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Front cover: Harvesting rice by hand in the Sepik. Photo B. Singh.

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RICE EXPERIMENTATION IN PAPUA NEW GUINEA

By J.H. Sumbak, Agronomist-in-charge, Agriculture Research Centre, Bubia

Rice research by the Department of Primary Industry was largely limited to Bereina, about 110 km north-west of Port Moresby, before 1970. Rainfall on the Bereina research station was of doubtful reliability, so the rice research was transferred to Bubia, a research station in the lower Markham Valley. Bubia, in fact, is much more central and able to serve all parts of the country. Currently, intensive research is being carried out in the Markham Valley and the East Sepik Province.

Early problems

Many of the varieties of rice first brought to this country were tall and therefore susceptible to lodging. El, a Javanese selection introduced to Papua New Guinea in 1940, was one of these varieties. It was grown extensively in the Sepik.

The presence of red rice (with different cooking qualities) in these varieties was also a drawback.

More recent introductions, recommendations

A limited number of newer varieties, developed at the International Rice Research Institute (IRRI) in the Philippines, were tested at Erap in the Markham Valley in the late 1960s. These gave high yields compared to the older ones. They responded to highly fertile soils by giving greater grain production, rather than greater leafy growth as had been the case with the old ones. Generally they showed marked resistance to lodging, mainly because they were shorter, but also due to their stronger stems. They were also not contaminated with red rice and lastly, they were non-photoperiodsensitive, flowering at a set period after planting irrespective of day length.

Out of these, Milfor 6 (2) (NG 6009 *) and B5580 A1-15 (NG 6010) were selected and grown at seven sites ranging from Dumpu in the Ramu Valley to Munum in the lower Markham Valley. Results were generally not good due to erratic rainfall at the onset of that particular wet season. (Also planting time was probably not ideal as has been observed since.) Other factors such as soil conditions, leptocorisa damage (particularly on Milfor which matured later than B5580 and consequently suffered from a build-up of the pest) and drechslera leaf spot contributed to poor yields. It was obvious that these factors had to be more fully appreciated before wide-scale rice production in the Markham Valley could begin.

Further introductions from IRRI, the Solomon Islands, Sri Lanka, the USA and Australia followed, and by the end of 1973-74 some 70 varieties had been tested at a number of sites under both irrigated and dryland conditions.

Selection was based on consistency in yield, relative short stature associated with resistance to lodging, resistance to pests and diseases as well as good milling and cooking quality. A number of varieties (e.g. IR5 and IR8—two of the so-called "miracle" rices) yielded well but were superseded or discarded because of inferior cooking qualities or particular susceptibility to certain pests and diseases.

The variety currently recommended, NG 6637 (referred to as 6637) was selected. It is an IRRI line (IR532-E-208), a sister line to the IRRI variety IR20. It has performed well under both dryland and irrigated conditions in the Markham Valley and under dryland conditions in the Sepik. It is superior to IR5 and IR8 in cooking quality, displays a tolerance to stem borer, and drechslera is not as evident as in other high-yielding types.

Variety 6637 has a medium growing period (4 to 4½ months) and grows to about 80 cm. It has consistently yielded around 5 000 kg/ha (up to 8 500 kg/ha on occasions) when irrigated, and around 4 000 kg/ha when grown under dryland conditions.

Other varieties are being introduced and compared with 6637.

This article describes some of the experimental work behind the recommendations given in the following article, "Rice-growing recommendations". This material was first circulated as Bubia Information Bulletin No. 16—Rice (17th March, 1975).

* NG . . . Papua New Guinea plant introduction number.

Sowing and seeding rate

An experiment carried out in the Markham Valley in 1974 indicates that optimum seeding rate can vary with variety and suggests that higher rates may be advantageous. This is illustrated in *Table* 1.

Fertilizer requirements

Nitrogen

Good responses to nitrogen (N) have been obtained with dryland rice in the Markham Valley and these are shown in *Table* 2.

Responses to N have occurred in the Sepik as well, and again they are more marked on grassland or previously cropped areas than on secondary bush land.

Very heavy applications (200 kg/ha and more) can cause lodging.

A trial on irrigated rice at Gabmazung, about 30 km west of Lae, compared yields obtained with N applied before puddling and N applied 19 days after puddling (*Table* 3).

These trials show that nitrogen should be added before puddling and suggest that under Gabmazung conditions 100 to 150 kg/ha are necessary.

Another trial looked at 60 and 120 kg N/ha as well as other nutrients on old paddies (14 crops) and new paddies (2 crops). In both cases the higher rate consistently outyielded the lower one but the additional response in the older paddy was much higher—26 % as compared to 9 % in the newer paddy. No response to phosphorus or potassium was obtained and no obvious deficiency noted. It is likely that a higher N rate than 120 kg is necessary.

Phosphorus

Additions of this nutrient have been shown to be essential with dryland rice at one site in the Markham Valley (Umi), beneficial at two others and possibly beneficial at another. Responses have not been obtained on heavier soils in the Cleanwater to Erap area. *Table* 4 shows additional responses to P with N, over N alone, at two sites.

On irrigated rice, one trial (at Gabmazung) using phosphorus and potassium showed no responses either on old or new paddies.

Further study of P rates and application methods is being carried out.

Other nutrients

It is now well established that periodic zinc (Zn) applications are necessary with irrigated rice, in parts of the Markham Valley at least. On relatively alkaline soils (pH 7.5. to 8.5) deficiencies of trace elements, especially Zn, are often likely. This is especially so if the irrigation water is high in bicarbonate, which can tie up trace elements. Of the potential water sources many are high in bicarbonate and have to be used with care.

Zn deficiency has been noted on sites as far apart as Bubia (10 km from Lae) and Cleanwater (70 km). Glasshouse and field work has shown that Zn deficiency is very much tied up with soil type, quality of the irrigation water and cultural practices, particularly between crops.

The severity of Zn deficiency varied—at Ganip and Cleanwater in recent trials Zn applications were essential while at Gabmazung responses were relatively slight.

It is emphasized that although Zn deficiency is a problem with irrigated rice the use of zinc sulphate has remedied this deficiency successfully at each site to date. Zn deficiency is much less likely with dryland rice and to date only slight symptoms at a limited number of sites have been noted and then only at the seedling stage.

Deficiencies of potassium and other nutrients have not been encountered with

***Table* 1.—Average yields (kg/ha) of four varieties at five sowing rates.**

Rate kg/ha	*NG 6628*	*NG 6624*	*NG 6637*	*NG 6924*	*Average*	*% increase over lowest rate*
30	2 005	2 960	2 975	3 725	2 915	
60	2 205	3 580	3 715	3 890	3 345	14.7
90	2 630	3 420	3 985	4 100	3 535	21.3
120	2 975	3 825	4 395	4 410	3 900	33.8
150	3 180	3 720	4 780	4 790	4 114	41.2

Table 2.—**Responses to N over 2 years in the Markham Valley.**

N rate	*Yield kg/ha*		
kg/ha	*1971-72*	*1972-73*	
		*Trial A**	*Trial B †*
0	1 438		
56	2 431		
112	3 263		
168	3 746		
224	4 453		
280	4 474		
336	4 526		
448	4 725		
0		4 291	2 950
30		4 450	3 970
60		4 400	4 220
90		4 475	4 820
120		4 458	4 630
150		4 325	4 770

* Area previously sown to legumes.

† On grassland with a further application of N 2½ months after sowing.

Table 3.—**Comparison of yields with N applied before puddling (trial 2) and N applied 19 days after transplanting (trial 1).**

N rate kg/ha	*Trial 1 Yield kg/ha*	*N rate kg/ha*	*Trial 2 Yield kg/ha*
0	3 910	0	2 140
56	4 430	50	3 800
112	4 870	100	4 430
168	4 700	150	5 390
224	4 690*	200	5 390†
280	4 750*	250	5 480†
336	4 590*	300	5 020†
448	4 200*	400	5 230†

* Leaf hopper damage.

† Lodging.

either dryland or irrigated rice to date in the Markham Valley or Sepik.

Weedicides

A number of weedicides have been tested. Trials in the Markham Valley at two sites indicated that diuron (Diurex), linuron (Afalon) and amitrol (Amitrex) and controlled weeds equally well. Diuron was equally effective at rates of 1, 2, 4 and 8 kg active ingredient (a.i./ha when applied with 300 l/ha of water. The other pre-emergence weedicides were effective at 4 and 8 kg a.i./ha with amitrol showing some toxicity to rice seedlings at the highest rate.

A number of other weedicides were fairly effective in controlling weeds but they were either quite toxic to rice or the safety margin at the recommended rate was too small to recommend their use. These included alachlor (Lasso), propachlor (Ramrod), trifluralin (Treflan), chloramben (Amiben), dichlorobenil (Casoran), asulam (Asulox), Cobex and Bladex. Simazine (Simatox) caused severe damage to rice under trial conditions in 1973-74 and should not be used.

Postemergence spraying with propanil (Stam F34) was shown to be fairly effective at rates of 3, 4.5 and 6 kg a.i./ha regardless of whether the chemical was aplied 23, 30 or 37 days after sowing.

Table 4.—**Response to P with N at two sites.**

Treatment	*Yield kg/ha*	
	Umi	*Ragiampum*
Control	1 682	2 480
N (100 kg/ha	2 207	3 400
N (100 kg/ha) + P (50 kg/ha)	5 118	4 260*

* This treatment suffered leaf hopper damage which reduced yields.

RICE-GROWING RECOMMENDATIONS

By J.H. Sumbak, Agronomist-in-charge, Agriculture Research Centre, Bubia

In recent years rice consumption in Papua New Guinea has increased greatly and now is equivalent to 90 000 tonnes of paddy rice per year. Consumption per head in 1971-72 was 35 kg.

Little of this is produced locally although rice was first introduced by missionaries and plantations at the turn of the century. The Sepik provinces produce most of the locally grown rice while there is some production in the Central and Madang provinces, and other provinces.

Conditions suitable for growing rice

Rice is grown in other countries under widely differing climatic conditions, being cultivated as far north as 45°, through the tropics and subtropics to 40° south.

Rice varieties which have been introduced to Papua New Guinea do not grow well above about 1 300 m. The International Rice Research Institute (IRRI) in the Philippines is looking for varieties suited for higher altitudes.

Generally, rice flourishes under conditions of high temperature, prolonged sunshine and adequate moisture.

Rice may be grown on dry land, in which case it is dependent on rainfall, or it may be irrigated.

Adequate moisture is the most important factor in assuring high yields. Rainfall requirements will naturally vary with soil type, drainage and evaporation, but generally at least 25 mm per week is required by the crop until flowering (about 2½ to 3½ months, dependent on variety) and later 50 mm per week. As all precipitation is not available to the crop a rainfall of 40 to 50 mm per week initially, increasing to 80 to 100 mm at flowering, would generally be ideal.

Unsuitable rainfall patterns make it impossible to grow dryland rice in some areas of Papua New Guinea.

In the upper Markham Valley and upper Ramu Valley rainfall is usually adequate for the early and mid season varieties, which mature in 120 to 135 days. The late varieties sometimes run short of water.

Sunshine and daylength are important. Rice flourishes during long periods of sunshine. This means that rice yields in temperate areas, which have longer day length, are generally higher than yields in the tropics.

However, varieties have been obtained from IRRI which are suitable for growing in Papua New Guinea.

Adequate sunshine during ripening is beneficial. Without adequate sunshine at this time crops tend to be more susceptible to disease and are harder to harvest.

Lack of sunshine at harvest time also makes some areas of Papua New Guinea unsuitable for growing rice at certain times.

Variety

The variety currently recommended, NG 6637* (referred to as 6637) has performed well both under dryland and irrigated conditions in the Markham Valley and under dryland conditions in the Sepik.

Yields of around 5 000 kg/ha as irrigated rice and around 3 000 kg/ha under dryland conditions can be expected with this variety.

Soils and fertilizer requirements

Rice can be grown on a variety of soils and can tolerate some quite acid and alkaline types. Generally speaking, soils of medium to medium-heavy texture are favoured, for dryland rice because they retain moisture better, and for irrigated rice as they are less likely to lose substantial amounts of water through excessive drainage. However, good crops of dryland rice have been grown on very light soils.

It is difficult to generalize about fertilizer use as specific soils will have specific requirements depending on the inherent make-up of the soil as well as any treatments the soil has undergone. Generally speaking, soils previously under bush fallow will have few fertilizer requirements while grassland soils almost inevitably require nitrogen.

This article was first circulated as Bubia Information Bulletin No. 16—Rice (17th March, 1975).

* NG. . . Papua New Guinea plant introduction number.

Trials of irrigated rice in the Markham Valley. Photo B. Singh.

Nitrogen

Under most circumstances the new high-yielding IRRI varieties will respond to additions of nitrogen (N).

Under dryland conditions in grassland areas which have only had a short period between initial ploughing and seeding heavier N applications are generally necessary. Under these circumstances sulphur (S) may also be needed.

At least 100 kg/ha of N are recommended and heavier applications may be worthwhile.

It has also been noted that very heavy applications (200 kg/ha and more) can cause lodging.

Where the soil has been fallowed for a reasonably long period (i.e. five or six months) or rice follows a legume crop, applications of around 50 kg/ha should suffice.

Generally, heavier soils require less N than the light soils, and on light soils split applications may be beneficial. This latter observation has been very obvious at Umi in the Markham Valley where the soil is very light and gravelly. Marked responses to split applications have been obtained.

As conditions under irrigation are usually better than under rainfed conditions, yields can be expected to be higher and hence nutrient requirements are greater.

At Gabmazung 80 kg N/ha appeared adequate on newer paddies, but 120 to 150 kg/ha were required on an area continuously cropped for some years. High rates of N caused lodging and also enhanced leaf hopper attack. At this site applications of zinc (Zn) were necessary and this will be mentioned later.

Nitrogen is generally added before puddling.

Phosphorus

Additions of phosphorus have been shown to be essential with dryland rice at Umi, beneficial at two other sites and possibly beneficial at another. The amount applied was 50 kg/ha, with 100 kg/ha N. One trial with irrigated rice at Gabmazung gave no response to phosphorus. This does not mean that additions of P are not necessary in other areas.

Further studies are being carried out.

Other nutrients

Zinc deficiencies have been noted at sites as wide apart as Bubia and Cleanwater. Zn deficiency is much less likely with dryland rice than with irrigated rice.

Deficiencies of trace elements, especially

The rice plant on the left was fertilized with zinc, while the one on the right which did not receive any zinc shows zinc deficiency. Photo B. Singh.

Zn, are often more likely on relatively alkaline soils (pH 7.5 to 8.5) and this is especially so if irrigation water used is high in bicarbonate.

The severity of Zn deficiency varies. At Ganip and Cleanwater, applications of about 50 kg/ha of zinc sulphate per crop (irrigated rice) are essential, while at Gabmazung, results are relatively slight, and only one application every three crops might suffice.

Sulphur deficiency is a definite possibility, especially on grasslands where there has been little opportunity for organic matter to break down. This is being investigated.

Water requirements

The quality of irrigation water can be a limiting factor, especially if soils were already high in soluble salts and are difficult to "wash" by percolating water down. Water sources with high levels of soluble salt and high sodium need to be treated with care. High levels of bicarbonate and chloride can also be deleterious.

Land preparation

Dryland rice

The aim is to create good conditions for germination as well as to kill any emerging weeds. A fine seedbed is preferable. In grassland areas the initial ploughing should be carried out sufficiently early to allow plant material to decompose before harrowing to form a final seed bed.

Under Markham Valley conditions in 1974-75 three ploughings (commencing five months before seeding) followed by three harrowings were found to be necessary in a commercial block for dryland rice.

The number of workings will vary for different areas, of course. In the Sepik provinces land preparation is limited to clearing and burning of secondary scrub with the bigger logs and stumps being left. The ground is not worked at all and rice is hand-sown in holes made by planting-sticks.

Irrigated rice

For irrigated rice there are additional requirements. With this type of rice the paddies are covered with water from transplanting or an early seeding stage to shortly before harvest. This supplies the rice with unlimited water and controls most weeds (which can be a problem in dryland rice).

An even depth of water throughout the paddy is essential and this is achieved by mechanized levelling, where land is already quite flat, or by contouring and levelling in hilly areas. Irrigated rice is grown extensively throughout south-east Asia where intricate systems of terraced farming have been evolved.

Once paddies have been levelled it is generally necessary to plough and allow the soil to dry for two to three weeks. Another cultivation may be necessary and this can be carried out in the same operation as fertilizer application. Water is then run on to the paddies and a rotary hoe is sometimes used to puddle the soil (that is, to partially seal the soil and prevent excessive water loss through drainage), and to mix the fertilizer. On a small scale this can be done by treading or using implements drawn by oxen or buffalo. Three or four days are allowed for clay particles to settle and provide the seal and then seedlings are planted.

Terraces, like these in the Philippines, are used for planting rice in many parts of Asia. Photo Julia Farley.

Sowing date

Dryland rice

When there is a distinct wet-dry rainfall pattern, dryland rice must be sown during the wet season. Ideally the first three to three and a half months should have ample rainfall and after that there should be ample sunshine and less rain so as to allow the crop to ripen and be successfully harvested. Excessive rain during rippening can severely hinder mechanical harvesting operations.

In the upper part of the Markham sowing should be done in early to mid January as generally reliable rain can be expected until mid April. Further down the valley (i.e. Leron Plains to Erap), it should be sown in December as the wet season tends to finish earlier. Dryland rice is a riskier proposition in this latter area.

If a real distinction cannot be drawn between seasons, dryland rice can be sown at any time of the year provided rainfall is adequate. Under such conditions the risk of diseases and difficulties during harvest are greater.

Irrigated rice

Irrigated rice can be sown at any time of the year, but highest yields can be expected during periods of high sunshine. If a definite wet season does occur it would be wise to avoid maturity coinciding with the wettest months.

Sowing rate

Dryland rice

Dryland rice is generally sown by planting seed directly into the field. Seed can be sown by hand or by machine. Many small-scale farmers sow by placing seed into holes made by planting-sticks on cleared ground. This method appears to be quite adequate provided holes are placed at regular intervals. Trial work to date has indicated that closer spacings are beneficial. It is suggested that 5 to 10 seeds be placed in holes 20 to 25 cm apart.

Where an area has been adequately worked, seed can be broadcast by hand or machine and turned in with harrows or rakes.

A new, shorter variety of rice at left is contrasted with the older tall variety of rice which used to be grown in Papua New Guinea. Photo M. Wright.

Turning the seed into the ground minimizes loss to birds and mice and ensures better conditions for germination.

Large areas are generally sown with adjustable drills. A depth of 2 to 4 cm is suggested.

For the recommended variety, NG 6637, the recommended seeding rate is 120 to 150 kg/ha.

Irrigated rice

Rice which is to be irrigated can be sown by transplanting seedlings from a nursery, by broadcasting as pregerminated seed, or by drilling seed before flooding.

Method 1. The first method assures good, even establishment but is labour-intensive. Nurseries are established by seeding heavily and covering with fine soil. It is important to keep seedlings well watered and fertilizer (generally nitrogenous) is sometimes used. A nursery area of 30 to 40 m^2 is generally sufficient to transplant 1 ha of paddy. Seedlings should be 4 to 5 weeks old when they are transplanted.

Method 2. Seed is sprouted in bags by watering two or three days before broadcasting. Sprouted seed can be hand-sown or broadcast aerially, with the latter method being widely used in Australia and the USA where labour is expensive. Sprouted seed is usually broadcast into freshly drained fields and then flooded and drained two or three times until permanent standing water is introduced. The importance of having flat paddies is self-evident.

Method 3. Ungerminated seed can be drilled into a moist seedbed which is flooded when seedlings are two or three weeks old.

As with dryland rice, establishment is probably more important than seeding rate. Although it is likely that optimum spacing will vary from area to area and variety to variety, a 20 x 20 cm spacing with 2 or 3 plants per site is suggested for transplanted rice in Papua New Guinea. Where rice is broadcast or drilled a rate of 80 to 120 kg/ha is suggested.

Weeds and their control

Rice seedlings are quite slow to establish and therefore compete poorly with weeds. Dryland rice is especially vulnerable in this regard as growth for the first 2 to 2½ months is slow. Aside from assuring an optimal water supply, flood irrigation also controls most

weeds, but there are some weeds which can flourish under flooded conditions, and therefore prove a hindrance. Weeds, aside from competing directly with rice, can also act as alternative hosts for a range of pests and diseases. Infestations of tall weed species can make mechanical harvesting dificult or even impossible.

Sound water management prevents the establishment of most weeds in irrigated rice. On the dry land surrounding the paddies, weeds can be effectively controlled by slashing, hoeing or the use of chemicals. Planting of suitable legume species is recommended.

In Papua New Guinea, as elsewhere, the main weed in irrigated rice is barnyard grass *(Echinochloa crus-galli)* which can compete strongly with rice and is also an alternative host to leptocorisa. Sedges *(Cyperus* spp. and *Scirpus* spp.) can also be a nuisance.

With dryland rice weeds can be a very real problem and can preclude economic production in some situations.

Under a long fallow, shifting system where rice is grown on a small scale, weeds are usually not a major problem, as the site is usually abandoned or given to alternative crops once weeds become prominent. Under Papua New Guinea conditions, two or three weedings are generally carried out.

Theoretically, on virgin land, weeds should not be much of a problem for the first and perhaps second crops. This may be true where weeds do not occur near the cultivation. However, it has been evident in commercial-scale plantings in the Markham Valley in 1975 that on virgin land or land uncultivated for at least six years weeds were a problem. Ingress of weeds was presumably by wind (*Digitaria insularis, Amaranthus* sp.) and by water (*Portulaca* sp. especially) and at least one weeding was needed.

There are a number of ways of minimizing weed infestation—

(1) Thorough land preparation can help, with several harrowings, timed to coincide with weed emergence. Also it is sensible to ensure that machinery is free of weed seeds. Spread by machinery has undoubtedly contributed to rottboelia infestations in the Markham Valley. It is also advantageous to spray or slash areas around the crop before the weeds flower.

(2) Weedicides will sometimes be essential. Three pre-emergence weedicides, diuron (Diurex), linuron (Afalon) and amitrol (Amitrex), are all effective. Diuron may be used at a rate of 1 kg active ingredient (a.i.)/ha aplied with 300 l/ha of water. Linuron and amitrol may be applied at 4 kg a.i./ha.

A typical Sepik subsistence garden of dryland rice. Photo B. Singh.

Other weedicides which were tried but are not recommended are alachlor (Lasso), propachlor (Ramrod), trifluralin (Treflan), chloramben (Amiben), dichlorbenil (Casoran), asulam (Asulox), simazine (Simatox), Cobex and Bladex.

Postemergence spraying with propanil (Stam F34) at a rate of 3 kg a.i./ha is also effective. It may be used 23 to 37 days after sowing.

(3) The use of rotation could be expected to help weed control although this has not yet been demonstrated on a large scale in the Markham Valley.

When grass species become uncontrollable a legume crop (e.g. soya beans, peanuts, cowpea) may be planted for a period. Chemical methods may then be used to control the weeds in that crop. To control problem weeds more vigorous crops such as maize or grain sorghum can also be included in the rotation, with either herbicides or interrow cultivation used to control weeds. A pasture phase may also be beneficial.

Pests and diseases

There are a multitude of pests and diseases that can affect rice. Fortunately some of the more serious do not occur or have not been recorded in Papua New Guinea to date, but could well be disastrous if they were introduced. For this reason unprocessed rice is a prohibited import into Papua New Guinea. Introductions of new varieties are being made by the Department of Primary Industry but only after strict quarantine procedures have been observed.

Insect pests

Leptocorisa, of which there are three species in Papua New Guinea, suck out the contents of developing grains and are the most serious and widespread pest. In grasslands in parts of the Sepik, where alternative hosts are numerous, they can preclude rice cultivation. In some areas they are seasonal and sometimes their incidence can be reduced by indentifying and reducing alternative hosts (usually grasses). Often this would not be practical. Spraying (with lindane, carbaryl) helps but its effect may be only short-term if large numbers of the pest exist outside the sprayed area. A number of cultural practices help. As the life cycle of the pest is short it can multiply quickly and affect later flowering plants more severely. Crops should be planted so that the flowering or ripening crop does not overlap with a new flowering crop. The pest will move from a ripe crop to a flowering one at or before harvest.

Stem borers, of which there are some 22 species, are serious rice pests in other countries but to date have not been a major problem in Papua New Guinea. There has been one species only reported to date in the Markham Valley *(Sesamia inferens)* but several other species of borer occur in other parts of the country. They cause damage by boring into seedlings and eventually preventing nutrient and moisture flow into the head. As a result heads are characteristically white and empty. Suggested control measures are crop rotations, stubble destruction and application of diazinon granules at 20-day intervals under irrigated conditions.

Leafhoppers and planthoppers, of which there are numerous species, can reduce plant height and tiller numbers if they attack in the early stage. They have, on occasion, greatly reduced yields on irrigated rice at Gabmazung. Additionally these pests can carry virus diseases such as yellow dwarf, orange leaf, tungro, grassy stunt and transitory yellowing (none of which have been identified in Papua New Guinea yet). Varietal resistance does occur but is liable to break down—this has recently happened in Guadalcanal (Solomon Islands). The use of chemicals (carbaryl, lindane) can help, provided the pest is recognized early enough.

There are a multitude of other pests but few (aside from armyworm in one instance in the Markham Valley) have caused major damage to crops in the Markham Valley or Sepik. Some of these potential pests include armyworm, cut worms, case worms, leaf rollers, leaf folders, green vegetable bugs and shield bugs. Mole crickets have been observed feeding on rice roots both in the Sepik and Markham Valley recently.

Diseases

Rice in Papua New Guinea to date has been relatively disease-free. A leaf spot caused by *Drechslera oryzae* has been the main pest and can cause considerable yield depression by loss of effective leaf area and damage to the grain. It is worse under rainy conditions. Some varieties show considerable resistance to the disease and the variety 6637 appears to be one of the less susceptible ones. Assuring crop evenness, use of fungicide-treated seed from disease-free crops will give some

measure of control. Blast *(Piricularia oryzae)*, a fungal disease, could be particularly disastrous if introduced to Papua New Guinea. Other diseases reported overseas include stem rot, sheath rot, Bakanae disease, sheath blight, false smut, bacterial leaf streak and bacterial leaf blight. Virus diseases have not yet been recorded in rice in Papua New Guinea.

Harvesting

Time to maturity varies greatly between varieties. Of those introduced to Papua New Guinea the maturity period varies from 100 to 160 days. In relatively humid environments, it is important to harvest at the correct time otherwise problems in harvesting, storage and processing will result.

Generally under lowland PNG conditions it takes about 30 days from flowering to ripening, although extremes of 14 and 56 days occur depending on variety. A moisture content of 20 % at harvest is desirable.

Harvesting techniques vary. In Papua New Guinea individual plants are cut and bundled, while overseas, sickles and various types of knives are used to cut individual ears. The rice is then threshed by beating against planks or by beating with wooden implements or by treading.

Large areas are usually harvested by tractor-drawn or self-propelled harvesters which carry out harvesting, threshing and winnowing in one operation. Threshed rice is termed "paddy" rice.

Storage

It is essential that rice be thoroughly dried before storage.

Before storage, rice should be winnowed and dried, ideally to 13 to 14 % moisture if it is to be milled soon, or to 10 % if it is to be stored for a while. A storage percentage of 10 % may be impossible to maintain under hot, humid conditions. Good storage facilities are necessary.

Processing

Before consumption, rice must be hulled. Paddy rice is fed into machines (either hand or machine-operated) where it moves between rollers to remove the outer husk. The de-husked rice is termed "brown" rice. Where machines are not available, husking can be carried out by using mortars and pestles.

"White" rice is produced by polishing to remove the closely adhering coat or testa. It is nutritionally undesirable as most of the vitamins as well as other nutrients are removed in the testa. White rice imported to Papua New Guinea from Australia contains vitamin-enriched pellets to make up for much of this loss.

PNG'S FOURTH AGRICULTURAL COLLEGE

Papua New Guinea's fourth national agricultural college is to be established at the existing Bainyik Agricultural Extension Station in the East Sepik Province later this year.

The college, to cost about K1 million, has been included to be set up as part of the East Sepik Rural Development Project.

The report of the working party on Agricultural Education and Training in 1975 recommended to the Government the establishment of an additional agricultural college in Papua New Guinea.

The Government has selected East Sepik as the best location for the college.

The project Manager for the East Sepik Rural Development Project, Mr Bill Graham, expects construction work on the new college to get under way in July this year.

Provision is being made for both male and female students to be enrolled at the college.

Facilities to be provided at the college would therefore include two male and one female dormitories, kitchen-dining room, community hall, library, science and home science block and one double classroom.

The students would undertake two-year certificate courses at the college. The college will also offer one-year diploma level training after the certificate course, as well as some in-service training courses.

TUNA TAGGING IN PAPUA NEW GUINEA

By A.D. Lewis, Fisheries Biologist, Kanudi Fisheries Research Station

Village fishermen, particularly in the Manus, Morobe, North Solomons and Central Provinces, have traditionally relied on coastal tunas as a source of food and have developed special techniques to catch them. As canoes are used, fishermen rarely ventured more than a few miles offshore, and the abundant schools of tuna spread throughout the seas of Papua New Guinea remained unfished. To investigate the potential of this untapped resource, a tuna-fishing company, a Japan-Australia joint venture, was formed in 1970 and experienced good catches almost immediately. Soon after, three other companies began operations, and it was obvious that Papua New Guinea would soon have an important industry based on a type of fish about which very little was known in the Western Pacific—the skipjack tuna.

As the fishery quickly grew in size, it became increasingly important for the government to be in a position to answer such questions as—

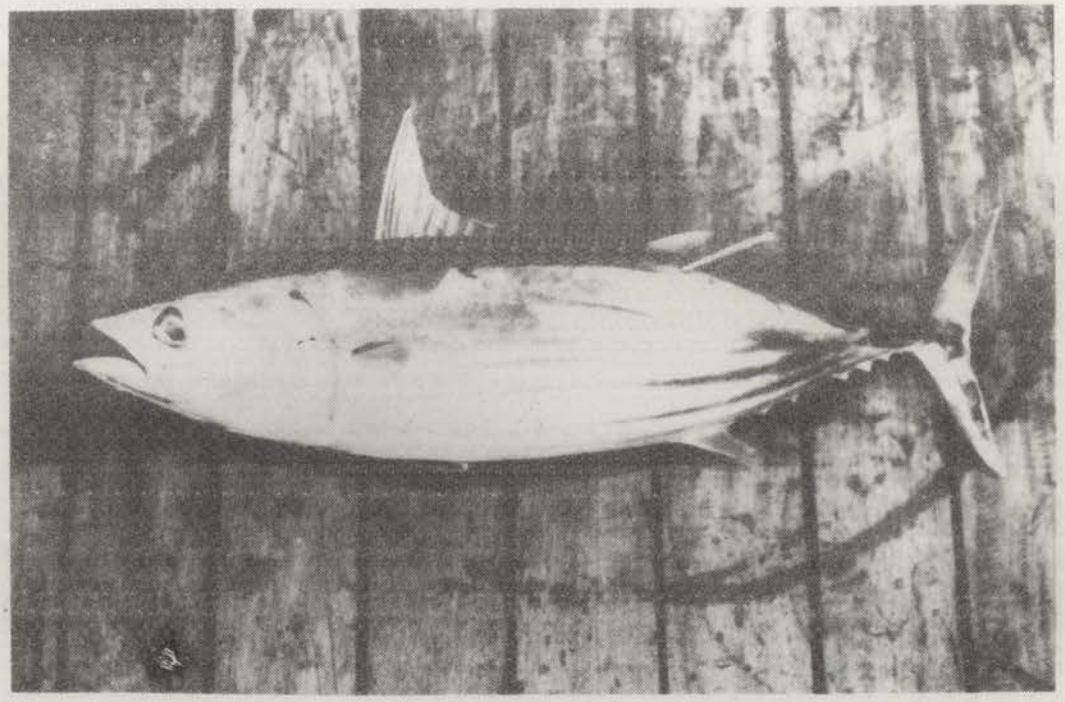
- Do these migratory fish spend all their life in PNG waters and if not, where do the skipjack which are caught here come from?
- Are other countries catching some of the same fish which are caught in PNG?
- Can an understanding of the skipjack's movements be used to help fishermen?

Some of these questions are not applicable to most of the fish we are familiar with, those of the coral reefs, beaches, mangroves and rivers, because they tend to spend their lives in one fairly small area. Tunas, on the other hand, are wide-ranging inhabitants of the open sea and some species are known to cross oceans several times during their lifetime, so these questions become quite important.

A common approach to this problem is to catch the fish being studied, mark them and

Fishing for tuna from traditional canoes in sheltered waters.

Inserting the tag into a fish held in the tagging cradle.



A tag inserted into the back muscle of a tuna.

release them. With the co-operation of fishermen, marked fish which are recaptured are returned with information on how, when and where they were caught. Over a period of time, answers to some or all of the questions asked can gradually be obtained.

Tagging tunas, however, presents problems. With their streamlined shape and special red muscle for endurance, they are built for constant rapid motion and depend on drawing a continous supply of oxygen from the sea-water passing over their gills. To remove them from the water for even a short time, particularly if they have been roughly handled during capture, means permanent internal damage and usually death. As it is important that as many as possible of the marked tunas survive, it is necessary that—

- Each fish is marked and returned to the water within 15 seconds of being hooked.
- The marker, or tag, should not damage the fish. It should remain securely attached and not be pulled off by the continuous fast flow of water, yet not interfere with the fish's normal movements.
- Each fish should be handled carefully and any which appear even slightly damaged should be rejected for tagging.

The tagging method

Tunas are caught using a variety of techniques—trolling from a moving boat, gill netting, purse seine netting (a very large net surrounds the whole school), long-lining and pole-fishing. The last technique, which is the basis of the commercial fishery in PNG, provides skipjack in the best condition for tagging. Small baitfish, kept alive on the fishing vessels, are thrown into schools of tuna. This excites them to the point that they will strike at feather jigs (coloured feathers bound on to a metal hook so as to resemble a small fish) on lines attached to poles (usually 2.5 to 3.5 metres long). They are then lifted into the boat and because the hook has no barb, are easily, shaken free. One man can pole four or more fish a minute when fishing is good.

When tagging however, the fish are not flipped over the fisherman's shoulder and on to the deck, but are directed towards a special cradle lined with wet slippery plastic. Here, the hook is gently shaken loose, and the fish slides down the sloping cradle towards the tagger's hands. He quickly measures it, inserts the tag and drops the skipjack over the side where it falls a few feet into the water. As

Poling tuna.

many as 800 skipjack have been tagged in one day, and as the usual size of skipjack in PNG is around 3 to 4 kilograms, this means that the tagger could throw 2½ to 3 tonnes of live tuna over the side on an exceptional day's tagging.

The tag

The tag resembles a small arrow, consisting of a flexible yellow tube with a nylon barb attached. The bright yellow colour helps to make it easier to see the tags, which is important when there are several thousand fish on deck.

The tags are about 11 cm (4½ inches) long and each one has its own individual number plus the words "DASF PORT MORESBY"*.

The tags fit neatly into pieces of stainless steel tubing which are sharpened at one end and can cut easily through the skin. The tubing, loaded with the tag, is pushed into the tuna's back, just under its second fin, i.e. the one which does not fold down. The tag barb

* The newest batch has the words "FISH RESEARCH PORT MORESBY"

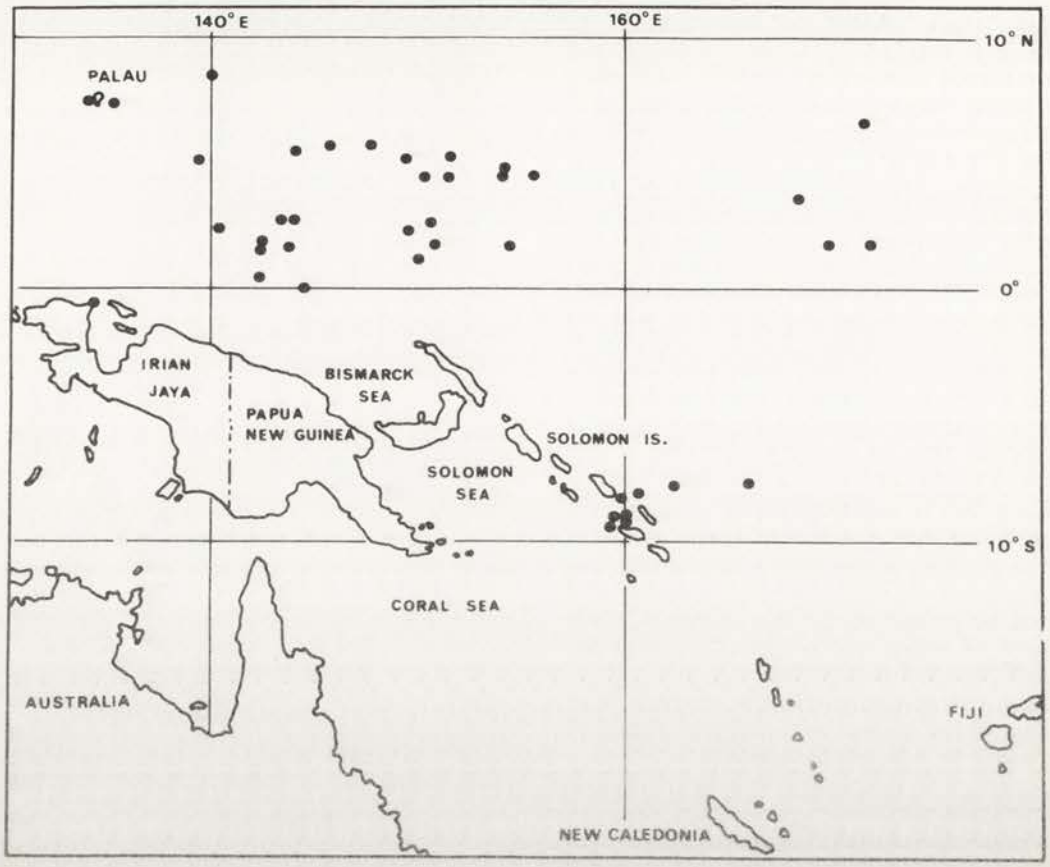


Figure 1.—Tag recoveries outside waters adjacent to Papua New Guinea.

hooks behind one of several small bones which support this fin and lock into place, while the tubing is pulled out. Care is taken not to push the tag in too far, to avoid striking blood vessels and damaging the fish unnecessarily.

If the procedure described is followed, fish are back in the water within ten seconds of striking at the jig.

They are generally in good condition and swim away rapidly; some are occasionally caught again immediately, and most fish probably do not suffer serious damage during tagging.

Numbers tagged and released

Since late 1971, when the work started, nearly 13 000 tunas have been tagged and released. Skipjack made up most of these (11 600), with yellowfin (nearly 1 000) and longtail tunas (about 400) tagged in smaller numbers. Yellowfin tuna grow much bigger than skipjack (up to 135 kg or more, as against about 14 kg for skipjack in PNG). Young fish (less than 10 kg) make up a small percentage of the commercial catch. Longtail tuna are a coastal species found only in the Gulf of Papua.

The majority of these tunas were caught and released from the Department of Primary Industry research vessels "Tagula" and "Rossel". Others have been released from commercial fishing vessels and on joint research cruises with Japanese scientists. Most work has been done in the Bismarck Sea where the Papua New Guinea fleets operate.

Recoveries of tagged fish

Over 750 tagged tunas have been recovered with information provided on their recapture. There is a reward of K2.00 for each tag returned with all the required information

Most of the recaptures have come from fishermen of the PNG-based companies, and boats based in Japan but fishing long distances from their home port. Papua New Guinea fishermen don't catch large numbers of skipjack very often, since the fish usually stay in the clear blue water outside the reef, but nevertheless, two recoveries have been made by local fishermen in canoes near Madang.

We also know of village fishermen catching tagged fish, seeing the tag and letting the fish go because, unfortunately, they though it was government property. Other tags are lost simply because they are not noticed on deck, but some of these are noticed later in canneries when the fish are being cut up. From checking boat catches and company catches, we know also that some boats and some companies are more careless than others and not all tagged fish are reported. Despite the loss of some tags, a very large amount of valuable information has been collected from the recoveries.

Skipjack have been recaptured two years after release; others have been recaptured, released and recaptured a second time. Many had moved only a short distance from where they were released; others were recaptured as far west as Manokwari in Irian Jaya (by a canoe fisherman), as far north as Palau, as far east as the Marshall Islands, nearly 3 000 kilometres away, and as far south as the Solomon Islands *(Figure* 1).

The results show that the skipjack are basically passing through Papua New Guinea waters—some may stay two years, others two weeks, but the paths they follow *(Figure* 2) are generally the same from year to year. We do not really know what factor or factors they are responding to as they make these migrations—currents, temperature, availability of food or other more subtle cues in their ocean world. What we do know is that skipjack tuna comprise a truly international resource not contained within national boundaries and as fishing pressure on them continues to increase, only a co-ordinated international approach will make it possible to reap this rich harvest year after year to the benefit of all nations in the Pacific.

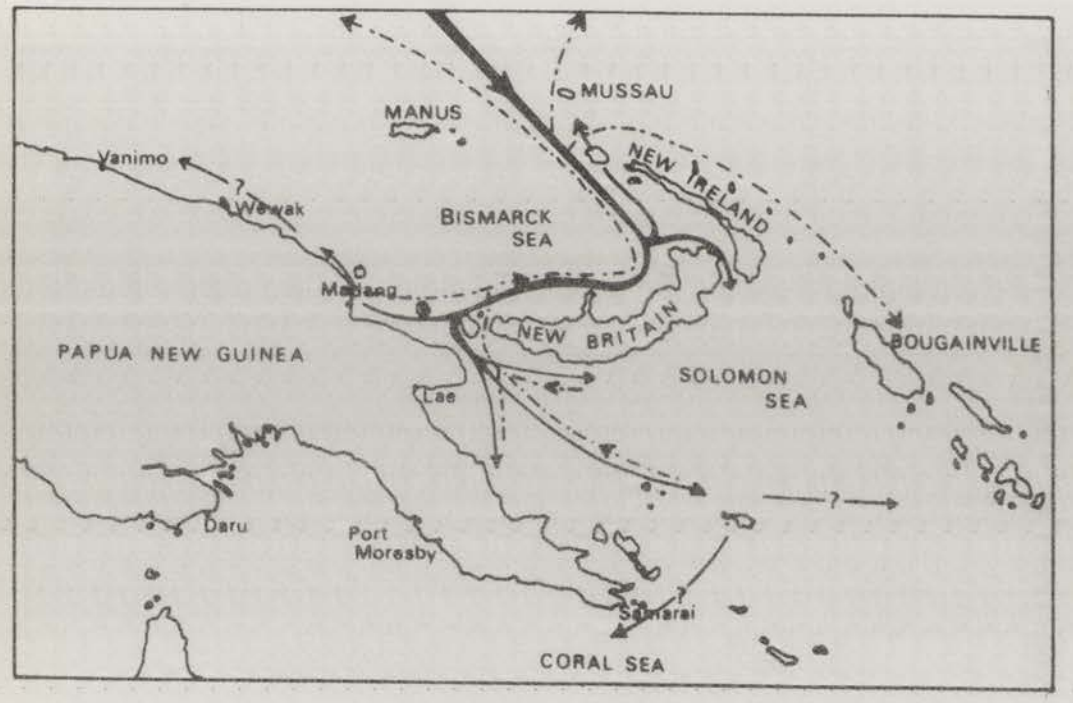


Figure 2.—**Skipjack movements within the Bismarck Sea.**

FIELD DAY, BUBIA

A successful field day was held at the DPI Agriculture Research Centre, Bubia, in the Markham Valley, in November. The large crowd which attended included Form II and Form IV students from high schools in Lae, many of whom will be returning to their villages after leaving school. These students attended to find out what crops are viable in the Markham Valley.

In his introductory hand-out, the Agronomist-in-charge of the research centre, Mr Jim Sumbak, made the following remarks.

"Aside from cleaning up a station the aim of any field day is to show things to the public. We hope that the public in general, Departmental staff, and the Bubia Agriculture Experiment Centre will benefit from this opportunity of getting to meet one another. The occasion is an excellent one for research workers to display some of the fruit of their labours and also for the public to comment on these. . . It is important, however, that deficiencies in research be pointed out as it is very easy for research workers to lose touch with reality. We hope this has not been the case at Bubia. We take the opportunity of encouraging people with technical problems to seek the help of this station. A number of farmers do have close contact with our station and we would like to see these numbers expanded.

"Over the years the function of the station has changed considerably. Whereas, not long ago, virtually all our work was limited to the Markham Valley and the station itself, Bubia staff are now involved in the Ramu Valley, the Madang, East Sepik, Eastern Highlands and Central Provinces as well.

"The work in the Markham and Ramu Valleys deals mainly with sorghum, peanuts, maize, sugar-cane and rice. Coconuts are looked at on Bubia but Omuru near Madang is the main centre where a hybrid coconut seed production scheme is underway. The Sepik work deals with rice while sorghum, maize and peanuts are tested in the Eastern Highlands and Central Provinces.

"Agronomists and Entomologists are on call whenever problems arise. The locust outbreak and green scale problems with coffee in the Wau area are examples of such problems."

Jim Sumbak and Deputy Director Syd Saville welcome visitors to the field day.

Part of the large crowd of visitors who attended.

Primary school children from the nearby Bubia community school also attended.

PAPUA NEW GUINEA RURAL STATISTICS

From the Rural Statistics Section, Planning, Economics and Marketing Branch

As a regular feature of Harvest it is intended to include extracts of statistics on the rural industries in Papua New Guinea. These data will be published twice a year in Harvest and will include export and import information thought appropriate to field officers and other readers, major commodity price indices and an annual production summary. In addition each issue containing these data will highlight a different crop or commodity and include background information to production and marketing in Papua New Guinea. In this way it is hoped that easily digested statistics on Papua New Guinea's rural industries can become available to a wider reading public than currently appears to be the case.

As an introduction to this first publication of rural statistics in Harvest, some brief commodity notes on major products for 1975-76 have also been included.

Coffee

International prices for coffee fluctuated widely about a steadily increasing trend throughout 1975-76. With the failure of other world harvests, PNG coffee received premium prices and DPI producer-paid parchment prices rose from 62 toea/kg for Arabica coffee and 56 toea/kg for Robusta coffee in July, 1975 to K1.15 toea/kg respectively in June, 1976. Very little movement in these prices has occurred since then, despite large upward movements in world prices. However a new purchase price is to be announced in early 1977.

Rising prices and increased plantings during the early 1970s have led to a steady increase in coffee production over the last 3 years. Production for 1975-76 stood at 42 000 tonnes of green bean coffee, an increase of 9% over the previous year. Indications are for a continued increase in production during 1976-77 though movement in world prices may affect this.

Cocoa

A similar upward trend in cocoa prices was apparent during 1975-76, again due to the failure of Brazilian harvests and those of other major exporters. Papua New Guinea constitutes a minor partner in world trade but is able to take advantage of any shortfalls in world production. DPI purchase prices for wet beans rose steadily through the year from about 19 toea/kg in July, 1975 to 33 toea/kg in June, 1976. World prices have temporarily stabilized but with annual planting increases of about 6%, PNG should continue to increase her world market share during 1976-77.

Copra

Despite some cost increases, prices for hot-air copra have risen slowly. DPI purchase prices rose from 12 toea/kg to 18 toea/kg during the year in line with world prices. PNG copra production is very sensitive to price and although production rose some 4% over 1974-75 figures, 1975-76 production of 137 000 tonnes is expected to fall during 1976-77 as prices stabilize.

Rubber

Rubber prices rose slowly over the year 1975-76 despite world production increases. A greater demand for natural rubber during the first half of 1976 led to a run-down of stocks and higher world prices, reflected in the rise of DPI produce prices for RSS 1 from about 39 toea/kg to about 63 toea/kg though most of this rise occurred during the March—June period.

PNG production has dropped sharply since 1973-74. However a continued world interest in natural rubber may lead to some increase and production may rise by more than 12% to 5 700 tonnes during 1976-77.

***Table* 1.—Smallholder crop production by province (tonnes) 1975-76**

	Crop							
Province	*Coffee*	*Cocoa*	*Copra*	*Rubber*	*Tea*	*Chillies*	*Rice*	*Cardamoms*
Western			32	27		5		
Gulf	2		2 056	40		5	5	
Central	23	4	810	147		2	410	
Milne Bay	86	8	3 975			11	5	
Northern	483	315	91	69		58		3.0
Southern Highlands	112				9	29		
Enga	1 522					3		
Western Highlands	9 369				610	0.2		
Chimbu	6 486					0.2		2.6
Eastern Highlands	6 885					0.3		
Morobe	2 535	95	1 217				7	0.7
Madang	305	511	4 749				103	
East Sepik	1 282	357	1 153	2		0.1	881	
West Sepik	217	27	237			8	199	
Manus		3	1 063					
New Ireland	1	240	9 794					
East New Britain	7	4 721	16 712					
West New Britain	2	355	3 225			16		
North Solomons	1	6 220	8 370					
TOTAL	29 318	12 856	53 484	285	619	138	1 610	6.3

Compiled by Rural Statistics Section, Department of Primary Industry.

***Table* 2.—Exports and imports of selected commodities (by quantity and value) 1975-76**

EXPORTS

Commodity	*Quantity (tonnes)*	*Value ('000 Kina)*
Coffee	35 842.72	42 138
Cocoa	30 410.18	28 613
Copra	99 971.0	12 214
Coconut oil	27 992.0	7 322
Rubber	4 902.65	2 703
Palm oil	27 086.79	6 618
Palm kernels	2 521.10	209
Tea	4 785.62	3 978
Chillies	138.0	120
Logs	376 052.0[1]	6 622
Sawn timber	29 305.0[1]	2 615
Plywood and veneer	12 925.0[1]	2 781
Wood chips	112 697.0[2]	3 897
Crocodile skins	116 000.0[3]	290

[1] Cubic metres
[2] Dry tonnes
[3] Inches

IMPORTS

Commodity	*Quantity (tonnes)*	*Value ('000 Kina)*
Fresh, chilled or frozen meat	8 871	7 741
Tinned fish	21 417	7 872
Rice	52 365	12 660
Sugar, refined	19 261	6 732

Compiled by Rural Statistics Section, Department of Primary Industry

Table 3.—**Price indices[1] for major agricultural exports, Papua New Guinea**

	Cocoa[2]		*Coffee*[3]		*Copra*[4]		*Rubber*[5]		*Tea*[6]		*Palm oil*[7]		*Palm kernel*[7]	
Year	*Average price Kina per tonne*	*Price index*	*Average price Kina per tonne*	*Price index*	*Average price Kina per tonne*	*Price index*	*Average price Kina per tonne*	*Price index*	*Average price Kina per tonne*	*Price index*	*Average price Kina per tonne*	*Price index*	*Average price Kina per tonne*	*Price index*
1970-71	450	100	891	100	177	100	412	100	953	100				
1971-72	361	80.2	715	80.3	114	64.6	373	90.4	867	91	223	100	104	100
1972-73	558	124	861	96.6	134	75.8	416	100.9	721	75.7	161	72.2	75	72.1
1973-74	931	206.9	921	103.4	425	240.3	627	152	754	79.1	290	130	195	187.5
1974-75	989	219.8	891	100	302	170.3	510	123.6	954	104.9	355	159.2	167	160.6
1975-76	928	206.2	1 373	154.1	139	78.5	611	148.2	954	104.9	227	101.7	64	61.5

Notes: [1] Base 1970-71 = 100

[2] DIS Rabaul basis

[3] FOB Lae basis

[4] CMB–FOB basis

[5] PRP price basis

[6] DIS basis—London

[7] FOB Hoskins basis

Compiled by Rural Statistics Section, Department of Primary Industry.

Note: Price indices may be an unfamiliar method of recording price movements to some Harvest readers. A price index simply shows how prices have moved since some arbitrary point in the past. In this case 1970-71 prices have been set equal to 100 and the price index shows by what per cent prices since then have varied. For example, coffee prices in 1971-72 were 20% lower than in 1970-71.

A SUCCESSFUL PIG FARMER

By T.S. Bannister, Senior Lecturer, Vudal Field Station

Mrs Agnes Tegura is a member of the Mogae Nambuga clan whose land is located on the edge of Mount Hagen township.

In 1969, Mrs Tegura purchased 3.6 ha of land from the Onambi clan. The land is next to the Kindeng Land Settlement Scheme in the Wahgi Valley. She also farms 3.6 ha which previously belonged to her father.

Mrs Tegura is a successful farmer . She has used the earnings from her farm business to buy trucks, and now, with her husband Joseph Tegura, also operates a successful trucking business.

Her commercial agricultural business includes pig-raising, sweet potato, peanut and coffee production. She also grows cabbages, pumpkins, taro, winged bean, pineapples and pawpaws for sale in the Mount Hagen market.

When possible, Mrs Tegura sells the farm produce in the market herself. She is helped by four women from her family. Six labourers do the heavier farm work such as digging drains and building fences.

Mrs Tegura says that pigs, peanuts and sweet potato are her most important agricultural enterprises. Of these the pig-raising requires most attention and at the same time provides most income. Her 75 pigs are managed in the traditional way, grazed on grass fallow during the day, fed cooked sweet potato in the evening and housed at night.

It is interesting that Mrs Tegura, who is a very successful pig farmer, is grazing her pigs while many blockholders on the land settlement scheme next to her farm have been enthusiastic about permanently housed pigs. In fact, most of these intensive piggeries have proved unsuccessful.*

* R.P. Freund. Bank Loans. Do they promote development. 1976 Waigani Seminar paper.

Agnes Tegura

Mrs Tegura supports her choice of the grazing method of pig raising with some interesting opinions on permanently housed pigs. She believes that permanently housed pigs require too high a level of management particularly in feeding and the control of external parasites. The water needed for adequate hygiene in cement-floored piggeries is often not available. The result is more disease and external parasites in permanently housed pigs.

Mrs Tegura also says that the use of protein concentrate produces meat which is unsuitable for the local market. Such meat must be eaten soon after being removedfrom the mumu or it will become rotten. On the other hand, meat from village grazed pigs fed only sweet potato will keep for two or three days after being cooked. Also, the feeding of protein concentrate produces a tender skin. This means the use of leg ropes causes injuries.

However, Mrs Tegura does prefer the crossbred of the European and Papua New Guinean pig breeds because they grow faster and larger than either of the parent breeds, in village conditions.

Fencing is becoming more important in the area where Mrs Tegura has her farm. The larger numbers of people and gardens (and pigs) now are resulting in more damage to gardens than in the past. In her opinion the fairly large capital expense of building a pig wire fence is money well spent. The pig wire fence needs less labour to build, less labour to maintain, and lasts longer than a bush materials fence. (The pig wire fence used on the farm covers about 0.5 ha and is moved around the farm as required.)

As well as caring for her farm and trucking business, Mrs Tegura finds time to attend regular meetings of the Melpa Area Authority and the PNG Transport Commission. In addition, she has taught the staff and students of Vudal Field Station something about the traditional culture of highlands food crops such as sweet potato and winged bean.

Mrs Tegura's pigs graze in a grass paddock, and are fed cooked sweet potato in the evening.

SUSPENSION FENCING

By Alan Ranson, Cattle Husbandry Adviser

Wire fences for cattle projects can be cheaper if the suspension method is used. Suspension fencing can be used on flat or fairly flat ground.

What is suspension fencing?

As the name suggests the fence is semi-suspended or "hung up" between strainer posts. High-tensile steel barbed wire is used. This makes the fence very springy, and when a beast touches the fence the whole fence starts to move. This tends to stop the beast from going near the fence again.

What is the difference between ordinary and suspension fencing?

Ordinary barbed wire fences need a post every 5 metres. Suspension fences require a post every 28.5 metres, with a strainer post assembly every 200 metres.

The suspension fence has wire spreaders every 5 metres to hold the horizontal wires the correct distance apart. These spreaders do not touch the ground.

The spreaders can be made by twisting two pieces of 4.0 mm (No. 8) plain wire and cutting it into lengths (see *Figure* 1).

How much money is saved?

The following are the costs per kilometre for the two types of fencing. These costs are for fences using star pickets. If the owner uses wooden posts cut from his own trees there is a considerable saving in labour when suspension fencing is used. The saving in cutting, carting and digging is estimated at 160 man hours.

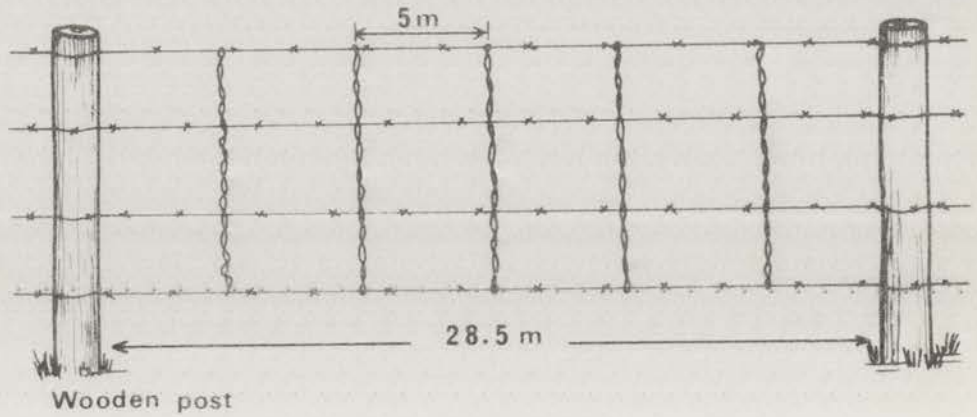


Figure 1.—Wire spreaders (not to scale).

Ordinary method

1. Using 10 SW pattern 14 gauge wire—

10 rolls 2.0 mm (14 gauge) 10 WA pattern wire	K165.00
200 star pickets @ K1.20	K240.00
3 strainer posts wooden @ K2.00	K 6.00
	K411.00

2. Using high-tensile wire

10 rolls 1.60 mm (16 gauge) high-tensile wire	K143.80
200 star pickets @ K1.20	K240.00
3 strainer posts wooden @ K2.00	K 6.00
	K389.80

Suspension method

10 rolls 1.60 mm (16 gauge) high-tensile wire	K143.80
30 star pickets @ K1.20	K 36.00
5 strainer posts wooden @K2.00	K 10.00
175 spreaders @ 10 t	K 17.50
	K207.30
Saving of	K182.50

Erection of fencing

For suspension fencing to be successful, the fence must be erected carefully.

Strainer posts must be at least 46 cm (18 inches) diameter and 2.1 metres (7 feet) long of which 0.9 metres or 3 feet should be in the ground.

Strainer assemblies should be constructed as in *Figure* 2.

Wire spacings should be approximately 30 cm (or 12 inches).

Special care must be taken when straining. All wires must be strained very tight with the same amount of tension on each wire.

On hilly or very steep or broken ground the fencing pattern may have to be changed. Posts should be placed on the tops of rises and bottom of depressions (see *Figure* 3). In such places it may be necessary to change to conventional fencing.

High-tensile wire will not withstand fires so remove dried grass from the fence line at times when fires are likely to occur.

Maintenance

Suspension fences are only satisfactory when they are kept properly strained. They should only be used by farmers who are capable of maintaining them properly.

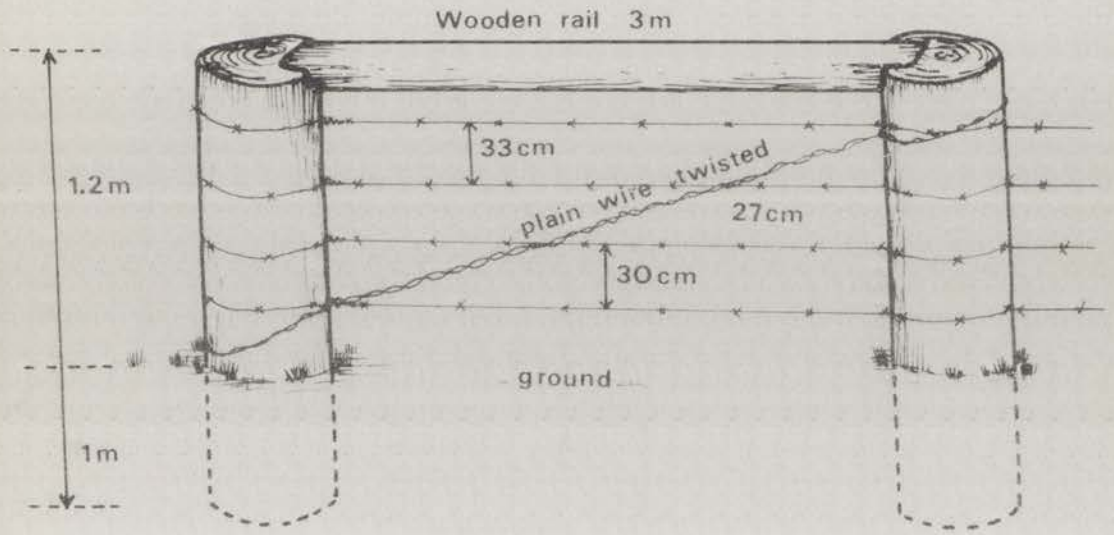


Figure 2.—Strainer assembly.

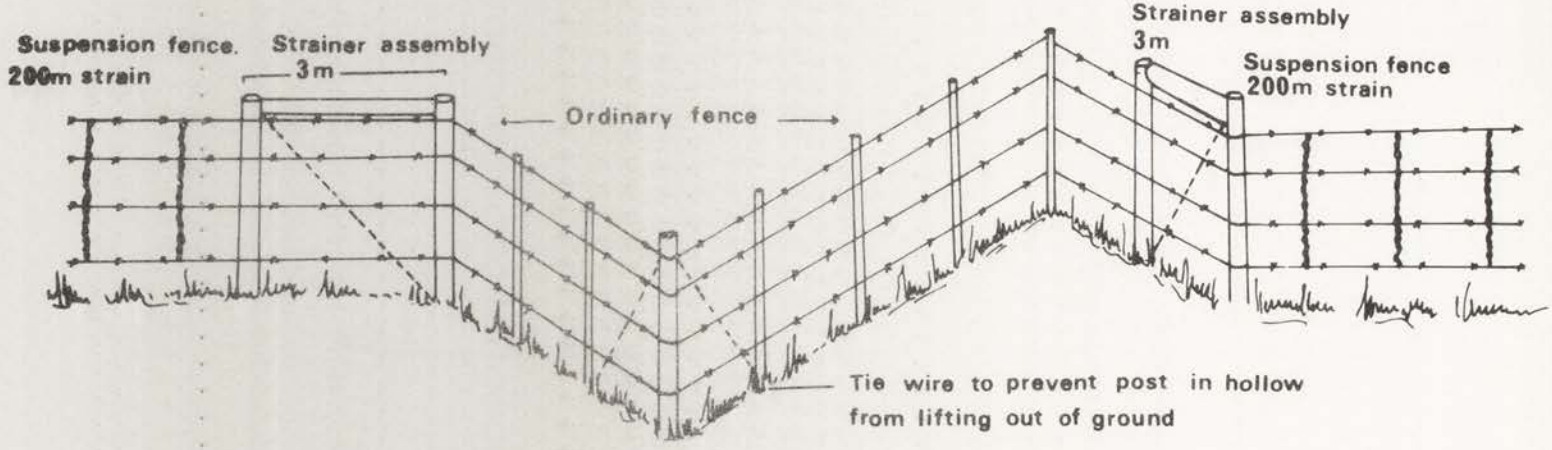
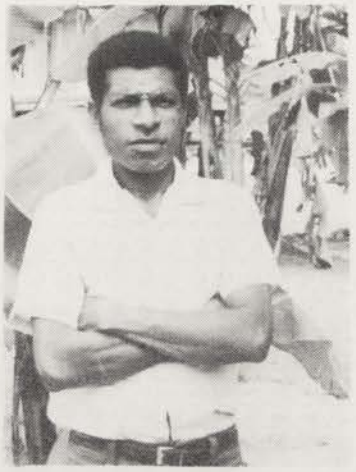


Figure 3.—Combination of suspension and ordinary fencing on hilly ground (not to scale).

WEST SEPIK PROVINCE

By Lawrence Daur, Provincial Rural Development Officer

Lawrence Daur comes from Yaunyai village in the Saidor district of the Madang Province. He attended primary school at Saidor, then went to Tusbab high school, and later to Sogeri senior high school. He attended Vudal Agricultural College from 1968 to 1970. His first posting was to Omuru in the Madang Province, and then on to Saidor and Josephstaal in the same province. He went to Maprik in the East Sepik Province in 1973, where he was posted for ten months as officer-in-charge of the Dreikikir subdistrict. In November he was transferred to Vanimo as associate Provincial Rural Development Officer, and was appointed PRDO for the West Sepik Province in January, 1974. He and his wife Albina, who is also from the Madang Province, have four children.



Mr Lawrence Daur.

The climate of the West Sepik Province has a "wet" season from October to April and a "dry" from May to September. The rainfall averages 2 500 mm per annum. Inland areas experience higher rainfall and lower temperatures. The highest rainfall is at Telefomin with 3 527 mm. The wettest months are December, January and February.

Temperatures in coastal areas are between 25 °C and 33 °C. In higher altitudes such as Telefomin temperatures are between 18 °C and 26 °C.

The strongest winds and rough seas occur during the north-west season (October to April).

The terrain consists of small strips of coastal plains, and the rest is mainly mountainous and swamps. Aitape is flat to rolling with mountains rising to 1 829 m. Telefomin station is roughly 2 500 m above sea level. There are approximately 2 600 km^2 of flood plains east of Green River and Amanab stations.

The soils vary from well-drained low-fertility soils in coastal areas to patches of fertile clay loam in the foothills. Large areas near Lumi are shallow clay to clay loams and leached sandy soils of low fertility. In high mountain areas and at Green River there are soils of poor fertility, mainly limestone clay with some patches of loam topsoil.

The vegetation is mainly thick rainforest, with sago swamps bordering the rivers. The flood plains of natural grass and the forest are the dominant features. There is good forest timber consisting of kwila, taun and garamut in the foothills of the Torricelli and Bewani mountains.

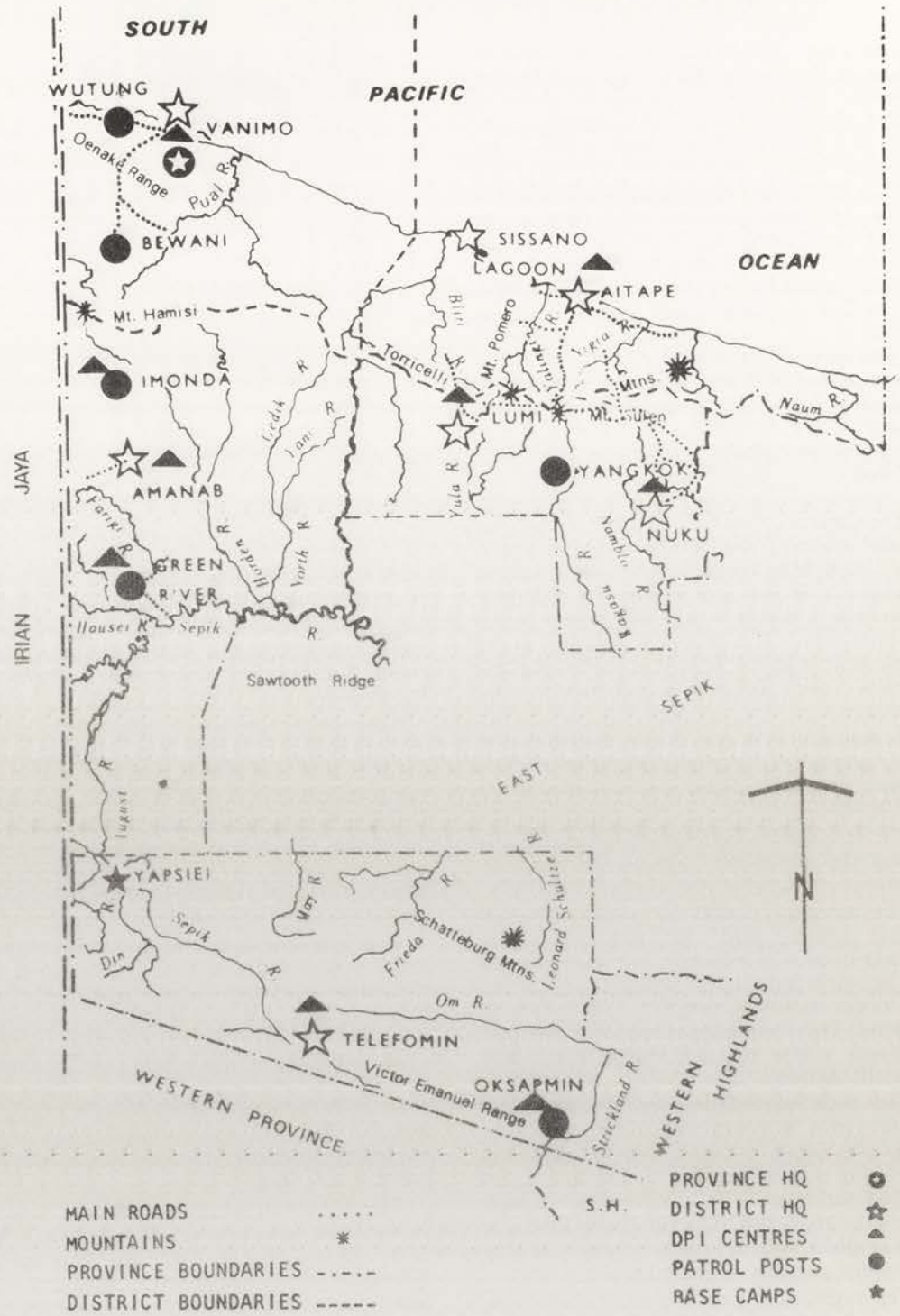
The total area of the province is approximately 31 000 km^2, consisting of 10 360 km^2 nonarable, 12 950 km^2 very marginal and 7 770 km^2 of arable patches.

There are approximately 7 770 km^2 in the 32.18 km (20 miles) wide quarantine zone along the border with Irian Jaya, which also limits agricultural development as no cattle or coffee industry is permitted.

Communications in the province are poor. There is no road access between Vanimo and the other districts. Lumi and Nuku are connected by road to Wewak. Aitape is in the process of linking up with Wewak, a road connection with Lumi is being slowly pushed through, and the first 64 km of the all weather road is being constructed from Vanimo to Bewani. The Vanimo to Sepik road is not however expected to be completed for another ten years.

There is an all weather road from Vanimo to the Irian Jaya border (42 km) and 27 km from Aitape to the Torricelli Mountains. There are short roads feeding out from most district centres. Due to the poor road systems

WEST SEPIK PROVINCE



most villages are accessible only by walking and motorbike tracks.

The main airfields are at Vanimo, Telefomin and Tadji (Aitape) which cater for DC3 and other small planes. There are 18 other airstrips all over the province. All district and subdistrict centres have airstrips. Air Niugini operates between Vanimo and main centres in other provinces and other operators (Douglas and Talair) operate regular and efficient services to outstations when weather permits.

Vanimo is connected by telephone to outside centres with STD, and Aitape is due to be connected soon. The rest of the outstations are connected with radio.

There is regular fortnightly shipping to Vanimo from Madang and Wewak. Low tides at Aitape restrict anchorage at times. General shipping restrictions are in force during the wet season because of rough seas.

People

The total population is 120 000 though approximately 20% of these are absentees. The most densely populated area is Lumi with seven people per km^2.

Spoken language varies from district to district. Malay is common along the border stations of Bewani, Imonda, Green River and Amanab. Pidgin is widespread in all areas except in the Oksapmin and Telefomin areas. Here only educated young people or those who have spent time on the coast can speak it.

Generally the nutritional level throughout the province is low. Apart from the subsistence gardeners of the Oksapmin and Telefomin areas, the remainder of the people are hunters and gatherers. Starch intake of these people is thus high as sago is the staple food. Lumi and Amanab districts are the worst affected areas. Coastal people supplement their food with fish which is abundant.

There are 78 community schools, 3 high schools and 8 vocational centres. Villagers generally show lack of interest in sending children to school and as a result there are very few educated people in villages, and most who go to school get jobs away from home.

Self-help groups have not developed much as yet. The formation of the Village Development Fund Committee in September, 1976, may generate more interest. The Catholic Mission has an organization called Young Christians, but it only started in 1974 and has had only a small influence in agriculture so far. The Wapei Industry Society have a timber mill at Lumi.

Missions have a great influence in the area on development and changing of the way of life. The main missions are the Catholic and CMML.

Land disputes are generally only minor disputes which are settled locally. Land is generally communally owned and of low value for agriculture and therefore unimportant.

Local Vanimo people received a large sum of money for timber rights in 1972. This is now invested at 10%, bringing K12 000 every six months, so there is little incentive among this group for cash cropping.

Nuku, Oksapmin and some parts of Aitape and Lumi are the only areas where people are keen on economic development.

Political

There are currently two levels of government within the province—local government and central government. Provincial government would appear at this stage to be a long way off.

Local government councils operate at Vanimo, Aitape, Lumi, Nuku, Bewani, Imonda, Amanab, Green River and Telefomin. Council tax varies between K5 and K10.

Members of the National Parliament are Paul Langro (Regional), Brere Awol MBE (West Sepik Coastal), Bewa Tou (Bewani), Yacob Talis (Wapei-Nuku), Anskar Karmel (Upper Sepik). Mr Langro is the deputy leader of the Opposition.

Other community leaders include the following: Stephan Holland (Aitape), Vegra Kenu (Vanimo) and Patrick Nehu (leader of the Mopi Association and member of the second House of Assembly for Telefomin).

Economy

There are five major cash crops grown in the province.

Coconut is grown along the coastal areas.

Coffee is scattered in coastal and inland areas. The major producing area is Lumi, closely followed by Aitape and Nuku. Arabica coffee was recently introduced into the Telefomin district.

Rice is grown in Nuku, Yankok and Lumi. It has been encouraged recently in Vanimo, Aitape and Green River.

(Left to right) Village leader Mr Patrick Nehu, rural development assistant Mr Gerald Guire, village farmer Mr Peter Lalley and president of the Vanimo local government council Cr Vincent Mohe visiting a fishing village near Vanimo.

In the produce storage shed at Lumi, (left to right) Cr Wanalap Salake of Lumi local government council, Cr Offi Walaku, president of Wapei council and Mr Alos Sorum, officer-in-charge of DPI, Lumi.

Rural development officer Aloa Sorum looking at coffee growing in the Lumi area.

Chillies are grown in most districts.

Rubber is being introduced on a large scale in the Amanab district.

Other crops include vegetables, which are expanding in Oksapmin, and copal gum, which is mainly limited to the Lumi district.

Livestock are mainly cattle, with a few pig and poultry projects.

Fishing in the West Sepik is excellent, but few people fish commercially.

Forestry is the main industry in the province, although the Goldore Timber Company has closed down after eight years of operation.

Development of the larger Vanimo timber resource in association with private enterprise has been delayed, and there are no immediate prospects of full-scale development for some years. Alternative smaller scale exploitation in association with agricultural developments is now consideration at both Provincial and Headquarters level.

There is a cane furniture industry at Pes village in the Aitape district.

A rich copper deposit at Telefomin is not yet exploited. Small-scale goldmining is carried out in the Lumi and Amanab areas.

A 1 000 ha land settlement scheme is now operating at Pes near Aitape.

Vanimo has branches of the PNG Banking Corporation and the PNG Development Bank. Steamships is the agency for the Bank of NSW.

AGRICULTURAL DEVELOPMENT PROGRAMME

Coffee

Robusta

Robusta coffee is the main crop. There are 488 ha of Robusta coffee, with about 3 900 growers. Production of parchment coffee last year was approximately 271 tonnes.

The 1976-77 aim is to increase plantings by 29 ha, and establish 21 nurseries to plant a further 28 ha.

Rejuvenation of 145 gardens will be carried out at Nuku, Lumi, Aitape and Vanimo.

At present coffee pulpers are very expensive and therefore not many people can afford to buy them. Vocational centres will be encouraged to make DPI-designed pulpers for resale to farmers.

Plantings will be increased annually by 8 ha, over the following four years. Rejuvenation of 100 gardens will be carried out each year.

Local government councils and trade store owners will be encouraged to obtain tools for resale.

Arabica

Arabica coffee has been introduced recently to the Telefomin area and the high-altitude area of the Lumi district. The area planted is 33 ha, and there are 203 growers.

In 1977-78 plantings will be increased by 17 ha—10 ha at Telefomin and 7 ha at Lumi. Fifteen nurseries will be established, and in 1978-79 10 ha will be planted at Telefomin and 5 ha at Lumi.

Market facilities will be provided in 1979-80 and processing facilities and maintenance tools will be obtained.

No further expansion is planned at this stage.

Rice

The area planted to rice is approximately 205 ha, with about 7 000 growers. Production for 1975-76 was 288 tonnes of paddy rice—250 tonnes from Nuku and 30 tonnes from Lumi.

Great interest in rice-growing is shown in Nuku, Yankok and Lumi. Little rice is grown in Aitape and Amanab.

The new variety 6637 has been introduced and is quite acceptable to the people.

The Sepik Producers' Co-operative Society buys much of the paddy rice from the people and resells it to Primary Industry. The marketing outlet provided by the SPCA will be maintained.

Mr Petrus Nambalam on his cattle project near Aitape.

In 1977-78 an increase to 250 ha is planned, as follows: Nuku 144 ha, Lumi 75 ha, Amanab 20 ha, Aitape 10 ha, and expected production will be 296 tonnes.

Current rice-processing and storage facilities are inadequate for this expanding industry.

Three new mills will be installed, at Amanab, Aitape and a large one at Nuku.

In 1978-79 planting in each area will be increased by 6 ha. A paddy rice storage shed will be built.

Cattle

There are 792 head of cattle on 139 projects, and 42 projects not yet stocked.

There are 290 head on plantations.

Most projects are small and require more advice on management and improvement of pastures. Their average area is 6 ha. People are interested in establishing new projects but lack funds and land suitable for projects.

Carrying sago to the river to wash.

Selling sago by the roadside.

In 1977-78 37 new projects are planned, and the 42 projects established in 1976-77 will be stocked with 65 head. Three hundred head will be obtained ready to stock 37 projects in 1978-79.

Improved pasture will be established on 117 ha in 1978-79, increasing the total area of improved pasture to 281 ha.

Two cattle crates will be built, through rural improvement programme funds.

In 1978-79 32 new projects will be established and stock obtained for these projects. One slaughter slab will be built. Farmer training will be arranged.

Pasture improvement will be maintained until all projects have improved pasture.

In 1979-80 the 32 new projects will be stocked. No more new projects are planned.

Subsistence

The aim of this programme is to improve nutrition. There are areas where most people are hunters and gatherers and therefore their nutrition is poor. An extension programme to

Aitape—sago-making by the traditional method.

introduce them to subsistence gardening has been started. The area most affected by malnutrition is Amanab.

In 1976-77 123 gardens were set up, mainly in villages—120 at Amanab, 1 at Nuku and 2 at Telefomin. High protein bean seeds and starch-based cereals have been distributed. However, due to traditional taboos some people tend not to accept some introduced food crops.

In 1977-78 40 new gardens are planned including 10 demonstration gardens and 30 village gardens.

Better planting materials are required. Cuttings of early-maturing sweet potatoes will be distributed. Taro and banana suckers will be obtained for distribution. More corn, soya bean and peanut seeds will be distributed.

DPI will advise the community development officers on the varieties of crops introduced, and they will teach ways of cooking these foods.

In 1978-79 DPI officers will continue encouraging subsistence gardening with better methods of farming and good planting materials.

In future years advice and assistance will be maintained. As people improve their health in areas where malnutrition is a problem, cash cropping will be encouraged.

Vegetables

Most vegetables for sale are produced in the Telefomin district. People in Telefomin and Vanimo districts are interested in vegetable-growing, but there are problems with transport and seed supplies. The industry is also facing some insect problems.

Four local government councils have begun obtaining vegetable seeds for resale. A coolroom and freezer have been established at Vanimo market centre.

In 1977-78 the Department will encourage the establishment of 7 ha of new gardens in the Vanimo district and 4 ha in the Telefomin

district, where transport is reasonably good.

All local government councils and local firms will be encouraged to purchase seeds for resale to farmers, so that local markets can be supplied.

In future years expansion will be encouraged in areas with a market outlet.

Coconut

There are 9 200 growers with 11 400 ha. The total estimated production is 400 tonnes of copra. There are 132 driers.

There are also two plantations of about 243 ha each. Their estimated production is 165 tonnes.

There are large numbers of trees in the province, but there are many nuts available which are not harvested due to low price, transport difficulties and lack of driers.

Farmers will be encouraged to build more bush material copra driers, each clan having at least one. Twenty-six new driers are planned for 1977-78—10 at Vanimo and 16 at Aitape.

Subsistence planting of coconuts will be encouraged.

Production will be increased over the next four years by construction of more driers. No increase in area planted is planned.

Chillies

Chillies are grown in most districts especially the border stations of Bewani, Amanab and Green River.

People are interested in chillies for it is an easy crop to manage and also has a very attractive market price. It is an important crop in the quarantine area.

Last year 87 growers produced 8 tonnes of dried chillies. The area planted is estimated at 5.8 ha.

In 1977-78 planting will be encouraged as follows: Vanimo 4 ha, Lumi 4 ha, Nuku 4 ha, Aitape 10 ha, Telefomin 1 ha and Amanab 4 ha.

Farmers will be advised on better management and processing methods, and on the right type of chillies to be planted. Four farmer training programmes for 20 farmers each will be arranged. In future years the Department will continue encouraging the crop and providing a better market outlet.

Pigs

There are 5 Development Bank projects and 25 semi-commercial projects. Most pigs are raised for subsistence.

Most farmers lack managerial ability. Imported feed is very expensive; however local farmers are not keen on producing their own stock feed (corn, peanut, soya bean, sweet potato etc.). The coastal people do not really make use of the coconuts available.

A pig farmers' association has been started in Vanimo.

Stock movement is under control in most areas.

Existing projects will be encouraged to improve on a semi-intensive basis. Local meat production for sale will be encouraged.

In 1977-78 extension services will concentrate on people who are willing to work hard to produce local feed to minimize the costs of imported feed.

In-service training on pig husbandry will be conducted for field staff.

In 1978-79 pig fattening projects will be encouraged close to the main centres of Vanimo and Aitape. In the following years, successful breeding projects will be encouraged to supply piglets to meet the demand from fattening projects.

Fisheries

The coastal people are beginning to show some interest in catching fish, maybe due to the setting up of a proper market outlet for fish in Vanimo. There are freezers and ice-makers at Aitape and Vanimo.

Ponds have been dug at Pasi and Green River, for breeding tilapia and goramy. In 1977-78 these ponds will be completed and stocked.

Four thousand trout fingerlings will be introduced to rivers in the Telefomin district.

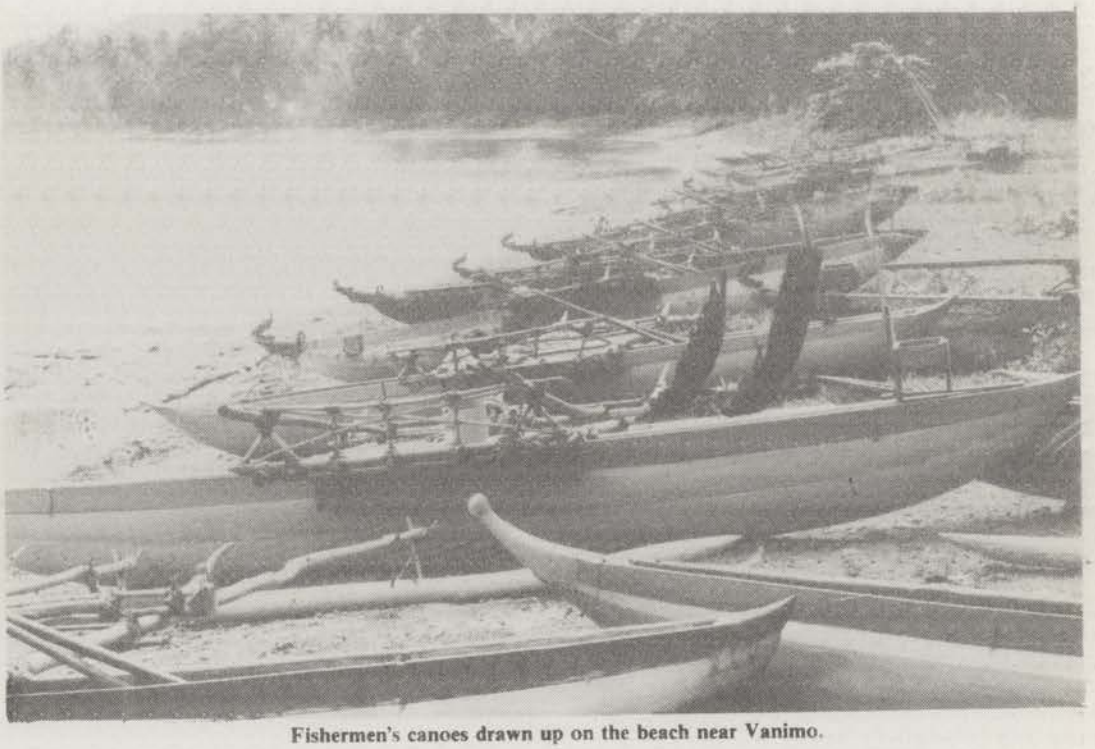
Extension services to fishermen on fishing techniques will be continued. Private firms will be asked to stock fishing nets for sale.

In 1978-79 coastal fishing will continue to be encouraged. Fingerlings of tilapia and goramy will be distributed to existing ponds.

In 1979-80 ice will be sold to fishermen, to encourage more fishing.

The extension service will continue to give advice on fishing techniques and preserving methods.

Village pig project.



Fishermen's canoes drawn up on the beach near Vanimo.

Poultry

Most poultry are grown for subsistence. Two layer projects have been started at Lumi. High quality feed crops (corn, soya bean etc.) have been introduced there.

In 1977-78 400 day-old chickens will be obtained from Lae. They will be raised to eight weeks old at Pasi extension centre and then distributed to villages. Thirty ducks will also be distributed.

One more layer project at Vanimo and two at Lumi will be established, and these will be encouraged to plant stock feed.

In 1978-79 advice to existing projects will be maintained, and more chickens will be obtained for resale to villages.

In 1979-80 stock feed projects to sell feed to poultry farmers will be encouraged. Training will be arranged for interested poultry and stock feed farmers.

Wildlife

Four demonstration crocodile farms have been established. There is interest in crocodile-farming; however the big problem is lack of food which is mainly fish.

In 1977-78 four projects will be established at Lumi, three at Edwaki, two at Au East and West and three at Aitape. Crocodile farming will be encouraged in future years wherever there is feed potential.

An officer will be trained in butterfly farming and will encourage butterfly farming in the Amanab and Vanimo districts in 1977-79.

Wildlife laws will be enforced, and wildlife management areas will be encouraged.

Mr Peter Lalley, poultry project owner.

Rubber

Apart from one ten-year-old block of 0.5 ha at Amanab, rubber is a newly introduced crop to the area. It is most suited to the area along the border, where it is not a restricted crop, in places where the soil is not suitable for other cash crops. People are showing interest.

Eight trials have been established in the border stations.

There are 33 689 seedlings available for distribution to projects and also 800 budded stumps.

The 0.5 ha of ten-year-old rubber trees are ready for trial tapping.

In 1977-78 a processing factory will be constructed at Amanab, and the old trees will be tapped as a demonstration.

Seedlings will be transplanted to five villages which have started clearing sites.

Farmer training will be arranged. Influential leaders will visit established rubber projects in other provinces.

More seeds will be planted in nurseries.

In 1978-79 five more villages will be encouraged to start planting and the area planted will be increased from 10 ha to 20 ha. Six more farmers will be trained each year, and the area planted will be increased by 10 ha each year between 1979 and 1982.

Cocoa

This is a new crop for the province. One expatriate is involved but not many local people as yet.

Three trials have already been established, at Pes, Bewani and Vanimo.

Planting of 60 ha at Pes was begun last year, but problems of shortage of planting material and lack of farmer understanding of this new crop have delayed progress.

In 1977-78 it is planned to continue with the planting at Pes. Four nurseries will be established at Aitape. Five hundred clonal cuttings will be obtained from the Lowlands Agricultural Experiment Station, for demonstration at Bewani. Planting at Vanimo will be increased from 10 to 12 ha. Training will be provided for all farmers now involved in cocoa.

In 1978-79 planting of 60 ha at Pes will be completed, and the areas around Pes will be encouraged to take an interest. Assistance for the development of the projects will be requested from the Development Bank.

Photography by Linda Cavanagh.

LOCUST EXPERTS IN PNG

The Department of Primary Industry has secured the services of two experts on locust control. They are Mr J. Roffey and Mr J. Tunstall, both from the Centre for Overseas Pest Research in London.

The Minister for Primary Industry, Mr Boyamo Sali said the two experts on locust survey and control would train a Locust Patrol Unit newly established in the Department to maintatin constant lookout for any future threats by locusts.

Mr Sali said the two experts have been made available by the British Government at the request of the Papua New Guinea Government for assistance in controlling the locust plague in the Morobe Province.

The Minister said at present the locust plague, which had been causing problems in the Markham and Ramu valleys periodically since 1973, appeared to be under control due to an intensive survey and aerial spray programme carried out by the Department of Primary Industry last year.

He said it was too early to predict a complete eradication of the pest and his Department was working on a long term plan for any future swarms.

Mr Sali said Mr Roffey and Mr Tunstall would train the new established Locust Patrol Unit for a period of four to six weeks.

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