

PN-AAP-355

ISN 33566

REPORT TO THE

MINISTRY OF AGRICULTURE AND FISHERIES

**FIJI**

**A Review of the  
Agricultural Research Division**

***ISNAR***

International Service for National Agricultural Research

The International Service for National Agricultural Research (ISNAR) began operating at its headquarters in The Hague, Netherlands, on September 1, 1980. It was established by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force, for the purpose of assisting national governments in strengthening agricultural research. It is a non-profit autonomous agency, international in character, and non-political in management, staffing, and operations. Most of its funds are provided by an informal group of approximately 30 donor countries, development banks, foundations, and other international organizations which make up the CGIAR.

ISNAR is the youngest of the 13 centers in the CGIAR network, and it is the only one which focuses primarily on national agricultural research issues. It provides advice to governments, upon request, on organization, planning, manpower development, staff requirements, financial and infra-structure requirements, and related matters, thus complementing the activities of other assistance agencies. Additionally, ISNAR has an active training and communications program which cooperates with national agricultural research programs in developing countries.

ISNAR also plays an active role in assisting these national programs to establish links with both the international agricultural research centers and donors.

**Citation:**

International Service for National Agricultural Research. 1982. The Organization and Program for Crops Research in Papua New Guinea. The Hague, Netherlands.

ISNAR R10

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**September 1982**

***isnar***

**International Service for National Agricultural Research  
The Hague, Netherlands**

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## List of Acronyms

ADAR	Assistant Director Agriculture (Research)
ADAB	Australian Development Assistance Bureau
ADAE	Assistant Director Agriculture (Extension)
AVRDC	Asian Vegetable Research Development Center, Taiwan
MAF	Ministry of Agriculture and Fisheries
CIP	International Potato Center, Peru
CPO	Central Planning Office
CSIRO-CIRC	Centre for International Research Cooperation, CSIRO, Australia
DA	Department of Agriculture
DP8	Development Plan 8
GDP	Gross Development Product
GADP	Gross Agricultural Development Product
EPS	Economic Planning and Statistics Division
FAO	Food and Agriculture Organization (of the United Nations)
FCA	Fiji College of Agriculture
FPC	Fiji Pine Commission
FSC	Fiji Sugar Corporation
IARC	International Agricultural Research Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, India
IITA	International Institute of Tropical Agriculture, Nigeria
IRRI	International Rice Research Institute, Philippines
ISWAR	International Service for National Agricultural Research, Netherlands
NMA	National Marketing Authority
NLTB	Native Land Trust Board
ODA	Overseas Development Bureau, United Kingdom
PAO	Principal Agricultural Officer (Office)
PSC	Public Service Commission
UNDP	United Nations Development Programme
USP	University of the South Pacific

# Chapter 1

## Introduction

### 1.1 Origin of the Mission

The review of the agricultural research system of Fiji grew out of a series of discussions between senior officials of the Ministry of Agriculture and Fisheries (MAF), Fiji, and the Director General of the International Service for National Agricultural Research (ISNAR). The review was officially requested by the Permanent Secretary, MAF, in his letter of December 14, 1981 (Ref. no. 35/13), and concurrence was given by the Director General of ISNAR in his letter of December 23, 1981 for ISNAR to cooperate with MAF in Fiji on the review.

Agriculture in Fiji is the mainstay of the economy and is by far the most important component in both the internal and export elements of the economy. Production and export of sugar dominates the economy, with coconuts as another major element. Sugar has maintained constant production in the traditional sugar cane lands, and production has been increased by expansion of cultivated areas. However, coconuts and most other cash crops and the mixed farming sector have not increased production in accordance with expectations. It is because of the importance of the agricultural sector, and concern that it may not be achieving its potential, that MAF requested ISNAR to review its agricultural research system to help determine whether it has the ability — given its present policies, structure, and human, physical, and financial resources — to generate the technology required for agriculture to achieve its potential.

### 1.2 The Terms of Reference

The Terms of Reference were determined on the basis of on-site discussions in Fiji between the Director of Agriculture and the Assistant Director of Agriculture (Research) of MAF and the Director General of ISNAR. These discussions took place in February 1982 and were followed by an exchange of letters between ISNAR and MAF to confirm the terms. It was agreed to have rather extensive Terms of Reference which would assist the ISNAR mission to assure that all major points of concern were investigated, as well as indicate in advance to the Fijian officials who would be contacted during the review what was to be the range of issues so preparatory thought could be given to them.

The Terms of Reference are as follows:

The review is to be carried out in July/August 1982 by a team supplied by ISNAR (International Service for National Agricultural Research) in consultation with the Ministry of Agriculture and Fisheries, Fiji.

1. The Review team will examine the research program of the Research Division which it has developed to meet the national goals and objectives as stated in Fiji's Eighth Development Plan, 1981-1985 and beyond, to make an independent appraisal of the program and its appropriateness and organization, with the specific view to suggest improvements. Specific attention will be given to the following:
  - (a) Study in retrospect the program and organization in terms of progress, special problems, staffing, allocation of resources, research priorities, the impact and appropriateness of external assistance, and dissemination and feed back of research findings to/from user groups, especially extension agents and growers.
  - (b) Study the stated objectives and workplan for the future program and organization to determine their appropriateness to research priorities, staffing, organizational structure, allocation of resources, projected external assistance, and additional external assistance which might be appropriate. The study will give due emphasis to resource allocation among various research sections and commodities to determine its appropriateness in order to meet the stated objectives.
  - (c) Study the suitability and the capability of the present research organization to undertake a multi-disciplinary approach to problem solving, farming systems studies and to evaluate the economics of production systems.
  - (d) In the content of (b) and (c) determine the suitability of the present structure of the Research Division to implement its program. The study will give due emphasis to staff numbers, qualification and experience, staffing and training needs, and maintenance of a satisfactory environment for development of both professional and sub-professional staff.
  - (e) The suitability of its procedures for establishing research objectives; identifying research priorities; planning, monitoring, and evaluating research projects; and modifying research programs in accordance with national agricultural policies.
  - (f) The adequacy of its contact with relevant research institutions or organizations within the country, the South Pacific region and outside the region for exchange of information and ideas. The team will also study the procedures for the transfer of external technologies relevant to local conditions.

- (g) The effectiveness of research links with users of research findings (i.e., extension staff, farmers, etc.) and the effectiveness of the means to evaluate the technology at the farm level.
  - (h) Study the role of communication and information in research and more broadly in the Department of Agriculture, and its organization and effectiveness to serve research, extension, growers, and policy-makers.
  - (i) Study the adequacy of infrastructure for research (buildings, laboratories, equipment, etc.) and supplies and maintenance for existing and projected programs.
  - (j) Study the budget expenditure and reporting process in terms of an appropriate balance between control and ability to act in a timely manner.
  - (k) In regard to livestock research, to review the report prepared by Dr. C.S. Andrew of CSIRO - CIRC of 1979 and to update and broaden it to cover the present and proposed livestock research program.
2. The outcome of the review will be a detailed report on the findings of the review and recommendations to improve the crop research program and organization, particularly in aspects discussed above and in any other aspects which may be noted for consideration during the review.

### 1.3 Form of Report

The report contained in this document will address the issues noted in the Terms of Reference but not on a point-by-point basis. Because of its specific nature in the Terms of Reference, (k) is addressed separately and reported in Annex 2.

The report has an introduction, then three main chapters, plus a concluding statement. The first of these chapters reviews the agriculture of Fiji, the second analyzes the agricultural Research Division, and the third evolves out of the preceding into a set of conclusions and recommendations prior to the concluding statement.

After the main report are a series of annexes which first set forth a general rationale for the role of agricultural research and then take up specific issues which the review team believes are sufficiently important that they are best addressed separately, even though some of the points are included in the main part of the review and analysis.

### 1.4 The Review Team

The team (see Annex 7) which carried out the review, analysis, and preparation of this report in July/August 1982 was composed of four ISNAR staff members and two consultants, representing a range of agricultural discipline specializations. However, they worked together as a team on

all phases of the review, analysis, and report preparation to produce this ISNAR document.

### **1.5 Acknowledgments**

ISNAR, on behalf of all the members of this mission, wishes to acknowledge the outstanding support and cooperation of His Excellency, the Minister of Agriculture and Fisheries, Mr. Jonate Mavoia, the Permanent Secretary, MAF, Mr. Robin Yarrow, the Director of Agriculture, Mr. Navin Patel, and the Acting Director of Agriculture at the time of the mission and Chief Economist, Mr. Kalio Tavola. A special vote of thanks goes to the Assistant Director of Agriculture (Research), Mr. Param Sivan, who played such an important role in all arrangements for the mission and who gave unsparingly of his time.

In all, the ISNAR team members contacted over 150 individuals at all levels in government service, private industry, university, international organizations, and farmers during its field work in July/August 1982. Without exception, the ISNAR team members were met with courtesy, with openness, and full cooperation in discussion of issues and provision of information. The list of individuals met, and who generously assisted the team, is too long to set down; but all who were met and gave of their time and knowledge are most appreciated, for it was only from these contacts and the information provided that the report could be prepared.

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**Chapter 2**

## **The Agriculture of Fiji**

### **2.1 Agriculture in the National Economy**

#### **2.1.1 Some General Characteristics of the Fijian Economy**

Fiji has a small island economy, with a limited domestic market. As a result of an open economy with a high level of trade dependence, internal economic activity is highly sensitive to world market developments. This has an important bearing on the production of its agricultural export sector.

All economic activity is highly dependent on the availability of transport, both between islands and to external markets. The result is that transport represents a large percentage of overall production costs; agricultural production in particular is critically affected.

Finally, the economy is characterized by the co-existence of a large element of subsistence production along with an increasingly developed market economy.

#### **2.1.2 Demographic Development and Employment**

Fiji's total population in 1980 was estimated to be 634,000. Growth rates came down from 3.3% in the fifties and sixties to 2.1% at present.

Migration from the outer islands to the main islands and from rural areas to urban centers has been increasing in recent years. The government is aware of this development and the inherent problems, and it has taken measures to counteract the urban drift. DP8, the national development plan for 1981 to 1985, focuses on the creation of employment opportunities in rural areas where the majority of Fiji's population resides. More than half of all new jobs will be created in rural areas.

The agricultural sector remains an important avenue for productive employment. In 1980, agriculture, including fisheries and forestry, provided employment for some 42% of the total labor force.

#### **2.1.3 The Role of the Agricultural Sector in the Fijian Economy**

The growth performance of the Fijian economy in recent years has been good by any standard. The average annual growth rate of the overall economy for 1968 to 1979 was 6%. This growth is mainly due to the performance of two dynamic sectors: the sugar industry and tourism.

However, the contribution of the agricultural sector to economic growth has been modest in recent years. As in most developing economies with a similar structure, the share of agriculture in gross development product

(GDP) has been declining. During 1968 to 1979 agricultural output grew at an average rate of 3.8% per year. It reached a low point in the mid-seventies and has since consolidated its position at 26% of GDP (in 1980), mainly due to the dynamic development of Fiji's sugar industry.

This trend is now expected to reverse. DPB projects that the agricultural sector will take the lead in terms of sectoral growth rates and will serve as the engine for development of the overall economy. Agriculture is expected to grow faster than the other sectors and, consequently, to increase its share in the overall economy.

The responsibility for generating economic growth falls on the agricultural sector because the build-up of a local manufacturing capacity is limited by the size of the domestic market and the difficulties in reaching overseas markets.

#### 2.1.4 Output of the Agricultural Sector by Major Commodities

The performance of the agricultural sector in Fiji is best described by indicating the development of major agricultural products over recent years (see Table 1, page 8).

The predominating and increasing importance of the sugar industry, represented by the Fiji Sugar Corporation (FSC), is clear, and sugar milling is the country's major manufacturing industry. Sugar accounts for roughly 75% of the country's total exports and provides employment to some 25% of Fiji's labor force.

The second most important crop in terms of output and land use is copra. The data presented suggest a decline in production of copra. A series of events, which include unfavorable price developments, drought, and cyclone damage, have all contributed to the decline of the industry and the limited amount of replanting (see Annex 3).

Rice continues to be an important crop. It is grown mainly as a rainfed crop with only limited areas under double-cropped irrigation. Rice production efforts reflect the government's desire to reduce rice imports.

Dalo and cassava remain important crops with respect to land utilization. Yet their total areas have declined over the past decade, due to increased urbanization and related changing consumption patterns.

Cocoa represents a successful attempt to diversify cash and export crops. Ginger, which is becoming established successfully, is a high value crop for both import substitution and export purposes. A citrus industry is being built up for similar purposes.

Pastoral farming for beef, dairy, and goat meat production has been given high priority in an effort to reduce imports of these products. A number of major beef schemes have been mounted.

## 2.2 General Agricultural Background

### 2.2.1 Brief History of Agriculture as an Industry

A successive influx of European and Indian settlers over the last 100 years has had a profound influence on the agricultural production systems of Fiji. The traditional integral subsistence system that characterized indigenous Fijian agriculture has, over this period, undergone a

progressive change to a mixed subsistence-cash cropping system. The advent of plantation agriculture, notably sugar cane during the last quarter of the previous century, has resulted in the establishment of a well-organized and productive agricultural industry within the plantation sector.

The present sugar industry, which could be described as a smallholder production system within a plantation mode, exemplifies the transition from large-scale estate management to smallholder agriculture in Fiji. Coconut was a major foreign exchange earner in early colonial times, but the industry has been declining steadily over the last two decades.

Smallholder commercial farming enterprises are a more recent development. High value horticultural and other cash crops, grown in these smallholder enterprises, have assured marketing prospects both in the domestic and export sectors. A large-scale cattle farming industry is being developed under the management corporation system, in addition to the development of individual beef farms. Indigenous food crops are grown under subsistence farming with small surpluses reaching the domestic market points. Rice production, which barely meets half the national requirements, is carried out both by smallholder subsistence farmers as well as under medium- to large-scale commercial enterprises and government.

The Department of Agriculture was established in 1905. In the first two decades of its existence, the department's work was centered mainly on the problems of plantation agriculture. After 1930 it was able to pay more attention to indigenous agriculture in the country, and it is from the Department of Agriculture that the present Ministry of Agriculture and Fisheries evolved.

The Research Division of the Department of Agriculture is presently subdivided into five major sections: agronomy, tree crops, plant protection, chemistry, and animal husbandry. Its research work is broadly classified into two categories, crops and livestock. The current programs are largely aimed at identifying and overcoming constraints in crop and livestock production. The Research Division also carries responsibility for producing high quality seeds and planting materials.

Table 1. Main agricultural products in Fiji. (Source: Ministry of Agriculture and Fisheries.)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
<b>Sugar</b>										
Cane yield per ha (t/ha)	54.2	51.0	54.4	47.9	44.2	48.3	51.5	52.1	65.6	49.9
Sugar production (t'000)	332	303	301	273	272	296	362	347	475	396
Sugar export (t'000)	334	340	279	258	253	250	322	293	428	441
<b>Copra</b>										
Copra production (t'000)	28.7	29.2	27.3	27.8	24.0	27.1	30.6	26.1	21.9	22.8
C. Oil production (t'000)	17.8	18.3	17.0	17.3	15.5	17.1	16.6	16.8	14.2	15.3
C. oil export (t'000)	16.9	15.2	18.3	14.3	16.1	13.3	17.5	17.8	15.2	12.8
<b>Cocoa</b>										
Production (t)	80	89	22	49	72	88	97	123	144	173
Export (t)	31	101	31	44	78	82	95	122	130	173
<b>Rice</b>										
Yield per ha (t/ha)	0.77	0.77	0.78	0.77	2.24	2.27	1.92	1.82	2.01	1.99
Paddy production (t'000)	17.2	17.2	15.7	17.2	22.9	20.6	18.0	16.1	18.7	17.8
Import paddy (t'000)	15.3	15.7	21.7	19.9	18.0	19.3	24.0	23.1	24.5	21.1
<b>Dalo</b>										
Yield (t/ha)						10.0	11.0	11.0	12.0	12.0
Production (t'000)						5.7	4.9	5.6	5.8	6.5
<b>Cassava</b>										
Yield (t/ha)						12.0	14.0	16.0	18.0	19.0
Production (t'000)						7.0	9.3	9.8	7.9	10.2
<b>Tobacco</b>										
Yield (t/ha)	1.31	1.43	1.17	1.31	1.85	1.76	2.24	1.81	1.99	2.10
Production (t)	176	275	211	254	407	473	539	269	301	413
<b>Passion Fruit</b>										
Production (t)		367	146	204	682	332	229	369	460	685
<b>Ginger (fresh)</b>										
Production (t)	796	796	1,180	1,252	1,419	1,091	1,815	1,845	1,829	1,462
<b>Beef</b>										
No. of animals slaughtered						9,753	10,592	12,032	15,901	15,805
Local production in terms of total consumption (%)						39	39	44	59	70
<b>Dairy</b>										
Production, BFE (t)						1,184	1,195	1,215	1,202	1,181
Local production in terms of total consumption (%)						56	31	28	23	25
<b>Pork</b>										
Production of pork meat (t)						325	336	468	646	502
Local production in terms of total consumption (%)						77	65	83	99	91
<b>Goat Meat</b>										
Production of goat meat (t)						256	252	306	332	451
Local production in terms of total consumption (%)						46	46	51	58	66

### 2.2.2 Crops Areas and Production.

Areas under crops or group of crops are listed below for those whose respective extent presently exceeds 1,000 ha.

Table 2. Areas in principal crops in Fiji. Source: Agriculture Census Report 1978, and more recent data available at MAF.

<u>Crop</u>	<u>Area (ha)</u>
Sugar cane	54,000
Coconut	65,300
Cocoa	2,000
Rice	9,800
Cassava	6,900
Dalo	2,950
Yams and minor root crops	1,150
Pulses	1,650
Yaqona	1,250

Other crops of economic significance, but whose individual cultivated extent is presently less than 1,000 ha, include tobacco, maize, temperate and tropical vegetables, groundnuts, pineapple, citrus, ginger, and passion fruit.

Production trends in the past have not been similar for all crops. The increase in sugar production during the period 1975-80 has come both from expansion in area and improvement in cane yield. Copra production has shown a decline during the last 10 years, while coconut oil production has been almost stagnant over the same period. Cocoa (dry bean) production has shown a significant increase during the period 1975-80. Rice production during this same period has shown a small decline. Although total area planted to dalo and other indigenous yams has declined in the past decade, the total production and yield of both dalo and cassava have increased significantly. Despite fluctuations in production during the last five years, tobacco, passion fruit, and ginger have maintained increases in production compared to the earlier five years, 1970-75. Vegetable production has shown a steady increase during recent years. There has been a significant improvement in beef, pork, goat, and poultry production during the period 1976-80, while dairy production has remained constant despite setbacks caused by hurricanes and floods.

### 2.2.3 Classification of Land, Land Tenure, and Occupancy

A first approximation of the classification of land in Fiji, according to Twyford and Wright (1965), shows four main categories. A brief description of each category and the extent (by percent) follows:

	Area as percent of the country
<b>Class I Land</b>	
Suitable for either annual or tree crops without modification	19.4
<b>Class II Land</b>	
Suitable for crops if some fairly minor improvements are made	10.5
<b>Class III Land</b>	
Needs major improvements for agriculture	31.9
<b>Class IV Land</b>	
Unsuitable for agricultural development but may be of limited use for production forestry	38.2

Four types of land tenure are found in Fiji:

- \* land held under custom by Fijian clans, known as mataqalis (a mataqali is a kinship group for owning land);
- \* customary land leased out to individuals of any ethnic origin;
- \* freehold land originally purchased by settlers of diverse ethnic origin;
- \* crown land that was not claimed at the time of cessation in 1874.

Approximately 84% of all land in Fiji is owned by mataqalis. Ten percent of this is reserved as "native lands" for the exclusive use of Fijians; the unreserved land can be leased but cannot be sold. The Native Land Trust Board (NLTB) leases such land to applicants on behalf of the Mataqalis, with 30 years as a maximum period of lease. A little more than 18,000 ha of such lands are farmed under lease by Fijian Indians.

Freehold land constitutes about 8% of the total land, and about 40% of the coconut plantations are on such land. Crown land accounts for the remaining 9%, half of which is either forest reserve or uncultivable land, such as in the eastern division.

Occupancy status of cultivated farmland is approximately 75% owner or lessee, 18% mataqali farming, and the balance tenant or other.

#### 2.2.4 Main Characteristics of Agriculture

A great diversity of agro-ecological conditions is encountered within the country in relation to its size. Twyford and Wright (1965) recognize six well-defined climatic regions in the Fiji archipelago. These range from "lowland climate with strong dry season," which corresponds to the Thornthwaite rational classification of C<sub>2</sub>A'a'r, to "lowland climate with no dry season and high rainfall," which corresponds to AAa'r in Thornthwaite's scheme. An "upland climate" is also recognized for land over 700 m elevation. For most purposes it is convenient to discuss agriculture within the three main zones in common usage in the country, namely the wet, the dry, and the intermediate. Soil moisture deficits in the dry zone usually occur in the period from August through October.

The general soil map of Fiji shows 15 soil mapping units, which correspond to eight soil orders of the U.S. Soil Taxonomy or else to 10 higher category units of the FAO/UNESCO system. The dominant soil order in the wet zone is the ultisols, while the dominant orders in the dry zone are the alfisols, mollisols, and oxisols. A wide range of agricultural commodities could, therefore, be grown under such diverse agro-ecological conditions.

Sugar cane thrives best in the dry zone, where the cool dry season enables a good build up of sugar. Past trials reveal a significant potential for growing rainfed coarse grains and grain legumes in this region. Vegetables and high-value horticultural and plantation tree crops are best adapted to the wet zone. The more productive coconut plantations occur on the recently developed soils from alluvium and coastal sands and also on the latosolic soils derived from younger volcanic rocks. Low solar radiation in the wet zone is one of the major environmental factors that constrain the attainment of high rice yields.

Almost all of Fiji's sugar is produced by smallholder growers, who produce sugar cane under contract with the sugar mills. Coconut production is mainly concentrated in the coastal areas, particularly in the outer islands. Indigenous Fijian smallholders grow about 60% of the copra. Rice is grown mainly as a rainfed crop, with only small areas under double-cropped irrigation -- rainfed rice is essentially a subsistence crop. Roots and tuber crops are grown mainly by smallholder subsistence farmers. High-value vegetables, horticultural, and other cash crops are grown by smallholders. Pastoral farming for beef and goat meat production is carried out as a part of mixed farm enterprises or on the various grassland associations that occur throughout Fiji. The special beef project at Yaqara is being developed under the management corporation system.

#### 2.2.5 Government Structure for Agriculture and Fisheries

The Ministry of Agriculture and Fisheries (MAF) is the main institution serving the agricultural sector of the country. The organization chart for the ministry is set out in Annex 6. The Permanent Secretary, who is in direct line to the Minister, is primarily responsible for policy formulation and overall coordination of MAF programs. He is supported by the Director of Agriculture, who supervises the technical divisions, and an Assistant Permanent Secretary, who looks after the administration as well as the service and educational divisions relating to agriculture. The Department of Fisheries, which has no formal linkages to agriculture, is under the direct line of authority to the Permanent Secretary.

The Director of Agriculture is responsible for coordinating and providing the proper direction to the working of the four individual divisions: research, extension, animal production and health, and drainage and irrigation. Each of these divisions is headed by an Assistant Director of Agriculture, who is responsible for the technical direction and administrative control of the staff within each division.

The Assistant Permanent Secretary plays a supportive role to the Permanent Secretary in administration and finance, besides playing a coordinating role with the Director of Agriculture. The Economic

Planning and Statistics Division (EPS) functions within the ministry and is headed by the Chief Economist.

The Research Division is headquartered at the Koronivia Research Station. The Assistant Director of Agriculture (Research) (ADAR) is responsible for overall administration of the division and the Koronivia Research Station. Six other research stations located in the major agro-ecological regions of the country conduct research on crops and farming problems specific to the region. (These are discussed in 3.4.)

The Assistant Director of Agriculture (Extension) (ADAE) has subordinate principal agricultural officers (PAO) in charge of each of four administrative divisions of the country. Each PAO administers a staff of agricultural officers and supporting staff -- the latter are the grassroots-level officials who are in direct contact with farmers.

The Education and Training Section conducts training at the Fiji College of Agriculture (FCA). Educational policies and objectives for the ministry are decided by the FCA council.

The Land Use Section, which is presently under the EPS Division, is located at the Koronivia Research Station and has regional units located with the PAOs for the western and northern divisions.

#### 2.2.6 Development of Agricultural Research

The Research Division is responsible for research on crops (other than sugar cane) and livestock. Crop production research includes work on the following crops or groups of crops: rice, root crops, vegetables, pulses, coarse grains, fruits and minor tree crops, citrus, coconut, and cocoa. Livestock research includes activities in pasture improvement and production systems, animal husbandry, and animal breeding. Specialist sections within the Research Division based at Koronivia are responsible for research in the fields of plant protection, agricultural chemistry, weed control, and botany.

The Land Use Section conducts investigations on the soil resources of the country and is responsible for the updating and classification of the soil resources data. It also carries out land-use research, besides providing supporting information and advice on land-use planning for both national and regional requirements.

The Drainage and Irrigation Division conducts investigations related to new irrigation development projects as well as on rehabilitation of existing irrigation projects.

MAF's Fisheries Division is administered separately from agriculture. Its work program includes some research -- a variety of feasibility studies of market potentials and methods of production and harvesting fish. Some investigations are carried out by fisheries officers, while foreign experts are involved in others. There do not appear to be formal links from this work to the Research Division in agriculture.

Research and development on sugar cane is the responsibility of the Fiji Sugar Corporation (FSC), which carries out its own research and also provides advisory service to cane growers.

### 2.2.7 Agricultural Research in Other Ministries and Organizations

The Sugar Cane Research center at Lautoka is the main facility for FSC's research and advisory service. It has developed a strong and effective research capability to serve the needs of the national sugar industry. Its cane breeding section is recognized internationally. Activities of the agronomy research section and the plant protection section have a close bearing on allied activities in the Research Division of MAF.

The Ministry of Forest Industries has a research unit that conducts investigations concerned with production and utilization of forest products. It utilizes some analytical services in the Research Division. The Fiji Pine Commission (FPC), a quasi-government body affiliated with that ministry, carries out some applied research. It has collaborated with the Research Division on investigations of weed and shrub control and grazing under pine plantation.

### 2.2.8 The Role of Agricultural Research in the National Setting

The main role of agricultural research, as viewed for government planning activities, is that of generating improved technology for agricultural production. The annual work program of the Research Division attempts to match in broad substance the stated objectives of the current national development plan, DP8. The aggregate of research projects contained in the work program cannot, however, be considered of sufficient scope and depth to fulfill the long-term objectives of development. The statement of national goals and objectives in DP8 reflects, to a degree, the use and interpretation of research information as well as the body of accumulated knowledge of the country's agricultural environment.

The strategies that should support the translation of research to increasing productivity at the farm level have yet to be planned and stated within an operational framework. This is important in so far as it would enable both research and extension personnel to recognize the meaningful roles that they have to play in the generation and application of technology.

Although there has been recognized a need to develop, maintain, and sustain minimum required strength of well-trained, competent agricultural research personnel in the different disciplines, the progress to date has fallen short of the real needs. The strength, composition, and duration of service of research personnel has been uneven. Agricultural research has thus not been able to play a consistent role in serving the needs of national development planning for the agricultural sector.

## **2.3 Agricultural Policy**

This section is concerned with the overall policy framework within which agricultural research is expected to contribute to the country's agricultural development and overall economic progress. It analyzes the extent to which stated policies and development objectives are matched by political decision-making and translated into policies.

### 2.3.1 Development Planning in Fiji

Fiji has built up over time considerable tradition in development planning. Its Central Planning Office has developed sophisticated techniques and undertakes planning at four levels: (a) macro-economic planning, (b) sectoral planning, (c) regional planning, and (d) project preparation.

Fiji has traditionally had an open economy with a liberal economic policy. Public sector activities have been kept to a minimum, so that the private sector has been free to develop. This explains the limited scope of public sector planning.

The planning effort is characterized by continuity, and the objectives and strategies of DP8 (the national development plan) are generally consistent with those of earlier plans. Table 3 displays growth guidelines for 1981-85.

Table 3. Planned annual rates of growth for 1981 to 1985 by sector (source: national development plan DP8).

Overall economy	4.7
Export agriculture	6.0
Domestic agriculture	4.9
Mixed subsistence	1.4
Forestry	5.6
Export fishery	9.8
Domestic fishery	2.8

### 2.3.2 Development Strategy for the Agricultural Sector

The national development strategy and its growth objectives are translated, at the next level of planning, into a sectoral strategy for agriculture. The principal targets of that strategy are:

- a. reinforcement of the position held by the traditional commodities such as sugar and copra, while emphasizing the diversified use of both cane and sugar (thus increasing the value of the products by further processing). The growth of sugar sustained the economy in periods of sluggish development elsewhere. Continued growth has been projected in DP8, with a target of 600,000 metric tons. The main constraints to further growth are international marketing limitations, the area identified for cane production, and milling capacity. No expansion has been projected for copra. Principal problems are price fluctuations and the resulting lack of incentives for production combined with an aging stock and declining productivity;
- b. diversification into new commodities for both the export and internal markets, such as cocoa, ginger, and citrus. Development of these commodities constitutes the major focus of DP8, with growth rates

projected at 44% (from a low base). While cocoa is the principal commodity to carry this projected expansion, ginger and citrus are expected to contribute substantially to increased export earnings. The ultimate purpose of these diversification efforts is a reduction of the dependency on sugar;

- c. the promotion of self-reliance in basic food crops through the expansion of production and import substitution. The products concerned are mainly rice, beef, and dairy products, as well as (on a minor scale) coffee, tea, mutton, and goats. While the principle of an open economy is fully accepted and heavy reliance on trade relations is accepted, efforts to promote increased self-reliance will be undertaken. Production of this group of commodities is projected to grow at 4.9% per annum, while domestic consumption is expected to increase by 1.5% per annum. As a consequence, the overall level of self-sufficiency is expected to improve by 25% over the planning period ;
- d. mobilization of the national potential in both fisheries and forestry.

### 2.3.3 Policy Objectives for Agricultural Research

It is obvious that these ambitious development targets formulated by DP8 imply important requirements in terms of general support for agriculture, generation of appropriate technologies, and technical assistance to farmers. A question which must be considered is how these targets translate into operational policies, support for agriculture in general, and support for research in particular.

Fiji is characterized by a great diversity of agro-ecological zones, a large number of commodities with good development potential, and yet limited resources to promote such development. Clear-cut choices and clearly formulated policies are required in order to maximize the utility of efforts and resources and to minimize the dispersion of funds. Yet, clear policies are lacking, except for sugar. Rice, coconut, and cocoa are cases in point. All are important crops and expected to play a critical role in the country's import substitution (rice) and export diversification (coconut and cocoa) efforts; all lack adequate research support.

While budgetary support for agricultural research is not in line with functional requirements and policy statements, DP8 does recognize the need to develop both an appropriate national capacity for the generation of technology and a coherent national policy for science and technology. For the time being, however, such a policy has not been established and decisions are ad hoc.

### 2.3.4 Agricultural Research and Policy Formulation

What should be the role of agricultural research in relation to development planning and policy formulation? Based on experience elsewhere (see Annex 1), the mission members believe that the research system should be closely linked with planning and policy formulation and have a significant voice in the process. It should make sure that

planners and policy makers have accurate information on development potentials, opportunities, and possible constraints. In order to be able to perform this function, the respective research teams must include all those elements that are essential for this purpose. This implies the existence of a multidisciplinary team with a strong socioeconomic input.

An evaluation of recent performance of the research team of MAF's Research Division indicates that there is ample scope for improvement and expansion of the division's role. To achieve the desired improvement, two things appear to be required:

- a. some strengthening of the overall analytical capability of the research team through the inclusion of a socioeconomic element;
- b. general recognition of the research team's capacity to perform such tasks, and the active will of planners and policy-makers to call upon the Research Division to cooperate as analysts, advisers, and contributors to good planning and policy formulation.

### 2.3.5 Agricultural Support Services

To a large extent, in Fiji the management and distribution of input supplies and other support services are handled by private sector institutions. The involvement of the public sector has been kept to a minimum and limited to those areas that are not adequately covered by private initiative. This is a reflection of Fiji's liberal policies. These policies have prompted the application of the principle of comparative advantage, i.e., leaving to the private sector all those areas that it will handle efficiently.

A system of agricultural subsidies has been operated by the Government of Fiji over the past years. This system includes both direct and indirect subsidies to agricultural producers. Payments are made to farmers or providers of goods and services in order to reduce the cost of these goods and services (mainly inputs) to the farming community. These subsidies have tended to reduce net input prices for farmers below actual market price levels. The intention was to reduce costs of production, to encourage the use of new or improved inputs, and to stimulate adoption of technological innovation.

Along similar lines, from time to time direct subsidies have been paid to farmers for the purchase of specific goods and services. Mostly these payments were intended to promote certain activities, such as coconut replanting and diversification.

The total allocation for agricultural subsidies in 1981 was F\$1,586,000 (US\$1,763,632) (13.5% of the operating budget of MAF). Similar provisions were made in the 1982 budget. Over and above this allocation, F\$800,000 (US\$889,600) was provided for interest subsidy on agricultural loans provided by the Fiji Development Bank.

The following notes on input supply and distribution as well as subsidy management refer to agriculture outside the sugar sector. (For sugar farmers, the FSC handles the total package of input supplies, technical, assistance, credit, and marketing. In this connection it should be noted

that FSC is the country's major importer of fertilizers and agro-chemicals. Through bulk buying arrangements and the resulting economies of scale, FSC fertilizer -- even at unsubsidized rates -- is delivered to sugar farmers cheaper than subsidized fertilizer is delivered to other farmers.)

Fertilizer supplies, which are imported due to the limited size of the local market and the resulting disincentives for local production, are distributed by the private sector. They are subsidized at source at 35% of landed costs.

Agro-chemicals are similarly handled and subsidized at 30% of landed cost. Other inputs such as fencing posts and wires are subsidized at 40% of purchase cost, with subsidies being granted to farmers on application. However, to reduce administrative cost, consideration is being given to delegating the tasks to cooperative societies that would receive the subsidies and distribute on behalf of the farming community.

Agricultural credit is managed by the Fiji Development Bank and commercial banks, with subsidies being provided from the central budget.

In a country like Fiji, marketing and storage constitute important elements in the chain of agricultural production. A number of factors -- such as the fact that Fiji is made up of islands with great distances between markets, the lack of transport infrastructure, and the limited size of local markets -- emphasize the importance of marketing assistance to the farming community.

The National Marketing Association (NMA) is being restructured in an effort to bring its operational concept in line with both Fiji's liberal policies and resource constraints. NMA's operational principles are to promote market development and to encourage private initiative, rather than to engage in activities replacing private enterprise. On travels through Fiji, the mission noted encouraging examples of new marketing initiatives promoted by NMA, such as the Taveuni Marketing Authority.

Another aspect of support for agriculture is the provision of quarantine procedures. This is particularly relevant in Fiji, which is free of many serious plant and animal diseases. The team supports the existing role of the Research Division in plant quarantine at this stage of Fiji's development. The Animal Health and Production Division should maintain its responsibility for animal quarantine.

On balance the review team considers the supply of supporting services to agriculture to be well handled and essentially in line with existing requirements and resource constraints. It was pleased to note that the system is periodically reviewed in an attempt to streamline procedures, reduce cost, and increase efficiency. The last of these reviews took place early in 1982.

## Chapter 3

# The Agricultural Research Division

In this review, primary attention is given to the Ministry of Agriculture and Fisheries. The team also examined the relationship of research within this ministry with other ministries, educational institutions, and organizations within Fiji and with its external contacts.

### 3.1 Structure and Organization of Agricultural Research

Fiji's agricultural research system is described first to set forth the existing situation and to try to determine the apparent strengths and weaknesses of its structure and organization.

Agricultural research is a division within the Ministry of Agriculture and Fisheries (MAF) (see Annex 6 for ministry organization). The Research Division is headed by an Assistant Director of Agriculture (Research) (ADAR) who reports to the Director of Agriculture. The Director of Agriculture is directly responsible to the Permanent Secretary, who is under the Minister of Agriculture and Fisheries.

The ADAR is responsible for all the work of the Research Division, including seven research stations (described in Section 3.4). In addition the ADAR is the administrator of the Koronivia Research Station, near Nausori, about 15 km from MAF headquarters in Suva. The other assistant directors in MAF are located at the central ministry offices in Suva with the Director of Agriculture, with the exception of the Assistant Director (Drainage and Irrigation), who is located at Walu Bay, about 1 km from Suva.

The Research Division is seen by MAF and other government ministries as the country's main resource for agricultural research. However, some research in MAF is conducted in the Economics, Planning and Statistics Division, the Animal Health and Production Division, and some in the Drainage and Irrigation Division -- all of which report to the Director of Agriculture.

The Fiji Sugar Corporation conducts its own research and is supported by a cess on sugar exports. Fish and fishing research is conducted by the Department of Fisheries in MAF. Research is performed by the Ministry of Forestry that could have direct relevance to the work of MAF, but the contact is limited. Private industry carries out some research on high value crops in Fiji, but to a larger extent it transfers and utilizes technology developed elsewhere. This review is mainly restricted to the Research Division, in accordance with the Terms of Reference.

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### 3.1.1 The Research Program

The Research Division each year develops a work program which lists research projects by commodities and disciplines. The projects are designed to solve crop and animal production problems. In addition to research, the division is also involved in producing seeds for some crops, raising grafted/budded materials or seedlings of tree crops for sale to farmers, and providing analytical services for pure food determination and forensic purposes.

The research projects are developed by individual research scientists or collaborating scientists and then presented for approval to the research committee, which is comprised of the section heads in the Research Division. Projects may be presented throughout the year, but it is preferable to have them presented and reviewed at a time when they can be included in the annual work program at the start of the year. Projects presented at other times are considered; however funding, which is always a problem, is even more difficult for these projects.

An annual work program is presented by the Research Division to MAF and is included in the MAF annual work program. In past years a separate section in the MAF program was devoted to the Research Division, listing its research projects by commodities and disciplines. However in 1982 the MAF annual work program included the work of the Research Division by commodities under the Extension Division and the Animal Health and Production Division. For each commodity there was a statement of its current status, extension objectives, extension work plan, research objectives, and research work plan. Research Division work in rice is included under the the Drainage and Irrigation Division; other Research Division work is presented under analytical and other services.

The advantage of this presentation is that it gives some background on each commodity and a general idea of production and production problems, linking both research and extension to the commodity. However, the research objectives are too general to provide specific goals for evaluation; the same is true of the research work plan. The main purpose of this presentation should be to indicate the interrelationships between research and extension and to set guidelines for cooperation, but this is not achieved. The lack of recognition of the Research Division in the 1982 MAF work program may be an oversight in printing; this needs to be clarified for the future.

The dominance of a project approach was evident in discussions with individual scientists and in reviews of the documentation in the Research Division. Research projects are essential for a research organization, but they need to be based in a research program with well-developed priorities and goals. Research projects which evolve out of the research program can be reviewed and evaluated, not only on their individual merits but on their contribution to overall research goals. It is the observation of the review team that more attention needs to be given to the establishment of such an overall research program.

The quality of the output of the research work, and its impact, require a more detailed appraisal than is possible in the system review carried out by the team. There appeared to be a great deal of variability, as could be expected, but research seemed to have had a significant impact on root crops, vegetables, pastures, pulses, and also cocoa in the past.

### 3.1.2 Organization of Research by Commodities, Disciplines, and Regions

The structure of the present system appears to be simple: it is presented in Figure 1

This structure is found to be more complex upon careful examination. Positions are tied to specific research stations, and the leaders of some commodity research programs may be based at locations different than that of the ADAR. All of the staff of the chemistry and plant protection sections are based at Koronivia. Some leaders of national research programs are based at Koronivia and others at different research stations, depending on ecological conditions that determine the production area for the commodity of their responsibility. Some staff may also be located on a regional basis.

There is greater flexibility in the system's operation than the organization chart (Figure 1) indicates. There is opportunity for a direct line from the leader of a commodity program to the ADAR, one not filtered through a unit head (e.g., agronomy). Therefore, for example, the senior research officer for dry zone pulse crops appears to deal directly with the ADAR on all program matters. In a small research organization, the advantages of this direct communication outweigh disadvantages. As has been noted, the research staff positions are for the most part tied to specific research stations. Each research station has its own administrator in charge and a farm manager; thus the research staff deals directly with the ADAR on program matters, but on most day-to-day issues they deal with the administrator and the farm manager. Such day-to-day issues include allocation of land for research, preparation of land, harvesting, storage, and transport. However, the research station administrators also report to the ADAR, so issues all come together in a single decision making point.

The present organization of research places commodity research leadership on a national basis, recognizes ecological differences and locates research stations in different zones, and meets regional needs with backstopping by selected discipline-oriented service units. This appears to be an effective way to organize and manage research in Fiji, but it requires excellent leadership and cooperation in program planning and execution. It also requires adequate support for travel for all staff involved in program implementation and evaluation.

There are gaps in the organization; the most obvious is the absence of staff or a program in social sciences. The Research Division does not have the capability to determine the economics of the technology it generates (such as the outcome of its pasture research) or to measure and

## Assistant Director of Agriculture (Research)

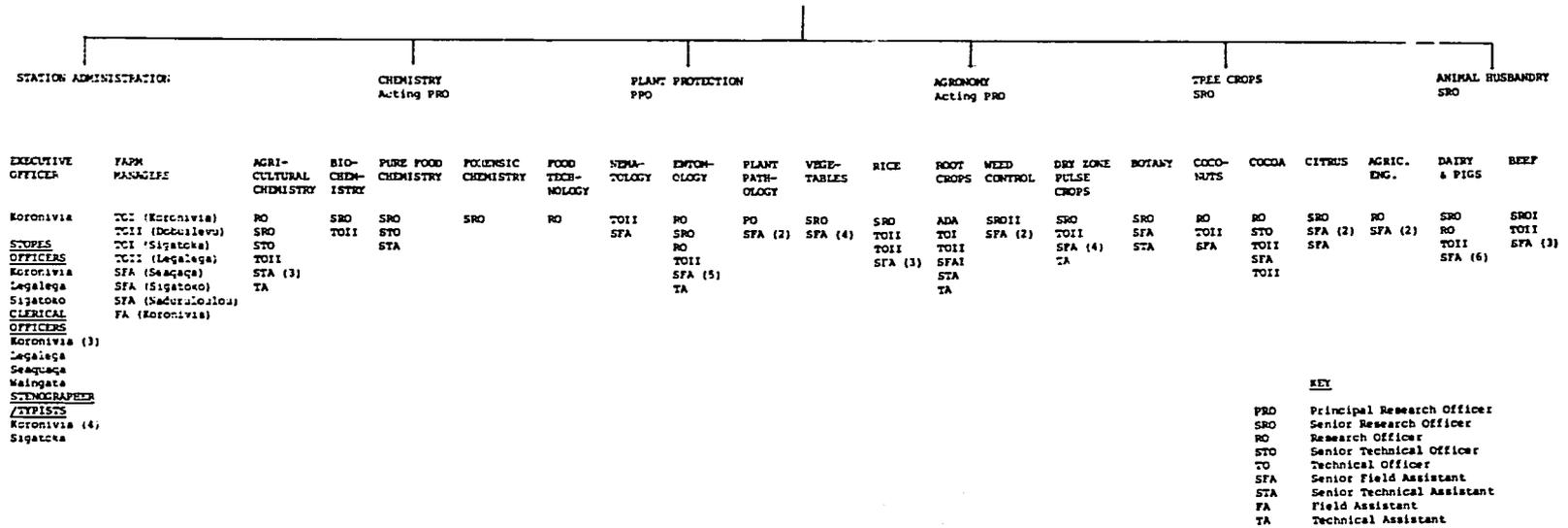


Figure 1. Organization Chart of the Research Division.

evaluate comparative production systems. Also it could benefit from staff and a program to investigate and measure the social and cultural consequences of introducing different technologies or to study the cultural and social elements that facilitate or constrain the utilization of certain technologies.

The organization appears to be meeting its minimum needs in biometrics through a series of ad hoc arrangements; this important area of work will need to be given more long-term consideration to assure continuity and competence. There is also a role for a general agronomist in the Research Division, one who would work on the interrelationship between crops and soils in several commodities.

The structure of the research organization in Fiji provides an excellent example of how to organize and carry out a research program in a small country that has limited resources but a wide diversity in its agriculture. Such a research system must include measures to assure that it is working on the most relevant problems and is linking with the systems that deliver research results to users. These matters will be addressed further in other sections, especially sections 3.2 and 3.7.

### 3.1.3. The Role of Koronivia

The Koronivia Research Station is given special attention because it is the headquarters for the ADAR as well as for a majority of the leaders of the commodity research programs, service units, and laboratories. The only significant concentration of research scientists in Fiji is at Koronivia. The station provides the physical location for these scientists and the facilities for their research, as well as the national laboratories. Koronivia is thus viewed as the national research facility, as well as the station serving the ecological zone of the region in which it is located.

The other research stations will be discussed in section 3.4.

### 3.1.4 Regional Allocation of Staff

In 1982 the Research Division divided its manpower and budget resources among seven research stations. Gross resources allocated were 288 positions and financial resources of F\$728,600 (US\$810,203) in recurrent and F\$83,000 (US\$92,296) in capital budget. The distribution of manpower in 1982, by stations and levels of training, is shown in Table 4 (p. 23).

Table 4 discloses that the majority of more highly trained personnel (71% of those holding degrees and 62% of the technical personnel) are posted at the Koronivia Research Station. None of those holding the Ph.D. and just 1 of 9 with the M.Sc. are based at other stations. Two of the other stations function without resident professional staff, and two have a single professional posted to the station. Operationally, however, research leaders from Koronivia or other posts supervise technicians who carry out projects at these stations. (This method of operation carries with it a strong need for travel funds to assure adequate professional leadership and supervision.) Given the organization for research and the

size of the Research Division, the present distribution of staff seems appropriate. As the staff grows, however, more people will need to be posted to stations other than Koronivia.

Table 4. Staffing at Research Division research stations by professional qualifications, 1982. Ministry of Agriculture and Fisheries, Fiji. Source: Personal communication by P. Sivan, Assistant Director Agriculture (Research).

Station	Professional			Technical			Other	Total	
	PhD	MSc	BSc	Dpl.Other					
				(T)		(T)			
Koronivia									
Ag labs	1	2	1	4	1	10	11	2	17
Station	3	6	7	16	28	7	35	89	140
Subtotal	4	8	8	20	29	17	46	91	157
Sigatoka	0	1	3	4	8	4	12	33	49
Legalega	0	0	2	2	3	2	5	12	19
Naduruloulou	0	0	0	0	1	1	2	16	18
Dobuilevu Ra	0	0	0	0	2	0	2	9	11
Seaqaga	0	0	1	1	4	1	5	12	18
Wainigata	0	0	1	1	2	0	2	13	16
Subtotal	0	1	7	8	20	8	28	97	133
Grand total	4	9	15	28	49	25	74	186	288

The Research Division has a favorable ratio of support staff to professional staff, as judged by usual international guidelines. Each of the 28 professional staff, on average, is backed by of 2.6 technical staff and almost 7 others (including clerical, stores workers, and laborers). The ratio of professional staff to technical support staff is about 1 professional to about 2 technical staff at the Koronivia station and, in terms of resident professionals, from 1 to 2 at Wainigata, to 1 to 5 at Seaqaga. At two stations without professional staff, each has two technicians to carry out projects supervised by several different research officers. With the level of support staffing generally provided, professional researchers should be able to devote their main attention to their research tasks.

### 3.1.5 The Multiple Role of the Assistant Director of Agriculture (Research)

It has been noted before that the ADAR serves as the administrator of Koronivia. The administrators of all the other research stations are

also responsible to the ADAR. Therefore, he has a dual role: a colleague of the administrators of the other research stations and a supervisor (or responsible administrator) for all research stations.

The present ADAR is also in charge of root crops research on a national basis, with major work carried out at Koronivia. Therefore, he has a triple rather than a dual role.

The fact that the ADAR has multiple roles is advantageous in that he is kept in close contact with the research staff, with the administrators of the research stations, and with specific research problems. There is a concern, however, that the multiple roles may divert attention from the primary concern of a research director: planning, monitoring, evaluating, and reporting the program, and interacting within and outside MAF to create and maintain awareness needed for continued support.

## 3.2 Research Planning and Implementation

This section describes how priorities for research and also individual programs are currently formulated, and it examines other available inputs could be incorporated to improve the current procedure. The section takes account of technology transfer, considering current procedures and possible improvements for monitoring and final evaluation of projects.

### 3.2.1 The Requirements for Planning

Successful national agricultural research requires sound assessment of priorities for research programs and good planning and implementation at the individual project level. Research management must have clearly defined priorities when allocating officers and funding to commodities or problem areas. The allocation should recognize goals of national planning so the allocation of research inputs reflects national needs.

The decisions concerned with individual experiments and projects then rest primarily with the research worker (or group of workers concerned with an individual project) and his immediate superiors, preferably with most of the input coming from the research worker. He must initially consider the possible objectives that experiments and projects within the program can meet, and then give them a priority ranking. The ranking will be based on both the relative importance of the objectives and the support and time likely to be needed to deal with them. Consultation is required at this point with other research workers, extension officers, farmers, economists, and anyone with relevant expertise. He will then design the experiments, with appropriate consultation about measurements to be made and statistical precision.

Once a project is approved, having been subject to appropriate scrutiny, it is initiated and its subsequent progress monitored. After the experiment or experiments have been concluded, the project is then evaluated: in most agricultural research this means comparing the new procedure or variety with standard procedures or varieties in farm trials and involves economists, extension workers, and farmers.

### 3.2.2 The Current Procedure

Currently there is a less than satisfactory relationship between the broad priorities given to research in different commodities and the agricultural priorities as expressed in the national development plan, DP8. For example, there is only one research officer allocated to coconut and cocoa research, despite the stated importance of these crops. The current allocation of research posts may be partly a historical legacy of previous decisions. Positions are usually only re-allocated when vacancies arise, and even then existing positions are usually re-advertised. There are no duty statements for officers, other than those listed in an advertisement for the position to which they successfully applied. The review team acknowledges, however, that there is less flexibility in moving staff between disciplines than there is flexibility within a discipline. The Research Division has to maintain a broad spectrum of skills; for example, it is desirable to maintain an animal husbandry officer interested in production research, although there is flexibility in assigning priorities to animal species (dairy, pigs, etc.) with which he is working.

The priorities, objectives, and experimental designs of projects are formulated by the officers concerned. There is no formal requirement for an officer to consult with anyone outside the Research Division, although he is expected to have discussed the proposals with his section head. Hence, some officers have sought outside advice on projects and some have not. Either the section head or the officer concerned presents the proposal to a meeting of section heads, held quarterly, within the Research Division. From this meeting, the group may return the project to the officer concerned as being unacceptable, or it may pass it on -- with or without suggested modifications -- to the ADAR, who may then discuss the proposal with the individual officer. New proposals are then discussed by the assistant directors of all the divisions and are forwarded, via the Director of Agriculture, for inclusion in the next year's proposals to go to the Ministry of Finance.

There are no formal arrangements for monitoring projects, but individual officers are expected to discuss progress with their section head; the current ADAR endeavors to have at least one discussion a year on each project. A written progress report on at least some of each officer's project is required each year as material for the annual report. There are no formal arrangements for deciding when a project should cease; the decision is made with inputs from the individual officer, the section head, and the ADAR, although the latter has the final responsibility.

In some cases individual research officers have been aware of overseas technology and research. This has contributed to the success of certain projects. In other instances, particularly with coconuts and cocoa, there has been inadequate appreciation of overseas technology and resources, as indicated in Annex 3. With the library and search facilities available in Fiji (section 3.5), and existing linkages with other organizations (section 3.8 and 3.9), there are adequate facilities for establishing and developing fruitful overseas contacts.

### 3.2.3 Improving the Assessment of Priorities

Although it is difficult to assign broad research priorities to either commodities or to major problem areas, this is an essential task; especially in the Fijian context of limited resources for research yet with a wide variety of crops and livestock types to be serviced. Recommendations on major research priorities should be formulated by the ADAR following discussions within Research Division, with assistant directors in charge of other divisions, and any relevant outside organizations. These recommendations should then be passed to the Director of Agriculture and Permanent Secretary of Agriculture and Fisheries, who must make the final decision about accepting them as firm commitments. Such commitments need to be based on long-term planning and not be subject to excessive revision. Obvious points to be considered include the stated importance of the commodity in the current development plan to the national policies relating to geographical regions of Fiji and to class of farmers. The probability of a successful biological and economic outcome to research must be assessed and also the input (personnel, finance, duration of research, etc.) likely to be required.

One difficulty experienced with the current development plan, DP8, is that it tends to set targets without a fully realistic appreciation of the research or development inputs required to meet them. There is also little indication of any priority between production targets set for different commodities. Clearer statements about research priorities will aid in overcoming these limitations in the appropriate sections of future development plans.

Assessment of major priorities for research must inevitably consider the best long-term use of the natural resources of Fiji. This is true particularly for the soil resource, which is non-renewable and can be permanently downgraded if used for unsuitable agricultural practices. Research planning must recognize that different forms of land use are often in competition, and hence good base data on land use is an essential ingredient in ensuring sound assessment of research priorities.

### 3.2.4 Improving the Planning of Projects

As a general rule, there has not been adequate consultation and discussion when projects, or individual experiments within projects, are being planned by the individual research scientists. The meeting of heads of sections within the Research Division, while worthwhile, should not be the only reviewing procedure for examining project proposals; these officers are not the major source of expertise on the problems faced by the farmers who produce a particular agricultural commodity. More consultation should be encouraged with senior extension officers, local or commodity-based extension officers, key farmers, or industry personnel. Such consideration will also tend to encourage more multidisciplinary planning by officers within the Research Division.

Commodity committees, of which there are 8 for individual crops and 5 for different livestock types, could be used to aid the formulation of project proposals. They typically consist of 4 to 5 members with 1 or 2 from Research Division, 1 or 2 from Extension Division, and 1 from the Economics, Planning and Statistics Division. Depending on the stage of development of each commodity, these commodity committees could be

extended with more representatives of farmers and of agricultural commerce. For example, such a committee for pulse crops in the western zone could comprise 2 or 3 farmers (including a large scale producer if applicable), 1 or 2 seed merchants, 2 extension officers, an economist, and a representative from FSC. The committee would examine such factors as the objectives of the proposals -- and how they relate to farmer's needs, consider the applicability of treatments, and suggest suitable sites in terms of soil type and cooperating farmers. A committee of this type could also minimize the setbacks experienced in a research project when the only research officer working with a commodity resigns and is replaced by someone with little experience in that particular commodity. Extension officers may have to act as the advocates for the interests of subsistence farmers.

The advice of economists on questions of economics and marketing should be sought at this stage. Their advice would be on the priority of problems in the commodity concerned and on the implications of research solving specific problems in either one or several ways.

The main role proposed for the commodity committee is to ensure that the planned research is relevant to the farming community. The subsequent examination of the proposal by the heads of section meeting and the ADAR would have a different objective: their primary role would then be to examine the research component to ensure that the proposal takes account of existing local and overseas knowledge, that the design is sound statistically, and that the proposal has been realistically costed in terms of labor, facilities, analyses required, etc. They should examine the constants in the proposed experiment(s), such as soil type, site preparation and basic fertilizer application, as well as examine the experimental variables.

When any proposal has been passed through this reviewing procedure and has been cleared by the ADAR and the meeting of assistant directors, it then passes to the Ministry of Finance. As it is then examined by people whose expertise is neither in agriculture nor research planning, it is essential the proposal be introduced in such a way that its agricultural merit is stated in simple and attractive terms. There was evidence that this had not been considered when project proposals were in preparation. Attention to this will help redress the present imbalance, where productivity tends to be equated only with development and not with research and development. Improved presentation of proposals can result in research being recognized as a way of preventing problems associated with development, rather than as a cure when the problems become manifest.

### 3.2.5 Improving Evaluation of Completed Projects

Evaluation of completed research in institutes that emphasize "basic" science is usually through recognition accorded to published scientific papers by scientists working in related fields. "Applied" research is more difficult to evaluate in that the final outcome must be measured both "scientifically" and "commercially." The usual process of scientific evaluation still applies, but more problems arise with "commercial" -- or in agriculture, "on-farm" -- evaluation. Such evaluation requires experience with the technique, variety, or revised procedure on farm demonstration trials. Planning for such trials, in terms of selection of soils, farmers, and treatments, would usually be arranged through the related extension workers, who would be associated with the project through the commodity committee.

After several seasons of both experiment station and on-farm research, the results should be evaluated by a group which could include the ADAR, the section or commodity head, scientists concerned, and two members of the commodity committee. There need not be a fixed requirement for a final report, but the key points arising from discussion should be noted so they can be made available to extension personnel, members of the Information Section who could prepare dissemination material, and research workers who have related interests.

While stressing the need for project evaluation, scientists should continue to be encouraged to record their findings in an appropriate applied science journal (Fiji Agricultural Journal, Experimental Agriculture, etc.). When scientists outside Fiji evaluate these papers favorably, it will assist in attracting more overseas interest and possibly involvement in Fijian agricultural research. Papers submitted by officers of the Research Division to the Fiji Agricultural Journal are critically refereed, but there is no requirement for refereeing when submitting papers to journals outside Fiji. While there is no need for a highly formal internal "editorial panel" system, it is suggested that the ADAR require that all authors of papers intended for outside journals must have their papers critically read by two referees, either inside or outside of the Research Division.

Finally, the "political" and social aspects of evaluation should not be overlooked. The image of the Research Division, and hence funding, can be improved when politically important people are shown successful on-farm trials, the final testing phase of a successful research project.

### 3.2.6 Flexibility in Procedures

In the preceding sections, there has been emphasized the need for examination of projects at the planning, monitoring, and final evaluation stages. However, it is realized that excessive reviewing and unnecessary meetings can lead to wasted time and staff discontent. Thus the means of improving research planning must not be allowed to become ends in themselves. The system should be as flexible as possible, with a minimum of extra meetings and travel. For example, meetings of commodity committees with identical or partly common membership could be held on the same day; project proposals to be discussed at commodity committee meetings should be circulated prior to the meeting so that informed discussion can commence at once.

However, if the suggested proposals are carried out in the right spirit, they need not be seen as interfering but as a way of improving the effectiveness, unity, and morale of the Research Division; they can strengthen relationships between research, extension, and farmers.

## 3.3 Staffing, Manpower Planning, and Training in Research

### 3.3.1 Present Level of Staffing

Staff resources of the Research Division may be arrayed according to assignment by commodity or discipline, by research station, and by level of training. Among other important resource factors are the ratios of

technical and support staff in relation to professional staff and continuity and experience as reflected in length of service. In assaying an organization at one point in time, it may also be important to consider trend data on key factors.

Although a large share of staff are posted at Koronivia Research Station, many have national leadership responsibility for a discipline or commodities, and they supervise work at several sites. Table 5 shows the dispersion of 1982 projects among the seven research stations.

Table 5. Research work by subject areas for stations where work was carried out, 1982. (Source: P. Sivan, ADAR.)

Research area	Sig	Research Station						Number stations by areas
		Lega	Nadu	Dobu	Seaq	Wain	Koro	
Animal husbandry					x	x	x	3
Pastures	x						x	2
Citrus			x		x			2
Cocoa	x		x	x		x	x	5
Coconut						x		1
Dry zone crops		x					x	2
Rice	x	x		x			x	4
Root crops		x		x	x		x	4
Vegetables	x						x	2
Local fruits	x		x	x	x		x	5
<b>Number of Research areas by stations</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>8</b>	<b>30</b>

In Table 6, the manpower complement for 1981 has been arrayed twice according to unit of assignment -- in one instance by level of training and other by rank. Disciplinary units are botany (2 staff), weed control (3), plant protection (12), and chemistry (16). The latter two have important analytical, regulatory, and service duties in addition to their research role. The 21 station administration personnel represent those involved in managing the stations under the division.

Table 6. Array of staff positions by level of training and rank aggregated by type of unit -- in 1981. Research Division, Ministry of Agriculture and Fisheries, Fiji. (Source: Annual report 1981.)

	Level of academic training				Total
	Degree	Diploma	Certificate	Other	
Crop or commodity units	12 <sup>a</sup>	21	3	4	40
Disciplinary units	10	9	0	14	33
Station administration	1 <sup>a</sup>	3	4	13	21
Total	23	33	7	31	94

	Rank or classification <sup>b</sup>					Total
	Prin. R.Off.	Senior R.Off.	Res. Off.	Tech. Off.	Other	
Crop or commodity units	1 <sup>a</sup>	6	2	10	21	40
Disciplinary units	2	5	3	5	18	33
Total	3	11	5	15	39	73

<sup>a</sup> ADAR is counted in administration and as PRO for root crops research.

<sup>b</sup> Station administration staff of 21 are classified differently and not counted here.

Agricultural research is typically a long-term activity. Investigations must be replicated over time as well as ecological situations. Continuity of staff may be a crucial factor in maintaining a line of work for sufficient time to support reliable interpretation of results. Rolls of the Research Division were analyzed for the period 1974-1981 as a measure of staff continuity. Thirty-seven different persons were listed in the eight years; time of service could be assigned to 25, for whom the average was 5.7 years. The analysis disclosed the following experience among the staff in post in 1981:

Number of persons	Years of service
21	4 or more
18	5 or more
15	6 or more
12	7 or more
11	3 or more

Table 7 displays the allocation of professional staff to the several units of the Research Division. The staffing at research officer and higher ranks is given in annual arrays for the years from 1974 through 1981. Subtotals are struck for the units that are primarily research and for the two units that are nominally analytical and regulatory. Four units had a vacancy for one or more years during that period. The final three years of the period, 1979-1981, show declines of 3.5, 4.5, and 3 manyears from the earlier peak staff periods. (In addition to the staff in these professional posts, there were in 1981 four other degree holders actively involved in research work as understudies.)

Table 7. Research officer manpower levels by research units from 1974-1981<sup>1</sup>. Source: Annual reports of Research Division, MAF.

Subject unit	1974	1975	1976	1977	1978	1979	1980	1981	(Av)
Animal husbandry	1	1	2	2	2	1	1	1	(1.4)
Pastures	2	1	2	2	2	2	2	2	(1.9)
Citrus	1	1	1	1	1	1	1	1	(1.0)
Cocoa	1	.5	.5	.5	.5	.3	0	0	(0.4)
Coconut	1	.5	.5	.5	.5	1.2	1	1	(0.8)
Dry zone crops	2	2	2	2	2	1	1	1	(1.3)
Rice	1.5	1	1	1	1	1	1	1	(1.0)
Root crops	2	2	1	1	1	1	1	1	(1.3)
Vegetables	1	2	2	1	1	1	1	1	(1.3)
Botany	0	1	1	1	1	1	1	1	(0.9)
Agric. eng.	x	x	1	1	1	1	.5	x	(0.5)
Weed control	x	1	1	1	1	0	0	1	(0.6)
Sub total	12.5	12	15	14	14	11.5	10.5	11	(12.7)
Plant protection	5	5	5	5	4.5	4	4	5	(4.7)
Chemistry	5	4	4	5	5	5	5	5	(4.8)
Sub total	10	9	9	10	9.5	9	9	10	(9.4)
TOTAL	22.5	21	24	24	23.5	20.5	19.5	21	(22.0)

<sup>1</sup> Research officers on study leave are omitted from this table.

While the review team suggests more multidisciplinary approach in research efforts, it recognizes the constraint of manpower resources. As

shown in Table 7, a single research officer is assigned to a research area that typically includes a number of commodities. Within supporting units, such as plant protection, there is only one weed control specialist to relate to all commodity programs. The division does not have a general agronomist or economics/management specialist, as would be desirable. Within the manpower constraint, it may not be possible to carry multidisciplinary approach beyond wide involvement at the program development and evaluation stages.

### 3.3.2 Manpower Planning

The review team found no evidence of formal planning in the field of research manpower. Manpower development activities are carried out. For example, seven Research Division personnel were on study leaves in 1982; a number of persons have been granted leave to advance their credentials and have rejoined the division. However, these activities seem to have been ad hoc and individual, not part of a formal plan.

A small staff has limited flexibility for manpower development programs. Few resources can be reallocated to keep a line of work going if the research officer assigned to it is granted leave. In some instances, it is possible for a staff member to pursue graduate studies at the University of the South Pacific (USP) in Suva and still carry on research; however, such work would be other than in agriculture, since the USP School of Agriculture is located at Alafua in Western Samoa.

Diplomates face a similar problem when they consider degree work. The nearest baccalaureate opportunity in agriculture is in Western Samoa. They may be able to earn the B.Sc. in science at USP in Suva, but they cannot specialize there in agriculture.

Manpower programs are affected by the ability of a system to offer attractive career prospects. Conditions of service -- promotion, rank in relation to others of similar status, and various amenities and perquisites -- are among the key factors; and some factors of service are decided beyond the organization itself. Research officers are accorded no unique status in the schemes of public service in Fiji, and the public service plan currently under review appears to have no change in status.

Few public service officials in developing countries seem to recognize ways in which government-wide personnel policies may work to the disadvantage of scientists. One typical problem is that often a person must assume administrative responsibility to achieve the top position in his area. Administration does not combine well with scientific pursuits, so few scientists continue their research contributions after becoming administrators. (The new plan in Fiji perpetuates this situation in that its proposed final grade requires performing functions in managing personnel and other resources.)

Often a system permits promotion of a scientist only when there is an appropriate higher vacancy. Promotion may depend more on another's move that creates a vacancy than on the performance of the promotable officer.

When positions are tied to geographic locations, a person may qualify for a given promotion only by moving. This may mean interruption in a

long-term research endeavor, and the scientist may be required to make difficult family accommodations to achieve promotion.

Government personnel systems managers in some developing countries have sought means to overcome these kinds of problems. In some cases, the research service has been given semi-autonomy, permitting it to develop personnel policies that fit the unique needs of its scientists. In some national personnel systems, a scheme has been formulated specifically to provide conditions of service that fit the work of the scientist.

Some present policies are seen as constraints on the motivations and achievements of Fiji agricultural scientists. Since a new plan is in review, the time should be right for a careful joint analysis of this situation, involving PSC and representatives of the Research Division. (A group of scientists has filed a statement with regard to the plan. The team was not in a position to evaluate the group's proposals fully; however, it concurs in the validity of concern expressed and suggests that careful consideration be given to the proposed "consulting scientist" grade as a means to redress one shortcoming of the plan.)

### 3.3.3 Training

As indicated in Table 4, there appears to be a satisfactory numerical balance among staff with different levels of specialist training for the Research Division. However, numerical balance may not be relevant where each research unit works in relative autonomy; the structure is not a scalar system in which a few persons with high research credentials (Ph.D.) give leadership to a middle cadre of officers (M.Sc.), who lead junior officers (B.Sc.), who supervise technical personnel (D.T.A. and others). In 1981 two field research units were led by staff with advanced degrees -- both M.Sc.; one of those two, the ADAR, also carried major administrative responsibilities. All others with M.Sc. and Ph.D. worked within sections where strong emphasis is on laboratory or regulatory activities rather than on field research.

These facts are not offered as negative criticisms of present personnel or of their current work. The team was favorably impressed by the work of research officers, especially since few have had opportunities for graduate studies, which are usually considered essential preparation for agricultural research. Some present officers pointed out their own needs for higher level training to advance their work beyond its present stage.

Several key areas of research expertise are not currently represented in the staff of the Research Division, including: statistics and biometrics -- for design and analysis of experiments; production economics -- for appraisal of the economics of pieces and packages of technology; and general agronomy or farming systems -- for evaluation of present systems of farming and of commodity research for "fit" to Fiji farming systems.

Agricultural research in Fiji may require a different mix of scientists, and some different ranges of training and expertise, than is now in the Research Division. A forward-looking plan for research is needed, one that helps shape and supports national agricultural development policy. Such a plan would provide a base for projecting manpower needs -- and thus training needs.

Training programs proposed for Research Division staff are subject to review and approval by officials in PSC. Approval is more likely when a proposal has a source of funding other than general government. Without its own financial support, the proposal must compete with demands from all parts of the national government -- agricultural research has no "most-favored status." However, a careful analysis of needs and benefits, leading to an articulated plan clearly related to national development goals, should strengthen the division in getting support for manpower development.

Needs for manpower development are seen in many areas of the Research Division activity. Different levels of training will be required. The present access to training opportunities is thus important.

Diploma training in Fiji is considered to be of good quality, especially as preparation for persons who will go into the extension services or other production or service phases of agriculture. The emphasis of the staff of Fiji College of Agriculture on self-examination should keep its programs in touch with the country's needs. The Research Division might be benefited if FCA could offer some further background in research procedures -- diplomates are a primary source for research technicians, but Research Division must devote considerable effort itself to training them on many routine research operations.

More attention by FCA to refresher and in-service training for technical officers could help Research Division strengthen the support staff capability; this activity may help qualify individuals for further development and training. Both organizations could gain from joint efforts in this area.

Degree training in the South Pacific region is limited to that available in the University of the South Pacific (at Suva and the School of Agriculture at Alafua, Western Samoa) and two universities in Papua New Guinea. The most accessible opportunity for Fijians is the Suva campus of USP; however studies there are limited to the basic sciences, since agricultural specialization is available only at Alafua. Science studies at USP appear to meet acceptable degree standards, and science graduates should be qualified for work in some areas of the Research Division with a minimum of orientation and supervised induction training.

Where agricultural specialization is necessary, however, there is no degree training available in Fiji. Both the USP School of Agriculture and the Agricultural Faculty, University of Papua New Guinea, are in developmental stages. A major development effort at Alafua, with external financial and program support, should add needed strength to that program. The team does not have sufficient knowledge to evaluate either degree or advanced training opportunities at UPNG.

Post-graduate training opportunities in the region are the same as those described above for degree work. The review team did not have a basis for evaluating the post-graduate programs in agriculture in terms of the needs of the Research Division.

A number of universities in Australia and New Zealand are sites for post-graduate training of agricultural scientists in the South Pacific.

These are well-established centers, and they offer work to standards recognized throughout the world. Areas of their scientific expertise represent problems as often encountered in South Pacific regions. Other developed-world post-graduate centers are available and attract Fijians.

In-service training in the Research Division is primarily a one-to-one exercise among research officers and technical staff, based on specific tasks. In cases where a number of staff require training in a particular area -- such as in laboratory processes -- a course may be organized for that purpose. FCA or USP are often engaged for the training. The Fiji Technical Institute has also been utilized for some in-service training.

It is clear that the Research Division will require additional resources in order to recruit, train, and retain an adequate staff of scientists. It will need supernumerary posts to be able to sponsor staff for advanced studies, while continuing present research activities; it will need finances to meet the high costs for overseas training (which will be required for some time in most of the advanced studies). In the light of present public revenues and expenditures, it is probable that external sources of aid will be necessary.

The review team found no planned program of in-service training within the Research Division. A number of useful efforts were reported, developed on a need basis. While this ad hoc approach may keep the staff at the minimum performance levels required, it falls short of a developmental approach which carries individuals to their potentials.

Constraints on training have been discussed in the team's review of this area. There are three main types: lack of incentives to attract the ablest diplomates and graduates and to encourage them to seek long and productive careers in the division; lack of personnel and finances to sustain a continuous program of professional staff development; and the lack of an articulated manpower development plan (based on a sound research plan). The review team believes the first two constraints can best be eased by dedicated and creative attention to the final one. Consultative support could be especially useful here, and both needed advice and finances should be available from external sources.

### 3.4 Research Stations and Analytical and Other Services

#### 3.4.1 Research Stations

The Ministry of Agriculture and Fisheries (MAF) has seven centers designated as research stations (see map 1, p. 38). Five are on the island of Viti Levu; two are in Vanua Levu. These stations were originally chosen, or taken over from other organizations, as sites for crop work in the various agro-ecological and farming regions.

Koronivia Research Station (210 ha), the principal agricultural research station where the headquarters for the Research Division and laboratory facilities of the MAF are located, represents the alluvial floodplain and low coastal hill country systems of the wet zone. Field crops research is carried out on rice, bananas, tubers, cocoa, and pastures, all of which are important land uses in this ecological region. Cropland is in short supply, and some work is done at nearby Naduruloulou Research

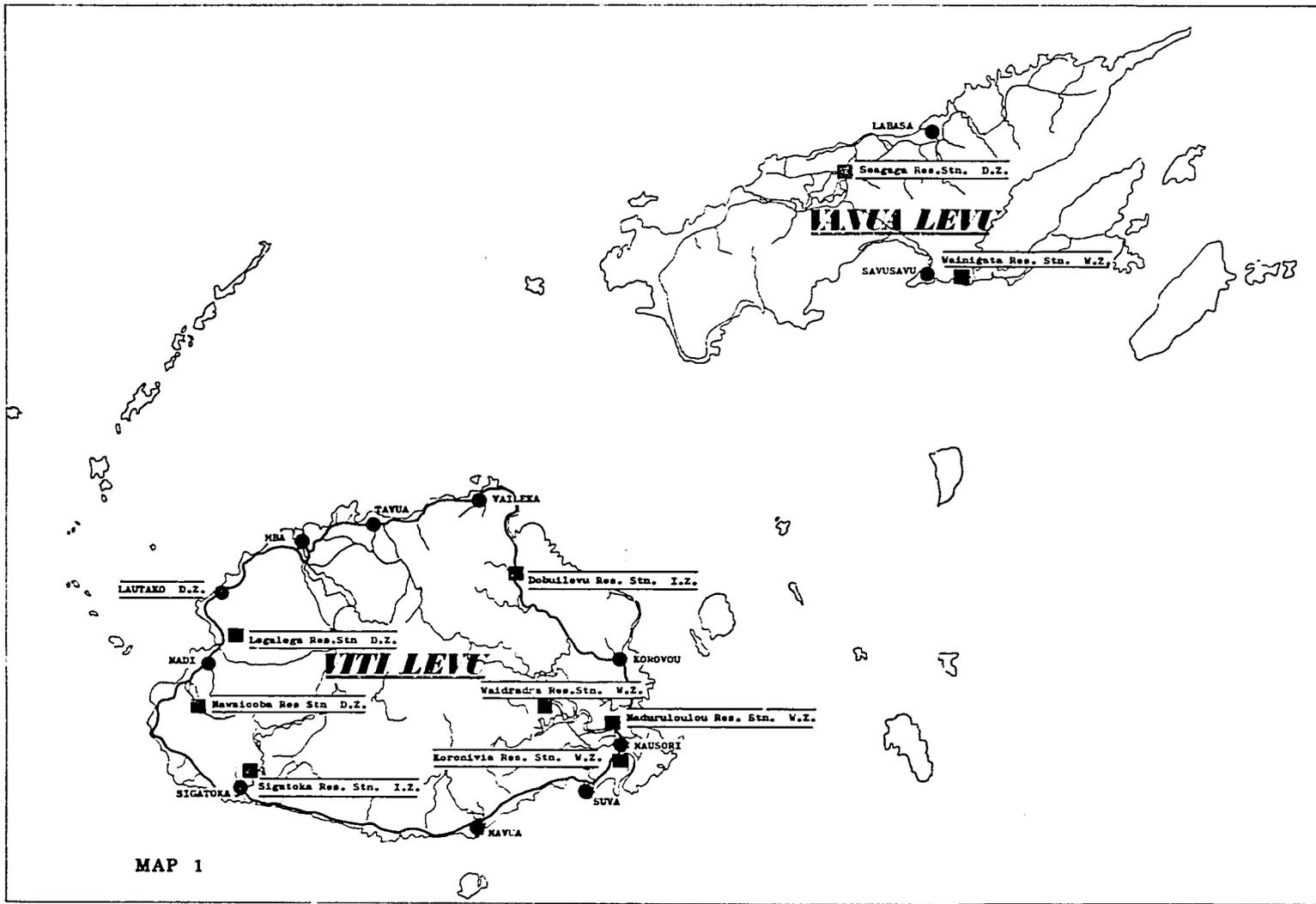
Station (90 ha), which represents the inland hill country system in the wet zone. Naduruloulou is an old quarantine station and is presently used more as a seed garden for tree crops than for field experimentation. It serves a useful purpose as a site for gene collections of cocoa, nutmeg, cloves, cardamon, and vanilla. Physical facilities are adequate at Naduruloulou. The in-house facilities at Koronivia would need expansion to accomodate needs of the immediate future. Major farm equipment and transport appear adequate, although funds for maintenance and replacement have been squeezed as budgets have failed to keep pace with inflation. The staff at Koronivia has library access at the adjacent Fiji College of Agricultural (FCA), which houses the central library of MAF.

Dobuilevu Research Station (50 ha) represents another inland alluvial flood plain and hill country system in the intermediate zone; it has somewhat lower rainfall and a more seasonal climate. The station has three soil groups that do not occur at Koronivia and would, therefore, be useful for long-term agronomic studies. About 5 ha in cocoa trials have outlived their usefulness, and about 6 ha are used for other crop trials. The balance is pasture, used for growing dairy animals. Its location is also important as it is within an area of a projected large development scheme and could have a major role to play in the future. The physical facilities are adequate for its present role.

Sigatoka Research Station (328 ha) is representative of the intermediate zone -- and more particularly the main vegetable farming region of Fiji. It is a complex of hill country adjacent to an alluvial flood plain. There is a marginal shortage of pasture land on the upland because of breeding herds of cattle and goats. Provision should be made to acquire some adjacent land both from upland and alluvial flood plain. In-house facilities would need expansion to meet the growing needs of this station. More basic laboratory equipment would be needed to service the seed purity maintenance and related activities.

Legalega Research Station (42 ha) is located on the older flood plain system of the lowland dry zone. The two common soils of the station are typical for the older flood plain system and do not represent the major soil groups of the various uplands in the dry zone. Despite this limitation, its location is central to the dry zone, and it has the advantage of being close to the sugar cane research station at Lautoka. This station is well suited for research on pulses and other dry zone crops; its location is convenient for carrying out on-farm trials on representative soils in the neighboring areas. It is suggested that a further 100 ha of land be acquired from farmers in the adjacent area to meet the future needs of research and foundation seed production. In-house facilities are presently adequate. Good residential housing would encourage attracting and keeping research scientists at this station. Equipment needs for the station should be determined by the nature of future expansion and posting of staff that is envisaged.

Seagaga Research Station (102 ha) represents a raised plateau area in the dry zone of Vanua Levu. It has a complex soil pattern made up of three major soil orders. It was formerly a forestry station and now serves mainly as a goat and citrus multiplication station. It is in a remote situation with poor communications. For the foreseeable future, work at this station should be reduced to a care-and-maintenance basis consistent with the multiplication functions being carried out there.



Wainigata Research Station (120 ha) represents the complex hill country soils in the intermediate zone of Vanua Levu. Its dry season is pronounced but shorter than at Seaqaga. Coconuts and cocoa make up the major research activity. The station is within the main area for coconuts and the area with most potential for cocoa and coffee production. The heterogeneous topography of the land makes it difficult to conduct good fertilizer and linked intercropping trials. A freehold property belonging to the District Council, some six miles from Wainigata, would appear suitable for this purpose; the work could be controlled from Wainigata. Should this not be available, a similar site should be sought. The physical facilities for its present role are adequate. For future outreach activities, its transport and other supporting facilities would have to be strengthened.

The former research stations shown on map 1, Nawaicoba and Waidrada, are no longer used for research. Nawaicoba is mainly used for quarantine, and its future will depend on the sheep program which will be based to a considerable extent at this station.

#### 3.4.2 Management Structure, Organization, and Staffing

Each of the seven stations of the Research Division is operated under an administrator, who is responsible to the ADAR for conduct of routine operations, timely reporting and accounting, expenditures of the budget, and allocation of resources. A senior officer in research is usually the station administrator, meaning he has dual responsibility: to the ADAR for administration of the station and to the senior officer in the commodity or discipline for his own research.

Each station has its own manager who has responsibility for conduct of the station, providing needed labor and equipment to support the research and other operations. Because of its nearness to Koronivia, the Naduruloulou station is operated under the same management.

The management system for the research stations appears to work well. Upkeep was observed to be good, especially when considered in terms of the limited operational funds available in recent years.

The Koronivia station fills a dual role as the central headquarters for the research system and as a center for a specific ecological region. It is well staffed in comparison to other stations. However, even here as noted elsewhere in the report, the review team believes some additional staff resources are required. For other stations which serve major ecological regions -- such as Legalega, where there is only one professional staff position -- additional staff is needed if the station is to serve as a research center closely linked to the agricultural development of the region. Well prepared medium- and long-term research plans, directed to national and regional development needs, are essential to determine the staff requirements for the research stations.

#### 3.4.3 Analytical Services

Two disciplinary sections at the Koronivia station devote major attention to analytical services. One, the Plant Protection group, has

responsibilities in licensing and regulation of agricultural chemicals in addition to research; the Chemistry Section is mainly engaged in services provided through five groups described below. The nature of these sections, in relation to other activities and of the Research Division, justify special discussion of certain issues and problems.

The Chemistry Section at Korinivia is divided into five groups, agricultural, biochemical, pure food, forensic, and food technology (the latter unit is soon to be rehoused in a new building). In 1981 the first four groups analyzed 5,633 samples involving 21,436 determinations. Of these, 56% of samples and 67% of determinations were analyzed by the agricultural chemical group; the respective figures for the other units were 12% and 14% by the biochemical group, 20% and 16% by the pure food group, and 12% and 30% by the forensic group. Eighty percent of the the biochemistry group analyses were carried out for agricultural purposes; less than 3% of the analyses by the pure food group and less than 1% by the forensic group were for agriculture.

Many items of the equipment in the Chemistry Section laboratories have more than overrun their estimated life span (e.g., atomic absorption spectrophotometer) or are insufficient in number or both (e.g., pH meters). The position regarding equipment is reviewed annually, but perhaps more emphasis should be laid on the possible results of failure of major equipment. Every effort should be made to procure new equipment in order to ensure reliability of operation, either from initial or external capital funding in view of the urgency, reducing the present equipment to standby.

Since the upkeep of the Chemistry Section is a charge on the capital and operational budget of the Research Division, it is reasonable to enquire whether the work of the pure food and forensic groups should not be transferred to the appropriate ministry having responsibility for home affairs. Services provided by the groups are normally those of a government chemist (or analyst); such facilities are normally made available at a central location. While a portion of the present budget would possibly go with the facilities, the laboratory space would remain; also the PRO would be spared the duty of identifying samples in court and testifying to the analyses -- activities that have little agronomic productivity.

The agricultural chemistry group analyzed 3,177 samples in 1981 involving 14,367 determinations. Sixty percent were for research purposes, 35% were for other government or quasi-government organizations, 3% were for the Extension Division, and 2% were for the private sector. Two main questions arise: first, are the 14 officers doing research in the division (including three research officers in plant protection but not five in chemistry) making full use of an average of 135 sample analyses per officer per year?; second, why are these services ignored by clients who would normally use such resources -- small farmers (through the Extension Division) and the private sector? A possible answer on lack of work for small farmers may be that extension officers are not fully aware of the information available through such analyses, or it may be that results are not interpreted adequately. A review of procedures might eliminate complaints about tardy service coming from the private sector; if such services were provided promptly and at economical charges (just high enough to eliminate irresponsible applications), private growers

might turn to these services instead of using alternative local or overseas ones as at present.

The review team noted that the chemistry group makes only a limited number of cross-checks on its analyses. Even though standard routines and materials are used, a working procedure should include checks on an adequate sampling of its tests by, for example, the laboratories at the Fiji Sugar Corporation and the University of the South Pacific, and by at least one overseas laboratory. Examples from other countries indicate the importance of adequate precautions to guard against errors that arise despite rigorous adherence to procedure; undetected errors may invalidate considerable work.

Issues associated with the Food Technology Section are less straightforward. Any firm going into food processing on a commercial scale would probably import or transfer its own technology. The primary requirement under those circumstances is for a laboratory to monitor standards; that already exists, whatever its future location. There is a need, however, for work on the processing of existing crops or others that may be introduced. This need would involve technology transferred and adapted to local conditions.

The Plant Protection Section also performs a regulatory function under the Pesticides Act. In 1981, 33 applications were received for registration of pesticides, and 28 were granted. There appear to have been no similar notifications regarding fungicides or herbicides, although it is understood that note is taken of those employed. As a matter of principle, it seems inadvisable to allow this and other regulatory functions to be performed at bench level. However, evaluation and testing, if necessary, should be carried out there, with approval given at a higher level by MAF staff.

None of the analytical service units is equipped to use electronic data storage and processing to enhance the use of the results of their tests. A study of the utility of either a minicomputer with peripherals (printer, floppy discs) or a computer terminal seems justified. Such equipment could support greater use of results by research officers through efficient means to record, collate, and retrieve records. The same equipment could be used to aid administration of personnel, payroll, budgeting, and other activities.

#### 3.4.4 Land Use Section

The Land Use Section is headquartered at Koronivia, where it uses physical facilities available within the Research Division. It is at present a part of the Economics, Planning and Statistics (EPS) Division within MAF. There are three working units within the Land Use Section, dealing respectively with soil survey and classification, soil conservation, and land use planning.

The earlier studies on soil resources of Fiji by Twyford and Wright (1965) provided a useful information base for major agricultural development projects during the last 20 years. The system of soil classification adopted by Twyford and Wright does not, however, easily permit correlating Fiji soils with those of other countries; and this has

meant that agro-technical information from more advanced countries could not be readily transferred to Fiji. To rectify this shortcoming, work is in progress to classify the existing soil series according to U. S. Soil Taxonomy, also to prepare modern 1:50,000 scale national soil maps, together with a set of supporting soil interpretation and correlation tables. A pedologist/soil correlator from New Zealand has been seconded for a two-year term to the Land Use Section at Koronivia to support this work. Commendable progress has been made to date, and it is suggested that the highest priority be given to support completion within the five years, 1980-85.

The Land Use Section is both a producer and a consumer of research results. Proper land use planning is based on a sound understanding of the resource base provided by soil survey and classification data, and its appropriate interpretation by the biological and social scientists. The EPS cannot be considered the ideal institutional base for the location of this section. The scope and nature of the Land Use Section's work requires a close involvement with crop scientists and agronomists. Its long term interests would thereby be more effectively served by a closer integration with the Research Division.

#### 3.4.5 Producing and Selling Seedstocks

Various items of planting material, produce, and stock are produced and sold by the Research Division. Usually this consists of cultivars in which a particular station specializes, and the usual buyers are farmers. This is one important interface with the agricultural community; properly organized, with materials sold at a reasonably economic price to enhance value, it helps stimulate progress. Formation of a planting material committee may be worth considering. Among its tasks could be evaluating cultivars to be multiplied; determining how and where this should be done; estimating amounts to be produced; and setting prices (including subsidies, if any). This would enable accurate budgeting of funds required. It might be prudent for government to consider applying some of the revenue arising from such sales to a revolving fund to improve production and distribution of planting material. (In one case, production of pulse seeds at Legalega, was limited by lack of funds.) Under the present arrangement, where sales income passes to general revenue, seed production represents direct competition for research operations funds.

#### 3.4.6 For Further Study

It is proposed to obtain an area on Taveuni Island that would be used for work on altitude zonation effects on vegetables, root crops, and fruit trees. Two areas of freehold land have been identified, about 14 and 72 ha, respectively, on the north and south boundaries. This land commences on the west coast side at about 460 m and goes to an altitude of 910 m. It is understood that there is fair access to these two strips of land, which have reasonable basalt-derived soils and perennial streams available. However, the topography over at least two-thirds of the area is steep; controlled work could be difficult and perhaps give misleading results, particularly on fertilizer effects. The opinion of the review team is that potentialities of Taveuni should be explored further for a

more suitable site before a final decision is made. The present marketing position for future crops appears difficult and unlikely to improve in the short term; it is assumed that this question been considered with a finding that prospects justify the expenditure.

The Wainigata Research Station is not suitable for the strictly controlled coconut variety, fertilizer, and linked inter-cropping trials needed in the main growing area of Cakaudrove District. An alternate site needs to be acquired where this work can be carried out, with the Wainigata station as a headquarters.

When originally acquired, the research stations were used as sites for controlled experiments determined by the Research Division. A distinction between research and development activities is no longer clearcut. It might be appropriate now to define the functions of individual stations, according to some or all of the following uses:

Locations for strictly controlled research trials;

Base from which to extend adaptive trials onto farmers' or plantation fields;

Site for development of proper nurseries for production of planting material, subject to selection pressure (particularly in the case of perennials);

Base for local investigations by subject matter specialists;

Site for establishment of genetic pools of both established crops and those which are assessed as having potential

In defining the functions of individual stations and what amendments or alterations would be desirable, first attention might be given to Seqaqa, Naduruloulou and Wainigata.

The role of the Food Technology Laboratory at Koronivia, in the view of the review team, needs to be reassessed in light of available resources and research priorities in Fiji. The laboratory appears to have a broad mandate but limited resources, and the likelihood of a productive output is limited. While this is a small part of the Research Division and of the work at Koronivia, it nonetheless draws on scarce resources and is working in an area where there are few examples of success under similar conditions. The research work associated with this new facility can be a positive factor in the work of the Research Division, but it was not apparent to the review team that this will occur unless a sharper focus is given to its proposed program and more evident links are made with other work of the division.

### 3.5 Communications and Information

The flow of information is important within the Research Division in two distinct ways: (a) in the operations of the system (the functioning of the various units) and (b) in the substance of its work (defining problems, understanding national development needs, utilizing existing knowledge, and presenting results). The review team evaluated

organizational aspects of communication as well as the more visible channels over which scientific information flows.

### 3.5.1 Organization and Information Flow

Within the division. The Research Division is a relatively small organization with few organizational lines (outlined in Section 3.1.2). In most instances, the ADAR has a direct line to each research officer; and each officer is in direct contact with his or her technical support personnel. This permits a simple, predominantly interpersonal, communication structure. Each research leader relates directly to the station administrator from whom he is allocated land, labor supply, and materials for his work. A majority of the researchers are based at the same location, Koronivia Research Station, which facilitates direct personal contact. Processes of planning and management, which are described elsewhere, operate mainly by direct interpersonal contacts.

The review team believes that generally good flow of information within the division can be improved. It is recommended that such steps as the following be taken to strengthen and widen understanding of the division staff: prepare minutes or reports of quarterly meetings of section heads and circulate them to all technical staff; include all research staff in some meetings that involve planning, reviewing, or reporting research projects; and encourage interdisciplinary discussions of research plans and results when appropriate. Specific current duty statements should be developed to guide the person in each post within the established staff and then used in reviewing individual performance. Statements should cover research objectives, duties and responsibilities, and criteria for evaluation of performance.

Within the ministry. The Research Division can deal with other MAF units in a straightforward and interpersonal manner. The ADAR sits as a peer among division heads reporting to the Director of Agriculture (DA). That one administrative level links the ADAR and top administrators of the ministry, permitting a close two-way channel between the division and the policy level in MAF.

Three relationships have special significance to the communications responsibilities of the Research Division: with the Extension Division; with the Fiji College of Agriculture (FCA), including the national library; and with the Information Section of MAF.

Communication with the Extension Division. The research and extension divisions are parallel within the organization, both reporting to the Director of Agriculture. The Research Division needs Extension Division input in defining production problems in the agricultural sector, in locating field research areas for on-farm trials of emerging technology, and in diffusing research results to potential users. The Extension Division needs the Research Division to provide adapted technology it extends.

The review team found considerable variation in the extent of contacts between extension and research personnel (see Section 3.7). There appeared to be no formal linkages or regular interactions. Some staffs were cooperating, generally as a result of individual initiative. The

Research Division makes its results available to extension workers formally in the annual report, in the Fiji Agricultural Journal, and in occasional research bulletins. Some extension workers indicated that many of the official reports offer relatively little that they can interpret and extend directly to farmers.

A closer relationship, formalized if necessary, would benefit both divisions. Extension workers could provide a continuing flow of information on needs and farming situations from their field contacts, perhaps through joint quarterly meetings between both divisions, similar to those now held within the Research Division. Research staff could probably contribute more to extension workers through direct demonstration and discussion of findings.

Communication with FCA. The Research Division headquarters and the campus of FCA are adjacent. This provides for much personal contact between the two agencies; students and college staff share projects on the same lands with researchers, for example. The library, which is housed on the campus, is evaluated favorably by the research staff (although the librarian reports relatively few requests for service from that group). Through an arrangement with a national library in Australia, it provides a point of access to worldwide agricultural data bases at no cost -- another service that is used only sparingly by the research staff, according to reports.

The Research Division diffuses some of its findings and experience to students at FCA through guest lectures. Since most technical workers in extension, research, and the private agricultural sector are recruited among diplomates of FCA, this personal communication link could be developed further and carried forward when students leave.

Communication with the Information Section. The one group of specialized information staff in MAF is found in the Information Section. This group provides services for publications, press, and radio. It is a ministry-wide service section, not included organizationally among the units that report to the DA. While it looks to the Research Division and other agriculture divisions for material, the section does not have formal links to them. Information officers report that they have difficulty in getting material from research officers.

The Information Section represents the ministry's link to mass media channels that can reach the widest sampling of audiences that are important as users of Research Division material. The section produces: daily 15-minute radio programs in English, Fijian, and Hindustani; farm page services to English and vernacular newspapers; and occasional farmers' leaflets. The section also arranges for the commercial printing of, but does not edit, the Research Division's annual report, the agricultural journal, and research bulletins. (Research Division support for strengthening this section is discussed in section 3.5.3.)

### 3.5.2 Quantity and Quality of Communication Products

The Research Division takes creative and editorial responsibility for several scientific reports: the annual division report, Fiji Agricultural Journal, and research bulletins. The scientific reports are presented in physical format and quality comparable to those issued in many countries; they are set in type, printed on book paper, and bound by a commercial printer. They are satisfactory for arrangements that bring 300 or more agricultural journals to Fiji on an exchange basis. Publishing charges are paid by the Information Section budget.

Most of the formal effort in reporting goes into the series listed above. Their usefulness is probably greatest for other researchers. Extension staff indicate that they do not find these materials fitted to their needs (they want information that can be offered as specific recommendations). The reports tend to be technical, offered with little context or implications; as such they have limited usefulness to policy-makers or persons who merely are interested in agriculture in Fiji. The division could gain from planning and preparing materials especially directed to some of its most significant audiences, as is recommended below (section 3.5.4).

The research staff occasionally prepares material for farmers' leaflets, which offer practice recommendations based on research. In this instance the manuscript is presented to the Information Section, and the publications editor supervises editing, illustration, and duplication. Most copies go to the Extension Division for use with farmers. Samples examined were uniformly of low visual quality, presented in typescript with hand-drawn illustrations, lightly inked, and of poor general legibility.

Press services of the Information Section utilize material from the Research Division. A service is issued each week to English and vernacular newspapers that have farm pages. English-language papers reach no more than 2% of farmers, it is estimated; that service emphasizes policy matters and public affairs reporting. The vernacular papers, in which more practice-oriented articles are presented, are reported reach many farmers. (It is said that 80% of the staff effort in press is given to the English-language service -- because it is subject to close scrutiny within MAF and in other parts of government.)

Radio represents the major mass medium in Fiji. It is estimated that all families have one or more radios, and that about half have audio cassette recorders. The Information Section provides daily programs (five days per week) for broadcast on the national network. Each program deals with an average of three to four topics in the 15 minutes; a separate program is produced and recorded in the MAF studio for each of three languages.

### 3.5.3 Staffing

The Research Division has no staff trained to specialize in information or communications -- which is true in many other

agricultural research systems. An officer may serve as editor, by appointment, for an annual report or other scientific publications, but no specialist support or training is provided. While some staff may play a supporting or review role for some of the reports, there is no formal review procedure for other reports, such as articles for international journals.

Discussion of staffing for communications work thus deals only with persons in the Information Section of MAF. One has a diploma in journalism, one has a bachelor of agriculture degree, four have had short-term training in some phase of information. Three persons are assigned to radio production, three to press services, one to publications, and others in section leadership and support services.

Staff members in Information Section recognize their lack of training for communications work; all have indicated aspirations for professional improvement, ranging from desire for overseas internships in broadcasting to degree work in communications. An experienced expatriate with 20 years of work in agricultural information is currently on assignment with the section, under an arrangement with the Commonwealth Fund for Technical Cooperation. He is working with the staff to evaluate their activities and to help strengthen them professionally with in-service and external training opportunities.

The review team recommends that the Research Division support steps to develop a staff of adequate size and training to provide it access to the following specialized support: professional editorial services to improve quality of scientific reports, bulletins, and articles; writing services to popularize findings from research and disseminate them to more potential users; upgraded production equipment and services to provide published materials of better quality; and professional advice on planning communications efforts.

#### 3.5.4 Communicating with Major Audiences

One of the most vital communication relationships for a research organization is with the policy-making units of the government it serves. Research provides results that can alter development policy alternatives, but policy-makers must know of the results and how they can be used. The analytical tools of researchers may be means of obtaining reliable answers to questions facing the policy-makers, but the researcher must know the questions. In discussions concerning national agricultural development policy, the review team found officers open and interested in more contributions from the research group. To be useful to them, however, contributions must go well beyond the reporting of data from experiments, as now characterizes formal Research Division reports. Considerable interpersonal contact may be necessary to establish productive two-way lines of communication.

The review team saw two principal types of materials prepared to communicate findings to other audiences, one type reporting to persons who could use technical results directly and the other prepared for use by producers. Only a few topics of the latter type were available. Both types need improvements such as could be provided by

professional writers and editors, especially to be more useful to the desired audiences. More attention should be given to identifying the key audiences -- including policy makers and political leaders, the extension services, and external assistance agencies -- and then to communicating effectively with them through personal channels as well as published materials. Especially because of limited literacy among some audiences, more attention should be given to communication by channels other than print. The Research Division should take more initiative to use radio to reach producers with appropriate information and advice. The potential of videotapes should be explored in such places as food markets. (Several groups in Fiji have needed expertise and equipment for videotape production.)

The Research Division relies heavily now on extension workers to communicate with Fiji agricultural producers. That is appropriate, and stronger links between the divisions can improve the two-way flow that is needed. However, the Research Division can build other bridges between its scientists and those who can use their findings. One such means is by identifying, and providing recommendations to, organizations that sell or supply inputs and who may offer advice to producers. Various other groups that work with producers, such as marketers and credit providers, can often help scientists identify problems on which research should be focused.

Research Division objectives stress adaptation of technology that exists elsewhere. This implies that researchers will know what is available and can concentrate on adapting and verifying promising technologies. They must be in touch. Basic structures and services exist to link the Research Division to the world sources of published agricultural science and technology, but the actual use made of them varies a great deal. The important personal interactions of scientists is difficult in Fiji. In many cases, only a few persons -- sometimes only one -- are doing research on a particular topic in Fiji, so there are few opportunities to interact with others for ideas and support on that topic. For many in Fiji, the only opportunity for this interaction is with persons overseas. Overseas conferences and study tours are costly, of course, but it may be false economy to limit this investment too much. It is recommended that means be sought to provide more support for this kind of activity by the staff directly involved in research projects.

### 3.5.5 Constraints

Two types of constraints seem to limit the exploitation of information opportunities by the Research Division. One is the lack of access to trained and experienced professional communications staff. The products of the press and radio sections in the Information Section seem to be of reasonable professional quality. Those staff members, however, are constrained by lack of professional standing in their relations with other divisions -- they are not looked to for professional counsel in communication planning or program development. Another type of constraint is in the relatively weak "clout" that the section has in terms of getting access to information. The staff is cast in a submissive role, with little more than personal persuasion to array against a possibly arbitrary view

held by a research officer. (For example, the publications editor has no editorial role in major research reports, although costs are paid from the Information Section budget.)

Equipment is also a constraining factor, although it is judged to be less limiting than are those noted above. A duplicator of reasonable quality is perhaps the most needed -- and recommended -- piece of equipment: farmers' leaflets are scarcely readable because of poor duplication (one wonders whether such a poor-appearing product is considered credible by potential users). Radio studio equipment needs upgrading. A turntable is said to be of inferior quality; lack of soundproofing of the studio causes interruption due to such noise as a heavy rain; cartridge equipment would add production flexibility for better editing and presentation of interview material.

Some investment in basic equipment for the Information Section should prove useful to the Research Division in its need to communicate effectively. Careful consideration of this point is recommended.

### 3.6 Finance and Budgeting

This section describes the budgetary procedures through which the research system obtains its funding and the procedures governing the management of funds. It looks at the adequacy of funding available to the Research Division and its programs in light of the government's ambitious agricultural development plans.

#### 3.6.1 The Budgeting Process

The present procedures of budget preparation and approval (program budgeting) which were introduced by the Government of Fiji recently appear to be functional and straightforward. Measures are being taken to overcome some initial problems encountered by research staff in handling these new procedures. In the Central Planning Office (CPO) a project planning unit is being established which will assist the technical ministries to build up their internal project planning capabilities. Along similar lines at the technical ministry level, a project planning and budgeting section is being built up within MAF, which will coordinate and provide leadership to the various divisions in their project preparation efforts. These units are expected to raise the quality of project preparation so that the research system will be more successful in attracting funds.

Procedures for the allocation of funds and their release appear to be satisfactory on the whole. A high degree of horizontal transferability of funds (transfers from one section to another within given votes) provides the necessary amount of flexibility.

Funds for the livestock and pasture programs are allocated separately from the crop programs and, consequently, funds cannot be transferred between these two broad groups. Funds for goat research, currently under control of Animal Health and Production, are separate from the Research Division, although local budgeting oversight is provided by the Sigatoka Research Station. If goat research were to come under

control of the Research Division, there would be more flexibility in moving funds between all livestock work. Possibly the crop/livestock barrier could also be removed, enabling movement across all programs in the Research Division.

The review teams believes that the flexibility in moving funds could be increased by two additional measures:

- a. eventually reducing the number of votes to more manageable dimensions (i.e., comprising the essential types of expenditure);
- b. streamlining the approval process for transfers of funds.

Funds allocated to research are normally made available in a timely manner. Hence, there are no serious cashflow problems.

Budget management, disbursement of funds, and accounting are organized on a decentralized basis. The monitoring of expenditure and reporting requirements are reasonable. Reports are organized on a monthly basis.

The team considers the existing procedures for project preparation, budget management, and expenditure control to be generally acceptable.

One financial management issue calls for a special comment. The proceeds from the sale of seeds, planting materials, and livestock on research stations presently flow to the government's central budget. The mission recommends that 50% of these proceeds be retained by the respective station and utilized for the establishment of a revolving fund. This would help to alleviate some of the stations' funding problems; yet, it would not constitute an income-generating activity which might divert the attention of station managers from research.

In a similar way, the chemistry section located at Koronivia Research Station, which carries out large amounts of chemical analyses for non-research clients (in particular, public sector institutions), should be authorized to levy charges for these services at rates which permit full cost coverage.

### 3.6.2 Financial Resources for Agricultural Research

In attempting to determine the adequacy of the level and structural composition of funding for agricultural research, consideration was given to the relative position of the agricultural sector within the national economy, the country's development objectives, the role and tasks assigned to agricultural research, and the overall resource base from which funds can be drawn.

A look at the government's central budget and the allocation of funds to the various ministries shows that the share of MAF in the national budget amounts to 5.4% of total resources (Table 8). This share not only sharply contrasts with the important contribution to gross development product (GDP) by agriculture (23.1% of GDP), it also conflicts with the development objectives and policy statements of DP8, which has assigned to the agricultural sector the role of an "engine of overall economic development."

Table 8. Allocations in the Ministry of Agriculture and Fisheries Budget to Research and Extension (F\$000). (Source: National Budget for 1982.)

	1981.	1982.	1983.
National budget	315,166.9	349,552.5	348,840.3
MAF budget	17,736.4	18,773.8	15,865
MAF budget as % of national	5.6%	5.3%	4.9%
Total MAF extension expenditure (crops, livestock, fisheries)	4,670.0	5,253.5	4,914.4
Extension as % of MAF budget	26.3%	28.0%	31.0%
Total MAF research expenditure (crops, livestock, fisheries)	2,189.1	2,353.4	2,228.2
Research as % of MAF budget	12.3%	12.5%	14.0%
Budget of Research Division	1,341.3	1,511.2	1,448.8
Budget as % of MAF budget	7.6%	8.0%	9.1%
Budget as % of national budget	0.4%	0.4%	0.4%

On a broader scale, research expenditure for agriculture (including livestock and fisheries, but excluding sugar) is less than 2% of the sector's contribution to GDP. With a share of only 8% of the ministry's total funds, the Research Division carries out its research program, produces seeds and planting materials, and provides chemistry laboratory services to non-research clients.

### 3.6.3 Allocation of Funds to Research Activities

The allocation of resources by the Research Division to its programs and activities directly follows the decisionmaking process on project preparation and program formulation (section 3.2). This process has, despite some imperfections mentioned earlier, produced generally satisfactory results. Yet there are a number of imbalances: they concern the allocation of funds in relation to such criteria as program area (commodities), region, client group, discipline, type of project, and type of activity.

Allocation of funds by program area (commodities): Support for different commodities has tended to follow historical patterns of staff development rather than functional analysis of research needs and development objectives. Allocations are not fully in line, therefore, with national development policies. The rice and tree crops programs (particularly coconuts) are examples of seriously underfunded programs (Table 9).

Table 9. Resource allocation by research programs and stations for 1982. (F\$)

	STAFFING						BUDGET ALLOCATION				Total		
	Professional			Technical			Clerical	Laborers	Establ. Staff	Unest. Staff		Operat. Costs	Capital
	TOTAL	PRO	SRO RO	TOTAL	STO TO	STA TA SFA FA							
<b>Crop Production:</b>													
Coconuts	1	-	1	2	1	1			29,433	19,576	2,650	-	51,659
Cocoa	-	-	-	4	4	-			31,148	71,346	6,313	-	108,807
Citrus	1	-	1	2	-	2			21,946	13,612	3,100	-	38,658
Fruits and minor tree crops									-	11,122	570	-	11,692
Rice	1	-	1	5	2	3			45,000	45,151	6,183	6,500	102,834
Minor field crops									-	13,612	3,100	-	16,712
Pulses and dry zone crops	1	-	1	6	1	5			46,615	35,768	8,000	1,800	92,183
Root crops	1	1	-	5	2	3			32,931	22,481	5,384	-	60,796
Vegetables	1	-	1	4	-	4			33,415	57,200	7,900	2,700	101,215
<b>Crop Research</b>	<b>6</b>	<b>1</b>	<b>5</b>	<b>28</b>	<b>10</b>	<b>18</b>			<b>240,488</b>	<b>289,868</b>	<b>43,200</b>	<b>11,000</b>	<b>584,556</b>
<b>Specialist Sections</b>													
Plant protection	5	1	4	11	2	9			122,751	52,080	17,150	-	191,981
Botany	1	-	1	2	-	2			22,486	3,432	1,250	-	27,168
Weed control	1	-	1	2	-	2			22,207	14,600	3,400	-	40,207
Chemistry	5	1	4	13	4	9			134,271	7,214	13,350	-	154,835
Reserve									-	22,506	7,350	-	29,856
<b>Specialist sections</b>	<b>12</b>	<b>2</b>	<b>10</b>	<b>28</b>	<b>6</b>	<b>22</b>			<b>301,715</b>	<b>99,832</b>	<b>42,500</b>	<b>-</b>	<b>444,047</b>
<b>TOTAL CROPS AND SPECIALIST SECTIONS</b>	<b>18</b>	<b>3</b>	<b>15</b>	<b>56</b>	<b>16</b>	<b>40</b>			<b>542,203</b>	<b>389,700</b>	<b>85,700</b>	<b>11,000</b>	<b>1,028,603</b>
<b>Livestock Research</b>													
Dairy and piggery	1	-	1	5	1	4			38,420	52,952	5,750	-	97,122
Beef and pastures	2	-	2	4	1	3			45,078	28,548	3,650	-	77,276
<b>LIVESTOCK RESEARCH</b>	<b>3</b>	<b>-</b>	<b>3</b>	<b>9</b>	<b>2</b>	<b>7</b>			<b>83,498</b>	<b>81,500</b>	<b>9,400</b>	<b>-</b>	<b>174,398</b>
<b>TOTAL RESEARCH PROGRAMS</b>	<b>21</b>	<b>3</b>	<b>18</b>	<b>65</b>	<b>18</b>	<b>47</b>			<b>625,701</b>	<b>471,200</b>	<b>95,100</b>	<b>11,000</b>	<b>1,203,001</b>
<b>Research Administration*</b>													
Koronivia	20			40		10	78		67,348	80,598	12,300	4,000**	164,236
Sigatoka	2			8		3	30		24,356	31,588	2,200	-	58,144
Legalega	2			4		2	10		15,684	3,632	1,580	-	20,896
Seqaqa	1			5		1	11		9,389	10,496	1,910	-	21,795
Dobuilevu	-			2		-	9		7,610	7,014	1,050	-	15,674
Wainigata	1			2		1	12		10,803	3,582	1,460	-	15,845
Maduruloulou	-			1		-	16		na	na	na	n	na
<b>RESEARCH ADMINISTRATION</b>	<b>26</b>			<b>62</b>		<b>17</b>	<b>166</b>		<b>135,190</b>	<b>136,900</b>	<b>20,500</b>	<b>4,000</b>	<b>296,590</b>
<b>GRAND TOTAL</b>	<b>26</b>	<b>3</b>	<b>18</b>	<b>127</b>	<b>18</b>	<b>47</b>	<b>17</b>	<b>166</b>	<b>760,891</b>	<b>608,100</b>	<b>115,600</b>	<b>15,000</b>	<b>1,449,591</b>

\* STAFFING figures include both program staff and administrative staff  
 \*\* Special Expenditure

PRO - Principal Research Officer  
 RO - Research Officer  
 TO - Technical Officer  
 STA - Senior Technical Assistant  
 TA - Technical Assistant  
 SRO - Senior Research Officer  
 STO - Senior Technical Officer  
 SFA - Senior Field Assistant  
 FA - Field Assistant

While DP8 has assigned them important roles in strategies of import substitution, export promotion and diversification, the required funds have not materialized.

Allocation of funds by region: While DP8 states government policy aiming at reducing regional differences, the allocative pattern tends to favor the central division (Table 10). The chronically low levels of travel funds for research staff based at Koronivia (or some other station), and who are expected to serve the country as a whole, tend to decrease their mobility and hence their impact in other regions.

Allocation of resources by type of client group: While under the present resource endowment not enough is being done for the commercial farming sector (and its demand increases steadily), less is done for the large group of subsistence farmers. Research for this group is demanding and complex, some parts of the farming systems would have to be studied to determine research priorities. A systems approach by a multidisciplinary team is required.

Allocation by research discipline: While certain sections and disciplines are adequately staffed and funded in line with minimum requirements (chemistry and plant protection) (Table 9), others are nonexistent (biometrics and economics). Remedial action is required.

Allocation by type of project (time-frame): As long as resource constraints do not permit adequate coverage of immediate research needs, it is difficult to envisage setting aside any substantial resources for research of a longer term nature. Yet a research effort on future problems is required. The mission feels that it would be appropriate to allocate to the ADAR on a yearly basis a certain amount (possibly some 10% of the research budget) for research activities of a more speculative, long-term nature.

An important consideration in the allocative process concerns decision-making between new projects and the strengthening of ongoing work. In some areas the mission noted an undue emphasis on the submission of new research projects. The team recommends that special consideration be given to rectify this deficiency.

Allocation of funds by type of activity: It is well known that, in order to mobilize the full potential of a good research team, adequate provision has to be made for equipment, maintenance, and operating and travel funds. Hence total funding has to be broken down into carefully balanced allocations. The optimal breakdown will largely depend on the type of program and its regional coverage and responsibilities. In a country with Fiji's regional diversity, a research team based in one location, but carrying responsibilities for more locations, needs travel and operating funds. Yet, as Table 9 shows, the allocation of operating funds is considerably less than 10% of total funds, which falls short of minimum requirements. Consequently, staff is partly immobilized and their effectiveness is jeopardized. The mission recommends that consideration be given to this fact. Researchers must be able to visit their clients in the different parts of the country (jointly with extension agents).

### 3.6.4 Funding of Research Support for Development Activities

Throughout its numerous visits to research stations, regional testing sites, development projects, development agencies, and development-related ministries, mission members became increasingly aware of four phenomena which characterize the relationships between research and development activities in Fiji.

- a. A heavy emphasis on development activities/projects, which is reflected in the allocation of funds within MAF between research and development-oriented activities.
- b. The majority of agricultural development projects are conceived and executed without appropriate research coverage.

Table 10. Budgetary allocations for recurrent expenditures by research stations from 1978 through 1982, by amounts and by index numbers.

Research station	Administrative division	Budgetary allocation					
		1978	1979	1980	1981	1982	
Koronivia	F\$000 index	Central	339.7 100	284.0 84	342.7 101	336.0 99	360.8 106
Naduruloulou	F\$000 index	Central	49.4 100	43.8 89	48.8 98	54.2 110	58.5 118
Sigatoka	F\$000 index	Western	106.1 100	122.1 115	123.0 116	109.5 103	123.5 116
Legalega	F\$000 index	Western	40.6 100	36.2 89	42.2 104	43.1 106	49.0 121
Dobuilevu	F\$000 index	Western	31.4 100	28.6 91	30.5 97	32.7 104	37.4 119
Seqaqa	F\$000 index	Northern	35.4 100	34.7 98	37.2 105	44.8 127	49.8 141
Wainigata	F\$000 index	Northern	41.0 100	35.2 86	38.8 95	42.1 103	48.6 119
A comparative index:			100	106	112.1	119.1	126.2

For comparison, these index values were calculated on assumptions of (1) no growth and (2) 6% annual inflation.

- c. As a result of lack of research coverage, technology problems that come up during project execution tend to make sudden demands which the Research Division finds difficult to satisfy on an ad-hoc basis. This places research in an awkward position as an adviser to development on technology matters.
- d. From a funding point of view, researchers are not equipped to cater for these additional demands for services.

From these observations the mission concluded that, while there is enormous need for research products, the contribution that research can make to agricultural development has not been recognized by those in charge of project formulation and approval.

To counteract this trend and utilize the full potential of the research service, the mission recommends that procedural arrangements be instituted whereby the Research Division is involved in the early conceptual stages of project design. It would act as an adviser on technology and participate in joint decision-making with development planners on the need for research components to be included in development projects. Such early consultation would allow for better planning and more realistic budget preparation. Appropriate allocations to cover the research input would be included in the project budgets. Funds earmarked for research would then be made available to the Research Division to pay for the services required.

### 3.7 Research/Extension Linkages

#### 3.7.1 Structural Relationships

The divisions of agricultural research and agricultural extension are headed by an Assistant Director of Agriculture (ADA). In the organization chart of the MAF, Annex 6, it is shown that each division reports direct to the Director of Agriculture (DA). Coordination of the work of these two divisions, along with the other divisions of Animal Health and Production and Irrigation and Drainage, would thereby be one of the main responsibilities of the DA.

The ADAR (research) is located at the Koronivia Research Station, while the ADAE (extension) and the other ADAs are located at the ministry headquarters at Suva. This physical separation of the heads of the two key divisions would make the task of coordination of the work of these two divisions more difficult for the DA.

Within the research division, the section heads at Koronivia, as well as the heads of the research stations in the different regions, report directly to the ADAR. Within the extension division, four regional principal agricultural offices (PAO), who are in charge of extension work for the four administrative divisions, of the country also report directly to the ADAE.

The foregoing organization structure is found to be suited and well adapted to a country of the size of Fiji. It has the positive attributes

of easily lending itself to further development and expansion while retaining its basic form. At the same time, the lines of command are clearly indicated within a structure of this nature. The degree of communication and feedback within a structure of this nature would depend on the effectiveness of the coordination that could be brought about between the DA and the two assistant directors, ADAR and ADAE. In operational terms, it would call for regular meetings and discussions between the director and the two assistant directors, especially on the strength and operation of the linkages and relationships between the research staff and the extension staff at the different hierarchical levels. For example, how does a problem of a weak linkage between the PAO of an administrative division and the head of the research station that serves that region get identified and brought up for resolution? In a similar way, what role does the DA play in ensuring that a special regional problem receives its due attention by a specialist research officer based at Koronivia? Could such problems be resolved between the two assistant directors themselves, or would it need the intervention of the director?

Whatever the strength and suitability of an organization structure, its full value is realized only to the extent that the operations flow smoothly within the structure. Where there are such complex interfaces -- as between research and extension here -- it cannot be assumed that operations and linkages will function as smoothly as intended on the strength of the structure alone. Constant monitoring, diagnosis, and analysis of operations and linkages have to be made in order to rectify weak linkages and remove bottlenecks in operation. These should be looked into at the different hierarchical levels and also at the respective operational domains within the structure.

The nature of authority carried by the individual assistant directors to resolve such problems, with or without the intervention of the DA, did not come through clearly. Nor was there much clear evidence of adequate institutional devices that would have enabled a regular monitoring and analysis of problems relating to the functioning of the various linkages.

The issues posed in the three preceding paragraphs would have to be carefully examined by the director of agriculture, together with the assistant directors of agriculture, with a view to setting up the proper institutional arrangements and formalizing relationships involving the director, the assistant directors, the principal agricultural officers of the administrative divisions, and the heads of regional research stations.

Location of the ADAR at the Koronivia Research Station and the ADAE at headquarters in Suva cannot be viewed as the best arrangement to foster close relationships between the two divisions. A closer physical location of the two divisions would enable frequent meetings, and thereby closer interaction, between research and extension personnel. Koronivia would seem an advantageous site. It would have an advantage for extension officers to be able to make direct contact with the research staff when visiting headquarters and also to have more frequent use of the library facilities.

At present the extension work on rice is carried out under the Drainage and Irrigation Division with its own staff who are not within the Extension Division. This arrangement cuts across the rationale of the

present neat structure in which the responsibilities of the research and extension divisions are clearly defined and understood. It also detracts from the lines of communication established between research and extension workers.

Furthermore, the focus of the Drainage and Irrigation Division is primarily on land drainage, flood protection, and the design and supervision of irrigation rehabilitation and construction schemes. A majority of the senior staff of this division consists of engineers. In such a situation, extension plays a secondary role to that of engineering. Extension oriented activities cannot, therefore, effectively fit into the structure and organization of this division. It is accordingly recommended that the extension work on rice be transferred out of the Drainage and Irrigation Division and placed in the Extension Division.

A similar anomaly exists in respect to the Animal Health and Production Division, which is headed by an ADA who is located at the ministry headquarters at Suva. Livestock officers working in the field are responsible for both regulatory functions and for fulfilling certain traditional extension roles. Personnel involved in livestock and pasture research have to extend findings through extension workers who are not in the Extension Division. Here it is recommended that these extension functions be handled by the staff of the Extension Division. The specialist officers who deal with dairying and associated enterprises could remain within the Animal Health and Production Division.

### 3.7.2 Linkages by Discipline

Linkages between research and extension staff are found along both disciplinary and commodity lines. Specialist research officers at Koronivia Research Station, especially those in the Plant Protection Section, are mainly discipline-oriented. At the regional research stations, the linkages are mainly commodity-oriented. This is not unusual for a country at Fiji's present stage of development in agricultural infrastructure.

A drawback in the present disciplinary approach is that the outpost regions are not equally serviced by the Koronivia-based officers, because of travel and other logistical problems. The Sigatoka vegetable research program, for example, needs the fulltime input of a pathologist to deal effectively with plant disease problems in the farming region -- and to help the extension workers serve farmers. The Legalega Research Station has sufficient work to keep one entomologist busy on pest problems in the dry zone.

It would take still more time in the regional station staff to advance to the stage of an interdisciplinary approach to problem solving. More researchers will be needed to provide a "critical mass" at the stations. Despite lack of a critical mass, good beginnings have been made at both the Sigatoka valley and the western division: on-farm research in progress there has some elements of a multidisciplinary approach, and research/extension cooperation improves the quality of knowledge and service available to farmers.

The Fiji Sugar Corporation (FSC) has evolved its own model of an interdisciplinary approach to problem solving for a single commodity. The extension personnel in this model, however, do not appear to play a significant role in the diagnostic and verification stages. It appears that they carry out what they are instructed to do by the research and senior administrative staff. Such a model would not be recommended for smallholder farmers outside the sugar sector.

### 3.7.3 Regional Disparities

Qualitative differences in research/extension linkages have been observed in the different farming regions. In the Sigatoka Valley the close involvement of the SRO (vegetables and fruits) with the extension officers operating there has helped to foster a close linkage between research and extension. In the western division, where research and extension are currently under the same officer, there has been a good opportunity for the development of positive linkages. In regions and areas where subsistence farming pre-dominates, the development of linkages has been comparatively weaker.

An imbalance in the distribution of research and extension staff between the respective administrative divisions is observed from the data presented in Table 11.

Table 11. Distribution of research and extension personnel by administrative divisions.

<u>Administrative division</u>	<u>Number of research personnel (BSc or above)</u>	<u>Number of extension personnel (all levels)</u>
Central	20 (Koronivia)	48
Western	6	43
Northern	2	33

The Koronivia-based staff includes a number of Research Division personnel who are involved in services other than research; with that allowance made, there is evident disparity in the ratio of research personnel to extension personnel.

### 3.7.4 Problem Identification and On-farm Testing

Identification of pest and disease problems -- plus giving advice on control measures -- constitutes one front-line activity of the field-level extension worker. An adequate body of information developed by research on the commonly occurring pests and diseases is now available to extension workers; it is only in the case of a new pest or disease that direct research intervention is needed.

Identification of the problems on which research needs to be conducted is usually done by the commodity research officer in the region, drawing on whatever assistance he can obtain. The specialist officers at Koronivia are one resource, and the extension worker can be involved in problem identification in the commercially oriented small-farming sector. The lack of socioeconomic disciplines in the research planning process is one of the more immediate shortcomings seen in all regions.

On-farm testing consists mainly of crop varietal testing, agro-chemical trials, and simple fertilizer trials. A greater proportion of these on-farm trials is made up of testing and evaluation of improved cultivars from the station varietal improvement programs. These are carried out jointly by the research and extension personnel. Limitation of funds for travel, and also for conducting on-farm trials, has restricted the number of locations and testing sites. If it were not for the facilities offered by the financially better-endowed farmers, the number of on-farm testing locations would be even less.

The technology presently developed within the research stations is fairly simple, and it easily lends itself to testing and verification under farmers' existing resources. Good examples of feedback to research from extension were noted in vegetable production in the Sigatoka valley and the Suva-Nausori area, root crops and ginger in the central division, and in the pigeonpea enterprises in the western division. The linkages that have developed in these instances are worth noting because they provide good working principles that could be utilized in similar situations in other regions.

### 3.7.5 Impact of Research

The impact of research has been visible for smallholder commercial farmers and commercial farmers with holdings of 8 ha or more. The impact of research on the small-scale subsistence farmer has been mainly confined to the use of improved seed material and improved pest and disease control. Some extension workers consider that there are few research innovations or farming practices that could be offered to the subsistence farmer.

However, it is encouraging to note that the need for effective links between research and extension is recognized by both research and extension.

### 3.7.6 Improvements in Research/Extension Linkages

No formal procedures have yet been worked out for research and extension personnel to participate together in problem identification and diagnosis. Following are some of the reasons adduced by the senior level extension officers:

- a. No provision exists for the PAO to sit in at the quarterly meetings where research progress is discussed.
- b. There is lack of a forum for discussion between research and extension staff at the lower levels -- the commodity committees serve a useful role in as far as the higher levels are concerned.

- c. Research and extension staffs tend to work on their own under the present structure.
- d. Research officers do not often seek the views of extension officers on what problems should be researched or discuss what research information is applicable to the farming conditions of an area.
- e. Links with the Koronivia-based research staff are usually based on single disciplines rather than on an interdisciplinary or problem solving orientation.

The ISNAR review team believes that some of these constraints could be corrected by formalizing the linkages between research and extension functions at three levels:

- a. Between the Director of Agriculture and the Assistant Directors of Agriculture for, respectively, Research and Extension.
- b. Between the Principal Agricultural Officers and the heads of the regional research stations.
- c. Between field extension staff and research officers.

It is further suggested that each region hold a pre-season meeting of the research and extension staffs within the region to agree on a program of extension field trials and adaptive research trials.

### **3.8 Agricultural Research Outside the Research Division of MAF**

#### **3.8.1. Public and Quasi-Government Organizations**

The Ministry of Forest Industries includes a silvicultural research division. The principal silviculturalist is responsible for the overall administration of the division, under a deputy conservator of forests. The principal silviculturalist is also a member of the board of the Fiji Pine Commission (FPC) and acts as liaison officer with its research unit.

The ministry obtains services of the Land Use Section of the Ministry of Agriculture and Fisheries (MAF) from time to time. The Chemistry Section of the Research Division processed 35 samples for them in 1981. However, some delay was reported in receiving results; where samples originate near Lautoka, the division uses the laboratory of the Fiji Sugar Corporation.

Identification of specimens falling outside its own expertise is referred to the Botany Section of the Research Division. Assistance of the Plant Protection Section has been enlisted in matters outside the competence of the silvicultural research division. There has been cooperation in pasture research, and some joint work is in hand. The division has provided material for shelter belts and other purposes.

The University of the South Pacific (USP) main campus is in the capital of Suva; the Faculty of Agriculture and its associated Institute for Research and Experimentation in Tropical Agriculture (IRETA) are located at Alafua in Western Samoa. The Research Division of MAF uses the facilities of the central library on the campus at Suva. Literature queries can be referred via the USP satellite link to the University of Hawaii and to international information agencies (e.g., FAO Lubin Library and Commonwealth Advisory Bureaux).

The agricultural library of USP is situated at the Alafua campus. Access to that library can be made through the central library at the USP campus in Suva; access to the faculty is usually by mail, since funds are insufficient to permit much travel. (Officers of the Research Division consider Alafua to have little assistance to offer presently; this view may change with the advent of a strengthening project for the faculty and IRETA (through the United States Agency for International Development).

The laboratory at the USP Institute for Natural Resources could be a partner for the analytical laboratory at Koronivia. A useful point of initial cooperation could be in providing cross checks for accuracy of results. Joint or supporting investigations could be launched later.

The proximity of the campus at Suva, however, is important in other matters: certain investigations can be "farmed out" to university faculties in pure and applied sciences; and joint use can often be made of facilities. (Electron microscope facilities offer an illustration of this point: The microscope is particularly useful for virological work, but it is often not possible to employ economically for applied research, in view of the special staff required. Such a facility may be justified at an academic institution.)

The Fiji Sugar Corporation (FSC), with headquarters and laboratories at Lautoka, dates from 1909. At one time there was a formal agreement of cooperation between FSC and the predecessor of MAF. There appears to be little bench-level contact between the two organizations, except on the board. At the field level there appears to be good rapport between extension officers and FSC field officers, concerned mainly with the growing of subsistence crops and the rotation of cane.

FSC has facilities for soil and foliar analysis. The laboratory cross checks its work with organizations in Australia, and with suitable arrangements it could run cross checks for the analytical section at Koronivia. The degree of utilization of the laboratories of the FSC is not known, but it is thought there may be some unused capacity. Tissue culture apparatus and nutrients analysis are also available there. It is possible that the FSC could arrange to service nearby MAF research stations for soil and foliar analysis.

The Fiji Pine Commission (FPC) is a quasi-government body devoted to the cultivation and exploitation of the Pinus caribea on lands unsuitable for other crops. Its main affiliations are with the Ministry of Forest Industries. The commission has a research unit of two persons and utilizes the services of the Land Use Section of MAF from time to time. The commission cooperates with the MAF Research Division in experiments with animals under pines.

The Fiji College of Agriculture (FCA), located adjacent to the Koronivia Research Station, trains students to the diplomate level in tropical agriculture (DTA). The ADAR is a member of the FCA academic board, and staff members of the Research Division lecture to students on specific subjects. The Chemistry Section analyzes samples for student projects (355 in a recent year), and the Botany Section made 1,252 identifications, mainly for teaching purposes. The FCA library provides a major reference source, and the librarian offers entry into communications networks.

The Coconut Board (which was established by enactment as a result of the Silsoe inquiry into the coconut industry) deals with processing, regulation, and exports. The board is advised by a council on which producers from the various sectors of the industry are represented. There is some contact between members of the council and the Research Division; it should be advantageous to increase such contacts. Many of the council members have practical experience in copra production and processing and in intercropping.

### 3.8.2. Other Organizations

A soil scientist from the New Zealand Department of Scientific and Industrial Research is on secondment to Fiji for two years from June 1981 and works with counterparts in the Land Use Section in updating the national soil mapping, soil classification and soil correlation information. The Chemistry Section of the Research Division cooperates with the soil survey team in the physical and chemical analysis of selected soils; 264 soil samples were analyzed in 1981.

### 3.8.3. The Private Sector

One category of organization in the private sector is those which are multinational in operations. Such organizations may turn to the research and development facilities of MAF for emergencies or minor concerns. For feasibility studies or projects that demand large scale investment, however, they are likely to turn to multinational consulting firms or to "in-house" advisers. Even relatively minor matters, such as soil and foliar analyses, may be contracted out overseas or to other local organizations.

Feasibility studies on oil palm, coffee, hybrid coconuts, or other development matters are not normally discussed in detail with the Research Division on three grounds: the lack of depth of knowledge on certain of the subjects; the lack of appreciation of the economic factors of production and processing; and the inability to grasp the importance of marketing. These organizations generally appreciate the duty they owe to Fiji; for example, it is said that some would be prepared to fill a leading role if MAF were to formulate a firm policy concerning the coconut industry and more economic use of coconut land, with an adequate time horizon and competent project preparation.

Another category of organizations in the private sector consists of those locally constituted companies which are unable to turn to international organizations and which have insufficient internal resources to carry out work on their own. For their needs in agricultural research, they are largely dependent on advice generated by the Research Division. Some are vocal in regard to their frustrations, even though some of their demands appear to be unreasonable. (Here it must be said that however large and efficient a research organization may be, it cannot escape informed and uninformed criticism; if it pays adequate attention to the informed group, who are usually the most influential, it will enlist supporters; service to those in the latter group may eventually prove educational for them.)

Objections raised by this group are the same on the surface as those of the multinationals: lack of depth of work in certain areas and inability of the official sector to appreciate the economic and commercial implications of recommendations. This view may be compounded by the difficulty they have in obtaining specific information either through extension sources or directly from the Research Division.

The last and largest section of the private sector is the small leasehold farmers and customary land owners. They are largely dependent on the Extension Division for interpretation and transmission of the results and implications of the Research Division's work. Appreciation may vary with the size of farm, type of crop, and -- in particular -- the personality of the local extension officer. It is difficult to get a reliable "feel" for the problems associated in relations with this group. One senses that perhaps too little information gets to the smaller farmers because extension officers must cover large areas, and feedback to the Research Division may not be strong and clear. A better linkage between research and extension organizations would probably generate an upsurge of interest by farmers such as these.

### 3.9 External Linkages

Fiji may be unique in that it does not depend heavily upon external funding or aid funding for its development. External aid funding represents only a small percent of the capital and operating budget of the Research Division of MAF.

All external funding requests are considered centrally in government offices of Finance and Planning. This system of processing provides the governmental controls on commitments and assures that external funding is considered in the budgeting process. Many individual scientists contacted felt hesitant about stimulating external aid projects, due to what they believed to be complex and time-consuming requirements in project preparation. These persons also expressed the belief that some small donors were not considering aid support for this reason, with another reason that the donor representative was not able to deal directly with the recipient institution or project staff. It appeared to the review team that the procedures are not unreasonable; some problems from the scientist's side may arise more from insufficient knowledge and understanding rather than from complexity of procedures.

#### 3.9.1 Linkage with International Agricultural Research Centers

There is evidence that Fiji has established contact and is benefiting, at least to a limited extent, from contact with four of the international centers (IARCs): IRRI, IITA, ICRISAT, and CIP. In addition, it has established good contact with AVRDC. Contact with ICRISAT in certain crops has been facilitated through association with the University of Queensland (Australia) for plant quarantine and cooperative testing.

Due to its small size and hence a relatively small area under production for each of the major commodities of the IARCs, Fiji does not attract major attention to these commodities. Therefore, a special effort by MAF

is required to stimulate and maintain contact -- beyond the present contact by occasional exchange of correspondence. Strengthened by support at higher levels in MAF, the quality of contact needs to be increased by exchange of visits. This will require some expense for travel for Fijian scientists, but the benefits should be well worth it.

### 3.9.2 Linkage with Bilateral Agencies

The bilateral linkages are primarily with Australia (the Australian Development Assistance Bureau -- ADAB), New Zealand and the United Kingdom (Overseas Development Agency -- ODA). There is a linkage with Japan and support for fisheries, among other support. Linkages have tended to be more toward development than toward research; development attempts have met with little success in some noticeable cases. The work on soil survey, soil classification, and benchmark soil studies have been excellent examples of productive cooperation and are providing a sound information base for development.

It has been stated that there are relatively few bilateral donors collaborating in Fijian agriculture. Yet, the country has many opportunities for small donors who could have significant impact. A number of these opportunities are in the area of staff training, while others are in the area of support for integral projects in the research system.

### 3.9.3 Linkage with Multilateral Funding Support

Multilateral funding support represents a small input to agricultural research in Fiji. The most evident input now comes from the United Nations Development Programme (UNDP) financing through Food and Agricultural Organization (FAO) implementation of the goat production project and the regional root crop project. Fiji has also been participating in the regional plant protection project under support from UNDP and the South Pacific Commission.

It is evident that multilateral funding could play a significant role in supporting the agricultural research program, especially in respect to crops that have been assigned importance in import substitution and export promotion strategies. Rice and tree crops are particular examples. This area should be actively explored.

### 3.9.4 Balance of Support between Research and Development

The balance of support from both internal and external sources has been strongly toward development projects. There are examples in Fiji where many thousands of dollars were spent to implement development projects -- e.g., integrated farming, irrigated rice, and citrus -- that lacked a research base. Some of these development projects appear to have brought little, if any return, even failing to provide guidelines for future action. Research can be built as a part of the development project, raising the probability of success from the total effort -- typically, research can be provided with a small share of the overall investment.

### 3.9.5 Importance of External Funding and Long-Term Internal Funding in the Present Structure

The source of funding is not the critical factor for the Research Division; the crucial point is that additional funding is required in the present structure, especially to train manpower within it. It is believed that external funding can be obtained on a grant basis for agricultural research and training, which would free national resources for other programs. As is well recognized in Fiji, external funding is usually temporary -- for a fixed term -- and financial support for the long period must come from internal sources. Therefore, long-term planning is an essential element to mesh external funding with internal resources to build long-term capability.

### 3.9.6 Potential Increases in External Support

It is the view of the review team that increased external support can be acquired, and that support can be expected for many years to come. With a well-planned overall research program, backed by evidence of long-term support by government, Fiji will have the potential for significant increases in external support. This support can be sought for training for research staff, for specific components of the research program, for the development of new components in the research system (such as agricultural economics and related social sciences), for expansion of work in farm implements, no-till farming, and many other items which are essential in research for Fiji's long-term agricultural development.

## Chapter 4

### Conclusions and Recommendations

The Research Division of the Ministry of Agriculture and Fisheries (MAF) has served Fiji well in the past. With additional resources and some modest changes in role, operational approaches, and range of staff expertise, it can serve Fiji better in the future. Some of these changes are within present options of the Research Division; some would require collaborative responses by other units of MAF; and some could occur only with appropriate actions by the government.

The ISNAR review team has presented the basis and reasoning for these suggestions throughout the main body of this report. They were developed as the result of observations in Fiji, and they include many ideas that came from present staff who are dedicated to an effective Research Division. In this chapter, the team summarizes its findings into a series of interrelated actions or activities believed to add strength to the Research Division. They are organized around major functions of management to carry out the tasks of the agricultural research system of a small developing country.

#### 4.1 National Policy Environment

National policy expressed in the current development plan, DP8, clearly designates agriculture as the major force in Fiji's development. However, it is the considered opinion of the ISNAR review team that the national budget does not provide a level of support consistent with the government's expectations of agriculture. Present support is inadequate for optimum development of the agricultural sector as a whole, as well as for agricultural research as an initiating force within it. Within agricultural development projects, too small a share is devoted to research as a basis for effective planning and allocation of resources. The question is not that of supporting one or the other -- development or research; rather it is a matter of enlarging both with a better balance between the two.

There are needs from the perspective of national policy that can enable the Research Division to make its potential contribution to agricultural development. The first of those needs, in the view of the team, is for a clearer definition of how agricultural research is regarded within the overall policy for Fijian agriculture.

DP8 calls for research to help find means to reach goals stated in terms of (a) low-cost technology for agriculture and (b) higher production of products for domestic consumption and for export. These are essential elements, but the two alone cannot significantly change performance of the agricultural sector. National guidance is needed also on broad matters of agricultural policy, including the pricing of the inputs for

production, marketing and pricing of agricultural products, and the support provided to the agricultural system -- factors of infrastructure, even the educational or advisory services provided to many groups that make up the sector.

When national policy has dealt with these factors, the Research Division can better determine where its capabilities are most needed and what agricultural sector problems it must solve for the good of Fiji.

Annex 1 offers an approach to defining a role for agricultural research; it is a statement of principles, not a finished proposal recommended for immediate adoption in Fiji. It provides a starting point from which the Research Division staff could think through a draft statement of its role and responsibilities, taking special account of the related roles of others within MAF. This initiative could focus MAF deliberations to reach consensus on the role and relationships of the Research Division in implementing agricultural policy, both within MAF and as an integral part of the national development plan. Such consensus would help the Research Division determine its objectives and priorities, and it would help the ministry and other units of government relate effectively to this source of increased strength for agriculture.

#### 4.1.1 Agricultural Research Is Needed to Serve Different Production Groups in Fiji

The review team concluded that there is some imbalance in the Research Division program in terms of the groups it serves. While more is needed to support commercial farming operations, the larger group of subsistence farmers is being served less well. Research for this subsistence group is demanding; individual commodity improvement generally is not enough. The different categories of farming systems within the subsistence group need to be analyzed before research priorities can be determined and research carried out to seek answers to the central problems. A systems approach by multidisciplinary teams is required, calling for innovative use of staff within the existing system.

In light of limited present staff, the review team recommends that work be carried out to classify the several groups of Fijian farmers into meaningful economic-social-cultural categories. The major problems or production constraints of each group would then be analyzed. Short-run emphasis could be directed to those problems where a solution will give the highest return in relation to national agricultural policy; the second priority could go to solve problems that reach across more than one category of farmers. In the longer run the emphasis may be placed on developing packages of technology to meet the needs of each group.

#### 4.1.2 Shifts in Research Emphasis

DP8 states government policy to be egalitarian, aimed at reducing regional differences. Although many staff are expected to serve the country as a whole, the major share of Research Division resources presently goes to the central division, with most of the research staff based at Koronivia. However, their ability to travel and properly monitor and evaluate research and development projects outside the central division has been severely limited by chronic shortage of travel funds. Existing imbalances seem to be increased rather than reduced.

In terms of the overall needs for research on commodities, the review team considers that certain sections, notably chemistry and plant protection, are adequately staffed; other specialties are not represented (for example, economics) or are staffed by one professional person. In such a case, if that person leaves, there is often a break in the continuity of important work.

The agriculture of Fiji is diverse. Difficult decisions must be made as to how to serve this agriculture with the number of staff that the MAF budget can support. The review team concludes that some additional staff resources are essential, and it recognizes that not all commodities grown in Fiji can or need to be served by the Research Division. An external review team is not the right body to determine which commodities are to be served directly and which ones will be accommodated by transfer of technology from abroad. However, the team urges that the Research Division establish a procedure to make such determinations and keep them under regular review. The Research Division has the capability to carry out this difficult task, but it may find it productive to engage some consultant services over a period of a few months. Such outside services could help to establish the criteria and assure the objectivity required.

It is noted, however, that the Research Division has an essential core of experienced staff in certain subject areas, who should be able to draw and interpret external research information. This approach could be profitably adopted in selective areas where an accumulated pool of both regional and global information is available.

#### 4.1.3 Agricultural Research in Relation to Development Projects

This review team has called attention to imbalances between research and development activities in agriculture; it has noted a strong tendency favoring development projects. It points to evidence in Fiji and elsewhere indicating that the practice of financing development without a research base is costly and seldom produces returns in line with investment. Agricultural development is an obvious and proper goal for Fiji, in the team's view. But it should be development that is economical for the producer as well as for the government. Increased investment in agricultural research would be productive in two ways: research can determine and validate development opportunities before projects are formulated, and research can be a valuable component in the development project, helping achieve the projected returns, providing guidelines for shifting development objectives, or for terminating unprofitable projects.

#### 4.1.4 Agricultural Research Base for Policy Formulation

The proper base for national agricultural policy rests on realistic potentials of the country's physical, human, and financial resources, taking into account its social and cultural conditions. In most cases this potential needs to be verified through research that takes account of these resources and conditions, as well as examining the probable consequences of the policy to producers and to the economy as a whole.

Agricultural researchers should be partners when this process is applied in the agricultural sector. They can provide research-based advice to those involved in formulating policies. This review team did not find the Research Division as actively involved as a source of information for policy as it believes possible and appropriate. Further, the division's capacity to contribute is incomplete, due to lack of staff with professional capability in the social sciences. The Research Division is neither able to inform policy makers on the economic or social consequences of the technology it is generating nor to analyze the economics of its production technology at the farm level.

It is the view of the review team that additional specific staff and program support are required by the Research Division to carry out its proper role in policy development. The division also needs to increase its ability to communicate with planners on information important in policy terms. (See sections 3.5 and 4.3.)

#### 4.1.5 Service Role

The Research Division now provides several service functions in its laboratories and in producing seedstocks on some of the research stations. These services are vital to the country, but they are not appropriate research functions. These services draw heavily on the time and other resources of staff and facilities that are already at what may be considered a minimum level.

The Plant Protection Section staff carries out regulatory activities related to licensing and importing of pesticides, fungicides, and herbicides. This work competes for time available for research by the small staff, and it could lead to conflicts of interest. The forensic and other analyses done for government departments in the Chemistry Section are outside agriculture -- they dilute already scarce resources. The Research Division has a certain responsibility for production of foundation or breeder's seed (including livestock), but it appears to the review team that the responsibility is being carried much further.

The team urges MAF to examine the service functions now assigned to the Research Division. Some may need to be retained as essential and directly related to research; means may be found to have those outside the scope of research taken over by a regulatory body or -- if they must stay under Research Division jurisdiction -- that additional resources be provided to compensate. However, it is the team's recommendation that minimum regulatory functions should be assigned to research staff.

## 4.2 Structure and Organization

The present Research Division structure seems effective, and the review team recommends no major structural changes. Some additions and shifts in responsibilities are recommended as means of strengthening the work of the division.

### 4.2.1 Additions to the Division

A serious shortcoming in the division is inability to deal with the economics of the technologies it produces or the economics of

production. Different solutions to a similar situation have been tried in many countries; almost without exception, the only long-term solution appears to involve social scientists in the Research Division interacting daily with the biological scientists. The review team rates as high priority this addition to the organization, recommending that an agricultural economist be brought on at an early date. The need for one or two more social scientists will have to be considered in the longer run, in line with priorities for other staff.

Headquarters of the Land Use Section which is now a part of the Economics, Planning and Statistics Division within MAF, are at Koronivia within facilities of the Research Division; some staff members are posted to other regions. The work of this unit would be more useful if it had a stronger research base. Its work would be benefited from close working ties with the biological and social scientists: the relationship should help assure that the unit's recommendations are appropriately tested and verified; and the land use expertise would be beneficial to some aspects of work by other researchers. The long term utility of this section can only be maintained as it further develops its research capability. The physical location of the Land Use Section staff at the Koronivia Research Station is a positive element. However, further organizational integration with the Research Division could be useful in the longer run toward achieving the mutual benefits which should accrue to the two parties as well as to agricultural development.

Livestock research is divided between the Animal Health and Production Division and the Research Division. The review team examined the respective advantages and disadvantages of having livestock research in each of the two divisions. It is the view of the team that agriculture in Fiji could be more efficiently and effectively served if all livestock production research was integrated into the Research Division. (The production and distribution activities of Animal Health and Production Division might be considered within the Extension Division. However, comments on this proposition are outside the terms of reference for the team.)

#### 4.2.2 Responsibilities of the ADAR

The several responsibilities of the Assistant Director Agriculture (Research) (ADAR) were examined and presented earlier in this report. The position of the ADAR is important to Fiji's agriculture; the person filling this position must be able to devote full attention to it. Responsibilities for the Koronivia Research Station are seen as possibly divisive; the ADAR should be free to address all the research stations and their staffs objectively. Also the leader needs to concentrate full attention on the issues of program planning, implementation, monitoring, evaluation, linkage with other divisions, as well as on planning and finance to assure support for the total program. Therefore, the review team recommends that the ADAR should have this position as his sole direct responsibility.

#### 4.2.3 Relationship Between the ADAR and ADAE

Research and extension divisions and functions are interdependent; they should act together in the process of research and development. The

present structure of MAF provides an excellent organizational arrangement for effective interaction between research and extension: the Director of Agriculture is responsible for both research and extension, among other divisions. That is an advantageous position from which to facilitate the interaction of research and extension. However, the review team observed that the interaction is not operating to the degree that appears to be possible and which could bring about more effective use of limited resources.

The ADAR works from offices at the Koronivia Research Station; the Assistant Director Agriculture (Extension) (ADAE) is accommodated at MAF headquarters, 15 km away. These two units should be in regular contact for program activities. It is the view of the ISNAR team that it would be desirable for the ADAR and the ADAE, with their respective supporting staffs, to be located at the same site. This would permit maximum opportunity for program planning and daily contact. (The Koronivia site seems to be an excellent setting, where both could give full attention to program matters. Full consideration of such a move, including facility requirements and other logistical issues, are outside this team's terms of reference.) A number of issues related to more collaboration between research and extension are set forth in Section 3.7 of this report.

### 4.3 Research Planning, Monitoring, and Evaluation

The processes and practices for determining and carrying out research priorities lie at the heart of a research system. Even the best staff, with good organizational structure and support, will produce useful results only when they are working on relevant problems.

The involvement of farmers and extension staff in research planning and evaluation is believed to be the most certain means to assure that the research system identifies the right priorities. The team heard frequent statements by extension workers of a desire to have more contact with research officers in program planning. It has been noted before that the physical location of the ADAR and the ADAE at the same site would facilitate this contact. But the involvement needs to be carried further. The team makes two recommendations which aim at the process of formulating research programs and encouraging a stronger orientation of the programs toward development:

- a. The team recommends some formalization of the process for involving users of technology, extension officers, and other research staff (including the proposed economists) as contributors to planning the research programs. The commodity committees, which already exist, could be most useful; they could ensure the type of dialogue required in this context.
- b. The second recommendation is intended to meet a number of functional requirements. It concerns the availability of travel funds to permit the research staff to fulfil their functions in a more adequate manner. Researchers must be able to leave the station and to visit their clients (often jointly with extension agents). The resulting dialogue will contribute to strong programs of research, highly oriented to development.

Strong inputs are needed from farmers and extension workers to plan programs; programs should be monitored and evaluated by the same group. This kind of involvement can provide an effective foundation to make on-farm testing an integral part of the research process.

#### 4.4 Linkages and Information Flow

Linkages of a research organization with its relevant policy-makers, farmers, and extension workers are the test of the utility of the research product. The team found evidence of some excellent linkages between research and extension, with other units of MAF, with the Fiji Sugar Corporation, the University of the South Pacific, the private sector, and some international agricultural research centers. There were examples where linkage could be established or improved. This issue was addressed in the earlier analysis of the system, with the team's suggestions for improving the linkages between research and extension. (Annex 4 deals in more detail in discussing needs and deriving specific recommendations concerning communications.) No additional recommendations are set out here, but the issue is recalled here among key conclusions and recommendations.

#### 4.5 Resources for Effective Research

##### 4.5.1 Human Resources

The Research Division requires additional professional staff in order to perform the tasks expected of it, including the goal of providing the basis for agricultural development. One example of additional staff has been discussed, the need for research resources in agricultural economics.

A number of policy decisions should be made before firm staffing recommendations can be set out. A number of questions should be answered: For example, is the Research Division to continue to carry out service functions in plant protection and chemistry, as now, or will these functions be shifted to a regulatory department, freeing the research staff now engaged in them? Will travel funds be made available for research staff to meet their national responsibilities from their base, or will additional staff be required to be based in regions to implement, monitor, and evaluate research? Is the Research Division going to concentrate efforts on a few major crops, or will it be required to cover a diverse range of crops and livestock?

The team urges development of medium term (5 years) and longer term (10 to 15 years) plans. Then a manpower plan and a training program can be fitted to them. Some technical assistance may be needed. This process could be carried out over a 6- to 8-month period, resulting in a sound research plan and accurate estimates of the requirement to carry it out. Such a process should involve several units, including the Research Division, policy officials within MAF, national units in policy, planning, and finance.

#### 4.5.2 Financial Resources

Financial resources cannot be viewed as a separate entity. Financial requirements emerge from program requirements. Fiji's present tight financial situation, which limits travel and maintenance and operation of equipment, puts a hidden cost on the research program -- that is through underutilization of professional staff.

One important issue not yet clearly decided is what research program Fiji wants and is willing to support. Decision makers have apparently not been convinced that there is a critical interaction between research and development and that good research is development-oriented, providing a solid base for development. Some large development projects appear to be adequately financed but have no research base (observers agree that several of them will bring little returns if any).

One way to increase financial support for research is to include a research component in each of the development projects. This is only a partial solution; what is really required is a well-developed research program with the finances required to assure the essential human and physical resources. It is only through this planning and budgeting process that a country can really determine whether and at what level to support research for its development.

#### 4.5.3 Physical Resources

In comparison to many countries, Fiji is well endowed with physical resources for its research program. But it has not kept pace with needs for replacement of laboratory, vehicle, and field equipment for its stations. An antecedent issue should be answered before decisions are made on replacing laboratory equipment; that issue is the extent to which laboratories of the Research Division will support the research function, and the extent to which they will provide service to other units or programs. The answer will help to guide in the selection of the kind and amount of equipment.

In one phase of this study, the review team was asked to consider a proposal of the possible addition of a research station to the Research Division. In an earlier part of this report dealing with infrastructure, the team noted that a number of the research stations are not really engaged in research activities. The team believes that some of these stations could be put to a better use in the total agriculture of Fiji. Therefore, it is recommended that the division undertake a specific study to evaluate each station on the bases of its present work, its potential or alternate uses, and possible transfer from research jurisdiction. The team views such a study as a research planning exercise. It could be carried out as a joint review by Fiji research staff and consultants. A part of that exercise would include a review of the laboratory and other support services now present on each station.

### 4.6 Finance and Budgeting

Issues on finance and budgeting have been discussed in other parts of this report. The accounting procedures appear to be timely and do not provide major difficulties in release of funds or in transfer of funds.

The policy put forward in the development plan for Fiji emphasizes funding on a project basis. While this basis may be useful in some areas of financial allocation, it does not fit well the special funding needs of agricultural research. As interpreted within the Research Division, emphasis has been on submitting a continuing series of new fixed-term projects. Experience has shown greater probability of long-run benefits from agricultural research based on sound planning over an indefinite time, with regular reviews to justify relevance of continuing support. More dialogue would be mutually useful among the appropriate staffs in Planning, Finance, and Agriculture. It is the team's view that the present structure can accommodate a productive strategy of less attention to new projects and greater attention to continued support for well conceived and monitored core research programs.

It has been noted before that the level of external funding in Fiji agricultural research is low in comparison to many countries. The team believes that additional resources can be attracted if well developed plans are put forward by the Research Division. It may wish to seek some outside consulting assistance to prepare plans that could be of much value to Fiji in its longer term agricultural development.

## Chapter 5

### A Concluding Statement

Many implicit and explicit conclusions and recommendations have been put forward in this report.

Many of the recommendations can be implemented without additional cost. Several of the recommendations call for specific studies to establish a base of information on which policies can be developed and from which financial consequences may be determined before commitments are made. (As a case in point, the review team believes that the suggested review of physical facilities could result in important savings for the division.)

Among many recommendations, the following stand out in terms of importance attached by the ISNAR review team. (They do not, however, reflect a specific order or priority.):

- 5.1 The research planning process needs greater involvement of the users -- especially farmers and extension staff -- in identifying research problems and in establishing research priorities. The use of commodity committees -- which are used from time to time -- should become standard operating procedure.
- 5.2 A medium-term research plan (5 years) should be developed, as should one of longer term (10 to 15 years). The two plans can be matched against human, physical, and financial requirements (including manpower training). The plans must be vetted and adjusted to meet requirements for agricultural development and potential support and then be incorporated into policy. Technical assistance for a 6- to 8-month period may be advisable to develop the plan, with consultants working with a designated group from the Research Division.
- 5.3 It is the strong view of the review team that the Research Division requires additional manpower. A number of policy decisions should be made before additional manpower needs are determined. Among needs are for an approved research plan setting forth the range of commodities to be included. Also there is need to decide how much of present service and regulatory activities in the Research Division will be transferred to another jurisdiction.
- 5.4 Priority attention on physical facilities should be given to a review and analysis of each of the research stations, including its facilities and equipment, to determine the continuing need for the various stations, whether required for research or whether some alternate use might make better use of some of the facilities. The requirements for facilities, equipment, and laboratories should be derived from the medium- and long-term research plans.

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- 5.5 The obvious short-term recommendation in regard to financial support is to find means to provide travel, operational, and maintenance support for professional staff work. To make first cuts in those funds in times of financial constraints is to hamper the organization and function far in excess of the temporary savings. The present system is built on the concept of a few senior professional staff grouped together in a few locations in order to provide a critical mass for interaction; it is necessary that they be mobile to implement, monitor, and evaluate research on a national basis. When they are immobilized, the quality of research is at great risk.

In the longer term, financial support must be linked to the plan that is developed carefully and reviewed regularly.

- 5.6 Heavy emphasis on development projects -- with neither previous research to test viability nor a built-in research component -- has been a costly venture for Fiji. (Projects can be cited where there has been little or no return and where, even after large expenditures, projects have not provided guidelines for future development. Research must be development-oriented (see Appendix 1, Role of Research); research merits a fair share of support in the overall agricultural development process. At the present time support is too heavily weighted on the development side.
- 5.7 The research staff, the extension staff, and farmers must work more closely together to monitor and evaluate research; the work needs to be tested and verified at the farm level as a regular part of research. The first step to implementing procedures for strengthening the interaction between research and extension must be at the level of the respective assistant directors.
- 5.8 The present publications on research are timely, but they relate to few audiences or persons besides other research workers. Different versions are needed for different client groups (including planners and policy-makers). The annual report of the Research Division could be structured and presented in different forms to serve policy, research, extension, and the general public. The Research Division should encourage efforts within MAF to strengthen the Information Section through updated equipment, training and staff development, and a broadened role of communications support services to all the units. The division could thus have professional help to place its results more effectively before audiences that have interest and use for them.
- 5.9 The basic organization of the Research Division is good. No major structural changes are recommended. The team does suggest addition of one section, transfer of some sections from other divisions to the Research Division, and that duties as administrator of the Koronivia Research Station be shifted from the ADAR. The team recommends that consideration be given to the following:
- 5.9.1 To the further integration of the Land Use Section within the Research Division (see 4.2.1).
- 5.9.2 To the full integration of livestock production research within the Research Division (see 4.2.1).

- 5.9.3 Add a social science section to the Research Division, with immediate recruitment of an agricultural economist (see 4.2.1).
- 5.9.4 Relieve the ADAR of duties as administrator of Koronivia Research Station to permit him to devote full time to directing the Research Division.

## 5.10

As is reflected throughout this report, the review team, found that the Research Division of the Ministry of Agriculture and Fisheries has served Fiji well. With some modest changes and further support it should serve even better in the future. The additional resource requirements, several of which can be determined only after further careful planning, should be seen as reasonable. This is particularly true given the importance of agriculture in the economy and the present small share of the national budget that the ministry and its Research Division now receives.

**THE ROLE OF AGRICULTURAL RESEARCH IN DEVELOPING COUNTRIES<sup>1</sup>**

I am pleased to have this opportunity to meet with you to discuss the role of agricultural research. I appreciate the invitation that Mr. Param Sivan, Assistant Director Agriculture (Research), extended to me on your behalf and at this time I want to thank him and all of you who have participated in the program of the ISNAR team. We have been met with an openness for discussion and a welcome that has been much appreciated by all of our team members.

While most of you know why our team is here, just let me recap that we are here at the request of the Ministry of Agriculture and Fisheries to review and advise on the agricultural research system. ISNAR was created to assist developing nations strengthen their national agricultural research systems. The basic premise is that most nations require strong agricultural research programs to serve their own needs and strong national programs can also effectively link with the international agricultural research commodity oriented centers in the CGIAR (Consultative Group for International Agricultural Research) of which ISNAR is a part. To assist in strengthening national systems the starting point is to review the existing system, at the request of the national government, as we are doing here in Fiji. The review is a comprehensive evaluation by an ISNAR mission in the field, to determine in discussion with a wide range of scientists, administrators, extension workers and producers: (a) the appropriateness of the existing research organization, (b) the relevance of the research program, (c) the use of the research products by national planners, farmers and others, (d) the constraints, if any, which appear to be seriously affecting the research program and (e) what changes may be appropriate given the human, natural and financial resources that might be made available within the context of the particular country.

One of the first tasks in a review by an ISNAR mission is to develop a common understanding, with national leaders, of what should be expected of agricultural research, or to put it another way what should be expected by whom. That is, who are the clients of research and what should be the research product for each client group? ISNAR has found great diversity of opinion among countries in which it has worked and among groups and individuals within countries on what should be expected of research -- or as topic for this evening suggests, the role of agricultural research. Because of this diversity of opinion and the conflicting views, as well as limited views in some cases as at ISNAR set forth for consideration three broad objectives as the goals of a national system.

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<sup>1</sup> Presentation to the Fijian Institute of Agricultural Science by Dr. William K. Gamble, Director General, The International Service for National Agricultural Research (ISNAR), August 4, 1982.

These goals are:

1. To make available to the government, in an appropriately interpreted form, key elements of information on which reliable agricultural development policies and plans can be based;
2. To make available to the farmers, in appropriately interpreted form and through appropriate channels, the detailed agricultural production information (including economic implications) on which to plan and implement production of crops and livestock, based soundly on adaptive research at the farmers' level;
3. To develop and maintain a group of well-trained, competent scientists in appropriate disciplines in active research positions capable of collaborative effort in problem resolution and in interpreting national and international scientific advances for the benefit of national development.

Agriculture is a complex industry which covers a broad range of activities of which agricultural production is only one. Even within agricultural production there is a complexity of different commodities (crops and livestock), pests, diseases, soil problems, input supplies and environments which must be dealt with by the farmers and therefore by research. Since agriculture is complex this reflects a complexity in research. While individual pests, diseases and other issues can be singled out, they must be addressed and resolved by research in such a manner that the farmer can utilize the results within his total farming system.

Before looking in greater depth at agricultural research the question must be answered as to whether a nation really wants to develop its agriculture. In a great many developing countries agriculture is the most important sector of the country and it is essential to make it productive as the key industry. However, agriculture does not stand alone but must be viewed as a sector within the total economy and there needs to be an overall agricultural policy within national policy goals.

A clearly defined agricultural policy with a firm commitment to science based growth is an essential prerequisite for the definition of a national agricultural research program. Such a policy for the agricultural sector will assign clear cut responsibilities to research and will be helpful in determining research priorities. Unfortunately the policy framework for agriculture in many countries is neither stated nor developed to the point required as a reference for agricultural research.

In relation to agricultural policy, the commitment to overall agricultural development is crucial. It is not sufficient, as is now the case in many countries, for political leaders to state that "agriculture is of utmost importance to the country's development" or that "agriculture is the priority of priorities". What is required is a policy which incorporates tangible support for the agricultural sector.

Let me return to the goals of agricultural research that I have indicated above and examine each of these to try to present more clearly the role of research

- \* to make available to the government in an appropriately, interpreted form, key elements of information on which reliable agricultural development policies and plans can be based.

You will note that I have listed development as the first point. Governments are interested in development and visible product outputs. This is essential for a government to assure its constituency that its money is being well spent. Agricultural research must develop the information base for agricultural development plans and not come on to the scene late in the process and be asked to implement research after projects have been formulated and committed, then only to determine that expensive plans are unrealistic and the set goals cannot be achieved. There are many examples in the world and some here in Fiji where considerable losses on projects or project failures could have been avoided if appropriate research had been conducted before the project was finalized.

Related to this issue is the question as to who benefits from agricultural research. A great deal has been written and said about the benefits of research to the producers and in recent years a number of studies in various countries have estimated returns on investment for certain types of research from 20 to 90 percent per year. Yes, it is true that the producers do benefit from productive research but the consumers benefit as well. They benefit from efficient production through lower food costs and they should benefit through better nutrition, reliability of food supply and satisfaction in national accomplishment.

Planners in government are under pressure from various sources to set targets to achieve certain national goals. However, they also are under pressure to produce plans and targets that are realistic and well documented. It is an essential requirement for agricultural research to provide government with appropriate, reliable, interpreted and well documented information on the present agricultural situation, its potential, the time frame to achieve the potential and the resources required (within keeping of the potential of the country) -- human and financial -- to achieve the potential.

The information that the agricultural research system provides to the planners should ensure that the government has the best information possible on opportunities for successful developments and also to warn of potential dangers and limitations in technical details of any proposed plan. This information may be based on direct experimental work; or on the implications of survey data on the natural resources of the country or market potentials; or, more frequently, on the sound professional interpretation of world knowledge of agricultural science in relation to national development needs. The agricultural research services should be the best source of such information and should be linked with development planning and the development of agricultural policy, with a significant voice in the process: by the same token, it should be held answerable for its advice with equivalently significant responsibility.

To turn to the second goal of agricultural research

- \* to make available to farmers, in appropriately interpreted form and through appropriate channels, the detailed agricultural production information (including economic implications) on which to plan and

implement production of crops and livestock, based soundly on adaptive research at the farmers' level.

The adoption of improved technology by farmers is one of the most important products of agricultural research. For this to occur, the farmer and the conditions under which he operates must be key variables for any research effort. Translated into operational practice, this means that more time and effort need to be spent in understanding, interpreting and documenting farmers' circumstances and in actually conducting some research in farmers' fields than has been the case in most countries. This requires the active involvement in research programs by all three parties concerned: the researcher, the farmer and the extension worker. ISNAR staff and others have observed in many countries that there has not been sufficient attention paid to the identification of problems at the farm level nor to the involvement of researchers in the farm testing and implementation of research output.

You will note that I have first emphasized research that is problem solving and produces improved technology for immediate use by farmers. This point is important in all countries, but in my opinion is of greatest importance in developing countries with scarce resources both in terms of trained manpower and finances. There is an enormous amount of research which has been carried out or is being carried out throughout the world. What the developing countries need is access to this research, its interpretation and the ability to test and adapt it to local conditions. Often for failure to spend a few dollars on international journals or for travel funds for scientists to participate in international meetings a nation loses access to relevant research findings which could accelerate its development and agricultural growth at great savings not only in time but in money. Whenever the number of research scientists in a country is small in comparison to its needs or where finances are a serious constraint it is a very unwise saving to reduce access to the international scientific community. Contact with the international scientific community is always important but in time of serious economic constraints it is even more important to keep this channel open. Unfortunately this view is not shared or at least it is not practiced in most developing countries.

The important thing to keep in mind in relation to the utilization of research findings from the international community is that what cannot be imported is applied research that adapts results to local conditions. Hence the heavy emphasis on applied research in the developing countries.

Agricultural research in a country with limited resources, and this applies to almost every developing country, must make difficult choices. Even if concentrating to a large extent on applied research and a problem solving approach of actual problems at the farm level the research organization cannot cover every crop and every problem. There must be a system to establish priorities, to allocate staff resources and to determine which are the critical problems for immediate attention and which ones have to wait. This process is further complicated (or perhaps the decision is made easier) by the availability of staff with particular disciplinary training. When there is a shortage of staff or gaps of certain disciplines one must look to short run solutions. The first place to look is within the country in other departments of government, educational institutions or the private sector to secure the particular input needed to carry out the specific research problem. Usually the

competence can be found within the country if one makes the effort to search it out and interest the person in the importance of the problem. If the competence required cannot be found within the country, then one must seek support from an international agency.

I have given the greatest importance to research of immediate and applied nature in developing countries. However, all agricultural research in a country cannot be of this kind. Some research must be carried out to meet future needs. There needs to be a balance between short term and long term research but in my view the balance is in favor of the short term research. Even so, it is essential that some long range research be carried out. This type of research requires equally careful planning as the short term research and it is often difficult to gain the administrative and financial support for this long range work because of the lack of understanding of its importance. The issue is further complicated in situations where staff are in short supply and therefore are under constant pressure in short term research and they often do not have the time to obtain the information needed for planning ahead and determining future problems and needs. In looking to long range agricultural research needs it is essential that a qualified research unit (and not a single scientist) conduct a detailed study of potential economic and technological development in the national and international fields for at least a few years ahead. When a nation does not have the full competence in its own staff to carry out this kind of a study it should seek the assistance it needs. However, it is not something that you leave to consultants or advisors. You seek their expertise but you must be a full partner in the study process and fully understand the problem and the implications of undertaking the research. It is not an easy process but with care and wise selection of those with whom you work long range planning can be done quite successfully.

In regard to this second goal of agricultural research I have spoken of research problem identification, the importance of applied research in adopting technology introduced from the international community to local conditions and short and long term research. The goal -- or the role of agricultural research -- goes much further. While the stated goal I gave you is very short it is full of meaning. It demands that agricultural (crops and livestock) research takes into account the economic implications to the farmer and his family. In many cases the social implications will need to be considered as well. This means that the market for the product must also be considered so market research is a part of the research package. It further demands that the adaptive research be carried out at the farmer's level. Research doesn't stop at the gate of the research station. The research station represents only one situation and recommendations to farmers can only be made upon the basis of research conducted or verified under their conditions. This is still a part of the role of research, for it is here at the farm level that the real interface between the farmer, the extension worker and the research team takes place. I am not certain what the correct balance should be between on-site research (on a research station) and off-site (mainly in farmers' fields) This will vary from situation to situation but probably should average between 25 and 50 percent. If research is verified in this manner and there is a real interaction between research and extension then the interpretation of research is easily carried out and the extension workers can then concentrate on a wider adaptation of the improved technology. I have been concerned here in Fiji to hear some research staff and some extension workers say that "the process is for research to pass the results to extension". This is a one way process

which should be dropped from everyones language. The development and transfer of technology must be an interactive and continuous process with continual dialogue between the research team, the extension team and the farmers.

Now let me turn to the third goal.

- \* To develop and maintain a group of well-trained, competent scientists in appropriate disciplines in active research positions capable of collaborative effort in problem resolution and in interpreting national and international scientific advances for the benefit of national development.

Again, this is a short statement but it is packed with meaning. It not only refers to assuring a continuing supply of well trained staff to continue to develop and maintain an effective research organization but it also implies how research is organized and conducted.

The research organization in any country must assure that it develops and maintains its appropriate staff strength and that staff development plans are regularly reviewed to assure that staff training and staff positions match changing needs. All too often we note in developing countries inadequate manpower planning and insufficient attention to staff training to meet needs. The question of staff numbers in any discipline or commodity research effort is a difficult issue to determine. It is generally agreed that to be effective in research there is a need for a critical mass of research scientists. According to Dr. A. T. Mosher, who recently authored a publication for ISNAR titled Some Critical Requirements for Productive Agricultural Research (p. 7):

Scientists from at least five to eight agricultural science disciplines, and at least two scientists in each, is probably the minimum critical mass for any serious research effort.

In a commodity-oriented research program for example, it usually cannot be known in advance how much contribution to increasing production of a particular commodity can be achieved through plant breeding, how much by bringing certain diseases under control, or how much through changing agronomic practices. Nor can it be predicted whether a particular disease can most economically be controlled chemically or through breeding for disease resistance. It is only by assembling a team with varied disciplinary background, and by working together, that these questions can be answered.

Another phase of the importance of a critical mass flows from differences of ability and of points of view among research scientists. It is better to have two or three soil scientists, two or three plant breeders, etc., rather than only one of each. One person may catch what the other has missed. They may favor different approaches to the problem, in which case it is better to try two or three of the approaches than to settle in advance on only one.

Inferred in the remarks by Dr. Mosher is the importance of interdisciplinary work in problem resolution. This is absolutely essential in applied research and in the development of improved production technology for farmers. Research managers must exercise strong leadership in the development of a problem approach with

interdisciplinary participation in the research program in developing countries. The interdisciplinary team must plan, execute, test, and evaluate the research on any specific research problem and as has been indicated before they should work closely with the farmers and the extension workers in the process.

In order to accomplish the desired objectives the research managers must see that the research scientists have opportunity to avail themselves of the literature from the international scientific community (and to contribute to it) in their respective fields and to participate in regional and international scientific meetings.

We have looked at three major goals of an agricultural research system which I believe express the role of a national agricultural research system. I have not included anything on the structure of a research system but I believe it is worthwhile in passing to state that regardless of structure or organization, it is noted that those systems which seem to be successful have in common the capability to respond to needs and to identify, resolve and interpret findings in terms of problems of the client groups. They also have the institutional flexibility to adapt to changing conditions. It is important to note here that in the successful systems there usually has been involvement by the researchers in the identification of farmers' problems and in the delivery and introduction of the research product, either directly or in close liaison with the agency responsible for this delivery.

In closing I would like to reemphasize the importance to a research organization that consumers are really prime beneficiaries of agricultural research and research management should seek their support for research. It is necessary to keep them informed of the benefits of research to them so they will help bring the necessary political support through government to assure the financial support. By the same token government policy makers must also be kept informed. It is your responsibility as research scientists to keep policy and budget officials aware of the importance of research and the benefits from productive research. Not everything you do will be a success story in terms of economic benefits but when there are such successes don't take it for granted that your annual report will suffice. See that the facts are well presented and you will build a sound base of support for continuation and development of an even more effective research program.

## RESEARCH ON PASTURES AND ANIMAL PRODUCTION

One specific objective listed for the ISNAR mission was that it update the Report on Pasture Research in Fiji, prepared by Dr. C. S. Andrew in 1979, and also consider feed sources other than pasture and animals other than beef and dairy cattle. Consequently this annex will first consider Dr. Andrew's report and his recommendations on research programs, then extend to other livestock research programs, and finally make recommendations on staffing.

(a) Updating the Report on Pasture Research

Dr. Andrew's report not only comments on the research programs as of 1979, but gives considerable background material. This background deals with the geology, soils and vegetation, reviews the results of previous research and also gives some valuable insight into problems such as defining fertilizer requirements and soundly evaluating pasture species. This background material is most useful and no further comment will be made on it. Rather each specific recommendation will be considered individually. The recommendations will usually be referred to by the numbering system used on page (iii) of the Andrew's Report but some mention will be made of details given on designated pages in the body of the report.

A general comment is that, while Dr. Andrew's recommendations are consistently sound, they would involve a major increase in research support if all were to be implemented. Thus, although some recommendations may not be supported at this point in time, it does not imply they are biologically incorrect. Rather the problem is of keeping a balance within the Research Division in terms of the resources allocated to pasture research.

Recommendation A1 (There is a need for research on the continuing fertilizer requirements of developing lands in order to sustain continued economic animal production and a high level of animal fertility).

Dr. Andrew's suggestions (p. 16) are sound and have been followed as far as resources have allowed. Soil and plant analysis have been used and also further nutrient trials laid down to assess response in terms of legume yield (e.g., Partridge 1981). This program could be contracted on the beef pasture program although the current monitoring studies such as on Yalavou should be continued. The use of test strips to detect fertilizer responses should be considered as this has recently been advocated for tropical and temperate pastures (e.g., Johansen 1980) and there is now a greater awareness of the limitations of soil and plant analysis (Rayment and Helyar 1980). Consequently the use of test strips on pastures is recommended as a way of monitoring fertilizer requirements, especially on the larger holdings (Yalavou, Yaqara and Uluisaivou). Elements of particular concern are P, K, Mo and S. Care needs to be taken to assess the impact of fertilized strips during a growth cycle when the paddock is not being grazed, otherwise responses can be masked by selective grazing. More attention needs to be given to

<sup>1</sup> Annex 2 prepared by Dr. R. M. Jones.

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the latosols and humic latosols than to the nigrescent soils. Further studies are required on Desmodium heterophyllum pastures on the wetter side of the island, following up on the studies of Krishna (1981).

There is considerable promise for rock phosphate as a fertilizer in Fiji (Anon 1980), but it is unlikely to become commercially available unless recommended for the sugar industry which is by far the major user of fertilizer. In 1978, for example, 10,300 t of super phosphate was sold to sugar cane farmers whereas an optimistic estimate of phosphate use on pastures, expressed as rock phosphate, was 533 t per year (Anon. 1980). Thus further research on the response of sugar cane to rock phosphate, although outside the scope of the Research Division, is to be encouraged in view of its potential effect on fertilization of pastures and consequently on animal production.

Recommendation A2 (While the above research - on fertilization - is in progress new animal production schemes involving land clearing should be minimized).

While supporting the recommendations that major new developments for beef production be minimized over the five-year period (1979-84), there are other additional reasons to those by Dr. Andrew that deserve mention. During pasture development at Yalavou, and especially Uluisaivou, there have been considerable ecological problems involving the ingress of woody weeds. Some of these have been resolved and some are still being tackled with the advice of Mr. Partridge. There is a good case for not initiating new major developments until these problems have been resolved. Also it will only be certain that land tenure questions involving management, land owners (mataqali), and farmers have been satisfactorily resolved when the schemes have been in a steady state of operation with a clear indication of their future financial returns. This applies to schemes based on either individual (Yalavou) or on corporate management (Uluisaivou). Furthermore, steady progress is being made in the quest for self-sufficiency in beef, from 40% in 1976 and 1977 (DP8 table 9.2.17) to 70% in 1980 (Singh 1980). Consequently, there is no strong case for major development of new beef schemes. However, this need not restrict the continuing development of individual farms.

Recommendation A3 (Greater attention should be given to the evaluation of pasture species, in relation to their nutritive value for animals and ecological attributes pp. 20-29)

The present range of species for the western division is basically suitable and there does not seem to be a priority for looking for 'better' or higher quality species at this point in time. While Nadi Blue grass has a slow start in the growing season, there is ample evidence that it is capable of good animal production (Partridge 1979). Perhaps there is an element of risk in relying so much on one legume, (Desmodium heterophyllum), even though D. triflorum and Alysicarpus vaginalis can be important with adequate fertilization and heavy grazing. However, this would not be a priority problem.

There is more priority for species evaluation studies, particularly for legumes, in the central division. A fuller examination could be made of Centrosema pubescens, mainly for set-aria pastures, and of legumes such as D. ovalifolium, D. heterocarpon and D. canum for heavily grazed pastures

of low productivity based on Axonopus compressus (carpet grass) and Paspalum conjugatum (sour grass). The quest for better legumes, or grasses to replace carpet grass and sour grass, cannot be separated from studies on nutrition and management. Also it could be worthwhile to screen for shrubby legumes that can grow on poorly drained and acid soils, Codariocalyx gyroides being one possibility (Lazier 1981), and to compare the Setaria splendida x anceps hybrid, now being grown at Koronivia Research Station, in later stage evaluation against S. anceps (cv. Kazugula) and S. splendida.

While there is merit in maintaining the existing museum of species at Koronivia and Sigatoka Research Stations (p. 28), these should not be allowed to expand and so consume unjustified resources.

Recommendation A4 (A well planned unit for the production of pasture seed, initially supported by the Department of Agriculture, should be established).

Currently there is some input by Research Division into seed production of stylo, Nadi Blue grass and, to a lesser extent, Kazungula setaria. This should be encouraged. However, these are being increased at different research stations and so it is difficult to see how a 'seed production unit' could assist. Seed production of these three species is of higher priority than that of Koronivia grass, signal grass and guinea grass (p. 29). Furthermore, it must be noted that the annual development rate of 6,500 ha, used by Dr. Andrew to calculate seed requirements, is over-optimistic rather than "conservative" (p. 23). The broader issues of the Research Division's role in seed production has been discussed elsewhere in this report, and pasture seed production should be considered by the proposed planting material committee (section 3.4.5.).

Recommendation A5 (Research is urgently needed to combat weed invasion in both the dry and wet zones).

Dr. Andrew's comments about the need for attention to weed control is supported. The problem in the western division is that of woody weeds (guava, wild yaqona, etc.) and the four main control measures are vigorous pasture species (such as Nadi Blue), goats, chemicals and fire. However, it is difficult to carry out realistic small plot experiments into these factors as there are many interactions. Furthermore, the build-up of adequate fuel for fires depends on manipulating the stocking rate of cattle. In contrast, small plot experiments are suitable for screening of herbicides. It is likely that the best approach to these weed problems will come out of the cumulative experience of Yalavou, Yaqara, and Uluisaivou, with Mr. Partridge coordinating this knowledge. Assistance can be sought from the weed science specialist at Koronivia Research Station for specific purposes.

Dr. Andrew dealt in detail with the problem of Navua sedge (Cyperus aromaticus) in the central division and it is encouraging to see the common approach that has developed with the Animal Health and Production Division and the weed science, pasture agronomy and animal husbandry sections of the Research Division. The only minor reservation with Dr. Andrew's suggestions is that it is not possible to accept the view that grazing management studies should only be undertaken after the detailed ecological studies on Navua sedge are complete (p. 47). With the promise

shown by Setaria species in controlling sedge, there is potential for grazing management and fertilizer studies on setaria to run in parallel with the ecological studies.

Dr. Andrew suggested also that consideration be given to using crops and a ley farming approach to combat Navua sedge in the alluvial soils in the eastern zone. This approach has a sound biological basis, as cultivation is an effective way of controlling Navua sedge. However, it is suspected there is no crop which can suitably meet the economic, biological and sociological requirements. Horticultural crops, for example, involve considerable labor and specialist skill, and also would need additional drainage works in some areas. If there was a crop which could be economically grown by the typical dairy farmer, keeping in mind the limitations of spare time, labor and suitable machinery, it is very probable that this approach would have been taken already. However, it should still be kept in mind. Fodder crops may be easier to handle than grain crops, provided they give an economic return.

Using a cropping phase can give the opportunity of undersowing pasture species, either when sowing the crop or after the final inter-row cultivation. Undersowing is showing considerable promise in many countries, for example it is used to sow Stylosanthes hamata into cassava in Thailand (Wilaipon et al. 1981).

Recommendation A6 (There is an urgent need for an agricultural economic analysis of results from grazing experiments).

The recommendation that a full analysis of the Nawaicoba and Sigatoka grazing trials be carried out is strongly supported. This has been done in a preliminary fashion (Partridge 1981), but should be extended to fully cost all aspects of stocking rate and fertilizer application. Such a study should reveal the long term cash flow for the different management options. Mr. Partridge has clearly shown the biological returns that result from application of superphosphate and it is of the utmost importance to accurately assess the economic value of fertilizer inputs. Fertilizer has the potential to substantially increase beef production in Fiji and the priority for this approach will only be truly known when the appropriate economic analysis has been carried out. It is simply not good enough to dismiss fertilizer as being "too expensive". Such analyses would have implications for individually owned beef farmers as well as for large development projects.

Recommendation A7 (The present experiment on grazing under pines should proceed for its full time but further research on pastures under pines should depend on the outcome of the existing experiment).

The Fiji Pine Commission has decided on a policy of using cattle to "clear" land prior to planting pines on land classes where the vegetation is competitive enough to suppress the growth of young pine trees. This pre-planting grazing phase is to be followed by grazing from year 2 to approximately year 9. This policy appears biologically and economically sound and no further research is required. However, problems have arisen with joint experimentation between the Pine Commission and the Research Division and this has led to de-stocking and likely permanent cessation of the grazing trial referred to by Dr. Andrew (Partridge 1981). Difficulties must be expected in joint experiments involving two

organization with such diverse outlooks when both are exercising some control, apart from practical problems that could develop under commercial usage. It is suggested that it would not be a priority need to proceed with more detailed work on spacings, fertilizer requirements and stocking rates to develop long term grazing strategies for pine stands. Furthermore, overseas experience has shown that pastures under tree plantations grown for timber have generally not given the anticipated benefit (Burton 1973).

Recommendation A8 (There is a need to continue research into pastures under coconuts).

Dr. Andrew dealt with the question of growing pastures under coconuts in considerable detail. However, this emphasis was apparently based largely on a belief that the number of beef cattle on coconut plantations as a percentage of the total number of cattle on the Fiji Islands was approximately 20%. However, the 1978 census suggests a much lower proportion of 6% (15,000 out of 247,000) even though 20% of cattle are in the northern division (Rothfield and Kumar 1980). When the continuing decline in the coconut industry is also considered, the priority for research into pastures under coconuts is obviously of lower priority. Furthermore, a study into pasture species, fertilizers and pasture management, taking measurements of both animal and coconut production, would require a major resource input over many years. Research into inter-cropping, outlined in Annex 3, would have higher priority.

Mr. Partridge has had some experience with pastures under coconuts in Fiji and is currently writing an information sheet on this topic, which should give useful guidelines to interested landholders. In addition, there is a considerable amount of information recently available from the Solomon Islands (Watson and Whiteman, 1981), Western Samoa (Reynolds 1981) and Indonesia (Rika et al. 1981), even apart from that recorded in the book Pastures under Coconuts (Plucknett 1979). If, for some reason, pastures under coconuts do become of high priority, a pasture/animal scientist should be sent on a study tour to appropriate centers in the Pacific Islands and southeast Asia to report on and summarize the available information before considering or planning an experimental program.

Recommendation A9 (No new animal experiments (beef or dairying) to provide production data should be contemplated for the present).

The proposition that "no new beef production experiments are required", is accepted, although there is an obvious need to see if it is possible to lift the usual calving percentage of some 50%. There is a problem, however, in that experiments on reproduction require large numbers of animals and large areas of land. It is suggested, therefore, that this problem is best attacked on the large developments at Yaqara and Yalavou. Mr Partridge has already made some start in this at Yaqara. Both developments have the resources to study the effect of improved nutrition (via fertilizers or supplements) and of changing the dates of calving and weaning.

However, it is not possible to accept the proposal that no new experiments on milk production are required. With the initial promise shown by Setaria splendida and S. anceps cv. Kazungula (Singh 1981)

further studies are undoubtedly warranted. Variables to be considered include stocking pressure, grazing method and nitrogen fertilizer. After the milk production potential of the setaria pastures is adequately documented, it would then be opportune to look at the output and economic benefits of feeding extra concentrates and minerals. As very high rates of nitrogen fertilizer are unlikely to be used in Fiji, it is unlikely that oxalate toxicity in setaria (Jones *et al.* 1970) will present a serious problem. However, the possibility should be kept in mind and firm recommendations made against allowing horses, which fortunately are not common in the dairying areas, to have access to setaria pastures.

Recommendation A10 (Research into the merits of continuous versus rotational grazing should be delayed until further research is accomplished on ecological problems).

This recommendation is fully supported and it is further suggested that there would be no point for research workers in Fiji ever being involved with formal comparisons of continuous and rotational grazing. There is a considerable amount written on this, reviewed by 't Mannetje *et al.* (1976) and Whiteman (1980), and there is no single answer appropriate to all situations. Grazing management has the objective of keeping the better productive species in and weed species out, and so successful management must be based on ecological understanding (where pasture stability is the main problem) and on matching pasture production with animal requirements.

One management practice not considered by Dr. Andrew is that of cut-and-carry feeding systems for dairy farms. Research on cut-and-carry is not recommended at this stage, but the animal husbandry research officer at Koronivia should liaise with officers of the Animal Health and Production Division to see if research is justified on this subject. The main argument for cut-and-carry is the presence of Navua sedge and successful use of setaria may largely overcome this problem. The other minor advantage of cut-and-carry would be of avoiding reduced intake during wet weather. Disadvantages would mainly be the extra labor, machinery and storage space required.

#### Recommendations on Leucaena leucocephala

Dr. Andrew has drawn attention to the potential for Leucaena leucocephala (pp. 32-3) and suggested its use be extended (p. 44). In fact, a study by Partridge and Ranacou (1974), which demonstrated the value of Leucaena as a supplement to Nadi Blue grass, was a pioneering work in this area and is regularly referred to in recent reviews (Siebert and Hunter 1981, Evans 1981). However, establishment of leucaena for supplementary feeding has not been commercially used on beef pastures in Fiji and this is understandable in view of the problems of slow leucaena establishment and the managerial skill required to utilize it. Although there are toxicity problems associated with leucaena in some, but not all, tropical countries (Jones 1979), it is most unlikely that these would be encountered with the levels of leucaena likely to be fed in Fiji. Problems would not be anticipated unless leucaena comprised more than 30% of the diet for an extended period of time.

However, existing stands of leucaena should be further capitalized on. This is most likely to happen with small goat units in the western

division, particularly as the use of goats on sugar cane farms is expanding, and to a lesser extent on certain areas of the Yalavou scheme. The use of coral sand in road-building is providing an ideal situation for leucaena to grow along roadsides in the intensively farmed areas in the west. However, at this point in time, it is believed that no additional research on leucaena is required, nor that its use be actively promoted, even though research and extension officers should be aware of its potential so that, as appropriate, its use could be quietly encouraged. There is currently an active research program in Australia into the toxicity problems of leucaena, and there is a distinct possibility that this could be resolved in the near future.

#### General Comments on Dr. Andrew's Recommendations

In general, it is suggested that the work input suggested by Dr. Andrew be reduced and that research be concentrated on pasture problems in the central division. This does not mean that pasture research on the western division should cease for all time. Serious disease problems on Desmodium heterophyllum, for example, could change priorities and require a search for alternative legumes to supplement the existing Desmodium triflorum and Alysicarpus vaginalis. The Research Division should maintain an active liaison link with management at Yalavou, Yagara and Uluisaivou so that problems in pastures can be identified at an early stage and appropriate action taken. Such liaison could be aided, for example, by associating an officer of Research Division with any review of these three properties.

Another point to be considered is that in 1982 there appeared to be steady progress towards self-sufficiency in beef production, as previously referred to. In 1978 there were 247,000 cattle in Fiji compared with 140,000 in 1968 (Rothfield and Kumar 1980). Boneless beef production was 2387, 2313 and 2246 t in 1979, 1980 and 1981 respectively, compared with 1417 t in 1976 and 1528 t in 1977 (DP8, p. 116). Furthermore, the documented potential of fertilizers to improve beef production from legume/grass pastures (Partridge 1981) has not been exploited. Hence the priority for research must be reduced as there would seem to be little merit in Fiji ever seeking to be an exporter of beef, except perhaps for smaller neighboring islands. With restricted resources, the priority for research lies in other commodities with proven export potential or where there is a realistic need of attaining self-sufficiency.

#### (B) Extending the Terms of Reference

##### 1. Goat Research

There is increasing interest in the potential for goats in Fiji, particularly in view of the fact that some 40% of the population do not eat beef. There were 66,000 goats in Fiji in 1978 and 122,000 in 1978 (Rothfield and Kumar 1980). Most of the goats (12,000) are in the western zone and 55,000 or 45% of all goats, were on sugar cane farms where the average herd size was only 6.3. Some of the current interest in goats is undoubtedly over-optimistic and has not fully appreciated the problems that arise in a goat industry, but nevertheless research into nutrition and management of goats certainly warrants support.

Goat research is primarily carried on Sigatoka Research Station and, although carried out by the Animal Health and Production Division, was quite logically recorded in the 1981 Research Division Annual Report.

The potential for goats in Fiji ranges from the use of very small units, such as for two completely penned goats on a vegetable farm, to the extensive grazing of large herds, such as proposed for some parts of the Yalavou scheme. However, the potential for goats is mainly for penned or tethered goats in sugar cane farms. There is a relatively greater demand for goat meat in these areas and, being a relatively small animal, goats are well suited to on-farm slaughter and consumption. Furthermore, there are more crop by-products, such as sugar cane tops and pigeonpea residues, in the western division.

Other advantages of goats are that they are more readily transported than are cattle, and also make earlier repayment of loans easier as they reproduce and mature more rapidly.

The current research on goat nutrition and production is being carried out by Dr. Hussain, and is financed through FAO. The present program on pen feeding of goats is fully justified, though no extra input is required. The current feeding studies are based on agro-industrial by-products such as coconut meat, wheat bran and molasses (Hussain 1981) but it is assumed that crop by-products (pigeon pea residues, dried cassava leaves etc.) will also be used in subsequent experimentation. The role of leucaena as a source of both energy and protein has already been mentioned. While considering feeding of pen or tethered goats it is difficult to see a role for large scale pen feeding of beef cattle in Fiji. In contrast, tethering of cattle of individual animals, with or without some associated cut-and-carry feeding, is a common practice, particularly on the sugar cane farms.

The major problems that will be encountered with the increasing use of goats in extensive grazing systems will be internal parasites and physiological stress, initiation of soil erosion, and loss of animals by theft and predation. Parasites can obviously be important under pen feeding conditions or when goats are browsing woody weeds, but there is far more chance of ingesting worm larvae when animals are maintained on short grassland. Goats are much more susceptible to worms than are sheep and, in Australian conditions, worm egg counts in goat faeces were 10-100 times greater than those from sheep on the same pastures (Lumbers 1979). Goats are also more susceptible to other diseases, such as footrot, and to physiological stress from exposure to wind and rain. Attention will need to be given to these factors and control will be by a combination of pasture management (spacing in relation to disease cycle), goat management (location of and number of shelters) and drenching. Whether there is a need for research on goat diseases will depend on future events and the relevance of overseas literature. It is possible that more troubles will arise through farmers not following correct procedures (whether prevention or cure) rather than through inadequate knowledge. Problems must be anticipated, particularly in the central division.

Goats present a much greater erosion hazard than do sheep, as they create and sustain bare patches on sloping hillsides and do not form contour tracks as do sheep and cattle. A careful watch should be maintained to see that this potential problem does not become serious, and livestock

officers must be encouraged to watch for early signs of erosion and explain the problem to farmers. In some cases, it may be possible to control the cattle-to-goat ratio by regulation, as for example on Uluisaivou or where a farm is supported by the Fiji Development Bank. The problem will mainly arise through concentration of goats and will not be greatly assisted by ad hoc rotational grazing. Penning of goats from evening to morning will help to reduce the erosion hazard as goats will be more concerned with eating and not playing during the period of release. Widespread introduction of goats will require more use of fencing that is also more costly per unit length than cattle fencing. Thus, although goats have considerable potential to assist in woody weed control, they should not be thought of as the main grazing animal for extensive grassland systems.

It is likely that there will also be more problems with theft and predation of goats by dogs than are experienced with cattle. There were reports that 1,000 goats were savaged by dogs in the western division alone during 1981. However, this has no direct bearing on research or research priorities.

## (2) Sheep Research

There is a continuing long term sheep program in Fiji, which is based on crossing the tropical Barbados Black Belly sheep, which is well adapted to tropical conditions, with traditional wool sheep. The continuation of this program is supported; currently the Barbados sheep are on Makogai Island under quarantine. The advantage of the proposed cross-bred sheep over goats for grazed pastures is that they will induce less erosion, are likely to be less prone to disease and climatic stress, and also should give a better liveweight gain per animal (Partridge 1981). They should also have a better carcass confirmation. The fecundity of cross bred sheep will probably be lower than that of goats under good conditions; but this may not be so under grazing. Sheep will require less handling and will be more suited to extensive grazing, whereas goats may be better suited to tethered and penned situations where they can express their greater potential fertility. It may be that the final animal population for extensive grazing will comprise cattle, sheep and goats -- the latter primarily for woody weed control. The problem of theft and predation with sheep could be as serious, or possibly more serious, than it is for goats.

## (3) Pigs and Poultry

The pigs and poultry industries in Fiji now meet internal needs and major export development is not anticipated in Development Plan Eight. Market expansion will presumably be mainly at the expense of other meats. Government policy is to encourage local farmers to grow more feed (e.g. maize, soybeans, dried and chopped cassava) for the pig and poultry industries and substitute this for imported feed. The pig and poultry industries are moving into larger scale operations and so it is likely that they will encourage feed substitution at their own initiative if there is an economic incentive. However, this is not a major priority for the Research Division although the existing level of research input into pig nutrition (Singh 1981, Partridge 1981) should be continued. Experience in some other tropical countries (e.g., The Philippines) suggests that if it is government policy is to bring about import

substitution, it may have to achieve this by legislation, even if at greater cost to consumers. The possible use of molasses and crude sugar as pig feed should be explored (Preston and Willis 1969).

(C) Resources and Personnel

The recommendations made in the Andrew's Report (p. iv) will be dealt with initially, and then followed by additional recommendations.

Recommendation B11 (That a specialist plant nutrition officer be appointed).

This recommendation is strongly supported. The officer to be appointed should have expertise in both plant and soil nutrition. He should be encouraged to spend a considerable amount of time consulting with and assisting other staff about nutritional problems, and not become solely devoted to his own experimental program. It could be a demanding but challenging role as it would cover pastures, annual crops and perennial crops. This position is proposed to be filled, at least in part and in the short term, by Dr. Haq under UNDP/FAO. However, the position should be given long term status with the Research Division, and not be dependent on transient funding. The officer should interact with soil scientists at the University of South Pacific, as suggested by Dr. Andrew. Adequate travelling funds must be made available for visits to centers away from Koronivia.

Recommendation B12 (That an ecologist be appointed to the weed control section in the Research Division).

This recommendation has been met in part with the appointment of Mr. Black who is involved in both herbicide and ecological aspects of weed control. However, for his appointment to be fully effective it is essential he be provided with adequate travelling funds to consult and/or cooperate with staff at outlying stations. Only then can full advantage be taken of this appointment.

Recommendation B13 (That a biometrician be appointed to the Ministry of Agriculture).

The support for biometrics should be upgraded, both in terms of expertise and equipment. Provision of desk micro-computers, with statistical packages, may also be a useful aid in station administration. However, it is problematical if a research group of about 15 officers actually engaged in experimentation can afford the luxury of a full time research officer (biometrician). This is particularly so as many of the experiments use, quite appropriately, simple designs. Possibly upgrading the skills of existing research and support staff may be adequate, particularly if assistance for more complex problems could be sought from statisticians at the University of the South Pacific. Care should be taken that all proposed experiments are examined for their statistical soundness during the procedures for project appraisal.

Recommendation B14 (This concerns adequate support and facilities for the three appointees recommended in B11, B12 and B13).

This point has largely been covered in the proceeding paragraphs which pointed out the need for adequate travelling expenses, and suggested upgrading computing facilities for statistical analysis. It is assumed that the plant nutrition officer would be allocated the usual level of technical support. This officer may slightly increase the demand for chemical analysis, but one of his main roles may be to increase the value of chemical analysis currently undertaken.

Recommendation B15 (That Fijian "understudies" be appointed to work with the plant nutritionist and ecologist and also to work with Mr. Partridge on beef cattle and pasture research).

This recommendation has been met in part by the overseas study leave awarded to Mr. Chand, currently doing a Master's course in pasture agronomy at Brisbane. The concept should be extended to all positions currently filled by an expatriate officers.

Recommendation B16 (Encourages cooperation between the Ministry of Agriculture and the University of the South Pacific).

This has been dealt with and supported in the main body of the ISNAR report; the most fruitful discipline for cooperation would appear to be that of soil science. One comment would be that such cooperation may be best expressed in short term projects. It appears that there is a reasonably high staff turnover at USP and this could cause problems if a longer term joint study was initiated in which the USP involvement was essential. However, continued discussions between the two organizations will benefit both, even apart from the possibility of joint studies.

Recommendation B17 (That an in vitro digestibility unit and mobile milking shed be provided at Koronivia Research Station).

The provision of an in vitro unit at this point in time cannot be recommended. It is not essential to have such a unit to make major advances in pasture improvement, as evidenced by the results from the program of Mr. Partridge. It is certainly not needed in pasture research for the dairying industry at this point in time. Furthermore, intake is usually a greater limitation to animal production than is digestibility.

There is now a considerable amount of literature which gives guidelines about likely digestibilities of plant part (leaf or stem) in relation to age and environment. So far, this information has been of little immediate practical benefit. A final comment is that even the presence of an in vitro unit could divert resources from higher priorities. If there ever was a critical need to assess digestibility for some specific reason, it is suggested that an approach be made to organizations in Australia and New Zealand.

Likewise, it is not recommended that a mobile milking shed be obtained at this point in time. The present dairy unit at Koronivia is suitably placed for milk production and grazing experiments on setaria and other pastures. Thus there is no immediate need for a mobile facility.

Recommendation B18 (That a computer, or access to a computer, be provided for as a necessary adjunct to the appointment of a biometrician).

This recommendation has largely been covered under B13. One problem with using large computers and a highly sophisticated statistical package, such as GENSTAT, is that the whole analytical system depends on having experienced operators who can manipulate the program and run the machines. The alternative concept of using simpler packages with locally based micro-computers is much more resilient to staff turnover and seems more appropriate for agricultural research in Fiji. The occasional more complex analysis could presumably be contracted out.

#### Additional Recommendations on Staffing

(1) Two recent complications involving staff are that Mr. D. N. Singh and Mr. Partridge are leaving the Research Division in August and December 1982 respectively. Mr. Chand is on study leave for his Master's degree and will not be back until December 1983. Mr. Singh's replacement should be appointed at an earlier date.

The overall assessment is that the research program on beef pastures is sufficiently advanced that there is no immediate need to replace Mr. Partridge at Sigatoka. Rather it would be best for the current research findings to be followed, monitored and modified on a farm basis, drawing on Mr. Partridge's experience and availability for consultation while he is based at Yaqara. The beef breeding program at Sigatoka Research Station can be adequately supervised by supporting staff.

Most of Mr. Partridge's work has either been written up or is being prepared for publication. However, these publications are in applied science journals and are not accessible to or in a form suitable for use by livestock officers. It is therefore recommended that Mr. Partridge prepare a final summative article which outlines in simple terms all the factors and procedures involved in pasture improvement in the western division (plant species, fertilizers, weed control, animal species, animal management, fire etc.). This article should give the understanding underlying improvement, and not just outline the procedures themselves. Such a report would be a most useful end-point to the last 10 years of pasture research in the western division.

It is also recommended that for the next three to five years the animal husbandry/pasture group focus on providing improved pastures in the wetter areas of the central division. The dairy pasture program has had an unfortunate history, but there are now good grounds for believing that setaria-based pastures could provide a satisfactory solution. Consequently it is suggested that a task force of three scientists (Singh's replacement, Chand and Krishna) can now tackle this problem in earnest. Miss Krishna can hold the program on the right course at a low key until the replacement arrive.

(2) It is recommended that once the animal husbandry/pasture agronomy group is built up again at Koronivia Research Station that the goat research officer (currently Dr. Hussain supported by UNDP/FAO) be transferred to the Research Division. The rationale for this recommendation is to ensure the maximum interaction between all Ministry of Agriculture officers engaged in detailed research on animal nutrition and production. Furthermore, the progress reports are already listed in the annual report of the Research Division, and the work is carried out on a research station under control of the Research Division.

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### IMPROVEMENT OF PERENNIAL CROPS<sup>1</sup>

This annex is intended to indicate, without too much detail, a problem presently confronting Fiji, an analysis of the factors which have given rise to the problem and a presentation of some of the steps which might be taken in the way of research and development support to assist in solving it. The problem is the present depressed state of the production side of the coconut industry.

#### The Problem

The problem falls into two parts, although it is clear that it should be treated as an entity; the first being consideration of the action to be taken in respect of a large portion of the industry which has reached such an age that its production is declining and it is beyond any efforts at rejuvenation; the size of this portion of the industry increases annually. An appreciation is therefore required to determine:-

- the desirable future size and location of the industry having regard to future production and internal and external markets;
- the degree of risk acceptable in attempting to increase yield per unit area of coconuts to achieve the foregoing;
- how an adequate turnover rate can be achieved to implement the decisions reached;
- the outlines of a long term Government policy to encourage the industry;
  - an adequate research and development policy to support the Government policy;
  - attraction of public and private financing.

The second part of the problem concerns those areas of coconuts which still have some years of life to run and where the canopy is sufficiently open to permit more economic use of the land by employing shade-tolerant second storey crops to improve both farmers' and Government income. Here the variables requiring attention are:

- the possible types of intercrops,
- their future market possibilities and thus the area to be established,
- the suitable soils and topography for each crop and their distribution to farmers according to these factors and to labour inputs,

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<sup>1</sup> Annex 3 prepared by Mr. C. W. Brookson.

- processing and quality control,
- the formulation of a firm Government policy to support the objectives arrived at in the above,
- formulation of a research and development plan to support the Government policy,
- attraction of public and private financing.

#### Method

The suggested method outlined in the following paragraphs to arrive at a solution is not necessarily the best or most direct, but it may serve as a guide. It is not possible to give adequate weight to all parameters in a short document, and changes of emphasis may be required.

#### A. Background

##### Climate

Located approximately 17° south of the equator Fiji is only just within the zone for the production of tropical crops. The country lies without the southern equatorial belt of low rainfall and commands a varying rainfall of from 1,800 mm to over 4,000 mm, this lower figure being on the leeward side of the islands, the figures on the windward sides being the medium and the highest being on the mountain ranges due to orographic effects. Unpredictable droughts have occurred of from three to four months reportedly on an average of five years.

Winds of high intensity to 100 km per hour with associated rainstorms have been reported from Suva. Resistance to wind damage is thus an important factor in all breeding and selection programs.

##### Topography

The two main islands, Viti Levu and Vanua Levu consist mainly of steeply dissected volcanic or sedimentary rocks with peaks ranging up to 1,000 m. Such land is 62% of the total area and agricultural land with slopes of under 14° is found only along the coastal plains, river deltas and the wider alluvial terraces of rivers.

#### B. Coconuts

##### Recent Position

The total area of coconuts has previously been estimated at about 89,000 ha; more recently by means of a Census of Agriculture<sup>1, (\*)</sup>, by examination of air photographs<sup>2</sup> and from other sources a revised figure of 65,300 ha has been obtained, with close agreement between the two major sources. This represents some 3.6% of the total land area and 6% of the agriculturally usable land in the country. The effect of

(\*) Footnotes are at the end of the annex.

identifying the actual planted area more accurately is to increase the yield per unit area, previously thought to be very low, to approximately 645 kg/ha/copra equivalent. This is on the assumption that there is considerable consumption of fresh nuts particularly in the rural areas.

By extrapolation from a 1979 FAO mission<sup>3</sup> report on the viability of the industry, which used the larger area figure, the following capability categories have been established:-

Capability: Four categories can be distinguished:

- 26,000 ha of the area are thought to have a very good potential for intercropping,
- 17,600 ha are thought to have a good potential for intercropping,
- 8,900 ha have only a slight potential for intercropping and
- 10,000 ha have little or no potential for intercropping.

The age of palms is a matter of some doubt. The current figures are, as percentage of the total area:-

	Age Class (years)						Total
	0-5	6-10	13-20	21-40	41-80	81+	
Fiji Census of Agriculture, 1979	9.0	16.6	20.2	18.7	23.0	12.5	100
Taveuni Island Survey 1977 <sup>4</sup>	5.7	9.5	11.4	13.6	51.8	8.0	100

The variation between these figures, especially in the skew of the curve to the older ages on Taveuni may be due to the preponderance of estates on the island, where better maintenance (relatively) may have kept the palms yielding longer. However, using the Census of Agriculture figures and assuming that the 41-80 year class is equally divided (although the Taveuni figures might suggest otherwise), then 24% (15,700 ha) of the trees are 61 years old or older and qualify for replanting; 11.5% (7,500 ha) are between 41 to 60 years old and could not be intercropped with perennials, some 28.8% (18,800 ha) could be intercropped if on a suitable land category, the balance of 35.7% (23,300 ha) would perhaps have 2,300 ha available for annual cash crops. Ninety-one percent of all palms are contained

either within the estate sector with 22% of the total area and an average size of 195 ha or with the majority holdings in Mataquali (village) lands comprising 69% with an average clan planting of 6.5 ha; the balance, 9% by difference, is on leasehold lands whose average planting (by survey in Northern and Eastern Divisions<sup>5</sup>) is about 2 ha.

#### Previous Subsidy Schemes

In 1963 a subsidy scheme, financed by the Commonwealth Development and Welfare Fund, aimed to rehabilitate existing plantings and to encourage replanting and new planting. By 1970 some 3,000 ha had been replanted and 24,300 ha newly planted. The scheme was revised in 1971 to encourage

replanting of overage palms and 3,900 ha were started up to 1975 when the funds were applied to diversification out of coconut. Opinions differ on the utility of these schemes, neither appears to have been successful but perhaps the results were not as bad as has been sometimes suggested<sup>6</sup>. The main problem was lack of supervision and inclusion of areas of unsuitable land. The disappointing results are attributed to "lack of adequate background of research and demonstrations and of insufficient numbers of trained field staff"<sup>7</sup>. As a matter of policy the use of subsidies (except on fertiliser) has been abandoned and any future schemes would depend on availability of credit from the Fiji Development Bank.

#### Viability of the Coconut Industry

Accepting the possibility of an average yield of 645 kg/ha per annum of copra equivalent, and with rare reported peak yields under conditions of good husbandry of 1,500 kg/ha per annum (inferring yields as low as 350 kg/ha per annum at the other end of the yield curve) a replanting program using present methods and cultivars does not appear to be economically feasible. A recent draft preparation report<sup>8</sup> indicated that yields would have to be of the order of 2,500 kg per ha per annum at full production with an immature period of from 4 to 5 years to obtain adequate returns to investment on coconut sole replanting. This calculation ignores the constraints of agricultural production and marketing in the out islands (particularly the Eastern Division) where coconuts will remain the chief crop for many years and where the peak yields may have to be discounted against possible social necessity and advantages.

In the large area (26,300 ha) of palms between 17 to 60 years of age there is the possibility of improving yields by application of inputs, where this is economically feasible, and by application of husbandry.

The economic position of the industry could also be improved in this segment by intercropping areas of suitable lands with, preferably perennial intercrops under palms over 17 years of age, but in the older sector of it with semi-perennials. The extent of such a development would depend on a number of local (labour, processing, transport, import substitution) and international (shipping, marketing) factors which would require careful economic review to avoid over-production or inadequate returns and consequent reaction in the agricultural community.

The following matters thus require consideration:

- a policy decision on the ultimate size of the industry, assuming that the production per unit area on the unknown area qualified and suitable (by integration of points in para 6(a)(b) and (c)) for replanting (part of 15,700 ha) can be increased; also considering a rational replanting program to overtake the backlog of overage palms. With this must be considered the required balance between domestic consumption and exports.
- a review of the industry in the light of the above, to estimate and decide on the acceptable risks in evolving and employing new cultivars, presently unused nursery selection and nursery growing techniques (routine elsewhere), replanting methods (sequential

- felling), inputs, husbandry and extension guidance which would enable the replantings to achieve optimum yield.
- consideration of the area (26,300 ha) of palms between 17 years and 60 years to determine:
    - (i) economic inputs and husbandry treatments to improve yields on the different land categories.
    - (ii) the extent of the areas suitable for intercropping and the types of intercrops according to land categories by integration of the factors in para 9; and by their possible processing, preservation, transport and markets,
    - (iii) the necessary infrastructure for the production of suitable cultivars of the intercrop cultigens selected, together with adequate nursery selection and nursery techniques and husbandry and input advice.
  - appropriate applied research, development, transferred technology and extension inputs to fit the program developed.

### C. Coconut Research

#### Background

Prior to 1920 only indigenous palms, reputedly highly heterozygous, were planted. These were the

- Fiji Tall, the main cultivar with two locally recognised sub-cultivars bearing green and red nuts. There is a cline of color between the extremes and the colors are probably an expression of segregation rather than true cultivars. The palm comes into bearing at six to seven years and has been reported as yielding well at 70 years of age. Under good husbandry it can produce between 11 to 13 bunches of nuts, with six to eight nuts per bunch. The nut is small; 6,000 produce one ton of copra.
- Niu Leka a semi-tall palm with a distinctive dense strong crown. The nuts are the same size as those of Fiji Tall with a similar color variation. The palm is reported to produce 12-14 bunches with six to eight nuts per bunch under conditions of good husbandry. The palm has occasionally been planted on a large scale.
- Rotuman Tall, found extensively only on Rotuma Island. The palm is said to be earlier into bearing than the Fiji Tall; the nuts show a similar color variation but are larger, at 5,000 to one ton of copra.

In 1922 Red and Yellow Malayan Dwarfs were introduced. These are true homozygous dwarf palms, coming into bearing at about four years and yielding for some 50 years. With 18 fronds male and female flowers of the bunches overlap in time and the palms are self pollinated. Each bunch under good conditions will produce six nuts. In spite of their high yield their use as commercial producers is not now common since it takes 7,500 nuts to produce one ton of copra which is rubbery and difficult to expel.

In 1961 Karkar and Markham Valley Talls were introduced from Papua and New Guinea and Federated Malay States and Rennel Talls were introduced in 1970 from Malaysia and the Solomon Islands. Pollen of Tahiti Talls and West African Talls was also imported. It is also reported that early importations of exotic palms by individuals or private organizations exist.

Hybridisation work started in the late 1920's<sup>9</sup> with reciprocal crosses between Niu Leka and Malayan Dwarfs. The progeny<sup>10</sup> came into being in three years, but variations in bearing were noted; the Niu Leka characteristics predominated. No yield records are available but production was reported as 'good'. Open pollinated progeny from these hybrids was planted<sup>11</sup> but no systematic records were taken. Exports of similar seed to the Solomon Islands in 1956 have resulted in palms which have been reported as high yielding<sup>12</sup>. Fourth generation open pollinated progeny descended from the original hybrids is presently outyielding all other cultivars in a trial<sup>13</sup> sited on heterogeneous land where recording is difficult and results uncertain; the trial has been affected by two cyclones in 1978 and 1980. In spite of the segregation which must have occurred the F4 progeny are still described as the initial hybrid in the reporting. The continued testing of the F4 progeny as distinct from F1 hybrids indicates inadequate appreciation of overseas technology.

Hybridisation was reinitiated in the early 1970s<sup>14</sup> and a number of reciprocal crosses between Talls, Dwarfs and Talls-by-Dwarfs were produced and some planted out in two trials; one trial with nine replications of ten varieties in single palm plots and the second with two palm plots of seven varieties. Losses in the cyclones of 1978 and 1980 have rendered these trials worthless; if indeed the initial design had any value. For what it is worth the Rennel Hybrid appears superior.

Since mass production of hybrid seed of Fiji Tall by Malayan Dwarf was also started<sup>15</sup> on a commercial planting on Taveuni (mainly by emasculation and open pollination but also by some assisted pollination) it seems that evaluation and planting of the hybrids were intended to be in parallel. However a low percentage of hybrids was obtained. Between 1972 and 1975 some 85,000 hybrid seeds and seedlings were distributed for planting (c. 350 ha) and in 1976 21 blocks of 1.5 acres (0.6 ha) each were marked for future examination. Some have been abandoned but the rest will be evaluated<sup>16</sup>.

At the same time three 2.5 acre (c. 1 ha) seed gardens were set up on the open pollination system.

- Fiji Tall (1960): Malayan Red Dwarf (1967/70)
- Malayan Red Dwarf (1960/61): Rotuman Tall (1970/71)
- Malayan Yellow Dwarf (1972/73): Selected Fiji Tall (1972/73)

No production has been made available from these gardens.

One fertilizer trial at Wainigata has been established on extremely heterogeneous topography. The trial was affected by the cyclones of 1978 and 1980. Results are of dubious value and the standard error is so great compared to the response that little useful economic information can be extracted<sup>17</sup>.

Two demonstration trials<sup>1\*</sup> on farmers' land show up the effects of husbandry and inputs adequately on palms of 13 years of age; no doubt were the expertise available the economic importance of these factors in cultivation of Fiji Tall and the break even point could be assessed.

The main and only station for controlled coconut trials is at Wainagata in the major coconut growing area of Cacaudrove on the island of Vanua Levu. Generally the station is unsuitable for controlled trials, particularly of fertilizer applications, because of the hilly topography.

Copra driers, recommended and popularized by the Silsoe committee, have been in production since 1970. A weak point of these driers is the furnace liner is constructed of such materials that its life averages six months, after which smoke contaminates the copra and the furnace must be replaced. No evaluation of an alternative furnace liner nor of the Ceylon dryer with its other economic advantages has taken place.

Work on coconuts is the responsibility of a Senior Research Officer, appointed in 1982 to a position vacant since 1979, and stationed at Koronivia. He also bears responsibility for research and development of other tree crops (mainly cocoa). Direct work is carried out by a Senior Technical Officer of considerable experience stationed at Wainagata.

#### D. Intercrops

##### Background

Currently some 10,000 ha of coconut land are intercropped, either with perennials such as cocoa, coffee or shorter term crops, yagona (Piper sp.) cassava, yams, groundnuts, bananas and dalo (Colocasia sp.). Cattle are often run on plantation and leasehold areas, more as a means of weed control than as a commercial enterprise since marketing of animals from the out islands is difficult. Some pasture grasses, Koronivia grass (Brachiaria humidicola), Nadi Blue Grass (Dicisanthium caricusum) and Balaga Blue grass (Ischaemum sp.) are recommended and have been established.

##### Cocoa (Theobroma cacao)

This small under story tree appears to grow well in the Savusavu - Buca Bay area of Vanua Levu and has been planted on various islands. It is compatible with mature coconut, whose yields improve because of the husbandry and inputs afforded to the intercrop; it regenerates well after hurricane damage and the smallholder cooperative processing and marketing arrangements have been inaugurated and are working. It is a suitable crop for small scale cultivation and some agronomic information is available. Subject to further investigation there would appear to be scope for exports under the protection of an area trade agreement with Australia. However the area of cultivation and extent of production would have to be strictly scrutinised to avoid over-production.

The present total area of cocoa is thought to be some 2,000 ha, more than 50% of which is in Vanua Levu. Much of this existing cocoa is

Trinitario, planted in 1956-65; because of difficulty in establishing it and because of its susceptibility to Phytophthora canker and black pod it has been superseded by Amelonado. The planting of the latter is to some extent subsidised to suitable smallholders by the issue of free seed, a grant of F\$40 (US\$ 44) per ha for farming and fertilizer and up to F\$1,000 (US\$ 1,111) for construction of a cooperative fermentary and drier.

Because of their dimorphic habit which requires little pruning and because much of the crop is developed on the trunk, seedlings are the favored planting material. In spite of the advantages of seedlings they are inherently variable (65% of the pods may be carried on 35% of the trees); however clonal material presents greater preparation and management difficulties for small farmers; it is restricted to maintaining the gene pool of the Department of Agriculture.

In the 1950s a valuable collection of clonal selections was imported into Fiji, including clones displaying self-incompatibility. Such clones have been used in seed gardens to provide open pollinated crosses between each other or with Amelonado. The resulting hybrids are more vigorous than the parents and have been extensively used in large scale developments in West Africa and East Asia ("WACRI" syn. "Sabah" hybrids). Nurseries at Naduruloulou Station in Fiji produce hybrids between Amelonado and various ICS and Scavina female parents; the Amazon selections, because of their slightly greater susceptibility to Phytophthora were discarded from the breeding program.

However, no hybrid seed has been issued to farmers, even after a recommendation by the previous Senior Research Officer in charge of tree crops<sup>19</sup> that Hybrid A (Amelonado x ICS 39) and Hybrid C (Amelonado x Scavina 12) are superior in ease of establishment and in early yield; though black pod numbers may increase with the absolute number of pods the substantially higher yields would compensate for this. There thus appears to be a case for cultivation of hybrids in drier areas or where it is possible to enforce good plantation hygiene, on at least a pilot scale.

The success of the Sabah and WACRI hybrids elsewhere, in particular the upper Amazon ones somewhat susceptible to Phytophthora but more tolerant to Oncobasidium theobromae, indicates that attempts should be made to duplicate these and to test progeny on a pilot scale, also issuing mixed seed of various parentages to farmers to reduce the risk of disease and to obtain the extra vigour and yield at the risk of some losses. The failure to consider the Upper Amazon hybrids reveals, as was the case for coconuts, inadequate appreciation of overseas results and technology.

ICS clones 39, 40, 60 and 89 with some other ICS clones also Scavina 6 and 12 and GS 29 (Granada) are available in the stations of the Research Division. Some few specimens of Nanay and IMC (Iqitos) clones and Lafi 7 (a Samoan selection tolerant to Phytophthora) are available. Surviving Amazon selections should be rescued, in particular Nanay 31, 32, 33, 34, Parinari 7 and 35 and IMC 47 and 60, all of which have proved valuable material in production of seedgardens<sup>20</sup>.

Presently the recommended density by the Research Division is that of a full stand on a sole planting (2,500/ha), density effects in a sole stand

have been examined but not densities under coconuts. Pruning x spacing trials at two locations gave anomolous results; however a pruning trial on 24-year-old cocoa showed an advantage to discretionary pruning, with high actual yield in 1981 of 2,193 kg//ha of dry beans.

Two variety trials of a number of hybrids tested against Amelonado have been in train for 11 and 7 years. In the former<sup>21</sup> Hybrids A and C have consistently outyielded Amelonado with actual yields of 1,500 kg/ha per annum and with a percentage of black pod only 2% and 3% higher at 10.7% and 11.9% respectively. In the latter<sup>22</sup> Hybrid A has not yet outyielded Amelonado while Hybrid C has, although with a black pod percentage of 29%. Yields are over 2,000 kg/ha per annum. The planting material for these trials was taken from a "hybridization" area and there is some doubt concerning the correctness to label of the material.

#### Coffee (Coffea Spp.)

Coffee was first introduced to Fiji at the end of the nineteenth century. Remains of plantings of old Coffea arabica can still be seen; Coffea liberica was introduced and at one time in the 1950's a commercial plantation was established; the beans found no ready sale commercially in view of their inferior quality and the planting has been abandoned. Coffea canephora (Robusta coffee) has been introduced and exists on some of the Department of Agriculture stations and in smallholdings and commercial plantings.

Robusta is a lowland type, relatively tolerant to leaf disease, which retains its ripe fruit. The quality of the bean is better than that of liberica but inferior to arabica. A commercial plantation of some 240 ha<sup>23</sup> has been established under coconuts using robusta seed from estates owned in Papua and New Guinea with nursery selection and polybag planting and is now coming into bearing. In spite of a minor attack of borer flowering and fruiting is such that the initial feasibility study estimate of 1,000kg/ha per annum at full production is likely to be exceeded by 50%<sup>24</sup>. A modern processing factory has been set up and it is initially proposed to market the crop internationally.

Coffee is thus a promising intercrop and could be employed in wetter areas where fungus attack inhibits cocoa planting, if labour for picking cherries is available. By reason of its membership of the International Coffee Organization, Fiji enjoys a minimum export quota of 1,500 tons per annum; the commercial organization would eventually account for 360 tons of this, leaving a balance of 1,140 for smallholders production; at 1,000 kg/ha per annum representing 1,100 ha. For import substitution only 60 of coffee appear to be imported but it is thought that this represents only coffee beans or ground coffee; the "instant" coffee imported and consumed by dwellers in urban and periurban areas and by the 600,000 tourists who annually spend nine days each in Fiji is not disclosed in the statistics. If small scale production of this latter proves feasible perhaps 2,000 ha could be cultivated affecting 4,000 holdings suitably selected at 0.5 ha per holding.

Apart from the provision of robusta seed from bushes existing on its stations the Department of Agriculture has no research and development work in hand and little knowledge of the pruning required for its dimorphic branching habit, or of the density for intercropping,

husbandry, inputs and processing of the crop. Responsibility is theoretically part of the work of the Senior Research Officer, Tree Crops; there is no other officer directly concerned.

#### Yaqona (Piper mysticum)

This crop is commonly found growing under coconuts on a wide range of soils. It is used for a traditional beverage extracted from the sundried roots and stem. Planted as cuttings it can be lifted in from three to six years for drying.

Currently it is a profitable crop commanding a price superior to coffee or cocoa in local markets. Although there is the possibility of an export market (if local drug laws permit) to expatriates from Fiji and other island states, demand would likely be mainly internal.

44. No ennoblement (except by farmers' selection) has taken place; two types are recognized by farmers in the Northern Division; it is reported that five exist in the Eastern Division. The marginal agronomy and husbandry is well known to farmers; it has not been examined, improved or systematised by the Research division. A root and stem wilt found on parts of Taveuni Island is being examined by the plant protection section.

Yaqona is a suitable intercrop with coconuts and its extended cultivation could be encouraged to a limited degree to improve incomes from existing mature stands of coconuts.

#### Vanilla (Vanilla planifolia)

This is a large climbing orchid, the capsules of which develop in the third year when the unripe fruits are dried and sweated to develop the distinctive vanillin flavour. Vanilla is still in demand since synthetic vanillin is inferior in aroma and flavour. It should be noted that, with the decline of the industry in Madagascar, there has been considerable planting, production and processing of vanilla in the Va'Vau Islands (the northern group of Tonga) which has attracted an Asian Development Bank loan; the principles of growing under coconuts, of training, of hand pollination and of processing are well understood there.

This is a very suitable crop for small or medium farmers, and would appear to grow well in the present small plantings. Subject to market enquiry, which would determine the extent of the possible intercrop, and with adequate transfer of technology it would seem possible to establish a pilot export industry and to supply local demand.

#### Cardamon (Elethenia cardamonum)

Cardamons form an important element in the preparation of curry stuffs in India. Fijians of Indian ethnic origin form over 50% of the population of the country and all cardamons are imported. There is thus clearly a case for import substitution.

Cardamon is a plant of the humid tropics cultivated under light shade, usually in areas of high and even rainfall (2,500 mm to 3,000 mm). It is normally cultivated at altitudes of 600 m to 1,200 m. Trial plots of cardamon in Fiji planted in 1979 and 1980 under cocoa at sea level are

now coming into bearing. Only where there is no dry season<sup>25</sup> is flowering and fruiting heavy, with some suggestion of fungus attack (reportedly *Fusarium* sp.). The cultivar is said to be Malabar, a statement confirmed by its habit. Trial plots were established at sea level by analogy with the practice in Papua New Guinea, where the planting material was obtained.

The agronomy and husbandry have not been explored in Fiji but are well known elsewhere, as is the processing.

#### Other Perennial Crops

Although the possibilities exist of exploitation of citrus, cloves, nutmeg, avocados, mangos and other fruit and nut trees their reaction to intercropping has not been determined; the necessity of adequate markets or processing facilities or both also remain.

#### Food Crops

Mixed cropping of exotic and local food crops and vegetables remains a possibility where markets exist. If clear felling, for replanting coconuts is practised, such crops could be grown for three to four years were there any shortage of land on the holding. It could not be practised if sequential felling, more likely to be acceptable to replanters, were employed. Such cropping could possibly be used at the end of the economic life of a planting when shade would not be too restrictive.

### E. Research and Development Support

#### Information for Planning

Information is required:-

- on the extent of the area of palms which require replacement, together with their location, also an appreciation of what proportion of this area is unsuitable for replanting by reason of topography, soil status or requirement for other development purposes.
- on the extent of the area of palms between 17 and 61 years together with their location. The area thus delineated should then be classified into areas and locations suitable for double story cropping with locations.
- a technical decision as to the possible location of the three main and two pilot scale intercrops suggested. Others could be included but in the first instance it would be advisable to consider only a limited list of more marketable commodities.
- desk studies to discover what degree of technology in production and processing is available locally or what could be imported in respect of the main crop and the intercrops.
- desk studies to make a first evaluation of possible internal and external markets; and the possible build up of production and the parameters of production.

- desk studies to evaluate the possible input of improved local or of transferred technology on the economics of processing and production.
- collation of the foregoing into a draft plan with evaluation of the risks attached to the various options presented.

The foregoing preliminary work would necessarily represent a team approach with the Land Use Section, the appropriate Research Officers for the various commodities and disciplines, the Extension Division and the Economic Planning Unit of the Ministry. Outside assistance on certain matters would have to be sought and coopted<sup>26</sup>. The object of this first enquiry would be to present to policy makers a draft plan (or options) on which a long term research and development policy on the coconut industry and other crops in a multistory cropping system could be determined to provide the basis for subsequent policy decision.

Whatever the decisions work on coconuts and the intercrops would have to be intensified in parallel with the preparation of the plan discussed above since no time can be lost in improving the present conditions and likely future developments in both coconuts and the possible multistory crops. These are set out by commodity below although it is again expected that they would be best handled as a single project by a multidisciplinary research and development team.

#### Coconuts

The cultivar position is urgent since there is little incentive to rejuvenate the industry without increased yield per unit area, particularly during the 5th to 17th years of life. The use of hybrid material is thus mandatory as it has become in the Philippines and Indonesia. Because of the possible real danger of importing diseases with any planting material (except perhaps pollen under strict supervision), recourse would have to be made to local resources. The urgent requirement of nearly one quarter of the industry for replanting indicates that there is no further time for long term testing and some element of risk will have to be accepted. Planting of hybrids and further testing would have to proceed in parallel.

Malayan Red and Yellow Dwarfs are available and if a 20 ha planting of these was established on a suitable site as female parents<sup>27</sup>, together with those already on Taviuni and at Wainagata, then assisted pollination could be employed. Such reports as exist on Niu Leku as a pollen parent should be checked and the 1970 report from the Solomon Islands followed up to reinforce this view. Rennel palms have been found to produce hybrids superior in yield to those from West African Tall (Port Bouet 121 syn. MAWA) in the Solomon Islands, Papua New Guinea and Malaysia and could be used as pollen parents after checks of performance with the appropriate organizations. Finally MAWA hybrids could be produced if pollen of West African Tall was allowed to be imported, although this procedure might be expensive and perhaps dangerous. A pool of pollen parents should be established.

A new fertilizer trial would have to be established using this material as would a variety trial and trials of intercropping under existing mature palms that would be rehabilitated, of at least the five crops

suggested. This would involve the acquisition of suitable land, preferably in the Cacaudrove district, that could be operated from Wainigata. The present fertilizer and cultivar trial should be abandoned. Definition of correct nursery procedures and detail for the handling of polybag seedlings would have to be prepared.

The fact that *Brontispa* has recently appeared in Western Samoa (1978) and the nursery disease *Marasmiellus cocophilus* in the Solomon Islands (1979), together with the incidence of "Vanuatu disease" on that island, suggests an enforcement of quarantine operations to keep Fiji clean. Within Fiji there are local infestations with *Orcytes rhinoceros* (indicating that control by *Rhabdionvirus orcytes* requires re-examination). Stick insects (*Graffea crouani*) appear in some areas as does Leaf Miner (*Promotheca caeruleipennis*). It may be that both Leaf Moth and Spathe Borer are important and require investigation.

The absence of a reliable controlled trial would require that in due course the facilities for soil and foliar analysis would have to be stepped up, both for the main crop and for the intercrops. In the curing of copra some work on replacing the short lived furnace liner of the kiln (leading to smoking of the copra) with a more durable substance would appear to be called for.

#### Cocoa

The clonal cocoa selections should be established at a central point as a gene pool and as many Amazon selections as possible should be reidentified and included in this. Existing seed gardens should be treated to prune the pollen parents and permit more vigorous growth of the female parents. It may be possible to overbud the pollen parents to increase the yield. Further gardens should be designed and prepared on the lines suggested in the FAO TCP Diversification report to produce Sabah hybrids. The use of mixed hybrid seedling progenies should be considered and explored.

Steps should be taken to systematise available information both within and without Fiji on double story intercropping of coconuts and cocoa and to prepare a first approximation of husbandry, input, processing and likely returns to investment for the information of the Extension Division and of farmers. Such information should be updated from external and from local sources as investigations proceed on rehabilitation of the coconuts and cultivation of the cocoa along the lines suggested earlier in this annex; in addition progeny trials would eventually be required for the Sabah hybrids.

In view of the volume of production which might result from the expected cocoa planting, some investigation to upgrade the present batch drier to continuous working would seem to be called for. Examples exist in other countries.

#### Coffee

While initial plantings of coffee would have to be made from progeny of existing seedlings; both public and private plantings should be screened and high-yielding plants should be selected for cloning. Such clones could be multiplied for both field planting (after testing) and for inclusion in seedgardens at a later stage.

Information on the intercropping, husbandry and inputs and processing would have to be collated from public and private sources within and outside Fiji, to prepare provisional information for the use of the Extension Division and farmers, together with likely returns to investment. This would be updated from external sources and also from local investigations on the intercrop cultivation of coffee. Progeny trials would eventually be required of local selections and possible imports.

Investigations and decisions on suitable small and medium scale processing of coffee would be necessary, probably with advice from abroad. Information on all aspects of coffee cultivation and processing could be sought from organizations in the South Pacific and East Asia<sup>2a</sup>.

#### Yaqona

Efforts should be made to select promising clones of yaqona. Attention should be given to collating the intercropping husbandry and input requirements and to the economics of returns to investment and time of lifting, so that the Extension Division and farmers may be in possession of the necessary information.

#### Vanilla

After adequate desk study of the crop an officer should be sent to Tonga to examine the methods employed in the present successful vanilla industry there. During his stay he should, amongst other matters, draw up a document of information for the Extension Division and for farmers outlining the procedures employed there and the return to investment. Upon his return he should launch pilot scale second story plantings of an appropriate size and in appropriate locations for evaluation.

#### Cardamons

After an appropriate desk study pilot scale plantings should be launched, both under coconuts and at altitude under forest shade in suitable climatic regions, for evaluation. Information on second story planting should be collected.

### F. Staffing Requirements

The foregoing items in Section E cover a considerable time and it would be for the multidisciplinary team to draw up a plan with priorities to cover such a long term project; which would be revised annually in the light of targets achieved, expected progress and funds required. Many of the requirements are of an applied research and development nature.

It is considered that the following extra staff would be required for such a team.

- Coconuts: In addition to the present Acting Research Officer, an extra Technical Officer and two Field Assistants. These would not include any support for seed garden work which may be included in any possible external loan.

- Cocoa: In addition to the existing staff, one Research Officer.
- Coffee: A Technical Officer and two Field Assistants.
- Yagona: A Technical Officer and two Field Assistants.
- Cardamons and vanilla: A Technical Officer and two Field Assistants.

The total incremental staff to support and investigate multistory cropping would thus be one Research Officer, four Technical Officers and eight Field Assistants, who would be phased in as required, on the advice of the team. The above does not include any staff for extra inputs from plant protection or chemistry.

## FOOTNOTES

- 1 1979/80.
- 2 The Land Use Section of the Ministry of Agriculture and Fisheries identified coconut areas on air photographs and transferred them to cadastral maps at 1:20,000.
- 3 Coconut Industry of Fiji TCP/FIJ/8901(1), FAO Rome, Feb. 1980. To the Government of Fiji.
- 4 Ministry internal documents, Quoted Ibid (p 7).
- 5 MAF FIJI and FAO/CP Tree Crops Development Project - Fiji 1982 (not released).
- 6 Ibid. page 7.
- 7 Child R. quoted by Casey (1969).
- 8 Ibid page 9. (Financial rate of Return to Farmers Investment: 19%).
- 9 Marechal H (1928) Fiji Agric. J. 1:16-45.
- 10 Planted at Navuso.
- 11 At Sigatoka.
- 12 4,100 kg/ha per annum copra equivalent: ANON (1970) An. Rpt. Joint Coconut Research Scheme (Yandina) Brit. Sol. Islands Protec. 1964.
- 13 An. Res. Rep 1951. Dept. Agric Fiji page 24.
- 14 Leather, R.I. (1972) Coconut Research in Fiji, Fiji Agric. J. 34:3-10.
- 15 Sundaram S. (1975) Coconut Hybrid Seed Production. Fiji Agric. J. 37:70.
- 16 Personal observation indicates that at least some of the palms are not hybrids but Malayan Yellow Dwarfs.
- 17 An. Res. Rept. 1981 Dept. Agric. Fiji. (p. 28).
- 18 Ibid, p. 28.
- 19 Vernon, 1978.
- 20 Toxopeus, 1965.
- 21 At Dobilevu, in the northeast of Viti Levu.
- 22 At Wainagata, in the South of Vanua Levu.

- 23 On the island of Taveuni.
- 24 Personal observation.
- 25 At Naduruloulou.
- 26 From the National Marketing Authority, the Fijian Development Bank, the Nature Funds Development Board, private commercial organizations, Coconut Board and Advisory Council and others.
- 27 Ibid, p. 6.
- 28 ORSTOM, Indian Coffee Board.

## COMMUNICATIONS<sup>1</sup>

Communication is an integral part of the research process; also it is a fundamental process in the functioning of the research organization. This review, therefore, separates the two broad types of communication:

1. The flow of information as part of research: (a) obtaining information on the nature of agricultural development problems to be the subject of work in the Research Division; (b) obtaining scientific and technological information from existing world agricultural knowledge to use in carrying out research; and (3) the reporting or dissemination of findings coming from work in the Research Division.
2. The flow of information vital to effective and efficient functioning of the division as an organization.

The report of the review team's analysis is organized around those types of information. The first type involves the research organization as both a receiver of information and as a sender. In the second type, the system is viewed mainly as it exchanges information among the various units that comprise it as an organization. The communication activities can thus be described in terms of the information management processes involved:

- \* input, the system's ability to receive or obtain the outside information it needs;
- \* output, its capability to disseminate its findings to those who can use them;
- \* throughput, the system's capacity to share information among the units for efficient operation and cooperation.

### Input: Getting Information from Outside

The first need for effective problem-solving research in agriculture is the correct choice of where the research system will focus its activity. That choice may be based on a country's needs in agricultural development, as reflected in national policies and balanced by a realistic sense of what is possible within the constraints in the agricultural sector.

#### National Policy Guidance

National planning documents show clearly that agriculture is recognized as a key sector in the social and economic development envisaged by Fiji's political leaders. Many imperatives for agriculture are set out in the current development plan, DP 8; many targets are set for

<sup>1</sup> Annex 4 prepared by Dr. K. Robert Kern.

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production and consumption, sometimes with little apparent understanding of the barriers that stand in the way. The Research Division needs a basis for setting priorities for its programs. The main avenue now by which policy guidance reaches the division appears to be in the relationship of the Assistant Director of Agriculture (Research) (ADAR) to other division heads in the Department of Agriculture.

Interpretation of higher policies seems to occur in the review of project proposals or in changes in funding within the Research Division. These proposals most often begin with the individual researcher, based on his or her perception of need or potential value of a line of work. While the contribution of the field researcher is important, the perspective of national policy may be overlooked when the only main initiative comes from the end point.

It should be noted that DP8 emphasizes adaptive research as the appropriate type in agriculture, and the division has the main share of its attention devoted to that type of work. In addition, DP8 stresses the need to make use of technologies developed elsewhere, which signals a need to be in effective contact with regional and world knowledge.

#### Defining Production Problems

Individual researchers play the initiating role in determining specific studies in the Research Division. Their perception of problems is a key factor. It thus becomes important that these researchers be in close contact with production situations, either by direct contact or through advisory relationships with others who are in touch. It appeared to the review team that individual research leaders were mainly left on their own to define and test their perception of problems. There were exceptions. In some cases, especially at regional stations, there is interaction between the research and extension staff working with producers of a commodity. Some instances were seen where field trials are carried out in farmers' fields.

A number of steps could be taken to bridge existing gaps between field situations and the research system. Examples: Principal agricultural officers from the regions could participate in quarterly research section heads meetings; they could reflect problems met in work of their staffs. Also, tours of research plots and farms of extension cooperators could take researchers and extension staff together to the fields; they could jointly observe production situations, considering research that needs to be done and relating recent findings to use in the fields. Commodity advisory groups, either formal or informal, could be assembled occasionally to help define areas of technology need -- as well as to review the results coming from research.

#### Keeping in Touch with World Knowledge

Library services. The main link of the Research Division with the outside world of science appears to be the national agricultural library, which is located adjacent to headquarters -- on the Fiji College of Agriculture campus. Research officers consider the library collection and the services to be acceptable. The library receives about 450 periodicals (some 350 on exchange arrangements based on provision of the

Research Division publications). The librarian sends a monthly bulletin to 52 points in the system: it reports materials received in the month with photo copies of some tables of contents. The staff member may then request copies of articles. Although the service is provided without cost to the staff member, the librarian reports that few use it. Field-based staff seemed satisfied with library services, although some miss the opportunity to scan the actual journals; they recognize that delays in moving the journals along makes unworkable the actual circulation of volumes. Some field officers have personal subscriptions to journals that relate closely to their own work.

Small collections of literature exist at the individual research stations, typically abstracts from the Commonwealth Agricultural Bureau and a few periodicals. The library offers free access to international data bases (through cooperation of an Australian library), but it is reported that few staff utilize it. (One field officer, who publishes in international journals, indicated that there is no place in Fiji where he can make a serious study of literature in his field; bibliographic citations, from a search of international data bases, have little value because many cited sources would not be available.)

The flow of scientific information via publications may be the most cost-effective means for Research Division personnel to keep in touch with their field of study. Regular receipt, prompt reporting, and responsiveness to individual requests for information command a high priority among support services. It would seem false economy to seek savings through reducing resources applied either to obtaining an adequate flow of new information or to securing the reference materials needed by the individual scientists.

Professional associations. Among the most productive channels of information from outside are networks that link persons engaged in the same lines of work. These relationships may develop between individuals attending national and international professional meetings and from contacts made on study tours. There is a lack of network opportunities for Research Division staff: one expatriate officer noted that there is no person in Fiji with whom he can discuss his field, no one to whom he can turn for assistance in thinking through problems, finding alternate methodologies, or interpreting findings.

The number of professional agriculturists in Fiji has been too small to support specialized scientific societies. The Fiji Institute of Agricultural Sciences provides a forum for interaction of agricultural professionals. However, it is not specialized to the point that it can serve the special interests of small groups of scientists.

The progress of science occurs as one person learns about and extends the work of those who have preceded him. In a time of vast literatures and narrowing specialization, the need is greater for direct interaction among persons working on similar problems. There is no substitute for direct contact; funds to support such contacts are an essential part of the investment in research. The need is even more vital for Fiji, which has few researchers, and they work mainly as lone investigators.

Training. Two types of training offer means of bringing new information into the Research Division: formal courses (degree and non-degree, within Fiji and abroad) and short courses. The main infusion from training appears to occur when staff members go abroad (seven were on study leave in 1982) and then return to the division. No formal arrangements exist for the staff member to share experiences with colleagues, although diffusion occurs by informal or personal exchanges. Occasional refresher courses may be held within MAF, often carried out by the FCA or a unit of the University of the South Pacific at the request of the division. The usual target group may be technicians, and the result may be mainly improvement in techniques and not much in introduction of new knowledge.

Training can be a powerful means of introducing new knowledge and expertise into a research system. The effectiveness will usually be enhanced by careful planning, both in regard to future research needs and for manpower development. Many sources of external assistance may be tapped to implement a sound master plan to strengthen research capability.

#### OUTPUT: Getting Information to Users

Two main classes of findings and implications come out of Research Division work. One type is that which policy makers can use as they make decisions about investment of resources to achieve national goals -- they need research information to project potential benefits from different policies. The other type concerns technology that will bring useful results in productivity. The two types call for different information, packaged and delivered by different means.

#### Informing Policy Makers

It is likely that the most important communication with policy makers occurs on a person-to-person basis. The extent of use of that mode and the content it carries cannot be evaluated with much confidence after one brief review. As has been noted earlier, the Research Division does not have the full range of expertise now to interpret fully the possible socio-economic (or political) consequences of its research findings.

One formal channel was identified that moves this information upward in the organization, participation of the ADAR in division heads meetings. His interactions with MAF officials provide other opportunities to supply information, often informally. Other research officers may make similar contributions. However, the review team did not find stated procedures or strategies to assure that this job is carried out.

#### Technology for Users

Results of Research Division work may be communicated on to users by any or all of three groups: staff of the division, Extension Division, and the Information Section of MAF. Other secondary diffusers may help; however, these three sources provide the primary initiative.

Direct communication. The annual report is the main technical reporting activity of the Research Division. Each section leader is responsible for filing annual reports of projects. An editor, designated by the

ADAR, prepares the division report from those submissions. When completed and approved (by division and MAF leaders), the manuscript goes to the Information Section of MAF, whose publications editor makes and supervises a contract for printing by a commercial printer. (The Information Section person has no editorial role in the process, although the cost of printing is paid from that section's budget.)

The Fiji Agricultural Journal is supervised by the Research Division. Agriculture division heads in MAF comprise the editorial board; editing responsibility is exercised within the division. The process of publication follows the same course as for the annual report. About 600 copies are printed; many go overseas to meet exchange agreements that bring journals to Fiji at no direct cost. The journal is planned for two copies each year; it is presently three issues behind schedule. Research bulletins are published occasionally on division initiative. The process is similar to that noted for the two series described above.

The three items of technical output noted above constitute the main method by which the Research Division presents its findings to the Extension Division (and to other audiences). Feedback indicates that extension staff see the material as too complex to be readily understood and used and often lacking a clearly developed practical application.

Research staff sometimes provide a less technical publication, a "farmers" leaflet. A typical leaflet combines simple text (in typewriter script) and line drawings prepared on and duplicated from an ink-transfer stencil. Examples seen were uniformly low in visual quality. (It was reported that the Information Section has requested budget to upgrade its duplication equipment, but the request has not been approved). A leaflet may result from research initiative or be a response to an extension request; it is thought to be more usual for initiative to come from the researcher. The Information Section publications editor edits, illustrates, and oversees duplication of these leaflets. The section budget for printing bears the cost.

Information Section dissemination. The Information Section of MAF uses research information in the services it provides to media. These include radio programs daily in Fijian, Hindustani, and English languages and weekly news services to national and vernacular newspapers (also issued in three languages).

Radio is the most truly mass medium in Fiji. Most families are said to have one or more radios; as many as half have cassette recorders. Each daily MAF radio program includes three to four topics in the 15 minutes. Radio officers initiate many of their own subjects, although some items come as directives from MAF administration. Officers complain of the difficulty of contact with research staff and the cooperation they receive. The radio section has its own studio in MAF quarters: it is not soundproof; the turntable for sound effects is said to be of poor quality; and maintenance of equipment is a major problem. (The section does not have cartridge equipment, which would facilitate more use of actualities -- portions of interviews, field sounds, etc. -- in narrated reports. Such production is tedious without the right equipment.)

Most activity in press services is devoted to preparing material for weekly farm pages in newspapers. The English-language papers are said to reach about 2% farmers, and the emphasis is on policy matters and public

affairs reports. Vernacular papers tend to have more emphasis on farm spend that amount of time because their work is so closely reviewed -- and criticized for grammatical or other errors.)

Some research-based information may also be disseminated by personnel in the Ministry of Information. One seconded staff member of MAF spends a portion of his time in writing on agriculture, including research.

There appears to be room (and need) for strengthening the relationships between Research Division staff as sources of information and Information Section staff as disseminators. A considerable ground of mutual interest exists, although the units are separated administratively -- one is within the agriculture department and one is a MAF-wide unit. More productive relationships might be built through joint appraisal of potential common interests; a formal memorandum of understanding could set a stronger base.

Extension diffusion. It has been noted above that the Research Division produces a variety of printed materials that go to extension workers. While considerable strengthening of that aspect could be useful, emphasis here is on the need for person-to-person communication between the staffs. The two divisions are at the same administrative level, both reporting to the Director of Agriculture; but few evidences were seen of formal linkage at any of the several levels. There were cases of working relationships, but they tended to be based on personal, geographic, or subject interest; cooperation was usually credited to individual initiative. (Exceptions were where researcher-station administrators were serving as division acting principal agricultural officer; considerable interaction occurred where there was both administrative leadership and personal willingness to work together.)

Research officers occasionally use short courses or workshops to report to the extension staff on technologies coming from their work. Initiative may come from either division. These cases are infrequent, and no annual program of refresher or in-service training is planned within the Research Division. (Increased discussion of in-service training needs is underway now within the Extension Division. This could result in closer relationships of researchers and extension staff.)

The Fiji College of Agriculture provides an indirect pre-service training channel through which Research Division results may reach the Extension Division. Research officers make guest presentations within courses offered in FCA. Most recruits to the Extension Division come from training at FCA; therefore, they have had some contacts with the people and results from research before they enter extension service. Some of those contacts may be continued, but there was no evidence noted of specific efforts to keep such lines intact.

#### THROUGHPUT: Communication Within the Organization

Communication within the Research Division is carried mainly through individual personal contacts. A quarterly meeting is convened regularly for interaction among the research leaders and the ADAR. This small group includes the heads of the 14 research units. Non-resident heads participate with those who are based at Koronivia, and some of the

practice material. The Information Section supplies photographs and duplicated copies of the items. A staff person at each newspaper edits the farm page, selecting or rejecting items and photos by independent judgment. Eighty percent of the section's press resources are said to be devoted to the English-language service. (Information officers say they meetings occur on the outlying stations. Most essential sharing of information probably takes place at these meetings.

Individual staff members raised no important criticisms of the flow of information among the research staff. Some in subordinate levels suggested that it would be useful for all to receive written minutes of quarterly research staff meetings. Some indicated that they would like to sit in regularly on those meetings.

#### Project Planning

Project planning occurs mainly from the field up. Research leaders submit their proposed work programs, based on their own sources of information. These may include -- but do not necessarily require: individual contacts with extension staff; field days; seminars by persons from outside the system; their own observations; discussions with other staff; and other sources.

#### Financial Monitoring

Financial information moves through monthly reports from the research stations -- all staff and projects are assigned to one or another of the research stations. The administrator determines timing of purchases and the cash flow at the station. Funds may not be shifted from one spending category to another without approval at division and ministry levels; with approval, however, shifts can be made. A farm manager at each station handles many of the day-to-day decisions on labor and other inputs according to approved plans. A staff accountant assists each station administrator with financial records. It was stated that reports move promptly, generally reaching the ADAR by the tenth of the next month.

#### Performance Evaluation

Monitoring of research activities appears to occur as a combination of reports in quarterly research meetings and as a result of personal visits. A written annual report is required from each research station. Personnel evaluations involve a formal and confidential report each year on each officer by the ADAR. "Good report" is listed prominently among qualifications for promotions in rank. No formal mechanism appears to exist for peer review or peer evaluation of either research projects or individual performance.

There appeared to be a dearth of written material relative to staff duties and responsibilities. Present staff members asked could not recall having received a formal statement of duties beyond what was included in the official advertisement of the vacancy.

A small complement of research officers permits personal contact to be the primary means of internal communication, and personal contact is considered the best single means. However, it would seem useful to supplement the personal with a few written documents. For example, duty statements would help guide the work of a staff member and provide a known basis for evaluating his or her performance.

### Transfer of Results

The Research Division uses three lines of reporting to get its results to others in MAF: annual report, flow to Extension Division, and reports through the Information Section. These activities are detailed in the preceding section (on output) and are presumed to be available to others in MAF. There are also many and various interpersonal links; there may be special field days and tours, although no schedule or plan was noted.

### In Summary

The Research Division is relatively small and uncomplicated in its operations. It has a good structure for interpersonal means to carry much of the needed operational information. It can also relate readily to other units of MAF. Many of the existing links could be strengthened a great deal, of course. There is considerable room for improving the amount and quality of reporting of results to national policy makers and to the Extension Division, Information Section, and other scientists.

### Recommendations

The analysis reported here discloses many opportunities for actions that should improve both the processes of communication and the usefulness of content carried. Recommendations are grouped according to the different communications functions of the Research Division.

#### Communication Within (Throughput)

- \*\* Continue the quarterly meetings of section heads as the primary means of information exchange and program planning and evaluation. Some of the meetings could involve all research officers (perhaps in one session before annual research programs are planned and in another that concentrates on reporting and reviewing the year's work). Written minutes of other meetings could be circulated to the staff.
- \*\* Stronger efforts should be made for more interaction with parallel and higher units of MAF, especially in correlating work more closely with Extension Division and with the Economics, Policy and Statistics office. Both those units can play key roles to help focus planning and to widen the impact of Research Division results. Formal statements of cooperation might be useful to define relationships and identify ways to serve common interests.
- \*\* Wider professional and scientific interaction is needed among the division staff, especially in contributing to project development. Peer appraisal and review of plans should result in more multidisciplinary efforts and probably some raising of methodological and analytical standards.
- \*\* Up-to-date and specific duty statements are needed for each post among the established staff of the Research Division. Statements should be specific to an individual position, based on three sources of inputs, the person holding the post, the supervising section head, and the ADAR. Statements should include research objectives, duties and responsibilities, and clear criteria for evaluation of

performance. The duty statement would then be a principal basis for the annual performance review.

#### Communication From Outside (Input)

- \*\* A better system is needed to involve research officers with the scientific literature of their field. (The present system is good in concept, but it does not generate sufficient continuing interaction -- especially by officers at outlying stations.) Among actions that might be considered are:
  - \* Develop and maintain at each outlying station a focused collection of references and current periodicals that apply to its mandated work (for example, place a working literature on grain legumes at the Legalega Research Station).
  - \* For journals that are equally important to staff posted at different locations, obtain duplicate subscriptions so all will have immediate access.
  - \* Provide a modest annual allowance that each research officer could apply toward purchase of selected journals for his own professional use (perhaps a 50% cost share).
  - \* Make literature review a standard requirement in planning for all research projects.
  - \* As part of quarterly research meetings, include a time period in which the group would hear reports and review assigned areas of multidisciplinary interest.
- \*\* Set aside some budget each year that will permit a few selected officers to attend professional meetings abroad.
- \*\* Seminars and travel scholarships offer a good means to expose officers to ideas within the wider community of scientists. Activities such as have been described in a tentative training proposal (in response to the World Bank review) should be supported.

#### Reporting Results (Output)

- \*\* To policy makers. A more sharply focused effort, based on person-to-person contact, is needed to explain the benefits and potentialities of agricultural research to support national development in Fiji. While the present annual report may be satisfactory for some higher echelon persons in MAF, it does not contain the kind of interpreted information that would be most useful to others in policy posts. Most of them will be served better by brief statements of problems studied and benefits derived -- in terms understandable to non-specialists in agriculture.
- \*\* To Extension Services. A clear definition of the respective and interdependent roles of the Research Division and the Extension Division is perhaps the most crucial need to improve communication between these groups. The separate and joint relationships of the two divisions could be defined with respect to the generation and

transfer of adapted technology for the agricultural sector. Under leadership of the Director of Agriculture, steps or procedures might be devised to assure that appropriate functions are implemented, which may include training and direct cooperation in various communication and activity modes.

\*\* The role of the MAF Information Section, vis-a-vis the communications tasks of the research and extension divisions, requires study and probably re-definition. (An expatriate training-communications officer has offered a number of proposals related to the Information Section. While not all details are endorsed fully, the general tenor is considered appropriate and constructive.) Steps are urgently needed to provide bases for more productive and complementary work between the Information Section and the Research Division. If provided with appropriately trained staff, the Information Section can be developed to furnish communications specialist services that may include:

- \* Professional editorial services to improve the quality of presentation of scientific materials (annual report, bulletins, and journal articles).
- \* Technical writing services to popularize findings from research (simplification of words and presentation). Carried out in collaboration with the Research Division staff, this work may be directed to policy makers, Extension Division, or others; writers may contribute to productions in print, mass media, or audio-visual formats.
- \* Production facilities from which can be provided reasonable quality in all published materials of the Research Division.
- \* Advice and support in communications program development.

## STATUS REPORT ON RESEARCH STATIONS

A range of data on Fiji research/experimentation stations was gathered by a team that in 1981 reviewed agricultural research in seven Asian Development Bank "member countries" (Appendix 4, Annex 6 in Gamble et al, Consultants' Report to the Asian Development Bank, June 19891, ISNAR). Data on stations of the MAF Research Division, updated to July 1982 by P. Sivan, follow:

Location: Dobuilevu

Elevation and Land Form: 68 m  
Inland alluvial plain and hill country complex

Climatic Characteristics:

Climatic zone	Intermediate
Total annual rainfall (mm)	2,660
Months with less than 100 mm rainfall	July, August

Present Land Use:

Total area (acres)	97
Distribution of crop areas (acres)	
Annual crops	8
Tree crops	12
Pasture	70
Other	7

Staff Strength:

Professional	Technicians	Others
PhD MSc Bsc	Dipl Other	
	2	9

Annual and Recurrent Budget (F\$000):

	1978	1979	1980	1981	1982
Capital		0.9		0.7	
Recurrent	31.4	28.6	30.5	32.7	37.4

Crops and Research Conducted:

Crop	Varietal evaluation	Breeding	Cultural practices	Pest control	Disease control
Cocoa	x		x		x
Yams	x		x		x
Taro	x		x		
Sweet potato	x		x		x
Tapioca	x		x		
Rice	x		x	x	
Local fruit	x				

Additional Comments on Adequacy and Constraints:

Land area:	Adequate
Staff:	Adequate
Budget:	Inadequate
Facilities:	Reasonable
Other constraints:	Lack of sufficient transport

Location: Koronivia

Elevation and Land Form: 15 m  
Alluvial flood plain and low coastal  
hill country system

Climatic Characteristics:

Climatic zone	Wet
Total annual rainfall (mm)	3,377
Months with less than 100 mm rainfall	None

Present Land Use:

Total area (acres)	294
Distribution of crop areas (acres)	
Annual crops	50
Tree crops	1 (cocoa)
Pasture	200
Other	43 (rice, root crops, bananas, vegetables)

Staff Strength:

Professional			Technicians		Others
PhD	MSc	Bsc	Dipl	Other	
3	6	7	28 <sup>a</sup>	7	89

<sup>a</sup> Five on study leave for B.Sc.

Annual and Recurrent Budget (F\$000):

	1978	1979	1980	1981	1982
Capital	9.0	10.9	12.6	49.7	78.5
Recurrent	339.7	284.0	342.7	335.9	360.8

Crops and Research Conducted:

Crop	Varietal evaluation		Breeding	Cultural practices	Pest control	Disease control	Others		
	1 <sup>a</sup>	2 <sup>b</sup>					3 <sup>c</sup>	1 <sup>a</sup>	2 <sup>b</sup>
Rice	x		x	x	x	x			
Taro	x			x	x	x			x
Tapioca	x			x	x	x			x
Yams	x		x	x	x	x			x
Sweet Potato	x			x	x	x			x
Pigeonpea	x								
Banana				x		x			
Pastures	x		x						x
Cocoa	x								x

Notes: 1<sup>a</sup> Varietal evaluations for resistance to pests, diseases  
2<sup>b</sup> Pasture ecology and grazing management  
3<sup>c</sup> Mechanization and economics

Additional Comments on Adequacy and Constraints:

Land area: More land needed for arable crops  
Staff: More professional staff needed; understudy weed control  
Budget: Much more work can be done if more funds could be made available  
Facilities: Additional equipment needed for agronomy work  
Other constraints: Short courses for specialist officers at appropriate centers overseas also desirable

Location: Legalega

Elevation and Land Form: 16 m  
Older flood plain systems of lowland western Viti Levu

Climatic Characteristics:

Climatic zone	Dry
Total annual rainfall (mm)	1,890
Months with less than 100 mm rainfall	May, June., July, August, September

Present Land Use:

Total area (acres)	124
Distribution of crop areas (acres)	
Annual crops	123
Tree crops	1

Staff Strength:

Professional	Technicians	Others
PhD MSc Bsc	Dipl Other	
2 <sup>a</sup>	3 <sup>b</sup> 2	12

<sup>a</sup> One also serves as acting PRO for Western Division

<sup>b</sup> One on study leave for B.Sc.

Annual and Recurrent Budget (F\$000):

	1978	1979	1980	1981	1982
Capital		6.5	3.7	0.6	1.8
Recurrent	40.6	36.2	42.2	43.1	49.0

Crops and Research Conducted:

Crop	Varietal evaluation	Breeding	Cultural practices	Pest control	Disease control	Others 1 <sup>a</sup>
Pigeonpea	x	x	x	x	x	x
Cowpea	x		x	x	x	x
Mung	x		x	x	x	x
Urd	x		x	x	x	x
Soybean	x		x	x	x	x
Peanut	x		x	x	x	x
Sorghum	x		x	x	x	x
Rice	x					
Maize	x		x	x	x	x
Su. flower	x		x	x	x	x
Root crops	x					

Notes: 1<sup>a</sup> Varietal screening against pests and diseases

Additional Comments on Adequacy and Constraints:

Land area: Presently sufficient; more needed for seed production.

Staff: More local staff needed; one local understudies an expatriate.

Budget: Barely sufficient to carry out present research work.

Facilities: Reasonable; residential housing would encourage staff interest in posting there.

Other constraints: Pulse seed production for distribution to farmers is using up research funds.

Location: Naduruloulou  
Elevation and Land Form: 5 m  
 Inland hill country system

Climatic Characteristics:

Climatic zone	Wet
Total annual rainfall (mm)	3,380
Months with less than 100 mm rainfall	None

Present Land Use:

Total area (acres)	77
Distribution of crop areas (acres)	
Tree crops	21
Pasture	40
Other	6 (banana, duruka) 10 (fishery)

Staff Strength:

Professional	Technicians	Others
PhD MSc Bsc	Dipl Other	
	1	16

Annual and Recurrent Budget (F\$000):

	1978	1979	1980	1981	1982
Capital					
Recurrent	49.4	43.8	48.8	54.2	58.5

Crops and Research Conducted:

Crop	Varietal evaluation	Breeding	Cultural practices	Pest control	Disease control	Others
Cocoa	x		x		x	
Local fruit	x					
Duruka	x		x			
Citrus						1 <sup>a</sup>
Ginger				x	x	
Macadamia	-- observation trial					

1<sup>a</sup> Root stock evaluation

Additional Comments on Adequacy and Constraints:

Land area: Adequate  
 Staff: Adequate  
 Budget: Reasonable  
 Facilities: Reasonable  
 Other constraints: Drainage and road improvement needed

Location: Seaqaga

Elevation and Land Form: 91 m  
Raised plateau of northern Vanua Levu

Climatic Characteristics:

Climatic zone Dry  
Total annual rainfall (mm) 2,591  
Months with less than 100 mm rainfall May, June, July, August

Present Land Use:

Total area (acres) 193  
Distribution of crop areas (acres)  
Annual crops 12  
Tree crops 92  
Pasture 80  
Other 9 (cassava, stylo, pineapple)

Staff Strength:

Professional			Technicians		Others
PhD	MSc	Bsc	Dipl	Other	
		1	4	1	12

Annual and Recurrent Budget (F\$000):

	1978	1979	1980	1981	1982
Capital	30.0	5.0			
Recurrent	35.4	34.7	37.2	44.8	49.8

Crops and Research Conducted:

Crop	Varietal evaluation	Breeding	Cultural practices	Pest control	Disease control	Others		
						1 <sup>a</sup>	2 <sup>b</sup>	3 <sup>c</sup>
Citrus	x		x	x	x			
Pineapple			x			x		
Cassava	x						x	
Stylo						x		
Goat								x

1<sup>a</sup> Propagation techniques

2<sup>b</sup> Evaluation of cassava as livestock feed

3<sup>c</sup> Goat feeding and production

Additional Comments on Adequacy and Constraints:

Land area: Sufficient  
Staff: Additional professional staff needed to work on cereal and pulse crops in the area  
Budget: Inadequate  
Facilities: Reasonable  
Other constraints: Additional transport vehicle required

Location: Sigatoka

Elevation and Land Form: 12 m  
Complex of hill country adjacent to an alluvial flood plain

Climatic Characteristics:

Climatic zone Intermediate  
Total annual rainfall (mm) 1,890  
Months with less than 100 mm rainfall June, July, August

Present Land Use:

Total area (acres) 610  
Distribution of crop areas (acres)  
Annual crops 20 (vegetables)  
Tree crops 15  
Root crops 5  
Pasture 570 (grazing)

Staff Strength:

Professional		Technicians		Others
PhD	MSc Bsc	Dipl	Other	
1	3 <sup>a</sup>	8	4	33

<sup>a</sup> One on study leave for M.Sc.

Annual and Recurrent Budget (F\$000):

	1978	1979	1980	1981	1982
Capital	25.0	0.9		8.1	2.7
Recurrent	106.1	122.1	122.9	109.5	123.5

Crops and Research Conducted:

Crop	Varietal evaluation	Breeding	Cultural practices	Pest control	Disease control	Others
Vegetables	x	x	x	x	x	a
Rice	x					
Tree crops	x					b
Passion fruit			x			c
Pastures	x		x			d

Notes: a Seed produced for distribution -- selected vegetables  
b Seedlings produced for commercial planting -- vegetables  
c Seedlings produced for commercial planting  
d Grazing trials

Additional Comments on Adequacy and Constraints:

Land area: Barely sufficient; more required for vegetables  
Staff: Inadequate; additional professional needed for vegetables  
Budget: Inadequate in both capital and recurrent  
Facilities: Reasonable; equipment needed for seed testing  
Other constraints: Need training of technical staff in vegetable and seed production

Location: Wainigata

Elevation and Land Form: 18 m  
Complex hill country, southern Vanua Levu

Climatic Characteristics:

Climatic zone	Intermediate
Total annual rainfall (mm)	2,471
Months with less than 100 mm rainfall	July

Present Land Use:

Total area (acres)	80
Distribution of crop areas (acres)	
Coconut	70
Cocoa	10

Staff Strength:

Professional	Technicians	Others
PhD MSc Bsc	Dipl Other	
1	2	13

Annual and Recurrent Budget (F\$000):

	1978	1979	1980	1981	1982
Capital	0.3	1.5			
Recurrent	41.0	35.2	38.8	42.1	48.6

Crops and Research Conducted:

Crop	Varietal evaluation	Breeding	Cultural practices	Pest control	Disease control
Cocoa	x		x		x

Coconut -- Varietal evaluation and cultural practices research will be restarted.

Goat Feeding and production work

Additional Comments on Adequacy and Constraints:

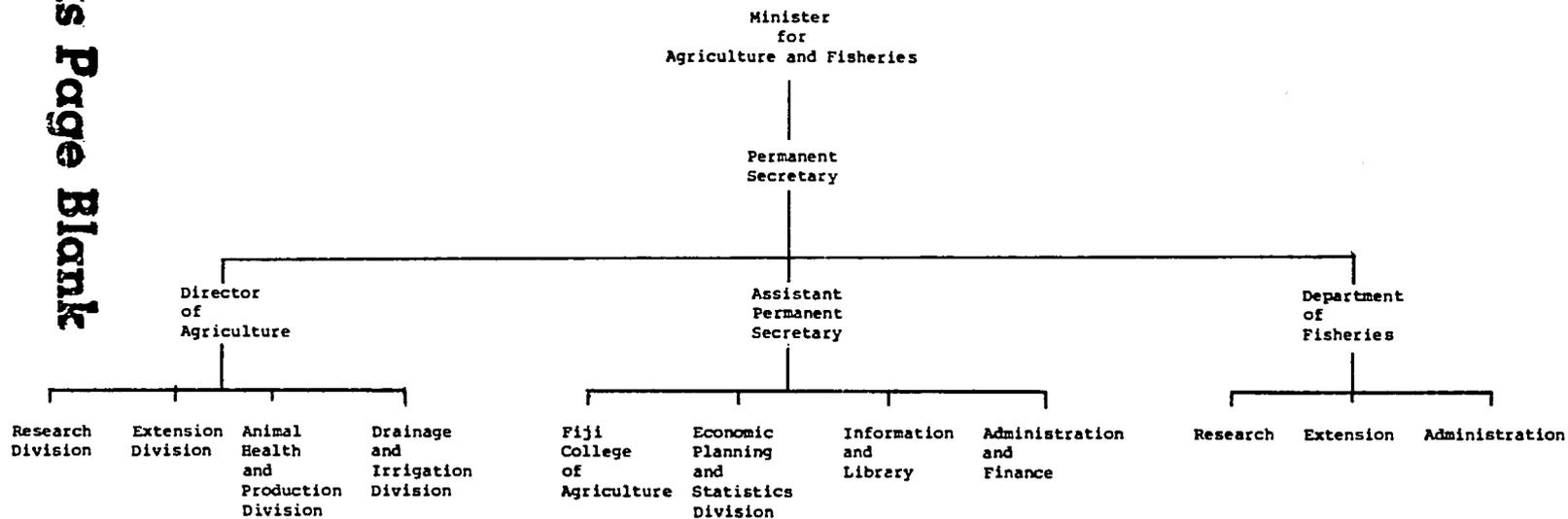
Land area: Sufficient but not suitable for coconut research; thus area needed for coconut

Staff: A local is required to understudy the expatriate in coconut research

Budget: Inadequate

Facilities: Additional facilities needed for coconut research

Other constraints: Cocoa hybridization work for yield and disease resistance is required; vehicle is needed for transportation

ORGANIZATION CHART OF THE MINISTRY OF AGRICULTURE AND FISHERIES

**THE REVIEW TEAM**

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