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OF WEST IRIAN

REPORT ON AGRICULTURAL PRODUCTION
IN WEST IRIAN

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Map of West Irian Frontispiece
Photographs - A series of photographs have been reproduced and are available in a separate folder.
CHAPTER 1

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

1.1 Introduction

West Irian is predominantly mountainous and lies just south of the equator. Its climate is humid tropical with little variation in weather throughout the year. Soils are generally poor and it has been estimated that only 3-5 per cent of the total land area is sufficiently fertile to support agriculture.

Cropping is at present largely limited to subsistence farming. In different parts of the province sago, sweet potatoes or rice form the staple food and a wide range of vegetables and fruits grow in suitable localities. Commercial plantings of cocoa, coffee, rubber and nutmeg have been made but where crops have been harvested yields have generally been low. Copra is produced mainly from wild stands of coconut palms.

Estimates of crop yield derived from various sources are given in Table 2.1 (page 13) together with suggested target yields for future projects. These target yields assume a reasonable standard of crop husbandry and the selection of localities best suited for planting the individual crops.

The main agricultural centres of production visited during the mission are described.

1.2 Possibilities for Development

The major factors which appear to limit agricultural development at the present time are:

(a) The problem of land ownership and frequent unwillingness of local tribes and individuals to transfer ownership of potentially
good land to Government so that it may be developed for agricultural production.

(b) The lack of capital among the local farmers, lack of credit facilities and shortage of development funds, particularly foreign exchange.

(c) Low education levels among local farmers resulting in lack of technical ability, as well as a frequent lack of enthusiasm for farming among local people. The shortage of foreign exchange limits the degree of mechanisation possible to overcome the shortage of good farmers and relieve the farmer of exhausting manual operations.

(d) The acute shortage of managerial and technical skills for project management and extension services.

(e) The difficult terrain resulting in very high cost of transport by river and road which is reflected in high production costs, making it difficult for West Irian to compete with other exporters.

Recommendations for assistance in the agricultural field assume that land ownership problems will be overcome, that credit facilities will be made available, that improved transport for produce will be provided and that the supply of trained technical staff will be gradually increased by expanding local training institutions.

Whilst most tropical crops grow reasonably well under West Irian conditions, little data is available on costs of production and returns. Of the cash crops cocoa, coffee, rubber, nutmeg, coconuts, castor, ground-nuts and corn show promise but the growing of some of these require greater agricultural skills than the local farmer at present possesses. A number of other crops merit further trial. Cultivation of rice in the southern swamp lands should be possible both to meet local requirements and later for export.
Besides the financial and exchange difficulties the problem of the irregular arrival of supplies makes the operation of mechanised equipment on any appreciable scale difficult and necessitates considerable capital being tied up in stocks of fuels and spare parts. To improve the farmers output and to lighten the more arduous cultivation operations the use of draught animals is recommended, as well as the limited use of light two-wheeled tractors where soil conditions are suitable.

1.3 Recommendations

Agricultural development for the production of export crops in the immediate future is envisaged as relying on schemes operated by local peasant farmers under close Department of Agriculture supervision. The availability of a sufficient number of trained staff from Indonesia for management and extension services is assumed as well as FUNDWI assistance to provide improved facilities for the training of farmers, improved road, river and sea communications and port facilities where these are inadequate.

Specific recommendations for assistance in agricultural development including the establishment of pilot projects to provide information for future development planning as well as the assignment of technical staff to advise in this field are as follows:

(a) Cocoa rehabilitation - A pilot project to rehabilitate the 680 hectares of cocoa in Japen Island is recommended. U.S.$ 50,000 of FUNDWI assistance is requested. If the pilot project is successful in raising yields to an economic level, the rehabilitation of the remaining 1,200 hectares in other localities would follow, which additional rehabilitation would involve a further U.S.$ 200,000 approximately.
(b) **Nutmeg and Mace** - It is recommended that the request by the Government of West Irian for assistance to increase production of nutmeg and mace be met. The assistance required is U.S.$9,000.

(c) **Kumbe Rice Project** - In view of the poor results from the pilot project and the uncertainties concerning large scale mechanisation in West Irian, it is recommended that the Kumbe Mechanised Project be abandoned.

(d) **Rubber production** - It is recommended that sufficient equipment be provided to tap existing mature rubber in 1968; and if the yields prove satisfactory that further equipment be provided to tap other planted areas as they reach maturity. The assistance required from FUNDWI for this project is initially U.S.$ 20,000 and a further U.S.$ 60,000 for areas at present immature.

(e) **Castor production** - The use of heavy mechanical equipment for castor seed production as proposed by the West Irian Government is not recommended, but rather the establishment of two pilot projects using existing light equipment. This will not require FUNDWI assistance but if results indicate that a large project is economically feasible then FUNDWI assistance will be required which it is estimated should not exceed U.S.$ 50,000 for a 1,500 hectare development project.

(f) **Groundnut and corn production** - These two crops are considered very promising and two pilot projects are recommended for which FUNDWI assistance of U.S.$ 18,000 would be required. If results justified rapid expansion of these crops then further assistance of U.S.$ 20,000 per year from 1970 onwards is tentatively recommended.

(g) **Fertiliser Trials** - In order to assess fertiliser response in areas selected for pilot projects a supply of fertiliser materials is necessary. It is recommended that FUNDWI assistance of U.S.$30,000 over the next 3 years be provided to purchase these materials.
(h) Pest, disease and weed control trials - It is recommended that FUNDWI assistance be provided to purchase equipment and materials for these trials at a cost of U.S.$ 20,000 over the next 3 years.

(i) Technical Assistance - It is recommended that the following specialists be assigned for 3 years to assist in establishing pilot projects and in development planning.

(i) An agronomist
(ii) An agricultural economist
(iii) A farm mechanisation specialist.

The team would with their counterparts and representatives of the Agricultural Department form the nucleus of a planning group. They would also maintain close liaison with the research officers of the Manokwari Research Station and in particular consider possibilities for improving the traditional system of shifting cultivation.

The services of consultants should also be available for short term assignments to advise on any specific problems that may arise. The cost of such technical assistance to FUNDWI would be U.S.$ 100,000 per year over the next 3 years.

(k) Research Station Equipment - It is recommended that FUNDWI assistance be provided for items requested under Education which are required specifically for agricultural research. The amount involved is U.S.$ 35,000.

(l) Reconditioning of Existing Agricultural Machinery - It is suggested that a list of spare parts needed to rehabilitate existing machinery be prepared as a first priority by the farm machinery specialist recommended under (j) above, and that FUNDWI assistance be provided to purchase such spares. The cost of these spares is provisionally estimated as U.S.$ 50,000.

(m) Meteorological Equipment - It is recommended that U.S. Weather Bureau Class 'A' evaporation pans be installed at all Agroclimatological
Stations. FUNDWI assistance to purchase the necessary equipment at an estimated cost of U.S.$ 3,000 is recommended.

(n) **Agricultural Training** - A reorientation of the curriculum in the agricultural high schools is suggested to provide a greater emphasis on practical work. FUNDWI assistance to provide equipment and materials needed is recommended.

Assistance by FUNDWI is also recommended to increase the staff of the University of West Irian Faculty of Agriculture to full establishment, to provide additional fellowships for the further training of graduates and to provide for visits by suitably experienced Indonesians or West Irians to the main crop producing centres overseas of special significance to agricultural development in West Irian. The allocation for this assistance must be decided in relation to assistance in other spheres of education.

The total FUNDWI assistance recommended for agricultural development projects over the next 5 years is shown in Table 4.1 (page 56). A definite expenditure of U.S.$ 535,000 is recommended for the first three years with a further U.S.$ 370,000 held in reserve for use if the pilot projects yield sufficiently satisfactory results to warrant the expansion of the recommended rehabilitation or development.
CHAPTER 2

PRESENT AGRICULTURE

2.1 Introduction

West Irian lies between the equator and latitude $9^\circ$S. The country is very mountainous with many peaks exceeding 3,500 metres. In many places the coastal plain is narrow or non-existent but on the north coast in the region between Sarmi and Nabire, and on the south coast between Kokonao and Merauke vast swamp areas occur.

The climate is humid tropical with rain at all seasons although in the extreme south near Merauke the months May to November inclusive are relatively dry. Temperatures average $26^\circ$C throughout the year with a diurnal range of less than $10^\circ$. In the Central Highlands the climate is cooler and average temperatures of the order of $18^\circ$C are typical. Monthly mean values of temperature, humidity, wind, sunshine and rainfall based on the climatological observations for the years 1961-1965 for selected stations are given in Appendix I. Tables 1.1 to 1.7.

2.2 Soils

The soils of West Irian are generally very poor having been mainly derived from parent rock low in plant nutrients and also having been highly leached by the abundant rainfall. Much erosion has occurred. In many areas soils are extremely shallow.

It is estimated by the Soils Division at the Manokwari Research Station that not more than 3-5 per cent of the total land area of West Irian has soils sufficiently fertile to support agriculture. This accords with a figure of 5 per cent for East Irian published in the I.B.R.D. Report on Economic Development of Papua and New Guinea.
Of the total area of land suitable for agriculture in West Irian a considerable proportion may only be used for subsistence agriculture by the population of the locality as difficulties of communications and transport preclude its use for growing crops for distant markets or for export.

The soils and localities where agricultural production is possible may be considered under three groups.

(a) **Soils of the North-west Coastal Region**

In this area discrete pockets of soils of fair to good agricultural potential are found both along the generally narrow coastal plain and occasionally inland as in the Sentani area. The area includes the adjacent islands of Biak and Japen. The soils range from clay loams such as occur in the Sentani Plain, at Serui on Japen Island and at Sjabes on Biak to the light sandy loam soils of parts of Nabire and the poor, light soils such as occur at the Manokwari Research Station.

These soils are generally high in organic matter when newly cleared and their continued fertility will depend on this organic content being maintained by suitable cropping practices. Generally the soils with higher clay contents will have the better potential and will be less liable to drought but some infield drainage is needed to avoid excessive waterlogging in the wetter months. On the lighter soils the use of fertilisers to maintain soil fertility will in the long run be necessary. The light soils of Nabire however appear exceptionally fertile and this area is considered one of the best for developing agriculture.

(b) **Soils of the Central Highlands**

A few pockets of fair to moderate soils occur in this region. The location of these is in all cases very isolated and they are unlikely
to offer any great scope for agricultural development apart from providing for the food needs of the local population.

(c) **Soils of the Southern Swamplands**

This very large area of alluvial soils includes extensive areas of good agricultural land in the Merauke region. The soils in this area consist of silty clays, often overlain with tropical peat in the low-lying areas and alternating with ridges of lighter sandy loam soils. They generally lie parallel to the coast and are derived from beach formation. The soils of this region generally appear very similar to those occurring on the coasts of Guyana and Surinam in South America which have been extensively surveyed. In those countries large drainage and reclamation projects have improved the potential of large tracts of agricultural land and it is thought likely that in the future similar schemes might be practicable in West Irian. The present system of soil classification by the Soils Division does not take into account the potentiality of the land if drained and a reclassification similar to that used for the F.A.O. Soil Survey in Guyana would probably reveal considerable areas suitable for development in the future should economically viable ventures materialise which would warrant the high development cost. These swamp soils are difficult to reclaim and in the case of the clay soils difficult to work but are generally suited to rice cultivation while the somewhat higher ridges could be used for arable crops, coconuts, and bananas.

Where the soils are overlain by tropical peat conditions are suitable for the evolution of acid clay soils with high sulphate content. Such soils referred to as 'Cat Clays' have been recorded by Reynders 1. In South America problem soils of this type have

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been studied by Cate and Evans\textsuperscript{2} and by Pons\textsuperscript{3}. With such soils extensive reclamation is unlikely to be economic.

Although Schroo\textsuperscript{4} found that the soils in this area have a saline groundwater in the drier months, salinity does not appear to be a problem at least for growing reasonably salt tolerant crops. Salinity however may well preclude the use of groundwater for irrigation making it necessary to convey irrigation water over considerable distances by canal from inland swamps or from rivers above the limits of sea water contamination.

A table compiled from data provided by the Soils Division at Manokwari showing the areas of land so far surveyed and classed as suitable for agricultural production is included as Appendix II. The data does not include land available in Biak and Japen Islands. Of the land in West Irian other than these islands a total of some 129,000 hectares would require little or no improvement to become suitable for agriculture and a further 27,000 hectares could be used for agriculture if extensive improvements such as drainage were carried out. Biak and Japen Islands may contribute a further 5-10,000 hectares and 3,000 hectares respectively.

2.3 Crops

At present agriculture is largely based on shifting cultivation locally known as ladang. Because of the poor soils and low standards of husbandry it is normally only possible to use the land for two or three years before declining yields and the invasion of lalang grass (\textit{Imperata cylindrica}) and other weeds forces the cultivator to move to a new patch of bush. The large area of land available and the low population density permits this frequent move which however involves the cultivator in a

\textsuperscript{2} Cate R. and Evans H. (1963) Symposium Agriculture in the Guyanas.
\textsuperscript{3} Pons L.J. (1963) Symposium Agriculture in the Guyanas.
great deal of effort in clearing new land. In the coastal swamp areas and particularly in the south coast regions the Sago Palm (*Metroxylon Rumphii*) grows wild and provides or provided until recently the staple food of the local people. Now rice (*Oryza sativa*) is fast taking its place although as yet relatively little is locally grown except near Marauke. In the Central Highlands the sweet potato (*Ipomoea batatas*) is the staple food crop and it is a popular vegetable elsewhere. In order to improve its nutritional value the research station has endeavoured to select sweet potato varieties having a higher protein content.

The diet is everywhere supplemented by vegetable and fruit crops suited to the local conditions. Numerous varieties of plantain and banana (*Musa sapientum*) are found. Cassava (*Manihot utilissima*) and Taro (*Colocasia esculenta*) are popular root crops. Onions (*Allium cepa*), Tomatoes (*Lycopersicum esculentum*), cucumbers (*Cucumis sativus*), corn (*Zea mays*), groundnuts (*Arachis hypogaea*), Sorghum (*Sorghum vulgare*), various legumes including *Phaseolus lunatus*, *Psophocarpus tetragonolobus*, Soya bean (*Glycine max*) and Pigeon pea (*Cajanus indicus*), Spinach (*Amaranthus oleraceus*), Chinese Cabbage (*Brassica chinensis*) and Kan-kun (*Ipomoea aquatica*) are among other vegetables cultivated. Fruits grown include *Citrus* spp. Pineapple (*Ananas sativus*) Pawpaw (*Carica papaya*), Breadfruit (*Artocarpus communis*), Guava (*Psidium guajava*) and Mango (*Mangifera indica*).

Near larger towns these crops are also grown on a small scale to sell in local markets. Prices particularly in Sukarnapura are very high. Appendix III gives a list of prices in Sukarnapura market. Most of the purchases in the markets are made by Indonesian families of Government officials and army personnel. The minimum wage of 5 W.I.R.\(^5\) for a single man or 7.5 W.I.R. for a married man means that the market prices are beyond the reach of local labourers.

In the coastal area cocoa, coffee, rubber and nutmeg have been

5. W.I.R. = West Irian Rupiah (10 Rupiah = 1 Dollar U.S.)
planted for commercial production but where these have been harvested yields have been low. Coconuts are harvested for copra but mostly from wild stands of palms where the very high plant population is a major cause of low yields. Agricultural demonstration gardens have been set up in the more important agricultural areas but even on these the standard of cultivation varies considerably and there is usually little attempt by the native farmer to emulate their practices.

Yield estimation under the present primitive conditions is often difficult. In Table 2.1 (page 13) estimates from a number of different sources are given for some comparisons. The final column suggests the level of yields which could be attained under good crop husbandry. These figures should be used for estimation purposes until further trials can be established to provide more reliable data.

Transmigration projects are being established in which farmers from Java are being settled. Here again the standards of agriculture vary considerably between projects. However, these transmigrant farmers are generally far in advance of the native farmers in ability and will provide a useful lead which the local people can follow.

2.4 Description of the Main Agricultural Production Centres

During the period of five weeks spent in West Irian an attempt was made to visit as far as possible all the more important centres of agricultural production. It was not possible to complete the full itinerary planned due to problems of aircraft availability, fuel supply and unserviceability of airstrips and roads. When visits were possible observations of growing crops were made and discussions were held with local agricultural staff and farmers on which the following descriptions are based.
### TABLE 2.1 Estimated Crop Yields under West Irian Conditions
(Kilograms per hectare)

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<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice Irrigated Mechanised</td>
<td>1,000</td>
<td>1,200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice Irrigated Non-mechanised</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upland Rice</td>
<td>750</td>
<td></td>
<td></td>
<td>2,500</td>
</tr>
<tr>
<td>Corn (Zea mais)</td>
<td>900</td>
<td></td>
<td></td>
<td>750</td>
</tr>
<tr>
<td>Legumes</td>
<td>400</td>
<td></td>
<td></td>
<td>2,000</td>
</tr>
<tr>
<td>Groundnuts (shelled)</td>
<td>800</td>
<td></td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>Soya bean</td>
<td>500</td>
<td></td>
<td></td>
<td>2,500</td>
</tr>
<tr>
<td>Castor</td>
<td></td>
<td></td>
<td></td>
<td>750</td>
</tr>
<tr>
<td>Copra</td>
<td></td>
<td></td>
<td>500-750</td>
<td>500</td>
</tr>
<tr>
<td>Nutmeg</td>
<td>c.150-200</td>
<td></td>
<td>950</td>
<td>750</td>
</tr>
<tr>
<td>Mace</td>
<td>c. 50 - 70</td>
<td></td>
<td>270</td>
<td>200</td>
</tr>
<tr>
<td>Rubber</td>
<td></td>
<td></td>
<td>500</td>
<td>750</td>
</tr>
<tr>
<td>Cocoa</td>
<td>c.220</td>
<td></td>
<td>390</td>
<td>500</td>
</tr>
<tr>
<td>Coffee</td>
<td>c.450</td>
<td></td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Tea</td>
<td></td>
<td>1,000</td>
<td>(experiment)</td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td>(result)</td>
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</tr>
</tbody>
</table>

At many sites it was noted that although such crops as cocoa, coffee and rubber as well as vegetables and fruit trees could be successfully established, growth and productivity were seriously retarded by lack of attention to field maintenance. In some cases crops seemed to survive
in spite of this. The value of training is seriously reduced by lack of performance records.

(a) **Sukarnapura area**

During the time available it was only possible to visit the agricultural area around Sentani. It was intended before leaving to inspect transmigration projects at Genjem and Arso but it was not found possible to charter an aircraft and it was anyway impossible to land at Genjem as the runway had not been cut as requested.

At Sentani an Agricultural Training School provides courses for students who have completed 6 years primary education. It has a capacity each year for 15 students who follow a 3 year course, consisting of lectures and practical work on land adjacent to the school.

Crops include vegetables, cocoa, coconuts, fruit trees, pineapples and maize. Standards of cultivation were generally low and machinery maintenance poor. No animals were used for cultivating although it would have been possible to obtain them from the livestock station nearby. There was little attempt at weed control and in an area recently ploughed for planting corn a large patch of lalang grass (*Imperata cylindrica*) was growing. This grass is a serious problem everywhere and in a nearby planting of Robusta coffee under light shade the coffee was dying out in a patch overrun with lalang grass. This coffee was too widely spaced and after 6 years had made poor growth. Experience elsewhere shows that if the crop had been hedge planted the higher plant population, easier maintenance and less need for shade would result in higher returns.

An eight year old planting of seedling rubber (*Hevea brasiliensis*) had never been tapped although trees were about 30 cm in diameter. A two year old coconut (*Cocos nucifera*) nursery needed planting out but no one was interested in collecting the young palms.
Several plots of cocoa under *Leucaena glauca* shade had grown well but had been severely neglected. A start had been made on weeding and pruning possibly because of our imminent arrival. The trees were spaced at 4 metres square which with the low branching habit and lack of regular formative pruning was too close. In the unpruned area the interlaced branches of the 10 year old trees prevented access for harvesting and made spraying impossible. The only way this could be overcome was by drastic tree surgery which must result in yield reductions. There were plenty of pods in all stages of ripeness but obviously harvesting was haphazard and no yield data was kept. No pest or disease control measures were applied and no fertilisers used.

Among other crops seen were a few plants of Black Pepper (*Piper nigrum*) and Vanilla (*Vanilla planifolia*) which appeared to be thriving.

For a school training personnel to fill junior posts in the extension service the standard of cultivation was deplorable. An adjacent school giving short courses for the upgrading of employees in the Agricultural Service was little better. At this school a number of Oil Palms (*Elaeis guineensis*) said to be 6 or 7 years old were growing. All were fruiting but no one seemed interested in this as a potential crop.

A visit to the nearby livestock centre was made but all the staff were away in Sukarnapura as we were not expected. At the Forestry Department nursery everyone had finished work and gone home it then being 11.30 hours.

Subsequently the Horticultural Demonstration Garden at Sentani was visited. Good tree fruit crops were seen, particularly oranges, bananas, guavas, rambutan (*Nepelium lappaceum*) and carambola (*Averrhoa carambola*). Robusta coffee was growing well and
fruiting heavily. All crops had prolific ground cover of Kudzu (Pueraria phaseoloides). This garden is also the site for a cocoa fermenting and drying unit. The equipment was adequate but at present unused. A native farmer's cocoa plantation was inspected and found to be so neglected and overgrown with weeds and bush as to make access impossible. This would seem to be the general condition of native cocoa in the area and it is not surprising that there is nothing to ferment.

The conclusion reached from these visits was that in the Sentani area, reasonable growth of cocoa, coffee, tree fruits and vegetables may be obtained under good crop husbandry. At present the standards of husbandry of both local farmers and some of the government institutions are very low. There is likely to be an expanding market for fruit and vegetables in Sukarnapura and most of the better land which is reasonably accessible is likely to be developed for these crops. The current price paid by the Department of Agriculture to the farmer for cocoa beans is 0.5 W.I.R. per kg of wet beans delivered to the fermenting station. This is equivalent to 15 W.I.R per kg of dry beans. Even with good crop husbandry the cocoa farmer would not earn more than 600 to 750 W.I.R. per year from a one hectare plantation, an area which is larger than the present average for a cocoa holding. Because maintenance is poor and yields are very low the income would be probably in the region of 200 to 250 W.I.R. per year. With the current inflated prices for food and other commodities this is an unattractive income compared with that to be obtained from a much smaller area of vegetables or even from wages earned as a labourer at 7.5 W.I.R. per day. Furthermore, there is little incentive for the local people to work for a money income because the shops are almost empty and it is impossible to buy even the simplest necessities.
(b) Biak area

Most of Biak island consists of infertile coral overlain by a thin highly acid layer of organic material on which cropping is virtually impossible. Near Sjabes an area of 600 hectares of better soil occurs which could be used for vegetable and fruit production. An area of ten hectares is being cleared by the Department of Agriculture for cultivation and one hectare is already cropped. Corn and ground-nuts were growing well and bananas looked promising. Other crops noted were onions, pawpaws, beans and chillies. A trial planting of upland rice had lodged badly and unless a shorter and stiffer strawed variety is introduced this does not appear to be a worthwhile crop. In view of the importance of Biak as a communications centre there is likely to be an increasing demand for fruit and vegetables and all the available good land will be required for these crops. Because the rainfall in the area is high (3,000 mm per year) and there is probably a loss of nutrients and organic matter from the soil the cultivation of legumes and green manure crops such as Kudzu and Calopogonium mucunoides during breaks in the crop rotation, together with the use of fertilisers to maintain soil fertility, is recommended. As the ground is undulating a ground cover is required to avoid the risk of erosion. At the Agricultural Department garden at Adebai a range of fruit crops is grown including oranges and other citrus spp., avocado pear (Persea americana), guava, pawpaw, soursop (Anona muricata) durian (Duria zibethinus), jak fruit (Artocarpus integrifolia) and pineapples are grown. Trial plantings of cocoa and rubber have been made but there appears to be insufficient good agricultural land available in Biak beyond that needed for fruit and vegetable production, for worthwhile planting of either rubber or cocoa.

Around the coast coconut palms are plentiful and appear to be
growing well, particularly on the offshore islands where the preparation of copra is an important activity.

(c) Japen Island

A visit was made to Serui where the Agricultural Demonstration Garden and a native cocoa farm were visited. The agricultural garden was badly tended. Most of the area was overrun with weeds and the growth of both corn and sweet potatoes was poor. The cocoa demonstration plot was completely neglected in spite of the importance of this crop to the area. A planting of dwarf coconuts was neglected but carrying a reasonable crop.

Japen is divided into three counties, East, West and South (Serui). The Serui county has between 70 and 80 hectares of native robusta coffee and 37 hectares of native cocoa. Each farmer has about \( \frac{1}{2} \) hectare of cocoa and almost all is mature. Estimates of yields for 1966 (obtained from the Agricultural Officer in Biak) were 150 kg per hectare of dried beans. The fermentation and drying station at Serui was inspected. Fermentation bins were adequate for at least 1 ton of wet beans per week but they could take 1\( \frac{1}{2} \) tons. Sun-drying is used exclusively although a heated drying platform was installed by the Dutch. The quality of the cocoa beans is poor with a high proportion of underfermented beans. It was suggested this was due to the farmers mixing Forastero and Criollo varieties. The native cocoa farm visited was at least no worse than the demonstration plot of the Agricultural Department. Two farmers were willing to talk of their problems but much of their conversation appeared to be complaints about the agricultural extension service which was lost in the translation. Farmers requested that tools be supplied and objected to delays in the payment made for their produce. The farmers also requested gifts
of consumer goods as an incentive to produce more cocoa. This form of incentive seems unsatisfactory and should in future be replaced by providing short term credit. Transport of beans to fermentation houses is a problem as is transport of fermented beans from the fermentation centres to Serui for final drying and export to Biak.

With a total area under cocoa of 681 hectares Japen Island is a major producing area but will require a considerable effort on the part of the agricultural extension service to raise production to reasonable levels.

(d) Nabire area

The crops seen growing in this area looked particularly good and the soil here is obviously favourable for development. The soils are generally light and suitable for cultivation by two-wheeled tractor. One such Japanese "Padtra" was operated by the Agricultural Department but as the equipment supplied was primarily intended for paddy cultivation it was not suitable for use with arable crops. Of particular note were some plantings of groundnuts and corn which looked exceptionally good. Yields of 5 tons groundnuts (in the shell) have been produced in a growing season of 100 days so that with reasonable standards of cultivation 2½ tons of shelled groundnuts and 2 tons corn per hectare should easily be achieved. Sorghum was also growing well but corn should give higher yields and be preferable as an export crop. Tomatoes were growing vigorously. However, the plant population was too high and sideshoots had not been removed. Consequently growth was too dense. Areas of upland rice were also seen. The samples of corn, rice and groundnuts produced were of a high standard. The agricultural extension service here is doing excellent work and should be encouraged to continue.
(e) **Manokwari**

In this area it was only possible to visit agricultural activities in the immediate vicinity of Manokwari. A visit to the transmigration project at Ransiki was deemed impossible as the airstrip was not usable and no boats were available to go by sea. Similarly it was not possible to see the cocoa planted at Warmare as a bridge half way along the road was said to have collapsed and no transport was available on the other side to complete the journey.

At the Manokwari Research Station the poor communications have resulted in the specialist research workers being out of touch with the problems of the extension service and of the farmers. It is at present impossible for specialists to visit problem areas and institute field trials. The station also seems out of touch with centres of agricultural research in other countries.

The Soils Department carries out soil surveys at a sample density of 1 site per hectare in areas previously selected from aerial photographs. The profiles are sampled at each horizon. The samples are analysed for chemical properties only, physical properties being ignored. At present no analysis for potash is possible as the flame photometer requires replacement parts.

There is no agricultural machinery specialist on the staff. The station's agricultural equipment is mostly idle awaiting spare parts, some having been inoperative up to four years. In the workshops there was a seed drill which had been there since the Dutch left and this had not been used although it is suitable for drilling vegetable and other seeds. No skilled operator seemed to be available.

Recently on the station more emphasis has been given to arable food crops than to perennial crops. Unfortunately the land selected
for food crop experiments and variety selection consists of a very poor, light and shallow soil and the results have been disappointing. It is evident that this soil is unable to maintain its fertility under continuous cropping. Shifting cultivation is normally practiced in West Irian to maintain a subsistence level of production, and would be the best method on this soil. The use of fertilisers to maintain soil fertility would be only of academic interest. Isolated communities could not use fertilisers for their food crop production.

Variety trials were being carried out with beans (Psophocarpus tetragonolobus), onions, squash, taro and upland rice. There was a trial comparing Malathion, DDT, Diazinon, Parathion and Lindane to control leaf beetle on cucumbers. Comprehensive and detailed records were being maintained but the sophisticated treatments under trial may be too advanced to be used by farmers most of whom use no insecticides at all. Moreover, Parathion is hazardous for farmers to use under primitive conditions.

Perennial crops were sited on very much better soils. Much of the area had been laid out by the Dutch. Cocoa was growing well in variety trials and spacing experiments. A spacing of 5 metres on the square appeared best. Yields of up to 1,000 kg/hectare have been obtained but at present heavy losses have occurred due to severe capsid damage to pods. The capsid species responsible was said to be Helopeltes but may have been Pseudodoniella. No insecticides are now available for control but B.H.C. and Carbaryl are said to be effective. Maintenance of cocoa was not good, water shoots were not removed regularly and there was no attempt at plantation hygiene. Eight full-time labourers were used on 12 hectares of cocoa which is about double the labour requirement on African plantations for the maintenance of

established cocoa. The best varieties were said to be Amelonado and I.C.S.I. Six year old rubber was growing well but had not been tapped as no equipment was available. Of the coffee plantings Robusta was making better growth than the Arabica at low altitudes. The coffee has been hedge planted at a spacing of 2 x 4 metres and this appeared to be a satisfactory plant density. Shading is necessary for both coffee and cocoa, the growth of coffee without shade being much slower. The cocoa on which shade had been removed showed the usual symptoms of dieback and weak flushing. Nutmeg five years after planting was well established under Leucaena glauca shade, although the spacing (4 x 4 metres) seemed rather close. A 2½ year old plantation of coconuts was well established with a cover crop of Calopogonium sp. and Mimosa pudica.

The few livestock kept on the station were generally disappointing, though the Bali and Bramah cattle were in fair condition. The pigs however were extremely undernourished.

In discussion with the research station staff it was evident that there is need for a more practical approach to agricultural experimentation. The collection of data on production costs and inputs and assessments of the economics of new agricultural techniques has largely been ignored. More research similar to that done by Soedjerwo on corn production is required with additional data on costs and returns. In this trial the best variety (Harapan) gave 1,600 kg/ha of corn without fertiliser, 2,400 kg/ha with 600 kg sulphate of ammonia, 250 kg phosphate and 120 kg sulphate of potash per hectare and 3,150 kg/ha with 20 tons manure per hectare and half the quantity of artificial fertilisers. This high response to fertilisers and organic matter is as would be expected in Manokwari soils. An analysis of labour requirements showed a total input

8. Soedjerwo, (1964) "Possibility of corn production in West Irian."
of over 300 man days per hectare, an astonishing figure.

The research staff considered that their most important function in the immediate future would be in introducing and testing new varieties and in seed multiplication for distribution. Previous efforts in this field have not been encouraging. The soils at Manokwari are unsuitable for seed multiplication. A substation was started at Waghete in the Central Highlands expressly for seed multiplication. With the present communications problem it cannot be adequately supervised and so far has produced only 2 kg of Chinese cabbage seed per year but is still kept in operation.

The Agricultural Faculty of the University is also at Manokwari. The staff at present consists only of the Principal and the research station staff assist with teaching. There appears to be too much theory and too little practical training in agriculture for the present needs of the country. This is a general fault at all levels of agricultural education. The aim should be to produce agriculturists with a knowledge of scientific method rather than scientists.

Also at Manokwari is a 7 hectares vegetable garden on land bought by the Agricultural Department from the local people for 25,000 W.I.R. At present $\frac{1}{2}$ hectare is cleared and cropped with the usual vegetables. Crops were infested with nut grass (*Cyperus rotundus*) which is likely to be a troublesome weed in vegetable cultivation in West Irian. No trials have been made to eradicate this weed with herbicides, although it seems likely that for vegetable production in the vicinity of the larger towns the use of herbicides could prove economic. Piped water is available in this garden and irrigation is essential in the Manokwari area on the light soils.
(f) **Fak-Fak area**

Due to lack of aviation fuel at Fak-Fak it was not possible to visit this area, which is the nutmeg producing centre.

(g) **Kaimana area**

Although the total area of land suitable for agriculture in this area is only some 30 hectares, the appearance of crops in the agricultural demonstration garden was very good. In particular cocoa looked good, one tree having a fine crop. Robusta coffee was the best seen anywhere and nutmeg was fruiting heavily. Cassava, sweet potatoes, caladi (*Colocasia*) and corn were all growing well and a magnificent bunch of bananas was observed. Along the shore wild coconuts were yielding well. A trial area of swamp rice has been established by the local Agricultural Officer, but this was too far away to see in the time available. Apart from producing the vegetable requirements for the village, the available area of good soils could produce a worthwhile crop of coffee for sale elsewhere in West Irian so providing a useful income in addition to that earned from copra.

(h) **Enarotalli in the Central Highlands**

This was the only settlement visited in the Central Highlands. Crops were disappointing, growth being poor and slow. At first sight the crops appeared deficient of nutrients, particularly nitrogen but it was reported that responses to fertiliser seemed small. Crops generally are unshaded and it seems probable that the poor growth and appearance is an effect of the high light intensity on clear days at this altitude (1,700 metres). Certainly Arabica coffee showed response to shade both from overhead shade and the effect of adjacent bushes. Unshaded tea
was making little growth. Corn also appeared better where shaded by adjacent tree crops. It would be worth studying the effect of shade on all crops in this area. If high light intensity is indeed the primary limiting factor a fertiliser response may also be achieved when shade is established. During our visit the area was very dry but during wet weather numerous surface drains are necessary to remove excess water. The present drainage layout seems unnecessarily complex and involves excessive labour. Although great effort had gone into the drain digging no attempt had been made to camber the intervening beds. It was alarming to see in this area of steep slopes and heavy rainfall that the main drains had been constructed straight down the slope with no cross checks to reduce water velocity. There is a grave risk of erosion and unless the layout is altered it is likely that in a few years what little fertile soil there is will be lost. The use of cover crops to avoid sheet erosion is also advocated. The conditions make the cultivation of vegetables, even just to meet local requirements, difficult and there seems little prospect for producing crops for outside markets. Where better conditions prevail Arabica coffee seems the most promising cash crop and the cost of transporting this by air to the coast might prove economic.

(j) Tanah Merah and Mindiptana

The experimental plantings of rubber at both these sites were visited. At Tanah Merah the 60 hectares of rubber was 4 years old and very spindly. About 2 per cent had been replanted. No cover crop had been established and lalang grass was beginning to take over. Besides the rubber planting the Agricultural Department was raising nutmeg, jakfruit and robusta coffee plants
for distribution and it was reported that 6 hectares had been planted in surrounding villages. There was an agricultural school for training local farmers on a 6 months course which had 24 students.

At Mindiptana some 200 hectares of clonal and seedling rubber had been established. Only half a hectare has been tapped for one cycle of 5 tappings. Yields of latex varied between 17 to 26 g per tree per day and averaged 19.75 g. A smoke house had been constructed to hold 200 sheets. Although the equipment available was not sufficient for the whole area, there had been no attempt to continue tapping even a small area using the knives, cups, latex buckets and single set of rollers available, to provide the necessary data on yields and production costs on which to decide future prospects for rubber.

(k) Merauke

The soils of this area consist of ridges of light sandy loam suitable for vegetable and fruit crops interspersed with lower lying less permeable soils well suited to paddy cultivation. The agricultural demonstration garden is located on one of the ridges of light soil. Crops of beans and corn were growing well and up to 4,000 kg shelled groundnuts per hectare have been obtained in experiments. During the dry season (June-October inclusive) irrigation is required. Citrus growth was fair but some dieback was occurring. Probably this crop suffers from the combined effects of waterlogging in the rains and drought in the dry season. A more extensive system of drains than is used at present should alleviate the waterlogging and the same drains could convey water in dry weather for sub-irrigation. Mangoes grow well and a planting of coconuts looked excellent. Machinery located at the
garden included a large 4 wheel tractor cannibalised to keep another tractor operating at Kumbe Rice Project, a small International Harvester tractor without any mounted tools, and 5 Japanese two wheel tractors (Iseki and Padtra) of which only one was in working order.

Nearby farmers were growing excellent rainfed rice achieving an average of 2,500 kg per hectare. Long strawed varieties are grown. These tend to lodge but higher yields should be possible with short strawed varieties. Good stands of corn and groundnuts were also being grown and excellent zebu cattle were being kept. The farmers are mostly of Indonesian origin, some of them having been in the area up to 50 years. Coconuts were seen in abundance everywhere.

The Kumbe Mechanised Rice Pilot Project was visited. This project on 288 hectares was laid out by the Dutch to provide data on water requirements and tractor and equipment performance for use in designing a 5,000 hectares project to grow rice for export to Europe. The Department of Agriculture has tried to continue the pilot project as a commercial rice producing enterprise, something for which it was never intended, and no records have been kept of water and other inputs used. Because of lack of fuel and spare parts the tractors are under-employed and in 1966 only 90 hectares were planted yielding no more than 1 ton per hectare. In 1967 the cultivated area is down to 48 hectares but there are large areas invaded by weeds so that the actual area of rice is probably about 30 hectares. Yields will if anything be lower than in 1966. Land is prepared by a disc ploughing and 2 harrowing operations using caterpillar D4 and D6 equipment. A 12 hectare field is ploughed in 4 days under dry conditions. The crop is sown by hand in March and harvested some
140 days later in August. A 1 1/2:1:1 NPK fertiliser is recommended at 350 kg/hectare but in 1967 it was reported that only a magnesium phosphate fertiliser was available and applied in the hope that it would give some response. Fertiliser is applied before planting. No hand weeding is done but the crop is sprayed with 2:4D using knapsack sprayers and applying 6 litres volume per hectare 1 month after planting. The application rate for 2:4D in lbs acid equivalent could not be ascertained. As there are no susceptible weeds to be seen the treatment was either very effective or there had been no non-graminaceous weeds in the first instance. There are no prophylactic treatments for pest control but outbreaks of stem borer are sprayed with Toxaphene.

Rainfall is supplemented by pumped irrigation there being two pumping stations providing a double lift from inland swamp areas. The pumping station inspected had 3 units of 14.5 HP each with a 4 metre lift. No information was available on pump output but probably each unit pumps 100 litres/second. There is a system of gravity drainage back to the swamp, the layout is complicated and not understood by local staff. It was first stated that there was no drainage but this statement was changed when the presence of a drainage canal was pointed out. Irrigation continues until after flowering and then stops to allow the fields to dry out for harvesting. The canal sluices are equipped with Parshall flumes for flow measurements but here again their operation was not understood by the local staff.

Harvesting is carried out by Claey's 5 metre cut combines. Only one out of three combines was in working order, because of lack of spares and particularly of 'V' belt drives on the drum. There is a drying unit and bin storage for at least 100 tons of paddy. The rice
mill has an output of 0.25 tons/hour and the milling factor is 45 per cent. The grain is dried for 36 hours removing about 10 per cent by weight of moisture but the final moisture is not tested. There is a very high proportion of broken rice and most of it was found to be broken before milling. It seems likely that sun-cracking or overdrying is responsible for this excessive breakage.

During the tour of the project a drag line excavator was seen. This was said to be in working order although it had been left in the open and was overgrown with vines.

As a pilot trial this project is serving no effective purpose and as a commercial rice enterprise it is proving to be a very costly venture. Although fuel was said to be in short supply the whole housing compound had been recently weeded by a bulldozer.

Adjacent to the Rice Project is a Transmigration Settlement which has been operating for one year. It is very clean and tidy and crops of groundnuts, corn, onions and beans were good. Bananas and pawpaw were growing well. Each settler has a $\frac{1}{3}$ hectare house lot on which to grow vegetables and will also have 1$\frac{1}{2}$ hectares of rice but so far this has not been cultivated. If these settlers were given the Rice Project land and irrigation water they could produce 3 tons paddy/hectare. This transmigration project and others like it are an excellent example for the local native farmers to emulate and probably will have a greater impact than the agricultural extension service is achieving at present.

At Kuprick village excellent crops of groundnuts, corn and coconuts were seen on the light loamy soil. Cultivation was by Javanese farmers who had lived for many years in the area. Their efficiency varied but the general appearance of their crops was very much better than those of the local farmers on adjacent land. Rice was growing well but was infested with Paddy bug (Leptocorisa varicornis). Yields of 2$\frac{1}{2}$ tons/hectare are claimed on rainfall alone.
A transmigration project at Kuprik had been established for only four months. Planting had been hurried in order to catch the end of the rains and crops were only fair but should be much better next year.

Throughout the Merauke area cattle are plentiful and in good condition and are increasing rapidly. They offer a more reliable source of power for tillage operations as their use avoids the risk of periodic shortages of spares and fuel caused by the irregular deliveries to this isolated region.
CHAPTER 3

POSSIBILITIES FOR DEVELOPMENT

3.1 Limiting Factors

At present agricultural development and the rate at which it proceeds is limited by a number of factors.

a) Land availability

The land in West Irian is owned either by the tribe or by the individual. There seems to be some uncertainty about this and the customary rights vary from one locality to another. Much of the land suitable for agricultural development is at present uncultivated and the owners are neither prepared to cultivate it themselves nor to permit others to do so. When land owners are prepared to transfer unused land to Government for project development the price asked, often in terms of foreign exchange goods such as outboard motors or cars is high. Even after transfer of the land to Government ownership may be disputed and in some cases after clearing has been carried out the Agriculture Department has had to abandon a project and relinquish the land to the original owner who then lets it revert to bush. In a country where good agricultural land is in such short supply this situation is irrational. In many countries it has been made necessary to demonstrate recent cultivation of land in order to establish occupation rights and even used and occupied land may be compulsorily purchased if required for project development. Some legislation to enable Government to take over at least land not presently in use or insufficiently developed might be considered. Otherwise the shortage of suitable land may well become the major limiting factor in expanding agricultural development.
b) Capital

In West Irian many people have not yet changed or are only now changing from a barter to a monetary system of trade. In these circumstances most potential farmers have no capital with which to finance agricultural operations and there are no facilities at the moment for providing credit. Government too has limited resources and the agricultural sector is only one of many demanding capital for development purposes. Shortage of foreign exchange in particular is acute. There seems little prospect in the immediate future for any marked change in the situation and development projects which place heavy demands on capital and foreign exchange will have to be deferred. Clearly agricultural development cannot be planned in isolation from the other sectors such as industry and mining, and a national plan for the allocation of financial resources is needed.

c) Manpower and Management

Of the total West Irian population of 750,000 many live in remote areas where only subsistence agriculture is possible. In areas where development of agriculture is feasible a considerable proportion of the potential labour force is unwilling to work as farmers. By some people agriculture is considered to be a degrading job and some operations are regarded as "woman's work". Hunting and fishing are better occupations for men. As in many other countries especially in the tropics a high premium is placed on leisure. The result is that it is difficult to find a sufficient number of industrious farmers prepared to put in the work necessary to ensure reasonable crop yields. Others who take up farming but do not work regularly become discouraged when yields are poor.

The general standard of education in adults is very low and this is reflected both in the low technical ability of the farmer and in the acute
shortage of people with the management and technical ability needed
to man the extension and research services and to supervise develop-
ment projects.

The use of mechanisation as a means of overcoming the shortage
of good farmers conflicts with the need to conserve foreign exchange
as well as increasing demands for scarce skilled personnel for
employment in the operation and maintenance of mechanical equipment.
The use of draught animals in agriculture is as yet largely untried and
could relieve the farmer of much of the more exhausting manual work
at present used in crop production. This and the limited use of small
agricultural tractors as a complement to and not a replacement for the
efforts of the farmer seems to be the only possible solution.

Management and technical skills can only be developed by training
and practical experience over a number of years. Although the
numbers of skilled West Irians will thus gradually increase the country
will continue to rely heavily on an increasing number of skilled and
experienced Indonesians being available to both Government and to the
private sector.

d) Export Markets

Whilst the need is great to develop the production of cash crops
for export in order to generate foreign exchange West Irian has to
compete with other countries which have considerable advantages in
factors affecting the economics of crop production. Although labour
costs in West Irian are not high in comparison with other countries
this is offset by the high cost of transport by river and road which
must increase the production costs of export commodities.

As a result of the above limitations crops requiring high inputs in
terms of labour, technical skills, capital and foreign exchange, which are slow
in providing a return on the capital invested, and for which the foreign market
is highly competitive are unlikely to be immediately successful under West
Irian conditions.
The use of FUNDWI resources to provide foreign exchange for the purchase of equipment and agricultural materials will not in itself result in a lasting improvement in the agricultural sector of the national economy unless expenditure in other sectors alleviates these limitations. However, the projects here recommended should provide a good deal of basic knowledge and experience which should be of great value for planning the ultimate agricultural development of the country.

In recommending FUNDWI assistance in establishing the proposed agricultural development projects, it is assumed that land ownership problems will be tackled and that the shortage of local capital and agricultural credit both long and short term will be rectified. FUNDWI assistance to improve communications and education is also being assumed so as at least to reduce the limitation imposed by inadequate transport facilities and in the longer term by the lack of technical skills and managerial ability. The establishment of successful development projects will depend on overcoming the indolence and poor husbandry of the local farmers and also of the lower levels of the agricultural extension service demonstrated by the neglected state of farms and of agricultural demonstration gardens. The agricultural training establishments will have an important influence on future development but the courses they provide will have to place a greater emphasis on practical agriculture and commercial crop production.

3.2 Possible crops

In planning for agricultural development generally and more specifically when assessing the merits of individual projects it is essential to know the agronomic and economic potentials of the individual crops and envisaged rotations.

In West Irian the information on potential crop yields is somewhat unreliable and it is apparent that the data provided by Government is largely of an estimated nature and does not represent, as the presentation would lead
one to assume, actual returns for each year. Furthermore data on such inputs as labour, machinery, fertiliser and other supplies and their cost is completely lacking. In such circumstances it is difficult to forecast the costs and benefits of any proposed development plan. To spend scarce foreign exchange on developing agricultural projects without a preliminary feasibility study based on reliable information cannot in the circumstances be justified. For this reason the majority of the proposals in the form put forward by the West Irian Government cannot be immediately assessed but must await the results of pilot projects laid down specifically for the collection of the necessary data.

There is no doubt that the crops suggested in the Government proposals, as well as other crops for which no specific proposals have been put forward, can grow reasonably well under local climatic conditions and in those areas where soils are favourable. In some cases, however, the relatively high level of agricultural skill required in order to ensure a satisfactory level of production makes it doubtful if such crops can at present be successfully grown by the average local farmer. The following is an assessment of the merits of individual crops.

**Cash Crops**

a) **Cocoa** - Although visits to all the major cocoa growing areas were not possible, in the areas visited the very low standard of crop husbandry practiced by the great majority of cocoa farmers and in some cases even by local agricultural officers in their demonstration gardens makes it seem unlikely that satisfactory returns can be achieved at present. The present yield of 150 kg/hectare in Japen Island and elsewhere compares with yields of 3 times this figure or higher in other countries using peasant farmer production methods. The present price paid to the producer in relation to current prices of consumer goods in West Irian provides little incentive for him
to make greater efforts to increase his yield. The poor quality of
the produce and particularly the lack of uniformity in fermentation makes
it improbable that West Irian cocoa could compete favourably with other
producers in the highly competitive world market. The very considerable
price fluctuations of cocoa over the last twenty years also makes this crop
rather unsuitable for West Irian under present conditions. If well grown
and fermented cocoa could, however, provide attractive returns to
the farmer and the crop should not be abandoned before sufficient
information has been collected on costs of rehabilitation and on potential
yields to enable its possibilities to be assessed on a more reliable basis.
It is considered that with good husbandry, proper pruning and the
appropriate pest control and crop hygiene measures yields of 500 kg/
hectare could be achieved.

b) **Coffee** - This crop was growing well in some locations, notably at
Kaimana and on some soils at Manokwari. It is easier to cultivate
than cocoa and does not require as much care in processing. Certainly
Robusta coffee is a promising crop for consumption in West Irian
thereby achieving a degree of import substitution. The possibility of
growing high quality Arabica coffee in the central highlands should be
further pursued by the Research Division. For estimation purposes
a yield potential of 500 kg/hectare may be assumed but some coffee
seen was producing considerably more than this.

c) **Rubber** - This crop makes moderately good growth but its yield
potential cannot be assessed from the little information at present
available. Unfortunately much of the rubber planted has been seedling
material, and if rubber is to be grown successfully in West Irian it
will be necessary to use the high yielding clones being used in other
rubber producing countries. Stocks of high yielding clonal material
should therefore be built up for trial and for future planting.
Meanwhile existing plantations should be tapped as they become mature to provide at least some data on yields and production costs, as well as to provide training in rubber production and processing for local farmers and departmental staff. Although sheet rubber has been produced at Mindiptana the sheets have been substandard in size and quality. It is thought that yields from existing rubber at Mindiptana could be 750 kg/hectare but rather lower elsewhere.

d) **Nutmeg and Mace** - It was not possible to visit Fak-Fak but from young nutmeg seen at Manokwari and young trees in production at Kaimana it is certain that this crop is suited to these localities. Development should go ahead subject to the limitations, if any, in world demand for these products. The stands were too immature to enable reliable estimates to be made of potential yields. Present production figures given by the Agricultural Bureau are very low and are only about a fifth of the production reported by the Dutch. Under good cultivation by peasant farmers a tentative yield figure of 750 kg/hectare for nutmeg and 200 kg/hectare for mace is suggested.

e) **Coconuts** - No figures were provided of present production and it would be difficult to estimate this as the greater part of the production is from palms growing wild in very overcrowded stands. Under these conditions yields are very low and the agricultural extension service has difficulty in convincing the local people that thinning to a reasonable plant density would result in substantial yield increases. Where soils are suitable and plantings of early maturing varieties at proper spacings of 8-10 metres have been made the crop is obviously much better. Present yields are of the order of 500 kg/hectare of copra but with new plantings and with proper management on lighter, well-drained soils, particularly in the Merauke area yields of 1 ton/hectare of copra should be possible.
f) **Castor** - This is a relatively new crop in West Irian and data from trials is lacking. Therefore it is difficult to assess what its local performance will be under commercial practice. Proposals to produce this crop using heavy tractors and mechanical equipment would seem doomed to failure after the Kumbe Rice Project experience with mechanised agriculture and if any mechanisation has to be considered then wheeled tractors should be used. Until the trial plantings started in 1966 have produced sufficient data it is not possible to assess the potentialities of this crop though there should be good prospects of its succeeding particularly on the silty soils around Merauke.

g) **Groundnuts** - Although no proposal has been put forward for expanding the production of this crop the excellent stands of groundnuts seen indicate that this should be a very promising crop for West Irian. The lighter soils are the more suitable ones particularly in the Nabire and Merauke areas, where yields of 2\(\frac{1}{2}\) tons/hectare of shelled nuts should be readily achieved. In order to ease the work of land preparation the use of draught cattle for ploughing or mechanisation based on light two-wheeled tractors should be considered under these soil conditions.

h) **Corn** - From the crops seen corn also appears to have a good potential, and seems well suited to those soils for which groundnuts are recommended and especially in rotation with groundnuts would simplify weed control. Yields of at least 2 tons/hectare should be possible though with fertilisers and the introduction of higher yielding varieties yields could be considerably in excess of this figure. Cultivation would be by draught animal or by light tractor as suggested for groundnuts. The present demand for grain for stock feed in Japan should result in a ready export market.
j) **Other possible cash crops**

The following additional cash crops are considered suitable for various parts of West Irian and small trial plantings should be made to assess their potential.

i) **Oil Palm** (*Elaeis guineensis*) might be an alternative to rubber on the soils suitable for the latter in the south of West Irian providing sunshine is adequate. High yielding planting material from Malaya should be imported for trial.

ii) **Black Pepper** (*Piper nigrum*) should be suitable for the Sentani area.

iii) **Vanilla** (*Vanilla planifolia*).

iv) **Yams** (*Dioscorea* spp.) besides being a food crop can be used for the extraction of dioscorin, a starting material for the manufacture of cortisone. The crop would be suitable for native cultivation.

v) **Fibre crops** (*Hibiscus cannabinus* and *Urena lobata*) should be tried as possible crops for future development.

vi) **Tobacco** (*Nicotianum tabacum*) was seen in a few localities. Production to meet local requirements would save foreign exchange and overseas tobacco companies might assist in research. Tobacco consumption is high at present and tobacco is also an important barter commodity.

**Food Crops**

a) **Rice** - will be the major food crop in the future and the area cultivated must be rapidly expanded. It is particularly suitable for the heavier soils and lower lying areas. The Merauke area will be the major centre of production. Preparation of the land may be by
hand or by the use of draught animals as in other eastern countries. The introduction of light tractors may come at a later stage but the use of heavy equipment to produce rice for local consumption cannot be justified in view of the large amount of foreign exchange involved. There are possibilities that considerable areas of swamp could be empoldered and reclaimed for rice production for export to neighbouring islands where over-population will result in serious food shortages in the foreseeable future. A feasibility study to consider the economics of such swamp reclamation schemes would have to be made in the first instance.

b) **Other food crops**

The expansion of the area planted to food crops other than rice, particularly leguminous crops is recommended in order to increase the production of food and especially so that a higher standard of nutrition can be attained. An adequate range of crops is available but the right cultivation techniques and crop varieties suitable for local conditions will have to be evolved, particularly for the Central Highlands where there is need for the selection of varieties adapted to higher altitudes and where the use of shade and fertilisers requires further investigation.

3.3 **Mechanisation**

The wisdom of investing in any large scale mechanisation of agricultural production in West Irian has already been questioned. Aside from the financial and exchange difficulties there will be the difficulties caused by the lack of internal communications and by the relatively infrequent deliveries of supplies from overseas. Because of these irregular supplies the operation and maintenance of the mechanical equipment can only be assured by carrying larger stocks of fuels, lubricants and spare parts at each centre of production. Thus the capital
tied up in such stocks would be appreciable and would be an added strain on the prevailing scarcity.

On the other hand the work output of the local farmer on the more arduous hand cultivation operations is low and the use of some means to increase his output must be encouraged if increased production is to be obtained. It is recommended that a much greater reliance be placed on the use of draught animals. Recent developments in the design of animal drawn implements and the design of an improved harness has led to a considerable increase in the output per animal.

The breeding and multiplication of suitable animals and their distribution to centres of agricultural production will require the assistance of the Livestock Division. At present only in the Merauke area are there any number of cattle available. It will also be necessary to instruct the farmers in the management and training of livestock for this role.

On light well-drained soils the use of small two-wheeled tractors for arable crops is also proposed. Where these or four-wheeled tractors are used, however, adequate stocks of fuels, lubricants and spare parts must be maintained.

There are at present large numbers of tractors of various makes lying idle due to lack of spare parts. The Agricultural Department was asked, through the counterpart officers accompanying our mission to provide a list of the spares needed to put these machines in working order. This was not provided and the time available did not permit a thorough examination of each machine seen. But it was clear that much of the equipment could be rehabilitated without difficulty if the necessary spares were provided.

9 Hawkins J.C. (1966) "Systems of Mechanisation for agriculture in developing semi-arid countries".
CHAPTER 4

RECOMMENDATIONS

4.1 General

The mission saw little of the subsistence farming of West Irian. Although the total production from this greatly exceeds that from plantations and from the Department of Agriculture plantings of cash crops, the improvement of subsistence farming will be slow. As there seems to be little possibility of private enterprise becoming interested in the production of export crops until these have been shown to be economically attractive it is envisaged that in the immediate future agricultural development in this type of production will have to rely on schemes operated by local peasant farmers growing the crop appropriate to each locality under close Department of Agriculture supervision.

The success of such development schemes will depend on there being a sufficient number of Indonesian agriculturists available for their management, as well as of properly trained extension service staff. The training of the peasant farmers will also be an important factor in increasing output and it is assumed that FUNDWI assistance will be provided for this purpose.

The present poor road and river communication facilities make access to some development projects virtually impossible and here again FUNDWI assistance will be required to improve these facilities and to provide additional shipping and port facilities where these are at present inadequate.

In view of the shortage of information on inputs and crop yields the recommendations given below are for assistance in the establishment of pilot projects, in providing equipment, and materials for agricultural investigation purposes during the next 3 years, and for the assignment of three specialists to advise on various aspects of the recommended programme.
It should be recognised that any commercial production in these pilot projects will be subordinate to the investigation aspects. The aim is to lay a foundation for future development.

The members of the team, all of whom will be experienced in tropical agriculture will during their 3 year assignment devote attention to the wider aspects of the agricultural development of West Irian, and as the results become available from the various pilot projects and studies, help to draft the outlines of an agricultural development plan.

4.2 **Cocoa Rehabilitation**

The Government of West Irian has requested FUNDWI assistance to rehabilitate 1888 ha of cocoa at a cost of U.S.$ 418,320. At present yields are low and maintenance has been completely neglected. There is no data available on which the future commercial potential for cocoa in West Irian may be assessed.

Rehabilitation would entail clearing the weeds and regenerated bush which has been allowed to infest the areas, extensive pruning of the cocoa and of the shade trees and the institution of a regular spraying programme to control the pest infestations which have been allowed to build up. In order to achieve higher yields the use of fertilisers and the carrying out of proper crop hygiene will be necessary. With improved yields the existing fermentation and drying facilities would be inadequate and additional facilities would need to be provided.

It is proposed that a pilot rehabilitation project be carried out to provide information on the economics of rehabilitation and the 680 hectares of cocoa on Japen Island is suggested as a suitable location for this pilot scheme. With the equipment recommended below the Agricultural Department should endeavour to raise cocoa yields from the present 150 kg to
500 kg per hectare. Data should be collected on costs of production and rehabilitation. After 2-3 years the success of the rehabilitation programme should be assessed and a decision made on future cocoa development. If prospects are favourable further financial assistance should then be provided for rehabilitation of the other cocoa areas.

The suggested equipment to be provided by FUNDWI for the 680 hectare pilot project is as follows:

(a) A boat to carry 4-6 persons, driven by a 40 H.P. outboard motor, for transport of agricultural extension service personnel by sea between cocoa growing locations and Serui.

(b) Additional cocoa drying facilities at Serui comprising:
   1 Rotary Drier
   1 Sliding roof Sun Drier.

(c) Equipment for farmers comprising:
   600 Pruning Knives
   300 Secateurs
   600 Spades.

(d) Equipment for pest and disease control comprising:
   12 Motorised knapsack sprayers/dusters
   24 Pressurised knapsack sprayers complete with long lance extensions, range of cone jet nozzles
   6 Charging pumps and adequate spare parts.

(e) Insecticides, fungicides and fumigation materials during the first year comprising:
   B.H.C. 5% W.P. 500 kg
   Rogor 40 2,000 litres
   Dieldrin 20% E.C. 2,000 litres
   Copper Fungicide 500 kg
   Methvl Bromide Fumigant 100 kg
The quantities could be repeated or modified according to need in subsequent years.

The West Irian Government should provide counterpart funds to meet the cost of salaries of local officers, of fuel, lubricants etc. The estimated cost of the FUNDWI contribution is:

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>U.S.$ 36,000</td>
</tr>
<tr>
<td>Year 2</td>
<td>7,000</td>
</tr>
<tr>
<td>Year 3</td>
<td>7,000</td>
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<tr>
<td></td>
<td><strong>U.S.$ 50,000</strong></td>
</tr>
</tbody>
</table>

It will also be necessary to provide sea transport for the delivery of fermented beans to Serui for final drying (20 tons/week) and for subsequent shipment of dried cocoa to Biak (25 tons/month). These quantities should be achieved by year 3.

If the rehabilitation programme is successful and if land transportation studies show that the cost of exporting cocoa from such inaccessible areas as Genjem can be economic, further assistance would be required in years 4 and 5 which may amount to U.S.$ 200,000 for agricultural equipment and materials. The actual requirements for these equipment and transportation needs cannot be assessed at this stage.

4.3 **Nutmeg and Mace**

The Government of West Irian has requested FUNDWI assistance for increasing Nutmeg and Mace production at Fak-Fak. The area planted is 3385 ha and agricultural equipment and materials costing approximately U.S.$ 9,000 have been requested. Although it was not possible to visit Fak-Fak to verify these requirements, the request is reasonable and the amount small. The items required are those listed on the Government's request, excluding the item for sea transportation.
The request for FUNDWI assistance to buy microscopes for research has been included in the Research Station recommendations (4.10). The West Irian Government would provide the counterpart funds which they have outlined.

It will be necessary to provide sea transport for the shipment of produce to Sorong. This amounts to about 600 tons per year at present but with improved cultivation practices could rise to 2,000 tons per year eventually.

4.4 Kumbe Rice Project

In view of the poor results in the Kumbe Pilot Project, together with the changed circumstances whereby rice is needed for local consumption rather than for export, thus no longer generating any foreign exchange it is recommended that the mechanised project be abandoned. The land should be used for hand planted rice production by farmers and the buildings and part of the land used for an Agricultural Training School (4.13).

No FUNDWI assistance is recommended at the present time, but assistance may be needed to provide a rice mill of greater capacity when increased production in the area makes this necessary.

4.5 Rubber Production

The Government of West Irian has requested FUNDWI assistance for the cultivation of 1,900 hectares of rubber at a cost of U.S.$ 68,910. With practically no information on yields it is not possible to assess the future prospects for this crop. It is recommended that sufficient equipment be provided to permit the existing mature rubber to be tapped in 1968 and if the results are satisfactory the remaining area should be tapped as it becomes mature. The equipment required will be as listed in the request of the Government of West Irian, the expenditure being approximately U.S.$ 20,000 in year 1 and U.S.$ 60,000 in year 2. River and sea transportation for the
export of the sheet rubber produced will also need to be provided for. This will be of the order of 250 tons/year increasing to 1,000 tons/year when all the existing areas are tapped.

4.6 Castor Production

The Government of West Irian has requested FUNDWI assistance in a Castor Plantation Project on 1,500 hectares at a cost of U.S. $128,320. No information is available from which the economic viability of such a project may be assessed and in the light of the experience at the Kumbe Rice Project, the highly mechanised production of castor bean would not seem practicable at the present time.

It is recommended that two pilot projects each of 20 hectares, one at Sukarnapura and the other in the Merauke area be established, using available equipment. A wheeled tractor for each location should be made available. As far as possible hand production methods should be used. Records should be kept of production costs and yields and the possibility of a large project reviewed after two years.

No FUNDWI assistance should be necessary for the pilot projects if existing equipment is used. If the larger project is implemented the requirements for FUNDWI assistance are unlikely to exceed U.S. $50,000 provided that no heavy tractors are to be used. This amount should be reserved for possible needs in Year 3.

4.7 Groundnut and Corn Production

Although no request for assistance has been made for these crops their considerable potential would justify provision from FUNDWI for two pilot projects, one at Nabire and one at Merauke. An area of up to 200 hectares is suggested for each location and data on production costs and yields must be kept to assess the prospects for future expansion either under
large scale or small scale enterprises. Some mechanical equipment could be provided by putting existing machines in working order and providing the correct tools for row crop work. The use of 7 H.P. two-wheeled tractors and 65 H.P. wheeled tractors should be compared for land preparations and inter-row weeding operations. All other work should be by hand cultivation although hand planters of the 'Planet' type might be used for sowing. After harvesting, the stripping of the nuts from the haulm would be speeded up by using a simple hand stripper. Such a machine has been developed at the Gezira Research Farm, Wad Medani in the Sudan by Sayed Ramleh. The machine could be made locally at a cost of about U.S.$ 30. The total equipment required for the two projects would be:-

2 - wheeled tractors 7 H.P., equipped with plough, cultivator tines, ridger and hoe blades 8

4 - wheeled tractors 65 H.P. with similar equipment plus 3 ton trailers 2

Hand planters, 'Planet' type 20

Hand strippers 20

The anticipated FUNDWI contribution would be U.S.$ 18,000 for new equipment and for spares to recondition existing equipment.

In the event of the projects being successful a rapid expansion of these crops would be possible and assistance of the order of U.S.$ 20,000 per year after Year 2 would be required.

4.8 Fertiliser Trials

Because of the very inadequate information on crop response to fertilisers it is important to undertake a programme of well designed fertiliser trials. Basically these should include the usual NPK trials preferably of factorial design but if soil or tissue analysis indicates
other possible deficiencies, these should be remedied by applications on observation plots in the first instance and incorporated into the main trials when responses have been identified. Research staff from Manokwari should supervise these trials which should be located in those areas selected for pilot projects. The FUNDWI agronomist would advise on what further lines of study should be undertaken in the light of the experience gained on the various pilot projects.

In order that such investigations may proceed it is recommended that FUNDWI assistance be given in supplying the necessary fertilisers. The suggested requirements in Year 1 are:-

- Sulphate of Ammonia: 20 tons
- Urea Granules: 20 tons
- Muriate of Potash: 10 tons
- Triple Superphosphate: 10 tons
- Ground Limestone: 20 tons
- Magnesium Sulphate: 2 tons

In addition trace elements for foliar application might be required.

In succeeding years 2 and 3 the list would be modified depending on the results already achieved.

The estimated cost is U.S.$ 10,000 each year over 3 years.

4.9 Pest, Disease and Weed Control Trials

In order to carry out trials on the control of pests, diseases and weeds, a range of dusting and spraying materials should be made available together with suitable spraying and dusting equipment under the control of the Manokwari Research Station. The equipment and materials could be held at Biak from where they could be issued to the various localities where field trials are being conducted. The following equipment is recommended:
Motorised knapsack sprayers/dusters 4
Pressurised knapsack sprayers with full range of nozzles and attachments 24
Charging pumps for pressurised sprayers 6
Adequate spares for all equipment.

Suggested agricultural chemical requirements for Year 1 are:

**Insecticides**

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>DDT 5% Dust</td>
<td>100 kg</td>
</tr>
<tr>
<td>DDT 5% W.P.</td>
<td>100 kg</td>
</tr>
<tr>
<td>BHC 5% Dust</td>
<td>100 kg</td>
</tr>
<tr>
<td>BHC 5% W.P.</td>
<td>100 kg</td>
</tr>
<tr>
<td>Chlordane 10% Emul. Conc.</td>
<td>50 litres</td>
</tr>
<tr>
<td>Dieldrin 20% Emul. Conc.</td>
<td>50 litres</td>
</tr>
<tr>
<td>Malathion 20% Emul. Conc.</td>
<td>50 litres</td>
</tr>
<tr>
<td>Rogor 40</td>
<td>20 litres</td>
</tr>
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</table>

**Fungicides**

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<th>Quantity</th>
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</thead>
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<tr>
<td>Colloidal Copper Fungicide</td>
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**Rodenticides**

<table>
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<th>Rodenticide</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warfarin</td>
<td>100 kg</td>
</tr>
<tr>
<td>Technical Endrin</td>
<td>5 kg</td>
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</tbody>
</table>

**Herbicides**

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:4D Amine</td>
<td>40 litres</td>
</tr>
<tr>
<td>M.C.P.A.</td>
<td>20 litres</td>
</tr>
<tr>
<td>2:4:5T Brush Killer</td>
<td>20 litres</td>
</tr>
<tr>
<td>Paraquat</td>
<td>20 litres</td>
</tr>
<tr>
<td>Dalapon</td>
<td>100 kg</td>
</tr>
<tr>
<td>T.C.A.</td>
<td>50 kg</td>
</tr>
<tr>
<td>Sodium Pentachlorophenate</td>
<td>50 kg</td>
</tr>
</tbody>
</table>
The list would be modified in Years 2 and 3 depending on results obtained.

The estimated cost is U.S.$ 10,000 in Year 1 and U.S.$ 5,000 in Years 2 and 3.

4.10 Technical Assistance

In order to assist in the establishment and operation of the recommended pilot projects, in collecting and interpreting the data obtained from these, in evaluating the economic feasibility of development projects and in overall planning for development in agriculture, the provision of 3 specialists is recommended. Their responsibilities would also include the tentative selection of sites for plantation expansion, decisions on the relative amount of land to allocate to the different crops during the early stages of development, and advice on the relative importance of agricultural production vis a vi forestry and mining developments in the different regions for establishing priorities in improving road and river communications. The team would maintain close liaison with the research officers of the Manokwari Research Station and in particular would consider how the traditional system of shifting cultivation could be improved.

The team would consist of:

(a) One agronomist with extensive experience in tropical agriculture to advise on the establishment and operation of the projects. This and the additional responsibilities outlined above would provide a very full work programme and the appointment of a second agronomist might be necessary.

(b) One agricultural economist to undertake the economic appraisals and assess the potentialities of the various crops.
(c) One farm mechanisation specialist to investigate the potential and limitations for mechanised crop production in West Irian and advise on mechanised operations on the pilot projects and on the rehabilitation of existing equipment. He would pay particular attention to the possibility of making greater use of draught animals.

Each specialist should be available for 3 years and should be provided with one or more counterparts from Indonesia, there being no West Irians available at present who have the necessary qualifications.

The specialists and their counterparts, together with representatives of the Agricultural Department should form the nucleus of a planning group which would prepare in due course a detailed development plan. After the suggested assignment of 3 years it is hoped that the counterpart staff would be able to take over the implementation of the plan.

The team would have to be provided with accommodation, transport and in view of present conditions in West Irian with assistance in importation of all necessary food supplies and other domestic requirements.

There should also be provision for short-term consultants to assist in any special problems in crop production which may arise.

The total cost of the team of three specialists including their passages, accommodation and other expenses would be approximately US.$80,000 per year. A further US.$20,000 per year should be allocated to meet possible requirements for short-term specialist assistance.

4.11 Research Station Equipment

The Manokwari Research Station has put forward a request for FUNDWI assistance. This has been included under the request for education assistance. Items of expenditure specifically for agricultural research amount to approximately US.$35,000\(^{10}\) and it is recommended that this be provided.

10. Includes US.$8,000 for microscopes entered under request for assistance in nutmeg and mace production.
4.12 Reconditioning of Existing Agricultural Machinery

The farm mechanisation specialist should firstly examine all the agricultural tractors and machinery now lying idle awaiting spares and prepare a list of spares required to rehabilitate those machines worth reconditioning. These spares should be provided by FUNDWI. The cost is estimated as being of the order of US.$50,000.

Hitherto there has been little standardisation and it is recommended that in future agricultural machinery and implements should be reduced to as few standard types as possible, thereby reducing the large stock of spares which have to be held.

4.13 Meteorological Equipment

In addition to the meteorological equipment requested by the West Irian Government it is recommended that all Agroclimatological Stations be equipped with U.S. Weather Bureau Class A evaporation pans complete with micrometer gauge and water temperature recorder. This will permit estimates of crop evaporation to be made and enable the seasonal soil water balance to be evaluated. The total cost is estimated at US.$3,000.

4.14 Agricultural Training

Agricultural training in West Irian can be obtained both at the agricultural high schools and at the University of West Irian's Faculty of Agriculture at Manokwari as well as in farmer training schools providing short courses of some six months duration, in special schools providing short upgrading courses for junior officers of the Department of Agriculture and in schools run by the missionaries.

The agricultural high schools by training students for junior posts in the extension service play an important part in the improvement of agriculture. However, they need to reorientate their curriculum to provide
a more practical course which could also be expanded with advantage
to include instruction on the maintenance and operation of farm implements
and light tractors and the training of draught animals. These schools
however need equipping with the necessary implements, workshops equip-
ment, fertilisers, spray materials etc. and it is recommended that
FUNDWI assistance be provided for this.

With this suggested reorientation there should be fewer of the
better pupils going on from the schools to the University and instead they
could be encouraged either to return to the land or by becoming junior
members of the extension service pass on their practical knowledge of
agriculture to the farmers.

It is suggested that an additional agricultural high school could be
opened on the Kumbe Rice Project using the existing buildings and part of
the land for rice plots and plots for other crops for each pupil.

The Faculty of Agriculture at Manokwari is at present inadequately
staffed and it is recommended funds be made available to bring the numbers
up to the full establishment. Some of the graduates from Manokwari with
the necessary ability and qualifications are eligible for international grants
and fellowships for further training in the Phillipines, U.S.A. and elsewhere.
Increasing the number of fellowships should be considered.

In order to gain wider experience and new ideas it is also desirable
that suitably qualified persons with some years of experience in their field
should have assistance to enable them to travel to other countries where
they would see new developments in crop production and agricultural
research. At present there would appear to be no West Irians of sufficient
experience in the agricultural field. If Indonesians were sent on such visits
at FUNDWI expense it would be necessary to ensure they would return to
West Irian for some years afterwards. This prospect would not be viewed
favourably by the majority of Indonesians at present. Centres
of particular interest for such visits would include the West African Cocoa Research Institute in Ghana, the Rice Research Institute in the Phillipines and the Rubber Research Institute in Malaya as well as reclamation projects in Guyana and Surinam where conditions are similar to those near Merauke. A close liaison with agriculturalists in Papua and Australian New Guinea should also be built up.

The amount which should be set aside for FUNDWI assistance for agricultural training must be related to the needs in other educational spheres and cannot be decided in isolation.

4.15 Total Recommended FUNDWI Assistance

The cost of the FUNDWI assistance for those agriculture projects being recommended in this report is shown in Table 4.1 on page 56.

The total expenditure definitely recommended over the next three years is US.$535,000 with a further expenditure of up to US.$370,000 in Years 3 to 5 subject to the progress on the pilot projects proving sufficiently satisfactory to warrant the expansion of the individual development programmes.
### TABLE 4.1 Recommended FUNDWI Assistance

**Agricultural Projects**

(Items in brackets are dependent on the success of the recommended pilot projects)

<table>
<thead>
<tr>
<th>Project</th>
<th>Amount in US.$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1</td>
</tr>
<tr>
<td>Cocoa Rehabilitation</td>
<td>36,000</td>
</tr>
<tr>
<td>Nutmeg and Mace</td>
<td>8,000</td>
</tr>
<tr>
<td>Kumbe Rice Project</td>
<td>Nil</td>
</tr>
<tr>
<td>Rubber Production</td>
<td>20,000</td>
</tr>
<tr>
<td>Castor Production</td>
<td>-</td>
</tr>
<tr>
<td>Groundnut/Maize Production</td>
<td>18,000</td>
</tr>
<tr>
<td>Fertiliser Trials</td>
<td>10,000</td>
</tr>
<tr>
<td>Pest, Disease &amp; Weed Control Trials</td>
<td>10,000</td>
</tr>
<tr>
<td>Technical Assistance</td>
<td>100,000</td>
</tr>
<tr>
<td>Research Station Equipment</td>
<td>35,000</td>
</tr>
<tr>
<td>Reconditioning Agric. mach.</td>
<td></td>
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<tr>
<td>Meteorological Equipment</td>
<td>3,000</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td>240,000</td>
</tr>
</tbody>
</table>
CHAPTER 5

ACKNOWLEDGEMENTS

In difficult conditions such as exist in West Irian, the operation of a survey mission requires a high degree of assistance and backing both inside the country and from outside. The irregularity of shipments to West Irian prevented the timely arrival of various supplies for the mission and for the local UNDP office. In view of this the support and assistance of Government and local officials who were themselves working under difficult conditions and who did everything possible to help us is most gratefully acknowledged. Without their help it might well have been impossible to carry out our assignments.

I would, in particular, like to thank the officials of the Department of Agriculture who accompanied me on my tour and who besides arranging transport and visits so successfully went out of their way to ensure that as far as possible food was adequate and accommodation comfortable.
APPENDICES I - III
APPENDIX I

CLIMATOLOGICAL DATA FOR SELECTED STATIONS BASED ON OBSERVATIONS FOR THE
PERIOD 1961-1965

TABLE I.1 Monthly mean maximum temperature in °C for selected stations

<table>
<thead>
<tr>
<th>Station</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sentani</td>
<td>31.8</td>
<td>31.6</td>
<td>31.6</td>
<td>31.1</td>
<td>31.0</td>
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<td>31.9</td>
<td>31.8</td>
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<tr>
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<td>30.2</td>
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<td>30.1</td>
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**TABLE I.2** Monthly mean minimum temperature in °C for selected stations

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**TABLE I.3** Monthly mean 24 hr average temperature in °C for selected stations
### TABLE I.4 Monthly mean relative humidity per cent for selected stations (mean of 6 am and noon observations)

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### TABLE I.5 Monthly mean wind kilometres per day for selected stations (mean of observed velocity at 6 am, noon and 6 pm)

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TABLE I.6 Monthly mean hours per day of sunshine for selected stations

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TABLE I.7 Mean monthly rainfall in mm for selected stations

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### APPENDIX II

**AREAS IN HECTARES OF LAND SURVEYED AND CLASSED AS SUITABLE FOR AGRICULTURAL DEVELOPMENT**

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## APPENDIX III

**PRICES OF AGRICULTURAL PRODUCE IN**

**SUKARNAHPWA MARKET**

### Fruit and Vegetables

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<tr>
<td>Breadfruit</td>
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<tr>
<td>Bamboo Shoots</td>
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</tr>
<tr>
<td>Sweet Potato</td>
<td>about 5 WIR per kilo</td>
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<td>Cucumber</td>
<td>4 WIR each</td>
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<td>Tomato (small)</td>
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<td>Dry Onions</td>
<td>5 WIR for about $\frac{1}{4}$ kilo</td>
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<td>Bananas</td>
<td>100 WIR per hand of about 8 bananas</td>
</tr>
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<td>Coconuts</td>
<td>3 WIR per nut</td>
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<td>Bean shoot</td>
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### Other Commodities

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<td>Eggs</td>
<td>3-5 WIR each</td>
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<td>Fish (snapper)</td>
<td>50 WIR for a fish of 1$\frac{1}{2}$ kilo</td>
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<tr>
<td>Cooking Oil</td>
<td>30 WIR per bottle</td>
</tr>
</tbody>
</table>

*W.I.R. = West Irian Rupiah (10 Rupiah = 1 Dollar U.S.)*