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ISNAR R21

# AGRICULTURAL RESEARCH PLAN

# FIJI

FIJI
Task Force of the Department of Primary Industries

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 governments of developing countries to strengthen their agricultural research. It is a non-profit autonomous agency, international in character, and non-political in management, staffing and operations.

Of the thirteen centers in the CGIAR network, ISNAR 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 infrastructure 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.

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Prepared jointly by

FIJI

Task Force of the Department of Primary Industries

ISNAR

International Service for National Agricultural Research

## FOREWORD

The Fiji Research Plan grew out of ISNAR's review of the Research Division of the Department of Primary Industries carried out in 1982 (See FIJI: A Review of the Agricultural Research Division; ISNAR R10). The review brought out that agricultural research in Fiji, unlike some of the other small countries in the South Pacific, had the basic resources of manpower and infrastructure to respond to the country's plans for agricultural development. A primary need was to increase the effective use of these resources, so that improved agricultural technology would have a greater impact on a wide range of crop and animal production systems. As a first step in this direction, it was recommended that the Research Division should examine its current research programs with a view to giving them a greater sense of direction and purpose. It was also recommended that the scientists formulate their research projects with clearly defined objectives, placing them in a time-frame for the purpose of monitoring and evaluation.

Accepting ISNAR's recommendations, the Ministry of Primary Industries (MPI) appointed a task force consisting of some of the scientists and senior officials from its own divisions and from other government departments. Members of this task force have worked jointly with the ISNAR staff during the last year. The research plan presented here is the product of this joint work. The plan identifies the priority areas of research, gives the main programs and projects for a five-year period, 1985-1989, considers the manpower and other resource requirements for its implementation, proposes a more compact organization for the experiment

station network, and makes suggestions for improving the overall efficiency of the system in terms of management support and a balanced allocation of the budget.

The evolution of the research plan during this period has involved intensive discussions between the ISNAR staff and the scientists of the Research Division, on the one hand, and the members of the task force, on the other. It is this process of interaction which probably will have a more lasting effect on the functioning of the agricultural research service in Fiji. The process has led to a greater recognition of the role of agricultural research in the higher counsels of the government of Fiji and the support it requires. The discussions also made the scientists more conscious of their responsibility and of the need to use improved management procedures for a more effective use of the available resources, particularly in the area of planning and programming. For the ISNAR staff, the development of the Fiji research plan has provided valuable experience and insight into the problems of a research service in a relatively small country.

I wish to take this opportunity to thank all those in the Ministry of Primary Industries and in other government departments who cooperated with ISNAR and the task force in the development of this plan.

W. K. Gamble

Director General

ISNAR

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# Chapter 1

# INTRODUCTION

The purpose of this chapter is to indicate the place and role of research in contributing to agricultural development. The dual role of providing information on which agricultural development policy decisions can be based and in developing the technologies to enable those decisions to be implemented is emphasized.

## 1.1 AGRICULTURAL POLICY

The principal targets of the strategy for the development of the agricultural sector in Development Plan 8 (DP8) were:

1. strengthening the position held by the traditional commodities such as sugar and copra, expansion of the production and of the range of uses of cane and sugar was envisaged subject only to constraints imposed by markets and availability of suitable and available land; for copra, however, emphasis was placed on increasing the value of the products by increasing their range and quality;

2. increases in the production of cocoa, ginger, and citrus for both export and internal markets;

3. promotion of self-reliance in basic food production with emphasis on rice, beef, and dairy products and, to a lesser extent, on coffee, tea, mutton, and goats;

4. mobilization of the national potential in both fisheries and forestry.

To be useful to the research division in developing a concerted plan to support this general strategy, there is a need for a clearer definition of specific production objectives and priorities than these general statements provide. It is recognized by the research division that agronomic and economic feasibility is only one of the factors involved in policy decisions at the highest level and that economic, social, and political factors are also important. The research services depend for their efficient operation on specific, consistent, but evolving, development policies so that research, which is inevitably looking to the future, can be soundly based. An excellent example of the value of an ongoing research program coupled with consistent development policies is to be found in the operation of the Fiji Sugar Corporation.

## 1.2 ROLE OF AGRICULTURAL RESEARCH

Research is a process which produces new or improved knowledge and/or materials. This new knowledge can be on any topic. In the agricultural production context it can cover markets and transport, agro-meteorology and land use capabilities, agronomic practices, including varieties, crop protection, livestock breeding and rearing,

disease control in livestock, post harvest handling of products, and social and economic factors at the farm level, among others.

This information, some of which may be derived from national research programs, can be used at both national planning and individual farm levels. It does not of itself produce crops or livestock, but it is an essential part of any soundly based agricultural industry, as is amply demonstrated by the success of the Fiji Sugar Corporation.

There are several aspects which need to be considered. Research is needed to protect existing production, to effect improvements in existing systems, to seek out new opportunities for expansion of present crops and stock, and to explore the possibilities for the introduction of new crops or animals.

To be able to carry out these tasks effectively it is important that research should be regarded as a continuous but evolving process, which needs well-trained and experienced staff for its effective implementation and whose contribution is fully recognized. The real strength of any research organization resides in the capacity of its staff, who need many years of experience to attain their full potential usefulness.

## 1.3 AGRICULTURAL RESEARCH POLICY

The ambitious development targets set out in DP8 require the provision of appropriate technologies on which production can be based. The plan recognized the need to develop both an appropriate national capacity to generate these technologies and a coherent

national policy for science and technology. So far, these needs have not been met. Unfortunately, the resources made available over the past few years have not enabled the Research Division to play its full potential role in supporting national agricultural development. This research plan may assist in the formulative process of the national policy and lead to better support for research.

The issues can be considered in two groups: those which concern national policy makers and the broad allocations of available national resources first to agriculture; and those which concern agricultural research. The second group concerns the use of those resources by the Research Division (and other units) to meet the agreed objectives. The two groups are closely interlinked, since, in most situations, resources are not adequate for all the identified and desirable research work to be done, and it ought not to be left to the Director of the Research Division to make decisions on broad priorities for research without the help of the higher-level policy makers. A broadly based advisory group is often useful.

### 1.3.1 Issues concerning national policy for science and technology

The need for a clearly defined national agricultural research policy stems from the large agricultural research effort which is being made in the international and regional research organizations and in many other national programs. The results and, in some instances materials, from these global efforts are available to Fiji and may reduce the amount or change the nature of work needed in Fiji. To use them, however, requires well-trained and experienced researchers in Fiji who have a

thorough knowledge of the national situation and can also interpret the results of external research in the light of national needs. This is not an easy task and calls for senior-level, experienced staff.

Despite the availability of knowledge and materials from elsewhere, the testing for location specificity in Fiji can only be done in situ, even though good first approximations may be possible on the basis of the world information. Thus, the research service needs to be strong enough and to have enough senior researchers to fill both roles. The first, interpretation of the world knowledge base, may be time consuming, but it is efficient use of time if done well; generally it would need good communications support and travel funds. The second, the generation of locally adapted technologies, requires the normal complement of research support staff and services. To do both parts effectively could require a larger complement of senior research staff and greater facilities for external study travel than is currently provided.

### 1.3.2 Operational policy at the research division (or unit) level

At this level the issue is usually one of determination of priorities within a given resource allocation or availability. As indicated in para.1.4, this research plan is designed to be implemented in the medium term of 5 to 10 years. Work must proceed in the meantime, and it is clear that all the demands on the Research Division cannot be met from existing resources.

The Research Director and his staff can make firm proposals on the use of existing resources, but deficiencies in market information, socio-economic capacity in the division, and the influence of other important factors as indicated in para 1.1, make it highly desirable for a broader group within the Ministry of Primary Industries (MPI) to be involved in the establishment of operational priorities. Such a group would act in an advisory rather than executive capacity.

## 1.4 PURPOSE OF THE RESEARCH PLAN

The main purpose of this plan is to show how to establish a framework within which research activities can be developed to adequately serve the agricultural industries in Fiji (excluding sugar). It is not designed to be a rigid and detailed blueprint but rather to show that any plan must have sufficient continuity to ensure that effective research work can be done. It must also be flexible enough to accommodate changes as they are required in response to unforeseen events. It sets out a series of objectives for research on the basis of the national development strategy and indicates how existing resources can be allocated to determined priorities in a logical way. Additional work would await additional resources. It sets out ways in which the work of the Research Division can be organized to meet the dual needs of maintaining staff proficiency in individual disciplines while applying these skills in interdisciplinary commodity or other programs.

It should also act as a guide for non-specialists so that, in particular, staff in non-technical ministries and departments can

understand the special requirements of research in relation to the work which it is asked to do and the kind of support needed for effective working.

The essential interaction among agricultural policy makers, researchers, extension officers, and producers to ensure that relevant work is done and that the results are useful is stressed throughout, as is the need for firm delineation of responsibilities for action once firm programs have been agreed upon.

A research plan would not usually include a detailed research program. A 5-year projected program has been developed and is presented, along with resource requirements and manpower development plans in Chapter 4, and Annexes 1-4. It is felt that this is necessary to indicate how the procedures which are proposed for program formulation, implementation of research, and the resources required for effective working can be shown in the context of research as an essential component of the agricultural development strategy. Manpower development plans have been drawn up within a 10-year timescale, since the training needed is often lengthy, the numbers who can be spared at any one time for further training from an already depleted complement is small, and staff should be built up in response to program demands and resource availability rather than in advance.

The question of funding, especially of recurrent costs, is given prominence, since there is evidence at present of under-utilization of staff time because of shortages of operational funds to meet recurrent expenditures on stations and for travel.

# Chapter 2

## PRESENT ROLE OF THE RESEARCH DIVISION

The Research Division is regarded within MPI and other ministries as the country's main resource for agricultural research. At present, some research is done in three other divisions, while the research division itself has major responsibilities and activities which should not be classified as or charged to the research budget.

The ISNAR report strongly recommends a consolidation of research activities into the Research Division, while preserving the essential interaction among the divisions responsible for development activities and research. Additional research capacity was seen to be needed in socio-economics and in biometrics. The report also proposed a separation of the non-research activities into different units. This was done on the lines of the Report of the Select Committee of Inquiry into Health Service in Fiji (Parliament Paper Number 28 of 1979). The report had recommended that the Colonial War Memorial Hospital Pathology Laboratory should be upgraded and enlarged to become the National Health Laboratory and increase its present scope to incorporate the virus laboratory, food and drug control, water standards, and forensic investigations and become the coordinating authority for all government laboratories in the country. Seed and plant material production for development purposes could be handled in a similar way by the Deparment of Agriculture while maintaining a research link in quality control.

The Research Division is responsible for crops research (except sugarcane) and some aspects of research on livestock, while through its service sections and, in conjunction with a section of the land-use division based at Koronivia, it assists research in other divisions and also in forestry. The sugar industry carries out its own research but, as a large user of good arable land, there may be need in future for closer links between itself and the Research Division to promote studies on sugarcane-based farming systems and avoid duplication of efforts on areas used for both sugarcane and other crops, particularly in the Western Division.

In the absence of an overall research plan and specific research programs, the work of the Research Division is dominated by the project approach. Individual officers develop proposals on commodities or in disciplines. These are presented for consideration and approval to a research committee, of which the divisional director is chairman, and the heads of the sections are members. This is a satisfactory method of working at this level, provided that the projects have evolved out of programs already agreed at the departmental level and in relation to specific objectives and in line with agreed priorities.

The structure of the division is relatively simple, but the sections are a mixture of disciplines and programs, e.g. plant protection as opposed to tree crops. Nevertheless, it appears to function well, and only minor changes seem likely to be needed as it increases in size to accommodate additional disciplines and extra programs. At present, both the chemistry and plant protection sections have major roles outside research for which the division is not reimbursed. Apart from using very scarce funds for non-research purposes, these functions use the equivalent of 3

to 4 senior research officers' time. The research officers are also involved to some degree in multiplying seeds and plant materials, which further detracts from their research work. With the relatively small complement of total professional staff in the division, these non-research activities materially affect the amount of research that can be done, since the available staff are spread too thinly over too many topics for effective work to be done in all of them. There is a chronic and absolute shortage of funds for operating costs and travel. This reduces the amount of work that can be done and causes imbalances in the program because travel is severely restricted.

# Chapter 3

## ORGANIZATION OF THE RESEARCH PROGRAM

This chapter assumes that eventually the non-research functions will be handed over to separately staffed and funded units which would be placed outside the Research Division, partly in a National Health Laboratory of the kind recommended by the Select Committee of Inquiry, to which reference has been made earlier. In the short term, however, these functions would continue to rest administratively with the Research Division, and it is proposed that a separate non-research unit (or units) would be created for this purpose with its own staff and funding support. It should be explained that non-research functions of this kind in other countries are not charged to the research budget, while in Fiji these appear to account for nearly 25 percent of this budget.

### 3.1 DEFINITIONS

To avoid confusion in terminology, the relationships among 'objective', 'program', 'project', and 'equipment' are set out.

1. An objective is a brief statement of a purpose towards which the work of the division is directed. It is important to distinguish between objectives and the means by which they may be attained.

For the Research Division, some of the objectives are to:

- develop improved varieties of crop plants for use in different agro-ecological conditions and different production systems;

- develop cultural practices appropriate to the production of higher yields (or stable yields in the face of adversity) and which make efficient and economical use of land, labor, equipment, and water;

- develop economically viable fertilizer practices which will sustain or increase yields on different soils;

- develop the protection measures needed to prevent damage from insects, diseases, nematodes, and weeds during growth, and losses after harvest;

- determine the economic costs and returns of current and potential new practices and evaluate these in relation to the development of new farm management practices and cropping systems;

- develop appropriate tools and machines and methods of using them that will increase labor productivity;

- develop on-farm testing as an integral part of research and, in conjunction with the extension services, arrive at practices which may confidently be recommended for adoption;

- introduction, testing, and recommendation of different breeds of livestock showing good performance in Fiji;

- develop pastures and other sources of livestock feed;

- devise economical means of control of the diseases and parasites which affect livestock in Fiji;

- devise improved management practices to minimize feed costs and maximize use of indigenous feeds;

- promote the role of the Research Division as a provider of some of the information on which development project decisions can be made;

- promote the role of research as an integral part of the production system;

- develop staff competence and the division's overall capacity to meet current demands, and others in changing circumstances, with maximum efficiency.

All of these objectives are within the scope of . at an effective research division can achieve over time and on which an evaluation of the division's work can be made. It should be noted that increases in output are not included. Such increases are development objectives; research can supply only some of the means needed to attain them. Actual production depends on many factors, of which research support is an essential one. Others

which may be mentioned are secure markets at remunerative prices; timely supply of credit, seeds, fertilizers, and other inputs at realistic prices; availability of labor and land; and the willingness of the producers to produce a particular item in competition with others, e.g. rice or sugar, pulses and rice, in sugarcane rotations (fallow periods).

2. A program is a broad but precisely defined plan for an area of research or training. It may require work in only one discipline or in several. The program statement should include: a short title; a brief statement of need; the work to be done, by whom, where, and when; designation of the program leader; and a list of criteria to be used in evaluating progress along with an approximate timetable indicating when evaluation will take place.

3. A project is part of a program: it is narrower in scope, more limited in its purposes, and usually describes the work to be done in one discipline in relation to the program as a whole. It may last for the duration of the program or only a part of it.

4. An experiment is the work unit. It is a specific piece of work (probably one of a series) done at a single place at one time.

An example may clarify these definitions.

Objective: Develop, evaluate, and promote the use of improved varieties of crop plants.

Program: Rice improvement.

Project: Develop cultivars suitable for saline areas.

Experiment:

1. Screen introduced cultivars and advanced breeding material at one location.

2. Make crosses between appropriate parents (at Koronivia).

3. Screen first-generation selections at an appropriate location.

Each location has one or more experiments.

## 3.2 PROGRAM ORGANIZATION

### 3.2.1 General considerations

There is seldom a 'best' way to organize the work of a research unit. Whatever form is chosen must meet several requirements if it is to achieve its stated objectives of serving agricultural development.

Two of the main requirements stem from the nature of research in agriculture. Apart from the first and last stages of the process, i.e., the analysis of the production situation and the

definition of researchable items, and the synthesis of the results of individual items of research into production packages, research is done in the individual disciplines which form the basis of scientific agriculture. Hence, the organization of the program must meet two specific needs. It must maintain and, wherever possible, improve the disciplinary competence of each research officer and support person while, at the same time, deploying those skills in individual disciplines in programs which may involve several persons, each in his or her own disciplinary capacity.

The precise organization is less important than the meeting of these essential requirements. To the extent that some routine services of identification and analysis are essential in almost every commodity or livestock program, there will be staff filling an essentially service role across several programs. These staff also need opportunities for the development of skills in their own disciplines.

While the concept of multi-disciplinary crop or livestock programs is not difficult to grasp, it is often difficult to apply the concept fully in small research units because of the difficulty of providing enough staff in each of the main disciplines to interact effectively with one another, and because of the large number of separate items of work which the unit (if it is at the national level) is required to do. At present, the total complement of professional officers in the Research Division is 23, of whom the equivalent of 6 to 8 are engaged in administrative or non-research service roles. This

leaves a maximum of 17 researchers, some of whom have been newly inducted and require training and experience to be effective. They must handle 7 major programs, many of which have 2 or more main crop or livestock components. The serious danger is that, by spreading staff too thinly over too many programs, and at different locations, the work that can be done is relatively shallow and superficial, with minimum science input or content. This emphasizes that the choice of programs and the allocation of priorities to them is an important part of program organization. This plan presents ways in which priorities can be determined, but the choice is not solely one for the Research Division to make; it does not attempt to set priorities, although indications on purely technological grounds are given in the programs set out in Chapter 4, Annex 1.

### 3.2.2 Definition of programs and allocation of priorities

Currently 7 major programs, each involving several disciplines, have been defined in response to the development objectives set in DP8. These are:

1. rice;
2. root crops (also ginger and yagona);
3. tree crops (cocoa and coconuts);
4. pulses and cereals other than rice;
5. vegetables (including potatoes and garlic);
6. tropical fruits (mango, passionfruit, papaya, pineapples and citrus);
7. animal production (milk, beef, sheep, goats, swine, and poultry).

Some work is proceeding in each of these programs, but there has been no establishment of criteria by which priorities for research efforts may be set in order to maximize the use of available manpower and funds and to ensure that the most pressing problems are addressed first. Rigid procedures are not necessary, especially in a small research division, but some guidelines need to be established. Among the components to be taken into account are:

1. has the objective been clearly defined;
2. what are the major identified constraints which need to be addressed;
3. can any or all of these be removed or ameliorated from what is already known on a world basis;
4. does the proposed program adequately address the remainder;
5. what staff and funds are needed to do the work; are these available;
6. how long will it take to arrive at an interim and/or final result;
7. what is the likelihood of a successful outcome of the proposed research;
8. what is the likelihood that the results will be adopted at the production level;
9. what will be the net value to the farming community and to the country if they are adopted?

Many of these items cannot readily be quantified or scored, and they do not cover all eventualities. For example, when new

markets have been identified, there may be a long time lag between initiating research work and the production of the first market-signed consignment. In the meantime, there is always a chance that the market requirements may have changed.

The difficulties involved in establishing priorities should not prevent the attempt being made, and it must be recognized that at the political level other factors may outweigh the essentially technical considerations given above.

Once a program is established, however, there must be an effective commitment of resources to enable the work to be done in an efficient manner, even if this means that some apparently highly desirable programs have to be suspended in order for this to be done.

### 3.2.3 Systematic monitoring and evaluation

Each component of each program should carry a clear indication as to when the progress of that component should be reviewed and the results to date assessed. Provided that the objective of each component is clearly stated in advance, regular monitoring and evaluation for program management purposes can take place against this objective. It is recognized that the objective may change over time but any material change should be subject to severe scrutiny to avoid drift away from agreed priority areas and into interesting sidelines. Some flexibility is essential, however, as is also the capacity to respond to unforeseen circumstances and demands for additional work items.

## 3.3 RESOURCES NEEDED FOR PROGRAM IMPLEMENTATION

For effective and efficient implementation of agreed programs, a balance is needed among the supply of staff, equipment, and facilities.

### 3.3.1 Physical facilities

The physical facilities available to the research division and under its direct control are generally adequate for work on crops and some of the work on livestock. Some of the major crop and livestock development schemes have provided and could continue to provide facilities for management and other studies to avoid the need to build parallel facilities purely for research purposes. In general, the facilities are well maintained and are in good condition.

Many programs, however, will require routine analytical services as components of research support. These services will continue to be provided in the short term by the chemistry and other groups which have developed facilities for this purpose for their non-research functions, including those for food, public health, pesticide registration, and forensic investigations. Eventually, however, many of these non-research functions would be transferred to a national health laboratory, and when this is done, routine facilities of laboratory analysis will have to be provided at Koronivia under the control of the director of the division. For the purpose of this document, it is assumed that

existing staff in chemistry and plant protection will remain with the Research Division.

The physical facilities available for the Research Division could be further augmented through collaboration with the Fiji College of Agriculture and with the Institute for Research, Education, and Training in Agriculture (IRETA) at the Alafua Campus. The Fiji College of Agriculture, with its hostel and field facilities, can provide useful support in the work relating to transfer of technology. The trainees from the extension division could be housed in the Fiji College of Agriculture hostels, and some crop demonstrations could be laid in that institution for the training program. The joint programs with IRETA scientists on selected problems should give the scientist of the Research Division access to the special equipment and laboratory facilities which may not be available at Koronivia.

### 3.3.2 Equipment and Transport

The laboratories and farms are well equipped, but as the programs of the division are increased in number or changed in content, appropriate replacement or additional equipment will be needed.

The range of agro-ecological conditions found in Fiji requires that work be done at several locations, and the present distribution of research stations reflects the department's response to this need. This technically desirable situation

presents several problems. The total staff which can realistically be assigned to any one station is small (except Koronivia), and small units, in general, need heavy servicing from headquarters. This can only be done effectively if ample transport and adequate operating funds are available. When the overall program proposed in this plan is being discussed, pending approval at the ministerial level, the whole question of the number of stations and the transport needed to service them needs to be addressed.

Several options are open. The number of purely research stations could be reduced, by using some for other purposes, such as seed multiplication and production, while still retaining, if necessary, controlled sites on them for some experimental work.

This could be accompanied by increases in staff on the remaining stations where the workload would require them, thus forming more effective working units because of better interaction between disciplines. An alternative would be to base all senior staff at Koronivia and have minimum staff elsewhere. This would imply a huge transport requirement and would also be technically most unsatisfactory.

The work of the division is essentially applied and adaptive research in support of development objectives. Two major components are involved: first, desk studies, mainly at headquarters, to find out what is already known or available elsewhere (this is an important and time-consuming activity);

and, second, work in the field and laboratory. With the numbers of research staff that can realistically be provided from national funds, transport must become a major item of expenditure. If, for example, there is a complement of only 2 plant pathologists to cover all crops on a countrywide basis, extensive travel is essential and inevitable, even though most of their work may be locational testing of results and methodologies developed elsewhere.

### 3.3.3 Staff development

The distribution of staff in post on 1 January 1984 is given in Annex 3, Table 1. When the graduate trainees, many of whom have now been classified as professional staff members, are taken into consideration, a total of 27 officers (in addition to the ADAR) are available, compared with the estimated requirements for the main programs and administrative direction as described in Annex 1 and Annex 3 and as given in Tables 2.A, 2.B and 5 of Annex 3. This requirement of 30 staff members can be met with a minimum of further recruitment, taking into consideration the availability of graduate trainees. It should be stressed that the recently promoted graduate trainees will require further training and on-job experience to become effective as professional staff members.

In terms of numbers and levels of training, the research support staff are realistic, in absolute terms, for the current work load, but the distribution between disciplines and the geographic locations may need some adjustments. The total

requirement of the sub-professional staff, as given in Table 3, of Annex 3 can be fully met from the existing strength. Thus, from the staff development and personnel management perspectives, the main problem to be addressed during the planned period is that of how to effectively use the existing numbers of staff with their additional training where this is needed. Any new or replacement staff can be recruited specifically for those disciplines which are presently underrepresented in relation to the needs of the programs.

The supporting grades have several vacancies. These could also be filled in such a way as to cover identified geographical or program needs as appropriate.

The recent review of the civil service reward structure did not appear to make any special effort to consider the needs of specialist research staff. Considering the grading of the professional staff in relation to the post of ADA (Research), the only problem would seem to be the lack of promotional opportunities in science for senior officers. The disparity between the salaries of the ADA (Research) and the Principal Research Officer grades does not appear unrealistic.

Of greater concern and importance is the updating of the knowledge and experience of staff in the light of the rapid advances that have been made in the technologies for the production of tropical crops and of livestock in the tropics during the past 10 to 20 years. Staff in Fiji have not been fully exposed to some of this work, which is directly relevant

to Fiji conditions. This is considered further in Annex 3, but the problem could be overcome by a series of short refresher courses at appropriate research units overseas and by guided overseas tours to see some of the new technologies in action. Also, the scientists in Fiji should be encouraged to organize collaborative research with centers like the International Rice Research Institute (IRRI) in the Philippines, so that flow of information, ideas, and materials can take place on a regular basis. It should be possible for Fiji scientists to visit these centers in the course of their joint programs.

The country should be evolving a more flexible policy in relation to international travel of its scientists in the interest of their research work. The present restrictions imposed by the Public Service Commission on such travel by government servants may have a sound basis, but restrictions of this kind in most countries do not normally apply to scientists whose work is so heavily dependent on international contacts. This is particularly true for a small country like Fiji, which cannot make heavy investments of its own in research services.

### 3.3.4 Budgetary support

Two main issues need to be considered. First, the adequacy or otherwise of the total funds allocated to the Research Division and, second, the distribution of these funds in relation to the maintenance of the institutional framework of the division and the programs of work to be carried out.

1. Normative figures can be used as a guide but cannot be expected to give precise indications of what needs to be spent in each case. The World Bank and other major agencies regard an expenditure of from 1 to 2 percent of the agricultural GDP as being a reasonable target for research expenditure in most countries. The figure should be higher for small countries with several crops to handle and lower for large countries with few crops. It also depends heavily on salary and wage levels in a country; countries with industrial or near-industrial salary scales, of which Fiji is one, would be at the upper end of the range.

From the latest figures available from the Central Planning Office the total GDP(A) would appear to be about $200 million at current costs. Of this about 47 percent is accounted for by sugarcane production, 9 per cent by fisheries and forestry, and 44 per cent by the crops, livestock, and subsistence sectors. Considering the strong move to increase the production of crops and stock to broaden the agricultural base, it would seem reasonable to consider research expenditure in the crops and livestock sector in relation to an expected GDP(A) of $100 million. Total research expenditure of from $1.5 to 2.0 million per annum would be a reasonable target.

The present position is that about $1.51 million is provided for research in the 1984 estimates. Of this, at

least 25 percent is taken up by non-research activities described in para. 3.2.1 leaving $1.13 million for research.

2. Of much more concern, however, is the distribution of this among salaries, wages, and operating costs. In countries with industrial-level salaries and which have effective research systems, the ratio of salaries and wages to operating costs is usually from 70/30 to 80/20. Since salaries and wages are about 30 per cent lower in Fiji than in industrialized countries (at least for agricultural research scientists) and material costs are rather higher because of freight charges, a realistic split for the Research Division would be from 55/45 to 65/35. At present the ratio is 88/12, and it is quite clear that this is the major problem which must be addressed in developing this research plan.

It has already been indicated in 3.3.3 that there is no pressing need for a significant increase in the total establishment of the division, provided that all of the staff are deployed in research activities. It is imperative, however, to provide additional operating funds for the staff to be fully employed on the agreed programs.

## 3.4 ADMINISTRATIVE AND SUPPORT SERVICES

The need for adequate well-trained support staff is well recognized in the Fiji administrative system. There is a weakness, however, in

the in-service refresher training for support staff and in the extent of the administrative support staff at substations.

The main administrative issue, however, is that raised in the ISNAR report about the dual role of the ADA (Research) as director of the Research Division and head of the Koronivia station. This issue was only partly resolved when a separate part-time station administrator was appointed for Koronivia in the middle of 1983. Following this beginning, it should be possible to free the ADA (Research) completely from his present responsibilities of experimental work and routine management so that he could devote most of his time in the area of policy making and overall direction of the research system. This should come about with the appointment of a full-time Director of Experimental Stations for Koronivia and associated stations. Since no appreciable increase in total professional staff numbers are envisaged during this program period, only a modest increase in technical assistants (field and laboratory) will be needed, along with a few additions to existing programs to fill evident gaps. In general, one research officer should receive technical support from two to three technical assistants for field and laboratory work, but this depends very much on individual programs. The suggested numbers of sub-professional staff for the research plan are given in Annex 3, Table 3.

## 3.5 COMMUNICATIONS

The need for research staff to be in close touch with policy makers, external research organizations, extension workers, and producers, has been stressed in relation to the formulation and implementation

of agricultural research policy and programs. It is also important that among researchers, extensionists, and producers there should be a working relationship on a regular and continuing basis to ensure that producers can be given the best available information and materials with which to work. There is already good interaction, both informal and formal (but infrequent), among the groups concerned. Care needs to be taken to avoid too much formality in these interactions, but in so doing gaps must not be allowed to develop. This may increase in importance when new crops are introduced or old ones are extended to new areas. While it is primarily the responsibility of the extension service to work with the producers, research staff must ensure that sound information is available to the extension service on a regular basis by creating an institutional mechanism for this purpose.

As a minimum formal program, one or two meetings each year on each major research program would be desirable. Travel support would be needed for these activities to be held at appropriate locations (research stations or in the main production areas).

# Chapter 4

# RESEARCH PROGRAM 1984-89

## 4.1 GENERAL ISSUES

The commodity (and other) programs proposed are given in Annex I. This introductory chapter, which should be read as part of the program, explains some of the background issues and the criteria used in deciding on the programs which are presented. It also gives indications on technical grounds of the priorities assigned to them. In developing commodity-style programs, the needs for other programs of a survey nature and on the national resource base (e.g., germplasm collections, soil capability, and climatology) should not be overlooked. The need to maintain and improve disciplinary competence is obvious.

The range of agroecological conditions found in Fiji is such that a large number of different crops can be grown. This is both a help and a hindrance in developing research programs, since it implies that choices (often difficult) must be made between conflicting possibilities.

Production is considered under four groupings as emphasized in dP8:

1. traditional exports (excludes sugar);
2. crops and livestock to replace current imports;
3. crops (other than coconuts) for existing export markets;
4. crops, currently consumed locally but having potential export markets.

The production of this wide range of crops and livestock has one theme in common. The cost of production must be realistic, both for the producers and the consumers, and should be such that it allows exports to compete in world markets, even when some of these may be protected for the time being. Research must, therefore, contribute to a highly cost-effective production process and should provide a range of production options to the country's planners and policy makers. It should be able to encourage local initiative even when the production costs are not the most competitive in the world.

This means, therefore, that although the range of items is considerable and the agroecological diversity is such that all those given below can be produced in Fiji, it will be necessary to select those geographical areas which have specific advantages for the production of particular items in order to minimize costs of production. Any departure from this ecologically 'best' situation will increase costs, risks, or both.

Land tenure problems may prevent crops from being grown in the most suitable areas. While the additional problems posed by growing them in less favorable areas may well be overcome at a price, this would present an additional burden on the research service.

## 4.2 INDIVIDUAL PROGRAM ISSUES

### 4.2.1 Traditional exports: coconut products

Coconuts represent a major food item as well as being a large earner of foreign exchange. Production is declining, and world prices for coconut oil as a bulk edible oil are not such as to encourage intensive replanting in an industry in which a substantial part of the area is in very old palms of low productivity. So far, a clear policy for the industry has not been set out.

The research program addresses three situations:

a. improved planting materials for those areas which will be replanted;

b. improved cultural and management practices for young palms (0 to 20 years);

c. intercropping of mature palms (20 to 60 years) to increase total farm incomes.

It stresses the need to use knowledge and materials from other countries to avoid wasteful repetition of work already done.

All three situations are important. The emphasis of projects

within the program may change as the policy for the industry becomes more clearly defined. Processing research is not included, since this is best done by the millers themselves.

### 4.2.2 Crops (including livestock feed) and livestock to replace imports

These include rice, vegetables (potatoes, onions, garlic), pulses, coffee, and maize, together with a range of smaller volume items. There are three livestock items: beef, dairy products and sheep and goats. There are nine separate items in this list. The items range in value (in the sense of replacing imports) from about $7.0 million for rice to about $0.5 million for garlic (figure for coffee not available).

Thus, no individual item has a large enough value to warrant a separate multi-disciplinary effort in research; yet each item requires a research input as an integral part of the production package. This problem, (which also affects items in 4.2.3 and 4.2.4) can likely be overcome by having multi-disciplinary teams for each of the main program items but with each member, apart from the leader in large programs, taking part in several different programs. There is a limit, however, to the extent that the time of one researcher can be sub-divided before efficiency is lost. This is a difficult issue which can only be resolved as the overall program develops. The figures given in Table 2.A of Annex 3 showing staff involvement in the main programs should be taken only as a guide.

The problem of choice of main programs can be seen from the figures given in Table 1, in which items under 4.2.2, 4.2.3, and 4.2.4, have been combined.

Table 1. Value of imports, exports, or potential exports estimates in $ million (1983)

| Item | Imports | Exports | Potential Exports |
|---|---|---|---|
| 1. Rice | 7.5 | - | - |
| 2. Vegetables | | minor | minor |
| Potato | 3.1 | | |
| Onion | 1.1 | | |
| Garlic | 0.9 | | |
| 3. Pulses | 2.7 | | |
| 4. Dairy products | 7.0 | | |
| Meat products | 8.0 | | |
| 5. Fruits | | | |
| Passion fruit | | 0.09 | 0.4 |
| Pineapple | | | 3 to 4 |
| Mango | | | 2 to 3 |
| Pawpaw (Papaya) | | | up to 0.5 |
| Citrus | | | 2 to 3 million |
| 6. Cocoa | | 0.2 rising | 5.0 |
| 7. Coffee | | | |
| 8. Ginger | | 3.0 declining | 3.0 |

The production of those items which would replace imports would not be an absolute gain, since some inputs would need to be imported.

Within this group there are specific issues concerning the technical feasibility of attaining the production levels needed.

a. For rice, substantial support of technological information and improved germplasm can be obtained from IRRI and other external rice research programs. It is doubtful initially whether a major breeding program is needed in Fiji. A specialist rice breeder is needed, however, to do the introductions, initial testing, and subsequent breeding work. Of greater concern is the nature of the soils and agronomic management in the areas available for expansion of rice growing. These present major nutritional and management problems. Similar problems in other countries have only been partially overcome, so that intensive research is needed in this area. Subject to major improvements (if not complete solution) of these soil problems, there seems to be a good chance of producing the technology needed to increase yields substantially.

b. Processed meat products would seem to be the next most important item. There is good evidence that the meat could eventually be produced in Fiji and that efficiency of production could be increased by research on pastures, feeds, and feeding practices.

A multidisciplinary approach for consolidation of research relating to improvement of breeds, feeding systems, including open grazing and upgrading of pastures, is presented. This can best be done in the research division, with its full complement of scientists from different disciplines.

c. Increases in dairy production are feasible, although research is needed on feeding and management. The results from such work,

which would involve pastures and their management (good initial research has already been done), would be of direct value in increasing beef production when this is required. The country is already approaching self-sufficiency in fresh beef production, but management problems in relation to pastures and feeding are becoming more common and require research attention.

d. Within the group of vegetables of which large amounts are imported, the potato is prominent and a likely candidate for home production. Major advances have been made in potato technology for tropical areas in recent years, and specific areas in Fiji in the drier zones would appear to have substantial potential. Cultivars suitable for the continuously wet lowland tropics are proving elusive and are not yet available. One of the reasons given for the expansion of the cassava area at the expense of taro is that cassava can be harvested over a long period. This may not be true of the potato in Fiji, but potatoes can be stored for reasonably long periods, which has the effect of lengthening the harvest season. There is a prospect of major advances in the growing of potatoes.

Both garlic and onions can be grown profitably in Fiji. Research on cultural practices and cultivar improvement is needed. Considerable support could be obtained from AVRDC and possibly some national programs.

e. There is a large importation of pulses for making dhal. Again, major advances have been made in pigeon peas (Cajanus spp.) research in India, Australia, and the Caribbean. The International Crop Research Institute for Semi-Arid Tropics (ICRISAT) in India has one of its important research programs on this crop. As a crop ripening in the dry season there should be a place for this crop in Fiji. Early results are promising but nematode problems need to be overcome possibly by careful crop rotations.

f. There appears to be little need for research on cassava where yields are good and production at an estimated 150,000 tons or more far exceed taro at about 35,000 tons. The cost of taro production is high and with the labor costs prevailing in Fiji, production can be made more attractive only by increasing yields, decreasing costs through improved cultural practices, and extending cultivation in the off-season when prices are high. The production trends are for cassava to increase and for taro to decrease; experience elsewhere shows that food consumption patterns are difficult to change. The long-term future of taro may be questioned when the likely competition from home-produced potatoes will be added to that of cassava. For the present, however, the modest program should continue and be reviewed in 5 years time.

Given sufficient staff and financial support, the technical basis for the increases in output proposed in DP8 could be well established for import substitution of some of the major items within a 5-year period from the start of each major program of work (not all can be intensified immediately).

### 4.2.3 Crops (other than coconuts) for existing export markets

This area is dominated by considerations of quality and price, so that planned production at realistic cost is essential.

At present there is a substantial market for fresh mature ginger, a modest and partially protected market for cocoa, and a small but exploitable market for passion fruit (juice and pulp), pineapple, pawpaw, and mango. Small quantities of these fruits are already exported and will be considered in 4.2.4.

The ginger industry is facing a severe problem of losses of rhizomes in storage and transit. This is threatening to destroy the export of ginger currently valued at $3.0 million a year. Vigorous and early research is needed to investigate the causes of the losses and to devise effective control measures.

Similarly in cocoa; production is low but good cultivars and practices are available for testing. Severe losses from black pod disease are limiting production. There is little doubt that this problem can be contained, but a concerted research effort on cultivars, cultivation practices, plant protection, and to promote correct processing is needed.

### 4.2.4 Crops currently consumed mainly locally but having export potential

Crops in this group are mainly tropical or sub-tropical fruits (passion fruit, pineapple, mango, pawpaw, and citrus). Of these

there is a small export trade in processed passion fruit and citrus, and fresh pineapples, mangoes, and pawpaws. The major problem in developing these crops for export is the different nature of the production, packaging, and marketing requirements compared with those needed in local markets.

Export markets in all of these are highly competitive, both in price and quality, so that prices to the producer are not usually high. Fiji at present has special trade agreements with Australia and New Zealand for exports of fruits to these countries and has the advantage of being near to them. In the long term, however, efficiency of the production process and improved post-harvest practices will be important factors in maintaining and increasing exports.

a. Passion fruit has been developed on a small scale and current production does not meet the demand from the processing company. The crop is hand-pollinated and thus the labor requirement is high. Root rots appear to be the main constraint when known technology is used. In the absence of disease problems, high yields have been obtained. Although passion fruit is a very useful crop for small farmers and to employ labor, this advantage will disappear if and when self-fertile or insect-pollinated cultivars are developed.

b. The fresh fruit market in pineapples, both local and export, is supplied by the cultivar Ripley Queen which,

though seasonal in production, is of very high quality and travels well. The production season could be extended by using known hormone treatments but, use of this controlled production method requires careful growth control and awareness of regular market demand, which must be met without failure. (The danger in off-season production is that the local price increases, and there is then a risk of starving the export market of its expected supplies, unless this factor is anticipated and production is planned accordingly.) Processing currently based on the same cultivar is starting to use Smooth Cayenne, which is more suitable (larger and less waste). It is of less acceptable quality for the fresh fruit market than Ripley Queen. For processing, a long harvest season is an advantage. This can be achieved through the use of hormones.

The cultivar position is well established, some work is needed to maximize yields and contain costs of production by the adaptation of well-established agronomic, fertilizer, weed, and nematode control practices which are used in other major producing countries.

c. A wide range of mainly seedling mangoes is grown for home consumption. A few recognized cultivars are available, and small quantities of the better ones are being exported by air as fresh fruit to distant markets. It is expected that this market will increase.

Seasonal production can be overcome to some extent by the use of cultivars which mature at different times but the scope is less than that for pineapples because of the flower induction stimulus (usually a dry period) which mangoes require. Site selection is, therefore, important and commercial production for export fresh fruit may need to be confined to a few favorable areas. Cultivar selection, improved propagation techniques, and agronomic practices based on experience elsewhere need to be developed.

d. The cultivars of pawpaw (papaya) produced for internal markets produce fruits of very good quality but of irregular and rather large size. There is a potential export market for small or medium-sized fruits of regular shape. Cultivars are available in other countries (some have already been introduced into Fiji) with these fruit characteristics. Additional introductions may be needed but, since Fiji is remarkably free from some of the serious diseases which affect pawpaw (papaya) in other countries, extreme care is needed in the importation of plant material of all kinds. Trials are in progress (and will need to be extended) to test a range of cultivars under good management conditions, both for yield and market quality. The size of the fruits, and their freedom from (mainly) anthracnose infections which develop in storage and transit, are essential attributes. The pawpaw (papaya) is much less seasonal in production than the mango or non-

hormone treated pineapples and it is easier to arrange a steady supply to overseas markets, although some production in the dry zone with irrigation may be needed to achieve year round production.

e. Production of citrus is beset with several major problems. The internal demand for seasonal fresh fruit is met, although the quality of some of the produce is not high. The demand for processed products is not large enough to sustain a processing plant unless the plant can use other materials in the off-season. World prices for processed citrus products (mainly juice) are not high and supplies in general are reasonably abundant. Fiji has a small outlet for juice products in a protected market in New Zealand.

In the field, the cultivar situation has not been well worked out, and there are serious pest and disease problems. Of these, damage to seasonal-producing cultivars by the fruit-piercing moth and dieback disease, known to be caused by a complex of factors, including the Tristeza and Exocortis viruses, may prove quite intractable.

The dry zone, and some of the outer islands of the Eastern Division appear to offer more favorable agroecological conditions than the main wetter parts of the country. For the islands, however, transport problems are severe.

Worldwide there is a vast knowledge of citrus growing. A detailed desk study should indicate, in relation to what is known about problems in Fiji already, what the practical potential for extending citrus growing in Fiji is and precisely what problems need to be overcome to achieve this potential which could well exist only in a few chosen environments in a few localities.

In this group of crops a change in outlook from local to export sales needs a complete reorientation of production methods as well as good research support. Evidence from other countries suggests that this usually occurs when adequate market opportunities are available and other constraints (non-technical) are few.

### 4.2.5 Research-extension linkages

Fiji, like many developing countries, faces problems in communicating new techniques of crops and animal production to farmers. The problems arise from absence of strong links between the research scientists and the extension service, whose job it is to take the new technological innovations to farmers. In Fiji this problem has been partly addressed by the setting up of a training and communication section in the Ministry of Primary Industries. The staff of this section has the responsibility of communicating technological information to producers via radio programs, newspaper articles, and extension pamphlets. However, the unit, located as it is in the

secretariat of the Ministry, is not in direct contact with the scientists and is not able to harness all the available information for passing on to farmers. If this section is to perform the functions assigned to it more effectively, it is necessary that the section as a whole, or a part of it, is located in the Koronivia Research Station. Alternatively, it would be desirable to have a small but separate extension education unit established at the Koronivia Research Station as a part of its regular professional staff. This unit would become the focal point of all extension activities in which the scientists have an important contribution to make.

## 4.3 CHOICE OF PROGRAMS

General issues and those specific to each of the main items have been presented in 4.1 and 4.2. Many other minor crops can be grown. While these should not be forgotten, attention is concentrated in the proposed program on the main items listed. A summary table on the features of each of the main programs is included in Annex 1 after the program statements.

It is proposed, and the programs have been afforded priority rating on this basis, that most weight should be given to the following items:

1. identified benefits in the medium term; these to be either security of food production, replacement of imports, or maintenance and increase of exports for existing and potential markets;

2. good prospects that research, in on going or new programs, can provide a firm technical base for production;

3. areas have been identified where production could take place;

4. adaptation potential appears good, provided that inputs are available and financial incentives are ensured at a realistic level.

Using these items as a guide in the crops sector, the programs fall into two groups: first, rice, coconuts, cocoa, ginger, taro, and some vegetables for which each of the items is satisfied; and second, the main tropical fruits where benefits seem likely to take much longer to be realized, although for passion fruit a small immediate opportunity exists. In the livestock sector the choice is more difficult, but the solution may be easier to arrive at. For both dairy and beef production, productive pastures are needed. Hence although projected at improving the output of dairy products, the main programs would also be of benefit for beef production. The present modest effort on goats, sheep, and swine will be continued.

## 4.4 PROGRAM IMPLEMENTATION

Although the general program content is determined by the needs of the production situations, several management issues arise when the programs are put into operation. It is assumed that most of the programs will includetwo or more disciplines, and hence research officers will be involved (see Annex 3 for proposals in this

regard). The main concern is: at how many sites is work needed within one program and, if the work requires the research officer to reside at the site, how many officers should be located at each site? Bearing in mind that the present complement of research staff is 28, which includes 6 graduate trainees and 11 newly inducted professionals who require on-job experience and training, and that some of them must perform laboratory and administrative support roles, not more than 15 to 18 research officers will be effectively available for the field programs. These officers will be required to cover the main commodity programs as outlined, plus support in the germplasm program and other minor crop work as time allows. Some of them will be involved in more than one program, so that the grouping of activities and of staff in relation to program needs in total, and the grouping of staff into effective-sized units on research stations, is a major issue for discussion and decision.

In addition to these 'who does what, and where' questions, there is the additional need to keep a reasonably even workload, whether fieldwork or reporting, throughout the year. Because of the seasonal nature of some of the fieldwork, this even work load may be difficult to arrange. It may only be possible if all staff are prepared for a flexibility of working which would make it possible for one researcher to accept some degree of responsibility for the work of another who may be stationed elsewhere. This flexibility will be assisted once the concept of multi-disciplinary programs, each with a designated leader, is fully operational.

The additional requirement is that all senior staff should have some time available to assist in general development of the division, including the training of junior researchers, support staff, and extension officers. No plan can lay down in advance how to achieve all of these inter-related objectives in program implementation. What is clear is that a thorough review is needed of precisely how many research stations, each staffed by a realistic complement of research staff, are needed. These would be supported by experimental sites on other farms, stations, or in main development projects, but managed mostly by other agencies.

Many of the crops which are included in the main programs are likely to be produced in the drier parts of the country, specially in the Western and Northern Divisions. Postulating the availability of 18 to 20 research staff for program activities with full establishment as proposed in Annex 3, and that there should be a minimum of three research officers at any station other than Koronivia (which will have more), it follows that no more than three research stations in addition to Koronivia can be adequately staffed. From agro-ecological considerations this would appear to be satisfactory if additional sites for experiments were available for work in other zones. Keeping in view these and other constraints of resources and the needs of adequate agro-ecological coverage, some of the research stations could be closed. The two which at present have very little research activity - Dobuilevu and Wianigata - fall in this category and should be used for other purposes by the Department of Agriculture. This will leave Koronivia and four other stations, of which Naduruloulou, being very close to Koronivia, can be managed from Koronivia as an extension of its own research on cocoa and for the maintenance of tree crops germplasm.

Although these operational matters are not strictly concerned with the program content, they determine how effectively and how efficiently the available staff can be used to get the work done. The division needs guidance on this before the work programs can be finalized.

Annex 1

MINISTRY OF PRIMARY INDUSTRIES

RESEARCH DIVISION

RESEARCH PROGRAM 1984-89

This program has been developed on the basis of the following assumptions:

1. The service facilities of a non-research nature will be consolidated into separately staffed and funded units, and eventually many of these will be transferred to a National Health Laboratory of the kind recommended by the Select Committee of Inquiry into Health Service in Fiji. Others, like seed production, will be organized separately under the Director of Agriculture, with technical guidance from the Research Division;

2. The animal husbandry/pasture agronomy work and goat and sheep research will be consolidated into the research division;

3. Additional disciplinary specialists, especially in agricultural economics and plant nutrition, will be recruited;

4. Early attention will be paid to consolidating research work into fewer stations with more staff on each;

5. The individual programs should address production problems in a direct manner and seek to make early progress in some of the topics chosen;

6. Much of the work on varietal development will be based on introduction and evaluation of germplasm from outside Fiji for which links will be established with international research centers and with some of the national programs in other countries;

7. Immediate attention will be paid to (a) ways of securing adequate on-going and reliable sources of funding of recurrent costs and (b) evolving priorities so that the available resources can be used for promoting studies which offer the largest potential in the short term.

## Program 1

## RICE IMPROVEMENT

### OBJECTIVES

1. To develop improved cultivars of rice for rainfed (bunded and non-bunded) and for irrigated conditions;

2. To study the nutritional requirements of the crop, with particular attention to the saline and acid sulphate soil areas and to devise economically viable fertilizer and soil amelioration practices for the main areas;

3. To develop economical methods of pest, disease, and weed control;

4. To test and develop appropriate machinery for use in production, on-farm storage, and processing;

5. To develop production practices which will have the potential to increase yields per hectare two-fold over a 5-year period;

6. To explore ways of producing rice in different cropping systems.

PROBLEMS AND WORK TO BE DONE

Cultivars need to be developed which are suitable for rainfed conditions and for saline and acid sulphate soils, under both rainfed and irrigated conditions. The management of the difficult soils available for rice production and the nutritional requirements of these soils require detailed study. Low-cost production packages combining improved varieties, cultural practices, manuring, and pest, disease, and weed control, are needed.

PROJECT TITLES

1.A Development of cultivars for irrigated and rainfed conditions (wetlands)

Several cultivars are needed. All should have higher yield potential and/or better field characteristics than those now in use. They should be free-tillering, dwarf to semi-dwarf in habit, medium duration, tolerant of low light intensities and of pests and

diseases, and responsive to soil improvement measures, including fertilizer applications. Sub-projects are:

1.A1 Improvement of existing high-yielding cultivars by incorporation of tolerance to pests and diseases;

1.A2 Development of new cultivars for the favorable environmental areas;

1.A3 Development of cultivars having cold tolerance for use in the cool season;

1.A4 Development of cultivars for saline and acid-sulphate soil areas;

1.A5 Development of cultivars having tolerance to prolonged dry spells.

1.B Development of cultivars for rainfed conditions (uplands)

Cultivars of reliable yield potential are needed. They should be vigorous in the seedling stage, with a good tillering capacity and of short maturity duration. Adaptability to a range of soil conditions and substantial drought tolerance are essential characteristics.

1.C Cooperation with national and international research units in the exchange and development of cultivars and germ plasm

This could provide cultivars or advanced lines known to carry most,

if not all, of the characteristics needed in the cultivars to be recommended in Fiji.

1.D Development of economically viable fertilizer (and soil amelioration) practices for each of the main areas of production

The range of agro-ecological and crop management situations is wide. The basic nutrient requirements of the rice crop are known. Attention needs to be concentrated on soil, fertilizer, crop interactions. Sub-projects are:

1.D1 Continuation of mapping and evaluating the soils resource base in relation to cropping potentials and management requirements to attain them;

1.D2 Development of fertilizer recommendations for favorable soil environments (no major agro-ecological constraints);

1.D3 Development of amelioration practices and fertilizer recommendations for saline and acid sulphate soil areas;

1.D4 Development of foliar analysis as a means of assessing the nutrient status of the rice plant.

1.E Development of economical methods of pest and disease control in each of the main growing areas and seasons

This will involve a combination of varietal, management, biological, and chemical practices to arrive at cost-effective recommendations.

1.F Development of cost-effective weed control practices for rice and for cropping systems which include rice

A combination of cultural and chemical methods will be investigated under this project.

1.G Evaluation of appropriate mechanization practices at all stages of rice production, drying, on-farm storage, and home processing (not factory scale)

1.H Development of the production of rice in a range of cropping systems

Special emphasis will be placed on the interactions among crops grown in rotation or in sequence.

1.I Development (synthesis) of production practices embodying improvements in individual components when these become available

The project will involve close cooperation among researchers, extensionists, and producers.

Program 2

## ROOT CROPS (ALSO GINGER AND YAGONA)

### OBJECTIVES

1. To develop cultivars of taro with high yield potential and good cooking quality;

2. To develop improved technologies for the production of taro.

3. To introduce and evaluate elite cultivars of cassava and yams;

4. To introduce and screen scab-resistant cultivars of sweet potatoes;

5. To devise ways of controlling nematodes of ginger and of increasing the size of the ginger rhizomes;

6. To reduce or eliminate losses (by rotting) of ginger rhizomes in storage and transit;

7. To devise control measures for the wilt desease of yagona;

8. To evaluate the existing germplasm, select superior cultivars of yagona, and develop suitable cultural practices for them.

PROBLEMS AND WORK TO BE DONE

Cassava has overtaken taro as the main root crop in Fiji. Ways of increasing yields, reducing costs of production, and spreading the harvest season are required to increase the competitiveness of the taro crop. Improved cultivars and cultural practices need to be developed.

There are no serious pests or diseases of cassava in Fiji, where yields are high compared with those elsewhere. Production could be increased to meet market demands. If cost-effective ways of producing dried cassava can be found, additional production would allow some replacement of imported livestock feeds. It is felt that there is a need to import elite material of cassava, yams, and sweet potatoes to broaden the genetic base of these crops in Fiji. In particular, resistance to scab disease of sweet potatoes is available in cultivars from IITA. The greatest care is needed to avoid the importation of unwanted pests and diseases.

A post-harvest rot of ginger rhizomes is causing severe losses and jeopardizing the export trade. The precise cause needs to be found and preventive measures devised. The yield of the crop is often seriously depressed by nematode infestation. Appropriate cultural practices and chemical treatments can control the infestations. Cost-effective combinations need to be devised. The size of the rhizomes is important in the export market. Ways of achieving increases in size need to be worked out.

Yagona is grown only for local consumption. It is being severely affected by a wilt disease of unknown etiology. This disease must be

brought under control before improved cultivars and cultural practices can be expected to lead to increased yields.

PROJECT TITLES

2.A Development of improved cultivars of taro.

2.B Improvement of the technologies for taro production.

The cost of production of taro is high, and production tends to be seasonal. These programs will emphasize the reduction of costs and labor needed in its production, and an evaluation of the possibilities of off-season production using supplementary irrigation.

2.C Introduction of elite lines of cassava, yams, and sweet potatoes.

This program is designed to broaden the genetic base, to introduce sweet potato material with resistance to scab disease, and to promote regional and international cooperation in the root crops program.

2.D Development of effective control measures for the nematodes of ginger.

Combinations of field hygiene, crop rotation, hot water, and chemical treatments may be needed. Apart from increases in yield and in the size of the rhizomes, the control of nematodes may be important in controlling the storage losses thought to be caused by *Fusarium spp*.

2.E Development of improved cultural practices, including soil conservation measures for ginger production.

This will involve cooperation with the soil conservation officers of the land-use section of the Economic Planning and Statistics Division of the MPI.

2.F Investigation of the causes of losses by rotting of ginger rhizomes in storage and transit to export markets.

The size of the losses and the value of the export trade require that detailed studies be made at all stages of growth, harvest, storage, and transport to find, first, the prime cause of the problem and, second, how it can be overcome. Both nematodes and *Fusarium spp.* are believed to be implicated, but precise information needs to be obtained.

2.G Investigation of the causes of yagona wilt and ways in which it may be controlled.

2.H Evaluation of existing cultivars of yagona, their improvement, and development of suitable cultural practices for their production.

## Program 3

## TREE CROPS

### OBJECTIVES

1. To develop improved planting material of coconuts.

2. To develop suitable cultural practices for replanting of coconuts and for plantings in new areas.

3. To develop suitable management practices for areas of mature coconuts in which understory crops of cocoa, coffee, and yagona may be grown (see yagona under program 2).

4. To develop improved planting materials of cocoa and coffee having high yield potential and disease resistance.

5. To devise production systems for coconuts, cocoa, coffee (and some other understory crops) which give economic returns to land, labor, and capital.

6. To select areas for cocoa and coffee development and coconut areas for underplanting with cocoa and coffee on the basis of agro-ecological suitability to maximize the likelihood of successful operations.

7. To maintain existing control of some major pests of coconut and to devise ways of controlling others of lesser (but potentially greater) importance.

8. To develop economic control measures for insect pests of cocoa.

9. To find ways to reduce black pod incidence in cocoa.

PROBLEMS

Despite past efforts in replanting, coconut production is declining steadily, mainly as a result of an aging palm population and poor management of the crop.

The world market situation is difficult, but about 35 percent of production is consumed in the country; this will increase as the population grows. There are three main production situations for which research support is needed: replanting, management of young palms (0-20 years), and possibilities for intercropping in mature areas (20-40 years). Hybrid varieties of proven yield capacity are needed for replanting in new areas. Economic management practices need to be defined for young plantations and mature plantations with or without intercrops. Of the possible intercrops, cocoa and coffee come within this program. Reliable planting material is needed having good yield potential and disease resistance, especially for black pod of cocoa. Interactions of plant material and plantation management systems require special attention. Methods of processing for quality products are already known; ways to apply these in Fiji need to be devised. Although substantial research is needed, there is already a large amount of

information available worldwide. This needs to be examined carefully and extensively to avoid repetition in Fiji and to allow what is already known to be applied to the production situations with confidence and without delay.

PROJECTS

3.A Collection of information for planning purposes for redevelopment of coconut areas and for the necessary research support.

This work will be a joint effort with the Land-Use Section, the Extension Division, and the Economic Planning Unit of the Ministry. It has several components.

3.A1 Survey of the extent of the areas of palms which need replacement, their locations, suitability for replanting by reason of topography, soil, or other parameters;

3.A2 Survey of the areas of palms between 20-60 years old, their locations and suitability for understory cropping;

3.A3 Establishment of pilot areas of doublestory cropping for research and demonstration purposes in chosen locations;

3.A4 A desk study of the extent to which available technology (local and worldwide) could be used directly in production and processing with a minimum of local checking (applies to coconuts, cocoa, and coffee);

3.A5 A desk study of the economics of using improved technologies in production and processing.

3.B Selection of pollen parents and initial production and testing of hybrid seed units of coconut.

Consensus on a world basis is that for replanting of coconuts for intensive production, hybrid material must be used to secure adequate rates of return on investments.

3.C Selection of mother palms of Fiji Tall, Rotuman Tall, and Niu Leka coconuts to be used as pollen parents for hybrid production, as in 3B, or production of seednuts for isolated seed gardens.

3.D Establishment of fertilizer trials, and the systematic sampling and analysis of coconut leaves, using hybrid plant materials.

Results of fertilizer trials in other countries cannot be applied directly in Fiji. To avoid the long delay in obtaining yield results from fertilizer trials, the amounts of fertilizer needed to produce near optimum nutrient contents in leaves (these levels are well-established and vary little from country to country) can be used as a guide to the levels needed. These fertilizer rates can then be tested in simple yield trials.

3.E Continuation of work on the evaluation of Amelanado selections and hybrid materials of cocoa.

3.F Introduction, evaluation, and propagation of Sabah bybrids

The more promising of these will be multiplied vegetatively for distribution to growers. Hybrid seed gardens could be established later, with the identification (and if necessary introduction) of parental varieties.

3.G Studies on control of cocoa stem borer and ring bark borer.

3.H Fungicides for black pod control.

3.I Continuation of fertilizer trials at the Matasawalevu Cocoa Development Project.

3.J Development of improved, low-cost cultural practices for pure stands and for cocoa grown under coconuts.

3.K Studies on the use of bud grafting for the propagation of selected cocoa materials.

3.L Desk studies of fermentation and drying techniques used in other countries and the selection of those appropriate for use in Fiji.

Techniques for the production of good quality cocoa are well known. Adaptation of production techniques to allow the best methods to be used in Fiji may be needed. (There are minimum and maximum qualities of cocoa that can be fermented correctly in one batch.)

3.M To study the coconut stick insect, Graeffea crovanii, to find ways of controlling localized severe outbreaks.

## Program 4

## PULSES (AND MAIZE)

### OBJECTIVES

1. To develop improved cultivars of pigeon pea (*Cajanus* spp.), cowpea (*Vigna* spp.), and of maize.

2. To introduce and evaluate improved germplasm of mung (*Vigna radiata*), urd (*V. mungo*), and other pulses.

3. To introduce and evaluate short duration pulses in sugarcane-based cropping systems.

4. To develop economical methods of soil management and fertilizer use for pulses and for maize.

5. To develop effective and economical control measures for insect pests, diseases, and weeds.

6. To develop production technologies, including crop rotations where appropriate, to restrict losses from nematodes.

7. To develop improved methods of on-farm storage and milling of pulses for dhal production.

8. To develop mechanized production of pulses to restrain costs.

PROBLEMS AND WORK TO BE DONE

Major technological advances have been made in recent years in pulse production in India and Australia based on national and international research (ICRISAT) advances. Promising adaptive research is already in progress in Fiji. A program has been designed jointly with the University of Queensland to take advantage of recent technological improvements in cultivars for specific situations, plant density, soil amelioration, and fertilizer practices, pest and disease control, and in mechanized production. Densely planted stands of appropriate cultivars sown at the correct times produce synchronous flowering of the crop, thus helping in pest control and in crop mechanization. Ways of using these advances in Fiji need to be worked out.

Similar advances have been made in Australia and at IITA in the production of cowpeas. A smaller but similar program to that proposed for pigeon peas is needed to take advantage of the advances already made.

Maize is needed mainly for livestock feed. Disease-resistant cultivars suitable for fully mechanized production are required. Soil management, amelioration of adverse soil conditions, and the definition of economically viable fertilizer practices are called for. Seed of cultivars and of nurseries for selection can be obtained from Australia and from CIMMYT.

PROJECT TITLES

4.A Cooperation with external research institutes in the development of improved cultivars of pigeon pea, cowpea, mung, urd, and maize for Fijian conditions.

Four sub-projects will be developed.

4.A1 Cooperation with the University of Queensland and with ICRISAT to develop improved cultivars of pigeon pea;

4.A2 Cooperation with IITA to develop improved cultivars of cowpea;

4.A3 Cooperation with AVRDC and some national programs in Southeast Asia to develop improved varieties of mung and urd;

4.A4 Cooperation with Australian sources, CIMMYT, and the Thailand National Program to develop improved cultivars of maize.

4.B Intercropping and double cropping of short duration varities of pulses in sugarcane-based systems.

4.C Development of weed control technology in pigeon pea and maize.

In all of the above, resistance to diseases will be a main factor.

4.D Investigation of the amelioration of adverse soil conditions and the development of economical corrective measures.

These studies are necessary to define areas which can profitably be used for this group of crops.

4.E Investigation of the effects of different crop rotations on the build-up of nematode populations in the soil.

Crop rotation is regarded as the most likely method of reducing the severe damage caused when monoculture of pulses is practiced.

4.F Control of insect pests by chemical, biological, and cultural methods.

Low-cost methods combining the various possible components are to be sought.

4.G Continuation of studies on field mechanization for the production of pulses.

4.H Studies on post-harvest technology of pulses.

N.B. The status of the joint Fiji/University of Queensland proposal for pigeon pea research needs to be reviewed.

## Program 5

## VEGETABLES (INCLUDING POTATOES AND GARLIC)

### OBJECTIVES

1. To develop improved cultivars of potato (*Solanum* spp.), onion, and garlic.

2. To develop improved cultivars of tomato and other vegetables.

3. To delineate suitable soils in favorable agro-ecological areas where these crops may be grown to best advantage.

4. To evaluate and demonstrate high-value vegetable production in greenhouses and plastic shelters during the off season.

5. To develop improved cultural practices for small- and large-scale production, including mechanization where appropriate.

6. To develop suitable crop rotations, including these crops, to minimize pest and disease problems.

7. To develop appropriate crop protection measures, both for protection and control.

8. To develop the use of fertilizers on a crop and whole-rotation basis to maximize the uptake of added nutrients and to minimize costs.

9. To evaluate the economics of different methods of storage of the crops so that seasonal gluts and shortages may be alleviated through on-farm or central storage.

PROBLEMS AND WORK TO BE DONE

There are major problems in production, storage, and marketing. These arise mainly from the large number of different vegetables grown and the relatively small quantities of each which are involved. For the research division, the main problem is how to handle such a diverse group of crops when few staff are available. The proposals in this program are to concentrate resources on a few items: potatoes, onions, garlic, and tomatoes; and to keep only a watching brief on the remainder, with the exception of protected cropping in the off-season to spread the work load of the staff.

Technically there are serious problems of pests, diseases, and nematodes, compounded by inadequate attention to crop rotations, and several pests and diseases are common to more than one of the crops grown. Progress has already been made in the identification of suitable cultivars of onion and garlic and of promising cultivars of potato and tomato. Non-technical constraints are serious; farm resistance to precision growing is one of them. Since the dry season is the most suitable for growing most of these crops, irrigation at reasonable cost is essential to prevent losses and reduce risks. Attention is needed to harvest technology, post-harvest storage, and marketing. Cool stores are used in other tropical countries for the crops on which the main research program is concentrated.

PROJECT TITLES

5.A Continuation of the cooperative program with CIP aimed at the identification and testing of improved cultivars of potato for both the main and off seasons.

5.B Continuation of work to develop economical fertilizer and cultural practices using the currently recommended cultivars of potato.

5.C Continuation of studies on post-harvest technology of potato, with emphasis on low-cost storage.

These projects have already made good progress in relation to the resources deployed. Intensification of the work is envisaged.

5.D Evaluation of garlic cultivars, with particular reference to disease resistance and to yield.

5.E Continuation of work to develop improved cultural and fertilizer practices for garlic, including the effects of different crop rotations on yield and the incidence of pests and diseases.

5.F Development of improved cultivars of bulb onions having resistance to diseases and good storage characteristics.

5.G Continued development of improved cultural and fertilizer practices for the production of onions.

5.H Development of improved cultivars of tomato and other vegetables using materials mainly from AVRDC, Philippines, and some commercial sources.

5.I Evaluation of the production of high-value crops in protected cropping in the off-season.

5.J Continuation of work on disease and insect pest control in all crops to maintain the resistance in the selected cultivars and in relation to improved cultural practices.

5.I Development of weed control practices using non-chemical and chemical methods.

All of the above projects aim to make full use of technologies available from outside Fiji and to adapt them to local conditions.

5.K To delineate suitable areas for the expansion of production of potato, onion, garlic, and tomato.

5.L In cooperation with other agencies, to examine the technical and economic feasibility of producing the main crops in these areas on large- and small-scale holdings (mechanization to be included).

5.M To investigate the technical and economic feasibility of producing certified seed potatoes and garlic seed in the Nadala/Navai area.

N.B. Many of the items in these projects are interlinked and need to be considered together. They are specified in detail to ensure clarity and to try to avoid omissions. The off-season work scheduled would ensure continuity of work for the research staff after the main field work season.

## Program 6

## TROPICAL FRUITS

### OBJECTIVES

1. To develop improved cultivars of passion fruit, pineapple, mango, pawpaw (papaya), and citrus.

2. To develop improved cultural, fertilizer, and crop protection practices for these crops.

3. To develop suitable harvesting, grading, and post-harvest handling practices, particularly for export consignments.

4. To develop economical production systems for these fruits for internal and export markets.

### PROBLEMS AND WORK TO BE DONE

The main problems arise from the difference between small-scale production for local markets and larger-scale production to meet export requirements. Production for the export market demands precision methods

applied to cultivars of recognized quality and acceptability. The outlines of most of the overall technologies needed are already known from experience elsewhere. What is needed in Fiji is intensive and critical research to adapt the general technologies to local conditions and to meet specific market requirements at economically acceptable costs. The projects outlined reflect the specific nature of these needs and what must be done to meet them.

For passion fruit, improved cultivars would be insect pollinated, high yielding, and resistant to collar rot and nematodes. The expression of this resistance could be enhanced by the development of improved cultural practices, fertilizer use, and weed control.

There is no immediate need for new cultivars of pineapple, but ways of maximizing yield and keeping costs of production down are needed. Application of known technologies after adaptation is the main need.

Market research is needed for pawpaw to establish consumer preference. Cultivar development depends on knowing clearly what is desired. Fiji pawpaws are already of good quality, so that where improvements are needed they are specifically to meet market requirements. Methods of producing seed which will give plants having specific fruit characteristics are already known. Although pawpaws can be grown in many locations, careful site selection with regard to soil, rainfall, and irrigation possibilities is needed for commercial production. Research is needed to evaluate the relative importance of these factors.

Mangoes are grown on a casual basis for local markets. For export a very few selected cultivars are needed. All tree crops in Fiji are liable to

damage from strong winds. It would be an advantage to produce mangoes on small trees with shelter-belt surrounds. Cultivar selection, stock/scion interactions, and cultural practices to meet the specific conditions in Fiji form the basis of the research needed.

Citrus is beset with many problems in Fiji. Only in the dry and intermediate zones is there a possibility for the production of seasonal types. Market studies are a prime research need to decide what is required for local sale and the high-priced, competitive export market. Once this has been determined, desk studies of the technical and economic feasibility of producing these items are needed. The technical constraints which research must address are mainly stock/scion interaction, pests and diseases, and the suitability of different areas for controlled production.

PROJECT TITLES

6.A Development of improved cultivars of passion fruit (self- or insect-pollinated) and with resistance to collar rot.

6.B Development of improved cultural and fertilizer practices, including weed control.

6.C Control of diseases by economical means, using a combination of host resistance, improved management practices, and chemical methods.

6.D Development of improved propagation and planting techniques (including nematode control) for pineapples.

6.E Adaptation of known improved technologies of pineapple production. Sub-projects are:

6.E1 Economical use of fertilizers;

6.E2 Use of hormones to ensure controlled long-season production for export markets;

6.E3 Improved cultural practices, including desuckering and weed control in ratoon crops;

6.E4 Nematcde control by cultural, management, and chemical methods;

6.E5 Observation of possible new cultivars in nursery plots.

6.F Screening of mangoes to select plants producing high-quality fruit for export. Possible introduction of cultivars from other countries.

6.G Development of propagation techniques of acceptable cultivars on the basis of known technology: study of stock/scion interactions (includes resistance to wind damage).

6.H Cooperation with potential producers of mangoes for export on site selection, spacing, and on fertilizer trials of chosen cultivars to promote early bearing.

The mango grows too slowly for development of export markets to wait for the results of long-term field trials. Provided that the

cultivars are acceptable, good approximations (with measurements and trials) can be made for management practices for new plantings.

6.I Development of improved cultivars of pawpaws through selection, introduction, and application of well-established seed production technology.

6.J Market acceptability studies on a range of cultivars.

6.K Development of improved cultural practices, including use of irrigation, to ensure continuity of production in the dry season.

6.L Desk study of production possibilities for citrus from technical and economic angles.

6.M Studies of stock/scion interactions on different soil types in possible citrus production areas.

6.N Development of improved cultural and fertilizer practices for chosen types of citrus within the cost limitations which markets impose.

6.O Studies in disease and pest control for selected citrus varieties.

Citrus production has many problems. The main question to be answered by the research program is whether it is realistic to try to produce seasonal production cultivars except in favored locations, possibly in the dry zone or on some of the outer islands. The threat of complete loss by high winds should also be taken into account.

# Program 7

## LIVESTOCK

### OBJECTIVES

1. To improve and sustain, at the higher level, the productivity of pastures for beef and dairy production.

2. To develop individual components which can contribute to this improved output, such as pasture species (grasses and legumes), fertilizer use, weed control, and other agronomic practices.

3. To continue studies on cattle nutrition, on growth rates, and on fertility (calving percentage) and to study possible interactions between breed and nutritional levels in this regard.

4. To develop local sources of concentrates for feeding poultry and swine to reduce expensive imports.

5. To determine where and how expansion of goat production could best take place.

### PROBLEMS AND WORK TO BE DONE

The pasture program is well developed. Much of the essential background has been established, and individual problems have been identified. Theproblems are most severe in the Central Division. Emphasis needs to

be placed on animal production through improved nutrition. This brings in the important role of pasture management in its broad sense. The major problems are those of the instability of the pastures, pronounced seasonability in their productivity, low nutritive value of their produce, difficulties in establishing and maintaining grass-legume mixtures, problems in seed production and the high cost of vegatative propagation, and limited information on nutrient requirements of the pasture species.

PROJECTS

7.A Development of improved pastures and their economic evaluation in the dry areas, and in the wet areas of the Central Division.

Sub-projects are:

7.A1 Evaluation of species of grasses and legumes, including the shrubby legumes for specific areas;

7.A2 Studies on nutritient requirements of these species in various combinations in pasture situations: fertilizer use in relation to yield and cost;

7.A3 Pasture management studies involving stocking rates and grazing patterns;

7.A4 Weed control in these management situations.

These four sub-projects are to be done as part of a series, since they are closely interlinked. Nutritional deficiencies have been identified and need correction before some of the newer species of legume can be expected to grow.

7.B Studies on the effect of nutritive levels on growth rates of beef cattle, growth rates and milk output of dairy breeds, and on the fertility of all classes of cattle.

7.C Continuation of studies on goat nutrition.

7.D Continuation of monitoring of pasture problems, especially woody weeds in the Western Division and finding ways by which they can be controlled.

7.E Ecological studies on grasses and legumes to complement pasture development and management projects.

This is a modest program for an industry of considerable value. Much is already known, so that these programs cover only the priority areas in the field of animal nutrition and pasture improvement which need greater attention.

Program 8

## CHEMISTRY, SOILS AND SOIL MANAGEMENT*

### OBJECTIVES

1. To continue work on the resource base of the country in soils and climatology in relation to the production of timber, crops, and livestock.

2. To maintain adequate laboratory and other facilities to support these studies and those on fertilizer use and plant nutrition.

### PROBLEMS AND WORK TO BE DONE

Many of the soils in Fiji present serious management and nutritional problems when brought into cultivation for tree crops, annuals, and pastures. Amelioration of these adverse conditions at acceptable cost is a major problem. There has been little work in the past in Fiji on soil/plant interactions: hence intensification of work on plant nutrition as in programs 1 to 7 is essential. To support this work, analytical services and greenhouse facilities for pot trials are essential. This is part of the contribution of the section to the individual programs.

The soil projects, including those relating to soil survey and capability with their interrelationships, must be consolidated in the research division.

* A substantial part of the projects concerning soil and plant nutrition in programs 1-7 and part of program 8 is covered by the Fiji soil and crop evaluation program. Items directly connected with components of programs 1 to 7 have been excluded.

PROJECTS

8.A To continue work on soils and land use, and the assessment of the potential of benchmark soils.

8.B To assemble agrometeorological data which, with the soil data, would facilitate selection of appropriate sites for agricultural developments.

## Program 9

## GERM PLASM COLLECTION AND MAINTENANCE

OBJECTIVES

1. To maintain, augment, document, and evaluate the range of plant materials available for screening and use in breeding in Fiji.

PROBLEMS AND WORK TO BE DONE

There are collections of cultivars and selected lines of the main crops grown in Fiji and of some new ones that are proposed for development. It is important to add to these and to have ready access to the materials available for screening and to maintain essential collections at reasonable cost. At present, the materials are in several different locations and are difficult to maintain adequately with the resources available.

PROJECTS

9.A To develop long-term storage facilities for seed of the main crops grown or likely to be grown in Fiji.

9.B To maintain small collections of the germ plasm available for crops which cannot be stored as seed.

9.C To keep adequate records of the above-mentioned materials regarding performance in Fiji, origin and genetic make up, where located, and how they are to be used.

Annex 2

## LAND FACILITIES AND EQUIPMENT

This annex considers the adequacy of current provisions in relation to the research program proposed. The conclusions would not require serious change when consolidation of research activities onto fewer sites takes place. There would need to be some changes in location of equipment and other facilities, but this would not materially affect the extent of the additional resources which need to be provided.

### LAND

The only additional land requirement would be in programs 3B (coconuts) and 6F to 6H (mangoes).

3.B Approximately 40 hectares of land are needed for the hybrid and fertilizer trials on coconuts. The land at Wainagata is not suitable. To reduce costs, consideration should be given to doing this work on a commercial replanting area, with adequate safeguards, or to making the area large enough to provide a self-sustaining plantation run by a professional manager (not by the research staff). Within this plantation, research trials would be accommodated.

6.F to 6.H

A similar situation arises with regard to mangoes (and other perennial tree fruits). A large site is needed if adequate trials are to be carried out. It may be possible to combine some of these trials with a commercial planting or to make the research planting large enough to produce significant income. (This would be expensive initially if all the costs were carried by research, because of the long required for the trees to come into bearing.)

These possibilities represent second-best solutions, however, to the costly problem of providing the large sites needed for trials on perennial tree crops. Ideally, the trials should be under research control on research stations or controlled sites.

Some additional land development work will be needed on the existing stations, particularly Koronivia, to accommodate the increased research programs. Drainage and irrigation works will be needed.

LABORATORY AND OFFICE ACCOMMODATION

Additional facilities of approximately 400m.sq. are needed at Legalega and for the dairy pastures program (400m.sq.). Additional space at a station on Vanua will be needed for the fruit work. (It is assumed that the full chemistry and plant protection laboratories at Koronivia will continue to be available to the research division when the non-research functions are separated from it.)

The major decision to be taken with regard to laboratories (and stations) is on consolidation of activities in fewer stations, at which more effective-sized numbers of staff could be located, and the use to be made of the stations no longer needed for research purposes.

Annex 3

STAFF

This annex considers present and projected staff numbers and the training requirements for a staff development program.

PROFESSIONAL STAFF (AND GRADUATE TRAINEES)

The present complement of the research division is 23 professional officers, including the Assistant Director heading the Research Division. As of December 1984, 22 staff members were in position, with one vacant position. In addition, there were 6 graduate trainees. Thus,

a total staffing complement of 28 officers, including the graduate trainees, is currently available.

Fiji has paid careful attention to postgraduate training of staff in the Research Division, and this has helped in the organization of research programs. However, not all the trained staff have been fully utilized for research purposes; there are other responsibilities of a service nature which reduce the effective staff strength available for research.

While the basic training of professional staff may be considered satisfactory, there has been a lack of opportunity for research staff to gain experience from exposure to work in other countries on a regular (non-degree qualifications) basis. This needs to be rectified by a steady program of short courses and visits to specific overseas centerswhere work of direct relevance to Fiji conditions is in progress. These opportunities need to extend to considerations of the organization and management of research as well as to those of a purely technical nature.

1. Present Pattern of Staffing

The staffing of the Research Division as of January 1984 is shown in Table 1 of this annex. Some of the 13 graduate trainees shown in this table have now been classified as professional staff, with the result that there is only one vacant post at the scientific level.

2. Proposed Staffing

(a) Research functions: Table 2-A in this annex gives the proposed staffing of the Research Division, taking into consideration the research plan presented here. The table lists the different disciplines and the programs which should be receiving scientific support from these disciplines. The totals of the vertical columns (programs) indicate the relative weight attached to the different programs. The totals in the horizontal rows show the numbers needed by discipline or subject.

Disciplinary research has been added in this table as a separate program, and this requires a word of explanation. The disciplinary research proposed here is not intended to be of the fundamental kind which is usually taken up in the experiment stations of more advanced research systems in the developed countries and some of the developing countries. Basically, this kind of research should help to develop useful information on important pathogens and pests and on the country's soil resources. In the absence of this knowledge, disease and pest control may become difficult, and the basic characteristics of soil may not be known, adversely affecting efficient soil management. Not all the required information will be available outside Fiji. Keeping these considerations in view, a professional strength of 1.25 has been proposed for studies of this kind.

The recognition of different disciplines listed in Table 2-A is important for several reasons. First, many of the research programs must be of an interdisciplinary nature. To take one example, the rice program will require joint efforts of the plant breeder, agronomist, soil scientist, entomologist, plant pathologist, and agricultural engineer. Second,

disciplinary competence available in any research service is a great asset, because while the programs may change over a period of time, competence of this kind would still be needed to take up the revised or new set of programs. Thus, a good plant nutrition scientist can work on almost any crop, even though he or she may have more experience of some than of others.

(b) Transfer of technology: The Ministry of Primary Industries has set up a training and communication section, with responsibility for the transfer of new production technologies to the extension staff and the farmers. The scientists, who are producers of technology and should be making recommendations to the extension service and farmers, have only a limited contact with this section, and for this reason, their role in the process of transfer of technology remains limited. The training and communication section, which neither generates technology nor is located in the Koronivia complex, cannot do an adequate job unless it establishes a close working relationship with the research group and keeps itself fully informed about new technological developments. It is, therefore, strongly recommended that at least a part of the staff of this section should be located in the Koronivia Research Station. This staff should become the link between the scientists of the experiment station network and the training and communications section, and through it with the extension service and farmers.

The training and communication section and the scientists of the Research Division, working jointly, have a number of important funnctions to perform in the process of technology transfer. Thus, they should be compiling, in a usable form, scientific information for the benefit of the extension workers and the farmers. The results of studies carried

out at experiment stations are often published as scientific reports in technical journals, which are not normally seen by the extension staff and farmers; these groups require technological information in a form consisting mainly of recommendations to farmers. It is important that packages of practices on different crops and in relation to animal production are prepared using the latest results of practical value which may be available. These extension bulletins, pamphlets, and other similar publications must be revised periodically. Some of the other duties include organizaton of training programs for the staff of the extension division and organization of field demonstrations and farmers' fairs. Fiji, with its small extension service, does not have a separate cadre of subject-matter specialists. The scientists of the Research Division are expected to perform this function. They must train the field extension staff in the latest technological innovations, and for this purpose, they must organize training programs with the help of the training and communication section. The training and communication section, with some of its staff located at Koronivia, should also assist the scientists in the organization of demonstrations of their technology on farmers' fields and in holding farmers' fairs on experiment station farms. New techniques of crop production can be more confidently extended to farmers if they are first tested for their viability under actual farming conditions. Also, as part of the process of transfer of technology, scientists must invite farmers to their experiment stations to see the latest crop varieties and other innovations which are presented in the form of special demonstrations for this purpose.

The scientists normally perform many of these functions relating to the process of transfer of technology, with the help of a small extension education unit, which they organize for this purpose as part of their

regular staff. The extension education unit becomes the nucleus and the focal point for all such activities. It is recommended that in Fiji this role should be performed by that staff of the training and communication section which is located at the Koronivia Research Station, as proposed above.

(c) Service functions: In addition to the staff required for the research programs, professional staff are also needed for the various service functions which have been entrusted to the Research Division. These include such services as chemical analysis of food samples for purposes of public health, analysis relating to forensic medicine, phytosanitary examination of samples for introduction and exchange of germplasm, testing of pesticides for their bio-efficacy, safety and purity, and seed production. Traditionally, the Research Division has carried out all these functions and, it is clear that for some time to come these will continue to remain with the Research Division. As had been proposed earlier, it will be necessary in the long term to take away these functions from the Research Division and create separate facilities and budget for this purpose.

The Government of Fiji recognizes this need and a reference has already been made to the report of the select committee of inquiry into health service in Fiji (Parliament Paper Number 28 of 1979). The report recommended that the Colonial War Memorial Hospital pathology laboratory should be upgraded and enlarged to become the national health laboratory so that it can increase its present scope to incorporate the virus laboratory, food and drug control, water standards, and forensic investigations and become the coordinating authority for all government laboratories in the country. It is proposed that at the same time

separate units in the Department of Agriculture should be strengthened for plant quarantine purposes and for pesticide registration and seed multiplication. While this should be the long-term policy, in the short term the various service functions, while being retained in the Research Division, should be organized as a separate unit with funding support and a budget of their own. The requirements of professional staff for these service functions are shown in Table 2-B.

The position with regard to the availability of professional staff is basically sound. With some additions and training, it should be possible to implement the research plan. The total requirement of professional staff as indicated in Tables 2-A , 2-B, and 5 is 30. The present staff strength, including the 6 graduate trainees, is 28 officers. Some of the newly classified professional staff members have less than three years of research experience, and a few of them have only recently returned after obtaining their degrees. These staff members would require on-the-job experience and/or training outside the country before they become fully effective as professional staff members.

SUB-PROFESSIONAL STAFF

The requirements of sub-professional staff are given in Table 3 of this annex following the pattern adopted for the professional staff. Thus, the projections have been made both for the different programs and the disciplines. It should, however, be added that it is not always possible to assign a particular sub-professional staff member to one particular program. It should be possible to utilize the service of these staff members with some degree of flexibility in the overall interest of the research work of the division.

The total requirement of 66 sub-professional staff can be fully met from the existing sanctioned strength if the 10 vacant posts can be filled. These continue to be frozen for the present but are expected to be released as the policy changes in this regard.

One area needs particular attention. The volume of records and results is such as to justify the use of desk-top microcomputers for this work. It is unlikely that a full-time bimetrician is needed or could be recruited. It would be useful, therefore, if two or more senior technical assistants could be trained in computational techniques, using microcomputers as a service to the division. They would not be responsible for statistical design of field experiments, which remains the responsibility of the professional staff.
Others could benefit from refresher courses in special skills. Requirements must be precisely defined by the research officers before provision can be made for such training.

LABOR REQUIREMENTS

Table 4 gives the projections of labor requirements for the different disciplines and programs. As against a labor requirement of 123, 124 are in post at present. In addition, there are 16 vacant posts. Future policy should be to reduce the labor requirement through increased mechanization of the various field operations. Following the development in recent years of a wide range of field equipment, it is now possible to use machines for various operations, including sowing, harvesting, and threshing of many crops, in addition to field-bed preparation. The machines not only help to reduce labor requirements, but they also add to the precision of field experiments.

## ADMINISTRATIVE STAFF AND SUPPORT SERVICES

Additional professional and non-professional staff are needed for the administration of the Research Division and for the various support services. Two positions are particularly important. First, the Assistant Director of Agriculture (Research) - ADAR - will have the responsibility for the overall administration and management of the research system and for policy making. He provides direction in the planning, programming, and monitoring of research and in projecting the role and requirements of the research service to the higher levels of Government. His other responsibilities include forging of links with international research centers and with national research programs in other countries which are of direct interest to Fiji. He also coordinates the work of the Research Division with that of other divisions, such as the divisions of extension, irrigation and drainage, and organizations like the Fiji Sugar Corporation. His duties may be defined as follows:

### Head of Research Service

1) Plan the country's overall agricultural research strategy, including research priorities. Help to evolve a national research policy.
2) Advise the government in the formulation of the administrative and personnel policies for the staff of the research service and for the development of a research infrastructure.
3) Plan manpower development programs.
4) Prepare the budget of the research service for total investment, its

balance in respect to different components and different sources of funding, including external assistance.

5) Organize programs of cooperation and collaboration with the different international and national research systems. Coordinate bilateral and multilateral assistance programs for research.

6) Monitor the progress and performance of the experiment station network and take corrective action at appropriate stages.

7) Develop close linkages with the extension service and other divisions and departments of the government relating to agricultural development.

8) Project the image and needs of the research service in higher levels of government.

Besides the ADAR as head of the research service, a director of experimental stations is needed for Koronivia and the other stations associated with it. He will have responsibility for the day-to-day management of research stations, for development of facilities in the form of laboratory and field equipment, for efficient use and deployment of resources and, above all, for the formulation and implementation of research programs and projects following the interactive mechanisms and procedures laid down for this purpose. The duties of the director of the experimental stations would be as follows:

Director of Experimental Stations

1) Translate national research priorities into programs and projects and assign them to different groups of scientists ensuring inter-disciplinary cooperation.

2) Monitor progress of field and laboratory experiments and prepare periodical reports for the head of the research service.

3) Identify technologies considered suitable for transfer to farmers, demonstrate them on farmers' fields and recommend them to the extension service with appropriate package of practices.

4) Allocate support services of sub-professional staff and field and laboratory facilities, equipment and other supplies needed by the scientists for the execution of their research projects.

5) Formulate development plans and externally assisted projects for the approval of the head of the research service, justifying them in terms of new initiatives and the projected gains.

6) Develop a cooperative working relationship with other national and international research systems.

The present position with regard to administrative support of this kind for the management of the research service at various levels is not very satisfactory. In Fiji today there is only one full-time staff member in position for these two functions. It is strongly recommended that a full-time director of experiment stations be appointed so that he can give all of his attention to the management of the stations. This officer will report to the ADAR. The present arrangement in asking one of the principal research officers, who has a full research program of his own, to take part-time responsibility as station administrator for Koronivia, is not satisfactory. The duties as defined above for the post of the director of experiment stations call for a new and full-time appointment.

It is equally necessary that the ADAR be freed of most of his present responsibilities in the field of research and routine management, so that

he can devote more time in the area of policy making and providing overall direction.

It should be explained that the research service in many countries has a third position, in the form of a station manager, to assist the director of experimental stations in the maintenance and operation of equipment for field and laboratory experiments and for other common facilities, including the maintenance of laboratory buildings and physical plants. Because of the fact that Fiji's research service is small and the needs of the scientific staff in terms of physical facilities are limited, it is not considered necessary to have an additional position of station manager. The director of experiment stations should look after these responsibilities, with support from farm managers provided as sub-professional staff.

Table 5 lists the administrative and support-service personnel required for the overall administration of the research system and its experiment stations.

TRAINING NEEDS

These can be specified only in general terms at this stage. Five additional persons require post-graduate training to qualify as professional staff. Together with the replacements needed to meet losses of various kinds, estimated at no more than 10 percent or two persons a year, this gives an annual requirement of 2-3 persons to receive postgraduate training.

In addition, it would be beneficial for about 20 percent of the professional staff to receive special or refresher training of up to 12

weeks in any year. This means that each officer would receive some in-service training at least once in 5 years. The total requirement would be for 5-6 such units of training in each year.

The need of a more flexible policy for international travel of scientists for this purpose has been stressed earlier.

These levels of training provision are the minimum needed to keep the staff of the division in touch with research developments elsewhere and to replace losses of staff by attrition.

It is important to develop the capabilities of all staff in whatever capacity they may work, since salary and wage costs are already much too high as a proportion of the total budgetary allocation, and numbers cannot be allowed to exceed minimum requirements for effective working. Efficiency is, therefore, at a premium. Conversely, staff need to have adequate resources with which to work in order that they can make their full contribution.

Table 1. Distribution of Research Staff in Different Commodity Research: December 1984

| | Professional | Graduate Trainee |
|---|---|---|
| **Crops** | | |
| Cocoa and Coconuts | 1 | 1 |
| Citrus | 1 | - |
| Rice | 1 | 2 |
| Root Crops & Ginger | - | 1 |
| Vegetables | 1 | - |
| Fruits | - | 1 |
| Dry Zone Crops | - | 2 |
| Plant Protection | 4 | 2 |
| Chemistry and Soils | 3 | 2 |
| Weed Control | - | 1 |
| Agricultural Engineering | - | 1 |
| Total | 11 | 13 |
| **Livestock** | | |
| Dairy | 1 | 1(1S/L) |
| Beef | 1 | - |
| Pigs | - | - |
| Total | 2 | 1 |
| **Administration** | | |
| ADA(R) | 1 | - |
| Farm Managers | - | - |
| Admin. & Clerical Staff | - | - |
| Total | 1 | - |

Table 2-A. Professional staff needed for the programs

| Disciplines | Programs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rice | Root crops* | Tree crops | Pulses & Maize | Vegetables | Fruits | Livestock** | Soil Resources | Germplasm | Disciplinary | Totals |
| Plant Breeding | 1.0 | 0.5 | 1.0 | 0.5 | 0.5 | 0.5 | | | 1.0 | | 5 |
| Agronomy | 2.0 | 0.5 | 1.0 | 0.5 | 0.5 | 0.5 | 1.0 | | | | 6 |
| Soils/Plant Nutrition | 0.5 | | 0.25 | 0.25 | 0.25 | 0.25 | 0.5 | 0.75 | | 0.25 | 3 |
| Entomology | 0.5 | | 0.5 | 0.5 | 0.5 | 0.5 | | | | 0.5 | 3 |
| Pl. Pathology | 0.25 | 0.5 | 0.5 | 0.25 | 0.5 | 0.5 | | | | 0.5 | 3 |
| Ag. Engineering | 0.5 | | | 0.25 | 0.25 | | | | | | 1 |
| Animal Husbandry | | | | | | | 2.0 | | | | 2 |
| Sub-total | 4.75 | 1.5 | 3.25 | 2.25 | 2.50 | 2.25 | 3.50 | 0.75 | 1.0 | 1.25 | 23 |
| Botany/Weed Sci. | | | | | 1 | | | | | | 1 |
| Ag. Economics | | | | | 1 | | | | | | 1 |
| Grand Total | | | | | | | | | | | 25 |

* includes ginger ** includes pasture research

Table 2-B. Professional staff for service functions in the Research Division

| Service Functions | Staff |
|---|---|
| Food and Forensic Medicine and Food Technology | 3 |

Table 3. Sub-Professional Staff Requirements

| A. Disciplines | Programs | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rice | Root crops | Tree crops | Pulses & Maize | Vegetables | Fruits | Livestock | Soil Resources | Germplasm | Disciplinary | Totals |
| Plant Breeding | 2.0 | 1.0 | 2.0 | 1.0 | 2.0 | 2.0 | | | 1.0 | | 11 |
| Agronomy | 4.0 | 2.0 | 3.0 | 2.0 | 2.0 | 2.0 | 3.0 | | | | 18 |
| Soils/Plant Nutrition | 1.0 | | 0.5 | 1.0 | 0.5 | 0.5 | 0.5 | | | 1.0 | 5 |
| Entomology | 1.0 | | 1.0 | 1.0 | 0.5 | 0.5 | | | | 1.0 | 5 |
| Pl. Pathology | 0.5 | 1.0 | 1.0 | 0.5 | 0.5 | 0.5 | | | | 1.0 | 5 |
| Ag. Engineering | 1.0 | | | 0.5 | 0.5 | | 1.0 | | | | 3 |
| Animal Husbandry | | | | | | | 5.0 | | | | 5 |
| Sub-total | 9.5 | 4.0 | 7.5 | 6.0 | 6.0 | 5.5 | 9.5 | 0.0 | 1.0 | 3.0 | 52 |
| Botany/Weed Sci. | | | | | 1 | | | | | | 1 |
| Ag. Economics | | | | | 1 | | | | | | 1 |
| Transfer of Technology * | | | | | 2 | | | | | | 2 |
| B. Non-research Service Functions | | | | | 10 | | | | | | 10 |
| Grand Total | | | | | | | | | | | 66 |

* Support for the professional staff of Training and Communication Section located in Koronivia Research Station

Table 4: Projection of Labor Requirements

| A. Disciplines | Programs | | | | | | | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rice | Root crops | Tree crops | Pulses & Maize | Vegetables | Fruits | Livestock | Soil Resources | Germplasm | Disciplinary | |
| Plant Breeding | 10.0 | 3.0 | 8.0 | 5.0 | 6.0 | 4.0 | | | | | 36 |
| Agronomy | 6.0 | 3.0 | 8.0 | 5.0 | 6.0 | 4.0 | 8.0 | | | | 40 |
| Soils/Plant Nutrition | 2.0 | | 1.0 | 1.0 | 1.0 | 1.0 | | | | 1.0 | 7 |
| Entomology | 2.0 | | 2.0 | 2.0 | 2.0 | 2.0 | | | | | 10 |
| Pl. Pathology | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | | 6 |
| Ag. Engineering | 2.0 | | | | | | | | | | 2 |
| Animal Husbandry | | | | | | | 11.0 | | | | 11 |
| Botany/Weed Sci. | 2.0 | | | 1.0 | 1.0 | | 3.0 | | | | 7 |
| Sub-total | 25.0 | 7.0 | 20.0 | 15.0 | 17.0 | 12.0 | 22.0 | 0.0 | 0.0 | 1.0 | 119 |
| Transfer of Technology | | | | | 2.0 | | | | | | 2 |
| B. Service Functions | | | | | 2.0 | | | | | | 2 |
| Grand Total | | | | | | | | | | | 123 |

Table 5: Administrative and Support Service Staff

| | Professional | Sub-Professional | Executive & Clerical | Supporting |
|---|---|---|---|---|
| Assistant Director Agriculture (Research) | 1 | | | |
| Director of Experimental Stations | 1 | | | |
| Farm Managers | | 7 | | |
| Executive Officers | | | 1 | |
| Clerical Officers | | | 7 | |
| Stores Officers | | | 3 | |
| Typists | | | 6 | |
| Mechanics | | | | 5 |
| Carpenters | | | | 5 |
| Drivers | | | | 17 |
| Messengers/T. Operators | | | | 2 |
| General Labor | | | | 9 |
| Watchman | | | | 1 |
| Total | 2 | 7 | 17 | 39 |

Annex 4

## BUDGET PROJECTIONS

It has already been emphasized in paragraph 3.3.4 that more money needs to be spent directly on research, as opposed to other essential but non-research tasks. In particular, the proportion of the funds available for operating costs relative to salaries and wages needs to be increased. This improved balance in budgeting can be accomplished by reducing staff and labor numbers and salaries or by increasing budget allocations for operating costs; in more practical terms, by some combination of these two possibilities.

Some costs are not under the control of the Research Division in that salaries and wages are fixed at the national level. What is available to the division is to increase the efficiency of its operations to reduce the numbers of staff and labor needed.

In industrialized countries virtually all field operations in agriculture including the research plots, are fully or partly mechanized to reduce labor numbers and costs. At the laboratory level, improved instrumentation has helped to reduce both staff and labor costs. Salaries and wage levels in Fiji are approaching those in the industrialized countries, so that hand labor in agricultural operations is extremely costly. For this reason, Fiji has a greater need to adopt some of these practices than many of the other developing countries.

The Research Division can contain its support staff and labor by gradual improvement of output by person. This implies, however, an increase in

capital investment. It is impossible to draw up accurate budget projections without guidance as to what policy the division should adopt. For the purpose of the projections in this annex, it has been assumed that total labor costs will not increase to accomodate the extra work which the research plan entails. The labor force will be restricted to that shown in Annex 3. Since wage levels will surely rise, this means more efficient use of existing labor and possibly a major reorganization of working methods on the experiment stations. Operating costs, on the other hand, are indicated to rise steadily to achieve a better balance between these and salaries and wages. The gradual rise by the year 1988 will result in a 70/30 split between salaries and wages, on the one hand, and recurrent (not capital) expenditure, on the other. It is assumed that most of the capital expenditures needed can be obtained from non-government sources. If salary levels also increase beyond the rate of inflation, these will need to be taken into account.

The projections on this basis are given in Table 1. The budget has been resolved into research and non-research functions on the asumption that the latter will continue to rest with the Research Division for the present. It has been proposed that funding support for these non-research functions should be made available additionally. If the same rate of increase of GDPA is assumed, then the projected expenditure by 1989 would represent 1.5 percent of GDPA attributable to the non-sugar sectors.

Capital budget projections have not been made although needs for replacing equipment and additional equipment at Koronivia for field work and for laboratory work in soil and plant nutrition have been recognized. Some additional building may be needed at Legalega and in the dairy program. Additional vehicles are essential in all programs. Total costs at present (1984) should not exceed $1.0 million but detailed current inventories and breakdown of projections need to be added.

BUDGET PROJECTIONS 1985-1989
(FJ$ 000's)

| | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | TOTAL |
|---|---|---|---|---|---|---|---|
| Salaries | 841.7 | 843 | 910 | 983 | 1062 | 1147 | 5786.7 |
| Wages | 738.9 | 620 | 670 | 724 | 782 | 845 | 4379.9 |
| Operating costs | 148.6 | 258.2 | 395 | 569 | 790.2 | 853.8 | 3014.8 |
| Total | 1729.2 | 1721.2 | 1975 | 2276 | 2634.2 | 2845.8 | 13181.4 |
| Research Functions | 1383.4 | 1376.9 | 1580 | 1820.8 | 2107.4 | 2276.6 | 10545.1 |
| Non-Research Functions | 345.8 | 344.2 | 395 | 455.2 | 526.8 | 569.2 | 2636.3 |

1. Actual allocation for 1984, after which the allocation is on the basis of the staff proposed and a gradual rise in operating costs.

2. No increase in base salary and wage rates.

3. Operating costs rise 8 percent per annum from inflation after 1988 when a 70/30 proportion has been reached between salaries and wages and these costs. The ratio is 91/9 in 1984, 85/15 in 1985, 80/20 in 1986, and 75/25 in 1987.

4. Research and non-research functions have been assumed to account for 80 percent and 20 percent, respectively, of the total budget.