questions in the same way. One way to overcome such disadvantages is combine informal investigations with formal ones, for example combining the use of a questionnaire with informal conversation and questioning about matters concerning the questionnaire.

The formal methods of primary data collection are generally undertaken to test and otherwise clarify the interdisciplinary team's reconnaissance and other findings, and to follow up on important topics. Verification comes primarily through statistical procedures, but also through insights gained by experienced researchers. The two main methods associated with the formal approach are single and multiple interview surveys. The single interview survey follows soon after the reconnaissance phase. A questionnaire is administered to farmers usually selected according to formal sampling procedures. The multiple interview surveys involve collecting data from a limited number of farms on a repetitive basis. This may continue for a year or more, or for the period needed to ensure that phenomena with the longest duration cycle of interest in the system can be described and documented. This type of survey is well suited for collecting continuous data, such as cash flows and food consumption (Shaner et al., 1982).

By analysing the secondary and primary data (2.e of Figure 2.2) the problems and opportunities can be divided into those that are well-defined, poorly-defined, and not presently worth pursuing (Shaner et al., 1982). Well-defined problems and opportunities are those that can serve as the basis for the next research activity. Poorly-defined problems and opportunities require further study and definition. Those not worth pursuing are problems with apparently no practical solution under present conditions or whose payoffs are substantially lower than those realised from other possibilities.

An informal reconnaissance survey was made of Indian farmers in Votualevu with the use of a questionnaire to aid discussion and collect similar information from farmers. The interviewer and farmers were not fluent in a common language which prevented direct conversation between the interviewer and farmers. An interpreter was used to translate from Hindi to English and vice versa. The aim of the survey was to gain as much general information as possible about the farming systems employed by sugar cane farmers, and then to focus more upon the roles, and productivity of the cow(s) they owned. Possible constraints on and opportunities for improved cow productivity

could then be identified. In turn this information would provide the basis for initial and practicable recommendations for improvements to these farming systems. The FSR approach described earlier detalis the next step, the design or planning stage, in the process of on-farm or down-stream FSR. However, further formal methods of primary data collection such as mulitple interview surveys, are recommended to confirm the problems and opportunites reported in this study before definite planning of on-farm research can proceed to test new technologies or recommendations for change to the current farming system.

2.4 SUMMARY

The evolution of FSR and its approach to agricultural research in developing countries has been presented and discussed. The initial diagnostic stage of FSR, involving the analyses of secondary information and the collection of primary data has been discussed in detail. The activities for this research reported in this study have been described in the contaxt of the FSR approach, and in relation to the diagnostic stage of FSR in particular.

Farming systems research was developed mainly because of the perceived failure of traditional or classical 'top-down' agricultural research to solve the problems of the small farmer operating in less favourable natural environments. Farmers in these environments were not adopting new technologies because the scientists and developers had only limited understanding of the management conditions and resources under which those small farmers operated and as a consequence were developing iprovements poorly suited to the farmers' needs.

FSR places the small farmer and the farm family at the centre of the research process. This research approach identifies smallholder farming systems in developing countries as being complex and dynamic, having evolved due to the agro-climatic, ecological and soci-economic conditions facing the farmers (Sands, 1986b). FSR proponents argue that the development of relevant and viable technology for small farmers must be grounded in a full knowledge of the existing farming system. New technologies should also be evaluated not solely on the terms of its technical performance, but in terms of its conformity to the goals, needs and socio-economic circumstances of the targeted small-farm system.

The primary objective of FSR is to improve the well-being of farming families in the target area by increasing the net productivity of their farming system, given the constraints imposed by resources and the environment and the objectives of farmers. Two main thrusts are used to increase productivity. First, the development and dissemination of relevant improved technologies and practices. Second, through the implementation of appropriate policy and support systems, to

create opportunities for improvement, and to provide conditions conducive to the adoption of technologies already available.

The four main stages of FSR are presented as, a) the descriptive or diagnostic stage; b) design or planning stage (problem identification and development of a research base); c) testing stage (on-farm research); and, d) recommendation and dissemination stage. Since this field research in Fiji is of the diagnostic type, the issues central to diagnostic studies using the FSR framework have been discussed in detail. The main aim of this diagnostic study is to help Fijian agricultural scientists and developers gain an understanding of the smallholder farmers in Votualevu, and the dairy enterprises they operate in particular and identify researchable opportunities for improvements to their systems.

Votualevu, a district in the Western Division of Viti Levu, was chosen as the research area. The target for research was those sugar cane farmers who owned cow(s) for non-commercial production of milk. Shaner et al. (1982) reported three important steps in the problem identification stage, the identification of existing farming systems, identification of problems and opportunities for improving the system, and the setting of priorities for research and implementation. Information about farmers can be gained from studies of the target research areas, and through the collection and analysis of secondary and primary data. The advantages and disadvantages of informal vs formal methods of primary data collection, as described by literature, are discussed.

The FSR approach has been followed in this study. Resource constraints for the field work necessitated important departure from recommended practices for diagnostic studies, the most important of these was that a multidisciplinary team could not be mounted for the study. Otherwise the writer aimed at following the procedures discussed in the problem identification stage of the FSR process. Collection of secondary information was carried out before and during the visit to Fiji. Analysis of this information showed a lack of available information on non-commercial dairy farmers. The collection of primary data was undertaken by an exploratory survey aided by a questionnaire. Further research into this particular farming system through more detailed formal surveys and on-farm research is needed before recommendations for change can be implemented. Following the introduction to Fiji and the dairy farming systems of the country in the next Chapter, Chapter 4 presents the methodology undertaken in this study, regarding the selection of farmers, the type of information received and problems associated with the field study in Votualevu.

3. AN INTRODUCTION TO FIJI

3.1 INTRODUCTION

This chapter presents an overview of the physical resources available in Fiji and introduces the agricultural systems of the country, with emphasis on the non-commercial dairy sector. Land, climate, soils, human resources, their distribution and uses are described in Section 3.2. This is followed in Section 3.3 by a brief description of the Fijian economy, its major exports and imports, and trading partners. The main agricultural products from livestock and crops are presented with respect to the Fijian economy. Land tenure is also discussed with special reference to the ethnic Fijian tenure systems and the effects of tenure on agriculture. The farming systems of Fiji are examined and the impacts of Fijian and Indian culture on them are addressed. Finally, an introduction to dairy production in Fiji is given, focussing on the commercial dairy industry and the non-commercial dairy sector.

3.2 PHYSICAL RESOURCES IN FIJI

3.2.1 Land

Fiji has a total area of approximately 18,330 square kilometers, made up of 844 islands and islets, including numerous atolls and reefs. About 100 islands are permanently inhabited. The main islands are Viti Levu (10,430 km^2) and Vanua Levu (5,550 km^2) which comprise 87 per cent of the total land area of Fiji. Other smaller islands are Taveuni (435 km^2) and Kadavu (408 km^2). The remainder of the islands are small and widely scattered. Fiji is split into four administrative divisions; namely the Western, Central, Eastern and Northern Divisions (Figure 3.1).

For this study, surveys were made of non-commercial dairy producers in the Western Division of Viti Levu. The two main cities of Fiji are located on this island, Suva, the capital, and Nadi. The Western and Central Divisions, and the main provinces and townships are identified in Figure 3.2.

Twyford and Wright (1965) are referred to extensively throughout this section. Unless indicated otherwise, their report is the main source of information. Viti Levu has three main types of land. These are flat land, undulating and gently hilly land, and steep, mountainous land. There is a sharp contrast in Viti Levu, between the steep mountainous terrain and the flat land of the coastal plains and river deltas. The latter occupy some 16% of the land surface of the island and are the main areas of settlement and agricultural production. Undulating land and rolling hills occupy only 17% of the total land area of Viti Levu. The remainder of the island is steep, mountainous land which is

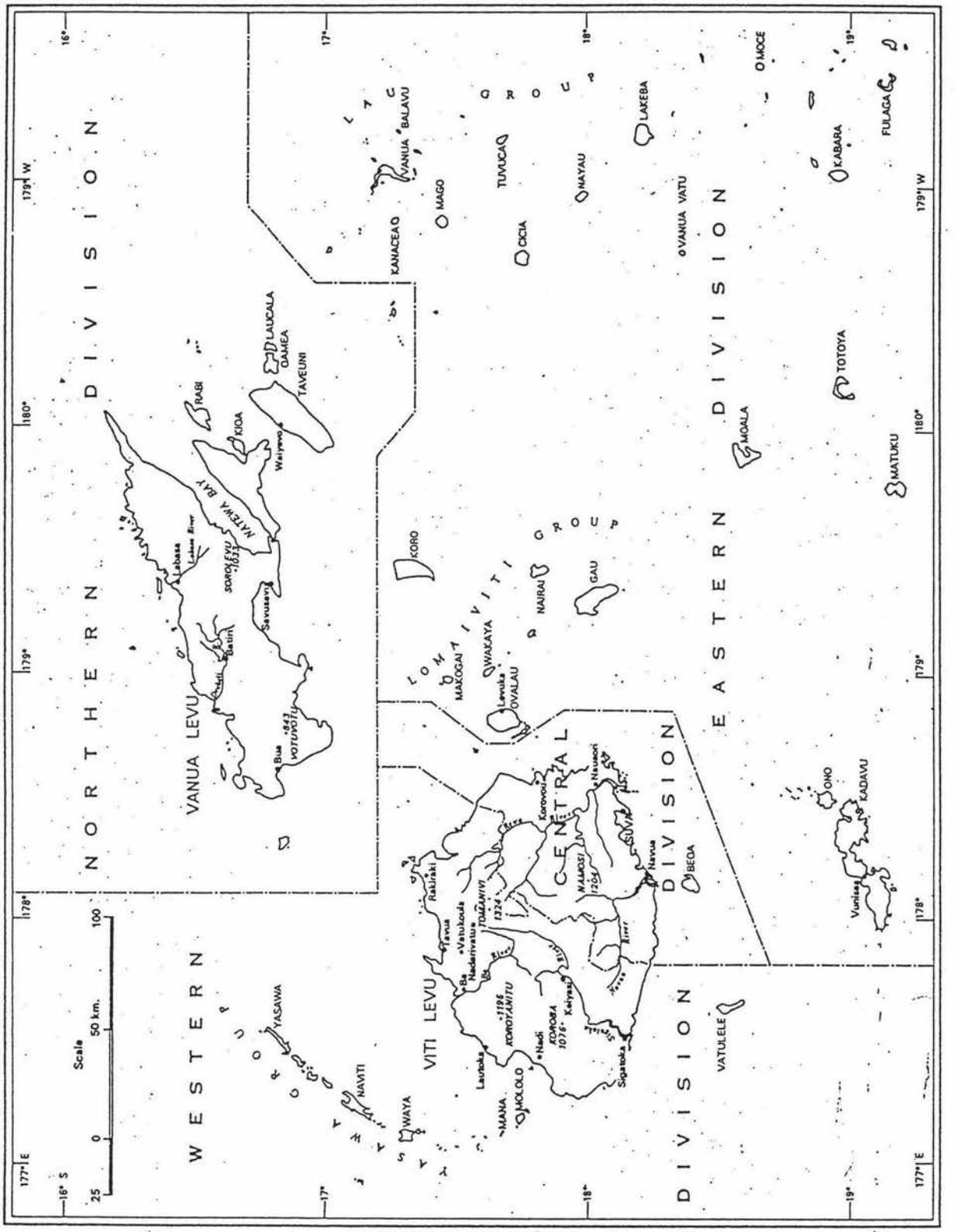
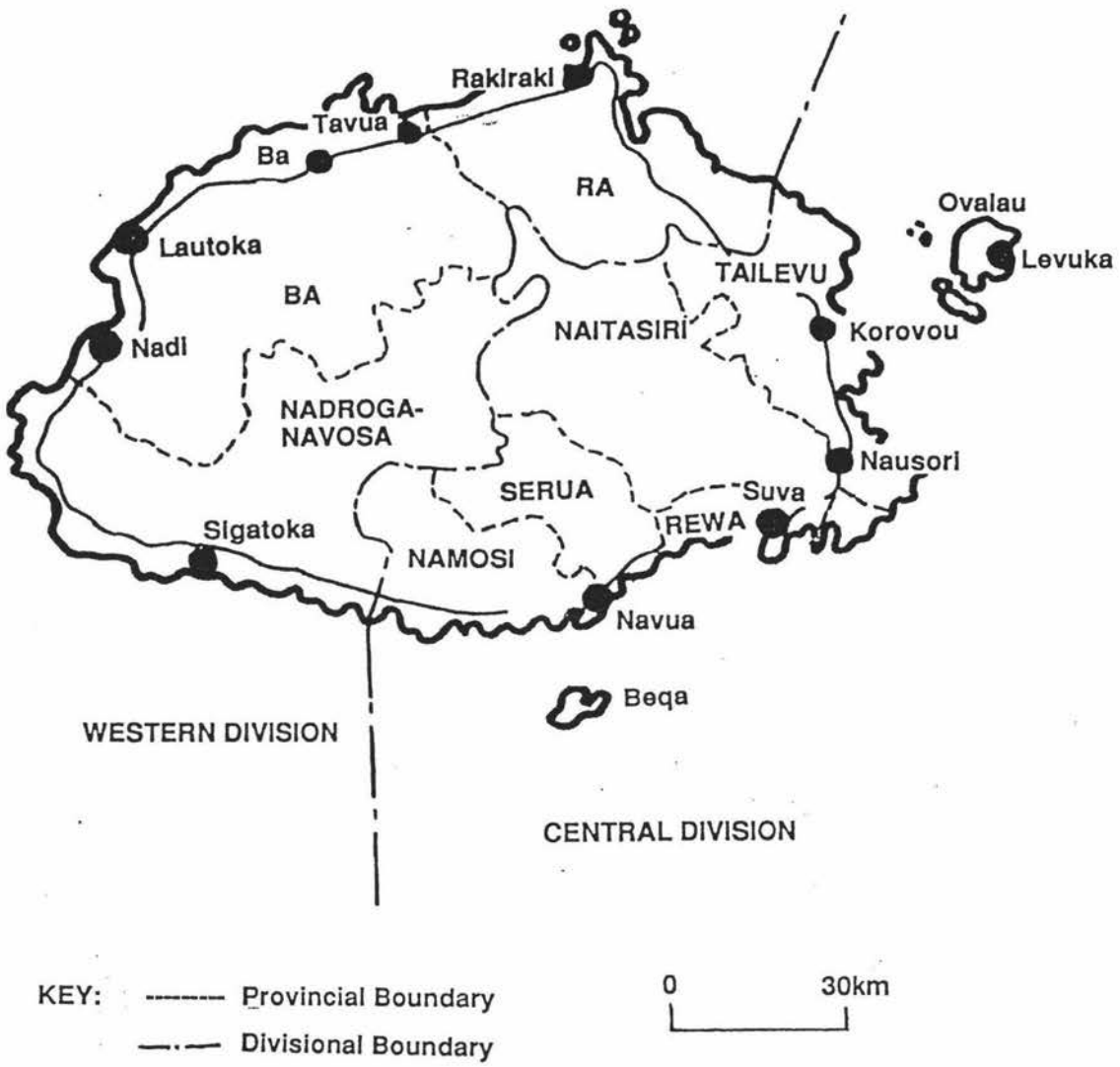


FIGURE 3.1: MAP OF FIJI

Source: Chandra (1983)

deeply incised by rivers and streams. Land use is strongly related to the nature of the terrain.

Figure 3.2: Viti Levu - Main provinces and townships



3.2.2 Climate

Viti Levu has five climatic regions. Figure 3.3 shows these regions and the locations of selected meteorological stations in the island. These are as follows:

Lowland Dry: Lowland areas with a strong dry season. These areas receive average rainfalls of between 1300 and 2500 mm per annum and are on the western coastal lowlands of Viti Levu. Nadi is the location of one of the meteorological stations servicing this area.

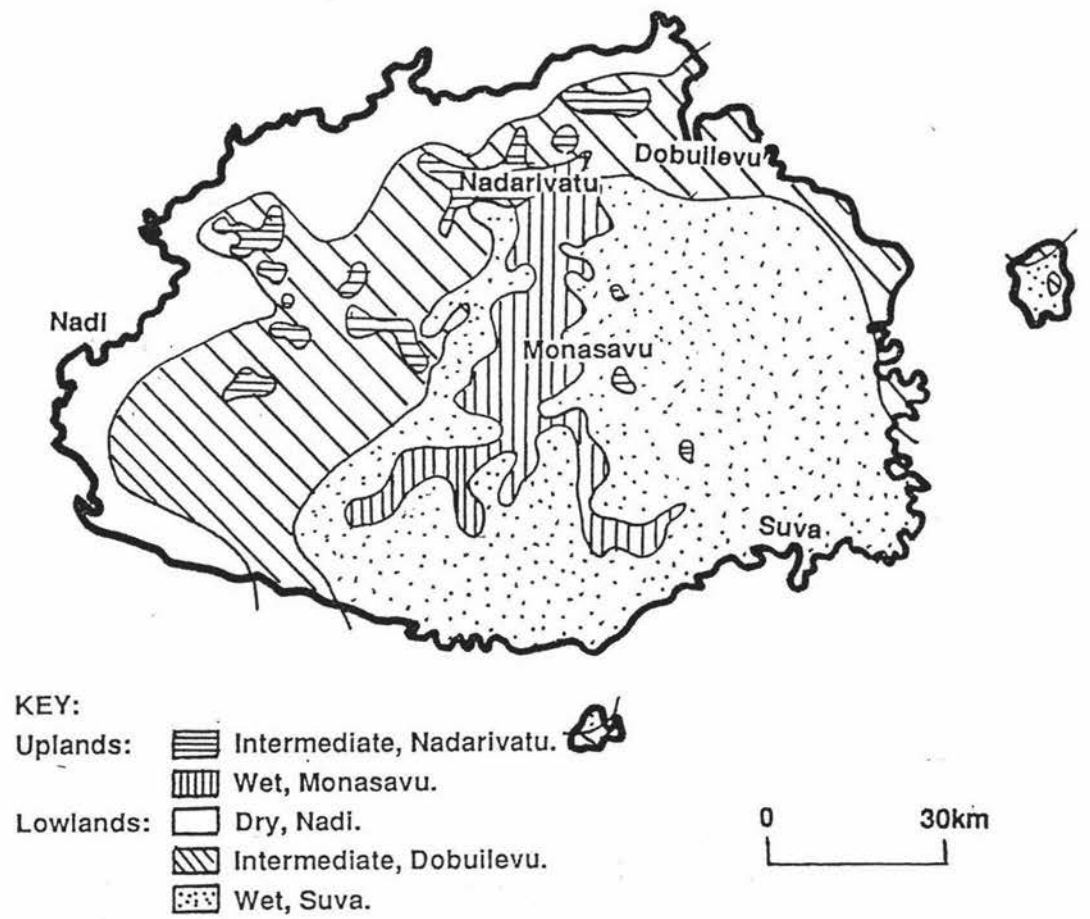
Lowland Intermediate: Lowland areas with a moderate dry season. A mean annual rainfall of 2000 to 3000 mm is experienced in the lower Sigatoka River valley and the coastal lowlands between Tailevu and Viti Levu bay. Meteorological records for this region are taken at Dobuilevu station.

Lowland Wet: Lowland areas with a weak or absent dry season and a high rainfall. An average rainfall of over 3000 mm per annum is received mainly on the south-eastern coast The Suva/Laucala Bay meteorological station services this region.

Upland Intermediate: Upland areas with a moderate dry season. This area is restricted to land over 600m in north-western and western Viti Levu. Average rainfalls exceed 3600 mm per year. Recordings are made at Nadarivatu.

Upland Wet: Upland areas with a very weak or no dry season. These occur on the south-eastern side of Viti Levu, in the high mountain ranges. The average rainfall is over 3800 mm per year, as recorded at the Monosavu meteorological station.

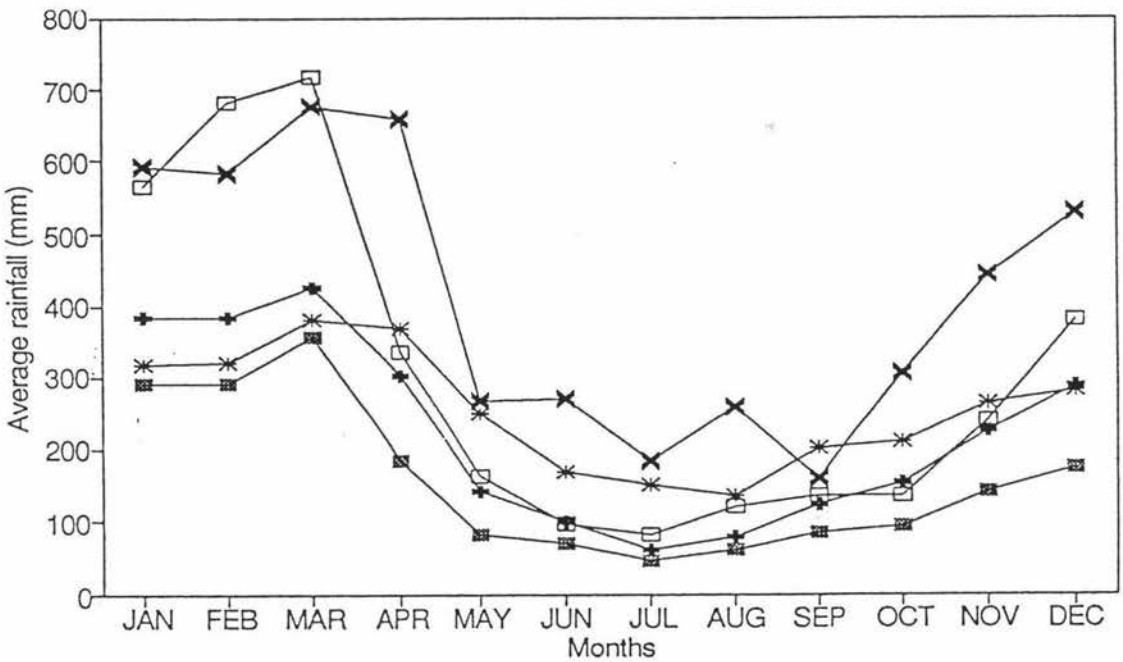
Figure 3.3: The climatic zones of Viti Levu



Source: Twyford and Wright (1965) and Matthews (1973).

Selected climatic data for the five regions, as serviced by the respective meteorological stations described above, are presented in Table 3.1. A unimodal distribution of rainfall is common for all islands of the Fiji Group. Figure 3.4 shows the annual distribution of rainfall for the five climatic regions of Viti Levu, as represented by rainfall at representative meteorological stations in each region. The wet season is from November to April and the dry season from May to October. March has the highest average rainfall and number of rain days. July is the driest month. The lowland dry region has four to five months each year with little rain, resulting in soil moisture deficits. Soil moisture deficits are irregular and of limited duration in the lowland and upland wet regions.

Figure 3.4: Average annual rainfall in the five climatic regions of Viti Levu



KEY:

Uplands: Intermediate, Nadarivatu.

Wet, Monasavu.

Lowlands: Dry, Nadi.

Intermediate, Dobuilevu.

Wet, Suva.

Derived from: Ministry of Primary Industries (1990; A1:1-11).

The monthly variation in rainfall is a key determinant of the distribution and types of crops grown in various zones. Sugar cane is the major crop grown in the lowland dry zone, as it requires a distinct dry period for maturation. Rice and vegetable crops such as English and Chinese cabbage, French beans, green beans, longbeans, egg plants, cucumbers and chillies are most important in the lowland wet zone. Farmers there are heavily reliant on the continuity of rainfall throughout the year for successful crop production. The high number of wet days in that region can restrict labour use for agricultural activities, especially land cultivation and harvesting of crops.

Table 3.1. Selected climatic data for the five regions of Viti Levu.

Climatic region	Average total annual rainfall (mm)	Average number of raindays/yr	Annual daily temperatures (°C)		
			Mean	Max.	Min.
Lowlands:					
Dry	1534	131	25.5	30.0	21.0
Intermediate	2679	140	24.1	30.0	22.0
Wet	3059	232	25.2	28.0	22.0
Uplands:					
Intermediate	3657	167	20.3	24.0	16.0
Wet	4935	266	20.1	23.1	17.1

Derived from: Ministry of Primary Industries (MPI), 1990; A1:1-11

Fiji is located in a zone of high hurricane hazard. The hurricane season coincides with the wet season and extends from November to April, although some destructive hurricanes have been experienced in Fiji as early as October and as late as May. The periodicity of major hurricanes hitting some part of Fiji is less than four years.

Fiji has relatively mild temperatures (Table 3.1). The monthly mean maximum temperature is less than 32°C and the monthly mean minimum temperature is greater than 18°C at sea level. The highest temperatures occur in January/February, and the lowest during July. The mild temperatures result in a year-round growing season for pastures and crops.

Relative humidity is directly related to rainfall. The highest relative humidity occurs in the upland wet areas (82-89 per cent), compared to the dry lowland areas where the relative humidity typically is between 66-80 per cent.

3.2.3 Soils and land use of Viti Levu

The soils of Fiji are relatively well mapped and described. They fall into three chief categories, those on flats derived from rivers, sea deposits, etc., those on rolling to hilly downland, and those developed on steep slopes of the hills and mountains. The percentages of the land surface covered by these categories of soils are 15 percent for flats, 20 percent for easy slopes and 65 percent for steep slopes. The steepland soils have severely limited agricultural uses. Soils are also divided by the altitude at which they occur, there generally being a division at about 550m between those of the uplands and those of the lowlands, although upland soils on Viti Levu are of limited extent.

The eight main soil groups in Viti Levu as based on their parent materials and climate are: 1. Recent soils from coastal sands; 2. Recent soils from alluvium; 3. Nigrescent soils; 4. Latosolic soils; 5. Humic latosols; 6. Ferruginous latosols; 7. Red yellow podzolic soils, and 8. Gleys and peats. A description of each soil group is given in Appendix 1.

The Twyford and Wright land classification was derived from consideration of the differences between individual soils and accompanying environments which would affect the potential for farming the land. A classification was devised which showed whether or not land in its natural state is suitable for agriculture and, if not, how much modification to the land is necessary to render it suitable for agricultural production. This classification provides a broad and useful assessment of the soil and agricultural resources in Fiji. The four main land classes Twyford and Wright defined were:

I. First-class land suitable for permanent agriculture without improvements.

II. Second-class land with soils suited to permanent agriculture after minor improvements (e.g. fertilisers and drainage).

III. Third-class lands with soils suited to permanent agriculture only after major improvements.

IV. Soils unsuitable for permanent agriculture or agricultural development.

Over one third of Fiji is made up of Class IV land, whilst almost 42 percent of Viti Levu comprises land which is unsuitable for agriculture (Table 3.2).

Table 3.2. Percentages of Fiji and Viti Levu in the four major land classes.

Major Land Class[1]		Fiji	Viti Levu
First-class	I	19.4	21.5
Second-class	II	10.5	7.7
Third-class	III	31.9	29.0
Unsuitable	IV	38.2	41.8
		100.0	100.0

Source: Twyford and Wright, 1965
[1] See text above for definitions of land classes.

Steep slopes, sometimes with thin soils, are often cultivated for both commercial and subsistence agriculture. This is done at a high cost in soil erosion. In the intense rainfall conditions that exist in Fiji, sheet and gully erosion cause severe erosion of cultivated lands even on gentle slopes. Landslides and slips on steeplands are a common occurrence in intense rainstorms, both in the

wet and dry zones. They can have considerable localised adverse effect on both arable and tree agriculture (Chandra, 1983).

Sugar cane, coconuts, vegetables, pulses, passionfruit and tobacco are grown mainly on flat to gentle rolling country. Other crops such as ginger, cassava, taro, cocoa, bananas and plantains are also grown on steeper hillsides. Cattle and goat production extend into the steeper hillside areas. Forestry is usually confined to marginal steep lands. Dairying is carried out on Class I, II and III lands, although the majority of commercial dairying occurs on second-class land in the wet lowland areas of the Central Division. The flat areas preferred for dairying are usually freely drained or moderately poorly drained clay; hill soils are often relatively infertile. Thus the major groups of soils used for dairy farming are recent soils from alluvium of the wetter climatic regions often including adjacent recent soils from coastal sands and also many of the less wet gley soils. However, on some farms even the very poorly drained gleys and the edges of peat swamps with organic soils are utilised. On rolling terrain humic latosols are most commonly employed for dairying with a few adjacent red yellow podzolic soils. Some nigrescent soils are also used in the Suva area.

Since 67% of Viti Levu is mainly steep, and 42% of the total land area is not suitable for permanent agriculture, the resulting pattern for agricultural use is complex. The land available for dairying is limited, as it is for other forms of arable and livestock agriculture, however the types of land and soil currently being utilised may be adversely affecting cattle productivity and health. The scope for increasing productivity of these lands is restricted due to limited land resources and limited money available for development.

3.2.4 Human resources, their distribution and use

The Fijian population numbered 715,375 (362,568 males, 352,807 females) at the census of 31 August 1986. The population includes indigenous Fijians, Indians, part-Europeans, Rotumans, Chinese, Europeans and other Pacific Islanders. Fiji has almost equal numbers of persons of ethnic Indian and Fijian origin. These account for 48.7% and 46.1% respectively, of the total population (Bureau of Statistics, 1988a). The ethnic Indians are descendants of indentured labourers brought to the former colony of Fiji in the late nineteenth and early twentieth centuries .

Population distribution

The two most populous Divisions are the Western Division and Central Division, comprising 39.6% and 36.4% of the total population respectively (Table 3.3). Hence, Viti Levu accounts for 76% of the total Fijian population. Indians account for the majority of the population in the Western Division,

whilst the Fijians account for more than half of the population in the Central Division. Suva, the capital of Fiji, had 69,665 people or 9.7 percent of the total national population in 1986 (Bureau of Statistics, 1988a).

Table 3.3. Ethnic distribution of the Fijian population in 1986

Division	Ethnic group						Total Population	
	Fijian		Indian		Other			
	No.	%	No.	%	No.	%	No.	%
Western	96873	34.2	180206	63.6	6270	2.2	283349	39.6
Central	136691	52.6	103058	39.6	20361	7.8	260110	36.4
Northern	57546	44.6	64509	49.9	7099	5.5	129154	18.0
Eastern	38195	89.3	931	2.2	3636	8.5	42762	6.0
Total	329305	46.1	348704	48.7	37366	5.2	715375	100.0

(Source: Bureau of Statistics, 1988a).

Of the total population, 61.3% live in rural areas and 38.7% live in urban areas (Bureau of Statistics, 1988a). A higher proportion of indigenous Fijians live in the rural areas compared to Indians, whereas the opposite is the case for urban centres. In 1986, 66% of the rural population were living in Viti Levu, and a further 25% in Vanua Levu. The Western Division accounted for almost half of the rural population (Bureau of Statistics, 1988a).

The total farm area in Fiji is just over 2774 km^2. Altogether there were some 66376 farms consisting of 37975 Fijian, 25820 Indian and 2581 farms of other races (Fiji Agricultural Census (1978))[1]. The average farm size is 4.18ha (Appendix 2;Table 1), however, a large percentage (almost 59%) of farms are below 0.5 ha and only 3.3% are over 20ha (Appendix 2;Table 2). The Central Division has a large number of small farms. In that Division nearly 74% of the farms are below 0.5 ha. The Northern and Eastern Divisions have a much smaller proportion (30% and 49% respectively) of farms less than 0.50 ha, due to the large coconut plantations situated in these Divisions. The total number of farming households is greater than the number of farms. As a result there is an average of 1.04 households per farm, with an average of 5.4 persons per household. (Fiji Agricultural Census, 1978).

[1]The last agricultural census performed in Fiji was in 1978, as a result there are few recent agricultural statistics. Another is scheduled to be carried out late 1991.

Demographic information and change

During the period 1980-86, 38% of the population was less than 14 years of age, and 60% were of working age, defined as 15-64 years of age (Commonwealth Secretariat, 1989). The 1986 census showed that 48.7% of the total population to be less than 19 years of age, a further 48.4% were between 20-64 years of age. The average annual growth rate of the Fijian population during the 1976-86 period was 2.09% (Chandra, 1983). The population in the year 2000 is expected to be 0.9m persons (Commonwealth Secretariat, 1989). The estimated crude birthrate in 1989 was 27 per 1000 population whilst, the crudé deathrate was six per 1000. Infant mortality was 35 per 1000 births and the life expectancy at birth is 67 years (Commonwealth Secretariat, 1989).

Most ethnic Fijians are Protestant Christians and the majority of Indians are Hindus, there are also smaller Muslim and Sikh communities. The census of 1986 reported 53% of the population to be Christian, 38% were Hindus and eight percent to be Muslims (Bureau of Statistics, 1988a).

There are two key features of demographic change occurring in Fiji. They are the high rates of internal migration and the rapid decline in population growth. Traditionally the location of the population in Fiji has largely been determined by place of birth, accessibility to land, sea, and water resources. However, with the emergence of the cash economy, the critical factor now is economic opportunity. Hence the high rates of internal migration to Viti Levu from rural areas within the main islands and the Eastern Division to the Central Division especially. Most of the migrants settle in the Suva-Nausori corridor which has the most employment opportunities. In the long term, the relative depopulation of the Eastern Division is likely to continue, because of more limited economic opportunities and the poorer resource base of that Division relative to the rest of the nation. Viti Levu is expected to continue to draw population from other areas of Fiji and the Suva-Nausori corridor is expected to become more densely populated as economic opportunities increase (Chandra, 1983).

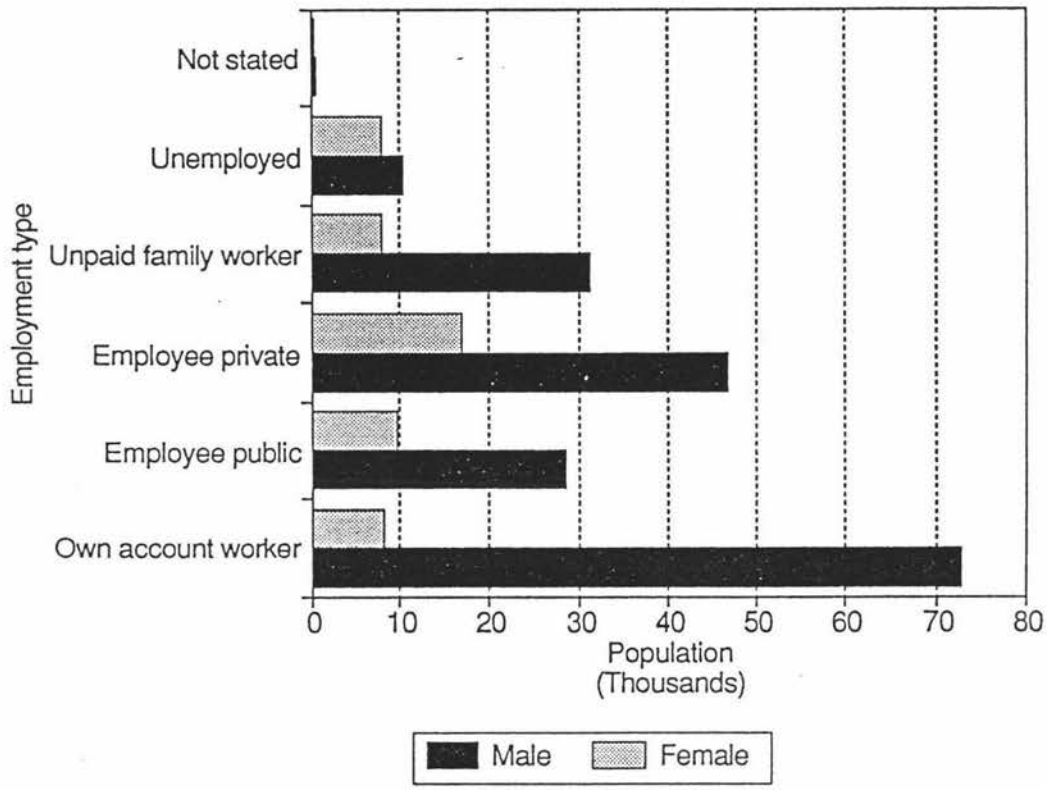
The labour force

Only 34% of the total population, or some 241,000 persons, were registered as economically active (i.e. more than 15 years of age) in 1986 (Bureau of Statistics, 1988a), compared to the potential workforce of 60% as mentioned above. Ethnic Indians mainly work in the private sector, and they dominate the 'own-account' or self-employed category (Appendix 2:Table 3). The number of ethnic Indians in the private employee sector is almost double that of ethnic Fijians. By contrast, ethnic Fijians dominate the 'unpaid family workers' category and the public sector, although a high proportion of the latter are in the armed services. Most of the higher places in the civilian public

service are filled by ethnic Fijians, while the manager/executive positions are filled mainly by ethnic Indians (Cole and Hughes, 1988).

As shown in Figure 3.5, the majority of the working population is male. Only 21% of economically active females are in the work force.

Figure 3.5: Economically active population in Fiji by employment type and gender



Source: Bureau of Statistics (1988; Table 17).

The agricultural and industrial sectors accounted for 58% of the total work force in 1986 (Appendix 2:Tables 4). Agriculture and tourism are the two main industries of Fiji, accounting for 44.1% and 10.8% of the labour force, respectively. The services sector employed 15.2% of the population in 1986 with another 8.1% seeking employment or working in jobs apart from these main sectors. Within the agricultural sector 39.4% (or 17.3% of the total working population) of the economically active population grow sugar cane, 30% are subsistence farmers and 0.5% produce dairy products, such as milk and cream (Bureau of Statistics, 1988a). Most farm work is performed by the family unit operating the farm (Chandra, 1983). In 1978 there were 88,810 fulltime farm workers over the age of 15 years. They represented 51% of the economically active population of Fiji at that time(Fiji Agricultural Census, 1978). Of these, less than three percent were permanent non-family labourers. Less than one percent of all farms employed permanent non-family labourers.

Only 33% of the economically active population were paid wages in 1986 (Bureau of Statistics, 1988a). According to the census of 1986, agriculture was the largest employer yet it accounted for only 2.7% of paid employment. The industrial sector employed 13.9% of the total labour force, but only 30.3% of those were in paid employment. In 1986 the service sector (including trade, transport and finance) accounted for 67% of all paid employment, reflecting the importance of tourism and government intervention in the economy. The percentage of ethnic Fijians (39%) in paid employment was markedly smaller than that of ethnic Indians (53%) (Bureau of Statistics, 1988a). More data and statistics on these matters are provided in Appendix 2:Table 5.

Table 3.4 presents the mean wage rates by employment group over the period 1980-1988. Workers in the electricity group have consistently been the highest daily wage income earner over this period. Agriculture has had the lowest wage rate over the whole period.

Table 3.4. Mean wages of earners by industry group, 1980-88 ($F/day).

Employment group	1980	1982	1984	1986	1988
Agriculture	7.44	6.16	8.64	8.24	8.56
Mining	8.40	9.28	10.56	10.72	12.32
Manufacturing	9.52	11.20	12.00	11.84	12.48
Electricity	10.16	12.96	14.56	15.20	16.80
Construction	9.36	12.00	11.92	12.40	11.60
Trade	8.88	10.32	11.20	11.28	12.08
Transport	9.76	11.76	12.56	13.20	14.24
Services	9.72	11.04	11.76	12.08	13.84
All industries	9.28	10.96	11.84	12.00	12.40

Source: Bureau of Statistics, 1990 (Table 10.4).

Thus, while the agricultural sector employed the largest number of people in the national labour force (44.1% in 1986), only three percent of those employed in agriculture receive wages. Furthermore , the agricultural wage rate is the lowest of all employment groups. This suggests that a large proportion of those in agriculture is engaged in subsistence farming, where the household consumes the majority of its own output and supplies most of its own inputs, including labour. The agricultural sector plays an important role in the provision of food to the rural community, although the returns to employed labour are small.

Nearly 40% of the working population in the agricultural sector grow sugar cane whilst only 0.5% are dairy farmers. The main paid employment within the agricultural sector is on sugar cane farms

during the harvesting season while only a small percentage of dairy farmers and their workers are paid wages.

3.3 THE FIJIAN ECONOMY

Some aspects of the Fiji economy are now discussed, with special reference to the agricultural sector. Overall performance of the economy is described in terms of national income and the contribution of each sector to GDP. Key aspects of agricultural production in Fiji are presented, including estimates of the yields from the main crop and livestock products. International trade is discussed with regard to imports and exports, balance of trade and main trading partners in Section 3.3.2.

3.3.1 National income and sector contributions to GDP

Fiji is one of the wealthier island nations of the Pacific (Euromonitor, 1991). It is second only to Papua New Guinea (PNG), which in 1988, had a Gross Domestic Product (GDP) of $US3,568m, whilst Fiji had $US1,075m (Appendix 3; Table 1). In 1988, according to estimates by the World Bank (The Far East and Australasia, 1991), Fiji's Gross National Product (GNP) per head, measured at average 1986-88 prices, was $US1,520. From 1965 to 1988 GNP per head in Fiji was estimated to have grown by an annual average of 1.9%.

The Fiji Reserve Bank estimated GDP to be $F1,655m in 1989 compared with $F1,385m in 1988. This was equivalent to $F2,292 per head (Bureau of Statistics, 1990). At constant 1977 prices, GDP was estimated to be $F811m in 1989 (an increase of 12.5% from 1988). Against the same base year of 1977, GDP per capita increased by 11.7% to $F1,123 in 1989 (Bureau of Statistics, 1990). Table 2 of Appendix 3 provides data on GDP at constant 1977 prices over the 1980 to 1989 period. During 1980-1989, it was estimated that GDP increased (at 1977 prices) by an average of 2.0% annually, and GDP per head by 0.4% annually (The Far East and Australasia, 1991).

Agriculture (including forestry and fishing) contributed 20.1% of GDP in 1988 (Appendix 3; Table 3.). Sugar cane is the principal cash crop and the sugar industry as a whole contributed an estimated 15.2% of GDP (at current prices) in 1988 (Bureau of Statistics, 1990). Between 1980 and 1986 agricultural production increased by an annual average of 3.0%. However, during 1987 agricultural production declined by 21.0%. In 1988, it increased by 3.2%. over 1987 and in 1989 by only 1.9% over 1988 (The Far East and Australasia, 1991). Industry (including mining, manufacturing, electricity and construction) contributed 20.4% of GDP in that year. During 1987 industrial production declined by 14.9% because of political troubles. Industrial production expanded again by about 6% in 1988 and 8.9% in 1989, mostly due to the recovery of the sugar

industry (The Far East and Australasia, 1991). Mining and quarrying contributed 2.8% of GDP in 1988. The most important mineral resource is gold. Other mineral reserves include silver and marble. In 1988 manufacturing contributed 9.9% of GDP.

The most important manufacturing activity is food processing, especially sugar and fish canning. Manufacturing has received particular encouragement by the Government since 1987 when the Government established a register for factories which would be exempt from any taxation provided 95% of their production was exported. By the end of 1989 there were 82 such companies (compared with 44 in 1988), of which 54 were garment manufacturers (The Far East and Australasia, 1991). Hydroelectricity is the major source of power in Fiji. The electricity, gas and water supply sectors contributed 4.1% of GDP in 1988. The services sector accounted for 64.6% of GDP in 1988. Financial and government services, both domestic and regional, make an important contribution to the Fiji economy. Much of the sector's service activities are related to the tourist industry.

3.3.2 Agricultural production in Fiji

The primary crop and livestock products in Fiji are described in this section. Special reference is given to the principal crops grown and their annual yields, the estimated national population of stock, and consumption of livestock products in Fiji.

a) Crop production

The principal crops grown in Fiji are sugar cane, coconuts, cassava, paddy rice, sweet potatoes, bananas, yams and taro. Table 4 of Appendix 3 shows the quantities of selected agricultural products produced in Fiji. Sugar cane is the most important crop by value. The national average yield for sugar cane in 1989 was 49.8t/ha, when four million tons of cane was produced. The second most important crop by value in 1989 was copra with a tonnage of 13,368t. Yields per hectare of some common Fijian crops are presented in Table 5 of Appendix 3.

b) Livestock production and population

The major products of livestock are draught power, milk products, poultry, eggs, meat, beef, pig and goat meat. In 1989, 4929t of chicken was consumed in Fiji, all of which was produced in the country (Appendix 3:Table 4). Only 63% (3140t) of the meat consumed in 1989 was domestically produced. Estimates of the livestock population of Fiji are provided in Table 3.5 below. The national

cattle population has been estimated at 159,000 head in 1989. The numbers of all domestic stock changed little from 1985 to 1989

Table 3.5. Fiji livestock numbers ('000 head)

Livestock	1978	1985*	1987*	1989*
Cattle	164	158	159	159
Chicken	1000	2000	2000	2000
Pigs	21	29	29	29
Goats	55	59	59	60
Horses	36	41	41	42

* Estimated
Source: MPI, 1989.

A description of the major livestock industries of Fiji is presented in Section 1 of Appendix 3. The dairy industry is discussed in detail in Section 3.6.

3.3.3 International trade

Traditionally Fiji's principal exports were sugar and copra. Tourism became important in the 1970's. Labour-intensive manufacturing industries were added in the 1980's. Sugar and tourism, however, continued to dominate the economy. Sugar and molasses accounted for 36.7% of total exports in 1989, earning some $F208m in that year. In 1989, 461,000t of sugar and 151,000t of molasses were produced from the 4.1m tonnes of sugar cane. Sugar production levels have remained below the record volume of 5m tons achieved in 1986, owing mainly to the political disruptions of 1987. Other important export crops are coconuts and ginger. In 1989 copra production increased to 13,370t, and coconut oil production increased by 15.8% to 7,618t, to earn $F5.3m in exports (Bureau of Statistics, 1990). Exports of green ginger were worth $F3.6m in 1989, and production increased by some 21% to 4,700t (Bureau of Statistics, 1990).

Some 4,200 kilograms of gold were exported in 1989, earning $F76m. In 1989 the tourist industry earned $F280m in foreign exchange, as measured by the gross inflows on the travel account of the balance of payments (Bureau of Statistics, 1990), compared with the sugar export earnings of $F208m. The political upheavals of 1987 adversely affected the tourist industry, with the tourist arrivals in that year falling to 189,866 persons from a record of 257,824 persons in 1986. Numbers of tourists recovered in 1988 to 208,155, and rose to 250,565 in 1989 (Bureau of Statistics, 1990).

Figure 3.6 provides a summary of Fiji's trade by commodity group. Together, exports of sugar, molasses, coconut oil, timber, fish, unrefined gold and garments accounted for 88% of the total export receipts in 1989 (Bureau of Statistics, 1990). Sugar dominates all domestic exports, and accounted for 39.1% of all exports by value in 1989 (Figure 3.6).

Food is an important import item, as are manufactured goods, machinery and fuel (Figure 3.6). The principal imports in 1989 were machinery and transport equipment which accounted for 25.5% of total imports by value. Nearly 77% of imports to Fiji are accounted for by machinery and transport equipment, manufactured goods, mineral fuels and food. (Appendix 3:Table 6 shows the amount of each commodity imported and exported, to and from Fiji in 1989.)

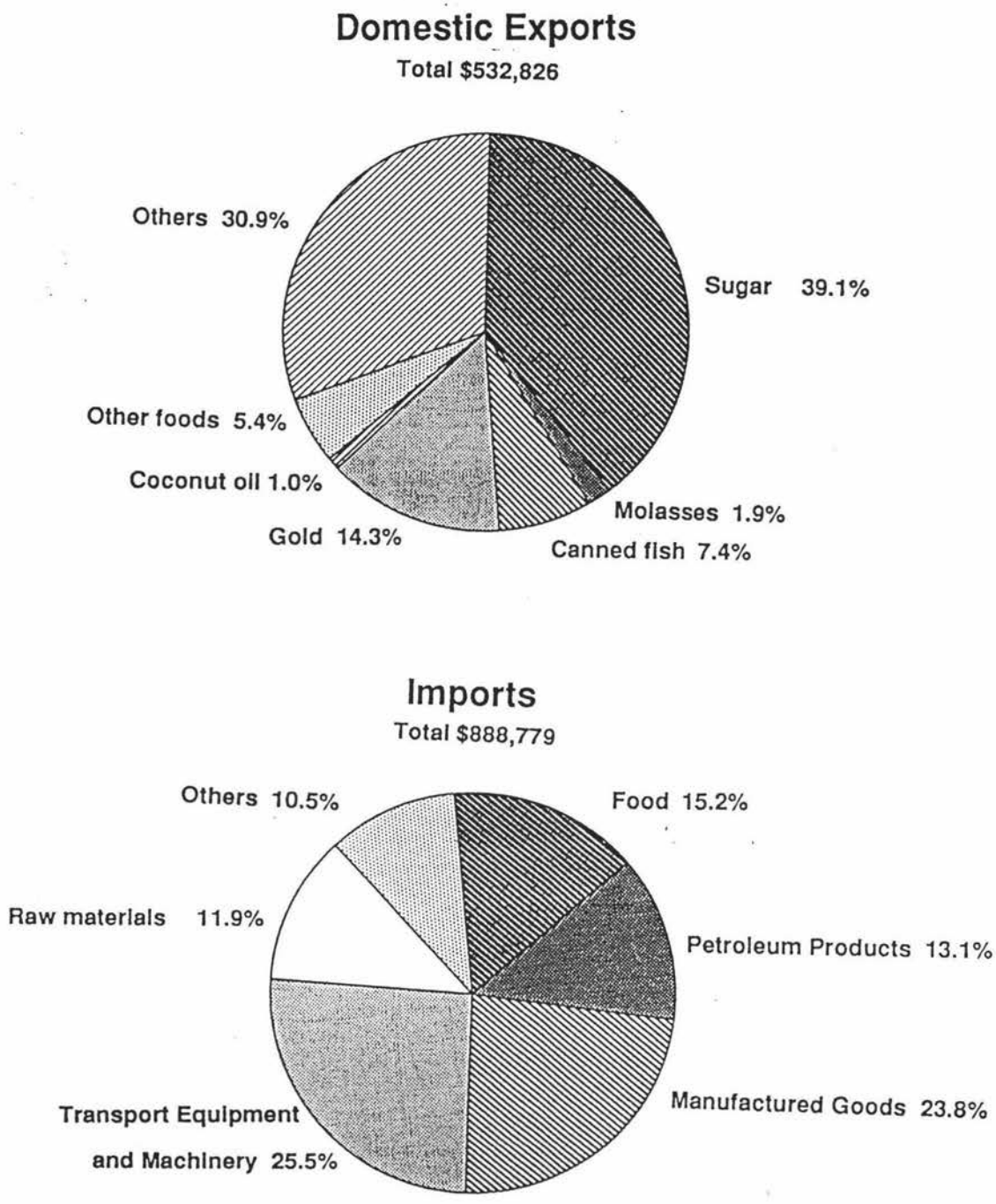
Fiji is heavily reliant on the importation of dairy products to meet the consumption needs of the population. In 1989, almost 590t of milk fat was produced by commercial domestic producers and a further 2125t was imported, indicating a level of 22% self sufficiency in this product. The main dairy products imported are full cream and skimmed milk powder, butter, ghee, evaporated and condensed milk. In 1987, approximately F$8m was spent on importing dairy products (Bureau of Statistics, 1988b), increasing to F$11m, or 1.2% of total import expenditure in 1989 (MPI, 1989). Tables 7 and 8 of Appendix 3 present further data on domestic production and imports of dairy products from 1979-1989. Fiji exports negligible quantities of dairy products. Fiji is therefore dependent upon international markets for dairy products.

Overall, imports have been growing relatively faster than exports, creating a widening trade deficit (Appendix 3:Table 9). In 1988, there was a deficit of F$127m which increased to F$251m by 1989.

The principal source of imports was Australia which accounted for 30% of total imports in 1989. New Zealand was the next most important exporter to Fiji, and accounted for 17.2% of imports to the country. Japan provided 13.4% of Fiji's imports. The United Kingdom is the principal market for Fijian exports, accounting for 27.2% of total exports in 1989. Australia and New Zealand are the next most important purchasers of exports accounting for 22.8% and 16.3% respectively of exports by value (Bureau of Statistics, 1990).

Australia and New Zealand are Fiji's largest supplier of food. Japan, Australia, New Zealand, United States, China and Taiwan provide the main part of Fiji's machinery and manufactured goods requirements. Imports from Japan comprise of tourist goods and motor vehicles (Bureau of Statistics, 1990).

Figure 3.6: Fiji's trade by commodity group, 1989 (F$000)



Source: Bureau of Statistics (1990; Chart 8.2)

The Fijian economy has a narrow base. The main components of growth in GDP are sugar and tourism. Fiji's agricultural sector is vulnerable to both adverse weather conditions and to fluctuations in international commodity prices. The agricultural sector contributed $F279.6m (20.1%) towards GDP in 1988. An estimated 15.2% of GDP was accounted for by sugar cane cash crops. In 1988 sugar and molasses contributed 36.7% of total exports. Fiji's heavy reliance on the importation of food (especially dairy products), manufactured goods, machinery and fuel also increases its vulnerability to changes in international markets and prices.

3.4 LAND TENURE

All land in Fiji is either Crown land, Freehold land or Native land. These three arrangements are discussed further below because the type of land tenure has a strong influence on the land use for agriculture and for dairying in particular. The administration of Fiji land by the Native Lease Trust Board is presented. The impact of tenure arrangements upon agriculture, and especially upon dairy farming, is discussed.

3.4.1 Land tenure arrangements in Fiji

Crown land accounts for nine percent of the area of Fiji. It consists mainly of land unclaimed at the time of Cession in 1874. Areas purchased by the Government since then and Fijian native land whose owners have died have added to the holdings by the Crown. Much of the Crown land consists of forested inland areas and mangrove flats in the coastal regions. Crown land can only be leased by users.

Freehold land accounts for approximately eight percent of Fiji. Owners of freehold land have titles to their land. Freehold land can be bought and sold. Most of the freehold land in Fiji today was acquired by early European settlers, especially coconut planters. The main areas of concentration are in Vanua Levu. Presently 40 percent of coconut land in Fiji is held under freehold tenure. Some of the outlying islands were also acquired on a freehold basis and are now being used as tourist resorts.

Native Lands, the third land tenure class, accounts for approximately 83% of Fiji. Native lands can be held either a Native Lease Land or Native Reserve Land. Native Lease Land accounts for 55% of Fiji and can be leased for farms, or for any other use, by a person of any ethnic group. Most of the Native Lease Land is located in the flat, coastal areas of the main islands and is already in use, typically by Indian farmers. Native Reserve Land, which accounts for some 28% of all land, can be used only by indigenous Fijians. This land comprises mostly of hilly, mountainous country in the interior of the main islands and remote outlying islands. These lands have limited uses for agriculture.

The following description of Native Land tenure and land policy is quoted from MPI(1990; A4:24-25).

> "The Fijian system of land tenure is basically one of entailed freehold, and is closely tied to the Fijian social structure. The Fijian way of life is based on closely related family groups or tokatokas, living together in villages and cultivating well-defined land areas originally acquired by conquest or occupation of empty land. Several such family groups

claiming descent from a common ancestor are linked to a larger social unit called the mataqali. For official registration of land titles the mataqali has been adopted as the proprietary unit. There are some 6,000 such units registered with membership ranging from a single individual to several hundred. The title of the land is vested in the mataqali. The land may consist of one block or several blocks and ranges in size from less than one hectare to several thousand hectares. The overall average size of a mataqali land unit is 243 ha. Fiji thus consists of a patchwork of mainly Fijian owned land with no large areas of land under a single title.

Fijians have for many years leased their land to other races for agricultural and other purposes. The early method was by direct approach to and negotiation with the land owning unit. If agreement was reached, Government approval was granted. This method was haphazard and unsatisfactory from a number of aspects.

In 1940, with the consent of the Fijian people, a Native Land Trust Board (NLTB) was established, as a non-Government corporate body, to handle the management of Fijian lands. This Board, in effect, acts as an estate agency for the benefit of the Fijian landowners. It arranges leases, collects and distributes rent, and is responsible for supervision of lease conditions. The enacting legislation also made provision for the creation of reserves, solely for Fijian use for current and future needs, where alien leases are not permitted. The NLTB's standard leases contain provisions intended to enforce good husbandry, but while it can exert pressure in extreme cases, the Board has not the staff to do as much as is desirable in this connection."

Rent on Native Lease Land is charged at the rate of six per cent per annum of unimproved value of the land. One quarter of the revenue and another 10% of other royalties goes to the NLTB and the remainder to the landowners. The rental revenue and royalties are divided amongst the mataqali members on the basis of their rank in the clan hierarchy (Chandra, 1983).

In Fiji land tenure strongly affects agriculture and other productive and economic sectors. The land tenure system determines the nature of land use by investment in land improvement. Farming, for instance, on a lease basis creates a high degree of uncertainty. Chandra (1983) discusses why this occurs and ways in which the uncertainty has been reduced.

"Uncertainty emanated from the short-term lease arrangements which, prior to 1966, could be as short as an annual tenancy agreement. Such uncertainty of continued tenure manifested itself in poor on-farm husbandry practices and in low levels of capital improvements such as drainage, soil fertility, fencing and pasture improvements. The net result of these factors was lower farm productivity than would otherwise have been

possible. In 1966 the Agricultural Landlord and Tenant Act (ALTA)[2] was implemented providing a minimum lease contract of 10 years on holdings of over one hectare. This period was found to be too short by farmers. Revised legislation was passed in 1976 which provided an extension of 20 years when the lease comes up for renewal at the end of the first 10 years. In addition, the minimum term for any new lease was set at 30 years. The tenants were also guaranteed compensation for improvements. The rent payable is assessed by a panel of valuers every five years. Although these new provisions have greatly reduced the degree of uncertainty in farming, most farmers, especially tree crop and livestock farmers, would prefer an even longer term lease period."

The Fiji Agricultural Census (1978)[3] showed that 69.4% (Appendix 4:Table 1) of all farms were on Native Land, almost 50% of which were Native Reserve Land. Native Reserve Lands are farmed only by indigenous Fijians. The remaining 19.5% of Native Lease lands would be farmed predominantly by Indians. The limitation of available lease land to Indians creates pressure upon the farmers to acquire or retain leases for agricultural purposes. Most dairy cattle are kept by Indian farmers whilst most beef cattle are owned by Fijians. Almost 83% of dairy cattle in Fiji were farmed on Native lands, over half of which were Native Lease lands in 1978 and mainly farmed by Indians (Fiji Agricultural Census ,1978). Farm productivity levels are thus influenced by land tenure arrangements in the same way as the natural endowments such as soils and climate affect productivity.

3.5 AGRICULTURE IN FIJI

A brief description of the main crop and livestock production systems in Fiji is presented. The main crops grown and the livestock in each production system are described. Their importance for feeding the Fijian population is summarised. A brief summary of the differences between Indian and Fijian farming systems is presented, with special reference to differences in the roles of cattle.

3.5.1 The main farming systems of Fiji

Chandra (1983) categorised the crop production systems into two broad classes:

i) Subsistence crop production systems; and

2Laws of Fiji (1967).

3All data used from this source are quoted from Chandra (1983).

ii) Commercial crop production systems.

A large variety of crops are grown in both commercial and subsistence production systems. Both the Fijian and Indian farmers have particular crop preferences for personal consumption and selling. These preferences determine the quantity and type of crops grown each year. Livestock are also farmed in commercial and non-commercial systems to meet the needs of Fiji and individual families. The main crops grown in the subsistence system are rice, root crops, pulses and vegetables. Other less important crops are breadfruit, mangoes and tumeric. The main root crops are cassava, taro, yams and sweet potatoes. The main pulse crops are pigeon peas, cowpeas, mung, urd and peanuts. The important vegetables grown include tomatoes, English and Chinese cabbage, beans, lettuce, egg plants, cucumber, okra, pumpkin and chillies.

Rice is the most important staple food crop in Fiji, and is consumed by all groups, although Indians may account for over 80% of the national consumption (Chandra, 1983). The root crops are the most common staple crops for the Fijians, who account for 90% of total consumption of them. Pulses are important to Indians. A considerable amount of the domestic production of vegetables is consumed as subsistence products by the rural households, with the remainder being marketed in the urban areas.

The main crops grown in commercial production systems include sugar cane, coconuts, ginger, cocoa, citrus, passionfruit, maize, sorghum and broomcorn, tobacco, yagona and masi. Watermelons, pineapples, bananas and plantains are also grown but are of less importance.

The main livestock farmed are beef, dairy, poultry, pigs, goats, horses and sheep. Key features of the pig, poultry and beef industries are described in Section 1 of Appendix 3. All of the livestock systems can be divided into two main sectors commercial and non-commercial. Goat farming is mainly carried out by sugar cane farmers, who are predominantly Indian, keeping small herds for subsistence use. The main breeds introduced to Fiji were Angora, Saanen and Anglo-Nubian, a mixture of these breeds now forms the basis of the present goat herd in Fiji (Chandra, 1983). Goat meat is the main product from goats. Horses are important draught animals. They are used extensively for the production of crops such as, sugar cane, root crops, dryland rice, pulses, maize and vegetables. On farms their main functions are ploughing, harrowing, scarifying and transportation of goods and people. Sheep are of minor importance in Fiji and almost all of sheep meat consumed is imported as fresh and canned meat.

Fijian and Indian farming systems are characteristically different. Chandra (1983) describes the following differences. Fijians usually live in nucleated villages and farm adjacent lands, with a household usually farming a definite block of land. Although the land is communally owned, farming is done by individual families. Each family provides for its own subsistence and commercial

crops. All important farming decisions are made by the head of each household. Due to the communal nature of the Fijian social custom, exchange of labour and capital items including food crops is prevalent. Each village behaves as an economic entity. Indian farmers, however, largely live independently of each other on their own blocks of land. The homesteads are usually located at one corner of the block. Many such blocks form a settlement. The only common features between blocks are the tenure arrangements and cropping patterns. There is limited economic interdependence between the households although some exchanges of goods and services may take place between neighbours.

There is little social and economic interaction between Fijian villages and Indian settlements. Each has distinct cropping and livestock systems, food crop preferences, customs and traditions. Chandra (1981) found that Fijian village farmers concentrate heavily on the production of the traditional root crops such as, cassava, taro, yams, sweet potatoes and bananas, whereas Indian farmers produce rice, pulses and vegetables.

Draught animals and animal drawn equipment are present on many farms. Indian farmers use more draught power than Fijian farmers, and prefer cattle as draught animals, whereas Fijians are reported to prefer horses for these purposes (Chandra and Sharma, 1979). Common animal-drawn implements include ploughs, harrows, scarifiers and wooden sledges. The important hand tools are knives, forks, spades, hoes and sickles. Chandra and Sharma (1979) present details of how oxen and horses are used on Indian and Fijian farms.

Fijian farmers reportedly keep cattle primarily for beef production and social purposes such as weddings, when cattle may be a gift, the food, or both. Milk is a by-product from the production of beef. Some fresh milk is consumed but no on-farm processing is carried out. The cattle are owned by individual farmers. In addition to using them for draught power Indian farmers keep cattle as providers of milk which is processed on-farm into a range of products, and for religious purposes. The cattle are not slaughtered for food. In the Hindu religion the cow is seen as a 'mother', and is highly respected. Farmers will usually keep the cow until she dies or the cow will be sold to another Indian farmer. Milk is consumed either as a liquid or processed form, such as ghee (butter oil) or butter. Most of the milk and milk products produced are consumed by the farm household, with small amounts being given away but rarely sold.

3.6 DAIRYING IN FIJI

The population and distribution of dairy cattle in Fiji is now discussed. A brief description of the two main types of dairy producers in Fiji is presented. Sections 3.6.3 and 3.6.4 describe the commercial and non-commercial dairy sectors, respectively.

3.6.1 Dairy cattle population and distribution

Cattle were classified in the Fiji Agricultural Census (1978) as being kept principally for meat and dairy purposes. However, the classification 'dairy cattle' does not necessarily imply that the animals are used for commercial dairy purposes. They may be used only to supply the farmer's own milk needs.

In 1978, the national cattle population was estimated at 247,430 head.
The Western Division accounted for 47% of all cattle, followed by the Central Division with 31.4% of the national cattle herd. The dairy cattle population was estimated to be 95,005 head in 1978 with the Western Division accounting for almost 53% (Appendix 5:Table 1). Farming in the Western Division is dominated by farmers of Indian origin. Since there is no commercial production of milk in the Western Division, farmers there keep dairy cattle mainly for subsistence purposes. Nearly 84% of dairy cattle are kept for non-commercial purposes.

Almost 34% of the national dairy herd are cows, 20% are male and female calves under one year of age, 14% are heifers and 18% are working bullocks (Appendix 5:Table 2). Only 5% of the herd is classed as breeding bulls, with the majority of these being located in the Western Division to support the natural mating systems used by Indian farmers.

3.6.2 The Dairy producers of Fiji

MPI (1989) identified three types of dairy producers in Fiji:

i) Members of the Rewa Cooperative Dairy Company supplying milk and cream to the Rewa Dairy factory. In 1989 there were 167 farms supplying milk or cream to the factory, totalling about 12m litre equivalents of milk per year.

ii) Registered non-factory commercial dairy farmers supplying fresh milk to town milk vendors who sell milk door-to-door in Suva or supply other towns. There were about 38 suppliers in 1989, producing 140t of milk fat equivalents (MFE), equivalent to some 3.9m litres of milk per year.

iii) Other farms located throughout Fiji which have one or more house cows for the production of fresh milk and ghee for home consumption. Their production was estimated to be about 25m litres per year in 1989.

Types (i) and (ii) above are categorised as commercial dairy producers, whereas the final group are non-commercial. Total milk consumption in 1989 was reported as 2712t (MFE) (75m litres of

whole milk) assuming a milk fat test of 3.6%. Commercial factory farmers supplied 16.5% of the consumption. A further 5% was provided by non-factory commercial producers. Importation of dairy products constituted the remaining 78.4% of total milk consumed in Fiji during that year. The domestic production and importation of dairy products in Fiji is presented in tables 7 and 8 of appendix 3.

3.6.3 Commercial Dairy Industry

The commercial dairy industry of Fiji is confined to the Central Division, on Viti Levu. The dairy cattle population there was estimated at 34,450 head in 1978. The percentage of this total which is owned by the registered dairy farmers is unknown. The Fiji Agricultural Census (1978) estimated a commercial herd of 15,600 dairy cattle, with the remainder being owned by non-commercial producers. Therefore, the production of all commercial dairy products in Fiji is derived from the commercial dairy herd of approximately 15,600 animals. Of the dairy cattle in the Central Division, almost 52% are cows, a further 22% heifers and 23% are calves under one year, the majority of which are female (Appendix 5:Table 3). Most of the dairy cattle population is located in the Naitasiri and Tailevu provinces of the Central Division (Figure 3.2).

The registered dairy farms in Fiji range in size from 10ha to over 200ha. Most are family owned. The usual herd size of a commercial dairy unit is 40-50 milking cows plus another 20-25 animals including heifers, calves and breeding bulls. A typical dairy farm consists of a homestead, a milking shed, and some 20-25 paddocks. The two principal dairy breeds are Friesian and Jersey, although Sahiwal cattle are also used to a lesser extent. Artificial insemination is used for herd improvement within the commercial dairying sector (Chandra, 1983). The most common pasture species present on commercial dairy farms are Para grass on the flats, and Batiki Blue grass and Koronivia grass on the hills (Chandra, 1983).

In 1989, about 22% of the total supply for milk products was produced domestically by commercial dairy farmers, imports accounted for approximately 68% of the MFE consumed in Fiji (Appendix 3:Tables 7 and 8). Fiji is therefore heavily dependant upon the importation of dairy products to meet the domestic consumption demands. Thirty percent of the total supply of beef is also produced by this sector (MPI, 1989). Milk produced on commercial farms is sold directly to the urban households or institutions, sold to the Rewa Co-operative Dairy Company (RCDC) for processing. or processed into cream and sold to RCDC for further processing.

The Rewa Co-operative Dairy Company (RCDC) is the sole processor of milk products in Fiji. It is owned by a cooperative of dairy farmers and located in Nasinu, 6.5km north of Suva. Milk is either collected daily from farms or twice weekly from chilling centres. In 1989, the RCDC received about

9m litres of liquid milk and 100t of butterfat as cream per year from farmers (MPI, 1989). RCDC produces a variety of popular consumer goods, including Ultra-Heat-Treated milk in Tetra-packs, pasteurised, homogenised, evaporated and flavoured milk, butter, ghee, cheese and yoghurt. It is also engaged in importing, repackaging and marketing all the major dairy products imported to Fiji, such as butter, ghee, cheese and powdered milk. The RCDC has a monopoly on all dairy products imported, exported and domestically manufactured.

The Fiji Government supports the commercial dairy industry in the following ways (MPI, 1989):
i) It protects the dairy industry through import licensing and tariff control on major dairy products such as milk powder, butter and cheese.
ii) It provides taxation relief to dairy farmers.
iii) It provides low interest rates through the Fiji Development Bank.
iv) It subsidises prices of fencing materials, equipment, livestock drugs, roading and water supply.
v) It provides a dairy extension service and disease control programme free to farmers.
The Government has placed emphasis upon increasing both efficiency and productivity from existing dairy farms through pasture improvement, genetic improvement, disease control, improved animal husbandry and management practices, especially milking techniques and hygiene in the dairy shed.

3.6.4 The non-commercial dairy sector of Fiji

The non-commercial dairy herd in Fiji was estimated in 1978 to be 79,400 head, or some 84% of the national dairy herd. These dairy stock were kept mainly in herds of one or two cows per farm. The production systems used have reportedly changed little since that time. Cows in these systems are kept primarily for subsistence milk consumption in the rural areas. Fresh milk and ghee are the main products.

MPI's annual report (1989) estimated non-commercial dairy production to be about 25m litres per year, which is more than double the quantity received by RCDC from the commercial sector. MPI also acknowledged that if non-commercial production is taken accounted in the national total, the level of self sufficiency increases to 43%. However, there is a scarcity of relevant production data on the non-commercial sector, so the reliability of these estimates can not be established. The actual productivity and importance of these dairy cattle to the rural sector is therefore unquantified, despite the fact almost 84% of the dairy cattle population belong to these subsistence dairy farmers. In strong contrast with the commercial dairy sector, the non-commercial sector receives no Government support towards increased productivity or returns for research or market development.

3.6.5 National consumption of dairy products

For Fiji to be self sufficient in dairy produce, the domestic commercial dairy industry would need to produce another 54m litres (giving a total of 66m litres) at current prices. In 1989 the average consumption of dairy products per person in Fiji was 3.8 kg MFE (MPI, 1989). Some of the important dairy products consumed are full cream milk powder, ghee and butter. Indians are reported to be the main consumers of dairy products in Fiji. There are no target national consumption figures available for milk products in Fiji. Consequently, there seems to be no basis for future expansion with respect to milk consumption. Commercial dairies are not producing enough milk to meet the demands of the domestic market, so milk and milk products are supplied from two other sources; Firstly, through imports which use up valuable foreign exchange, and secondly, the non-commercial dairy producers. However, nothing is known about these enterprises, the levels of milk production and the potential capacity of this sector to contribute towards the consumption demands of the population. Hence the emphasis of this study on the non-commercial dairy producers in Viti Levu.

3.7 SUMMARY

This chapter has presented an overview of the physical and human resources, economy, land tenure, and agriculture in Fiji, with emphasis on the non-commercial dairy sector.

Fiji has a total area of 18,300 km^2 split into four administrative divisions. This study concentrates on the main island, Viti Levu, which covers the Western and Central Divisions and accounts for all but a small percentage of dairy cattle in Fiji. Viti Levu has a sub-tropical climate with a distinct wet and dry seasons. Only 58% of this island is suitable for permanent agriculture.

In 1989, the population of Fiji was estimated to be 727,000, the main ethnic groups being Fijian and Indian. Approximately 76% of the total population are located on Viti Levu, and 9.7% are in the capital, Suva. Almost two thirds of the population live in rural areas, the majority of which are located on the main island. In 1986, 241,000 persons were registered as economically active, of which 33% were paid wages. The agricultural sector employs the largest number of people (44.1%) however, only three per cent of those employed receive wages, and at the lowest rate compared with other employment groups.

Agriculture and tourism are the principal sectors contributing to the Fijian economy. Sugar, copra and ginger are the main exports, whilst the major imports include manufactured goods, food, machinery and fuel. Fiji is heavily reliant on the importation of dairy products to meet the consumption needs of the population. A widening trade deficit exists due to increasing imports

There are three different types of land tenure present in Fiji. Native land accounts for 83% of the total, this affects the amount and type of land available for leasing to persons other than Fijians for agricultural use.

The types of crops grown and roles for livestock are affected by the differences between Indian and Fijian farming. The principal crops grown are sugar cane, coconuts, cassava, paddy rice, sweet potatoes, bananas, yams and taro. The major products from livestock include draught power, milk products, poultry meat, beef, pig and goat meat. Crop production systems can be grouped into two broad groups, subsistence and commercial systems, each growing different crops.

In 1978, the total dairy cattle population was estimated to be about 95,000 head. These cattle are farmed in two main groups, which can be labelled as commercial and non-commercial dairy producers, respectively. The commercial dairy group is located in the Central Division of Viti Levu. In 1989, Fiji produced only 22% of the total commercial sales of milk and milk products in the country. The remainder was imported. The Rewa Cooperative Dairy Company is the sole processor and marketer of all dairy produce in Fiji. The Government provides significant financial and institutional support for the commercial sector. Nearly 84% of the dairy cattle are owned by non-commercial dairy producers in the Western Division of Viti Levu. However, there is a lack of relevant data on these animals leaving the actual productivity and importance of these dairy cattle to the rural sector unquantified. The shortage of other than anecdotal information on this latter producer group provided a strong rationale for undertaking this study. The methodology and results from research upon the roles and productivity of cows in the non-commercial dairy sector are described in the remainder of this thesis.

4. STUDY METHODOLOGY

4.1 INTRODUCTION

This chapter presents the methodology followed in the study. The procedure for sampling of farmers is described in Section 4.2. Field operations are presented in Section 4.3. This is followed in the next section by some comments on the practicalities of undertaking these field studies.

The main aims of this study are to gather primary information in order to describe the smallholder farming system(s) and to assess the role and contribution of non-commercial dairy cows to the income, nutrition and cultural well-being of Indian families in the Western Division of Viti Levu. Two hypotheses were to be tested through the field studies. First, that the smallscale cow herds, typically one or two cows, make a significant contribution to the nutrition and economic and cultural well being of the families which keep them. Second, that these small herds are maintained and produce using resources of low opportunity cost to the farm family.

A literature search focussing on the Fijian dairy industry was undertaken prior to arriving in Fiji. Discussions on the topic were held with a number of persons with first-hand familiarity of agriculture in Fiji, and of the dairy sector in particular. The literature and discussions provided useful background to the field study, but highlighted the dearth of information available on the non-commercial sector of the Fijian dairy industry.

4.2 SELECTING THE SAMPLE FARMERS

Prior to undertaking field visits in Fiji, discussions were held with a number of individuals and groups about the study, its objectives, proposed field methods, the advantages and disadvantages of different approaches to the study and other practical matters relating to field studies in rural Fiji. These discussions were held with agricultural scientists from Koronivia Research Station (KRS), veterinarians, lecturers and students from the Fiji College of Agriculture (FCA), Animal Health and Production (AH&P) livestock officers, and Extension officers from the Ministry of Primary Industries Headquarters. A reference search was also performed at the University of the South Pacific (USP). Few relevant references were identified to supplement the material already located in the previous searches. Throughout the field study period there was close collaboration with Government officials from the Farm Management Information Systems (FMIS) and, the Economic Planning and Statistics Division of MPI (EP&S), and staff at the FCA. Authorisation for the field work was granted by the Ministry of Primary Industries.

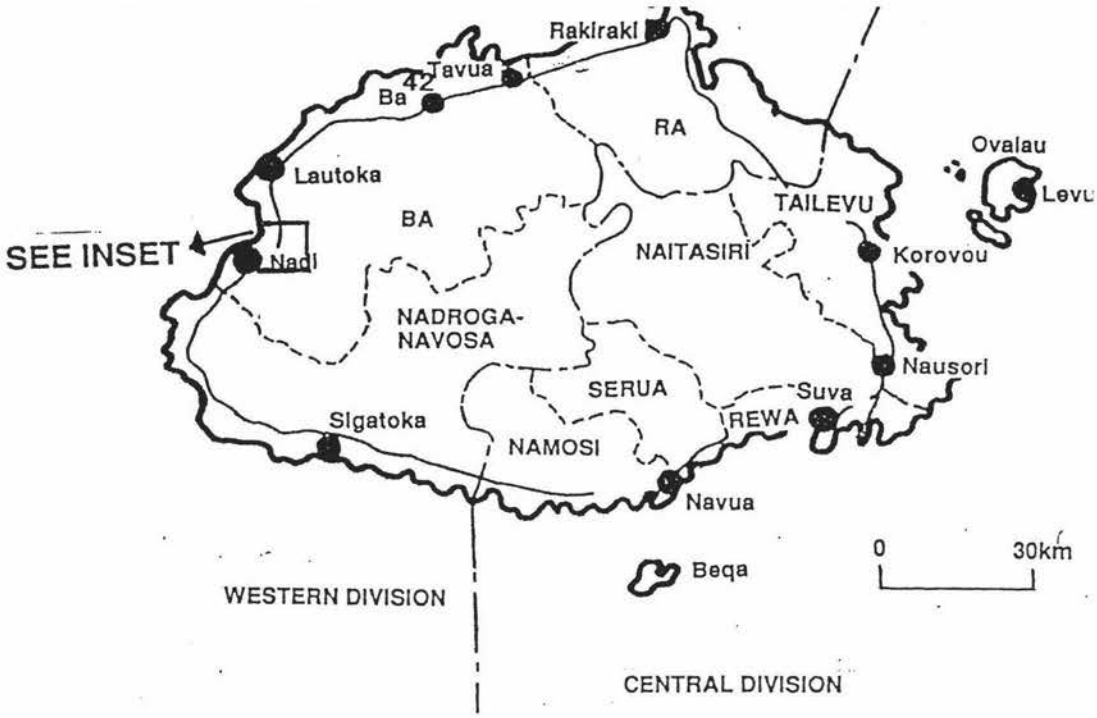
Visits were made to the dairy research farms at KRS and FCA, and a commercial dairy farm near Nausori in Tailevu (Figure 3.2). A day trip with FCA staff into Tailevu Province provided an introduction to agriculture and farming in Fiji. The only documentation available on the Fijian dairy sector was concerned with the commercial dairy sector. No material (published or unpublished) was located which dealt specifically with the non-commercial dairy sector in Fiji.

It was concluded from these discussions that the objectives of the study would be best met if the target population for the field study would be of Indian farmers involved in non-commercial milk production. Various experts reported that most non-commercial dairy farmers in Fiji would likely own one to two cows for milk production. Indigenous Fijians were not targeted in this study as the view of those experienced with dairy production was that these Fijian farmers keep cattle primarily for beef and not dairy production (see also Section 3.5.1). The informal information available suggested that the majority of the small herds owned by Indian farmers were in the Western Division. These farmers had systems mainly concerned with sugar cane for production but cows were known to be prominent enterprises. Some cows were known to be kept by rice farmers in the Central Division but the number of farmers was considered to be small relative to the number of farmers with cows in the Western Division.

The most recent agricultural census of Fiji was done in 1978, and the information from that source was regarded by knowledgeable administrators as being outdated and unreliable as regarding its use as a sampling frame. As a consequence, a list of farmers in the target population in the Western Division was not available. Therefore it was necessary to rely upon local extension officers' knowledge of their areas to provide a sample of farmers for the study. Votualevu was chosen as the survey area due to the presence of sugar cane farming and farmers owning house cows for non-commercial milk production, the constant topography, and the relatively easy access by vehicle to farmers. Figure 4.1 shows the location of the survey area. In most cases it was decided that the principal decision-maker of each household, typically the farmer, would be interviewed.

4.3 FIELD PROCEDURES

Five non-commercial dairy farmers were interviewed in the Central Division prior to the field visits in the Western Division. These interviews provided initial field experience, and ideas for improving the questionnaire to be used in the survey proper. As was to be the case in the survey in the Western Division these five interviews were made with the assistance of an interpreter. The pilot survey indicated that surveys of farms in the Western Division would each take up to one and a half hours to complete. The questionnaire was revised significantly as a result of the outcome of the pilot survey, especially with regard to details gathered to establish individual cow histories. Extra cross-checks were included to improve the reliability of the field data collections.



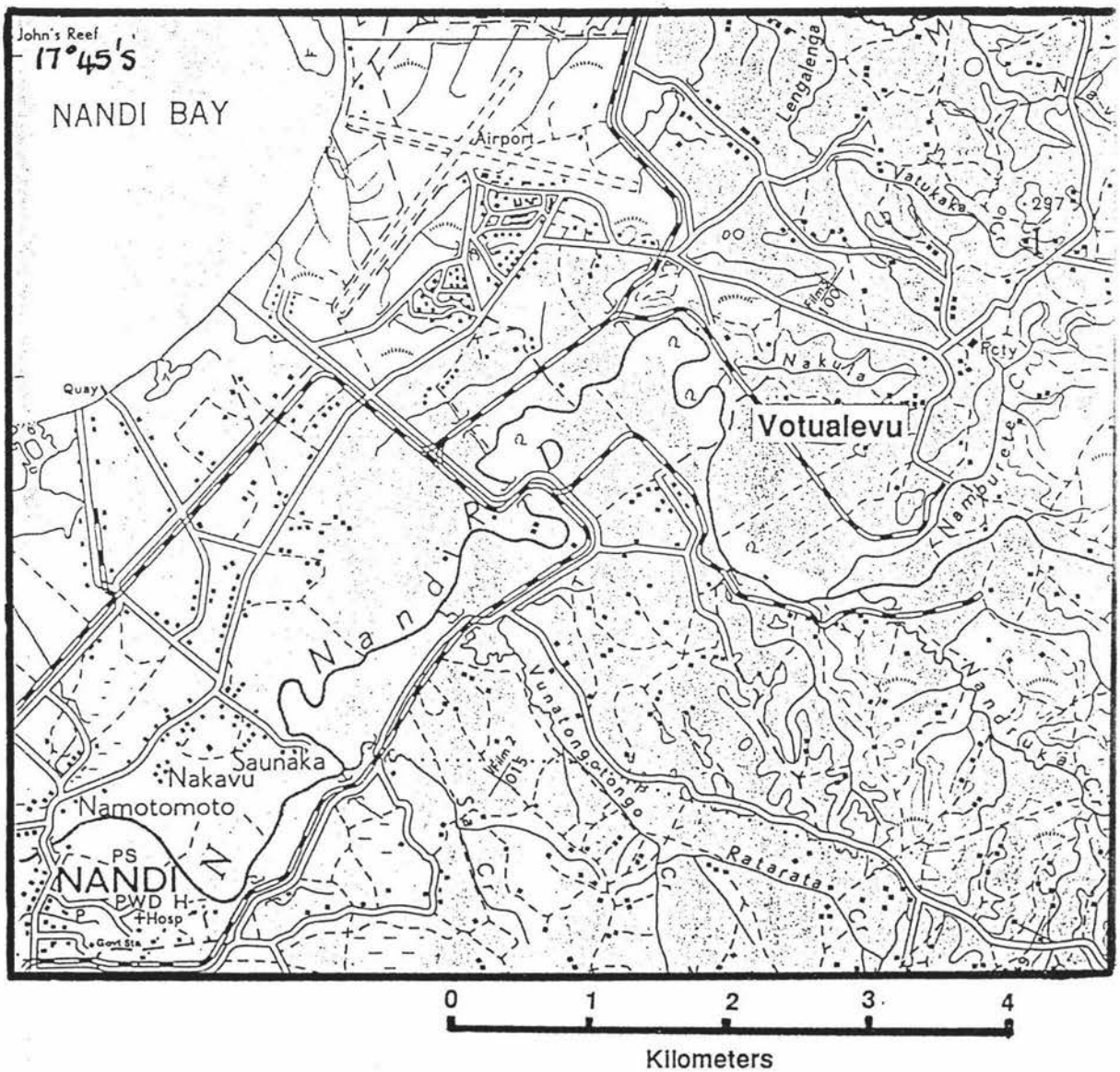


FIGURE 4.1 (a): VITI LEVU
(b): LOCATION OF THE SURVEY AREA; VOTUALEVU

Source: Sheet 10: Nandi; Viti Levu. 1:50,000. D.O.S. 1960.

Field visits were done over a three day period in the Western Division. The time available to extension officers to support the field work and transport were both limited. A total of 19 Indian sugar cane farmers was interviewed. Together these farmers had 36 dairy cows. Surveying began at 8am and typically finished at 6pm, with each interview taking approximately one and a half hours to complete. The survey was performed near the end of the hot/wet season, which is the 'best' season of the year for the cattle enterprises. All questions were framed in sych a way as to have the farmer focus on the 'annual' view of the dairy systems. This was done to minimise potential bias introduced if the focus was on the 'best' season only.

Although a few survey farmers were known by the extension officer, the majority were not known by him. Thus there should be little bias arising from 'prior' knowledge of the subjects. All farms were along a 5km stretch of a second class all weather road in Votualevu which was selected as the focus of the study by the extension officer. Thus, all surveyed farmers were from a similar area reducing the amount of physical variation attributed to climate, topography, soils and farming systems. The close proximity of farmers allows for an adequate comparison between farmers and livestock. The survey was performed quickly and with ease, the mixed informal and informal approach to the exploratory survey provided primary data on a previously unresearched topic.

MPI Extension officers provided transport to the survey area, the initial contact with farmers, and translation between English and Hindi. The interview procedure involved approaching a homestead along the road to inquire if the farm owned cows for non-commercial milk production. If they did, permission was asked to interview the farmer. In the early stages of surveying two farmers' wives were interviewed. They seemed hesitant in their replies to questioning. However, the information provided by them is included in the results reported in Chapter 5. In the later farm visits only the male farmer was interviewed. If he was not present then the interviewers went on to the next farm on the road. In three instances a return visit to a farmer was made to interview the farmers not present on the first visit. Only one farmer was not interviewed because he was unavailable. The area served by this road is reported informally to have at least 35 farmers.

A basic questionnaire was used to gain information from farmers on the following topics. General farm data such as farm area and land type, land tenure and use (including estimates of area of each crop), livestock owned and herd composition by age and sex, and labour supply and general mode of use were recorded early in the interview. A rough farm map was sketched with the farmer's help to familiarise the interviewer with the farm and use of land. General information on the role of cattle on the farm, animal husbandry and management techniques such as calf rearing, animal health, mating, nutrition and milk production were also recorded. Finally, details were obtained of reproductive histories and milk yields of all cows in each herd. A copy of the questionnaire used in the survey is presented in Appendix 6. Cross checks were used in the interviews to identify possible inconsistencies provided by farmers, these problems were considered to be most likely to occur

when estimating various animal production parameters such daily milk yields and the fate of milk produced (i.e. quantities produced, consumed and processed). The age of cows was checked against the number of calves born and the inferred calving intervals. The age of a calf and the stage of lactation were also compared with the last calving date.

The questionnaires completed on each day were re-read and checked that same evening to ensure that the data were as complete as possible and informal data gathered at the same time of each interview were fully recorded. A field diary was used each day and night to supplement the formal questionnaire with informal comments and impressions. The information was later collated and transferred to specially designed computer spreadsheet programmes at MPI Headquarters in Suva. A brief report was given to the EP&S Division of MPI approximately three weeks after the survey. It summarised initial field survey results, identified possible constraints on cow productivity and presented opportunities and recommendations of further investigation. A seminar presenting these results was also given at FCA to staff, MPI officials and extension officers, and agricultural researchers from KRS before returning to New Zealand at the end of March 1991.

In addition to gathering milk production and life histories of all cows, their condition was assessed and a condition score of one (very thin) to eight (fat) was given. However, since not all of the cows were viewed together the scores given to sighted cows may not be consistent enough to allow interfarm comparisons to be made. Information on the number of stock owned, methods of heat detection and mating, last calving date, calf rearing, daily milk yields, lactation length and stage of lactation were provided orally by farmers. Consequently the information provided can not be confirmed, but the cross-checks used during the interview should ensure the information is generally reliable. The data received, however, on the numbers of stock (especially calves) owned per farm and the decisions made with respect to their fate are not held to be fully reliable by this writer. Confirmation of these data will require further field investigations. Concerns here about the quality of the information arise due to time and labour limitations in the field.

The following areas were not addressed in the questionnaire due to time and resource limitations in the field: cow and calf mortality; identification of the grasses and other plants eaten since most cows are grazed away from the farm; corresponding feed quality and quantity eaten per day in relation to the animals stage of growth, pregnancy and milk production. These aspects require further field work with the use of specific facilities for investigating feed quality and intake levels.

Although cross-checks were extensively used the results should be verified by extensive studies of individual animals in later surveys of the non-commercial dairy sector of Fiji. If longitudinal studies of these issues could be undertaken they would supply more information than can be provided by the crossectional studies of the type used in this study. Techniques such as using dentition charts to age stock, measuring daily milk yields and use, recording actual calving date and other events

would be necessary. Further comment on the extensions of this study is presented in Chapter 6 and Appendix 13. Accurate ways of measuring liveweight of stock at different stages of growth, pregnancy and production are required on-farm, but were not carried out in this survey. Practical means of doing this are now available with the advent of lightweight electronic weigh beams. These were not able to be provided for this study. However, the core of the material gathered is considered adequate to meet the objectives of this study.

4.4 ISSUES OF IMPLEMENTATION

Some practical issues involved in conducting a field survey in Fiji are now discussed. Factors such as language, nationality and gender of the interviewer, the reliability of the information received from farmers and cultural traditions are noted.

Language was a barrier to communication between the interviewer and the farmer. The majority of surveyed farmers preferred to speak Hindi rather than English, even when it was possible for them to speak understandable English. This may have limited the full understanding of farmers' comments and responses. Using an interpreter limited opportunities to examine some issues more fully, especially in regard to developing understanding of management processes and the reasons they are used. The factual responses were dealt with adequately through the interpreter. The crosschecks may have been reduced in their effectiveness by the use of the interpreter as linguistic subtleties could only be used to a limited extent. It would have been possible to select farmers competent in English as those to be surveyed but, on balance, this would have been an undesirable potential source of significant bias.

The information provided by farmers may have been influenced by the presence of two MPI officials (men) and interviewer. The interviewer was a white English speaking woman. As a consequence the farmers' initial reactions were ones of caution. Overall, the presence of the extension officer/interpreter and use of the Hindi language probably facilitated rather than hindered communication. The MPI officials had indicated prior to the interviews that the farmers may be wary of giving information in case it would be used against them for taxation purposes. However, once the objectives of the study were understood, the farmers were willing to answer questions. Wide ranging and open discussions occurred in all instances. The salient points of these conversations were translated to the interviewer.

The possible effect of season on the value of the study has been considered. February and March are the hottest and wettest months of the year (see Figure 3.4), so plant growth is greatest at this time. The information therefore received on the amount of feed available for livestock will depend upon the time of year in which the survey was carried out. In this case it can be anticipated that cow

condition will be at its best during the survey period compared to other times of the year.

Before most interviews proceeded the farmer expected the interviewing team to spend up to an hour drinking 'kava', the traditional mode of welcome to rural Fijian households. This limited the total number of visits which could be made in a day and should be taken into account by others planning field studies in the country.

4.5 SUMMARY

The methodology used for surveying Indian farmers who keep cows for non-commercial milk production in the Western Division of Fiji has been presented. The procedure for selecting farmers, the field operations and the practicalities of undertaking such field studies in Votualevu have also been discussed.

A literature search and various discussions with people from Fiji was undertaken before travelling to Fiji, to a gain understanding of the Fijian dairy industry. These sources provided useful background information, however, they all highlighted the lack of information on the non-commercial dairy sector of the Fijian Dairy Industry.

Prior to undertaking the field studies in Fiji discussions were held with people from agricultural training institutions, such as the Fiji College of Agriculture; officers of a range of Government Departments, to determine the methodology and location of the field surveys. A further literature search was undertaken at the University of the South Pacific, but few relevant references were found to supplement those located by other searches which had been made in New Zealand libraries.

The target population selected for the study was Indian farmers partaking in non-commercial dairy production. Informal information suggested that the majority of small herds, with one or two cows, was located in the Western Division. Farmers in that area grow sugar cane as their dominant enterprise. A list of the target population of farmers was not available, so local knowledge of extension officers was relied upon to provide a sample of farmers for the survey. Votualevu was chosen as the study area due to the presence of both sugar cane farming and non-commercial dairy farmers. The principal decision maker of each household, typically the farmer, was chosen for interviewing.

A pilot survey of five farmers was carried out in the Central Division before interviewing in Votualevu. This provided initial field experience for the interviewer, and an opportunity to use and

revise the questionnaire to be used in the Votualevu study. Significant changes were made to the questionnaire as a result of the pilot surveys.

Field visits in Voutalevu were limited to three days due to the time and labour constraints of MPI officials. A total of 19 farmers were interviewed, which gave information on 36 non-commercial dairy cows. The MPI officials provided transport and field translation between English and Hindi.

The content of the questionnaire is briefly presented. Information on basic farm background and land use, animal husbandry and management techniques, the role of cow(s), individual cow history identifying the reproductive performance and milk production from surveyed cows was collected during the interview. The condition of sighted cows was also recorded. All information was provided orally by farmers. Consequently, crosschecks were placed within the questionnaire to minimise and make it easier to identify inconsistencies.

Questionnaires completed each day were reread and checked the same evening to ensure the data were as complete as possible. A daily field diary was kept to collect informal data not covered in the questionnaire. On completion of the field visits, information from the questionnaires was collated and transferred to computers at MPI in Suva. A report presenting the initial results, constraints on cow productivity and possible recommendations for further investigation was given to the EP&S Division of MPI three weeks after the survey. The report was presented as a seminar at FCA to a group of persons who had contributed towards the field study.

Issues such as language, nationality and gender of the interviewer, reliability of information received and cultural aspects have been discussed in relation to the carrying out of field studies in Votualevu.

Results from the 19 surveyed farmers on the roles, production and reproductive performance of their cow(s) in the Western Division of Fiji, are presented in the following chapter.

5 RESULTS

5.1 INTRODUCTION

Background information on the farmers surveyed such as the land, labour and animal resources are presented in Section 5.2. Section 5.3 provides a summary of the production histories of individual cows owned by the surveyed farmers. The husbandry and management of cattle are discussed in Section 5.4. Section 5.5 describes the importance of non-commercial dairy cows to a typical farm in Votualevu in terms of their monetary worth and the value of milk and milk products to the nutrition of the farm household. The returns to farm labour from the crop and cow enterprises are also discussed. Farmers' views on the likely effects to their household of not keeping a cow are also reported.

5.2 LAND, LABOUR AND ANIMAL RESOURCES

General information about the farms surveyed is presented in this section. Topics covered are farm area, land tenure and utilisation, labour employed, and the numbers and types of livestock owned.

5.2.1 Land area and tenure

Within the sample, farms ranged in size from 2.2 to 14.8 ha. The median farm area was 4.4 ha with an average area of 6.08 ha. Thirteen of the 19 farmers interviewed were leasing Native lands (Table 5.1).

This sample showed the median size of Freehold properties to be larger than farms held under there tenure arrangements. Approximately 68% of the farms surveyed were on Native Lease lands. Farm sizes on Crown lands and Native Lease lands were similar.

Table 5.1. The number of farmers and median size of farms by land tenure system.

Land tenure system	Number of farmers with tenure type	Median area per farm[1] (ha)	Range in farm size (ha)
Crown land	3	4.4	2.2-10.0
Freehold land	3	6.3	4.0-7.8
Native Lease land	13	4.0	2.4-14.8
Total	19	4.4	2.2-14.8

[1] The distribution of farm land area tends to be skewed. As a consequence the value of the mean is influenced by the extreme values which in turn distorts the mean value. The distribution also tends to be bimodal, hence the mode does not provide an accurate picture of the spread of data values. The median is therefore used to provide a representative value of the distribution, since the median statistic is less affected by extreme values in a skewed distribution.

The average farm size recorded in the Western Division during the agricultural census of 1978 was 2.81 ha. Nearly 89% of all farms in the same Division were less than 5 ha in 1978 (Appendix 2; Tables 1 and 2). The survey data are comparable to the farm sizes recorded in 1978, since the median survey farm area was reported as 4.4ha. Native Lease lands accounted for only 19.5% of total farms in Fiji in 1978 (Appendix 4; Table 1). However, the distribution of Native Lease lands through the Divisions is unknown. The lack of available information on provincial data does not provide a comparison for survey results, hence the representativeness of this sample with regard to the whole population is unknown.

5.2.2 Land utilisation and crops grown

Sugar cane is the major crop grown in the Western Division. In 1978, 40,586 ha of sugar cane were grown in the provinces of Ra, Nadroga, Navosa and Ba. This accounted for almost 75% of the total area of sugar cane planted in Fiji (Fiji Agricultural Census, 1978). Smallholder family farms dominate sugar cane farming in Fiji (Chandra, 1983). Therefore sugar cane is, in most cases, the main source of cash income from smallholder farms in the Western Division.

Other crops grown include rice, assorted vegetables and pulses which are primarily consumed by the farm family. Mixed foliage, defined by the writer for the purposes of this study as an area of leased or communal land set aside as 'uncultivable', is used by farmers mainly for grazing their livestock. Mixed foliage comprises of native grasses and other plant species. There was no

evidence of sowing specific pasture grasses or managing this uncultivated land especially for livestock feed.

Table 5.2 shows the types and areas of crops which were reported to be grown by surveyed farmers. All 19 farmers grew sugar cane. From the surveyed farms, a typical farm (based on median figures) may comprise of 73% in sugar cane, and 14% as mixed foliage, with the remainder used for assorted vegetables and rice. Table 1 of Appendix 7, presents the area of each crop grown by surveyed farmers.

Table 5.2. The type and areas of crops grown by surveyed farmers.

Type of crop grown	Total median area of crop grown (ha)[1]	Median area in crop (%)[1]	Range of area cropped across farmers (ha)[2]	Number of farmers growing each crop
Sugar cane	3.2	72.9	1.6-5.2	19
Vegetables	0.2	4.5	0.1-1.2	12
Dryland Rice	0.4	9.0	0.4-1.4	11
Pulses	0.0	0.0	0.2-0.6	3
Mixed foliage	0.6	13.6	0.4-5.4	13

[1] From all 19 surveyed farmers.
[2] Of those farmers that grew crops.

The type of tenure arrangement had some effect on the sort of crops grown (Table 5.3). For instance, farmers on both freehold and crown land had larger areas (compared to the sample median) planted in sugar cane. No rice or pulses were grown on farms on either freehold or crown land. Farmers on freehold lands had a larger area in mixed foliage, whilst farmers on crown lands had none. The areas of cropped land under Native Lease tenure compared favourably, in most cases, to the sample median values for all types of tenure.

Table 5.3. The effect of land tenure on the area of crops grown.

Land tenure system	Median areas of crops grown (ha)				
	Sugar cane	Assorted Vegetables	Rice	Pulses	Mixed Foliage
All types	3.2	0.4	0.2	0.0	0.6
Freehold lands	4.8	0.2	0.0	0.0	0.8
Crown lands	3.6	0.8	0.0	0.0	0.0
Native Lease lands	3.2	0.4	0.4	0.0	0.6

The differences between tenure systems and the types of crops grown may be a reflection of the land class on which crops are grown. Section 3.2.3 defines the four main land classes of Fiji, according to the suitability of the land to permanent agriculture. It is surmised that surveyed farmers on crown land would be categorised under the land use class II, since only sugar cane and assorted vegetables are grown. The lack of mixed foliage suggests that all of the land is cultivatable, and of undulating to flat topograhy. Freehold and Native Lease farms, however, have a proportion of land defined as uncultivatable suggesting a poorer class (III or IV) of land use with steeper topography in places.

5.2.3 The farm labour supply

The farm family provides the majority of labour inputs to the farm. On average, three family members worked full time on the farms surveyed. The minimum number of full time workers reported for a farm was one person with the maximum number of full time workers being eight. Only two farmers employed full time permanent labour from outside the family. They had larger farms of 10 and 10.8ha respectively, and employed one and two labour units. Casual labour is engaged mainly from May to January for the sugar cane harvesting season. An average of two casual workers per farm was reported as being used, although from one to six persons were reported as being employed for that purpose. Of the 19 farmer's families interviewed, only six members in total had jobs outside the farm, of which five were full time and one was part time. The farm wage rate varied between F$5-8/day or F$7-8/ton of harvested sugar cane. Five farmers shared their labour resources for harvesting cane. No payments were reported to have been made for those exchanges. More detailed information of the farm labour supply is presented in Table 2 of Appendix 7.

Labour for the livestock enterprise is also provided by the farm family. The tasks involved which utilise farm labour include milking, feeding, and walking the cow(s) to their grazing location each day. Milking is done by all members of the family and takes 10 to 15 minutes per milking. On average, up to an hour per day is needed to find suitable grazing for the cow. This time will be longer during the dry season when feed supply is limiting and the cow is taken further afield to find sufficient feed resources.

No relationship was evident from this sample between farm size, amount of labour employed and tenure.

5.2.4 Livestock

The survey showed that a typical farm may have a herd of two cows, a calf, a pair of working bullocks, a goat and some chickens. In some cases horses were kept for draft purposes and a bull for breeding. Table 5.3 details the numbers and types of livestock owned by surveyed farmers at the time of the survey. Cattle provide draft power, replacement stock, milk and milk products for family consumption.

All except one[1] of the 19 farmers surveyed owned one to two cows, and in some cases calves were kept. The calves are either reared as replacement heifers or working bullocks, to be kept or sold. Whenever working bullocks are owned there are two present per farm, making a team for cultivation purposes. All bullocks are worked in pairs. Bullocks are only used in three to four months of the year to cultivate land for sugar cane, rice or vegetable production. Most land preparation occurs around and during the rainy season. For instance, land is cultivated for rice planting over November and December, whereas land for sugar cane is prepared from December to May (MPI, 1990; Chandra, 1983). Farmers estimated the value of their working bullocks at F$100-300 per bullock or F$300-1000 per pair, depending on the age of the bullocks when sold. A pair of trained working bullocks is reputed to be more than twice the value of a single animal. Further information on the estimated value of working bullocks sold at different ages is given in Appendix 7: Table 3.

1This farmer owned a pregnant heifer. He is still included in the results since the survey targeted dairy cattle owners.

Table 5.3. Numbers and types of livestock owned by surveyed farmers in the Western Division during February 1991.

Type of Livestock per farm[1]	Median number of stock owned owned	Range of number of animals livestock type	Number of farmers owning
Cows: Milking[2]	2	0-3	18
Dry	0	0-2	2
Heifers[3]	0	0-2	4
Calves (female)	0	0-2	9
Calves (male)	1	0-2	13
Working bullocks	2	0-2	10
Breeding bulls	0	0-2	4
Goats (mixed age/sex)	1	0-20	10
Pigs (mixed age/sex)	0	0-1	3
Horses	0	0-3	6
Chickens	(Present but not counted)		15

[1] From all 19 surveyed farms.
[2] At the time of the survey.
[3] Heifer: defined as a young cow which has not yet calved.

5.3 COW HISTORY

This section presents data on the age, breed and condition of cows owned by surveyed farmers. The methods of heat detection and mating are also described in Section 5.3.3, followed by a discussion on the age at first calving and calving intervals in Section 5.3.4. Section 5.3.5 presents information on milk production and lactation length.

5.3.1 Age and breed types

The estimated mean age of surveyed cows, as reported by farmers, was six years (ranging from three to 18 years). Only four farmers owned heifers which ranged in age from 1.5 to three years. Not all cows and heifers were sighted during the survey so some errors in age estimates can be anticipated.

Since none of the farmers interviewed kept mating records it was not possible to determine the breed mix of an individual cow. However, the cows owned by the farmers surveyed were predominantly of a 'mixed or native' type. Of the 37 cows from which data was collected, 29 were of 'mixed or native' breed, seven were Jersey crosses and one was a Friesian cross.

5.3.2 Cow condition

A scoring system was used to assess and record the condition of cows. A score of one in this system denotes a very thin and emaciated animal. The maximum score of eight is given to a very fat animal. A New Zealand MAFTech Aglink publication (Buxton, 1984; FPP 498) on condition scoring of dairy cows was used as a field guide. A copy of this publication is provided in Appendix 7. A visual assessment of condition was made of nine cows and one heifer. The majority of cows averaged a score of 4.0, the highest was 6.5 and the lowest 3.5. The higher condition scores (6.0-6.5) were from two pregnant cows, aged 6.5 and 10 years, and one pregnant heifer (three years). All three were in the final three months of pregnancy. The lower scores (3.5) were from older cows (9 and 15 years), which were also milking. All other 28 cows were away from the homestead at the time of the visit and could not be assessed.

The survey was performed during February, near the end of the hot/wet season in Fiji. Pasture production increases significantly throughout this period, although nutritive value, as indicated by crude protein content, decreases as the season progresses (Ranacou, 1986a). The greater amount of feed available for cattle in the hot/wet season is expected to have a positive effect upon cattle condition. Consequently, general cow condition should be better at the time of the survey than any other time of the year. Since the condition scores were based on the New Zealand standards set in FPP 498 the reported figure of 4 for Fijian cows is equivalent to that of New Zealand stock. Cow condition was low considering that this was the peak time of year for pasture and plant production. It is expected that cow condition will decrease during cooler, drier months of the year. The nature and timing of the survey prevented any assessment of the effect of cow condition on productivity. Continual collection of cow condition scores for at least 12 months would assess the seasonal variation in cow condition and address the possible relationships between condition and productivity.

5.3.3 Heat detection and mating

Some 63% of cows were reported by the farmer to show signs of oestrus about once per month. The other cows were reported to exhibit heats at intervals ranging from once every 15 days to once every two months. The oestrus cycle of dairy cattle in New Zealand (Holmes and Wilson, 1987)

normally occurs for one day at intervals of about 21 days, but the interval can vary from 19 to 25 days. Thus, the results of this study suggest that cows in Fiji have longer intervals between oestrus compared to New Zealand cows. This difference may be attributable to generally poor condition of Fijian cows than cows in New Zealand, to differences in breed of cattle, climate, nutrition and the seasonality effects upon the quality and quantity of feed available in Fiji. However, there are no specific results available on the effect of these factors upon cattle in Fiji. Estimation of these effects would require longitudinal field studies over a few years.

Farmers were asked how many times cows were mated before they became pregnant. On average, cows were reported to be put to the bull 1.3 times per pregnancy. Some farmers did note that it could take up to three services in some cases before the cow became pregnant. One farmer noted that his heifers were usually served two or three times before successful conception, whereas his cows typically went to the bull once.

The reported date of last calving was recorded as a crosscheck for the stage of lactation and age of calves in the herd. It was also used to determine the season in which cows calved so the possible effect of season on conception could be assessed. Records from 30 cows were collected, 28 of which were still milking at the time of the survey and the other two were both dry and pregnant. Figure 5.1 presents the date of last calving and estimated conception date from the stage of lactation for 28 cows. This figure shows that 75% of the surveyed cows had calved over the end of the cool season through the hot/wet season from January to March 1990, and from October 1990 to January 1991. Conception is therefore estimated to have occurred during the end of the dry/cooler months of April to June 1989 and over the previous wet season from October 1989 to April 1990. The results showed that none of the surveyed cows conceived between June and October of 1989.

Farmers appear to pursue the strategy of having their cows conceive irrespective of the time of year in which mating occurs. This strategy is consistent with the primary thrust of cattle keeping which is to have milk available for offtake over the whole year (to the extent this is possible), even if the resultant calving (and subsequent lactation) is at a time of the year which causes nutritional and lactational stress on the cow. However, the results suggest that oestrus activity of the cow may be effected by season as during the cooler months the cows are reported to cycle less frequently. This is likely to be due to nutritional stress.

The possibility of heifers having an extended calving interval after their first parturition due to factors such as poor feeding levels and the effect of season upon oestrus is recognised. However, this could not be estimated during this study.

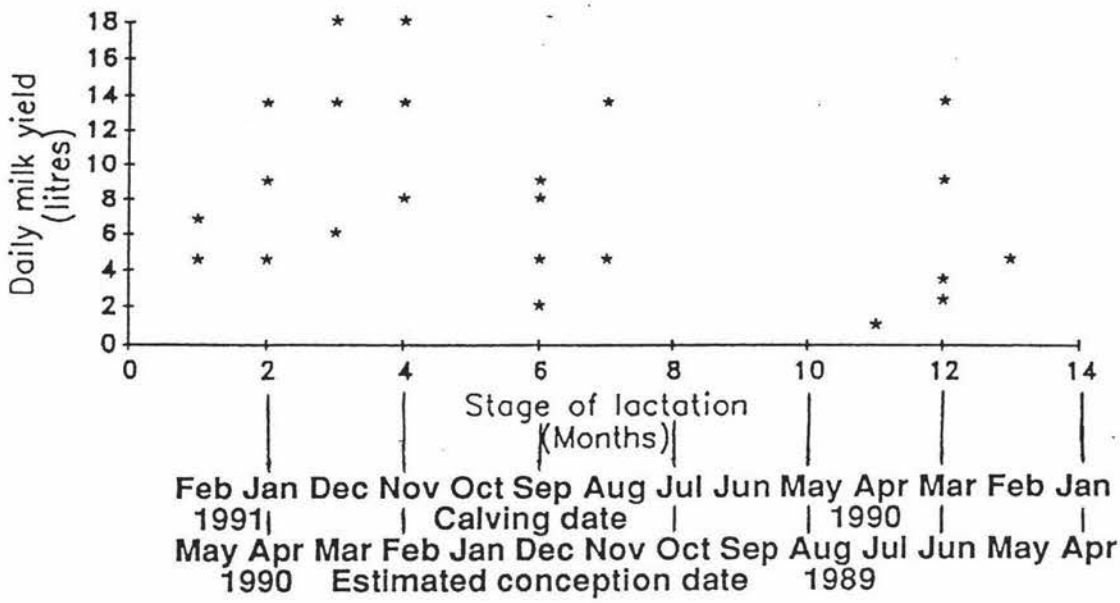


Figure 5.1. The spread of calving and conception dates for surveyed cows based on their stage of lactation.

Fertility and nutrition issues are known to be important determinants of cow productivity and reproductive performance, however, they are very difficult to measure especially with a small number of farmers who only own one or two cows. The lack of information on these issues provides a great source of variation within results. Long term field studies over at least 12 months with a large number of farmers would be required to address these issues. The effect of season upon the quality and quantity of feeds available and subsequent effects on the reproductive activity of cows could be addressed by recording data on cow condition, the frequency and duration of oestrous, the number of services until the cow is pregnant, dates of mating and subsequent calvings, anoetrous period, calving intervals and calf growth. If continuous studies are not practicable then research should be done at the wet and dry times of the year to gather information from both extremes. If time and funds were limiting field studies a worst case scenario could be adopted by collecting data only during the dry season.

5.3.4 Age at first calving and calving interval

The average age at which heifers were reported to have calved was estimated at 34 months (range 24 to 54 months). This compares favourably with the target age at first calving for commercial dairy heifers, as reported by MPI (1990) in Appendix 8. The possibility of improving the age at first calving i.e. calving at an earlier age, will depend upon the nutritional effects on cow condition and liveweight and the subsequent effects on reproductive activity (age at puberty and mating) in young stock. This study was unable to ascertain the main factors causing the deffered age at first calving.

Calving interval is defined as the period of time between consecutive calvings for an individual cow. To ascertain this figure farmers were asked how often a calf was born. The average interval between calvings as reported by farmers was 18 months (range 12 to 36 months).

5.3.5 Milk Production and lactation length

None of the farmers interviewed kept records of milk production from their cow(s), so total lactation yields per cow reported below are only estimates. Daily milk yields of each cow were estimated by asking farmers how much milk their cow(s) produced on the morning of the interview or on the previous day. The stage of lactation was determined by the number of months each cow had been in milk up to the day of surveying. Table 5.4 presents a summary of lactation information from the cows owned by surveyed farmers. These data give a first approximation of the milk production pattern over the whole lactation, they are however, prone to error since none of these yields were actually measured. During the first eight months of lactation the milk yield averages an estimated 9.5 litres per day, reducing to six and then 4.5 litres per day for nine to 12 months, and 13 to 16 months after calving, respectively.

Table 5.4: Estimated daily milk yields per cow (excluding milk fed to calves) by stage of lactation for cows owned by surveyed farmers.

Parameter	Estimated milk yield (l/cow/day)	Months of lactation			
		1-4	5-8	9-12	13-16
Average yield	8.4	10.0	7.2	5.8	4.5
Range of yields	1.0-18.0	4.5-18.0	2.0-13.5	1.0-13.5	4.5
Number of cows	28	15	7	5	1

Lactation length is defined as the total period of time a cow is in milk. This performance parameter was estimated for the cows owned by surveyed farmers by asking the farmers how long each of their cow(s) had milked in their previous lactations. The total average length of lactation so estimated for those cows in milk at the time of the survey was 12.5 months. On average, the cows in milk during late February 1991 at the time of the survey were some 5.5 months into their lactations, and were producing 8.4l/day[2]. The milk production, as reported from these dairy cows compares favourably with that of cows in commercial dairy herds in Fiji which produce, on average, between nine to three litres per cow per day (Appendix 8).

2One cow was reported to be producing nearly 14l/day after 12 months of lactation, and at 18 years of age. The extended length of this lactation could be attributed to the birth of another calf during the lactation.

Age and stage of lactation were plotted against daily milk yields for the cows on which estimates were made to see if any relationships existed between these parameters and to compare the productivity of each cow surveyed. A regression analysis was done with daily milk yield as the dependent variable, and cow age and the stage of lactation as the independent variables. The following hypotheses were tested:

i) Average daily milk yield increases as the cow(s) get older.

ii) The daily quantity of milk produced will be effected by the stage of lactation.

No statistically significant relationships between cow age, stage of lactation and daily milk yields could be estimated from the data collected in the survey. The sample size in this survey was too small to discern any relationships between the estimated parameters. Also, the results relied heavily upon the farmer's memory for data, consequently the estimates of daily milk yields and the subsequent stage of lactation are not definitive. Measurement of daily milk production over various lactations for more cows will be required before any statistically reliable relationships can be estimated.

Calving dates were estimated for all cows in milk of the time of the survey to examine whether season of calving had an effect on milk yield. No statistically significant relationships could be estimated. However, the analysis is still based on these results.

Holmes et al. (1987) reported that milk production from cows in New Zealand can be expected to increase from one lactation to the next until the fourth or fifth lactation when the typical New Zealand cow is six to seven years of age. Typically in New Zealand milk yields for dairy herds increase over the first three to five months, and thereafter the yield will decreases until the end of lactation. The maximum daily yield will peak three to six weeks after calving for individual cows, then yields will decline gradually for the rest of lactation. No such pattern was found to exist from surveyed non-commercial dairy cows, due to the small size of this survey sample and the probable compounding effects of season of calving, nutritional status and other factors.

5.4 COW HUSBANDRY AND MANAGEMENT

Details of animal husbandry practices including calf rearing, disease control, grazing management, mating and milking procedures were gathered in the survey. These are now discussed. The information presented is as reported by the farmers, unless stated otherwise.

5.4.1 Mating method

Only four of the 19 farmers interviewed own entire bulls for breeding purposes and these bulls were mainly of 'mixed/native' breed. The other farmers surveyed rely on neighbour's bulls for mating their cows. These bulls were said to be kept on farms up to 30 minutes walk away. Farmers did not highlight any preference(s) for a particular breed of bull for mating and seemed to place greater importance on ensuring the cow is served when on heat than on specifying a breed preference for the future calf. This mating strategy appears to work overall, as evidenced by reported calving intervals. However, problems may occur in the exhibition of oestrus by cows. If heat is inhibited through poor nutrition or a climatic effect, then the interval between subsequent calvings and hence matings will be adversely affected. The extent to which intercalving intervals are significantly greater than 12 months suggests some biological wastage associated with sub-opotimal mating.

There was no significant difference in farm sizes or the numbers of cattle owned by those farmers who owned an entire bull and those who did not (Appendix 8: Table 1). Farmers reported that the only time the cow(s) and bull(s) were together was for mating. Otherwise they are kept separated when housed and grazed separately.

All surveyed farmers used the individual cow's behaviour to detect oestrus. Only one farmer reported the cow mounting other stock as a sign of heat. Those surveyed farmers who owned a bull did not use it for heat detection only for mating. Farmers reported leaving the bull and cow together for mating for two to three hours.

No information was collected on the duration of oestrus or if a fee was charged for the use of the bull to service a cow.

5.4.2 Calf rearing and milk offtake

On all of the surveyed farms the calf was reported to be allowed to suckle from its dam after the cow had been milked. Farmers reported the calf as always being present at milking to calm down its mother and stimulate milk let-down. The dependance on the calf being present at milking is related to the breed of these cattle, since cows of many Bos indicus breeds will not let-down milk unless the calf is present. Throughout the day the cow(s) and calves were separated, the calves were kept near the homestead whilst its dam was taken elsewhere for grazing. This arrangement is continued until after the calf is weaned so the farmer can control the calf's milk intake.

Two main calf rearing methods were reported by surveyed farmers. The first involved the calf suckling from one or two quarters, twice a day until the calf was weaned, or in some cases for the

whole lactation. This approach was used by nine farmers. In the second method, adopted by seven farmers, calves were fed one or two quarters either once or twice a day, for up to three months. Milk intake was then reduced to one quarter once per day for the rest of the lactation or until the calf was weaned. Another approach adopted by two farmers involved the calf being fed from one quarter, once per day throughout lactation. In each of the above methods a few (five) farmers would allow the calf to feed ad libitum from its dam for one to three days, or even up to two months after parturition, with little or no milk being collected for family consumption during this time. These farmers then used one of the three methods described above. No other feedstuffs were reported to be fed to the calves. The quantity of milk consumed by the calf was not measured, although an estimated three litres/calf/day can be calculated if the following assumptions are met:

a) An average milk production of 8.4l/day (excluding milk suckled by the calf) by the dam;

b) The calf consumes the equivalent of one quarter per day from its mother.

Further research is needed into the actual quantities consumed by the calf and how this may vary in the different stages. Longitudinal field studies will be the most appropriate for this purpose. The feed intake level of the calf will also affect the future performance from that animal. The feeding levels of calves on-farm and the subsequent effects of feeding upon growth, sexual maturity and mating with respect to their future production requires further investigation. This research is a prerequisite to the introduction of changes to the current systems.

In most cases farmers did not formally wean the calves from their mothers. They reported some calves are weaned by the mother by the time the calves are seven to eight months old, although the majority seem to be weaned at some 11 to 12 months of age, when the cows stop lactating. Two farmers reported stopping their calves from suckling when their dam is a few months pregnant, because they observe a decrease in daily milk yield at that time. These 'native' bred cows were still be milked by the family for consumption. The calf was, however, present during milking to stimulate milk let-down.

Sixteen of the 19 farmers surveyed reported no preference for feeding male or female calves. Three farmers, however, reported using calf sex-based preferential feeding strategies. Two farmers fed more to their female calves preparing the heifers better for future milk production. One farmer fed more milk to his male calf so it would grow faster. The stated purpose for this strategy was for the calf to be ready earlier for land preparation work on the farm as a bullock.

No farmers reported the use of milk substitutes such as milk powder or concentrates to supplement the feed intake of calves. All calves were tethered and able to eat grass and other plants when they desired. During the early months of each calf's life, the farmers relied upon the dam's milk production to meet the calf's requirements. The unreliable supply and high cost of milk substitutes MPI, 1990, quoted a price of F$93.28/25kg bag of skim milk powder; the equivalent to

11 day's agricultural wages) were reported to be strong reasons against the purchase of milk substitutes by non-commercial dairy farmers for their calves.

All farmers reported rearing their heifer calves as replacement stock for future milk production. Male calves on the other hand were reared and trained as working bullocks either to be sold as a working pair, or to replace old stock on the farm. Farmers with one cow can expect a heifer calf to be born approximately every three years on average, assuming a 50% chance of a male or female calf being born at an average calving interval of 1.5 years. Farmers reported that the procedure for rearing and keeping a heifer calf as a replacement depended upon the age and reproductive ability of the dam. A farmer, therefore, expected a cow to give seven to eight calves before ending her productive life. Hence, after five or six calves the farmer would rear and keep a heifer calf as a replacement for the cow in a few years. Information on the fate of other heifer calves born earlier could not be determined during the limited time available at the interview. The information received on the numbers of calves owned per farm and the decisions made with respect to their fate are not definitive and require further investigation.

The fate of the milk produced varied between farms. The following information was reported by survey farmers and relies upon their memory. No written records were available. Nine farmers reported giving away excess fresh milk to their neighbours. None was reported to be sold. The quantity given away ranged between 4.5l/day to 2l/month. Five farmers occasionally sold ghee at the farm gate, with the amount sold ranging from six 750ml bottles twice a month to four bottles per year. The average farm gate price for ghee, as stated by survey farmers, was F$3.50-4.00/750ml bottle. This can be compared to the daily wage rate of F$8.56 for agriculture in 1988 (See Table 3.4). Five of the 19 farmers kept all their milk for their family, with no sharing between other families or selling of milk. In all cases the first priority reported for milk use was for family consumption (as boiled milk) and for processing, also for family use. The fate of milk produced on surveyed farms, and estimates of the quantities consumed, processed and products produced are shown in Table 1 of Appendix 9.

On average 13l/day/year was produced per farm, of which four litres was consumed as boiled milk and the remaining nine litres was processed by physical churning into ghee, butter and curd. Approximately four (750 ml) bottles of ghee per week can be processed per farm household, and 0.74 litres of boiled milk consumed per person per day. Per capita consumption (PCC) of fat and protein from liquid milk is estimated to be 11.9kg and 10.8kg per year, respectively. Appendix 9 provides calculations of the quantities of milk consumed. The level of fat consumption by survey farm families is three times greater than the average quantity consumed per capita in Fiji of 3.8kg milk fat equivalents (MFE) estimated by MPI in 1989. These survey families are therefore receiving high quantities of milkfat and protein solely from the liquid milk produced and consumed on-farm. Since the farmer is dependent upon the calf to stimulate milk-let down in its dam, the effects on milk

offtake from the cow if the calf could usefully be investigated with respect to the quantities of milk available for consumption by the family. Issues such as controlled suckling in later stages of lactation would allow more milk for family consumption, which will affect the nutritional well-being of the farm family.

5.4.3 Feeds and feeding

Limited time in the field prevented the identification of plant species and quantities consumed by cattle. Since the cow(s) were usually fed away from the farm. However, native grasses such as Para grass (Brachiaria mutica) and Nadi blue grass (Dicanthium caricosum), and other plants were along roadsides and uncultivated land, on which the farmers reported grazing their cattle. For the purpose of this study the term 'mixed foliage' is used to denote the feeds eaten by cattle surveyed in Votualevu. Further investigation and extensive field studies into the botancial composition of 'mixed foliage', the types of feed preferred by cattle, and quantities consumed in the diet of cows would be necessary to allow the potential performance and productivity of non-commercial dairy cows to be assessed rigorously.

All surveyed farmers reported tethering their cattle day and night. The cows are kept in the farm compound at night to minimise theft and are taken out during the day to a suitable place for feeding, such as along river banks or roadsides. During the sugar cane harvesting season (May to January) farmers reported supplementing their cattle with cane tops. The cows are usually taken to the cane fields by farmers and tethered on harvested areas whilst the farmers continue cutting cane. Farmers reported leaving their cows on cane tops only for no more than one to five hours, because a decrease in milk production was later observed when cows were fed purely on cane tops. As a consequence farmers reported feeding a higher proportion of mixed foliage to cane tops in the cows daily diet. For example, nine farmers fed only 20% cane tops with 80% mixed foliage. Four farmers did not feed cane tops to their cow, because they had noted a decrease in milk production in association with the practice.

Preston and Leng (1987) reported the following;

> "Cane tops are one of the most under-utilised resources even in those countries in which shortages of animal feed and of fuel are most evident. When they are fed to livestock, however, they have been generally used inefficiently because of the lack of knowledge of the need for "key" supplements. If they could be treated safely (and economically) to increase fibre digestibility this would improve their feeding value. Urea-ensiling has been effective in this respect."(pp 146)

Sugar cane tops are high in fibre (57% of dry matter) and low in crude protein, 2.7%, below the critical level of 7%. Intake of cane tops is inhibited because of their low digestibility and low

nitrogen content. When crude protein exceeds 7% in the herbage, digestibility does not appear to be affected (Milford and Minson, 1966). However, if herbage with a CP content below 7% is fed to animals, microbial activity in the rumen is depressed by lack of nitrogen. This causes an incomplete utilisation of structural carbohydrates in the ingested forage and a slow rate of passage of the digesta. Therefore, forage digestibility and voluntary intake are significantly reduced (Crowder and Chheda, 1982). This is reflected in poorer animal performance when fed this produce, e.g. milk production and liveweight gain. Table 1 of Appendix 10 provides more detail on the composition of sugar cane tops. None of the surveyed farmers reported using any form of supplementation whilst their cows were fed on cane tops, hence the noted decrease in milk production. Implementation and extension of the benefits of supplementing cane tops with urea and other high nitrogen compounds to increase their digestibility and nutritive value in Fiji could increase the effectiveness of utilisation of this widely available resource. The availability of urea or other supplements, cost, safety and health aspects should be specifically addressed for Fijian agricultural systems. Applied and adaptive research will both be required. Basic or strategic research will not be needed.

Only seven of the surveyed farmers reported feeding their cows at night as well as during the day. The cows were tethered in the farm compound. One farmer noted a decrease in grass growth over the dry/cool season, consequently he fed cut grass to his cow at night to supplement her diet. However, during the wet season no grass was fed at night. Another farmer mentioned feeding a mixture of cut cane leaves and grass at night throughout the cane harvesting season. Four farmers preferentially fed their cow(s) cut and carry Para grass at night in late pregnancy and in early lactation to supplement their diet for one to two months, after which the cow(s) were fed only during the day. One farmer fed his cow cut grass at night if she was still hungry.

Feeding cattle at night as routine practice would increase the average level of nutrition in the diet especially during the cool/dry months when pasture and plant production is minimal. Heat stress also has an indirect effect upon cow productivity via nutrition. When the air temperature is close to body temperature it is increasingly difficult for the cow to lose the heat she produces. As a result feed intake is reduced. Hence, in environments with high temperatures, heat stress will depress the productivity of the cow through inadequate nutrition due to reduced feed intake. Feeding at night when the temperatures are lower could result in an increase of cow condition and liveweight, having a flow through effect upon reproductive activity, such as the onset of puberty in young heifers or oestrus in mature cows, and the quantities of milk produced.

Only three farmers reported feeding supplements to their cows. One farmer fed coconut milk at approximately 400 ml/day throughout the year. Another fed bran mix, an industrial by-product from wheat and rice processing. Approximately 250 gm/day of this mix was given when the cow was milking. The crude protein content of bran is estimated to be between 14% to 16% on a dry matter basis. It can provide a valuable source of protein for milk production during the months

when the protein content of pastures and forages is low. The third farmer of these three feeding supplements fed molasses to his cow once per month throughout the year.

The main reasons given by farmers for feeding supplements was to keep the cow healthy and well fed. Limited time in the field prevented assessment of cow condition in relation to supplementation and whether the supplements did or did not fulfil the farmers objectives. MPI (1990) priced molasses at F$27.00/200l drum (F$81.00/t) and bran mix at F$9.00/50kg bag or F$180/t in February 1990. The lack of feed supplementation for cattle by survey farmers in general, may be attributed to two factors. Firstly, the farmers perceive that their cows are receiving sufficient quantities of feed and/or, secondly, the cost of purchasing concentrates is too high to warrant supplementary feeding. The small survey sample and limited time in the field prevented sufficient information being collected on the effect and adequacy of the cow's diet upon her requirements for growth, pregnancy and milk production. This issue of supplementation warrants the attention of researchers in Fiji.

The effect of seasonality has already been briefly discussed in Section 5.3.2 with respect to the condition of surveyed cows. However, the following graph (Figure 5.1) indicates the seasonal differences on dry matter production of some native pasture species in Fiji. The hot/wet season occurs in Fiji between November to April, with the cool/dry season from May to October (See Section 3.2.2).

Mission grass (Pennisetum polystachyon) and Nadi Blue grass are the two main grass species present in the drier parts of Viti Levu (Roberts, 1970). Average annual yields of 9,400 and 8,900 kgDM/ha/year respectively, were recorded in Nawaicoba (lowland dry region of western Viti Levu) by Ranacou (1986b) over 1971 and 1972. Another widely established grass throughout Fiji is Para grass, which can achieve dry matter yields of between 13,000 - 22,000 kgDM/ha/year (as reported by Ranacou (1986a)).

All three grasses exhibit marked seasonal fluctuations in growth, being low in production during the drier cool winters and high in production during the summer. Payne et al. (1955) reported that both moisture and temperature are most likely to be responsible for the decrease in pasture dry matter production during winter. The level of crude protein in forages also has a significant effect upon digestibility. In autumn and winter, crude protein in para grass falls below this critical level of 7% (Ranacou, 1986a). Nadi blue grass and Mission grass were reported to have the following range of crude protein contents from 5.7 to 9.0% and 5.8 to 7.3% respectively (Ranacou, unpublished). The level of crude protein in native Fijian grasses therefore remains close to the critical level for animal intake in terms of digestibility and voluntary intake, which in turn affects the level of milk production and performance of cattle.

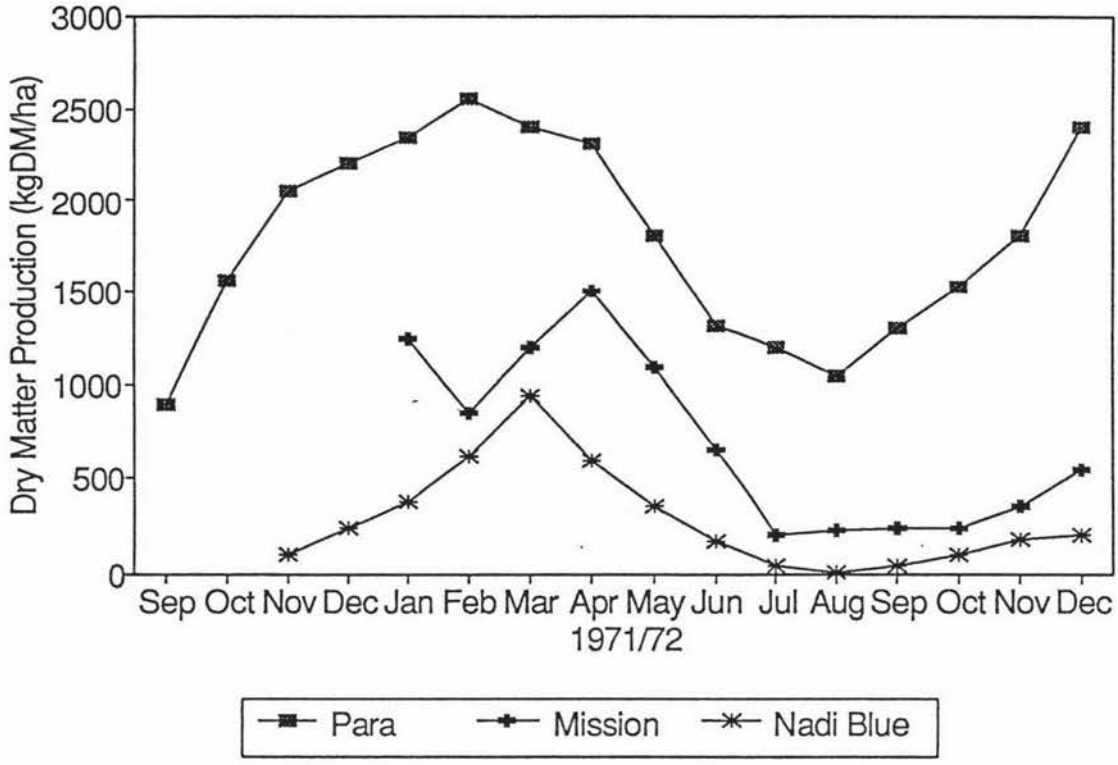


Figure 5.2 The effect of seasonality on pasture production of Para grass, Mission grass and Nadi Blue grass (Ranacou, 1986)

The harvesting of sugar cane spans over the cool/dry season providing an alternative feed for cattle when pasture growth and quality is low. This is another reason why the use of cane tops with urea supplementation would be beneficial in increasing production levels.

5.4.4 Milking procedure

All surveyed farmers reported milking by hand, taking approximately 10-15 minutes per cow for this activity. The usual method, as reported by farmers, consisted of allowing the calf to suckle for one to two minutes, then tying the cow's hind legs to prevent kicking during milking. The udder is then washed with fresh water. the cow is then milked. Fresh milk, ghee or butter was used in some cases to keep the teats moist throughout milking. All farmers kept the calf present whilst milking to stimulate milk let-down of the dam, and to keep the cow quiet.

Three different milking strategies were reported by the farmers. Eight farmers reported milking their cows twice a day, in the early morning and late afternoon throughout lactation. Seven farmers milked twice a day for about six months, then once per day for the remainder of the lactation. Finally, four farmers only milked once a day for the entire lactation period. The use of this latter

practice suggests that the cows are not yielding at levels which would induce stress in the cow by not milking twice daily.

5.4.5 Animal health

The Fijian Government has a animal disease control programme in place which manages and administers the control of diseases such as tuberculosis (TB) and brucellosis in cattle. Veterinary officers employed by MPI visit most farmers free of charge once per year to test for TB and brucellosis, to treat any diseases present, and to give stock a general health check. The main animal health problems in the commercial dairy sector, as reported by a vet pathologist from Koronivia Research Station, are internal parasites in calves, dystocia, milk fever and mastitis. The main animal health problems experienced on non-commercial dairy farms are not documented.

At the time of the survey all except one surveyed farmer said they had no significant disease or animal health problems. The diagnosed problem was mastitis. A veterinary officer had already visited the farmer and medication had been prescribed.

Only 21% of the farmers (four of the 19 surveyed farmers) reported taking any preventative measures against disease, and this was primarily to combat internal parasites in calves. Drenching frequency varied from once per month to twice per year. The estimated cash costs of animal health to farmers ranged from zero to F$150/year, although most farmers reported costs of between F$10-F$20/year.

There are only two Government veterinary officers for the Western Division. Their main task is TB and brucellosis control. This limits them to one visit per farm per year. If farmers otherwise need veterinary help they must go to Nadi and seek advice and medication for the problem. The non-commercial livestock farmers thus have limited Government support with respect to animal health diagnosis and treatment. This may be a constraint on productivity but this could not be established in this short field study.

5.5 THE VALUE OF COWS ON A TYPICAL FARM.

A typical farm has been synthesised from data collected in the field in Votualevu. Some of the key aspects relating to the typical farm are presented in Section 5.5.1. The importance of non-commercial dairy cows to Indian farmers in Votualevu is discussed from two perspectives. Firstly, on the basis of the monetary value of production from both the crop and cow enterprises, and secondly, on the basis of the value of milk and milk products to nutrition of the farm household.

These are discussed in Section 5.5.2. Detailed information on the assumptions made and calculations performed to estimate the monetary and nutritional value of the cow(s) to the typical farm family are presented in Appendix 11. Finally, farmers' views on the effects upon the farm and farm family if cows were not owned are discussed in Section 5.5.3.

5.5.1 A typical Indian farm in Votualevu.

Some of the key aspects which relate to the importance and value of the cow(s) to a typical farm are now discussed. Further information on the management and husbandry techniques adopted on this farm are presented in Section 1 of Appendix 11.

The total farm area is 4.4ha, of which 73% is given over to sugar cane production (Table 5.5). Sugar cane is the farm's main commercial crop enterprise and alas the primary source of income from the farm. The remaining area comprises of rice, assorted vegetables and mixed foliage or uncultivated land.

Table 5.5 Areas of each crop grown on a typical farm in Votualevu.

Type of crop grown	Median area (ha)
Sugar cane	3.2
Dryland rice	0.4
Assorted vegetables	0.2
Mixed foliage	0.6
Total farm area	4.4

Source: Based on median values recorded in the author's field study.

The average family size is 5.4 persons per household. The farm family supplies the majority of labour for the farm. Two casual workers are employed per farm per year, usually during the sugar cane harvesting season. Typically, each farmer owns two cows, a pair of working bullocks, a goat and some chickens. The cows are kept primarily to produce milk and provide young stock, whilst the bullocks are used for land preparation and cultivation purposes.

The average milk yield per cow is 6.3l/day, or approximately 4600lmilk/year from both cows. This milk is consumed by the farm household as 1426l of boiled milk and 3174l of processed milk

products. On a per person basis, 0.72l/day of boiled milk is consumed and 3.6 bottles/week of ghee is processed on the farm. These figures are calculated on an annual basis taking into account the total lactation length and calving intervals. Sections 2 and 3 of Appendix 11 present the assumptions and calculations made towards gaining these figures on milk production and consumption for a typical farm.

5.5.2 The monetary and nutritional value of two cows to a typical farm in Votualevu.

The importance and value of owning two cows to the farming household is now presented from two aspects, their monetary worth and, the nutritional value of milk and milk products under the whole farming system.

The annual net revenue received from commercial crops after removing variable costs is estimated to be F$4676.32 (F$1299/ha) whereas, the annual net value of subsistence crops is estimated to be F$757.00 or F$151.40/ha. Appendix 11 Sections 5, 6 and 7 provide the assumptions, calculations and results of the typical farm budget. Table 5.6 below presents a summary of the net value of production from the crop enterprises engaged on a typical farm in Voutalevu. Sugar cane provides the highest income to the farm. This crop is worth some F$4629/year. Although subsistence crops are low in value by comparison, their importance to the diet of the Indian farm family is great, since a large proportion of the most staple crops in an Indian family's diet is supplied from farm-produced or subsistence crops. Chandra (1982) reported that the Indian subsistence component of farming is more effective in supplying the dietary needs of the household because some of the more expensive foods such as rice, are wholly farm produced. Almost 60% of an adult Indian's diet in Fiji is supplied from subsistence crops (Chandra, 1982).

Table 5.6 The annual net return from commercial and subsistence crops on a typical farm.

Type and area of crop	F$	F$/ha
Commercial crops (3.6ha):		
Sugar cane (3.2ha)	4629.42	1446.69
Rice (0.4ha)	46.90	18.76
Subsistence crops (0.2ha):		
Mixed vegetables and rice (0.2ha)	757.00	151.40
Total for all crops (3.8ha)	5433.32	1429.82

The net value of production from the two cow system is estimated to be F$2073/year. This is estimated from the imputed market value of milk and milk products produced by two cows (Sections 2-4, and 7 from Appendix 11). The imputed market value for liquid milk and ghee is estimated to be F$1412 and F$701, respectively. The only annual variable cost to be deducted is F$20/cow for animal health purposes. The imputed value of this enterprise is equivalent to 38% of the net income received from commercial and subsistence crop systems. Cows, therefore, are of significant economic importance to farmers and their families.

The annual per capita consumption from 1426l of liquid milk produced from two cows is 11.6kg MFE, and 10.5kg of protein. The National Research Council (NRC, 1989) reported various recommended allowances for dietary protein in the United States population. These are presented in Table 1 of Appendix 12. These figures provide a basis for comparing the dietary protein intake of Indian farmers in Votualevu with the recommended daily allowance for protein in the United States of America. The estimated 28.8g/day consumption of protein solely from liquid milk is comparable to that of an 7-10 year old person in the USA. However, in the calculations for on-farm protein intake, the quantity of protein from processed milk products and other foodstuffs has not been quantified, as such it can be assumed that the actual level of protein intake will be greater than 30g/day/head. Chandra (1982) estimated the protein consumption of an Indian adult in Fiji at approximately 68g/day from his/her diet, which was composed mainly of rice and pulses (mung, urd and peas). It is expected that the level of protein consumption on a typical farm would exceed this if rice and pulses taken into account. The recommended dietary intake by NRC for adult males and females (25-50 years of age, and at weights of 79kg and 63kg respectively) in the US was 63 and 50g/day of protein, respectively. It is concluded, that liquid milk provided from two cows is a significant source of protein and milk fat for the Indian farm families, and therefore, that cows are important to the nutrition of a typical Indian farm in Votualevu.

In order to compare the crop and cow systems on an equal basis, the net return to labour is taken into account by calculating the net return to the farm for each enterprise against the number of man-days required per system. Section 8 of Appendix 11 presents the assumptions and calculations made to estimate the number of man-days for each system. Table 5.7 below provides a summary of these data. The main tasks involved with owning two cows are milking, feeding and the time spent processing milk products.

In terms of the returns to labour, the cow enterprise gives a lower return than the combined crop enterprises by a margin of approximately F$3.00/m.d. The commercial crops, namely sugar cane, are much higher than the average return to labour from the combined crop enterprises and the two cow system, confirming the secondary data and survey findings that sugar cane is the main source of income to smallholder farms in Fiji. The relatively high returns to labour from the cow enterprise

Table 5.7 The estimated number of man-days per year employed on each enterprise and the net return to farm labour on a typical farm in Votualevu (F$/man-day).

Enterprise	Number of Man-days (m.d.)	Net return[1] (F$)	Net return to labour[1] (F$/m.d.)
Commercial crops	64	4676.32	73.07
Subsistence crops	137	757.00	5.53
Average all of crops	201	5433.32	27.03
Two cows	87	2073.00	23.83

[1] Returns are imputed for subsistence crops and the cow enterprise.

compared to the combined crop enterprise highlights the importance of these cows to the farming system. Although the returns per man day to farmers are less than the combined crop enterprises, the opportunity cost of owning two cows is low. Cows utilise few resources which would otherwise not be used. There are only a few times of the year when the demands for labour from the crop enterprises compete with the cow enterprise. Further investigation is needed into other constraining factors such as feed availability and labour supply before any increase in the numbers of cows kept per herd can be recommended with confidence. Farmers goals also need to be investigated, as does the market for milk and milk products.

5.5.3 The effects upon the farm and farm family if a cow was not owned.

Farmers were asked to suggest how their domestic and farm circumstances would be altered if they did not own a cow(s) and how it would affect their farm/farm family. Similar responses were given by all farmers on these issues. These are now discussed. Farmers reported that without a cow for their family living costs would increase since milk and milk products would have to be purchased if the same level of milk consumption was maintained in the family. An increase in expenditure would result in a decrease in farm profits and cash available for other uses. Farmers reported that a reduction in the nutritional welfare and health of the family would probably occur. Furthermore, they would be unable to meet the expected social and religious needs of their family and the community if they did not own a cow.

5.6 SUMMARY

This chapter presents the results gained from interviewing 19 farmers in Votualevu. A general background into the land, labour and animal resources of the surveyed farms is presented, followed by a discussion of information from records on 37 cow histories. Aspects of cattle husbandry and management are reported and discussed. The importance of the cow(s) to the farming household is addressed identifying her monetary value and the importance of milk and milk products to the nutrition of the farm family. Farmer's views on the effect of not owning a cow or cows upon the farm and farm family are also presented.

The majority of the farms in the survey were on leased Native or Crown land. A median farm area for the group of 4.4ha was recorded. All farms grew sugar cane, which accounted for approximately 73% of total farm area. A combination of mixed foliage, assorted vegetables, rice and pulses were also grown on farms in varying proportions. The farm family supply the majority of farm labour. On average two casual workers were employed per farm, mainly during the sugar cane harvesting season. Each farmer owned a few cows, a pair of working bullocks, a goat and some chickens. Family labour was also used to milk, feed and work the cattle. Cattle are kept primarily to provide draft power, replacement stock and milk and milk products for the farm family.

The individual cow histories showed that the average age of surveyed cows was six years. The majority of cows were of 'mixed' or 'native' breeds. The effect of season upon feed availability was examined with regard to cow condition at the time of the survey. In February 1991, the cows sighted had an average condition score of 4, suggesting that they are adequately nourished at that time of the year. No data were available on the annual cycle of good/poor nutrition, but it can be anticipated from the data on climate and feeding regimes that cow condition varies significantly over each year.

Over 50% of surveyed cows were reported to exhibit signs of oestrus about once per month when not in calf. On average, cows were reported as being put to the bull 1.3 times before conceiving. Most surveyed farmers reported using a neighbour's bull for mating, however, no breed preference was indicated. Oestrus was detected predominantly by cow behaviour. All farmers took their cow(s) to the bull for mating when oestrus was detected. Calving dates were used to estimate the date of mating and hence, the effect of season upon cow conception. Mating was found mainly to occur during the hot/wet months when both feed quality and quantity are best. Seventy five percent of the cows owned by surveyed farmers were mated from April to June 1989, the end of the dry/cool season, and from October 1989 to April 1990 over the hot/wet season. Conception did not appear to occur between June and October of 1989, suggesting that oestrus activity of cows was adversely affected by the cool/dry season and probably the poorer nutritional status of cows at that time of the year.

The average age at first calving for the heifers on these non-commercial farms was two years and ten months. The average interval between calvings was 1.5 years.

As reported by farmers, calves are reared using various methods. Calves are separated from their mothers a few days after their birth. The two main options for feeding calves were: 1) one to two quarters twice a day until the calf is weaned, and 2) one or two quarters twice a day for three months then, reduced to one quarter once per day for the remainder of the lactation. Eighty four percent of surveyed farmers reported having no sex preference for feeding either male or female calves. No form of milk substitutes or concentrates were fed to unweaned calves. The majority of farmers did not formally wean their calves, natural weaning occurred from seven to 12 months of age, or when the cow finished lactating. Heifer calves were reared as replacements whereas male calves were reared and trained as working bullocks to be sold as a team or used to replace old stock.

The average total length of past lactations as estimated by farmers was 12.5 months. An average daily milk yield of 8.4 litres/cow/day over a lactation was estimated in February when the cows were on average some 5.5 months into their lactations. All surveyed farmers milked by hand, taking approximately 10-15 minutes per cow. The calf is always present during milking to calm down the dam and to stimulate milk let-down. Milking practice varied between farmers. Milking once or twice per day, or a combination of both was reported.

On average 13l/day of milk (annual yield from two cows adjusted by calving interval) was produced per farm, of which four litres was consumed as boiled milk and the remaining nine litres was processed into ghee, butter, curd or whey. Approximately four (750ml) bottles of ghee can be processed in a week. Per capita consumption from boiled milk was estimated at approximately 11.9 kg MFE and 10.8kg of protein. Most of the milk and processed products are consumed by the farm family. Ghee is occasionally sold at the farm gate to neighbours for F$3.50-4.00/750ml bottle. Farmers were reported as preferring to give away any excess milk and ghee to their neighbours over selling the products.

Statistical analysis of cow age and stage of lactation with daily milk yields showed that no significant relationships exist between these parameters. The sample size was too small to discern such a relationship. More extensive research on individual animals in the non-commercial dairy sector is needed to enable key relationships such as the links between nutrition, reproduction and milk production to be estimated. Without such data it is impractical to identify or promote improved strategies for such farmers to follow.

Limited time and resources in the field prevented detailed identification of plant species fed to and consumed by cattle. Further investigation into this subject is necessary, with special reference to

seasonal shortfalls in the nutritional value of the forage in relation to milk production, reproduction and annual growth.

All farmers tethered their cows day and night. During the day the cows are taken away from the farm and grazed along roads or riversides. Only seven farmers fed their cows at night, this consisted mainly of grasses cut in the fields on and off the farm and carried back to the homestead. Only three farmers reported the use of supplements, coconut milk, bran mix or molasses. The use of cane tops as a feed during the sugar cane harvesting season (May - December) is common, but farmers reported depressed milk yields when their cows were fed purely on cane tops. The farmers reported a mixture of grasses and plants usually being fed to minimise this effect on milk production.

Persons knowledgeable about Fijian farming systems cited animal nutrition and management techniques as the main constraints upon commercial dairy production. However, the effects of these on cow productivity in the non-commercial sector is unknown. It is recommended that extensive research upon individual animals in the non-commercial dairy sector, focussing on their productivity and reproductive ability, be carried out to verify and expand upon these results in order to develop profitable and adoptable recommendations for these essentially subsistence cow enterprises.

The Fiji Government has a programme to control tuberculosis and brucellosis in cattle. Survey farmers are visited once per year by a veterinarian as a part of this control programme and to give all stock a general check over. Only four farmers reported using preventative methods against disease or animal health problems, which involved the drenching of calves against internal parasites. Various veterinarians in Fiji reported internal parasites in calves, dystocia, milk fever and mastitis as the main animal health problems in the commercial dairy sector. The incidence of these problems in the non-commercial dairy sector and their impacts are not known.

The importance of owning a cow(s) has been discussed to establish the financial and nutritional value of this enterprise on a typical farm in Votualevu. A typical farm was presented with some key aspects relating to the importance of owning cows being discussed. A whole farm budget was prepared, identifying the revenue and costs of commercial and subsistence crop enterprises and the two cow system. Sugar cane is the main source of income from the farm, with an estimated net value of F$1447/ha (F$4629/year). The total net revenue from the combined crop enterprises (commercial and subsistence) was F$5433/year. The net value of production from the two cow system was calculated as F$2069/year, or 38% of the net crop revenue.

The reward to the farmer for labour in each enterprise was also calculated as the net value of production (F$) per man-day (m.d.). The return to labour from sugar cane (F$73/m.d.) and the

combined commercial and subsistence cropping enterprises (F$27/m.d.) exceed the return to the cow system of $23.83/m.d. However, the opportunity cost for owning one or two cows is low because they use otherwise unutilised feed and labour resources.

The milk consumption levels per household for a typical farm over a year have been estimated to be approximately 0.72l/day of boiled milk per person and approximately five (750ml) bottles of ghee per week (Appendix 11; Section 3). Per capita consumption of fat and protein from liquid milk alone was estimated to be 11.6kg and 10.5kg per year, respectively. Estimates of protein intake from other food sources in the Indian family's diet were not quantified from this study. However, the survey results show that liquid milk is a significant source of protein and milkfat to the Indian farm family in Votualevu. Energy intake levels by members of the farm family are not limiting in these farming systems.

Farmers' views on the effects upon their farm and family reinforced the findings from the monetary and nutritional value analyses. The farmers suggested a decrease in available income and profits since money would need to be spent purchasing dairy produce to meet the same consumption levels as provided by the cow(s). Therefore, if a cow was not owned a reduction in the nutritional welfare, health and income of the family would most likely occur.

In conclusion, the analysis of survey data, combined with the reported views of the farmers support the hypotheses that cow(s) are of major importance to the monetary and nutritional well-being of the Indian farm households of Votualevu, and that these cows are maintained and produce using resources of low opportunity cost to the farm family. These hypothesis can not be rejected. Other factors constraining the numbers of cows owned and the goals/needs of farmers require identification before further recommendations for improving the current system can be made.

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

Smallholder farming systems dominate crop and livestock production throughout developing countries. Cattle are predominantly maintained under traditional systems of small-scale mixed cropping and livestock farming. However, research into the roles and importance of cattle, or other livestock, within these smallholder systems has been limited when compared with that done on cropping systems.

This study focusses upon smallholder dairy production in the South Pacific nation of Fiji. Dairy cattle in Fiji are held in two main farming groups, the commercial and non-commercial dairy producers. Nearly 84% of the total dairy cattle population are owned by small-scale or non-commercial dairy producers, the majority of which are located in the Western Division.

A review of available literature revealed a lack of information on the non-commercial sector of the Fijian dairy industry. Consequently an eight week study was conducted during February and March 1991 which investigated smallholder, non-commercial dairy producers in the Western Division of Viti Levu. A total of 19 Indian sugar cane farmers were interviewed in the Voutalevu District of the Western Division. Information on 36 non-commercial dairy cows was collected from these farmers.

Sections 6.2 and 6.3 presents summaries of the hypotheses to be tested and achieved through the field research and the results gained from these surveys, respectively. The methodological issues and implications for future research are discussed in Section 6.4. The recommendations for future research in the research area or for Research and Extension agencies are discussed in Section 6.5. Finally, Section 6.6 presents the conclusion to this dissertation.

6.2 Study hypotheses and objectives

Two hypotheses, presented in Chapter 1, were to be tested through the field studies. These were, first, that the smallscale cow herds, typically one or two cows, make a significant contribution to the nutrition and economic and cultural well being of the families which keep them. Second, that these small herds are maintained and produce using resources of low opportunity cost to the farm family.

The main objectives of the field research were to collect primary data on the whole farming system and the non-commercial dairy cow enterprise, in order to define and quantify the role and

contribution of these cows to the economic, nutritional and cultural well-being of Indian families in the Western Division of Viti Levu.

6.3 Summary of field survey

A summary of the main findings from the field survey in Votualevu is now presented.

No statistically significant relationships between cow age, stage of lactation and daily milk yields can be estimated from the data collected in the survey. This is attributed to the small sample size of the survey, making it difficult to discern any relationships between the estimated parameters.

Nutrition and fertility are linked and are primary determinants of cow productivity and reproductive performance. However, these relationships can not be estimated using the data from the small number of farmers who only own one or two cows. A longitudinal survey rather than a cross-sectional survey is needed to provide the requisite data. The absence of such information makes difficult the formulation and extension of recommendations to producers to improve their system.

Surveyed farmers in Votualevu reported the use of cane tops as a feed during the sugar cane harvesting season from May to December. However, farmers also noted depressed milk yields when their cows are fed purely on cane tops. A mixture of grasses and plants is usually fed to minimise this effect on milk production. None of the farmers report using any form of supplementation whilst their cows are fed on cane tops. This accounts for the reported decrease in milk production.

Persons knowledgeable about Fijian livestock farming systems cite animal nutrition and management techniques as the main constraints upon commercial dairy production. However, the effects of these on cow productivity in the non-commercial sector remain unknown. The main animal health problems experienced on non-commercial dairy farms are not documented, but animal health is not, according to the farmers surveyed, a significant constraint on their cow enterprises.

The whole farm budget model of a 'typical' farm in the survey area shows that the imputed net value of production from a two cow dairy enterprise is about F$2073, about 38% of the net crop revenue (F$5433/year). The returns to the farmer for labour use are highest from the combined crop enterprise at $27/man day, compared to $23.83/man day from the two cow system. However, the opportunity cost for owning cows is low since the feed and labour resources utilised in this system will otherwise have not been used.

Milk consumption levels per household on a typical farm are estimated at 0.72l/day/head of boiled milk and approximately five (750ml) bottles/week of ghee. Estimates of per capita consumption of fat and protein from liquid milk are 11.6kg and 10.5kg per year, respectively. Survey results show that liquid milk is a significant source of protein to Indian farm families. Farmers report that if a cow is not owned by the farmers then the nutritional welfare, health and income of the family will be significantly reduced.

Analysis of the primary and secondary information gathered in this study show that non-commercial dairy farmers are sufficiently homogeneous to regard them as one recommendation domain for the purposes of further research and extension of innovations in the area.

6.4 METHODOLOGICAL ISSUES AND IMPLICATIONS FOR FUTURE RESEARCH

A farming systems research (FSR) approach provided the framework for this study. The concepts and processes incorporated into the FSR methodology, as expressed in the literature, were discussed in Chapter 2. The four main stages of FSR were presented as, a) the descriptive or diagnostic stage; b) design or planning stage (problem identification and development of a research base); c) testing stage (on-farm research); and, d) recommendation and dissemination stage. The limited resources available for this study and the focus on a low cost research approach prevented the recommended 'FSR multidisciplinary' team from being assembled. Field work in this study was limited to the initial diagnostic stage. The procedures discussed in literature relating to the problem identification stage of FSR were used as guidelines by the writer in the field. Collection of primary data was undertaken by an exploratory survey aided by a questionnaire, whilst the collection of secondary information was carried out before and during the visit to Fiji.

The research approach used in this study departed in some respects from the recommended FSR methodology as reported in the literature. This was mainly because of the need to undertake the study at low cost and with only a short period of field work. However, sufficient information was gathered to provide information on a previously unresearched topic. It also enabled opportunities and recommendations for further research in these systems to be identified.

The FSR approach adopted in this study is recommended as the basis for future field studies on these production systems. A single field investigator able to speak Hindi (or make use of an interpreter) should be able to carry out the longitudinal field studies over at least 12 months required to extend the baseline knowledge gathered in the current study and thereby allow the diagnostic and design phases of the systems research to be completed adequately. The types of information which require further investigation and the suggested methodological approach are now presented. Appendix 13 provides an outline for further studies and the areas requiring

now presented. Appendix 13 provides an outline for further studies and the areas requiring investigation and measurement. these field studies could be led by an experienced general agriculturalist who could be supported as required by suitably trained specialists.

6.5 Recommendations for future research

Although cross-checks were extensively used in this survey to minimise errors of fact and understanding, the results need to be verified by extensive field studies of individual animals in the non-commercial dairy sector of Fiji. If longitudinal studies of at least 12 months are undertaken on issues such as fertility, nutrition, cow condition and milk production, they would supply more information than can be provided by the cross-sectional studies of the type used in this study. However, priorities for long term research in specific areas of more immediate importance such as the contribution of milk to the consumption, and hence nutrition, of milk in farm families, the identification of feeds consumed by cows, and the use of labour for the cow enterprise will be addressed in this section.

Recommendations for further research are presented for the study area in Votualevu in Section 6.5.1. Recommendations for the national Research and Extension agencies in relation to the area are presented in Section 6.5.2. The implications of the area being considered as one rather than two or more recommendation domains for the purposes of research and extension in the general area are discussed in Section 6.5.2.

6.5.1 In the study area; Votualevu area

Further investigation into the nutritional contribution of milk from non-commercial dairy cows to Indian farm families is one of the priority research areas for future research in the Western Division. Identification of feedstuffs consumed by cows and the amount of labour utilised over a period of time will also require further investigation. The goals and needs of these smallscale farmers need also to be addressed, with reference to future research and development on the non-commercial dairy cow. The information to be collected and recorded in order to address these priorities is now discussed.

To estimate reliably the nutritional contribution of milk to family welfare requires data on the levels of milk production, quantities consumed by the family including the amount left for the calf, quantities and products from processing, and the fate of milk and milk products. Data will need to be gathered on at least a monthly basis over a full year.

Measurement of daily milk production over a whole lactation, or if resources permit, various lactations for a larger number of cows will be required before any statistically reliable relationships can be estimated. The measurement of daily milk yields and the fate of milk, records of the actual lactation length, and stage of lactation compared to milk yields, by way of longitudinal studies, are also necessary to gain more comprehensive data than received through this study. Again, observations made over a full annual cycle should suffice to allow these relationships to be estimated. Should research resources be available, potential interyear differences could be approximated if the systems are studied over two full cycles.

Further investigation of the botanical composition of the plant species in the 'mixed foliage' diet of cows, and the effects of seasonality on the growth of these species is necessary to assess the performance and production potential of these non-commercial dairy cow enterprises. The main part of these studies could be done by the investigator, however it is likely that some basic analytical determinations will be needed on samples of feed unless these are otherwise available.

It may be possible to use cow condition scores over a period of at least 12 months and contemporary data on feed supplies and their use to estimate the (possible) effects of season upon cow condition. Analysis of these results against the levels of productivity at subsequent times of the year may also allow relationships between cow condition and productivity to be assessed. A minimum sample of 30 farmers could be monitored by one suitably trained field investigator to achieve this goal. If statistically reliable estimates of these relationships can be made then the condition scores of these animals should be able to be developed as a powerful tool for use by extension personnel concerned with effecting improvements to these systems.

At each farm visit the field investigator should attempt visually to assess the cow in order to collect data on cow condition, the plant species being consumed, availability of water and distance from the homestead.

Measurement of time from the homestead to the cow(s) will allow the researcher to estimate the amount of time per day labour is used for taking the cow(s) to their grazing place. Investigation into the distribution and allocation of farm labour throughout the farm enterprises in a year is required.

Fertility and nutrition relationships are primary contributors to cow production and reproductive performance. Field studies over a larger number of farmers over at least a year will be required to elaborate this complex of relationships. The effect of season upon the quality and quantity of feeds available and subsequent effects on the reproductive activity of cows could be addressed by recording data on cow condition, the frequency and duration of oestrous, the number of services until the cow is pregnant, dates of mating and subsequent calvings, age at puberty and first

calving, anoestrous period, calving intervals and calf growth. Improved understanding of these issues will be of direct benefit to both researchers and extension personnel in Fiji.

A longitudinal study would provide the researcher with an opportunity to follow the fate and role of calves through multiple visits to the target farms. Further research is also needed into the actual quantities consumed by the calf and how this may vary due to different stages of lactation. The feed intake level of the calf affects the future performance from that animal. Consequently the feeding levels of calves on-farm and the subsequent effects of feeding upon growth, sexual maturity and mating with respect to their future production requires further investigation. The extent to which this can be carried out by a low input resource FSR approach may be limiting. Over a 12 month period, however, data could be collected on the liveweight gain of calves by weighing the calf on a regular basis using portable scales (and using a field rule of thumb that 1kg of liveweight gain per month is the approximate result of 6kg whole milk). These data would allow the extent of wastage (or conversely the opportunity for productivity improvements) to be estimated. This information would also be of value to the research and extension communities in Fiji.

In these systems the farmer is dependent upon the calf to stimulate milk-let down in its dam, in order to be able to extract milk for use by the family. This letdown problem is of lesser importance and potentially absent in herds where Bos indicus - Bos taurus cows are kept. The feasibility and desirability of extending the use of Bos taurus breeds (such as Friesians and Jerseys) in these systems needs to be evaluated rigorously. The greater use of such crossbred cattle may not be acceptable to these Indian farmers. Information on the current farming system needs to be recorded and analysed before the use of such crossbreeding systems can be unambiguously advocated.

Animal health effects the performance and productivity of stock. Further investigation into disease or health problems which may be present in these small scale livestock systems will be needed to establish the case for use of an expanded veterinary programme in the Western Division. Research into 'home medicine' techniques used by farmers may be helpful and allow the researchers to learn from farmer experiences. However, the latter suggestion is of low priority compared with the other recommendations given above for further field studies with farmers owning cows in the Western Division.

6.5.2 For research and extension agencies

The findings of this study suggest that non-commercial dairy farmers of Indian farmers in the Western Division of Fiji can be regarded as being in one recommendation domain for the purposes of research and extension activities. This greatly simplifies the task of undertaking both research

and extension concerned with the dairy systems as compared with the situation in other developing countries where many recommendation domains can be described in dairy systems. Section 6.5.1 gave details of applied and adaptive research needed for Indian dairy farmers of the Western Division. Some other research and extension issues in regard to dairy systems in Fiji also have reference as well to the commercial dairy systems in the country. These are now discussed.

Implementation and extension of past research into the supplementation of urea and other high nitrogen compounds to increase the digestibility and nutritive value of cane tops in Fiji could increase the effectiveness of utilisation of this widely available resource in the Western Division of Viti Levu and also be of value to the commercial dairy systems. The availability of urea or other supplements, cost, safety and health aspects should be specifically addressed for Fijian agricultural systems. The effect of such supplements upon lactating and growing animals (including levels of intake) should be addressed. This could be done by experimentation on research stations, supplemented by on-farm research. Applied and adaptive research will both be required. Strategic research results on these topics are already available from the work of nutritionists in countries such as India, Australia, Cuba and Colombia, among others.

The non-commercial livestock farmers have limited Government support with respect to animal health diagnosis and treatment, but they still manage to survive. Education of farmers on the animal health problems common to their cattle would be useful to alleviate the demands on an already limited number of veterinary persons and to allow adequate education in animal health preventative techniques to be extended to farmers. If the results of longitudinal studies recommended above support the tentative findings of this study, then the Fijian Government is encouraged to investigate the opportunities available for training extension personnel in the management and productivity of non-commercial dairy cows including basic preventative health care. Dissemination of these findings to research and education institutions will be necessary to allow for more interactive research between farmers and researchers. The interaction between extension officers and smallholder dairy farmers will need to be increased for effective dissemination of new technologies or for management techniques to be adopted. Such results should also find ready application in the expanding commercial dairy sector.

6.5.3 For other dairying areas in Fiji

It was concluded from the field study in Votualevu that all non-commercial dairy farmers in the Western Division are sufficiently homogeneous to allow them to be treated as being in one recommendation domain for research and extension purposes. However, it is suggested that an initial exploratory survey similar to the type used in Votualevu, be carried out with others owning one or two cows for non-commercial dairy purposes in the Western Division to confirm or reject

this finding. Possible differences in husbandry and management practices, in the numbers of cows owned and fate of the milk produced may be identified. The extent to which such differences would be sufficiently large as to oblige the specification and use of more than one recommendation domain for research and extension needs to be established.

6.6 Conclusion

The survey data and views of surveyed farmers support the hypotheses that smallholder dairy herds of one or two cows, make a significant contribution to the nutrition and economic and cultural well-being of the families which keep them. The opportunity cost of owning a small herd is low since the resources utilised for this system would otherwise have not been used.

It is recommended that further research be undertaken in the non-commercial dairy sector of Fiji, focussing on their nutritional contribution to the farm family, the identification of consumed feedstuffs by the cows and the goals and needs of smallscale farmers. This is needed to verify and expand upon the results of this study and to provide the basis for the development of these important agricultural systems in Fiji.

APPENDIX 1. The main soil groups of Viti Levu

The eight main soil groups of Viti Levu, as categorised by Tywford and Wright (1965) are:

1. Recent soils from coastal sands.

Young, very sandy soils from various coastal deposits on the shores of the islands. Saline soils, which have seawater drainage problems, are unused for agriculture in an unimproved state but are sometimes reclaimed for agriculture and fishery development.

2. Recent soils from alluvium.

Soils derived from river deposits which occupy river floors. For example, the floodplains of Sigatoka, Rewa, Nadi, Ba, and Navua rivers. These soils are generally fertile, deep and agriculturally valuable. Most of the agriculture in Viti Levu is concentrated on these floodplains.

3. Nigrescent soils.

Shallow black, nutrient rich soils mainly suitable for pastures because of shallowness, but can be intensively cultivated, vegetables for example. These are found in large areas throughout Viti Levu especially in the lowland dry zone.

4. Latosolic soils.

Older sandy or silty soils, deeper, especially those derived from volcanic ash, but in which particles of unweathered parent material are still in solum. They are fertile and constitute some of Fiji's best soils even though they are often acidic and in high rainfall areas.

5. Humic latosols.

Deep, weathered clays, rather acid and often of low nutrient status, however constituting good agricultural soils when properly treated with fertilisers.

6. Ferruginous latosols.

Deep, weathered gravelly clays, from very strongly decomposed basic parent materials. These soils are of little agricultural value.

7. Red yellow podzolic soils.

Deep sandy soils in which the clay content increases in the subsoil, derived from acidic parent materials. Very strongly weathered and usually leached, they are of rather low fertility but still have some agricultural value for pastures, certain tree crops and vegetation. They require large inputs of fertiliser to obtain even moderate levels of production.

8. Gleys and peats.

Swamp soils which occupy low-lying depressions in valleys and on plateaux, the shores are often fringed by marine marsh soils. Gley soils are extremely important for some aspects of agriculture such as wetland rice cultivation and grazing dairy cattle in the wet zone. Organic soils have the worst drainage problems. They occur only in small areas and are unimportant to agriculture.

APPENDIX 2: Selected farm size and population and employment statistics in Fiji.

Table 1. Farm area and size.

Divisions	Total farm area (ha)	Number of farms	Average farm size (ha)
Western	85528	30475	2.81
Central	47611	18699	2.54
Northern	125032	11072	11.29
Eastern	18962	6130	3.09
Total	277133	66376	4.18

Source: Fiji Agricultural Census (1978) as quoted by Chandra (1983).

Table 2. Farm size distribution.

Divisions	Farm size (ha)										
	0.00-0.19	0.20-0.49	0.50-0.99	1.00-1.99	2.00-2.99	3.00-4.99	5.00-9.99	10.00-14.99	15.00-19.99	20.00-49.99	>50.00
Western	12770	4164	2073	2152	1766	4110	2265	474	81	452	166
Central	10565	3232	1885	1185	388	477	422	151	22	127	245
Northern	2270	1094	471	546	750	1408	2213	818	598	531	374
Eastern	1221	1753	1164	544	186	198	482	127	156	299	
Total	26826	10243	5593	4427	3090	6193	5382	1570	857	1409	785

Source: Fiji Agricultural Census (1978) as quoted in Table 4.2 of Chandra (1983).

Table 3. Economically active population by employment status in 1986

Class of employment	Fijians (%)	Indians (%)	Others (%)	Total (%)
Own account work	29.7	39.9	14.2	33.6
Employees	34.1	48.0	61.9	42.2
(Public sector	16.1	14.9	20.7	15.8)
(Private sector	18.0	33.1	41.2	26.4)
Unpaid family worker	28.3	4.1	16.7	16.3
Unemployed	7.6	7.6	6.6	7.5
Not stated	0.3	0.4	0.5	0.4

Source: Bureau of Statistics, 1988a.

Table 4. Employment in Fiji by industry group in 1986.

Employment group	Number of population employed	% of population employed
Agriculture	106305	44.1
Industry		
Mining	1345	0.6
Manufacturing	18106	7.5
Electricity	2154	0.9
Construction	11786	4.9
Services		
Trade	26010	10.8
Transport	13151	5.4
Financing and real estate	6016	2.5
Other services	36619	15.2
Others and unemployed	19668	8.1
Total	241160	100.0

Source: Bureau of Statistics, 1988a (Vol 3; Table 5)

Table 5. The number of the working population in paid employment

Employment group	Number of population in paid employment		% of population in paid employment	
	1986	1990*	1986	1990*
Agriculture	2165	2302	2.7	2.6
Industry				
Mining	1206	1315	1.5	1.5
Manufacturing	13937	21914	17.5	24.3
Electricity	2070	2403	2.6	2.7
Construction	6964	6073	8.7	6.7
Services				
Trade	14100	14629	17.7	16.3
Transport	7747	9802	9.7	10.8
Financing and real estate	4864	5906	6.1	6.6
Other services	26765	25679	33.5	28.5
Total	79818	90023	100.0	100.0

(Note: * Estimates of paid employment as at December 1990.)
Source: Bureau of Statistics, 1990 (Table 10.1); Bureau of Statistics, 1991 (Table 1).

APPENDIX 3: Selected national and industry level statistics on Fiji.

3.1: THE MAJOR LIVESTOCK INDUSTRIES OF FIJI.

3.1.1 Pig Industry

The majority of specialist commercial pig farms are located in the Central Division. There was a total of 43 farms and approximately 1910 sows in 1989 (Ministry of Primary Industries, 1989). In 1989, 551t of pig meat was produced locally and a further 55t imported, giving a total consumption of 606t. The total value of imported pig meat was F$243,000 in 1989. Overall per capita consumption is low. It peaked in 1983 at 1.1kg/hd/year but has declined since then to 0.8kg/hd/year in 1989 (Ministry of Primary Industries, 1989). The retail of fresh pig meat for local consumption is concentrated in only a few urban centres such as Suva, Nadi and Lautoka. Hotel trading absorbs the bulk of local pig meat followed by fresh pork sales to consumers in urban areas, and live pig sales for magiti/farm gate.

3.1.2 Poultry Industry

The broiler, egg and duck sectors all achieved record production in 1989. The broiler sector produced 4929t of meat from registered poultry slaughterhouses which was 23.6% above 1988 production (3989t). MPI (1989) related this increase directly to chicken consumption, because of its competitiveness with other locally produced meat, and the shortage of imported lamb particularly during the last quarter of 1989. Exports and imports in chicken meat are not commercially important. The egg sector produced 3.13 million dozens during 1989 which was 2.2% over the 1988 production (3.06 million dozens). Fiji is self sufficient in eggs. The increase in egg output was a direct result of stable and high egg prices during the year coupled with young stock coming into lay during the second half of the year (Ministry of Primary Industries, 1989). Duck meat is of minor importance in Fiji.

3.1.3 Beef Industry

Local beef is produced from the following production systems around the country:

1) Tethered cattle from smallholder cane and rice farms;
2) Commercial farms funded by the Fiji Development Bank (FDB);
3) Dairy farms;
4) Ranches;
5) Coconut plantations.

Beef production as reported by throughput in registered abattoirs in 1989, was the lowest in the

last decade. A total of 2089t of boneless beef equivalent was produced. This was 12.1% less compared to 2377t produced in 1988. MPI (1989) related the drop in production mainly to the effects of the 1987 drought aggravated by the high cost of inputs, little support from financing institutions to fund rehabilitation programmes, and inadequate resources for supervision and training. Net imports of fresh beef increased by 9.8% from 1120t in 1988 to 1230t in 1989. The bulk of the imports were utilised for canning. Total imports in 1989 were valued at F$3.36m compared to F$3.07m in 1988. Local beef production accounted for 63% of total beef consumed.

Table 1. The trends in Total Gross Domestic Product over 1977-1988 for selected Pacific Island nations ($US million).

Country	1977	1980	1982	1983	1984	1985	1986	1987	1988
Fiji	725	1215	1197	1131	1181	1144	1302	1165	1075
French Polynesia		1140	1147						
Kiribati		43	23	23	24	20			
New Caledonia		1182	905	824					
Papua New Guinea	1644	2549	2396	2584	2564	2403	2656	3142	3568
Solomon Islands	82	145	164	124	175	160	145	147	176
Tonga	34	61	65	66	65	56			
Vanuatu			106	123	129				

Source: Euromonitor (1991; Table NO: 0303).

Table 2. Gross Domestic Product (GDP) of Fiji at constant 1977 prices.

Year	GDP at constant factor cost (F$ million)	Annual growth rate of GDP (%)	GDP/head of population (F$)	Annual growth rate of GDP/hd (F$)
1980	679.3	-1.7	1072.0	-3.7
1985	703.7	-5.1	1010.0	-6.6
1987	715.6	-6.1	993.0	-7.0
1988	721.3	1.0	1005.0	1.2
1989	811.2	12.5	1123.0	11.7

Source: Bureau of Statistics, 1990 (Table 3.1).

Table 3. GDP in Fiji by sector at current factor cost (F$m)

Sector	1970	1975	1980	1985	1986(r)	1987(p)	1988(p)
Agriculture	48.2	132.0	199.5	215.7	277.1	304.9	279.6
Mining	2.5	8.0	-2.5	13.9	17.5	31.2	39.0
Manufacturing	23.7	60.0	107.6	111.3	136.6	157.3	137.2
Electricity	2.4	8.0	14.8	40.4	48.2	44.0	56.9
Construction	11.2	39.0	73.4	63.9	64.0	61.2	50.4
Trade	31.7	107.0	162.4	210.0	223.5	207.6	273.4
Transport	10.4	34.0	80.4	121.7	131.7	138.7	151.6
Finance	21.3	69.0	112.4	165.9	181.9	182.0	197.0
Other services	17.5	58.4	177.3	271.3	299.7	243.0	273.4
Other branches	..	..	6.8	10.0	10.5	10.4	11.7
Imputed service charges	..	..	-31.0	-46.6	-64.5	-70.0	-85.2
Total GDP	168.9	515.4	901.1	1177.7	1326.1	1310.4	1385.0

(p) Provisional
(r) Revised
Sources: To 1975, Cole and Hughes, 1988; 1980-88, Bureau of Statistics, 1990.

Table 4. Primary production in Fiji of selected agricultural products (tonnes)

	1980	1985	1986	1987	1988	1989
Sugar cane (000s)	3360	3042	4109	2960	3185	4099
Copra	22802	21112	22510	12999	10714	13368
Paddy Rice	17846	27574	24600	23477	32147	31827
Tobacco	413	377	293	208	144	224
Cocoa	130	225	286	468	238	375
Beef	3525	3357	3644	3762	3565	3136
Pork	574	574	641	610	530	558
Goat		641	680	690	691	679
Chicken	2961	3612	3838	3690	3989	4929
Fish	6296	10202	9834	12324	13900	14354

Source: Bureau of Statistics, 1990.

Table 5. Average yields of selected crops in Fiji (t/ha)

Crop		1985	1986	1987	1988	1989
Sugar		42.9	59.6	41.7	49.8	49.8
Rice		2.4	2.1	1.9	2.4	2.4
Ginger:	Mature	21.6	24.9	23.4	23.8	33.9
	Immature	10.9	22.9	20.4	18.4	17.5
Cocoa					0.6	0.8
Tobacco						2.3
Passionfruit		6.4	10.6	11.1	6.4	7.6
Dalo					9.5	7.5
Yams					9.6	8.5
Sweet potatoes					7.6	7.4
Cassava					10.5	8.9
Vegetables					7.6	7.4

Source: Ministry of Primary Industries, 1989.

Table 6. Main Fijian exports and imports in 1989 by value.

Commodity	Imports (c.i.f) (F$000)	Exports (f.o.b) (F$000)
Food	128047	286328
Beverages and tobacco	6781	385
Crude materials	8092	30872
Mineral fuels	116780	1
Oils and fats	10423	5561
Chemicals	80005	4092
Manufactured goods	211351	19365
Machinery and transport equipment	226833	824
Misc. manufactured items	87497	106551
Misc. transactions	12970	78847
Total	888779	532826

Note: Exports and Imports are under the Standard International Trade Classification (SITC).
Source: Bureau of Statistics (1990).

Table 7. Domestic production (MFE)[1] of dairy products in Fiji, 1979-1989.

Year	RCDC[2] Factory suppliers			Registered Non-factory suppliers[3]			Total Domestic Production
	Whole Milk (t)	Cream (t)	Total Milk (t)	Raw (t)	Ghee (t)	Total	
1979	256	126	382	58	48	106	488
1980	246	109	355	62	50	112	467
1981	265	76	341	63	55	118	459
1982	284	62	346	70	60	130	476
1983	315	74	389	75	65	140	529
1984	312	72	384	85	75	160	544
1985	317	109	426	95	80	175	601
1986	293	98	391	95	75	170	561
1987	315	136	451	80	70	150	601
1988	311	108	419	80	70	150	569
1989	331	116	447	70	70	140	587

[1]MFE; Milk Fat Equivalents (assuming 4.8% milk fat)
[2]RCDC; Rewa Cooperative Dairy Company
[3] Registered non-factory suppliers produce and sell fresh milk to town milk vendors.
Source: Ministry of Primary Industries (1989:50)

Table 8. Domestic production and imports of dairy products (MFE), 1979-1989.

Year	Total Domestic Production	Total Imports	All Products	Domestic production as % total	Per capita consumption
(t)	(t)	(t)	consumption	(kg MFE/day)	
1979	488	3591	4079	12	4.4
1980	467	3094	3561	13	5.7
1981	459	2510	2969	15	4.6
1982	476	2004	2480	19	3.8
1983	529	1693	2232	24	3.4
1984	544	2005	2549	21	3.9
1985	601	2174	2775	22	4.0
1986	561	2756	3317	17	4.6
1987	601	2309	2909	21	4.1
1988	569	2447	3016	19	4.2
1989	587	2125	2712	22	3.8

(Ministry of Primary Industries,1989:50

Table 9. Fijian balance of trade on all items in 1985-1989 (F$000).

Period	Imports	Exports of local products	Re-exports	Total Exports	Trade Deficit (-) Surplus (+)
1985	507993	190630	80797	271427	-236566
1986	493598	241865	70577	312443	-181156
1987	465106	334091	74513	408604	-56502
1988(p)	658821	447215	83972	531187	-127634
1989(p)	888779	532826	104194	637020	-251729

p) Provisional
Source: Bureau of Statistics (1990).

APPENDIX 4: Selected statistics on farm households by land class in Fiji.

Table 1 Land tenure and farming households

Land tenure	Farms 1 hsehlds	Farms 2 hsehlds	Farms 3 + hsehlds	Tot No. of farms	Tot No. of hsehlds	% of total farms
Freehold	7609	160	102	7871	8313	12.0
Crown	11986	217		12203	12420	18.6
Native Lease Land	11919	524	353	12795	14137	19.5
Native Reserve Land	32338	367		32705	33073	49.9

Source: Fiji Agricultural Census (1978) Chandra (1983: Table 4.2)

APPENDIX 5: Selected statistics on the dairy cattle population in Fiji.

Table 1. The distribution of dairy cattle by Division in 1978

Division	No. of farms with dairy cattle	Average No. of cattle per dairy farm	Total No. of dairy cattle
Western	13735	3.7	50329
Central	2964	11.6	34447
Northern	3434	3.0	10139
Eastern	75	1.2	90
Total	20208	4.7	95005

Source: Fiji Agricultural Census (1978; Table 10.3).

Table 2. The number of cattle classified by age, sex and function within each Division.

	FEMALES			MALES					
PROVINCE	Calves < 1 yr	Heifers	Cows	Calves < 1 yr	Steers 1-3 yrs	Steers 3 yrs +	Breedg Bulls	Workg Bullocks	ALL CATTLE
Western	12319	13588	37679	11631	3980	838	6981	29648	116664
Central	8268	14540	29023	8095	7786	2739	2913	4293	77657
Northern	4749	6000	15105	4015	4120	3270	1909	9984	49152
Eastern	293	1026	1798	271	246	0	323	0	3957
Total	25629	35154	83605	24012	16132	6847	12126	43925	247430

Source: Fiji Agricultural Census (1978; Table 10.6).

Table 3. Classification of dairy cattle by Province in the Central Division by age and sex in 1978.

Province	Calves		Heifers	Cows	Breeding Bulls	Total Dairy Cattle
	Under 1 year					
	Female	Male				
Naitasiri	2448	1891	4498	7918	616	17371
Serua	364	82	251	956	73	1726
Rewa	208	115	312	515	37	1187
Tailevu	2170	496	2554	8415	528	14163
Namosi	0	0	0	0	0	0
Total	5190	2584	7615	17804	1254	34447

Source: Fiji Agricultural Census (1978; Table 10.6).

APPENDIX 6: Questionnaire used for surveying farmers in the Western Division of Viti Levu in 1991.

FARMER NAME: .....

NATIONALITY (FIJIAN OR INDIAN): .....

LOCATION OF FARM: .....

CLIMATIC ZONE: .....

INTERVIEWER: .....

A. BASIC FARM DATA

1. Area of farm .....

2. Topography (flat(1), gentle/rolling(2), steep(3). .....

3. Tenure: Area

Freehold _____

Leasehold _____

If leased, term of lease _____

time to run _____

4. Land utilisation

	Type	Area
Crops		
Total		

	Type/Species	Area
Pasture:		
Improved		
Native		

5. Map of Farm (situation of crops etc. - brief)

6. Livestock

	Type of livestock	Numbers	Breed			
			F	J	FXJ	Native
Cattle:	Milking cows	.....				
	Dry cows	.....				
	Replacement hfs	.....				
	Replacement bulls	.....				
	Working bullocks	.....				
	Bulls (breeding)	.....				
	Total					
Others:	Goats	.....				
	Horses	.....				
	Chickens	.....				
	Pigs	.....				
	Total					

7. Labour

		Number	hrs/d
Crops:	Family labour		
	Permanent labour (non-family)		
	Casual labour		
Livestock:	Family labour		
	Other (non-fm)		

Labour limits: Labour supply limiting? YES/NO

If Yes, when:

Time(s) of year _____

For what job? _____

Wage rates F$...../day

Do any of the family work off the farm? YES/NO

If Yes,

No. days/week _____

Task _____

B. CALENDAR OF EVENTS

Wet/hot season Cool/dry season Hot/wet

CROP	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

(Sowing, weeding, harvesting...)

When are working bullocks used?

Any other important events during the year which affect the farm?

C. ROLE OF CATTLE OF FARM

1. Bullocks

2. Cows

3. Calves Hfrs

Bull

D. CALF REARING

1. Any sex preference for rearing YES/NO

If Yes, MALE/FEMALE

2. Feed/Nutrition
(milk, grass, other)

3. Age at weaning

4. Are any calves sold? YES/NO

If Yes, Age:

Sex: F/M

Reason:

Price received: F$...../calf

E. ANIMAL HEALTH

1. Major problems:
   Cows

   Calves

2. Prevention methods
   (drench calves?)

3. Do they use a vet? YES/NO

   If Yes, how often

4. Costs:
   Drugs used
   Vet fees

F. MATING

1. Mating method:

2. Breed of bull: F J FXJ Native

3. Ownership of bull: Farmer
   Neighbour

4. Heat detection: Number

   (a) How often does she come on heat? _____

   (b) How often is she mated until she is pregnant? _____

5. Do you mate her whilst she is milking and if she shows a heat? YES/NO

6. When was she last mated?

7. Do you think she is pregnant? YES/NO

8. How often does she have a calf?

G. NUTRITION

1. Type of feed YES/NO SPECIES

(a) Grass Native _____

Improved _____

(b) Supplements: When used Amount Price

Coconut meal _____

Mollases _____

Mill mix _____

... _____

... _____

(c) Crop residues Type When used Amount

_____

_____

_____

_____

2. Grazing management

		Proportion of the day spent (%)
Tethered	(Graze	_____
	(Cut + carry	_____
Yarded	(Cut + carry	_____
	(Supplements	_____
Paddock	(Break graze	_____
	(Free range	_____

24 hrs = 100%
day = 50%
night = 50%

H. COW CONDITION

1. Cow Number Est LWT C.S.

_____
_____
_____
_____
_____
_____

2. Value of cow F$..... /cow

I. MILK PRODUCTION

1. Daily yield.....gal/day

2. Lactation length (current) .....months
(past) .....months

Est. Tot. Production:
(calculated later)

3. Is there a time of year you get a surplus of milk YES/NO

   If Yes, when:

   what do you do with it: Sell:

   Process into:

   Consume at home:

4. Method of milking: (a) Hand YES/NO

   (b) Machine YES/NO

   If Yes (b) - number of cups =

5. How often per day do you milk? 1 x /d AM PM

   2 x /d

6. How long does it take to milk?

7. Is the calf present at milking? YES/NO

   If Yes, why?

8. Fate of milk: (Est. % of total)

	F$	Product
Household liquid	_____	_____
Household cooking	_____	_____
Household processing	_____	_____
Shared/sold	_____	_____

9. Price of sold milk F$...../.....

10. How much is sold daily?

11. To whom do you sell it? Local market:

    Local vendor:

12. What are your priorities for the milk?

Family:
Processing:
Calf feed
Sell:

(1 - 4)
most important least important

J. OTHER

1. Manure: Is it collected? YES/NO
If YES, for what reason?

2. Do you use it as a fertiliser? YES/NO

K. DISCUSS

1. How important are the cows to you and your farm and family?

2. Do they have a religious significance? If so what is its effect on their day to day management.

3. Do they hold any social value?

4. Are they a readily available source of capital or finance?

5. How would it affect you if you had no cattle?
(the effect on the farm and farm family)

6. Are you satisfied with the performance of your cows?
(constraints on production)

7. How can MPI help you?

(State at end: Thanks and if it is necessary, at a later date would the farmer mind another visit?

Farmer Number	No. of cows & hfs	Cow no.	Breed	Status	Age	Age first calvg	No.calves		Date last calvg	Age at weang	Daily milk prodn	Stage of lactn	No. serv /preg	Date last serv	Preg (Y/N)	Expd calvg date	Calv int
							Male	Female									

APPENDIX 7: Crops grown, labour supply and values of bullocks and cattle numbers of surveyed farmers.

Table 1. The median areas for crops grown by surveyed farmers

Farmer number	Farm area (ha)	Land tenure type	Area of crops grown (ha)				
			Sugar cane	Assorted vegetables	Rice	Pulses	Mixed foliage
6	4.4	C[1]	3.6	0.8	0.0	0.0	0.0
7	2.2	C	2.0	0.1	0.0	0.0	0.0
8	10.0	C	6.0	0.8	0.8	0.0	0.8
9	4.0	F[2]	3.2	0.4	0.0	0.0	0.0
10	6.28	F	4.8	0.2	0.0	0.0	1.2
11	6.8	NL[3]	4.8	1.2	0.0	0.0	0.8
12	8.4	NL	3.6	1.2	0.8	0.0	0.0
13	14.8	NL	8.0	0.0	1.0	0.2	5.4
14	2.4	NL	1.8	0.2	0.0	0.0	0.4
15	7.8	F	4.8	0.0	1.4	0.0	0.8
16	4.0	NL	3.2	0.0	0.4	0.0	0.4
17	10.8	NL	5.2	0.8	0.0	0.0	4.8
18	3.2	NL	2.4	0.0	0.6	0.0	0.0
19	4.0	NL	3.2	0.0	0.4	0.0	0.4
20	6.4	NL	3.2	1.0	0.0	0.0	2.2
21	8.0	NL	2.4	0.0	0.4	0.6	4.6
22	4.0	NL	3.2	0.0	0.4	0.0	0.0
23	4.0	NL	1.6	0.4	0.8	0.4	0.8
24	4.0	NL	2.0	0.4	0.8	0.0	0.6
Median	4.4		3.2	0.2	0.4	0.0	0.6

[1] C = Crown land
[2] F = Freehold land
[3] NL = Native Lease land

Table 2. The farm labour profile of 19 surveyed farmers in February 1991.

Farmer number	Area (ha)	Numbers of on-farm labour			Wage	Off-farm labour rate (F$)	
		Family	Permanent	Casual	Livestock[1]		
6	4.4	1	0	5	Fmr	8/day	N
7	2.2	2	0	0	Fmr/Wf	0	Y
8	10.0	2	1	1	Fmr/Wf	8/d	N
9	4.0	1	0	3	Fmr	5-6/day	Y
10	6.3	2	0	2	Fmr/Wf	8/ton[2]	Y
11	6.8	3	0	2	Wf	7/ton	N
12	8.4	3	0	0	Fmr	Share[3]	Y
13	14.8	2	0	4	Fmr/Wf	6/day	N
14	2.4	2	0	3	Fmr/Wf	Share	N
15	7.8	2	0	6	Wf	5/day	N
16	4.0	3	0	5	Wf/Ch	7/day	N
17	10.8	8	2	2	Any	6/day	Y
18	3.2	6	0	3	Any	6/day	Y
19	4.0	2	0	2	Ch	7/day	N
20	6.4	3	0	0	Ch	0	N
21	8.0	1	0	2	Fmr/Ch	Share	N
22	4.0	2	0	0	Any	Share	N
23	4.0	2	0	0	Any	Share	N
24	4.0	3	0	0	Any	0	Y

[1] Fmr = Farmer; Wf = Wife; Ch = Child(ren); Any = Anyone in the family.
[2] F$/ton of sugar cane harvested. Farmers reprted that 3-4t could be harvested in one day.
[3] Shared labour: Farmers work as a team harvesting sugar cane on their farms at no cost.
[4] N = No; Y = Yes.

Table 3. Estimates of the value by age of working bullocks.

Age of bullock (years)	Price Received (F$)	
	Sold singly	Sold as a pair
1	100-300	
1.5	100	300-400
2	80-100	200
3		450-800
4		800-900

Table 4. Farm area and cattle numbers of surveyed farms which own entire bulls

Farmer number	Farm area (ha)	Number of cattle owned			
		Bulls	Cows	Heifers	Bullocks[1]
14	2.4	1	1	2	2
20	6.4	1	3	0	0
23	4.0	2	2	0	0
24	4.0	2	1	0	2

[1] Working bullocks

APPENDIX 8: Recommended husbandry practices on commercial dairy and beef farms in Fiji as reported in MPI (1990).

1) Commercial dairy farms:

On commercial dairy farms the aim is to mate cows 75-90 days after calving (or at any cycle thereafter), so one calf per cow per year can be born. There are two main mating methods used. Firstly, a bull runs with the cows at a ratio of 1 bull to 40 cows. Secondly, by artificial insemination using imported semen from New Zealand.

The target age for first calving was reported as two years and six months for Friesian and Jersey dairy cattle. A target calving interval of one year is aimed at on commercial dairy farms.

MPI (1990) reported target weaning weights at 80 and 72 kg for Friesian and Jersey calves respectively. Weaning ages of 8 - 12 weeks are aimed for depending on the feed and weight of the calves. Calf rearing as reported in the Farm Management Manual (MPI, 1990) consists of three main systems. The first option is to leave the calf with a nurse cow, so it can suckle ad libitum. Secondly, the calf is left with its mother for part of the day to suckle then separated and finally, a bucket system is used. The calf is taken from its mother within the first few days of calving and fed from buckets. The calves are fed either whole milk at about 10% of their body weight, milk replacement powders as a substitute of whole milk, or whole milk (or subsistute) for an initial period followed by skim milk as the calf grows towards its weaning weight. In all three rearing systems grass and concentrates are available to the calf from the third week. Post weaning calves are grazing and receive approximately 500 grams of concentrates until one year of age. Calves are drenched every three weeks to control internal parasites.

2) Commercial beef farms:

MPI (1990) recommends mating beef cows from December to April when cows are improving in body condition, and when pasture availability is high. "On all year round mating high conception is achieved during this period" (MPI, 1990). Calving would therefore occur during the following September to January, as cows calve into the wet season when pasture availability is high.

APPENDIX 9: Estimates of milk production and consumption on surveyed farms.

The fate of milk produced on surveyed farms is reported below on a per farm basis.

Table 1. Fate of milk produced per survey farm.

Farmer Number	Total Milk Yield (l/day)	Quantity (l/day)		Processed product
		Boiled	Processed	
6	9.0	2.0	7.0	ghee, curd
7	8.0	4.0	4.0	ghee
8	18.0	1.0	17.0	butter, ghee
9	1.0	1.0	0.0	
10	9.0	2.25	6.75	ghee
11	13.5	4.5	9.0	ghee, butter
42	27.0	9.0	18.0	ghee, butter
13	22.5	4.5	18.0	ghee
14	9.0	4.5	4.5	ghee, butter
15	13.5	4.5	9.0	ghee
16	13.5	4.5	9.0	ghee
17	14.0	8.0	6.0	ghee
18	27.0	9.0	13.5	ghee
19	2.0	2.0	0.0	
20	12.0	4.0	8.0	ghee
21	9.0	2.0	7.0	butter, ghee
22	13.5	2.0	11.5	ghee, butter
23	22.5	4.5	18.0	ghee
24	13.5	0.75	12.75	ghee
Average value	13.6	3.9	9.4	
Median value	13.5	4.0	9.0	

Milk production and consumption on surveyed farms is estimated as follows.

1. The average milk yield per cow is 8.4l/day (median = 8.0l/day).

2. The average lactation length is 12.5 months (median = 12 months) whilst the average interval between calvings is 1.5 years. Taking these factors into consideration it is assumed that the cow has 1.5 lactations every two years, resulting in a 274 day lactation per year.
The estimated average total milk production per cow per year is:

8.4l/cow/day x 274 days = 2300l/cow/year

However, the typical farm owns two cows so, 4600l/year/farm is produced.

3. Average milk production/household/day = 13.6l (median = 13.5l)
Average amount of liquid milk consumed = 3.9l/day (median 4l/day)
Average amount of milk processed = 9.4l/day (median = 9l/day)

Since the average and median values for milk consumption are similar, it is assumed that the total amount consumed per day is 13l; of which 4l are consumed as boiled milk and 9l are processed into ghee, butter and curd.

Therefore, the estimated average milk production per household per year is:
13.0l/day x 365 days = 4730 litres

4. Seventeen litres of liquid milk are required to process 750ml of ghee.
Assumptions and calculations:
Ghee is 100% butter oil.
Milk has a 4.4% butterfat content in 1kg of milk, so there is approximately 0.044kg of butter/kg of milk.
Therefore, assuming 1 kg milk = 1 litre milk
then, 1 litre milk = 0.044 litres butter.

To calculate the amount of milk (q) required to produce 750ml of ghee,
(q ÷ 1litre) = (0.750 ÷ 0.044)
q = 17 litres of milk.

5. 0.74l/day of boiled milk is consumed per person.
Assumptions and calculations:
The survey farms produce 13l/day of liquid milk throughout a year, which is split into 4l of boiled milk and 9l of processed milk products.

The average family size is 5.4 persons per household (Bureau of Statistics, 1988).
The quantity of milk (c) consumed per person in each household is calculated as,
c = (4l consumed/household/day) ÷ (5.4 persons/household)
c = 0.74l/person/day.

6. 3.7 bottles of ghee are produced per farm per week.
Assumptions and calculations:
9l/day are processed into ghee, butter or curd.
17l of milk is required to produce 750 ml of ghee.
Therefore, 9l milk processed x 7days = 63l/wk milk processed
So (63l/household used for processing/wk) ÷ (17l used for making one 750ml bottle of ghee) = 3.7 bottles of ghee equivalent processed each week.

7. Per capita MFE consumption per person is 11.9kg/year.
Assumptions and calculations:
The quantity of milkfat equivalents (MFE) consumed per person per year is calculated using a 4.4% milkfat test and a daily liquid consumption of 0.74l/person.
1 litre milk is approximately equal to 1 kg milk
So, 0.74lmilk consumption/hd/d = 0.74kg/hd/d of milk consumption
740g/hd/day of milk consumption x 4.4% milkfat = 32.6g/hd/d of milkfat consumption or,
32.6g/hd/day x 365 days = 11.9kg MFE/hd.

6.The per capita consumption of protein from milk is 10.8kg/year.
Assumptions and calculations:
The quantity of protein consumed per person per year is calculated using a protein concentration of 40g/litre of milk, or 4% protein content, from the 0.74l of milk consumed per person per head per day.
Therefore, 0.74kg/hd/day x 0.04 = 29.6g/hd/day of protein or,
29.6g/hd/day x 365 days = 10.8kg protein/year.

APPENDIX 10: Main chemical components of sugar cane stalks and tops.

Table 1. Composition of sugarcane tops and of the rind and pith fractions of cane stalks and tops produced by the "Tilby" process.

Parameter	Cane stalks		Cane Tops
	Pith	Rind	
Dry Matter (DM) (%)	22.0	39.0	27.0
Composition (%DM)			
Protein (N x 6.25)	1.4	3.2	2.7
Ether extract	0.2	1.0	0.8
Total sugars	46.0	24.0	27.0
Fibre	45.0	70.0	57.0
Ash	1.9	3.1	5.3
Sulphur	0.2	0.3	0.4

Source: Preston and Leng (1987)

APPENDIX 11: A model and related analysis of a typical Votualevu farm with dairy cows.

Section 1: A description of a 'typical' farm with dairy cows in Votualevu.

All figures used below are based on the median results from the survey.

The typical farm from the survey area comprises of 3.2 ha of sugar cane, 0.4 ha of rice, 0.2 ha of assorted vegetables and 0.6 ha of mixed foliage or uncultivated land. The two main crops grown are sugar cane and rice. Sugar cane is the main source of income from the farm.

The average family size is 5.4 persons per household in the peri-urban area of Nadi (based on the 1986 census (Bureau of Statistics, 1988)). The farm family supplies the majority of labour for the farm. Two casual workers are employed per farm per year, usually during the sugar cane harvesting season.

Each farmer owns two cows, a pair of working bullocks, a goat and some chickens. The cattle are of 'mixed or native' breed.

Most cows exhibit oestrus once per month after calving. The mating season lasts for six months from January to June, therefore calving occurs in the following October to March, over the hot/wet season. A neighbour's bull is used for mating, and there is no particular breed preference for sires. Cow behaviour is the common method used by farmers for oestrus detection. Each cow goes to the bull some 1.3 times before conceiving. Heifers calve at two years and ten months of age, with subsequent calvings intervals of 1.5 years.

Various methods for feeding calves can be used by farmers. In the most common system the dam and calf are separated a few days or weeks after birth and they are together only at milking time. The calf is always present at milking to calm down its mother and stimulate milk let-down. The number of times a calf is fed and the quantity can vary from one to two quarters, once or twice per day. No preference is given to either the male or female calves. No concentrates or milk subsititues are fed to supplement the calf's diet up to weaning. Natural weaning occurs from seven to 12 months or when the cow stops lactating. Heifer calves are reared as cow replacements. Male calves are reared and trained as working bullocks, to be sold or to be kept to replace an older animal.

The length of lactation is typically 12.5 months, with variations from lactation to lactation probably occurring due to time of calving in the year, age of dam and general status of the animal. Milk production per farm on a typical day is 13 litres. Four litres (31%) of milk is consumed as boiled

milk. The remaining nine litres (69%) is processed into ghee, butter and curd. All milking is done by hand.

The cow(s) are tethered day and night. During the day they are fed on mixed foliage away from the farm, nothing is fed at night. Throughout the sugar cane harvesting season cane tops are fed to cattle as part of their daily diet. No form of supplementation is received by stock.
A veterinary officer visits the farm once a year to test all livestock for tuberculosis and brucellosis, and give them a general check for other animal health problems. No charge is levied for this visit. Drenching cattle against internal parasites is the only preventative measure used by farmers and is done at the farmer's cost.

Section 2: Estimates of milk production on a 'typical' farm.

1. The average milk yield per cow is 8.4l/day.

2. 4600l milk/year is produced by two cows on a 'typical' farm.
Assumptions and calculations:
The average length between calvings is 1.5 years, and each cow has an average lactation length of 12 months. Therefore each cow has 1.5 lactations every two years.
365 days x 1.5 = 547days per lactation
or 274d/year/cow.
The average total milk production per cow per year is therefore:
8.4l/cow/day x 274 days = 2300l/cow/year
Since, two cows are owned then, 4600l/year/farm is produced.

3. 6.3l/d of milk is produced per cow.
Assumptions and calculations:
2300l/c/yr ÷ 365 days = 6.3l/c/d

4. 16.8l/day of milk is produced from the two cows owned.
Assumptions and calculations:
8.4l/day/cow x 2 = 16.8l.

Section 3: Quantities of milk consumed and processed, and the imputed market value of this product on a 'typical' farm.

1. Quantities of 1426l and 3174l of milk are consumed as boiled milk and processed products, respectively.
Assumptions and calculations:
A percentage split of 69:31 for respective quantities of milk processed to boiled.
6130l x 69% = 3174l processed/year
6130l x 31% = 1426l liquid milk/year.

3. 0.72l/day of boiled milk is consumed per person.
Assumptions and calculations:
The 'typical' farm produces 16.8l of liquid milk per day per year, which is split into:
16.8l x 69% = 8.7l processed/day
16.8l x 31% = 3.9l boiled milk/day

The average family size is 5.4 persons per household (Bureau of Statistics, 1988).

The quantity of milk (c) consumed per person in each household is calculated as,
c = (3.9l consumed/household/day) ÷ (5.4 persons/household)
c = 0.72l/person/day.

4. 3.6 bottles of ghee are produced per farm per week.
Assumptions and calculations:
8.7l/day are processed into ghee, butter or curd.
17l of milk is required to produce 750 ml of ghee.
8.7l milk processed x 7days = 60.9l/wk milk processed
or (81.2l/household used for processing/wk) ÷ (17l used for making one 750ml bottle of ghee)
= 3.9 bottles of ghee equivalent processed each week.

5. 187 bottles of ghee per year are produced per farm.
Assumptions and calculations:
Assuming that 3174l/year of milk is processed into ghee
then, (4230l milk processed/year/ farm) ÷ (17l used for processing one 750ml bottle of ghee)
= 187 bottles of ghee equivalent processed per year.

6. Per capita MFE consumption per person per year is 11.6kg.
Assumptions and calculations:
The quantity of milkfat equivalents (MFE) consumed per person per year is calculated using a 4.4%

milkfat test and a daily liquid consumption of 0.72l/person.
1 litre milk is approximately equal to 1 kg milk
So, 0.72lmilk consumption/hd/d = 0.72kg/hd/d of milk consumption
720g/hd/day of milk consumption x 4.4% milkfat = 31.7g/hd/d of milkfat consumption or,
31.7g/hd/day x 365 days = 11.6 kg MFE/hd

7. The per capita consumption of protein from milk is 10.5kg/year.
Assumptions and calculations:
The quantity of protein consumed per person per year is calculated using a protein concentration of 40g/litre of milk, or 4% protein content, from the 0.72l of milk consumed per person per head per day.
Therefore, 0.72kg/hd/day x 0.04 = 28.8g/hd/day of protein.
So, 28.8g/hd/day x 365 days = 10.5kg protein/year

8. All money is expressed in Fijian dollars (F$).

9. The equivalent imputed market value for liquid milk from a 'typical' farm is F$1412/year.
Assumptions and calculations:
The retail price of Rewa long life milk was F$0.99/litre (Suva, February 1991).
1426l/year is consumed as boiled milk.
So, 1426l/year x F$0.99/l = F$1411/year.

10. F$701/year is the market value for ghee produced on the 'typical' farm.
Assumptions and calculations:
The market price for ghee is F$3.75/750ml. (The price of ghee varies according to the producer for instance, the farm gate prices are estimated to be F$5.00-6.00/750ml bottle whereas, the retail price of imported New Zealand ghee was F$3.75/750ml (February 1991). This latter price will be used in following calculations.)
187 bottles (750ml) of ghee processed per year per farm.
So, 187 bottles x F$3.75/bottle = F$701/year

Section 4: Cost of owning cattle on a 'typical' farm.

1)The variable costs associated with owning two cows is F$40/year.
Assumptions and calculations:
The farmer only purchases drench for the cows to combat intestinal worms. the price spent per cow is estimated at F$20. Two cows therefore, cost F$40/year.

2) The cost of feeding and rearing calves is assumed to be equivalent to the price received when they are sold.

3) The working bullocks are classed as part of the cropping enterprises as they are use for land preparation and cultivation purposes. Therefore, the cost of owing a pair of working bullocks is assumed to be absorbed within the crop enterprises.

Section 5: Assumptions used to calculate the production of commercial and subsistence crops on a 'typical' farm.

1) Area and type of crops grown, the median area is used to provide a more representative value of the sample.

Table 1. Areas of each crop grown on a 'typical' farm.

Type of crop grown	Median area (ha)
Sugar cane	3.2
Dryland rice	0.4
Assorted vegetables	0.2
Mixed foliage	0.6
Total farm area	4.4

The sugar cane crop cycle is three and a half to four years long, in the following manner:
Plant cane -> first crop (≈15 months) -> first ratoon (≈27 months) -> second ratoon (≈39months) -> replanting of new cane.
MPI (1990) reported the time to maturity as 14-18 months for a planted crop and 12 months for a ratoon crop.
It is assumed therefore that one third of the area in sugar cane is a plant crop and the remaining

two thirds is a ratoon crop.
Therefore, 3.2ha ÷ 3 = 1.06ha plant crop so,
3.2 - 1.06ha = 2.14ha ratoon crop

2) The price paid by farmers for the harvesting of cane is F$7.50/tonne cut.
The farm family provides the majority of farm labour. The main times of the year when labour is limited are:

- May to January for sugar cane harvesting;
- October to January for rice harvesting and weeding of sugar cane.

Casual labour is employed for one to three months, seven days a week usually for harvesting cane.

3) A price of F$48/tonne was received by farmers in the Western Division for fresh/green sugar cane (Nand, D. (MPI extension officer) personal communication, February 1991).

4) Yields of sugar cane.
MPI (1990) quoted yields of 62tonnes/ha for a plant crop, and 50tonnes/ha for a ratoon crop.

5) A price of F$0.35/kg for rice is received by farmers (MPI, 1990).

6) Yield of rice sold.
A traditional crop of dryland rice yields between 1.5 to 2 tonnes/ha for one season (MPI, 1990). In this case 1.75tonnes will be the assumed yield.

It is also assumed that home consuption of rice and seeds for the next crop are supplied from the previous harvested crop. The remainder is sold. Chandra (1982) reported that an Indian adult (from the Sigatoka Valley) consumed 106kg of rice per year. Therefore if there are 5.4persons/household it is assumed that an equivalent amount of rice for four Indian adults is eaten per household.
That is, 106kg x 4 ≈ 420kg/rice consumed/year.

MPI (1990) reported a seeding rate of 90kg/ha of rice. This figure will be assumed as the seeding rate in the budget for 0.4ha of dryland rice.

7) A mixture of vegetable crops is grown for subsistence purposes by the farm family. Vegetable crops such as, egg plants, English and Chinese cabbage, chillies, cucumber, pumpkin, tomatoes and green beans are grown varying proportions within 0.2ha of a 'typical' farm.
The quantities consumed per household are estimated from studies done by Chandra (1982) on the levels of consumption in a Indian settlement. The quantities consumed annually for subsistence crops are shown in the following table. The average of 5.4 persons/household is assumed to be equivalent to 5 Indian adults per farm household.

Table 2. The types and quantities of subsistence crops consumed on a 'typical' farm.

Vegetable type	Quantity consumed/year	
	Per adult (kg)	Per family (kg)
Egg plants	40	200
Green beans	28	140
English cabbage	10	50
Chinese cabbage	10	50
Chillies	0.7	3.5
Tomatoes	12	60
Pumpkins	7	35
Cucumber	5	25

The average annual market price for vegetables is estimated from MPI's January 1990 figures. There are no input costs such as fertiliser or herbicides for the subsistence crops.

Section 6: Calculations for the budget of a 'typical' farm in the Western Division of Viti Levu.

A. Commercial crop revenue:

Sugar cane:

Plant crop: 1.06 ha @ 62 t/ha = 65.7 t
Ratoon crop: 2.14 ha @ 50 t/ha = 107 t
Total yield = 172.7 t
Total area in crop = 3.2 ha
Price received for harvested cane = F$48/t

Rice:

Yield = 1.75 t/ha
Area in crop = 0.4 ha
Total yield = 700 kg
Consumption/year/hshld = 530 kg
Seed for next crop = 90 kg x 0.4 ha = 36 kg
Quantity for selling = 700-530-36 = 134 kg
Price received for rice = F$0.35/kg

B. Commercial crop expenditure

(Please refer to the MPI Farm Management Manual (1990) Chapter 9 for the source of the following figures)

Sugar cane: (A) Plant crop (1.06 ha):

1. Plant crop.
Seed cane to plant @ 5 t/ha costing F$26/t.
Each year 1.06 ha is planted therefore 1.06 ha x 5 t/ha x F$26/t = F$137.80

2. Fertiliser.
Ammonium sulphate @ 750 kg/ha, F$13.25/50 kg x 15 bags x 1.06 ha = F$210.68
Superphosphate @ 500 kg/ha, F$13.25/50 kg x 10 bags x 1.06 ha = F$140.45
Nitrate of potash @ 250 kg/ha, F$17.00/50 kg x 5 bags x 1.06 ha = F$90.10

3. Herbicide - cane spray.

Three applications per year @ F$27.51/ha therefore,

3 x F$27.51/ha x 1.06 ha = F$87.48

4. Harvesting cane.

Labour costs: F$7.50/t.

Plant crop yield = 65.72 t/ha @ F$7.50/t = F$492.90/ha

5. Transportation of cut cane

65.72 t @ F$5/t = F$328.60

Sugar cane : (B) Ratoon Crop (2.14 ha):

1. Fertiliser.

Ammoniun sulphate @ 750 kg/ha, F$13.25/50 kg x 15 bags x 2.14 ha = F$425.33

Superphosphate @ 250 kg/ha, F$13.25/50 kg x 5 bags x 2.14 ha = F$141.78

Nitrate of potash @ 125 kg/ha, F$17.00/50 kg x 2.5 bags x 2.14 ha = F$90.95

2. Herbicide - cane spray.

Three applications per year @ F$27.51/ha therefore,

3 x F$27.51/ha x 2.14 ha = F$176.61

3. Harvesting.

Labour costs: Ratoon crop yield = 107 t x F$7.50/t = F$802.50

4. Transportation of cut cane.

107t @ F$5/t = F$535.00

Rice (0.4 ha):

No costs.

C: Subsistence crop revenue (from imputed market prices)

F$572 is the equivalent market value to the farm growing subsistence crops its own consumption.

Table 3. The annual monetary value of subsistence crops consumed on a 'typical' farm.

Vegetable type	Amount consumed per family (kg)	F$/kg	Total F$/year
Egg plants	200.00	0.50	100.00
Green beans	140.00	1.70	238.00
English cabbage	50.00	1.50	75.00
Chinese cabbage	50.00	0.35	17.50
Chillies	3.50	1.00	3.50
Tomatoes	60.00	1.50	90.00
Pumpkins	35.00	1.00	35.00
Cucumber	25.00	0.50	12.50
Total			571.50

Section 7: A 'typical' farm budget

A. Commercial crops:

Rice (0.4ha)

Crop Revenue:

Rice	134kg @ $0.35/kg	46.90

Crop Expenditure:

	Cost ($)
None	0.00

Total ($)	46.90
Total ($/ha)	18.76

Sugar cane (3.2ha)

Crop Revenue:

		Income ($)
Sugar cane	172.7t @ $48/t	8289.60

Crop Expenditure:

		Cost ($)
Plant crop (1.06ha):		
Seed cane	5t/ha @ $26/t	137.80
Fertiliser	Ammonium sulphate @ 750kg/ha	210.68
	Superphosphate @ 500kg/ha	140.45
	Nitrate of potash @ 250kg/ha	90.10
Herbicide	$27.51/ha 3x/yr	87.48
Transport	65.72t @ $5/t	328.60
Labour	harvesting 65.72t @ $7.50/t	492.90
Plant costs:		1488.01
Ratoon crop (2.14ha):		
Fertiliser	Ammonium sulphate @ 750kg/ha	425.33
	Superphosphate @ 250kg/ha	141.78
	Nitrate of potash @ 125kg/ha	90.95
Herbicide	$27.51/ha 3x/yr	176.61
Transport	107t @ $5/t	535.00
Labour	harvesting 107t @ $7.50/t	802.50
Ratoon costs:		2172.17
Sub-total		3660.18

Total ($)	4629.42
Total ($/ha)	1446.69

B. Subsistence crops:

Vegetables (0.2ha)

Crop Revenue:

		Income ($)
Egg plants	200kg @ $0.50/kg	100.00
Green beans	140kg @ $1.70/kg	238.00
English cabbage	50kg @ $1.50/kg	75.00
Chinese cabbage	50kg @ $0.35/kg	17.50
Chillies	3.5kg @ $1.00/kg	3.50
Tomatoes	60kg @ $1.50/kg	90.00
Pumpkins	35kg @ $1.00/kg	35.00
Cucumber	25kg @ $0.50/kg	12.50
Rice	530kg @ $0.35/kg	185.5
Sub-total ($)		757.00

Crop Expenditure:

	Cost ($)
None	0.00

Total ($)	757.00
Total ($/ha)	151.40

C. Total crop budget for a typical farm

Sugar cane (3.2ha):

Total ($)	4629.42
Total ($/ha)	1446.69

Rice (0.4ha):

Total ($)	46.90
Total ($/ha)	18.76

TOTAL BUDGET FOR COMMERCIAL CROPS (3.6ha):

Total ($)	4676.32
Total ($/ha)	1298.98

Subsistence crops (0.2ha):

Total ($)	757.00
Total ($/ha)	151.40

TOTAL BUDGET FOR ALL CROPS (3.8ha):

Total ($)	5433.32
Total ($/ha)	1429.82

D.Total budget for the two cow enterprise

		Income ($)
Liquid milk	1426l/yr @ $0.99/l	1412
Processed milk	187 bottles @ $3.75/bottle	701
Sub-total		2113

		Cost($)
Animal health	$20/cow/year	40
Sub-total		40

Total ($)	2073

Section 8: Assumptions and calculations of the farm labour component (man days) for crop and cow enterprises on the 'typical' farm.

A. Commercial crops:

Sugar cane; Plant crop (1.06 ha):

1. Land preparation takes 20 man-days.

Assumptions and calculations:

Prepare land: 10 days

Cultivate land: 10 days

2. 5 man-days are required for cleaning and weeding.

3. 1 man-day for fertiliser application.

4. 3 man-days for herbicide application.

Assumptions and calculations:

Three applications are made per year.

1 man-day is required per hectare.

Sugar cane; Ratoon Crop (2.14 ha):

1. 11 man-days are required for cleaning and weeding.

Assumptions and calculations:

It takes 5 man-days for 1ha so, for 2.14ha it takes

2.14ha x 5man-days = 11 man-days.

2. 2 man-days are required for fertiliser application.

Assumptions and calculations:

It takes 1 man-day for 1ha so, for 2.14ha it takes

2.14ha x 1 man-day = 2 man-days.

3. 6 man-days are required for herbicide application.

Assumptions and calculations:

It takes 1 man-day for 1ha with three applications per year so, for 2.14ha it takes, 2.14ha x 3 x 1 = 6 man-days

Rice (0.44ha)

1. Labour costs per hectare:
Cultivation = 10 man-days
Planting = 5 man-days
Weeding = 5 man-days
Harvesting = 8 man-days
Stacking = 5 man-days
Threshing = 8 man-days

A total of 41 man-days/ha. However, only 0.4 ha are planted.
Therefore, 41 man-days x 0.4 ha = 16 man-days used in rice production.

B: Subsistence crops.

137 man-days per year are utilised by the subsistence crops.
Assumptions and calculations:
Three hours per day is spent in the 0.2ha plot of assorted vegetables.
So, 3hrs/day x 365 days = 1095 hrs/year.
A man-day is 8 hours of work per day.
Hence, (1095 hours/year) ÷ (8 hours per day) = 137 man-days/year.

C: Cow production

The main cost incurred by owning a cow is labour, which is supplied by the farm family. It is assumed that the same amount of time is needed to take the cow(s) to the grazing place irrespective of whether one or two cows are owned. The average milking time of 30 minutes has been averaged out over all the survey farms.

1. Milking two cows utilises 23 man-days per year.
Assumptions and calculations:
Each cow takes 10-15 minutes to milk so for two cows 30 minutes/day is required hence, in one year 182 hours are utilised in milking the cows.
(182 hours/year) ÷ (8 hours/day) = 23 man-days spent milking two cows.

2. Feeding two cows occupies 41 man-days.

Assumptions and calculations:

The effect of season upon feed availbility is accounted for in the following ways:

a) During the wet season it is assumed that there is plenty of feed available. For 6 months of the year approxmately 40 minutes per day is used for taking the cows to their grazing spot during the day. Nothing is fed at night.

So, 40mins/day is equal to 4hours/5days.

6 months = 182 days so,

(182 days x 4hrs/day) ÷ (5 days) = 145.6 hrs/6mths

Therefore (145.6 hrs/6mths) ÷ (8 hrs/day) = 18 man-days.

18 man-days are utilised during the wet season for feeding the cows.

b) During the dry season however, the quantity of feed available is assumed to be even less, so limiting the cows diet. The cows are still tethered during the day but it is assumed that the average length of time required to take and collect the cows each day is longer. Hence an average figure of one hour per day

1 hour/day for 183 days (6months) is 183 hours.

So, (183 hrs/6mth) ÷ (8hrs/day) = 23 man-days.

23 man-days are required during the dry season for feeding the cows.

A total of 41 man-days are utilised feeding the cows.

3. Processing of milk products requires 23man-days per year.

Assumptions and calculations:

On average 30 minutes/day is spent processing liquid milk into products such as ghee and butter.

So, 30 mins/day is equal to 1 hour/2 days, therefore in one year 182 hours are utilised by the processing of milk products.

(182 hours/year) ÷ (8 hours/day) = 23 man-days spent processing milk from two cows.

Section 9: Return to labour (F$/man days) of the crop and cow enterprises to the 'typical' farm.

1. Return to labour ($/man day) from the crop enterprises.

	Number of man-days
A: Commercial crops	
Sugar cane:	
Land preparation	20
Cleaning/weeding	16
Fertiliser	3
Herbicide	9
Rice:	16
Sub-total	64
B: Subsistence crops	
Assorted vegetables	137
TOTAL	201

TOTAL BUDGET FOR ALL CROPS (3.8ha):

Total ($)	5433.32
Total ($/ha)	1429.82

F$/MAN-DAY FROM THE CROP SYSTEMS

F$5433.32/201man-days =	F$27.03

2. Return to labour from the cow enterprise.

Task:	Number of man-days
Milking	23
Feeding	41
Processing	23
TOTAL	87

TOTAL BUDGET FROM COW PRODUCTION

Total ($)	2073

F$/MAN-DAY FROM THE COW SYSTEM

$2775/87man-days =	$23.83

APPENDIX 12: Recommended allowances of reference protein and US dietary protein.

Category	Age (years) or Condition	Weight (kg)	Derived Allowance of Reference Protein[a] (g/kg)	(g/day)	Recommended Dietary Allowance (g/kg)[b]	(g/day)
Both sexes	0–0.5	6	2.20[c]		2.2	13
	0.5–1	9	1.56		1.6	14
	1–3	13	1.14		1.2	16
	4–6	20	1.03		1.1	24
	7–10	28	1.00		1.0	28
Males	11–14	45	0.98		1.0	45
	15–18	66	0.86		0.9	59
	19–24	72	0.75		0.8	58
	25–50	79	0.75		0.8	63
	51+	77	0.75		0.8	63
Females	11–14	46	0.94		1.0	46
	15–18	55	0.81		0.8	44
	19–24	58	0.75		0.8	46
	25–50	63	0.75		0.8	50
	51+	65	0.75		0.8	50
Pregnancy	1st trimester			+1.3		+10
	2nd trimester			+6.1		+10
	3rd trimester			+10.7		+10
Lactation	1st 6 months			+14.7		+15
	2nd 6 months			+11.8		+12

[a] Data from WHO (1985).

[b] Amino acid score of typical U.S. diet is 100 for all age groups, except young infants. Digestibility is equal to reference proteins. Values have been rounded upward to 0.1 g/kg.

[c] For infants 0 to 3 months of age, breastfeeding that meets energy needs also meets protein needs. Formula substitutes should have the same amount and amino acid composition as human milk, corrected for digestibility if appropriate.

Source: National Research Council (1989: Table 6-4)

APPENDIX 13: Outline of a project to undertake further studies of non-commercial dairy producers in the Western Division of Fiji.

Aim of the project:

To undertake low cost field studies with non-commercial dairy farmers in the Western Division of Fiji of a type and for a period which will allow the resource bases, objectives and activities to be specified and will allow the essential production dynamics of the system to be established. The study will take due account of the soils, plants and crops, animals and farmers and their families in the system. A basic understanding of the target system should be achieved through intensive, longitudinal (multivisit) field investigations by a general agriculturalist over a 12 month production cycle. Support of an interpreter may be required. The findings of the study should significantly enhance the opportunity to evaluate the benefits to be derived from further research and extension to improve the system.

Duration of and target area for the project:

Two areas in the Western Division of Viti Levu are selected to test the conclusion of the Votualevu study in 1991 that all non-commercial dairy farmers in the Division can be treated for research and extension purposes as they are in one recommendation domain. The two areas for research are therefore; a) In Votualevu, and b) another area within 20km radius of the Votualevu area which has smallholder non-commercial dairy production systems. The field studies would be carried out over a 12 month period.

Number of farmers to be surveyed:

Twenty farmers in each of the two targeted areas would be surveyed. The investigator should aim to visit three farmers per day when in the field, with each visit lasting approximately 1.5 hours. A 'typical' day could therefore incorporate about 4.5 hours of farm visits with the remainder spent collating and analysing data collected from that day. Each farmer should be visited at monthly intervals. The investigator would need to be in the field for approximately 15 days each month.

Ministry support:

Ministry backing for this research would be required. Transport to and from the field for farmer visits would be needed. Depending on the skills of the appointee, an interpreter may be required. Portable (electronic) scales would be needed to capture accurate liveweight data, as would sampling bags and basic analytical support for plant identification and evaluation. The availability of veterinarians or animal health specialists for occasional consultation on diseases and selected problems would be necessary. Regular reports on the project would be made through the year to Government officials, agricultural researchers, extension and education personnel. A four month reporting cycle to these groups would be appropriate.

Nature of the field studies

An exploratory survey of farmers in both areas selected for study is recommended. This will not be a simple repetition of the exploratory survey reported in the main body of this thesis, because that study has already identified many strengths and weaknesses of the existing system, which would influence the conduct of the exploratory survey. Further, the recommended exploratory surveys should be done with field equipment (including portable electronic beam scales) which will allow for better quantification of the farm situation than was possible in the first study in Votualevu. The exploratory survey would be followed by monthly visits to each farmer to provide the data and understanding necessary to allow the annual dynamics of the system to be quantified.

The exploratory surveys:

An initial exploratory survey of the whole farming system would be required to find out general farm data such as, farm area and land type, land tenure and use (including estimates of area of each crop), soils and climate, livestock owned and herd composition by age and sex, and labour supply and general mode of use. A rough farm map should be sketched to familiarise the interviewer with the farm and use of land. General information on the role of cattle on the farm, animal husbandry and management techniques such as calf rearing, animal health, mating, nutrition and milk production need to be recorded. Finally, details of the reproductive histories and milk yields of all cows in each herd should be gathered. Following this exploratory survey the issues addressed in the next section need to be applied to this situation, enabling similar data to be collected.

The following provides suggestions of the type of information to be gathered in the exploratory surveys:

Farmer name

Family: (numbers, age and gender, nuclear or extended family.)

Location: (Farm area (ha); Land tenure; Soils and topography; Climate.)

Land use: (Farm map showing location and area of crops, water supply and boundaries.)

Livestock owned: (numbers; gender; age; purpose for ownership; method of identification.)

Labour supply: (numbers of permanent, casual and family labour; who does what; off-farm employment; When are casual labour employed)

Cow history: (status (milking, pregnant, dry) of heifers and cows; age; stage of lactation; number of calves born previously; milk yield; calving interval.)

Calf rearing: (sex preference; feeding policy; age at weaning; fate.)

Animal health: (diseases; preventative methods.)

Mating: (heat detection; frequency and duration of oestrous; date of last mating; number of services per pregnancy; age at first calving; bull preference; ownership of bull; location of bull used.)

Feeds and feeding: (general policy for feeding e.g tethering; supplementation; crop residues.)

Milk production: (estimate milk yields; total length of lactation; current stage of lactation; milking methods e.g. hand, presence of calf; how often the cow(s) is (are) milked; fate of milk; levels of milk consumption.)

Follow-up monthly visits:

On each visit to a farm the following data should be collected and updated:

Date; interviewee; farmer; season.

Crop production: (Basic cropping activities, inputs and outputs since last visit.)

Livestock owned: (Births, deaths, sales, purchases, other transactions.)

Livestock Production: (Visually assess and condition score stock; record animal liveweights and current grazing place and daily management regime.)

Milk production: (status; stage of lactation; yield; number of times per day the cow is milked; visits are preferably at milking time on occasion to record the actual quantities milked; method of milking; fate of milk, quantities boiled, processed and sold or given away; quantities consumed by farm family.)

Feeds/nutrition: (identify plants used/not used by animals; record supplementation and crop residues, and quantities and types consumed; specify animal and grazing management e.g. tethering, free grazing; fed at night, types and quantities/availability of water during the day, labour use.)

Mating/fertility: (when the cow(s) were last on heat; duration; whose bull was used; visual sighting of the bull; distance from farm to the bull; time spent with the bull; date(s) of mating.)

Calf rearing: (feeding, number of quarters fed and for how long; number of times fed per day; sight calves to identify feedstuffs they may be eating during the day, where they are located in relation to the dam; fate of calves.

Labour supply and use: (For family labour and hired or casual labour; payments; use. etc.)

Animal health: (Problems, actions, costs, effects etc.)

These detailed data would be complemented by general observations made during each visit.

Expected products of the Project

- Detailed information of the whole farming system with emphasis upon the role and productivity of one or two cow herds. Interactions between the cattle and crop systems will be assessed.
- Identification and evaluation of the relative importance of the different plants and feeds to the farming system in each season.

- Records of cow condition scores and weight change over the year, facilitating the estimation of the relationships between grazing regime, animal growth, milk production and fertility.
- Knowledge of the changes in and the sources and reasons for the changes in animal inventories.
- Knowledge of the traditional calf rearing systems and the potential for mitigating the competitive aspects of milk offtake for calf use and family use.
- Knowledge of the productivity of the cattle in the systems and the opportunities (if any) of affecting improvements to the system.
- Labour use by season for the crop and livestock subsystems.
- Identification of the scarce resources in these systems by season and the impact of that scarcity on the performance of the overall system.
- Improved understanding of farmers' goals for their crop and livestock subsystems and estimates of the production potential of these smallholder dairy systems under different technology and policy scenarios.
- Evaluation of the likely value to producers and cost to the State of expanded Government support for smallholder non-commercial dairy producers in the Western Division.

Farm Production & Practice

Ministry of Agriculture and Fisheries

Dairy Cattle Condition Scoring

How to do it

Dairy cows which calve in good condition and are then well fed after calving give good milkfat production. Condition scoring is a quick and easy method by which farmers can ensure their cows are in fact in the right condition at the right time.

In the first 2–3 weeks after calving, dairy cows cannot eat enough feed to satisfy their requirements. Cows in good condition can use body-fat reserves to compensate for this 'under-feeding' and to provide extra energy for high production. Using condition scoring, farmers can decide on the most suitable conditon for their cows at calving and the feeding management to achieve this

Condition scoring

Condition scoring is a visual assessment of the fatness of an animal. The fat cover over the backbone, hips, ribs, and around the base of the tail, and the prominence of the pinbones are assessed by eye, and each animal is then given a score ranging from one to eight. A score of 1 indicates a very thin and emaciated animal; a score of 8, a very fat animal. On most farms cows range from score 3 to score 6.

Condition scoring requires no capital outlay, involves little time and, unlike weighing, is independent of gut fill, cow size, and stage of pregnancy.

When to condition score

Dairy farmers are to some extent aware of their cows' condition every day. However, a positive approach to cow condition should start in the autumn, when decisions on drying off and feeding ultimately have to be made to achieve a desired condition at calving.

Thinner cows, especially young cows, may be dried off early. It is difficult to prevent condition loss on high producing cows, and these need to be fed well while dry so as they can regain lost condition before calving.

During late pregnancy it is more difficult to improve condition because more feed is used for the growing foetus.

Condition scoring at least fortnightly during the autumn and winter will give a reasonably accurate indication of the herd's condition. Then, in conjunction with regular feed assessments, feeding can be managed to achieve whatever targets are set for calving, preferably score 5–6.

Hints on condition scoring

- Assess only fat cover on backbone, hips, ribs, and around base of tail.
- Do not let gut fill or animal size influence the score. It is best done after the morning milking.
- It is best to let each cow walk past in a race, the assessment being made from the rear.
- Do not ponder over each score – think quickly and write the score down.
- Do not have the previous scores visible.
- When making feeding decisions do not complicate management by splitting the herd into several feeding groups – two or three is ample. Some cows are always thin or always fat. Consider the overall herd condition foremost.

Cost of gain in condition

To improve a cow's condition by one score (a gain of approximately 30 kg live weight) 150–200 kg of pasture dry matter is required. This is equivalent to:

- 10–13 bales of hay.
- 1 t of silage.
- 150–200 kg of meal.
- 4–6 weeks of pasture feeding to appetite.
- Pasture growth reponse to 40 kg of urea.

Return from gain in condition

The benefits of improving body condition (up to score 6) by one score at calving are:

- An extra 5–10 kg of milkfat/cow.
- An increase in milkfat test of up to 0.3% in early lactation.
- A reduction of up to 6 days in the calving to first oestrus interval.
- Generally healthier cows.
- Benefits of extra condition at calving may be greater for lower genetic merit cows than for high genetic merit cows.

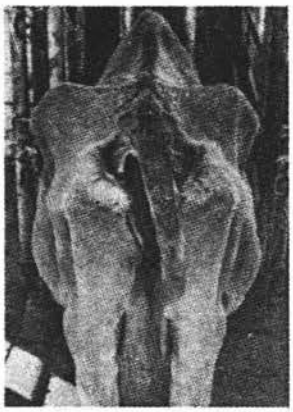
Summary

Wintering a dairy herd consists of allocating feed (pasture and/or supplements) so as cows calve in a desired condition and have sufficient saved pasture to feed the herd adequately in early lactation. There are many combinations of grazing rotations, supplement feeding, and drying off dates to achieve a "successful" wintering. Regular condition scoring and feed assessment during the autumn and winter will help management decide on the best combination.

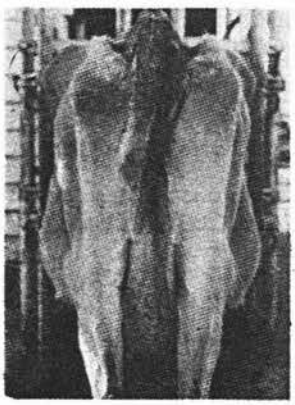
agink FPP 498 *1st revise 3/3000/9/84* Information Services, MAF, Private Bag, Wellington, N.Z.

How to score body c

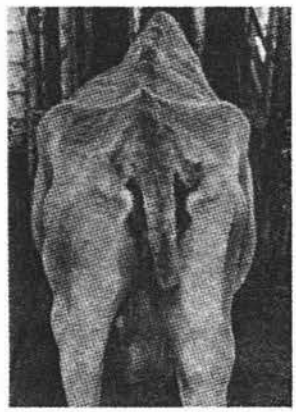
Score 1



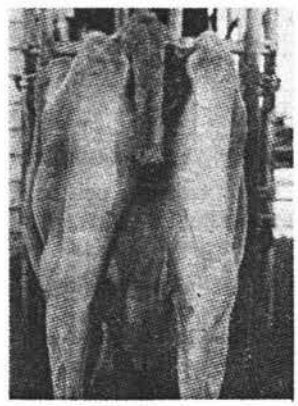
Little flesh over the skeleton. Backbone is sharp and is a very prominent ridge. It is very easy to feel individual lumbar vertebrae. The shape of each short rib can easily be felt.



Score 2

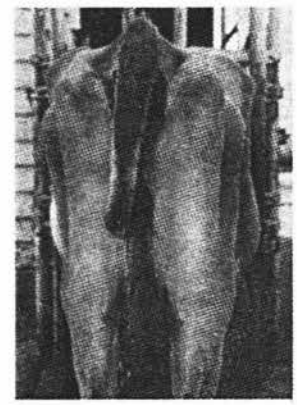


Area around base of tail is deeply sunken in. Backbone is a prominent ridge. Hips and pins are very prominent. The shape of the ends of the short ribs can be easily felt. It is easy to feel between the tops of the short ribs.

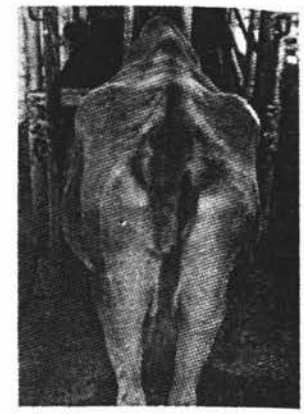


Score 3

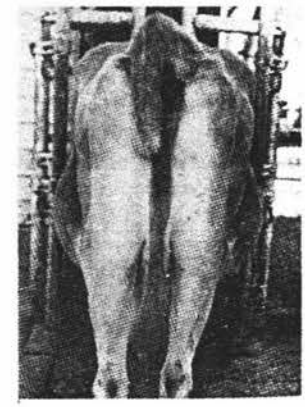
Area around base of tail is sunken in. Backbone is a prominent ridge. Hips and pins are prominent. The ends of the short ribs can be easily felt. It is possible to feel between the tops of the short ribs with pressure.



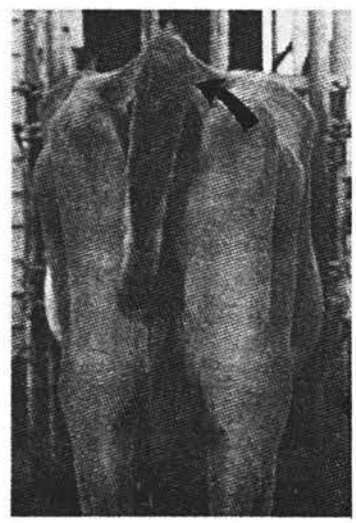
Score 4



Area around base of tail is only slightly sunken in. Backbone is a raised rounded ridge. Slight fat covering over pins, hips and short ribs. The ends of the short ribs can be felt and are rounded. It is not possible to feel between the tops of the short ribs.



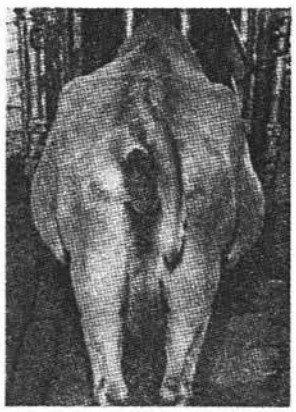
The indicators



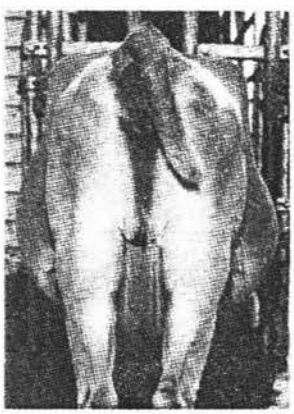
Amount of fat around base of tail and prominence of pin bones.

ition of dairy cows

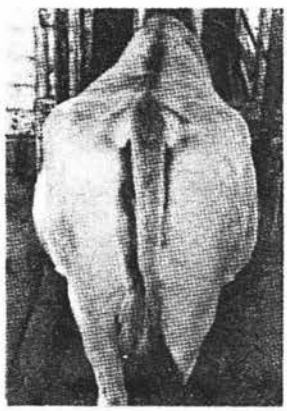
Score 5



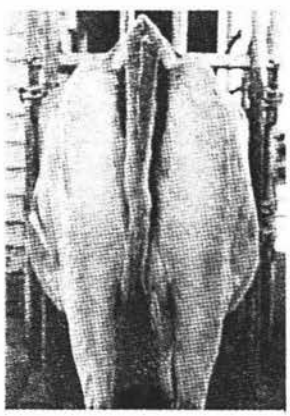
Area around base of tail is almost filled out. Backbone is a rounded ridge. Even fat covering over pins, hips and short ribs. Only some of the short rib ends can be felt. It is not possible to feel between the tops of the short ribs.



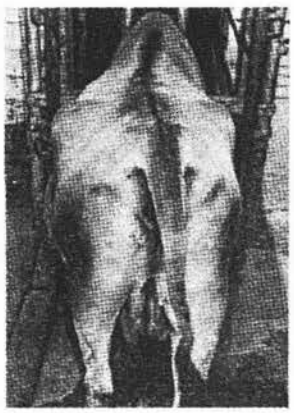
Score 6



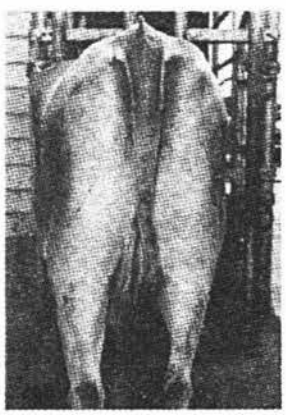
Area around base of tail is filled out. Back is rounded across the loins. Cannot feel the ends of the short ribs or between the tops of the short ribs. Tailhead is still prominent.



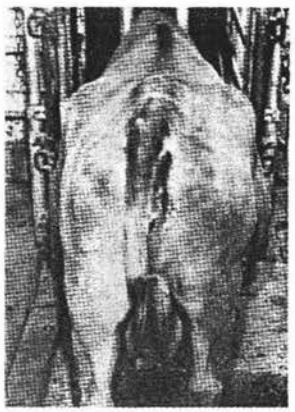
Score 7



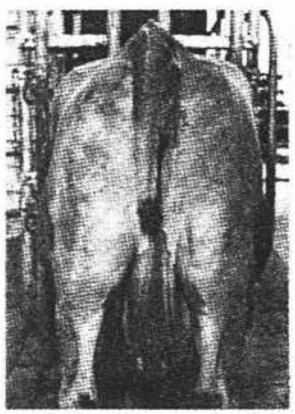
Back is flat across the loin. Backbone can only be felt by pressing down firmly. Cannot feel short ribs. Hips are well rounded. Tailhead is a rounded ridge with some folds of fat either side.



Score 8



Backbone is covered by a thick layer of fat and cannot be felt. Cannot feel short ribs. Hips are no longer obvious. Tailhead has large folds of fat on either side.



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