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South Pacific Agriculture:
Challenges and Opportunities for ACIAR and its Research Partners

Edited by: Gabrielle J. Persley and Paul Ferrar
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Foreword

The Policy Advisory Council of ACIAR met in Apia, Western Samoa, on 17–21 June 1985. As part of the week-long discussions, ACIAR organised a one-day seminar on South Pacific agriculture with the aims of: describing the agricultural sector in the South Pacific to those members of the Council not familiar with the region; outlining ACIAR’s activities in the region; seeking the views of other agencies working in the Pacific on agricultural research needs and possible areas of collaboration; raising policy issues related to ACIAR’s activities in the Pacific for the Council’s consideration; obtaining from the Council members their views on the future direction of ACIAR’s program in the South Pacific.

In addition to reporting on the Apia Seminar, this volume also contains a description of ACIAR’s activities in the South Pacific, and reports on progress of the 18 projects ACIAR is currently supporting in Papua New Guinea and the Pacific Islands.

ACIAR wishes to thank the Hon. Toi Aukuso, Minister of Agriculture, Forests and Fisheries, Western Samoa for hosting the seminar. We thank also the Director of Agriculture and the staff of the Department of Agriculture for their assistance in the organisation and their participation in the seminar. Particular thanks are due to Mr Sofara Aveau and his colleagues in the Department of Agriculture for organising the field trip which set the stage for the seminar. Professor Dennis Osbourn and his staff at the University of the South Pacific also cooperated in the field trip, for which we are grateful. We are also most grateful to the Australian High Commissioner, Mr A. Godfrey-Smith, and Mr B. Wall, First Secretary (Development Assistance), for their assistance in organising the Council meeting. ACIAR’s Council Member from the South Pacific, Tau’ili’ili Uili Meredith from Western Samoa, also contributed greatly to the success of the meeting.

We are grateful to the members of the Policy Advisory Council and the representatives from other national and international agencies for their participation in the Seminar. Three ACIAR project researchers (Drs Flemming, Raff and Waterhouse) were also travelling in the region at the time in relation to their project work and we are pleased that they were able to participate in the seminar.

We hope this publication will prove valuable in fostering further interest and cooperation in agricultural research and development in the South Pacific.

May 1987

J. R. McWilliam
Director
Australian Centre for International Agricultural Research
Summary and Recommendations

The purposes of the seminar were:
1. to describe the characteristics of agriculture in the South Pacific;
2. to outline ACIAR's current projects in Papua New Guinea and other
Pacific Islands;
3. to consider research opportunities in important areas such as farming
systems, crop improvement, biological control of pests and weeds,
fisheries, animal production and animal health;
4. to discuss ways in which ACIAR’s program might complement and
interact with the activities of other agencies, such as the Australian
Development Assistance Bureau (ADAB), the New Zealand Ministry for
Foreign Affairs, the South Pacific Commission (SPC), the International
Service for National Agricultural Research (ISNAR) and the University
of the South Pacific (USP); and
5. to consider policy issues for ACIAR in the future development of its
Pacific program.

The policy issues considered at the seminar were: (a) style of ACIAR’s projects; (b)
bilateral and/or regional approach to research; (c) relationship between research and
development; (d) economic rationale of projects; (e) training; and (f) cooperation
with other agencies.

The need for a difference in the style of ACIAR’s projects in the South Pacific was
recognised, because of the smallness of the departments of agriculture, the limited
number of staff engaged in agricultural research and the lack of suitably trained
people and infrastructure in some countries. Several conclusions were drawn from
the seminar which need to be taken into account by ACIAR when preparing collabora-
tive research projects in the Pacific Islands. These are summarised below.

Geographic Distribution of Research Activities

ACIAR needs to strike an appropriate balance between bilateral and regional
activities. While it may appear superficially more efficient to support regional
research activities, this approach is not always likely to be successful, due to the
diversity of the countries and their different priorities in agricultural research. It is
therefore important for ACIAR to adopt a flexible approach and be able to support
research projects either bilaterally or regionally.

In deciding which research areas require support, it is important to take account of
the development priorities of individual countries, which often differ. In terms of the
perceived priorities of the departments of agriculture in the Pacific Islands, there are
surprisingly few areas of common interest.

ACIAR is developing its South Pacific program primarily on a bilateral basis, but
is identifying some areas of common interest where a number of bilateral projects
can be linked. These areas include farming systems, coconuts, root crops, biological
control of pests and weeds, fisheries and animal health.

Mode of Operation

There is a need to modify ACIAR’s usual mode of operation developed for its
collaborative research projects in Asia, where there is a much larger national re-
search infrastructure. In the case of the Pacific Islands, ACIAR will need to give
more emphasis to:
1. the training of national staff in agricultural research either in the region or in Australia;
2. the provision of staff from Australia for short or long periods in situ. This will be a new feature of ACIAR’s mode of operation, and will be mainly restricted to the Pacific region; and
3. the provision of essential scientific infrastructure, such as equipment and publications.

**Research Priorities**

The determination of priority areas for research is a key factor for many countries. Commodities which are important in several countries include coconuts, root crops, bananas and fish. Socioeconomic studies such as market and price studies are also considered critical. Research management is an area which requires strengthening in several countries.

**Research and Development**

The economic rationale of research activities in the South Pacific is particularly critical. Research needs to be closely linked to agricultural development. Several agricultural development activities have been undertaken in the South Pacific with an inadequate research base. ACIAR will be looking to link closely with ADAB in some of the latter’s development activities to facilitate the link between research and development and maximise the likelihood of adoption of results.

**Cooperation with Other Agencies**

There are many research activities in the South Pacific supported by national governments, regional and international agencies and bilateral donors. There is a need to tailor ACIAR’s program to complement the activities of other bodies. The participation of representatives of several other agencies in this seminar is a recognition of the importance of these interactions.

**Staff Development**

There is an urgent need to build research capacity throughout the Pacific Islands, by providing technical training and postgraduate opportunities in all fields of agricultural research. Again, links with ADAB will be important since ADAB supports an extensive training program in the South Pacific.

**Conclusion**

The Pacific Islands are presently at a critical stage in their development. On the one hand they face the problems of urban drift, unemployment, overseas migration and the aspirations of many people to join the modern cash economy. On the other, some governments wish to decrease their countries’ reliance on foreign aid, and become independent countries economically as well as politically.

Agriculture is the dominant sector of the economy in the South Pacific countries. All the national development plans list the development of the agricultural sector as one of the major priorities. Agriculture is the sector which is being asked to provide food for increasing populations, provide substitutes for imported food, earn foreign exchange, provide increased cash incomes for farmers, and generate increased employment.
Attempts to develop the agricultural sector in many Pacific countries have been disappointing. Productivity has been low; cash incomes have not increased; export volumes have not expanded rapidly; and increased employment opportunities have not matched population increases. Various biological, social, economic and political factors have been identified as limiting increased agricultural production. The biological factors, at least, may lend themselves to research-based solutions.

Well planned agricultural research may assist in increasing the productivity of the agricultural sector. New technologies will, however, need to be carefully tested before their widespread introduction, since they will have to operate in the often fragile ecosystems for which the present farming systems are peculiarly well adapted.

It is a political and strategic reality that ACIAR must have a program in the South Pacific. The Pacific Islands will continue to have an agricultural sector, irrespective of how successful some countries may be in diversifying their economies. The challenge to ACIAR is to identify agricultural research activities which will contribute to agricultural development in the Pacific Islands, and which can be undertaken efficiently and successfully by partnerships between scientists in Australian research institutions and those in national departments of agriculture and regional institutions in the South Pacific.

ACIAR's Policy Advisory Council endorsed these general characteristics of ACIAR's mode of operation in the Pacific Islands. The Council noted the need for ACIAR to adopt a flexible but careful approach to assessing priorities and undertaking its research projects in the South Pacific. It noted the need to work closely with partners in the South Pacific. The Council also reiterated the need to rate training as a key issue in the South Pacific. Finally, there is clearly an enormous potential for agricultural development in the South Pacific and the Council recommended that the Pacific countries continue to receive high priority within ACIAR's research program.
Opening Address of the Minister of Agriculture, Forests and Fisheries, Western Samoa

Hon. Toi Aukuso

I am pleased to have been invited, through the good offices of the Australian High Commission, to open this Seminar on South Pacific Agricultural Research, with special reference to a role for the Australian Centre for International Agricultural Research—ACIAR.

I would like to add to the official welcome extended by our Prime Minister to Councillors and members of the Centre staff of ACIAR, as I understand that for this Seminar there are additional guests, speakers, and other invited participants. On my own behalf, and on behalf of the Director, the staff of the Department of Agriculture, Forests and Fisheries, and the primary producers of Samoa, I bid you a warm and sincere welcome.

Agriculture is everybody’s business. It is the most important sector of our economy, and I feel this responsibility in my portfolio. In Samoa, and for most if not all of the South Pacific, agriculture is part of our traditional way of life.

Agricultural research, on the other hand, has not been a traditional part of the Department of Agriculture, Forests and Fisheries. There have been publications on our brief history of endeavours to establish an appropriate agricultural research division for the Department, including the recent studies by ISNAR, so I need not duplicate the details here. However, I would like to acknowledge that the infrastructure for our research in agriculture, stock, forests and fisheries has been possible through the aid programs of Australia, New Zealand, West Germany, and UNDP/FAO, to mention a few.

Agricultural research requires highly trained personnel. Because of other pressing priorities, posts in research are usually the last to be localised. The equipment and the laboratories are costly in the face of our own difficulties of distributing budgeted provisions for maintenance and capital works. I am not contributing any new knowledge here, as distinguished agricultural scientists of ACIAR and participants of this seminar are aware of and are more experienced with these problems and difficulties, and ways of overcoming them. I wanted, however, to draw your attention to the scale and status of agricultural development appropriate to the size and work program of an efficient and viable national research unit.

I do not think that these are problems peculiar to Samoa, but rather I consider that they are regional, and are intensified as national scale of size diminishes. Strengthening of national agricultural research systems, rather than developing a regional research facility, appears now to be the trend, following the ADB South Pacific Agricultural Survey and the ISNAR missions in the region.

Within our limited crop range, the coconut palm occupies a core role, with research required in genetics, breeding and agronomy, including crop protection measures. Taro and other root crops are staples of Samoa and other parts of our region—again with increasing importance as national sizes of islands and island groups become smaller. I would like to draw attention to some crops which in our opinion have potential for further exploitation, such as the breadfruit, other tropical fruit and vegetables, and floriculture.
Production units are small in Samoa. Small-scale farms are the rule rather than the exception. The small size and the shifting cultivation system requires a basic research approach to management of soil and cropping patterns, to sustain or even improve the soil, and increase crop yields.

I have been impressed with the list of ACIAR projects based in the South Pacific, and I need not dwell on the research requirements to develop more fully our forests and fisheries.

You have visited some of our Department’s research units in coconut hybridisation, the Crop Development Centre, our Livestock Division, and other agricultural sites. Scientists’ eyes are very perceptive, and I hope the visits were worthwhile. I would like to emphasise that we are still establishing our own agricultural research in terms of human and other resources to include also fisheries and forestry. There have been many difficulties encountered.

I am sure that an appropriate role will be found for ACIAR to help develop our regional agriculture further. I wish you well in the execution of your duties, Mr Chairman, and through you I wish all participants a very fruitful seminar.

And now, it is my privilege to declare the seminar officially opened.
By way of introducing agriculture in the South Pacific, I would like to discuss briefly the geography of our region, the people, and their perspective of the world at large.

The Pacific area may be defined by the boundaries of the Pacific Ocean itself, which comprises one-third of the earth’s surface, an area larger than all the land in the world. However, for most practical purposes, the Pacific area may be considered to be bounded by a line drawn from Easter Island, round the Tuamotus and Marquesas to the east, Hawaii and the Marianas to the north, the Palau, Papua New Guinea and New Caledonia to the west, and finally round Norfolk Island, the Tonga Group and Rapa to the south.

This is the region divided by Dumont D’Urville in 1830 into Polynesia, Micronesia and Melanesia, and contains some 100 million km², including several thousand islands and over 300 atolls, more than three times the number in all the other oceans combined.

The South Pacific region is a well-defined geographical area, mostly sea. If the 462 000 km² of land in Papua New Guinea are excluded, there remains only 110 000 km² for all the other islands, or an aggregate area about equal to that of Cuba or one that could be comfortably accommodated in one corner of Papua New Guinea. The population of approximately 5 million people is rather more evenly divided, with some 3 million in Papua New Guinea, and 2 million in the other islands.

Lest it be thought that a region so small in area and population can scarcely warrant the attention which is being given to it by international organisations including ACIAR, I would add that its importance is an antithesis to these factors. To quote from Professor H. E. Maude (1971): ‘fragmentation, geographical in Polynesia and Micronesia and cultural in Melanesia, has provided as near a reproduction as one can find anywhere of a natural laboratory for the social scientist: a multiplicity of societies which, in varying degrees of isolation from one another through barriers of ocean, mountain or mutual distrust, have developed a heterogeneous assemblage of social, economic and political systems, of culture traits and complexes, beliefs, values and attitudes, which can be observed in detail and in time-depth owing to the smallness of the groups and the relatively brief length of their occupancy.’

In addition, the ocean itself, the largest single geographic feature in the world, provides an increasing proportion of our research documentation in the form of oceanographic data, which includes the work being done in marine biology and geology, the many aspects of marine geophysical research, and meteorological observations. As we exhaust the resources of the terrestrial globe, the oceans become ever more important to the researcher.

The South Pacific region is still a ‘natural laboratory,’ not only for social scientists but for agricultural scientists. It also suggests the potential value to be realised in a joint approach of both categories of scientists as is occurring in the ACIAR-supported farming systems project in Tonga and Solomon Islands. The results might also unravel the close ties of agricultural and social practices in traditional living, and add value to their respective influences be they constraints or advantages.

The other purpose of this introduction is to convey to you that the ‘multiplicity of societies . . . in varying degrees of isolation’ have developed a mixture of national units which are proportional to the number of agricultural systems in our region. The number of agricultural systems may be even more numerous, since they are compounded by environmental factors.

**Natural Resources**

Soil, the main base of natural resources in the region, ranges from low fertility to infertile. For instance, none of the islands of Kiribati nor the northern Cook Islands has any land which can be classified as being other than of low fertility. For Western Samoan soils, 51% of the land area is described as of low to very low natural fertility, with a further 35% too stony for mechanised agriculture (Wright 1963). The fertility status of most of the region’s soils is not reflected in the lush natural vegetation, which is a result of high rainfall and rapid cycling of nutrients from the temporary rich organic forest litter. Changes occur when these soils

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* National University of Western Samoa, Apia, Western Samoa.
are put into more permanent agricultural use, such as for growing tree crops. These changes, whilst they may allow for short-term traditional food cropping, are the basis for shifting cultivation in the region and are one of the constraints against the move from subsistence to plantation or commercial production.

Although soils have been surveyed and classified in varying degrees at the national level, little work has been done on the intercountry relationship except for Wright’s work in Western Samoa, Fiji, the Cook Islands, and Niue. There is also evidence that certain groupings at the subregional level are interrelated. Most soils research has been done by the New Zealand Soils Bureau in the Cook Islands, Tonga and Fiji; ORSTOM in the French Territories; the US-based International Benchmark Survey and Network; CSIRO’s work in Papua New Guinea; and FAO and UNESCO on an international scale.

The valuable pioneering work of scientists in the evaluation of resources in our region could be used to further develop agriculture on the national and regional level, with links to extend it internationally, with expected benefits. The transfer of agricultural technology could be facilitated from one setting to another with similar resources, by the use of common systems for classifying the resources of the region.

In the South Pacific Agricultural Survey, Ward and Proctor (1980) wrote on the evaluation of resources of the region: “It is clear that the existing surveys of land potential for agricultural development are far from satisfactory and that further research on methods of classification, as well as basic data collection at larger scales, are needed if adequate assessments are to be made. At present, it appears that the existing surveys are generally not used in project planning because of their inappropriateness. This situation also applies to other environmental data. It is clear that climate imposes significant constraints on agriculture in this region, yet the types and detail of data available rarely match the real needs of those planning agricultural enterprises. It is to be hoped that some of the methodological problems involved may be clarified by a study being undertaken by Dr R. Hills (Development Studies Centre, Australian National University, Canberra). Meanwhile, one can give wider application to Brookfield’s statement that ‘the scientific sieve may . . . let pass some attribute or attributes that are significant in full land evaluation’.”

Agriculture in the Pacific Island Economies

With the exception of the mineral-rich island nations such as Nauru and New Caledonia and those heavily dependent on outside sources such as some of the US Territories, the main base of the Pacific Island economies is agriculture. Agriculture, including forests and fisheries, is of paramount importance to the region, providing food, fuel, raw materials for processing, building and other domestic uses.

Agriculture contributes 51% to the gross domestic product (GDP) of Tonga, 33% for Papua New Guinea and 11% for Kiribati. For domestic exports, agriculture contributes 99% for Western Samoa, 98% for Solomon Islands and Tonga, and 13% for Kiribati.

According to the economic authorities of the Pacific Islands Studies Program based at the University of Hawaii (Anon. 1984), there are six constraints that contribute significantly to the economic dependence and vulnerability of Pacific Island nations: (1) the need for some states, still not fully independent, to gear their economies to the needs of a colonial power rather than their own needs; (2) the strain of trying to finance extensive government programs internally; (3) the high cost of energy coupled with the region’s almost complete dependence on imported fuels; (4) an over-reliance on imported food supplies; (5) a lack of diversity in exports; and (6) an over-reliance on foreign aid. Most of these constraints are related to the agricultural-based economies. Let us consider the two that are directly related to agriculture: dependence on imported food and diversity of exports.

The dimension of imported food dependency is perhaps more critical. The populations of some island countries and territories may have outgrown their resource bases. At the subnational level, one can find single islands like Majuro in the Marshall Islands with populations that could not be supported from existing land and sea resources on the atoll. If the supply of imported food were cut off, people would starve.

Among Pacific Islands, Solomon Islands appear to be the best equipped to substitute local food supply for imported food. At the other end of the spectrum, we find in American Samoa and Guam people who have acquired a marked preference for imported foods, encouraged by the absence of tariff barriers to food imported from the United States.

Some Pacific governments have adjusted their import tariffs to make locally grown food more attractive to buyers and sellers, in order to reduce food imports and encourage local agriculture. Papua New Guinea and Fiji have been leaders in this area. Fiji now supplies most of its own beef, whereas in the past much of the beef was imported from Australia and New Zealand.
Smallholdings are the rule in the Pacific Islands. The smallholder sector operates at a subsistence level, and constraint-filled with mostly social pressures.

For Western Samoa the smallholder sector contributes 85–90% of the principal export products of copra and cocoa. In the Solomon Islands, which is among the few Pacific countries with trade surpluses, the contribution to exports of the smallholder sector compared to the plantation sector is considerably less. The transitional model of production is between subsistence cropping and plantation cropping. The latter is the commercial mode associated with organised factors of production (land, labour and capital), good management, and profits (Ward and Proctor 1980).

The plantation mode refers to the commercialised level of production rather than the scale. Following this, it can be assumed that there is potential in the desirable progression for smallholders to move into the plantation (cash-cropping) mode given identified and removable constraints.

### Range of Crops

Crops are more important than livestock in the South Pacific. The staple food crops are root crops such as taro, yams, cassava, sweet potatoes and swamp taro. Sago palm and breadfruit are also important staples. Vegetables and fruit species important for export and processing are listed in Table 2.

#### Table 1. Composite index of economic vulnerability.*

<table>
<thead>
<tr>
<th>Country</th>
<th>Composite Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonga</td>
<td>17</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>18</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>22</td>
</tr>
<tr>
<td>Fiji</td>
<td>27</td>
</tr>
<tr>
<td>Western Samoa</td>
<td>27</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>28</td>
</tr>
<tr>
<td>Kiribati</td>
<td>39</td>
</tr>
<tr>
<td>Cook Islands</td>
<td>40</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>41</td>
</tr>
<tr>
<td>New Caledonia</td>
<td>45</td>
</tr>
<tr>
<td>Niue</td>
<td>48</td>
</tr>
<tr>
<td>French Polynesia</td>
<td>49</td>
</tr>
<tr>
<td>Trust Territories of the Pacific Islands</td>
<td>50</td>
</tr>
<tr>
<td>Guam</td>
<td>52</td>
</tr>
<tr>
<td>American Samoa</td>
<td>60</td>
</tr>
</tbody>
</table>

** Least to most vulnerable.

#### Production Modes

The fragmentation of the region’s land area continues down to the level of production units. Smallholdings are the rule in the Pacific Islands. The smallholder sector operates at a subsistence level, is tradition-based, conservative in land and agricultural practices, and constraint-filled with mostly social pressures.

[Table 2. Vegetable and fruit species for export and processing.*](#)

<table>
<thead>
<tr>
<th>Product</th>
<th>Exports</th>
<th>Location and Processing Possibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>U</td>
<td>Cook Islands, drying (experimental stage)</td>
</tr>
<tr>
<td>Breadfruit</td>
<td>U</td>
<td>none, or only occasional traditional fermentation, stock and human storage food</td>
</tr>
<tr>
<td>Avocado</td>
<td>U</td>
<td>none, various preparations</td>
</tr>
<tr>
<td>Orange</td>
<td>P</td>
<td>Cook Islands, canned juice</td>
</tr>
<tr>
<td>Mandarin</td>
<td>U</td>
<td>none, canned fruit</td>
</tr>
<tr>
<td>Mango</td>
<td>U</td>
<td>none, canned fruit and juice</td>
</tr>
<tr>
<td>Pineapple</td>
<td>U, P</td>
<td>Cook Islands, canned fruit and juice</td>
</tr>
</tbody>
</table>

*(Continued on next page)*
Coconut is the most important single crop and is the 'tree of life' to the region, not only in terms of export earnings from copra and as raw material for processing, but for various local uses. For the smaller islands the coconut is more important for local consumption than for its export value.

Livestock, Fisheries and Forests

There is a lack of information on livestock and fisheries in the region. Recent trade statistics suggest that fish is becoming an increasingly important commodity for export, following recent fishing agreements which define Exclusive Economic Zones (EEZ). Livestock and fish products are also important imports, giving the impression of some potential for import substitution with these commodities. However, the beef and dairy industries have limited potential, being restricted to the bigger islands, with the cutoff point at about the scale of Solomon Islands (Ward and Proctor 1980). Pigs are also important, having high social values in Papua New Guinea, Western Samoa, Tonga, and other islands. Poultry and goats are also important. Sheep have some potential in Fiji and in the Papua New Guinea highlands.

There is an increasing need for fuelwood and for other forest products for domestic uses. Social forestry and agroforestry are planned in various parts of the region. This is part of the increasing awareness in the region of the rapidly disappearing natural forests, and the need to replant trees to restore the economic, social, aesthetic, and conservation worth of forests.

Agricultural Research

I wish to make two points regarding agricultural research in the region. One is that trained staff is required for research in the face of other competing staff needs in agriculture. The second is that assistance in project identification and formulation may be required in some countries. On both points, some flexibility and special consideration might be given by ACIAR when developing its research program.

I think that this introduction, however incomplete, would be inadequate without my mentioning a deficiency in publications on the region's agriculture, including publications on research. This has been pointed out in the South Pacific Agricultural Survey by Ward and Proctor (1980), but I fear that there has been little collective action to make up for this deficiency. There should be a useful and flexible sharing of results and experience in agriculture amongst the member countries of the South Pacific, with greater accessibility to published material.

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South Pacific Agricultural Research: A Review

Gabrielle J. Persley*

The Jackson Review of the Australian aid program recommended four geographic areas of priority for future Australian assistance (Anon. 1984a). The geographic areas, in order of priority, are: (i) Papua New Guinea and the small island states of the Pacific and Indian Oceans; (ii) Southeast Asia and the smaller states of South Asia (Bhutan, Nepal and Sri Lanka); (iii) China, India, Pakistan and Bangladesh; and (iv) other developing countries.

The South Pacific (encompassing Papua New Guinea and the small Pacific Island states) is an area of high priority for ACIAR. The purpose of this paper is to provide some information on the Pacific Islands and their agricultural sectors; outline current agricultural research and development activities in different countries; describe ACIAR’s current program in the South Pacific; and raise some policy issues.

Geographic and Economic Characteristics of the Pacific Islands

The Pacific Islands lie between 141 °E and 157 °W and 5 °N and 23 °S. There are 22 countries within the area of the South Pacific Commission, with a total population of 5 million. They comprise 1200 islands with a total land area of 550 000 km² set in 30.6 million km² of sea. Excluding Papua New Guinea, the remaining South Pacific countries have a population of 2 million, a land area of 88 000 km² and a sea area of 27 million km². Some of the key statistical features of the countries are given in Tables 1–5. More detailed information is available in the statistical summaries produced by the South Pacific Commission (Anon. 1984b).

The common features of the South Pacific countries are: their small size; fragmentation of land areas; the scattered nature of island communities; and their remoteness from major markets. The countries share common problems associated with their smallness and remoteness. However, their common features should not obscure the fact that there are major differences amongst the countries in culture, natural resources, topography, climate and stage of development.

Culturally, the major ethnic groups are Micronesians, Melanesians and Polynesians, with Fiji also having a substantial Indian population. Melanesians are the dominant group in the Southwest Pacific, in countries such as Papua New Guinea, Solomon Islands, and Vanuatu. Polynesians are the main ethnic group in the Southeast Pacific (Tonga, Western Samoa, Cook Islands, Tahiti). Micronesians predominate in the islands north of the equator.

In the agricultural sector, differences amongst the countries are a reflection of differences in topography, climate, land capability and natural resources, as well as the differences in the agricultural development plans and priorities of the various governments.

Topography

There is considerable variability in topography within the Pacific Islands. At one extreme lie the coral atolls, such as in Kiribati, Tuvalu and the northern Cook Islands. The atolls are deposits of rubble and sand with some rock and hard pan. Soil development is poor and agricultural potential is limited. Copra and fish are the only agricultural exports. Root crops and coconut palms are the major subsistence crops.

At the other extreme are the high islands, which are composed of volcanic hills, rising up to 2300 m in Papua New Guinea, and up to 1000 m in other island countries. The soils on the high islands are more fertile than those on the atolls and support a greater diversity of crops. Some land is suitable for commercial cropping (such as for sugarcane in Fiji), while other areas are suitable for tree crops such as cocoa and coffee (e.g. Western Samoa) or pastures (e.g. Vanuatu).

Rainfall

Another important variable is rainfall. Land use is closely related to rainfall. Kiribati and Tuvalu lie in a low rainfall area (1578 mm/annum on Tarawa Atoll in Kiribati; 700 mm/annum on Tuvalu). Western Samoa (3500 mm/annum), and Fiji (2940–3640 mm/annum) lie in high rainfall zones. Tonga receives moderate rainfall (1680–1990 mm/annum). Most South Pacific countries lie within the cyclone.
Three basic production systems in the South Pacific have been described by Yen (1980a). These are: (1) integral subsistence systems; (2) mixed subsistence/cash systems; and (3) plantation systems.

**Integral subsistence systems:** These are the traditional, self-contained production systems which incorporate a variety of food crops, particularly the starchy staple crops, tree and fruit crops (notably coconut), animal husbandry (particularly pigs and chickens), and fish.

**Mixed subsistence/cash cropping systems:** These systems combine the production of traditional food crops, fish and small animals with the production of cash commodities. Cash commodities may be either those produced solely for sale (such as...
vanilla, coffee and cocoa), or those produced both for domestic consumption and sale (such as coconut, fish and pigs).

The proportion of land devoted to cash cropping varies from year to year, depending on several factors, including the need for cash and the price of various commodities. These are now the most common systems in the Pacific Islands. The major change has been the reduced production of food crops, and the consequent increased purchase of food, particularly imported tinned food.

**Plantation systems**: These are large-scale production systems characterised by monocropping, capital input, centralised management, wage employment of labour and export of almost all production. Plantation systems were first used in the South Pacific for coconut and sugar cane. They were later extended to other commodities such as coffee and cocoa. Crops such as rice and oil palm are now also being produced in plantation systems in various countries. There is also increasing production of traditional staple crops such as bananas and root crops in small-scale plantations, for export. Cattle production and fisheries are also being conducted on a larger scale.

The traditional production systems were characterised by their small-scale nature, subsistence base and social orientation (Sevele 1980). These characteristics are retained in the mixed subsistence/cash cropping systems since certain cash crops fit easily into the traditional system of bush fallowing.

The traditional systems are well adapted to their environment, stable and productive (Fisk 1976). They involve some intricate methods of production of traditional crops, particularly root crops which are also important in fulfilling social obligations (Yen 1980b). They have led to the situation of subsistence affluence described by Fisk (1976). Food shortages are rare in the South Pacific.

The change from the traditional subsistence systems to the mixed subsistence-cash cropping systems reflects the social changes which have occurred in the South Pacific over the past century. An abundance of subsistence products will no longer satisfy the aspirations of Pacific Islanders. They also wish to have money and the products it can buy. The desire of Pacific Islanders to join the cash economy is demonstrated by increasing rural to urban migration, overseas migration, involvement in cash-generating activities, and consumption of imported goods, including imported food.

**Food Crops**

The staple food crops in the South Pacific are given in Table 6. The most important carbohydrate sources are the root and tuber crops, and certain trees such as sago palm and breadfruit. Coconut is an important subsistence crop as well as the dominant cash crop. The traditional food crops are

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**Table 3. Total South Pacific trade.**

<table>
<thead>
<tr>
<th>Country</th>
<th>Exports</th>
<th>Imports</th>
<th>Balance of trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Samoa</td>
<td>173 110</td>
<td>100 034</td>
<td>+ 73 076</td>
</tr>
<tr>
<td>Cook Islands</td>
<td>3 858</td>
<td>20 474</td>
<td>-16 616</td>
</tr>
<tr>
<td>Fiji</td>
<td>280 175</td>
<td>562 403</td>
<td>-282 228</td>
</tr>
<tr>
<td>French Polynesia</td>
<td>25 321</td>
<td>485 337</td>
<td>-460 016</td>
</tr>
<tr>
<td>New Caledonia</td>
<td>286 938</td>
<td>357 827</td>
<td>-70 889</td>
</tr>
<tr>
<td>Niue</td>
<td>454</td>
<td>2 952</td>
<td>-2 498</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>733 645</td>
<td>965 284</td>
<td>-231 639</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>58 136</td>
<td>66 636</td>
<td>-8 500</td>
</tr>
<tr>
<td>Tokelau</td>
<td>64</td>
<td>342</td>
<td>-278</td>
</tr>
<tr>
<td>Toaga</td>
<td>7 707</td>
<td>34 999</td>
<td>-27 292</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>36</td>
<td>2 592</td>
<td>-2 556</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>25 067</td>
<td>45 270</td>
<td>-20 203</td>
</tr>
<tr>
<td>Wallis and Futuna</td>
<td>0</td>
<td>5 540</td>
<td>-5 540</td>
</tr>
<tr>
<td>Western Samoa</td>
<td>9 612</td>
<td>59 910</td>
<td>-50 298</td>
</tr>
<tr>
<td><strong>South Pacific</strong></td>
<td><strong>1 604 000</strong></td>
<td><strong>2 710 000</strong></td>
<td><strong>-1 106 000</strong></td>
</tr>
<tr>
<td><strong>Regional Total 1981</strong></td>
<td><strong>1 604 000</strong></td>
<td><strong>2 710 000</strong></td>
<td><strong>-1 106 000</strong></td>
</tr>
</tbody>
</table>

Table 4. South Pacific exports by principal products (SA'000, 1981).

| Products                          | American Samoa | Cook Islands | Fiji | French Polynesia | New Caledonia | Niue | Papua New Guinea | Solomon Islands | Tokelau | Tonga | Tuvalu | Vanuatu | Western Samoa |
|-----------------------------------|----------------|--------------|------|-----------------|---------------|------|------------------|-----------------|---------|-------|--------|---------|-----------|--------------|
| Fish and seafoods\(^{(a)}\)       | 166 170        |              |      |                 |               |      |                  |                 |         |       |        |         |           |              |
| Bananas                           |                | 526          |      |                 |               |      |                  |                 |         |       |        |         |           |              |
| Fruit and vegetables              | 1 161          | 1 865        | 50   |                 | 132           |      | 111\(^{(b)}\)    |                 |         |       |        |         |           |              |
| Sugar                             | 137 043        |              |      |                 |               |      |                  |                 |         |       |        |         |           |              |
| Coffee, tea, cocoa and spices     | 2 696\(^{(d)}\) | 47\(^{(c)}\)  | 371\(^{(f)}\) | 150 400\(^{(g)}\) | 902\(^{(h)}\)  | 277\(^{(i)}\) | 1 108\(^{(k)}\)  | 1 238\(^{(l)}\) |         |       |        |         |           |              |
| Other crops                       | 10 021\(^{(m)}\) |              |      |                 |               |      | 26\(^{(n)}\)     |                 |         |       |        |         |           |              |
| Animal feed                       | 5 552          |              |      |                 |               |      |                  |                 |         |       |        |         |           |              |
| Copra                             | 268            |              |      |                 |               |      |                  |                 |         |       |        |         |           |              |
| Coconut oil                       | 6 620          | 4 591        |      |                 |               |      | 15               |                 |         |       |        |         |           |              |
| Palm oil                          | 18 471         |              |      |                 |               |      |                  |                 |         |       |        |         |           |              |
| Wood and by-products              | 2 063          |              |      |                 |               |      |                  |                 |         |       |        |         |           |              |
| Minerals                          | 12 376\(^{(r)}\) | 222 371\(^{(s)}\) | 388 898\(^{(t)}\) | 525\(^{(u)}\) | 465 | 407          |                  |         |       |        |         |           |              |
| Shells, coral, etc.               | 248            |              |      |                 |               |      |                  |                 |         |       |        |         |           |              |
| Other\(^{(x)}\)                   | 1 388          | 1 655        | 89 110 | 16 922          | 63 279      | 302 | 40 763          | 1 676         | 3       | 1 815 | 5       | 14 297  | 2 694     |              |
| Total                             | 173 110        | 3 858        | 280 175 | 25 321          | 286 938      | 454 | 733 646         | 58 136        | 64      | 7 707 | 34      | 25 067  | 9 612     |              |


Notes:

- (a) mainly tuna
- (b) mainly passionfruit
- (c) mainly taro
- (d) mainly ginger
- (e) vanilla
- (f) coffee
- (g) 64% coffee, 30% cocoa, 6% tea
- (h) cocoa
- (i) vanilla
- (k) 93% cocoa, 7% coffee
- (l) cocoa
- (m) molasses
- (n) honey and beeswax
- (o) mainly rice
- (p) desiccated coconut
- (q) wood products
- (r) gold
- (s) nickel
- (t) 98% copper ore & concentrate and 2% gold
- (u) gold
- (v) mainly cultured pearls
- (x) includes re-exports
Table 5. South Pacific imports by major commodity groups ($A'000, 1981).

<table>
<thead>
<tr>
<th>Group</th>
<th>American Samoa</th>
<th>Cook Islands</th>
<th>Fiji</th>
<th>French Polynesia</th>
<th>Caledonia</th>
<th>New Guinea</th>
<th>Solomons Islands</th>
<th>Tonga</th>
<th>Tuvalu</th>
<th>Vanuatu</th>
<th>Wallis and Futuna</th>
<th>Western Samoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Food</td>
<td>15 395</td>
<td>4 622</td>
<td>79 781</td>
<td>80 412</td>
<td>60 089</td>
<td>698</td>
<td>177 010</td>
<td>7 118</td>
<td>8 638</td>
<td>785</td>
<td>14 950</td>
<td>1 416</td>
</tr>
<tr>
<td>1 Beverages and tobacco</td>
<td>3 286</td>
<td>1 089</td>
<td>4 710</td>
<td>9 866</td>
<td>11 515</td>
<td>209</td>
<td>10 864</td>
<td>2 424</td>
<td>1 929</td>
<td>118</td>
<td>2 155</td>
<td>1 097</td>
</tr>
<tr>
<td>2 Crude materials</td>
<td>1 753</td>
<td>487</td>
<td>4 623</td>
<td>10 074</td>
<td>5 155</td>
<td>73</td>
<td>4 683</td>
<td>600</td>
<td>1 797</td>
<td>68</td>
<td>527</td>
<td>542</td>
</tr>
<tr>
<td>3 Mineral fuels etc.</td>
<td>45 057</td>
<td>4 160</td>
<td>144 271</td>
<td>61 752</td>
<td>100 542</td>
<td>563</td>
<td>205 205</td>
<td>15 376</td>
<td>5 745</td>
<td>421</td>
<td>8 012</td>
<td>1 000</td>
</tr>
<tr>
<td>4 Animal and vegetable oils and fats</td>
<td>1 626</td>
<td>108</td>
<td>6 145</td>
<td>2 240</td>
<td>1 500</td>
<td>5</td>
<td>2 434</td>
<td>337</td>
<td>38</td>
<td>6</td>
<td>260</td>
<td>341</td>
</tr>
<tr>
<td>5 Chemicals</td>
<td>3 012</td>
<td>1 250</td>
<td>38 883</td>
<td>24 617</td>
<td>19 841</td>
<td>146</td>
<td>58 492</td>
<td>3 855</td>
<td>1 888</td>
<td>114</td>
<td>2 858</td>
<td>1 442</td>
</tr>
<tr>
<td>6 Manufactured goods</td>
<td>10 453</td>
<td>4 110</td>
<td>92 748</td>
<td>78 809</td>
<td>45 777</td>
<td>411</td>
<td>136 377</td>
<td>12 249</td>
<td>6 590</td>
<td>405</td>
<td>5 116</td>
<td>248</td>
</tr>
<tr>
<td>7 Machinery and transport equipment</td>
<td>9 119</td>
<td>2 838</td>
<td>122 846</td>
<td>159 494</td>
<td>70 257</td>
<td>599</td>
<td>286 221</td>
<td>19 342</td>
<td>5 503</td>
<td>353</td>
<td>6 539</td>
<td>903</td>
</tr>
<tr>
<td>8 Miscellaneous manufactured goods</td>
<td>2 847</td>
<td>3 378</td>
<td>49 631</td>
<td>54 069</td>
<td>42 510</td>
<td>248</td>
<td>70 817</td>
<td>5 080</td>
<td>2 802</td>
<td>276</td>
<td>4 385</td>
<td>2 684</td>
</tr>
<tr>
<td>9 Miscellaneous transactions</td>
<td>7 485</td>
<td>61</td>
<td>18 764</td>
<td>4 007</td>
<td>642</td>
<td>—</td>
<td>13 183</td>
<td>255</td>
<td>68</td>
<td>46</td>
<td>470</td>
<td>531</td>
</tr>
<tr>
<td>Total</td>
<td>100 034</td>
<td>22 103</td>
<td>562 403</td>
<td>485 341</td>
<td>357 827</td>
<td>2 952</td>
<td>965 284</td>
<td>66 636</td>
<td>34 999</td>
<td>2 592</td>
<td>45 270</td>
<td>5 540</td>
</tr>
</tbody>
</table>

Table 6. The staple food plants of the South Pacific.

<table>
<thead>
<tr>
<th>Species</th>
<th>Common name</th>
<th>Centre of origina</th>
<th>Adaptation</th>
<th>Distribution&lt;sup&gt;(a)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocos nucifera</td>
<td>coconut palm</td>
<td>Oceania (?)</td>
<td>Coastal plain, extending inland, low altitudes usually below 200 m</td>
<td>All</td>
</tr>
<tr>
<td>Metroxylon sagu</td>
<td>sago palm</td>
<td>Oceania</td>
<td>Lowland and swamps, with tolerance to brackish conditions</td>
<td>PNG</td>
</tr>
<tr>
<td>Metroxylon salomonense</td>
<td>sago palm</td>
<td>Oceania</td>
<td>Similar to <em>M. sagu</em>, but has greater adaptability, growing on slopes up to 250 m, in high to medium rainfall areas</td>
<td>SI</td>
</tr>
<tr>
<td>Artocarpus altilis</td>
<td>breadfruit tree</td>
<td>SE Asia</td>
<td>Coastal, low altitude hills up to 300 m</td>
<td>All, but dominant in eastern SI, T, WS, CI, K</td>
</tr>
<tr>
<td>Musa spp. (2 forms)</td>
<td>banana</td>
<td>SE Asia</td>
<td>Coastal to 2000 m</td>
<td><em>Emusa</em> All <em>Australimusa</em> PNG, F, SI, WS</td>
</tr>
<tr>
<td><em>Emusa</em>, and <em>Australimusa</em></td>
<td>fe'i banana</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioscorea alata</td>
<td>yam, greater yam</td>
<td>SE Asia</td>
<td>Dryland, lowland to 1500 m</td>
<td>PNG, SI, F, T, WS</td>
</tr>
<tr>
<td>Dioscorea esculenta</td>
<td>yam, potato yam</td>
<td>SE Asia</td>
<td>Dryland, lowland to 500 m</td>
<td>PNG, SI, F, T, WS</td>
</tr>
<tr>
<td>Colocasia esculenta</td>
<td>taro</td>
<td>SE Asia</td>
<td>Varieties differentiated into adaptation to either high water table conditions (e.g. drained swamps) or dryland conditions in high rainfall areas up to 600 m</td>
<td>All (rare in K)</td>
</tr>
<tr>
<td>Alocasia macrorrhiza</td>
<td>giant taro</td>
<td>SE Asia</td>
<td>Widely adapted, coraline soils, tolerant to dry conditions but also grows in rain forest up to 1000 m</td>
<td>All but prominent in WS, CI, T</td>
</tr>
<tr>
<td>Cyrtosperma chamissonis</td>
<td>swamp taro</td>
<td>SE Asia</td>
<td>Adapted to swamps and high water table, brackish conditions; some forms thrive in volcanic mountain soils under managed forest. Used in atolls as one of few annual crops.</td>
<td>SI, K, unimportant in PNG, F, CI</td>
</tr>
<tr>
<td>Xanthosoma sagittifolium</td>
<td>Fiji taro, kongtaro, (many names)</td>
<td>America</td>
<td>Wide adaptation, lowland coastal to 1000 m</td>
<td>All but K; important in T, WS</td>
</tr>
<tr>
<td>Manihot esculenta</td>
<td>cassava, manioc</td>
<td>America</td>
<td>Wide adaptation, sandy to heavy soils, but prefers light alluvial. Best at less than 1000 m</td>
<td>All except K</td>
</tr>
<tr>
<td>Ipomoea batatas</td>
<td>sweet potato</td>
<td>America</td>
<td>Wide adaptation to 2500 m, sandy to heavy soils. Some tolerance to drought and cold, but killed by frosts</td>
<td>PNG, F, SI, CI, K</td>
</tr>
</tbody>
</table>

Source: Adapted from Yen (1980b)

Notes: (a) PNG - Papua New Guinea  
F - Fiji  
SI - Solomon Islands  
T - Tonga  
WS - Western Samoa  
CI - Cook Islands  
K - Kiribati
grown primarily for domestic consumption, with surplus being sold for cash. Most are grown in the mixed subsistence/cash cropping systems which have become dominant in the Pacific this century.

Cash Crops

The major cash crops in the South Pacific are coconut, cocoa, coffee, oil palm, and sugar cane. Other cash crops include rice (Papua New Guinea, Solomon Islands), vanilla (Tonga), chillies (Papua New Guinea, Solomon Islands), citrus (Cook Islands), bananas (Tonga, Cook Islands), and ginger (Fiji). The relative importance of the cash crops for export from various countries is shown in Table 4. Coconut is the only crop which is significant in all Pacific countries.

Livestock and Fisheries

Farmers in the South Pacific have traditional, subsistence animal production systems based mainly on domesticated pigs and chickens (Quartermain 1980). There is some commercialisation of pigs and poultry in Fiji and poultry in Papua New Guinea. Pig production is particularly important in the social and agricultural systems of most countries.

Government goals for livestock production include import substitution, reduction of prices for consumers, increase of rural incomes, improvement of animal nutrition, and development of species with export potential. Most emphasis is being given to the goal of reducing imports by increasing local livestock production.

Fishing is a major commercial and subsistence enterprise in the South Pacific since all the countries have a sea area many times greater than their land area. The utilisation of fisheries resources is becoming of increasing political interest in the region (see Copland, this volume).

Agricultural Research in the South Pacific

The differences amongst the South Pacific countries are reflected in their different approaches to agricultural development and their different priorities in agricultural research. The Pacific countries are facing common problems in agricultural development but they are seeking different solutions.

Agricultural research is conducted on a national basis by most South Pacific countries and on a regional basis by the University of the South Pacific, particularly the Institute for Research, Education and Training in Agriculture (IRETA) in Western Samoa, and the South Pacific Commission (SPC). There are also several international projects, mainly of regional ambit.

The status of agricultural research in the South Pacific has been described by the Internatinal Service for National Agricultural Research (ISNAR 1981). ISNAR has subsequently undertaken more detailed surveys of agricultural research in Papua New Guinea (ISNAR 1982a), Fiji (ISNAR 1982b), Solomon Islands (ISNAR 1982c) and Western Samoa (ISNAR 1983). ISNAR has also assisted Fiji and Western Samoa in the preparation of 5-year research plans, which identify priorities in agricultural research and personnel requirements.

The major constraints to agricultural research identified by an ISNAR team in 1981 are listed below. Although the ISNAR report was completed several years ago, the overall situation has changed little in the intervening period: (1) Staff constraints, specifically the lack of an adequate number of appropriately trained staff to conduct agricultural research; (2) Biological constraints, particularly the lack of suitable quarantine arrangements to allow the safe introduction of crop germplasm from outside the region and the interchange of crop germplasm within the region; (3) Policy and planning constraints, relating not only to agricultural research but to agricultural development policies, such as pricing and distribution of inputs; (4) Infrastructure constraints, such as inadequate facilities, equipment and transport; and (5) Organisational constraints, particularly the need to design appropriate research organisations for small countries; to reduce the isolation of individual scientists working in remote locations; and to provide adequate financial support for agricultural research.

Another important constraint is the lack of a close relationship between agricultural research and development in many Pacific countries. Many agricultural development projects have commenced with an inadequate research base, and have subsequently not been as successful as envisaged.

Agricultural research is generally not well supported and funded by governments. In times of financial stringency, agricultural research in the South Pacific (as elsewhere), is one of the early casualties.

The continual turn-over of staff in many countries affects the continuity of research. There are insufficient trained local scientists to meet the staffing requirements of the departments of agriculture. Consequently, many positions are filled by expatriate staff, often on short-term contracts. The
common term of 2-3 years is seldom sufficient time to complete a substantial piece of research, translate it into an improved agricultural technology, and write up the work in a permanent, available form.

In addition, research is only a small part of the brief of the departments of agriculture, whose staff are also responsible for agricultural development activities, quarantine, and other regulatory activities and extension. Thus the time and personnel available for longer-term research activities are limited.

**Policy Issues**

There are several policy issues which are being considered in the development of ACIAR's program in the South Pacific. These are described below.

**Bilateral or Regional Approach**

ACIAR needs to strike an appropriate balance of bilateral and regional activities. Under ideal conditions, one may favour regional activities in preference to bilateral. However, it is important to take account of the developmental priorities of individual countries, which often differ. In terms of the perceived priorities of the departments of agriculture in the South Pacific, there are surprisingly few areas of common interest. One approach which is being developed by ACIAR is to identify common themes, and to develop a series of bilateral projects around a single theme. Common themes include coconuts, biological control of insect pests and weeds, and farming systems.

**Economic Rationale**

The economic rationale of ACIAR activities in the South Pacific is particularly important. Research in the South Pacific needs to be closely linked to agricultural development. There are many interesting problems on which to work but few which are likely to contribute to agricultural development.

**Style of ACIAR Projects**

The style of ACIAR projects in the South Pacific needs to be different from projects in other countries. This is a reflection of the small size of the countries and their departments of agriculture; the few staff engaged in agricultural research (as distinct from development) activities; the lack of essential infrastructure and adequate research facilities in many countries; and the shortage of trained people available for research activities. ACIAR may need to place more research staff in-country on a short- or long-term basis, to work alongside the staff of the departments of agriculture.

**Training**

There are few local staff and a limited number of expatriate staff engaged in research. ACIAR will need to take a more active role in short- and long-term training, possibly in conjunction with the Australian Development Assistance Bureau (ADAB).

**ADAB/ACIAR Collaboration**

There are prospects for ACIAR to work with ADAB in some areas, where ADAB is interested in providing assistance to part of the agricultural sector, and ACIAR is able to contribute to the research relevant to development. ADAB has established a Pacific Regional Team who are responsible for the identification of development projects for ADAB. There would be advantages in ADAB and ACIAR working together when developing activities which have both research and development components.

**Relative Importance of Agricultural Commodities**

There needs to be an appropriate balance of activities in the various subsectors of agriculture, related to the importance of the commodities in the agricultural sector in the Pacific countries and their potential contribution to development. Crops are likely to remain significantly more important than livestock, both for domestic consumption and export.

**Conclusion**

The challenge to ACIAR is to identify agricultural research activities which will contribute to agricultural development in the Pacific Islands and which can be undertaken efficiently and successfully.

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Coconut Replanting in the Pacific Islands

John Raff*

The coconut (Cocos nucifera) is one of the world's most important and versatile trees and fully deserves the title 'tree of life.' There are approximately 8 million ha of coconuts grown in the tropical regions of the world, of which 600,000 ha are in the Pacific Islands. The coconut is an important crop in both the social and economic development of the South Pacific countries. At the national level, coconuts provide an important source of foreign exchange. At the village level the coconut is an integral part of people's lives, providing food, shelter and cash. Coconuts are predominantly a smallholder crop. Seventy per cent of production is derived from properties of less than 2 ha.

There has been little research on coconut palms in the Asia/Pacific region relative to the importance of the crop. This has been recognised by the Technical Advisory Committee of the Consultative Group for International Agricultural Research (CGIAR), which in a recent review on priorities in international agricultural research recognised coconut as being the oilseed crop most in need of international research support (Anon. 1985). International research on the crop is currently underfunded and has the potential for high payoff. Furthermore, coconut is a smallholder crop that fits a unique ecological niche and offers a broad range of dietary, income and employment opportunities.

There are several major problems facing the coconut industry. On international markets coconut is facing increasing competition from alternative crops such as oil palm and soybean. The productivity of many coconut plantations is declining. A major factor affecting the decline is the age structure of plantings, with well over 50% of plantings being beyond their normal commercial life.

The need for extensive coconut replanting has been recognised by both national governments and international agencies and a number of replanting schemes have been initiated. Generally the replanting schemes have had little impact on the smallholder sector of the industry. It has proved particularly difficult to encourage smallholders to replant using currently recommended practices and improved planting material.

The factors which motivate the smallholder to replant involve complex interactions between social, economic, and, in some countries, political factors. Part of the reluctance of smallholders to be involved in replanting schemes may be because some of the schemes impose specified replanting systems on the farmer. Much of the 'state of the art' technology for replanting is not relevant to the limited-resource situation of the smallholder. Many of the currently recommended practices are oriented more towards large-scale plantation farming rather than the limited-resource, smallholder sector of the industry.

Smallholders are an important but diverse section of the industry. The major questions involved in replanting are: (1) What is the best available planting material? (2) What nursery practice and replanting system is most appropriate to the needs of the smallholder? and (3) What supplementary sources of income are available during the non-productive period? Specific answers to these questions will vary in different locations. Hence there is a need to develop appropriate packages to assist the smallholders in each region.

Sources of Improved Planting Material

Research on genetic improvement of coconut has been dominated by the production and evaluation of coconut hybrids. Hybrids may be produced by crosses between dwarf x dwarf, tall x tall and, most commonly, dwarf x tall. The dwarf x tall hybrids have been of particular interest as they display both the early bearing characteristics of the dwarf types with the greater vigour and large nut size of the tall.

Much of the valuable work on hybrids has been conducted at the Institut de recherches pour les huiles et oléagineux (IRHO) research stations, particularly in the Ivory Coast, where there are large-scale, long-term, hybridisation programs. The hybrid produced by the cross between Malayan Yellow Dwarf and West African Tall (MAWA) has been widely distributed in Malaysia, Indonesia and the Philippines. Papua New Guinea is also producing coconut hybrids, mainly from the cross between Malayan Red Dwarf and Rennell Tall, but also by

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crosses between a range of other local and introduced varieties.

The scientific evaluation of the field performance of hybrids is still in its infancy. However, sufficient information is available to be cautious about the widespread planting of the present limited range of hybrids. Some of the difficulties identified to date include: (1) susceptibility to drought; (2) susceptibility to typhoon damage; (3) susceptibility to pests and diseases; (4) lack of local information on the performance of both exotic hybrids and hybrids between local tall and dwarf varieties; and (5) limited availability of hybrid seed nuts.

Hybrids have not been a significant seed source for voluntary replanting on smallholder properties in the Pacific Islands. Most smallholders replant with seed nuts from local high-yielding tall varieties, i.e. mother palm selection. There have been conflicting reports on the genetic gains derived from mother palm selection. Since this is such a commonly used system by the small farmer, it is an important area in which to conduct research to optimise the potential genetic gains.

Hybrids have not been grown in many Pacific Islands because they have not been available. In the past there has been considerable movement of seed nuts between countries. However over the last decade there has been increasing awareness of the serious diseases that may be transferred through seed nuts. Quarantine regulations now restrict the large scale introduction of material. In the future it may be possible to reduce the risk of the introduction of exotic diseases by transporting zygotic coconut embryos stored in vitro.

Tissue Culture of Coconuts

The technique of embryo culture has already been established for several coconut varieties by IRHO scientists. With further development and when used in conjunction with disease indexing techniques, embryo culture will allow the safe exchange of coconut germplasm between countries. ACIAR is presently supporting the development of embryo culture techniques for use in PNG and other Pacific countries. ACIAR is also supporting the development of improved indexing techniques for the cadang-cadang viroid, and the causal agent of Foliar Decay induced by Myndus taffini (FDMT) in Vanuatu (thought to be a virus), by Dr John Randles of the Waite Institute in South Australia, in collaboration with scientists at the IRHO Station in Sararou, Vanuatu and the Albay Research Centre of the Philippines Coconut Authority (Randles et al. 1987).

Another area of tissue culture which is likely to have considerable impact on the coconut industry is the vegetative propagation of coconut palms in vitro. Vegetative propagation may involve a range of techniques including embryo multiplication, meristem culture or embryogenesis.

Tall varieties of coconuts are outcrossing and therefore highly heterogeneous. High-yielding, early-bearing individual palms exist in tall populations. There would be obvious advantages in being able to propagate vegetatively individual outstanding trees.

Nursery Practices

Nursery practice is widely recognised as an important factor in coconut improvement. Current recommendations are based mainly on IRHO research. Selection is carried out on the germinating nuts. Seed nuts are placed in germination beds and the first 50% of tails and first 60% of hybrids to germinate are selected and the remaining nuts discarded.

The basis of selection on tall varieties is believed to be associated with the removal of nuts produced from self-pollination in individual tall trees. Hybrid seed nuts are first selected to remove non-hybrid seeds but the basis of the presently recommended 60% selection is not clear.

The nuts selected from the germination beds are then grown in either inground or polybag nurseries. Coconut seedlings grown in polybag nurseries are said to bear 6–12 months earlier than seedlings grown inground.

There are a number of problems with the polybag system for the small farmer. Polybag nurseries require considerable resources, including fertilisers, plastic bags and reliable irrigation. Because of their high capital expense, polybag nurseries are usually located at regional centres. Many small farmers live in isolated areas and it is impractical to transport heavy seedlings in polybags. It is more convenient to transport seed nuts. This necessitates the use of village nurseries. It is also difficult to convince the small farmer to discard 40% of seed nuts, particularly if they have been purchased and transported considerable distances.

There is a need to identify the key factors inducing early bearing in polybag nurseries and develop a new technology based on village nurseries rather than centralised nurseries.

Planting Systems

The currently recommended replanting systems of several major international organisations involve the removal of all palms before replanting. The
complete removal of palms is ideal for the establishment of young palms but it is not a system favoured by the small farmers.

A small farmer from the Philippines made the following comments on replanting systems involving total removal of all palms: (1) What would be his source of income for his family during the period until the new palms come into bearing? (2) If he removed all his trees at one time, the next replanting would only be required in 50 years and his grandchildren would not know how to replant; and (3) What would he use as an overstorey for his intercrops?

**Conclusion**

On small farms there is a whole diversity of ‘non-ideal’ situations and most management decisions involve compromise. There is a need to understand the practical constraints on small farmers and provide relevant information for the development of replanting systems which are suited to the small farmers' requirements. Key areas of current technology need to be identified and modified to gain maximum benefit in the ‘non-ideal’ situations commonly found on the smallholder properties.

Coconut will always be an important crop in isolated areas, particularly on islands where there are few alternative crops. However monocultures of coconuts may not be economically viable when farmers are close to markets and may grow a wide range of other crops. In this situation selection characteristics may need to be altered. The most economically desirable coconut may be selected on the basis of maximum yield with an open canopy that allows sufficient light penetration for the intercrop below. The future of coconuts on smallholdings will continue to involve gaining maximum output with minimal input. To achieve this it is necessary to optimise the efficiency of a biological ecosystem, and that is a very complex challenge.

**References**


Biological Control of Pests and Weeds in the South Pacific

D. F. Waterhouse*

A workshop on the biological control of the major invertebrate and weed pests in the Southwest Pacific was held from 16 to 26 October 1985 in Tonga. The workshop was sponsored by ACIAR, the German Agency for Technical Cooperation (GTZ), the Tongan Government, the South Pacific Commission and the UNDP/FAO-SPC Project for Strengthening Plant Protection and Root Crop Development in the South Pacific. The Commonwealth Scientific and Industrial Research Organization (CSIRO) Australia, the Department of Scientific and Industrial Research (DSIR), New Zealand, the Commonwealth Institute of Biological Control (CIBC), and the University of Hawaii provided biological control experts as speakers. Some 25 individuals from about a dozen Pacific countries participated.

The rationale for the workshop was that most of the major pests of the Pacific region were introduced. Most of them are unimportant or far less important in other parts of the world where they are controlled by natural enemies that did not accompany the pests into the Pacific. Classical biological control (the introduction and establishment of such natural enemies) has been found to be more often effective in island communities than in more complex large land masses.

Although there have been many biological control successes over the years in Hawaii and Australia, and also in the late twenties and early thirties in Fiji and a few other South Pacific countries, the results of attempts in the Southwest Pacific in recent decades have generally been disappointing. A major exception is the introduction and establishment of Baculovirus oryctes which, in many islands, has produced excellent control of the rhinoceros beetle, which can be a serious pest of coconut palms.

The many unsuccessful attempts at biological control in more recent times have been due to a variety of reasons, including the lack of suitably trained staff, the lack of necessary reference literature in most of the countries, inadequate planning and funding and a general lack of appreciation of some of the elements essential for successful biological control. Another problem has been the lack of readily available knowledge of exactly where in the region the various major pests occur, so that collaborative ventures have not been easy to plan.

Accordingly, ACIAR invited me to assemble the background information necessary for an effective workshop and to take overall responsibility for the program. The local organisation in Tonga was the responsibility of Dr D. Stechmann, leader of the Tongan-German Plant Protection Project.

The first major task was to identify the major invertebrate pests by consultations with the 17 participating countries (Cook Islands, Fiji, French Polynesia, Kiribati, Marquesas, New Caledonia, Niue, Papua New Guinea, American Samoa, Western Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna and Guam). The tables and distribution maps in which the results are summarised show the distribution and occurrence of the major insect pests and weed species. They have been rechecked with all participating countries and also with taxonomic and other experts elsewhere. These tables and maps of key pests dramatically highlight not only major quarantine risks, but opportunities for collaborative action.

In the foregoing survey all countries in the region were asked to assign a rating to their major pests and to indicate which they considered to be their top 10 most important arthropod pests and their top 10 weeds. When the results of this survey were compiled a group of 22 insect pests and 14 weeds stood out as being of prime importance. Dossiers were then prepared for each of these. The dossiers are designed to provide an overview of the origin, distribution, life history, pest status and natural enemies of each pest. The information on natural enemies includes data on their occurrence, and on their effectiveness if they have been used for biological control. The dossiers provide the basic information required by Pacific countries in deciding on the most relevant and promising targets to attack by traditional biological control means. The dossiers will be published in book form by Inkata Press on behalf of ACIAR in 1987. The proceedings of the

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The workshop will be published by GTZ and ACIAR in 1987.

In summary, the objective of the workshop was to provide a sound technical basis for decisions nationally and regionally on the biological control of the major pests of the region. The workshop critically reviewed the justification for biological control and also its procedures. It considered the dossiers and arrived at considered views on what projects should receive priority attention. Advice was given on information that must be included in any persuasive submission for funding by development agencies.