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CONTENTS

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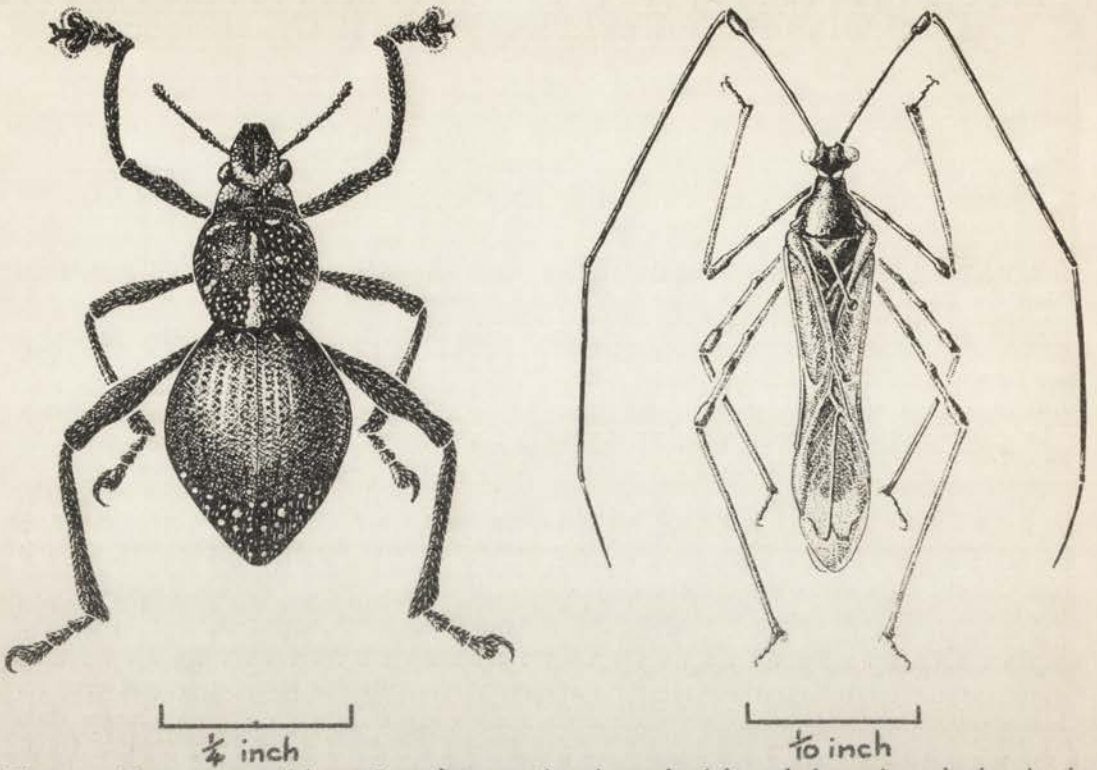

Figure 1.—The cocoa weevil borer, *Pantorhytes szentivanyi*, on the left, and the main podsucker in the Northern District, *Helopeltis clavifer*, on the right

Recommendations for Control

1. Where the infestation is heavy, trees should be sprayed every six weeks with trichlorphon. One gallon of the commercial product is added to 5 gallons of water, and mixed thoroughly. This is then used in a portable motorized low volume spraying machine, spraying at the rate of 2 gallons per acre. This gives good droplet size, good coverage, a high percentage kill and low labour costs. It is possible for one man to cover an acre of cocoa trees in two hours.

For heavily infested areas, the spraying should be continued every 6 weeks for at least a year. After this time, the frequency may be reduced to once every three months.

Health Hazard: Trichlorphon is poisonous if excessive amounts are spilt on the skin, inhaled or swallowed. Precautions to ensure the good health of sprayers are given below under "Safety of Spraying".

2. If there is an infestation of podsuckers (such as *Helopeltis clavifer*) as well as the *Pantorhytes* weevil, the spray programmes for the two may be combined. Either lindane or trichlorphon will kill podsuckers, but a 3-week cycle is needed because of the very short life cycle of the insect: from egg to adult takes only 3 weeks. Lindane is cheaper than trichlorphon, more effective against podsuckers (but not against *Pantorhytes*), and safer to use, so the introduction of a second insecticide is justified. For use, 13 fluid oz of the commercial product (16 per cent lindane emulsifiable concentrate) should be applied per acre in 3 to 6 gallons of water. This gives an active ingredient application of 2 oz per acre.

A spraying with lindane halfway between two trichlorphon sprayings is recommended if podsuckers are causing damage.

3. If the infestation is not heavy, control may be achieved by the following:

(*a*) Around each area of cocoa there should be a strip of the leguminous creeper, *Pueraria*, 40 to 45 ft wide. *Pueraria* is difficult for the

Pllate I.—A cocoa tree showing severe defoliation caused by the *Pantorhytes* weevil

weevil to walk through, and is not a satisfactory food, so it acts as a vegetative barrier. Complete isolation cannot be achieved, of course, because there are always roads, cars and people to help the weevil across the barrier. It is suggested that new plantings of cocoa should be on areas of no more than 20 acres. This will help isolate infestation within particular areas.

(*b*) It has been found that where the shade trees are high (rubber, coconuts or primary bush) the *Pantorhytes* infestation is reduced. Heaviest infestation is found where there is no shade, and moderate infestation where there is low shade (such as *Leucaena*) or a dense canopy of the cocoa itself. The Department therefore recommends that cocoa shade should be rubber, kamarere or coconuts. All these trees should reduce army worm and *Pantorhytes* population and damage.

(*c*) For new plantings, it appears that clonal cuttings are better than seedlings because they are more resistant to *Pantorhytes*. The reason for this is probably the absence of the jorquette in the cutting. This will be investigated further in the near future. Clonal cuttings have the advantage that they are resistant to dieback and come from high-yielding stock.

BACKGROUND RESEARCH WORK

Needless to say, a good deal of research work was carried out before these recommendations were made, and work on various aspects of the spraying programme and on the life-history, ecology, biocontrol and insecticidal control is proceeding. An increased understanding of these items will lead to more effective spraying.

The first investigation was a study of the various insecticides which could be used, considering effectiveness, ease and safety of use, and relative costs. This work indicated that trichlorphon was most satisfactory.

I. *Effectiveness of Spraying for Pantorhytes*

The production figures (*Table* 1) showed a considerable increase after the commencement of the spraying programme.

Table 1.—Summary of production trends (lb of wet beans)

Settlement Scheme	Jan.-June, 1968	July-December, 1968	January-June, 1969	July-December, 1969	January-June, 1970	July-December, 1970
Sangara	36,406	53,047	139,171	145,546	116,277	84,153
Girua	8,703	22,480	38,783	56,098	38,467	44,354
Isevini	74,977	80,787	207,783	207,152	189,801	185,096
Arehe	143,983	123,553	136,624	107,311	51,781	84,231
Total						
lb wet beans	264,069	279,867	522,361	516,107	396,326	397,834
tons dry beans	47.1	49.7	93.3	92.2	70.7	71.1
			Total 1968— 96.8			
			Total 1969—185.5			
			Total 1970—141.8			

Notes.—1. Spraying for *Pantorhytes* control commenced in September-October, 1968 using Dipterex SP80 (High Volume spray).

2. Dipterex LVC (Low Volume) was substituted for Dipterex SP 80 during July-August, 1969.

3. Spraying for *Pantorhytes* control except for a few isolated blocks virtually ceased in November, 1969.

4. Spraying for both *Pantorhytes* and podsucker control, but mainly podsucker control, recommenced in August-September 1970. Consequenty there would have been some regression in the trees due to both *Pantorhytes* and podsuckers. The marked fall in production showing up in 1970, especially on Arehe, was due to podsuckers.

5. Some of the increased yield over the period January-December, 1969 was no doubt due to increasing use of lindane to control *Helopeltis clavifer*, but most of the increase was the direct result of increased tree vigour and subsequent production as a result of control of *Pantorhytes*.

6. Before spraying commenced in September-October, 1968, the Schemes were classed for *Pantorhytes* damage as follows:—

Moderate .... Arehe;
Moderate/severe .... Isiveni; and
Severe .... Sangara, Girua.

II. *Effectiveness of Spraying for Podsuckers*

At Pirive, in the Kokoda Valley, a trial is proceeding to determine the cocoa production in different areas sprayed for podsuckers with lindane at intervals of 1 month, 2 months and 3 months. A control area is not sprayed at all. *Table* 2 shows total production for the 12 months period December, 1969, to December, 1970.

Table 2.—Production of sprayed and unsprayed cocoa

Spraying interval (in months)	Production of dry beans (lb)	Percentage increase of sprayed over unsprayed plot
1	766	65
2	672	45
3	586	26
No spray	465	—

III. *Safety of Spraying*

Trichlorphon is an organo-phosphorus insecticide, and whilst it is safer than other insecticides of a similar chemical nature, caution is needed to ensure that the men operating the spraying machines suffer no ill effects.

Sprayers cannot avoid inhaling the spray, especially in areas where the cocoa trees have formed a continuous overhead canopy.

Although there are no visible symptoms until the patient's condition is serious, a test to determine the amount of cholinesterase in the blood gives an indication of possible poisoning effects. The normal cholinesterase content is 90 to 150 units. Blood samples taken from sprayers three times per week showed a steady drop in blood cholinesterase content. The danger level of 45 units was reached in 6 weeks. To guard against the possibility of serious illness, all spray teams should work for no more than a fortnight continuously, followed by a month on other work.

Since the worker carries the diluted spray on his back (and the diluted spray is still quite concentrated) a leaking machine must never be used. When the spray is being diluted, the worker must take care that any spray spilt on his hands is immediately washed off.

Finally the worker should wash his clothes as soon as he has finished spraying. Sleeping in spray-sodden clothes should certainly be forbidden.

Plate II.—*Pipturus argenteus*, the main original host tree of *Pantorhytes*

IV. *Cost of Spraying*

Costs were calculated on the basis of the following data:—

Insecticide costs $11.70 per gallon;

One gallon is sufficient for 3 acres;

Frequency of spraying is 6-weekly in the first year, and 3-monthly in the second year; and

One man can spray 4 acres in a day.

Estimated costs per acre are given in *Table* 3.

V. *Effect of Spraying on Other Insects*

There is always the danger that spraying with a chemical insecticide will kill the "good" insects as well as the "bad" ones. If the spray kills the *Pantorhytes*' natural enemies, this could lead to an increase, rather than a decrease, in the *Pantorhytes* population.

To check this point, two areas having similar degrees of infestation of *Pantorhytes* were subjected to two different treatments. One area was sprayed at monthly intervals with trichlorphon, while in the other area, the *Pantorhytes* weevils (adults and larvae) were removed by hand. This is a slow and laborious and expensive task, and it is not possible to remove every weevil, but it is a method of removing some weevils without affecting the other insects.

Table 3.—Estimated costs of spraying per acre per year

	Machine plus spares	Petrol/oil	Insecticide	Labour	Total
First year	$2.71	3.60	31.20	2.15	39.66
Second year	$1.35	1.80	15.60	1.07	19.82

The predators of the *Pantorhytes* weevil that were particularly under scrutiny were a tipulid fly *Nephrotoma* sp., a tachinid fly *Doleschalla*, and a bethylid wasp *Propistocera*. *Nephrotoma* looks like a large mosquito. It normally feeds on leaves, but will prey on small insect larvae or *Pantorhytes* larvae in larval channels. *Doleschalla* larvae feed on *Pantorhyhtes* larvae and eventually kill them. *Propistocera* feeds on the *Pantorhyhtes* in the late larval and early pupal stages. Since the damage to the cocoa tree is done by the larval stage of the *Pantorhytes* weevil, *Propistocera* does not help much, except that it reduces the number of adults which will give rise to the next generation.

In this trial, 5 sites, each of 10 trees, in each treatment area were inspected carefully and the number of weevils counted as accurately as possible. Initially the number of adults per site was about 50, but after 3 months of spraying, the number in the sprayed areas had dropped to 10. In the manual control area (that is, where weevils were removed by hand), the population per site had dropped to 25. The totals in the two areas fluctuated about these levels until after 8 months the numbers dropped to about 10 in the manual control

Plate III.—A sprayer at work. One disadvantage of low volume spraying is that the spray coming from the nozzle is barely visible

area also. This was probably due to migration onto less populated trees in the vicinity.

In both treatments, there was initially a decline in the proportion of channels harbouring the tipulid *Nephrotoma* sp. This was most pronounced in the insecticide treatment area, and it was initially thought the insecticide may have been having a deleterious effect on this species.

Fly traps were also set up in each block to see how the insecticide was affecting other insects in the two areas. Sampling showed that the insecticide treatment had no effect on ants nor on other insects occurring in or on the cocoa.

After 20 months, the spraying was stopped and the area was observed to see how quickly the population of *Pantorhytes* would build up again. Recovery was rapid, and the adult count soon averaged 110 (as against 10 with spraying). The increase in larval numbers was also rapid in the area formerly receiving the insecticide treatment. The incidence of *Nephrotoma* was quite low during this initial period, but subsequently increased.

VI. *Crazy Ants*

To many planters it seems that crazy ants (*Anoplolepis longipes*) can provide the best solution to the problem of the *Pantorhytes* weevil. When the ants come, the weevils go—it seems so simple. The evidence is, however, that the ants do not kill the weevils, they just annoy them. So the weevils go away—probably to another cocoa tree where there are no ants.

The ants appear to be quite unpredictable in their behaviour. More needs to be learnt about the conditions under which they will establish a colony and why they will suddenly leave it. The Department has commenced a study of the *Anoplolepis* ant to study its general biology,

Plate IV.—Two cover crops which may be used for a vegetative barrier—*Pueraria* in the foreground and *Momordica* behind

food preferences, climate preferences, nesting sites, natural enemies, and other factors that will affect its population growth and stability. Early indications are that conditions which are best for the cocoa are not good for the ant and vice versa. If this is confirmed, then obviously it will not be possible to manipulate the ant to be an effective controlling agent of *Pantorhytes*.

VII. *Long Term Studies*

The work on population dynamics of *Pantorhytes* being undertaken by Dr E. Hassan will be described in the next issue of *Harvest*. He is seeking to answer such questions as "what conditions cause an increase in the *Pantorhytes* population?" and "how far does one weevil travel in a day or in a year?"

A study of the weevil in its natural habitat is obviously fundamental for any system of control.

Further work will be reported as results become available.

Vegetable Growing

K. H. VAN HORCK, Experimentalist

Highlands Agricultural Experiment Station, Aiyura, Eastern Highlands District

This article has been written in response to many requests from people wishing to grow vegetables for sale. Problems of marketing, however, must not be overlooked. Accordingly, this article on the technical aspects of growing vegetables concludes with a brief discussion on marketing by D. R. J. Densley, Chief Agricultural Economist.

MOST European-type vegetables can be grown in Papua and New Guinea, in areas which are sufficiently elevated to provide a temperate-like climate. Generally speaking, vegetables can be sown at any time of the year in the Highlands, provided they can be watered adequately, because the temperature does not vary much from season to season, and there is a fairly constant day length throughout the year. Even at sea-level it is possible to grow some vegetables such as beans, tomatoes, pumpkins and Mignonette lettuce.

Preparing Seed Boxes

Some plants do not transplant satisfactorily, and best results are obtained by sowing where they are to remain. These include spinach, peas, beans, cucumber, pumpkin and corn. Others are best sown first into seed boxes.

The boxes or trays should be of convenient size, say 18 in x 12 in and not deeper than 4 in, so that one person can carry them easily to the planting site. There are also special plastic trays of 12 in x 12 in on the market which are very suitable.

A useful medium for filling the trays is three parts of sifted top soil with one part of clean sand, mixed thoroughly.

The seed should be sown sparsely and covered with approximately $\frac{1}{8}$ to $\frac{1}{4}$ in fine soil, so they will have enough space to develop into strong plants. If sown too thickly the young seedlings will grow up spindly and will never grow into strong, vigorous plants.

When the seedlings are about 3 in to 4 in high, they are ready for planting into the field.

Care should be taken that the seed boxes are never allowed to dry out, but are kept in a shaded place until two weeks before planting out. At that time they are placed in the sun for hardening off for one hour the first day, and gradually increasing the hardening off periods so that they are in the sun all day for the last week before planting out.

When transplanting, it is very important to make sure that the roots hang free in the planting hole and are not bent in any way.

Preparing the Beds

A convenient size of bed is 4 ft wide with a path of 18 in between the beds. The soil must be worked until it is fine and friable. It is advisable to have the beds raised approximately 8 in to allow drainage of surplus water. All the paths should run into a deeper drain capable of carrying away all the water.

After the block has been dug over to an even depth, not disturbing the sub-soil, the beds are marked out and the soil in the "paths" placed on the beds. When all the beds have been formed this way they are raked to distribute the soil evenly on the surface and level the edges.

If animal or poultry manure is available, it should be well dug into the beds. This will reduce the need for artificial fertilizers. The fertilizer should not come into contact with seeds but be raked into the soil beneath them.

Watering

Care should be taken to see that the vegetable beds always have adequate water, and in

dry weather regular watering will be needed. The vegetables will then grow quickly and will therefore be more succulent and appealing. This applies particularly to leafy types such as lettuce and cabbage. On the other hand, too much water can stagnate the root systems, making the plants unhealthy.

Weeds

Apart from robbing the soil around plants of nourishment, weeds provide a harbour for snails, slugs, thrips, aphis and other pests which damage or destroy plants.

It is better not to allow the weeds to grow so big that they have to be removed from the garden. Lightly chipping them as soon as they appear and leaving them to decompose on the surface provides a useful light mulching. In this way any nutrients removed from the soil are eventually returned.

Planting Notes

BEANS AND PEAS: Plant direct into bed, approximately 2 in deep, 6 in between plants and rows 2 ft apart. Varieties recommended: Climbing beans—Westralia, Snake (Yard Long, Asparagus) bean. Dwarf bean—Brown Beauty. Peas—Telephone, Greenfeast.

BEETROOT AND PARSNIP: Plant sparingly in drills in bed approximately 1 in deep and thin to 4 in between plants; rows 1 ft apart. Beetroot variety recommended: Early Wonder.

BROCCOLI AND BRUSSELS SPROUTS: Sow in seed box and transplant at 18 in in the row and rows 2 ft apart. Varieties recommended: Broccoli—Green Sprout. Brussels Sprouts—Champion.

CABBAGE AND CAULIFLOWER: Sow in seed box and transplant at 30 in in the row, and rows 2 ft apart. Varieties recommended: Cabbage—Select Succession, Sugar Loaf, Savoy King (warmer areas), Prize Red (pickling). Cauliflower—Snowball "A", Snowball "X", Early Shorts. When the cauliflower heads start to form, it is essential to protect them from rain.

CHINESE CABBAGE: Sow in seed box and transplant at 12 in in the row, and rows 1 ft apart.

CAPSICUM: Sow in seed box and transplant at 12 in in the row, and rows 1½ ft apart.

CARROT: Plant sparingly in drills in bed ½ in deep, and thin to 3 in between plants; rows 1 ft apart. Varieties recommended: Topweight, Western Red. These are both resistant to carrot virus.

CELERY: Sow in seed box and transplant at 6 in between plants, rows 1½ ft apart.

CUCUMBER: Plant direct in beds in groups of 3 seeds, and thin to 1 plant. Spacing 4 ft each way.

LETTUCE: Sow in seed box and transplant at 12 in in the row, with rows 1 ft to 1½ ft apart. Varieties recommended: Winter Lake, Great Lakes, Pennlake, Imperial 615, Mignonette (warmer areas).

ONION: Sow in seed box and transplant at 4 in in the row, with rows 1 ft apart. Varieties recommended: Hybrid Granex Brown and White, Early Lockyer Brown and White, Early Crano Brown.

PARSLEY: Sow in seed box and transplant at 12 in in the rows, rows 1 ft apart.

PUMPKIN: Plant direct in position in groups of 3 seeds and thin to 1 plant. Spacing 10 ft each way. Varieties recommended: Butternut, Buttercup, Golden Hubbard Squash.

RADISH: Sow in drills in the bed, ½ in deep, and thin to 2 in in the row, with rows 6 in apart.

RHUBARB: If using seed, sow in drills ½ in deep and thin to 18 in in the row, with rows 2 ft apart. Crowns can be planted direct 18 in apart in the row, with rows 2 ft apart.

SILVER BEET AND SPINACH: Sow in drills 1 in deep and thin to 6 in in the row. Rows 1½ ft apart.

TOMATO: Sow in seed box and transplant at 24 in in the row, with rows 3 ft apart. Varieties recommended: Devlin's Choice, Grosse Lisse No. 45.

TURNIP: Sow in drills in the bed and thin to 6 in in the row, with rows 1½ ft apart.

PESTS AND DISEASES OF VEGETABLES

Diseases can be caused by fungi, bacteria, viruses, nematodes, and other micro-organisms. In order to keep the amount of disease as low as possible, the following recommendations should be observed:—

1. Use commercial packeted seed if possible; if not, use seed from plants which are free from disease.
2. If a disease occurs, send specimens to the District Rural Development Officer, or to the Principal Plant Pathologist, D.A.S.F., Konedobu, for identification and advice on control measures.
3. Many fungus diseases such as leaf spots can be controlled by spraying with a fungicidal spray such as copper oxychloride or "Zineb", but to be effective the spray must be applied as soon as the first spots appear. Mildews are more effectively controlled by sulphur dust.
   Virus diseases are often carried from plant to plant by insects such as aphis and thrips, so some measures of control may be obtained by destroying these pests. Affected plants should be weeded out and burnt.
4. After the vegetables have been picked, destroy the plant residues by burning if disease was present in the crop.
5. Special measures, such as rotation of crops, should be taken if a soil disease is present.

Spraying and Dusting

In most cases, spraying is more effective in controlling plant disease than dusting, provided the spray is applied thoroughly.

It is necessary to wet all parts of the plant with spray, particularly the underside of the leaves.

Dusting may also be effective, but its efficient application is limited to periods when the air is very still, preferably in the early morning when the leaves are still wet from overnight dew. Shaking or sprinkling dust over a plant is not successful because the dust does not reach the underside of the leaves. The best method is by a dust gun or puffer-type squeeze duster.

Insect Pests

Many insect pest problems can be avoided by spraying routinely with 0.05 per cent malathion every 7 to 14 days. Malathion is supplied commercially as a 50 per cent concentrate. To dilute this to a 0.05 per cent solution, add ½ fluid oz to 3 gallons water. Recommendations for specific pests are given in the accompanying table.

The application rates stated on the pesticide labels should be carefully followed. Lower rates may be ineffective, while higher rates are wasteful and may burn or otherwise damage the plants. If pesticides are applied to excess, a harmful amount will remain on the vegetables after harvest. Under no circumstances should pesticides be applied to vegetables closer to harvest time than 30 days for DDT and lindane, 7 days for dicofol and maldison, and 3 days for carbaryl.

Snails and slugs are controlled by a bait containing metaldehyde or a mixture of metaldehyde and B.H.C. The bait is placed in small heaps in several places on the bed.

Ants are a general nuisance and can undermine beds, interfere with the feeding system of nearby plants, and carry aphis to plants and

PEST CONTROL RECOMMENDATIONS FOR VEGETABLES

Pest	Chemical	Method of Application	Interval Between Treatments
Leaf-eating caterpillars	DDT or carbaryl (Sevin^{R}, Septene^{R} Resistox^{R})	spray or dust	7 to 14 days
Cabbage moth	carbaryl	spray	7 days
Cutworm	lindane	water into soil	14 days
Grasshoppers	lindane	spray or dust	7 to 14 days
Leaf-eating beetles	lindane	spray or dust	7 to 14 days
Aphis	maldison (Malathion^{R})	spray	7 days
Thrips	DDT or maldison	spray	7 days
Green vegetable bug (shield bug)	maldison	spray	7 days
Red spider, mites	dicofol (Kelthane^{R})	spray	7 days
Bean fly	DDT or lindane	spray	3 days after seedlings emerge; 3 days later, thereafter 7 days

Note.—DDT must not be applied to cucumbers or pumpkins as it can kill them. Lindane must be applied cautiously on these crops.

then tend them there. They can also do considerable damage in seed boxes by carrying away small seeds. They can be controlled by spraying or dusting the soil surface in the seed box with DDT immediately after sowing, to protect the seed, and then treating the ants' nest itself by saturating with 2 per cent chlordane in water.

VEGETABLE MARKETING IN THE TERRITORY

Over recent years concern has been expressed at the inability of areas around Port Moresby, and to a lesser extent around other major Territory centres, to supply requirements of fresh fruit and vegetables. Shortages have occurred with both native and European type vegetables and prices in Port Moresby continue to remain relatively high. Territory imports of fruit and vegetables in all forms in 1968 to 1969 were valued at over $2 million. In addition the import bill for rice and other substitutes for local food continues to grow.

Several European and indigenous growers have successfully started to grow fruit and vegetables in areas adjacent to Port Moresby. Attention is now being directed towards the economic possibilities of using irrigation for cash cropping.

Production of fruit and vegetables in other parts of the Territory, especially in the Highlands, has increased substantially over recent years, but further development has been hampered by high transport costs in gaining access to markets.

The Department of Agriculture, Stock and Fisheries together with other departments is attempting to overcome some of the problems faced by Territory fruit and vegetable growers. Apart from examining problems associated with the actual growing of fruit and vegetables, attention is being given to problems of packing and transporting produce. In addition, an interdepartmental committee is examining the question of the desirability of the establishment of an Administration fresh food holding centre-wholesale market complex in the Port Moresby area. Growers throughout the Territory have expressed the need for a centralized market centre catering for the volume grower of both native and European type vegetables. The number of growers now selling large quantities of fruit and vegetables direct to wholesalers and retailers, and to Administration hostels and other institutions indicates that a commercial fruit and vegetable industry in the Territory is rapidly developing.

Fertilizer Notes for Highland Vegetable Growing

D. W. P. MURTY, Chief Chemist

These notes were written in answer to queries from persons interested in growing vegetables in the Highlands, but they contain a great deal of general information on fertilizer choice and application. It is well to remember, however, that they were written for Highland conditions, and the comments on liming and fertilizer use have been directed at the acid clay loam soils with low phosphate availability that make up a very high proportion of Highland soils.

A FERTILE soil is one which provides all the essential nutrients to the plant as required. It follows that the fertility of a soil will depend not only on the essential nutrients being present, but also on their presence in a form available to the plant to meet the requirements for satisfactory growth and development.

Thus a nutrient element may be present in the soil, but unavailable to the plant due to its insolubility, or because it is in some way "fixed" within the soil structure. On the other hand, excessive quantities of an element may lead to toxic effects in the plant, or a deficiency of an element may result from an imbalance in the proportions of the essential nutrient elements present in the soil, with high concentrations of one element interfering with the uptake of another of relatively lower concentration.

Soil Reaction (pH)

Nutrient availability can be influenced by acid or alkaline reactions of the soil. In alkaline conditions, deficiencies of trace elements, manganese, iron, copper, zinc and boron can occur. Phosphorus deficiencies can be encountered in soils that are of moderate acidity, while strong acid soil reactions tend to be associated with reduced availability of calcium, magnesium, phosphorus and to a lesser extent, nitrogen, potassium, sulphur and boron.

Acidity and alkalinity are measured on the pH scale, which is a logarithmic measure. For ease of application, it can be considered as a scale of 14 points, with a midpoint of pH 7.0 representing neutrality, when the degree of acidity is exactly balanced by the degree of alkalinity. All measures below pH 7.0 represent reactions that are acidic, and those above pH 7.0 are alkaline. As the scale is logarithmic, changes in whole units represent tenfold changes in the degree of acidity or alkalinity. Thus a soil of pH 5.0 is 10 times more acid than a soil of pH 6.0, and a soil of pH 4.0 is 100 times more acid than one of pH 6.0.

The pH range 6.0 to 7.0 is the most favourable for the availability of nutrients to plants, but plant species vary in their preference for soil reaction, some being quite fastidious in this respect. This is indicated in the following table which shows the most favourable soil reaction recorded in literature for different vegetables.

Crop	pH Range	Crop	pH Range
Beans (French)	6.0-7.5	Onion	6.0-7.0
Beetroot	7.0-8.0	Parsley	6.5-7.5
Broccoli	6.5-7.5	Parsnip	6.5-7.5
Brussels Sprouts	6.5-7.5	Peas	6.0-7.5
Cabbage	6.0-7.0	Potato	4.5-6.0
Capsicum	5.4-6.8	Pumpkin	5.5-7.0
Carrot	6.5-7.5	Radish	6.5-7.5
Cauliflower	6.0-7.0	Rhubarb	5.5-6.5
Celery	6.5-7.0	Silver Beet	6.0-7.0
Cucumber	5.5-7.5	Spinach	7.0-8.0
Leek	7.0-8.0	Tomato	6.0-7.0
Lettuce	6.5-7.5	Turnip	5.5-7.0

Lime

Soil acidity can be reduced by application of lime in its various forms. Agricultural lime (ground limestone) which is predominantly calcium carbonate, is the safest form to use. Although it corrects acidity, it is not strongly alkaline, and it neutralizes the acidity very slowly over a period of time. This slow process, lasting some weeks or even months, is less likely to disturb the balance of other nutrients and induce deficiencies. Burnt and slaked lime

are also used to neutralize strongly acid soils, but are not recommended for normal horticultural practice, as they are very alkaline in reaction and may have a deleterious effect on plants and roots.

The amount of agricultural lime required to correct unfavourable acidity will depend upon the pH of the soil, the type of soil, its organic content and buffering capacity, the fineness of the agricultural lime being used, and the annual rainfall. Heavy clays of pH 5.0 with high organic content may require three tons per acre of pulverized agricultural lime to raise the pH of the soil one unit to pH 6.0. However, a single application at this level may cause a "shock" reaction in the plant, and repeated dressings at a lower rate of application are generally recommended. Soil reactions in the Highlands region are frequently found to be in the range of pH 5.0 to 5.5, and recommendations of $\frac{3}{4}$ to $1\frac{1}{2}$ tons of lime per acre per annum (6 to 12 oz per square yard) depending on the pH, would not be considered excessive.

Overliming can induce deficiency disorders with leaf symptoms visually apparent. The correction of these disorders would require large applications of organic matter or alternatively dressings of sulphur or fertilizers containing sulphur such as sulphate of ammonia.

When correction of soil acidity is deemed necessary to obtain optimum vegetable production, it is preferable to apply the agricultural lime at least one month prior to field planting as some vegetables such as parsnips are sensitive to fresh applications. In this way the young seedling is given an opportunity to obtain some advantage from the corrected soil conditions at shallow depth early in its development, without the danger of lime reaction.

There is a tendency to regard lime solely as a soil ameliorant to reduce acidity and improve soil structure, and to overlook its importance as a source of calcium, an important and essential plant nutrient. While the quantity of lime necessary to reduce soil acidity may be very large, relatively small amounts of calcium are required to satisfy the nutritional needs of plants. Excess of calcium may restrict the uptake of potassium.

Dolomite

Dolomite or dolomitic limestone is similar to agricultural lime in its action. It contains magnesium carbonate as well as calcium carbonate and is preferred in some areas where magnesium is deficient.

Organic Manures

A prerequisite for successful production of vegetables is that the soil is well supplied with organic matter. Not only does the organic content provide necessary nutrients for adequate growth and development of crops, but it also contributes to, and maintains, favourable physical conditions of the soil.

Inorganic fertilizers (of mineral origin) may be utilized to provide or supplement the chemical needs of plants if soil fertility is inadequate, but by and large, inorganic salts have little or no beneficial effect on the physical properties necessary for a satisfactory plant-soil relationship. This does not mean that inorganic fertilizers are less important than organic manures. It simply means that a lack of organic matter may prevent the inorganic fertilizers from being fully effective.

The importance of the beneficial influence of organic matter on the soil should not be overlooked. It improves the texture of the soil, which in turn affects the exchange of air between the soil particles, the regulation of soil temperature and the effective growth of the microbial population. When the soil is lacking in organic matter, a surface crust is often formed. This restricts the movement of air, and the penetration of water into the soil. The surface crust can also be a barrier to emerging seedlings.

If the organic content of the soil is low, organic supplements in the form of animal manure, well-rotted vegetable refuse or compost should be applied and worked in. Alternatively, some practice of green manuring, entailing the production of a suitable cover crop should be adopted. Most of the manures of an organic nature, whether of animal or plant origin, contain nitrogen and phosphorus as well as smaller quantities of potassium, calcium, magnesium, sulphur and trace elements.

Green manures represent a cheap and effective method of improving soil fertility. Leguminous cover crops are of high value because of the ability of the associated rhizobium bacteria to take nitrogen from the air and convert it into a form which is readily assimilated by the plant; the cover crop, when turned in, has a relatively high nitrogen content. It is usually profitable to apply supplementary phosphorus

and potassium fertilizers to promote more leaf growth as these elements will ultimately become available and benefit the following crop.

Inorganic Manures

For commercial production of vegetables the principal nutrients, nitrogen (N), phosphorus (P) and potassium (K) are generally supplied in the form of inorganic fertilizers and the method, rate and frequency of application is determined on the basis of the fertility of the soil and the requirements of the crop.

The soil conditions and requirements of a particular kind of vegetable must be considered in making a choice of fertilizer to obtain the most effective use. Thus the sensitivity to chlorides of beans, cucumbers, lettuce, onions, pumpkins, radishes and tomatoes should be taken into account if fertilizer dressings are to be applied. In soils known to be deficient in both potassium and sulphur, potassium sulphate would be preferred to potassium chloride (muriate of potash). In circumstances where both potassium and nitrogen additions are required, potassium nitrate may be preferred.

Nitrogenous Fertilizers

Nitrogenous fertilizers are available in many forms, but those most commonly used in the Highlands are urea and sulphate of ammonia. Both can have a deleterious effect if they come into contact with plant roots and leaves when applied in a concentrated form.

Urea has great value because it is a very concentrated form of nitrogen (46 per cent) and has little effect on soil reaction. Repeated heavy dressings of urea over prolonged periods on strongly acid clay soils, however, can lead to saturation of the soil colloids with ammonium ions and as a consequence induce deficiencies of other elements. Urea should not be used in soils of low sulphate availability unless elemental sulphur or a compound containing sulphur is applied to compensate for the low sulphur availability.

Sulphate of ammonia contains a little less than half the nitrogen content of urea (21 per cent) but it also contains sulphur. It is advantageous for use when both nitrogen and sulphur deficiencies may limit growth, but it has an acidifying effect on the soil. As with urea, frequent heavy dressings of sulphate of ammonia on acid clay soils over a prolonged period of time can lead to ammonium saturation of the soil.

Nitrate fertilizers are of great value as top dressings for rapid counteraction of nitrogen deficiencies when they become visible. The nitrate ion is very mobile and can be taken up by the plant easily, but by the same token, it can be easily washed out under conditions of high rainfall or sandy soil. Nitrate fertilizers are available as sodium nitrate (16 per cent N), potassium nitrate (13 per cent N), ammonium nitrate (34 per cent N), calcium ammonium nitrate (20 per cent N) and ammonium sulphate nitrate (26 per cent N). In recent years ammonium nitrate has gained wide acceptance as a rich source of nitrogen. It has a high ability to absorb water and because of explosive hazards which restrict its transport by aircraft, it is not recommended for use in the Highlands. In mixtures with chalk as calcium ammonium nitrate it has wide application overseas and has found useful application in the Territory on acid soils.

Phosphatic Fertilizers

Phosphatic fertilizers are available as water soluble phosphates such as superphosphates, ammonium phosphate and sodium phosphate. In these forms the phosphate is available to the plant in the young stage when the root system is developing. On acid soils with a high iron or aluminium content, however, the phosphate can form insoluble complexes which make the phosphorus unavailable to the plant. This problem can be overcome to a large extent by the use of di-calcium phosphate or rock phosphate, but transport costs preclude use of the latter in the Highlands.

Potash Fertilizers

Potash fertilizers are water soluble and are available as potassium chloride (muriate of potash, 50 per cent K), potassium sulphate (sulphate of potash, 41 per cent K, 18 per cent S) and sulphate of potash magnesia (Patent Kali, 22 to 25 per cent K, 5 to 8 per cent Mg and 15 to 20 per cent S). Potassium sulphate and Patent Kali are advantageous for sulphur-deficient soils, and for crops known to be sensitive to the chloride ion. Muriate of potash is cheaper if potassium only is required.

Mixed Fertilizers

While dressings of single fertilizers are ideal for correction of specific deficiency disorders, continued application of single fertilizers of the same type can lead to nutrient imbalance

in the soil. To guard against this, fertilizer mixtures of varying composition can be obtained.

Mixed fertilizers may have varying proportions of N:P:K and may contain additives such as magnesium and trace elements. They are characterized by a high nutrient content, a uniform granulation and physical properties suitable for uniform distribution in the field. They may be obtained in a form free of chloride and containing sulphur if desired.

The initial choice of the most suitable complete fertilizer to use depends upon the soil fertility and nutrient needs of the crop to be grown. Where sulphur deficiencies occur, a fertilizer free of chloride and containing sulphur should be selected. Broccoli, beetroot, cauliflower, carrots, parsnip and rhubarb require a fertilizer with a higher percentage of potassium than nitrogen.

Application

Fertilizers may be applied in different ways. Frequently they are "broadcast" in which case they are spread evenly over the whole area to be planted. When only small quantities are involved or the space between rows is wide, or when soil fixation of phosphorus or potassium is likely, the fertilizer is often placed in bands. The fertilizer may be left as a top dressing on the soil, or it may be turned in. Because of the concentration of fertilizer in the band, care should be taken to ensure that there is no direct contact with the plant or its roots.

ARE YOU AN EXPERT?

IF you have some technical knowledge that would be of practical value to a grower, a grazier or a fisherman, you are invited to submit your manuscript to the Editor of *Harvest*.

Manuscripts should be typed with double-spacing on one side of the paper only. There is no minimum length for articles, but authors should aim at 1,500 to 2,000 words (roughly six pages of foolscap double-spaced typing).

The language used should be standard English with a minimum of technical terms. Technical words may be used, but should be explained the first time they are mentioned.

Photographs and diagrams should be included where applicable. Black and white photographs should be 6 in x 8 in glossy prints. Negatives will be accepted if prints cannot be obtained. If black and white photographs are not available, coloured slides may be submitted to see if black and white prints can be made from them.

All articles are submitted to the Editorial Committee for approval before publishing.

NEW TRAINING SCHOOL

THE facilities for livestock training have been expanded with the conversion of the Livestock Station at Bisianumu into a livestock training school for farmers, and for field officers of the Department, such as Livestock Assistants and Rural Development Assistants. Three courses will be run each year, and initially there will be 24 trainees at each course. A livestock officer, Mr P. Long, is Officer-in-Charge of the school.

Similar training courses are already operating at the other livestock training schools at Erap, Baiyer River and Urimo. These four schools have places for a combined total of 178 trainees at each four-month course.

Enrolment at courses is processed through Regional Rural Development Officers who notify District Rural Development Officers of the places available to them for each District.

Latex Collection in Disposable Plastic Bags and the Use of Expanded Plastic Rainguards

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This article is reprinted from the Planters' Bulletin *of the Rubber Research Institute of Malaya, No.* 104 *(September,* 1969). *The assistance of the Institute in giving permission for reprinting, and for supplying the photograph, is gratefully acknowledged.*

Two further articles on polybag collection appeared in the same issue of the Planters' Bulletin.

The Editor of Harvest *would be glad to hear from rubber growers in Papua and New Guinea who have used this method of collection.*

TAPPING and collection now account for the major cost of natural rubber production. Modern methods of exploitation with higher yielding trees have resulted in longer flow times so that an increasingly high proportion of the crop is recovered as cuplump. Research in progress aims at further extending the flow time. Cuplump is potentially a top grade rubber but can all too easily lose part of this potential by contamination. The possibility of collecting the whole of the crop in one top quality form is attractive but cannot easily be accomplished by traditional methods.

METHODS AND MATERIALS

The traditional equipment for collection from an individual tree is of course a spout and container. If costs can be lowered sufficiently there is much to be said for the use of disposable containers, of a design which affords protection against contamination. The present work concerns the possibility of using light gauge polythene bags. The bag can be left on the tree for several tappings to reduce costs. However, this raises new problems, one of which is protection from rain. An inexpensive rainguard would be advantageous, even for traditional tapping and collection systems.

Rainguards

Rain can get into the collection directly by rain falling on the cut or container, and indirectly by seepage down the trunk. The latter is by far the greater problem. Rain falling on the tree as a whole is drained down the trunk. The rainguards we have investigated are all designed to reduce trunk seepage. They can be either skirts, or canopies, or gutters. In our experience, whatever type of guard is used, it is necessary to attach it to the tree by a watertight seal, otherwise water creeps between guard and bark. Merely stretching a flexible material round the trunk is useless, and some kind of sealing compound is always needed.

Skirts

Perhaps the simplest guard is a sheet of polythene tied round the tree above the cut and extending below the cut. If sealed to the trunk at the line of attachment by some kind of cement, it provides complete protection against rain. Variations on this theme incorporate wire rings in the lower edge of the polythene to make the skirt stand out from the trunk. Pioneering work on polythene skirts has been done by the Rubber Research Institute of Ceylon. Unfortunately there are disadvantages:—

1. If the skirt extends below the cut it has to be lifted for tapping which retards the operation. Also the skirt is apt to be damaged by repeated handling, especially if the tapper feels that it impedes his operation.
2. Experience in Ceylon indicates that long skirts of this type result in a high humidity at the panel which may lead to panel diseases.

These disadvantages can be largely avoided, though with reduced protection, by making the skirt shorter; in which case some kind of frame

is used to make it stand off from the tree and give a canopy effect. This can be done by spreading the polythene by a wire frame, something in the manner of a lampshade, or by using a stiffer material such as galvanized iron. The difficulty is cost of manufacture and attachment to the tree. Trees vary in diameter so that lampshade-type guards need some degree of individual fitting.

Gutters

The Rubber Research Institute of Ceylon developed a rubber gutter of 'U' section which we have tried in the present study. This is effective in stopping trunk seepage if securely sealed to the tree. It is, however, too costly and heavy. We attempted to cheapen and lighten this by using extruded highly filled rubber sections, but these were not very successful in field trials and we then moved on to the idea of using lightweight expanded polymers such as rubber, polythene, or polystyrene blown to low densities. The lightness of these materials offers advantages in material costs and flexibility, also the lightweight rainguards produced can be fixed effectively to the tree with very simple adhesive/sealing compounds. In fact for all these materials field or concentrated latex serves admirably for fixing and sealing. In terms of cost/volume ratio, expanded polystyrene is the cheapest material currently available.

Rainguards can be devised to give almost any degree of protection from rain, but costs are related to performance. The expanded polystyrene rainguard which we shall now describe is the cheapest yet developed. It gives fair protection against light rain seeping down the trunk, but is not proof against heavy showers or driven rain.

EXPERIMENTAL

Expanded Polystyrene Rainguards

Expanded polystyrene is locally available in 2 ft x 4 ft sheets of various thicknesses. One virtue of this material is the ease with which it can be cut using a hot wire. The guards we used were cut from $\frac{3}{8}$ in sheet using a simple hot wire cutter. The sheet was sliced at an angle to give a strip of the profile shown in *Figure* 1. The length of the guard strip required depends on the girth of the tree and the tapping system and was controlled in manufacture by varying the width of the sheet fed into the cutting machine. The strip should be at least 6 to 8 in longer than the tapping cut to give some overlap at each end. The guard strips used in our experiments were made in three standard lengths, 24, 32 and 48 in each, varied to suit local conditions.

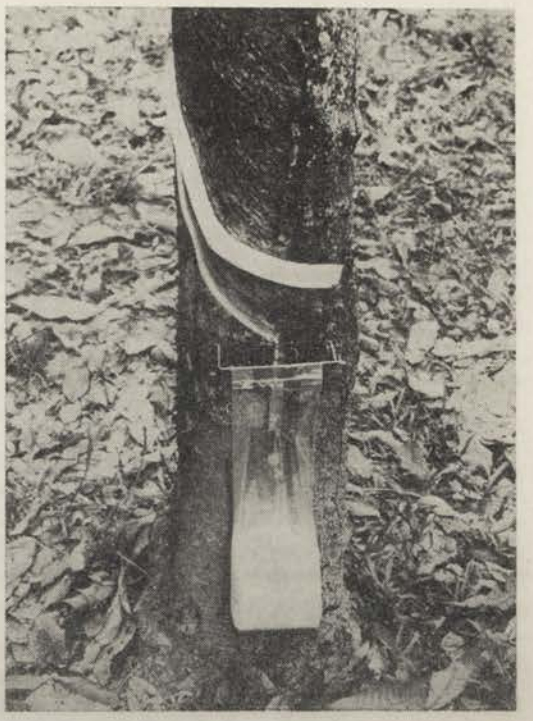


***Plate* I.—Rainguard and bag collection equipment in the field**

To fix the guards, the tree and one face of the guard strip were coated with either latex concentrate or field latex. Concentrate was slightly easier to apply and dried faster. The latex had to be completely dry before any attempt was made to stick the two surfaces together. It was then possible to press the guard on the tree when adhesion was immediate forming a small diversionary gutter above the cut. A few drops of latex were poured into the top end of this and allowed to flow along the whole length. When this dried the gutter was watertight.

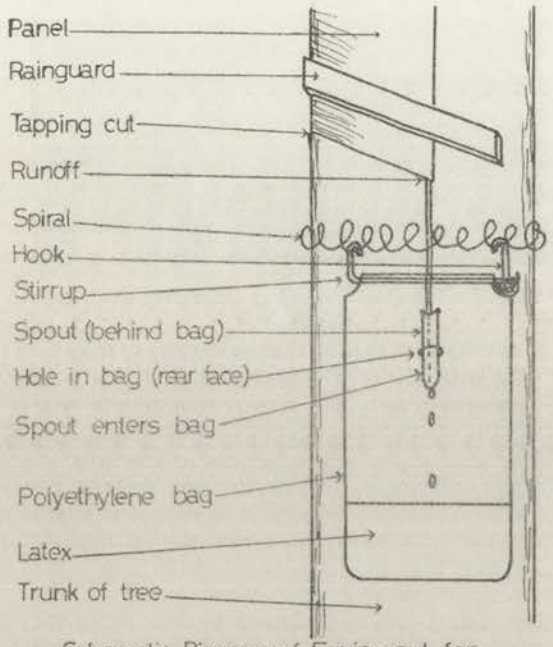
The field operation of fixing the guard was very much simplified if the polystyrene surface was pre-coated with latex. This was done by coating the entire sheet before cutting. It was convenient to add a little colour (carbon black dispersion or coloured emulsion paint) to the latex so that the field operator could identify the coated surface. With coated strips one man

goes ahead painting the trees with latex, while another follows behind at a suitable interval putting the guards in position and sealing them by pouring a little latex along the gutters.

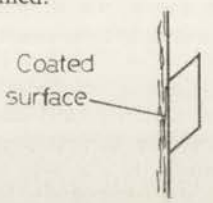
For most trees no other operations are required. The plastic is sufficiently flexible to mould around normal irregularities in the bark such as the discontinuities at the edge of the tapping panel. If the bark is exceptionally uneven or covered with moss it may be necessary to trim or scrape to give a more acceptable surface. The plastic is, however, surprisingly tolerant to minor bumps and hollows.

If any mishap occurs in fixing the guard to the tree, for example if the operator breaks a guard strip or finds the guard not long enough for an exceptionally long cut, repair or extension strips are readily cemented to it with latex. Good butt joints are easily attained.

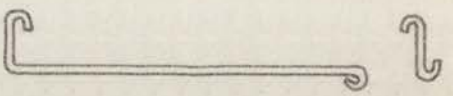
The thickness of the guard strip is limited to $\frac{3}{8}$ in by the need for flexibility. If a deeper gutter is required to take a bigger flow of water, a second guard strip is stuck on top of the first, which gives better protection but doubles the cost. The cost of the coated rainguard strip as we make it works out at approximately 2 ct/ft. If very large quantities were made it is hoped that this could be reduced. Initial trials encouraged hopes that the guards would last for a long time, but subsequent experience showed that they are susceptible to attack by insects and birds, so that 4 to 6 months appeared to be their useful service life. Investigations are being made as to whether their durability can be improved, or whether more expensive but tougher materials would be economically justified.



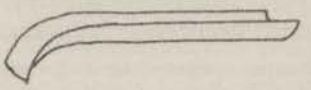
Schematic Diagram of Equipment for Plastic Bag Collection



Cross section of plastic rainguard.



Stirrup hanger and hook for suspending plastic bag from wire of spiral.



Sketch of spout with curved tip.

Figure 1.—Schematic diagram of equipment for plastic bag collection

Plastic Bag and Auxiliary Equipment

An effective collecting bag should be cheap, strong enough for the job, easy to fix and store before use, and more effective in keeping out dirt than the traditional cup. Polythene is a suitable material and several designs have been developed which can be mass produced from polythene sheet or lay-flat tubing. Essentially, these all consist of a bag made from 0.04 mm gauge polythene, sealed except for a small hole facing the tree for inflow of latex and perforated or folded over at the top to take a wire

stirrup on which the bag hangs at the tree (*Figure* 1). This wire stirrup or hanger has an eye at each end through which wire hooks serve to attach it to a wire spiral ring on the tree itself (the normal spiral rings used for cup collection can be used).

To deliver latex satisfactorily to the bag a modified spout is used (*Figure* 1). This is fixed to the run-off in the usual way, it differs from normal spout only in that it is bent so that it does not jut out so much.

In use the leg of the spout should be parallel to the trunk and about $\frac{1}{4}$ to $\frac{1}{2}$ in away from it. To fix the bag to the tree, the tree end of the spout is entered into the hole in the bag and the bag is drawn upwards. The wire hanger is slipped through the top loop of the bag and hooked onto the wire spiral (*Figure* 1 and *Plate* 1).

Tapping is done in the normal way, the tapper collecting only the tree lace. Collection of the bags is a separate task for which unskilled labour may be used, at staggered collection intervals of two or three weeks, each bag receiving the latex from several tappings before being brought to the factory. With such a system the efficiency of the tapper can be greatly increased and the collection can be rationalized.

Collection with alternate daily tapping would be somewhat as follows. Latex from the first tapping flows into a virtually sterile bag and usually stays liquid for at least twenty-four hours after which bacterial contamination builds up to a point where the latex autocoagulates. Due to the considerable bacterial population which will now be present, the second and subsequent tappings coagulate rapidly. The bag can be collected at any time after the last dripping has coagulated. The rate at which this happens is likely to vary somewhat with field conditions.

If experience in a particular plot shows that the bags contain uncoagulated latex over a period long enough to upset the rhythm of collection, the procedure would be to shift the full bag onto a second hanger further round the spiral at the time when the new bag is hung to receive the next collection. The tree then, for a brief period, would have two bags, one full awaiting completion of coagulation, and one empty, to be filled by the next series of tappings. This situation is however unusual and with tapping at longer intervals than alternate daily it will not arise. The tapper is concerned only with his tapping, the collection and fixing of the bags is a separate task, and would be organized so that a steady flow of full bags comes into the factory at convenient times irrespective of tapping activities. Obviously this presents a new organization situation and managements will have their own ideas on how this may be carried out most efficiently. It is in this area that perhaps most investigation still has to be done, the nature of the idea is such that it can only be investigated properly on a fairly large scale and in a real work situation.

Receipt in the factory

The full bags are collected in baskets and brought to the factory by lorry. If the rubber is to be sold to SMR specifications it is absolutely necessary to strip the coagulum out of the bags. The coagulum does not adhere strongly to the polythene but is not so loose that it will merely drop out when the bag is opened. It is necessary to peel the bag away. At present this is done by hand but mechanisation is being studied. Current practice is for the operator to slit the bag with a sharp knife, pull the rubber out by hand and drop it into a tank of water. The polythene is discarded. The lumps of coagulum are suitable for making block rubber.

The possibility of putting the bagged rubber, polythene included, through the whole process, has been studied. The granulation stages shred the polythene and mix it with the rubber. With a low melting point polythene, the shreds of polythene partly fuse in the drier but are still visible as white specks in the finished product. There may be no objection to this for some applications, but for others the particles of plastic would be disastrous. Such rubber could not be sold as a general purpose product, and on SMR testing the polythene would separate on the test sieves and be classed as "dirt". For the production of SMR rubbers it is therefore essential to remove the polythene completely. The waste polythene can be burned, but possibilities of its recovery as a by-product are being investigated.

RESULTS

No problems were encountered in setting up the equipment on the trees. The pre-coated rainguard strip proved much superior to the uncoated strips for fixing in the field.

There is a real tendency for the two faces of the bag to stick to each other, thus reducing the capacity of the bag. This is particularly so when trees are being fitted for the first time with the new spouts; a few drops of latex then exude from the spout wound. If the bags are put on the trees before this flow has stopped, it is apt to cement the bag faces together, for it is insufficient in volume to open up the bag and it dries rather quickly. It is necessary to ensure that the bag is opened out a little before any latex flows into it, which can be done by puffing a little air into the bag or rubbing the faces together before fixing. Bags were tried which incorporated gussets and other devices to make them open by themselves. These were easier to use but fractionally more costly. As the workers became more experienced, the difficulty began to disappear, so that it is doubtful whether the problem is serious enough to justify any modification to the plain bag unless this can be done at no extra manufacturing cost.

The rainguards gave good protection against drizzling rain but were ineffective in heavy showers, when the volume of water coming down the trunk was found to exceed the water carrying capacity of the gutter. Protection was improved by doubling the thickness of the guard strip. Rainwater flooding over the rainguard reaches the tapping cut and runs into the bag. This kind of flooding happened frequently but there was no indication that any of the crop was lost thereby. When the bag filled with water over the coagulated rubber the tapper was required to tilt the bag forward before the next tapping so that surplus water ran out again to make room for the new latex.

No problems were found in tapping and the tapping task was increased by 50 per cent without difficulty. It could doubtless be doubled.

The rainguards deteriorated more rapidly in the field than in laboratory experiments mainly because of attack by insects and birds; experiments with guards chemically treated to discourage such attacks are in progress but no results are yet available. At present the service life of untreated guards at the R.R.I.M. Experiment Station seems to be about four months. After this period the cut will have moved down the trunk away from the guard so that protection is also somewhat diminished.

One curious effect of the polythene bag method of collection is that variations in performance of individual trees are displayed in a rather striking and semi-quantitive fashion. Walking through a field set up with bags it is possible to observe the cumulative performance of individual trees over a number of tappings. In some trees unusual bacterial infection is evident from the distinctive appearance of the latex. This is a feature which has some advantages for estate management.

The bags were collected in baskets and transported by lorry, some of the bags remaining in the baskets and others being heaped on the floor of the lorry. No difficulty was encountered, the bags did not stick together and arrived in the factory in reasonably clean condition. Coagulation was complete in bags which had been left for the full cycle. A little serum dripped from some of them but the operation was still not "messy". In the factory the bags were slit by hand, the lumps of clean coagulum being dropped into clean water. With inexperienced labour, throughput was about two bags/minute/person. A well-filled bag is easier to strip than an almost empty one.

The lumps of coagulum obtained from the bags are much softer than cuplumps. The coagulum was blended by creping and converted to Heveacrumb. There were no problems in handling the material.

Properties of the Rubber

The product has the properties which would be expected from an auto-coagulation process, namely high initial viscosity, fast cure on the TC test and low nitrogen. In colour it falls short of SMR 5L but is paler than a normal cuplump rubber. In contrast to cuplump rubber it is extremely clean, and has a low iron content. It should be a most attractive general purpose material with good market potential.

SUMMARY AND CONCLUSIONS

The advantages of plastic bag collection as we see them at present are:—

1. Increased effectiveness of the tapper.
2. Upgrading of part of the crop especially as regards cleanliness.
3. Elimination of coagulation in the factory.
4. Rationalization of collection, which can be done by unskilled labour over a time schedule not limited by the need to bring in latex in fluid condition. The number of lorries required can be reduced; the need for latex collecting stations disappears.

5. Continuous visual indication of individual tree performance in the field.
6. No costs for cups.

Against these the following have to be offset:—

1. Cost of polythene bags and hangers which over a period exceeds that of the semi-permanent cups.
2. Labour cost of fixing new bags after each collection must be added to the cost of collection.
3. Cost of stripping the polythene from the rubber.
4. Some loss of PRI which may have to be made good by chemical treatment if very long collection periods are required.
5. Risk of theft or costs of avoiding it.
6. The product is darker in colour than the best whole latex factory coagulated rubber.
7. Premium rubbers from latex cannot be produced.

Operating costs of a method such as this on an experimental station are not necessarily those which would be achieved by a commercial estate. (The cost aspect has been covered in some detail by Collier and Morgan (1969) presented at this conference.)

A major item in what has come to be known as "polybag" collection is the costs of the bag, spout and rainguard. At present all are manufactured in relatively small quantities and involve a certain amount of handwork. If these items were required on a massive scale, there is good reason to suppose that costs could be significantly reduced. Even at present equipment prices, it is clear that a substantial saving can be made on tapping and collection costs by adoption of the polybag method.

Whether this can be realised as a profit depends on the market price which can be obtained for the new product as opposed to the alternatives which can be produced under more conventional practices. Broadly speaking the new process upgrades the lower qualities of estate production, but inhibits the production of latex products carrying the highest premium such as latex concentrate, pale crepe, SMR 5L, and the CV rubbers. At present rubber prices and differentials, this would approximately offset the advantages of lower tapping and collection costs.

It is thus obvious that under present day conditions polybag collection could not be recommended for general adoption. Nevertheless there may be circumstances in which it would be useful. On a long term view, we must consider that the viability of the natural rubber industry depends on its capacity to compete at prices dictated by developments in the synthetic rubber industry. Development of the polybag collection method provides an effective insurance for production cost savings should necessity arise.

Acknowledgements

The author would like to express his appreciation to Dr J. B. Gomez and his Colloid Research team, Mr Chin Peng Sung and his Applied Research team, Mr J. F. McEwen and Mr N. M. Pillai of the Experiment Station, the technical staff of Century Plastics Ltd, and the many others who have contributed active help and constructive criticism in this project.

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The Growing of Passion-Fruit

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Rural Development Officer, Goroka

Passion-fruit is grown to a varying extent in most of the Highlands Districts of the New Guinea mainland. The variety grown is mainly the purple passion-fruit (Passiflora edulis) *which thrives in frostfree regions between* 3,000 *and* 6,000 *ft elevation. Cottee's General Foods Ltd have a large factory at Goroka where all the fruit from the various Districts is processed and the juice then shipped to Australia.*

THE passion-fruit plant is a woody, perennial climber and for this reason is grown on some structure or support. It has fairly large, lobed leaves with tendrils at the nodes to support the vine as it climbs. The flowers are large and conspicuous with a crown of numerous thread-like rays and varying combinations of colours in which purple predominates. They depend largely on insects for pollination.

The name comes from the symbolism of the crucifixion seen in the flower; Spanish explorers who first found the plant in South and Central America named it "The Flower of the Passion".

The edible pulp and seeds of the passion-fruit are important constituents of both fresh and canned fruit salads and are used for flavouring. A considerable part of the crop is processed. The soft drink trade has greatly increased its requirements of passion-fruit juice as a flavouring constituent during the last few years.

Plate I.—Seedlings should be planted out when they are about 6 in high. Note the fence which will provide support for the vine (Photo: D.I.E.S.)

The harvest of passion-fruit is seasonal, the bulk being harvested from late December to April with the peak coming about mid January.

Prior to 1952, Cottee's Ltd purchased their passion-fruit requirements totally from New South Wales and Queensland and from a company-owned operation in South Africa. In 1952 due to difficulties caused by Government import regulations, passion-fruit from South Africa could not be imported into Australia, and as a result the South African operation was closed down. It was then decided to try to obtain passion-fruit requirements from New Guinea.

When the industry was first established in Goroka, indigenous farmers had very little cash income. Consequently, the Administration was anxious to introduce new industries which would enable the people to grow cash crops other than the usual vegetables.

Passion-fruit can be grown under "wild" conditions through the trees, fences and pig houses. Special knowledge or experience is not needed to grow the crop. A regular collection system has been organized by Cottee's and growers know when the truck will come. When fruit is purchased at the road side, the buyer spreads it out on a sorting table, and green and over-ripe fruit is removed. The price ranges from 2 to 2½ cents per lb in the Eastern Highlands and may vary slightly in other districts. The pulp is frozen after extraction in four gallon containers, which are freighted to Lae by road and then shipped to Australia.

In the first year of operation (1952), 6,000 gallons of juice were produced. This caused Cottee's to start a factory in Goroka. In 1955 passion-fruit growing was commenced in the Mount Hagen area and a factory was established there. The crop soon became a popular one.

With the success of passion-fruit as a cash crop, the Administration also introduced coffee plantings. It took four to five years for coffee

Plate II.—Vines growing on a yar tree (*Casuarina* sp.) (Photo: D.I.E.S.)

to bear. As the coffee came into bearing, the passion-fruit production fell rapidly and in 1962 the passion-fruit factory at Mount Hagen was forced to close.

In 1969 passion-fruit growing was once again promoted by Cottee's and the Administration, and introduced throughout the Highlands region. Passion-fruit is ideally suited to the Highland villagers. It requires no capital investment and very little work output and the cash return is satisfactory. It grows in a variety of soil conditions. Passion-fruit is very susceptible to virus and fungus attack when intensively cultivated. Commercial cultivation of passion-fruit requires a fairly high degree of management and is not encouraged at present.

As a subsistence crop, three cultural practices are recommended:—

1. Growing on Casuarina trees.
2. On garden fences.
3. On village homes or pig houses.

Nurseries

The majority of seedlings are produced in "open beds" central nurseries and distributed by Cottee's and D.A.S.F. to the grower. Village level nurseries are also planted and encouraged. The main points to take into consideration when establishing nurseries are:—

1. Select well drained soil in a slightly shaded area;
2. Turn the soil over to a spade depth;
3. Break the soil to a fine tilth;
4. Construct a suitable protective fence where necessary;
5. Form the soil into seed beds approximately 3 ft wide;
6. Mark out rows approximately 9 in apart (one handspan);
7. Plant seed thinly approximately $\frac{1}{2}$ in deep and cover;
8. Weed frequently; and

Plate III.—A house can provide support for a vine. (Photo: D.I.E.S.)

9. Germinated seedlings approximately 2 in high should be thinned to 2 in spacings.

Seedlings 6 in high should be planted out. Tall, leggy plants are better avoided, but if they must be planted, they should be cut back.

Selecting Planting Areas

(*a*) Under Casuarina trees.
(*b*) Fences—any type suitable, e.g., fences around cattle projects, subsistence gardens.
(*c*) Houses—village houses, pig houses, etc.
(*d*) Possibility of wire strung between trees around settlement blocks.

Planting Out

1. Clear a suitable space 2 ft from the base of trees.
2. Prepare a hole approximately 10 to 12 in wide and deep.
3. Replace top soil and firmly plant seedling.
4. Water seedlings.
5. It is advisable to place a pit-pit stick in a suitable position for the vine to grow on to the tree, fence or house.

Maintenance

1. Keep the ground clear around the plant.
2. Train vine on to tree, fence or house.
3. A useful life for vines under subsistence conditions is three years. Therefore new replacement vines should be planted every two years.

Harvesting

1. When fruit is mature it falls on the ground. The only "harvesting" required is to clear the fruit from the ground. A vine may produce fruit 6 to 10 months after planting, but the main crop is produced after about 18 months. Cottee's purchase all the fruit in the Eastern Highlands, and in other districts they have their agents who do the purchasing.
2. During the "flush" it is advisable to pick up the fruit daily and store in a cool place until sold.
3. Ground below the vines should be kept clear to facilitate picking up.

Diseases

Fortunately disease is not a great problem in New Guinea. This is probably due to the fact that the crop is grown under "wild" conditions and is not susceptible to attack by diseases. Once passion-fruit is grown in a high density, problems arise with diseases.

Plate IV.—When the fruit are ripe they fall to the ground. If the ground is kept clear of grass and weeds, the fruit are easy to find

(Photo: D.I.E.S.)

Brown Spot of Passionfruit

This disease is caused by a parasitic fungus (*Alternaria passiflorae*) which, under favourable weather conditions, can destroy a crop and cause serious damage to the vines. The first symptoms are small circular brown spots which appear on the leaves. Older spots may be either circular or angular in outline and may be almost an inch in diameter. Affected leaves drop off quickly and the vine may lose all its foliage. On the stem the disease appears in the form of elongated dark brown areas.

The disease on the fruit is a dark green spot. As the spot enlarges the diseased portion sinks inwards forming a slight hollow, becoming brown in the centre. Eventually the skin shrivels and the fruit drops off.

Control

In the Territory, spraying is impracticable so pruning is the recommended method of control. Affected leaves and stems should be burnt as soon as the disease appears. Leaves which have fallen to the ground should also be collected and burnt.

Damping Off

This is found in very many nurseries. It is caused by a fungus in the soil. At the beginning of damping off the seedling may show a pale colour due to the destruction of the chlorophyll. The stem of the young plant becomes constricted above the ground and the young seedling falls over. The plant becomes a dirty white colour and shrivels. Damping off may be greatly reduced by soil sterilization or seed disinfection. This may be carried out by heat, or by chemicals, where Zineb is used.

Cultural Practices

Seeds are planted in a moist soil and are not watered again until they germinate. They are then watered only when the temperature rises, usually in the latter part of the morning.

Pruning

Pruning serves a variety of purposes. Dead wood is removed and the vines are opened up to assist in disease control. Pruning stimulates the production of new fruit-bearing laterals. Fruit is borne on new wood or vines.

Dense vines promote the development of leaf and fruit diseases such as brown spot. By pruning disease conditions are made less attractive.

When pruning, all laterals are cut about 12 to 18 in from the leader, usually with a pair of secateurs.

CONCLUSION

All seeds are obtained from the Cottee's factory at Goroka, and distributed upon request to the Highlands Region.

The market for passion-fruit is at present quite buoyant, and provided quality is maintained, growers will have no difficulty in selling their fruit.

Planting material is obtained from the Cottee's factory at Goroka, and is distributed upon request throughout the Highlands Region.

Plate V.—The buyer will buy only good, ripe passion-fruit (Photo: D.I.E.S.)

The Work of the Land Utilization Branch

F. P. ALAND

Chief Land Use Officer

For any government wanting to increase the economic development of its country, the first question is, "What is there in the country that can be put to better use than it is now?" And this leads to other questions such as, "How much land is there that is suitable for cash crops? Which particular cash crops? Will one crop grow much better than others in this area?"

SO a vital task of the Department of Agriculture, Stock and Fisheries is to study the land to find the best use that can be made of it. It is not sufficient to study maps of the area (usually there aren't any!) nor even to fly over it and look at it from the air. Much more detailed work than that is required. Before a decision can be made on the most suitable crop for an area, the agronomists need to know what type of soil is present, if there are any deficiencies in the soil, something about the slope of the land, and of its rainfall. So when a Land Utilization Officer makes a map of an area, he does not merely note hills and valleys, rivers and swamps; he maps the types of soils in the area too, and this means taking many samples of the soil for analysis in Port Moresby later. When the area to be covered is several thousands of acres, the work may well last for some months or even years. It goes without saying that the areas concerned rarely have any roads at all; there is a good deal of footslogging in this work.

Detailed surveys of land use potential have been made before all the major agricultural development projects of the Territory have been started. These include the development of tea in the Western Highlands, cocoa in the Northern District and the Warangoi area of New Britain, and the oil palm project at Hoskins.

The work of the Land Utilization Branch is not limited to the work in the field. The field work is only the beginning. The work is followed through at Headquarters, on further technical and economic aspects by other branches.

The Branch serves as technical adviser to the Land Development Board, which is concerned with all agricultural development projects. Staff of the Branch assisted in the initial negotiations with the World Bank which subsequently led to the oil palm project by providing technical data, and by accompanying officials of the Bank to the proposed sites of development to give on-the-spot explanations of the soils involved in the scheme.

On the technical side, the Branch is an integral part of the Research and Surveys Division of D.A.S.F., and consequently works in close collaboration with the Chemistry Section, and with the agronomists who are concerned with the growing of the crops. The Branch quite frequently follows up the broad reconnaisance surveys conducted by the Land Research Section of CSIRO, and also interprets their findings for the policy makers on land development.

The more routine work involves the mapping of soils throughout the Territory, and their classification into categories for ultimate land use. Classification of the soils into families and series facilitates comparisons and contrasts of the different soils throughout the Territory. Information about the chemical and physical properties of the soil help in the crop yield predictions.

Mapping the distribution of the soils is most important so that any hazards can be avoided. Aerial photography is of great assistance in this work, but at times it is essential to have very detailed maps produced from intensive ground traverses.

The big task of the routine chemical analysis of all the soil samples brought in is carried out by the Chemistry Section, but the Land Utilization Branch has its own laboratory for research on physical properties of the soil.

The Soil Physics Section is studying the nature of clays, investigating the interaction of nutrients with the soil. It is known that in many cases, plants suffer from a deficiency of some nutrient, even though there is plenty of that nutrient in the soil; for some reason it cannot get out of the soil and into the plant. The reason may be that it reacts chemically with another nutrient, and the resulting new chemical compound becomes fixed on the surface of the clay particles. One well-known example of this is the interaction in acid soil of iron with phosphorus to form iron phosphate. Iron by itself is quite mobile, and so is phosphate; but together they anchor each other on the surface of the clay particles and are quite lost as far as the plant is concerned. Before a solution to these problems can be found, a full understanding is needed of the chemical reactions which are taking place.

A major part of the Soil Physics Section's work is concerned with soil microscopy. A great deal can be learnt by studying thin sections of the soil under the microscope.

These sections are not easy to make. Much patience, experience and good equipment are needed. A plastic resin is used to impregnate and harden the soil lump so that the components of the soil are fixed. Very thin sections are then cut (using special equipment) mounted on a glass slide and examined under the microscope.

When all the information has been collected, the results are compared with analyses from agricultural stations and plantations within the Territory and overseas. All the information is integrated to provide a good background picture of the land usage available.

Wahgi Valley Survey

The very thorough investigation which led to the present growing of tea in the Wahgi Valley gives a good example of the work of the Land Utilization Branch. Broad reconnaissance surveys made in 1955 to 1956 indicated that the soil was satisfactory, and that if the excess water could be drained off, a lot of good agricultural land would be available, thus accelerating the economic progress of the area.

In 1957 detailed survey work was started which took 3 years to complete. The team working on the task consisted of two professional officers, five technical assistants and many casual labourers from nearby villages. Although the total area covered was over 120,000 acres, the survey was a very intensive one. Of the land showing agricultural potential, the soil of every half acre was identified and mapped. Several hundred soil samples were taken, which were analysed by the Chemistry Section. In addition, all the plantations already established in the Wahgi Valley were mapped (for their soil types) and leaf and soil samples from these properties were analysed. Wherever it was possible to obtain accurate information by careful work, this was done.

Once it was known what soil types were involved, it was possible to lay down agronomic trials on the areas where the soil was typical of the whole valley. An experimental station was established at Olgaboli, and the crops tried were coffee, tea, various shade trees, and food crops. From this it appeared that tea would be most satisfactory for the area.

The work was then extended to the peripheral areas of the main swamp and this led to the establishment of the land settlement schemes at Kindeng and Avi. To date some 11,000 acres of the peripheral swamp area has been drained by the Branch. The officer-in-charge of this work has come from New South Wales where his main task was the conservation of water. Now he has to reverse his sights and concentrate on getting rid of water!

A new experimental station, the Kuk Tea Research Centre has been opened, and the work at Olgaboli is continuing with the Agronomist-in-Charge controlling the work of the two stations. Olgaboli is typical of the main swamp area, whereas Kuk, having swamp and undulating terrain, is more representative of the whole valley.

As a result of the Branch's work, and the subsequent work by the agronomists, tea production in the Wahgi Valley expanded rapidly. There are now 12 large tea estates established by private companies, and some 400 smallholders growing tea on land held either by Administration lease or by customary land tenure. Another 200 leases will soon be made available to smallholders. Three tea factories are now in operation, and a further two will be in production by the end of 1971.

Tea exported from the area during 1969 to 1970 amounted to 770 tons, and is commanding a good price on the world market. Production has exceeded the predictions made 10

years ago, although here, as everywhere, there is the problem of rising costs to be faced.

Following on from the work by departmental officers, a feasibility study of drainage of some 16,000 acres of swamp is now being undertaken by a leading firm of overseas consultants. Members of the firm include notable world authorities on drainage.

From this description of the work of the Land Utilization Branch it will be evident that a great deal of careful and painstaking research is carried out before any big agricultural project is undertaken. It may confidently be stated that few, if any, other developing countries have had the advantage of such a service preceding new agricultural projects.

Plate I.—Councillor Kuwok Bitan, Ministerial Member Tei Abal and Assistant Rural Development Officer Naphtali Kamare examine sheets of rubber from the smokehouse of the new processing factory at Magipopo in the Lake Murray area. Mr Tei Abal, Ministerial Member for Agriculture, Stock and Fisheries, officiated at a ceremony to open four rubber factories in the area

NEW RUBBER FACTORIES AT LAKE MURRAY

IN the past, the people of the Lake Murray area of the Western District of Papua have depended on the sale of crocodile skins for their cash income. Because of the serious drop in the numbers of crocodiles, this source of income is no longer adequate.

When the people asked the Administration for help in setting up a rubber industry, the Department of Agriculture, Stock and Fisheries staff provided seed, and practical help for planting. All the rubber is planted on individually owned blocks of land, and each block owner will eventually have 6 acres of rubber.

So far there are 81 acres of rubber at Buseki, 57 acres in Nago, 51 acres in Upovia and 56 acres in Magipopo. The project was financed by the Development Bank.

On Thursday, February 18th, 1971, Mr Tei Abal, Ministerial Member for Agriculture, officiated at a ceremony at Magipopo village to open the rubber processing factories of the four villages. Over 200 people attended the opening, and a demonstration of rubber processing was given by Mr Napthali Kanare, an Assistant Rural Development Officer.

Treatment of Crocodile Skins

These notes on the preservation of crocodile skins have been compiled from information issued in Europe, Africa, and Papua and New Guinea. The purpose of this article is to stimulate discussion amongst persons engaged in the crocodile skin industry. If you have better methods for any part of the process of crocodile skin preparation, you are invited to write to the Editor of Harvest, *giving technical details of your methods.*

WHEN a crocodile is killed, the hunter must take the trouble to treat the skin properly, otherwise he will not get a good price for it.

The careful treatment should start immediately after the crocodile is killed. However it is killed—shot, speared or hooked—it is important not to damage the belly. A good skin that would be worth $50 will bring only $10 if there is a bullet hole in the belly. So any wounds or marks that occur during the killing of the animal must be on the head or the back.

The carcass should be removed from the water as soon as it has been killed, but this is not always possible. The carcass should certainly not be left in the water longer than eight hours, as decay sets in after this time. If left still longer, the carcass will eventually float to the surface. If this happens, the skin will be useless to the tanner.

When the carcass is removed from the water, it should not be dragged out over rough or stony ground, as this will damage the belly skin. If it cannot be pulled out at a grassy place, the carcass should be turned over and pulled out on its back.

When the carcass is taken out of the water, it should be skinned immediately, and the skin treated with salt. Speed is essential, otherwise the skin will start to rot or will dry out. Because of the danger of drying out, it is also important to keep the skin in the shade. It should never be left in sunlight. The sun dries the skin out and then it will not absorb the salt which is necessary for curing. Under these conditions, the scales take on an oily appearance and this makes tanning more difficult. Consequently the tanner and the buyer give a lower price for such a skin.

Ripping Lines

Cutting the skin off the carcass is known as "flaying". It is important that the skin is not damaged when it is being removed from the animal. For this reason pointed knives should not be used. A knife with a blade no more than 4 in long, and rounded not pointed at the end, is most suitable. The operator should pull the skin away from the body with one hand, guiding the knife carefully so that it cuts only the flesh and does not puncture the skin at all. He should always be able to see where the knife is going. Particular care is needed when removing the skin under the legs, as the skin is thinnest at this point, and therefore most easily torn or cut.

In order to get the best-shaped skin, the cuts in the skin should be made as shown in the diagram. The cuts are made along the back of the animal so that the widest possible belly width is obtained.

Head.—Cut the skin across the back of the neck just under the hard disc on the top of the neck (ABCD). Then cut towards the snout on each side (AE and DE) and along the lower jawbone until the two cuts meet at the front.

Body.—From the neck cut, make two long cuts the full length of the body (CFFH and BFFH) leaving two rows of hard scutes (horny scales) on each side of the cut skin. The new law about crocodile skins states that these two rows of scutes must be present on each side of the skin. Except in the East and West Sepik and Madang Districts, a skin may not be bought or sold if it measures more than 20 in between the innermost row of scutes on each side.

Legs.—Hold the leg firmly at the "wrist" and pull it out away from the body. Starting at the main body cut (F), make a cut along the length of the leg, passing over the point of the elbow to the wrist (G). At the wrist, cut around the leg as close to the foot as possible. Similar cuts are made on the other legs.

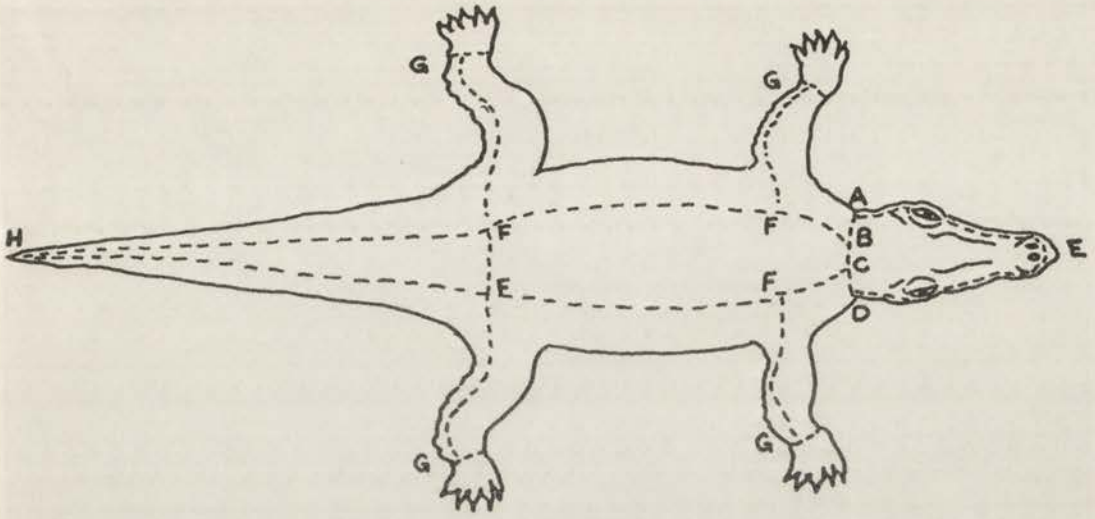

Figure 1.—The ripping lines of the carcass. Note that the cuts AE and DE are on the lower jawbone

It is most important that the leg cut passes over the point of the elbow, otherwise a "pocket" will be formed. This is a defect which reduces the price. If cut correctly, the skin will have light-coloured scales surrounded by an even dark edging.

Tail.—To remove the tailpiece, the easiest way is first to cut the triangular piece on top between the back legs and the tip of the tail (FFH). Then remove the skin from the tail by working downwards from the main body cut.

Cleaning the Skin

When the skin is separated from the carcass it should be placed on a flat, smooth surface, and any surplus flesh or fat should be scraped off. Any tissue left on the skin will stop the salt penetrating, and will thus give uneven preservation.

The scraping is most easily done with a scraper (like a fish scaler) made from a piece of hoop iron attached to a handle about a foot long. Often large freshwater clam shells are used to scrape skins, but this is rather tiring on the wrist if many skins have to be done. The scraper can be sharpened with a file, but it should not be so sharp that it can damage the skin.

Cleaning the skin of the tail often causes trouble. There is a lot of fat on this part, and if it is not all removed, the salt will not penetrate to cure the skin. To make matters worse, the skin is thicker on the tail, so thorough penetration is all the more necessary.

If the curing process is not effective, decay sets in, resulting in scale-slip. This loosening of the scales makes the skin unsuitable for tanning. If it is not arrested, it will spread over the whole skin.

Washing

When the inside of the skin has been scraped clean, it should be washed with clean water. This should be poured on from above, while the skin is scrubbed with a brush. Frequently the skin is dragged back to the river for washing at this stage, but this is not advisable; it may make the skin muddy, and it will still have to be washed with clean water.

First Salting

Odd bits of skin should be cut off to give the skin an even shape, and then it is ready for salting. The salt removes the moisture from the skin and stops it rotting. It is important that the salt used is clean and dry. Salt that has been used on another skin and shaken off should not be used again. The salt should be clean, dry and fine; coarse salt does not give good penetration.

The salt is rubbed into the skin on the flesh side. This may be done by hand or with a cloth, or with a smooth piece of wood. It must be done before the skin dries out.

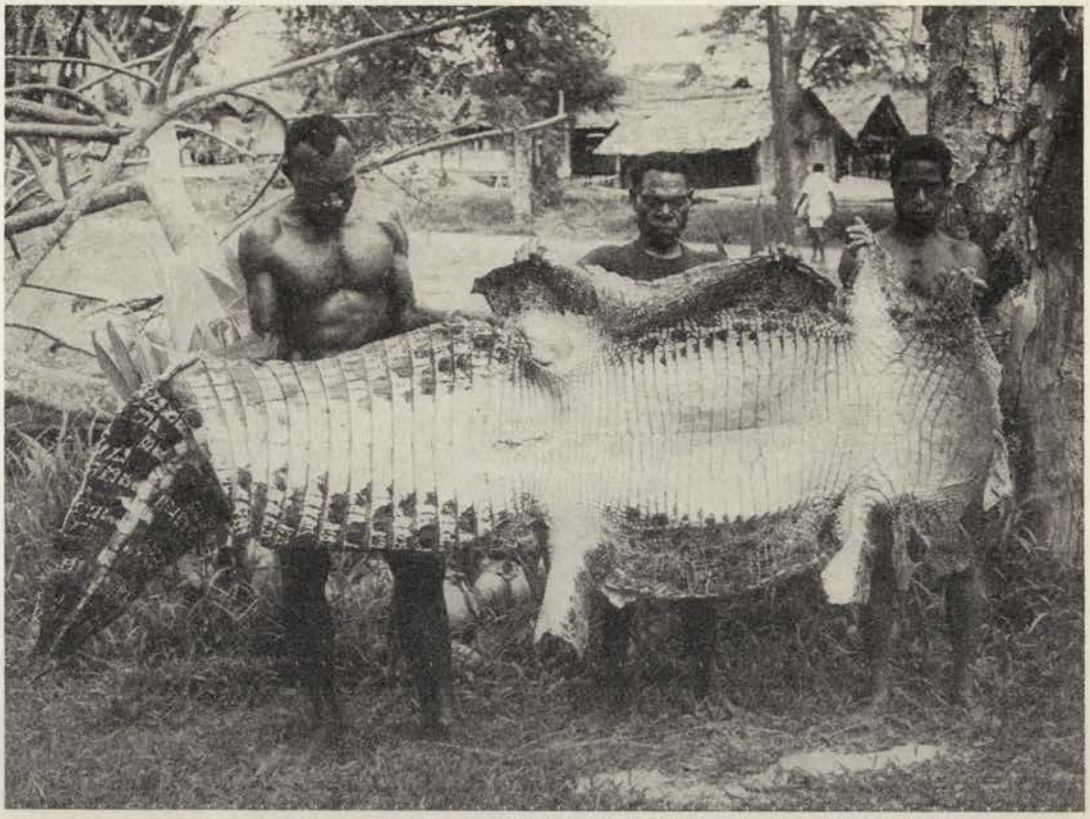

Plate I.—The skin obtained from flaying as illustrated in *Figure* 1. The two rows of scutes (horny scales) can be clearly seen (Photo: D.I.E.S.)

The skin is then hung up to drain on a wire rack, with the flesh side uppermost. The excess moisture and salt will drain away, and after about two hours the salting process should be repeated.

The skin is then folded or rolled and put in a cool dry place for one, two or three days, before being re-salted. For the second salting a small amount of Merpin should be added to the salt (1 lb Merpin to 200 lb salt). The old salt should be shaken off and thrown away and new salt should be rubbed in.

The salt must be evenly spread and very thoroughly rubbed in.

The first salting usually reveals some flesh and fat that was missed at the first scraping. This should be removed before the second salting.

Final Treatment

After the second salting the skin is removed to a shed or storehouse, where the skin will be protected from both sun and rain. The floor of the shed should be covered with salt. Lay the first skin, flesh side up, on the floor, and add more salt on top. Add another skin, then another layer of salt, then another skin, and so on. The pile should then be left for about ten days.

During this time the skin is "cured", that is, it is treated so that it will not rot. The natural moisture of the skin is replaced by strong salt solution which stops the bacteria growing, and this stops the skin decaying.

If decay sets in, the first indication will be "scale-slip". This may occur at any time if the skin comes into contact with water—which could be the result of a leaking roof or of rain during transport to the curing shed.

After ten days, the skins at the bottom of the pile will be further advanced in curing than those at the top. It is advisable, therefore,

Plate II.—Inspecting and packing skins (Photo: D.I.E.S.)

to re-stack the pile, reversing the order of the skins (but still flesh side uppermost). The same salt may be used provided it has not taken up any red colour.

Signs of Scale-Slip

If "red-heat" is detected, scale-slip is sure to follow unless immediate action is taken. "Red-heat" starts as a pink colouration of the salt; as soon as it is seen, the whole area should be scraped clean and new dry salt mixed with Merpin should be thoroughly rubbed in.

Another method of detecting scale-slip is the light bluish appearance of the scales on the belly. Pressing a finger on the scales will indicate if there is moisture or air between the skin and the scale; if so, scale-slip is sure to follow.

Any skin that gives off an ammonia smell is very likely to develop scale-slip. An experienced operator can also detect scale-slip by the sound of the scales as the skin is moved about. These are dry and have lifted from the skin, but have not yet become detached from the skin.

Packing and Transport

After the second salting, skins should be folded and put in a cool dry place. They should not be put in houses or places where there is a great deal of wind, as the skin will become hard and dry, especially at the edges. During transport and storage, the skins should be protected from rats, which will chew holes in skins and thus reduce a first grade skin to a third grade one.

Weigh Your Cattle with a Tape Measure

J. H. SCHOTTLER

Animal Production Officer, New Guinea Lowlands Livestock Station, Erap, Morobe District

It is often important for persons dealing with cattle to have an indication of the liveweight of the animal or to know whether the animal is losing or gaining weight. The best method of determining liveweight is to weigh the animal on a scale, which should indicate liveweight to within ± 5 lb. However, where a scale is not available or practicable, it has been found that an estimate of liveweight can be obtained by measuring the circumference of an animal immediately behind the shoulder, usually known as the "heart girth".

THERE is available commercially a tape called "Weighband", developed in the United States of America, which is marked off in pounds weight instead of inches, and which enables the weight of an animal to be read directly. This band, however, was designed from measurements made with British breeds of cattle under improved conditions. Because of price and availability, many farmers in the Territory are unable to make use of them. However, an ordinary tape measure marked off in inches can now be used because of work carried out recently at the New Guinea Lowlands Livestock Station, Erap.

Plate I.—To measure heart girth, the tape is passed around the body and held just tightly enough to flatten the hair

To determine the feasibility and accuracy of this method with cross-breed Brahman and Afrikander cattle, some 550 cattle were weighed and the heart girth measured in two successive weighings one month apart. It was found that the heart girth increases in proportion to the weight in a curvilinear function. That is, the difference between successive weights for a proportionate increase in heart girth becomes larger as the animal increases in weight.

Estimating the liveweight of an animal by this method, it is not as precise as that obtained by weighing the animal. An animal indicated as weighing 250 lb would be within ± 25 lb, and the range increasing to ± 50 lb at 950 lb liveweight.

Where the object is not to determine the actual weight, but to determine whether the animal is losing or gaining weight, then for a particular animal it is possible to observe relatively small weight changes. Where animals had gained weight, there was a corresponding increase in heart girth. Similarly it would be expected that losses in weight would be indicated by a reduction in heart girth circumference. However, the reduction in heart girth would cease when sub-cutaneous fat and other expendable tissue had been utilized. The animal could then continue to lose weight with no corresponding reduction in heart girth, since the skeleton of the animal would not reduce in size. It is at this point that the farmer will have to rely on his eye rather than the tape.

To obtain consistent readings with the tape measure, certain procedures must be followed. The tape is passed around the animal directly behind the hump on the back. The tape should be held tightly enough to flatten the hair, but not contract the skin.

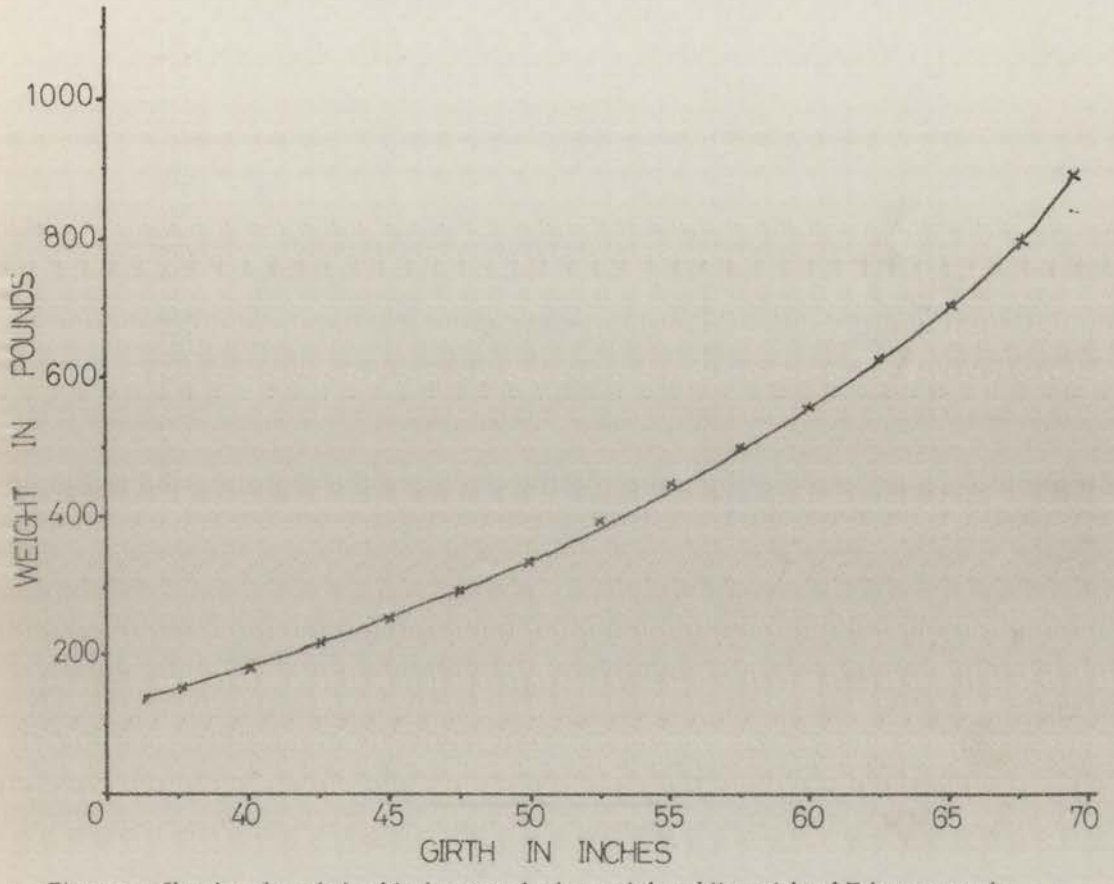

Figure 1.—Showing the relationship between the heart girth and liveweight of Zebu-cross cattle.

The animal being measured should stand with both front legs together, the head slightly elevated and not be twisted or hunched. If the animal lowers its head or is hunched in the crush, the heart girth circumference will be increased. Since very few cattle are likely to assume the ideal stance, the tape measure should be held taut and the minimum reading obtained. Unless the operator observes these procedures, large errors and inconsistencies will result.

This method of estimating liveweight would be useful where cattle are being sold for slaughter, or where the approximate liveweight is required so that the correct amount of drench or drugs can be administered. Where it is the change in weight, rather than the total weight, which is important, this method would be very useful, particularly to give less experienced farmers some indication of the progress of their cattle.

The following girth measurements and weights were obtained:

Heart Girth (in)	Weight (lb)
36½	136
37	141
37½	147
38	152
38½	159
39	166
39½	172
40	177
40½	184
41	192
41½	200
42	207
42½	215
43	222
43½	230
44	237
44½	245
45	252
45½	260
46	268
46½	276
47	283
47½	291
48	300
48½	308
49	317
49½	326
50	336
50½	345
51	355
51½	365
52	375
52½	385
53	395
53½	406
54	417

Heart Girth (in)	Weight (lb)
54½	428
55	438
55½	448
56	458
56½	468
57	479
57½	491
58	503
58½	516
59	528
59½	540
60	553
60½	566
61	579
61½	592
62	606
62½	620
63	636
63½	652
64	668
64½	685
65	702
65½	720
66	738
66½	756
67	775
67½	792
68	810
68½	828
69	847
69½	865
70	884
70½	905
71	927
71½	950

Research on Pig Production

G. L. MALYNICZ,

Veterinary Officer (Pig Production)

The Pig Section of the Department of Agriculture, Stock and Fisheries is carrying out research work to assist the growth of the pig industry in Papua and New Guinea. The main base for this work is at the Tropical Pig Breeding and Research Centre at Goroka, with further work being carried on at Erap in the Markham Valley and Kurakakaul in New Britain. Vudal Agricultural College and the Popondetta Agricultural Training Institute also have their research programmes.

IN the South Pacific area, pigs have always been the most important domesticated animal, and in many areas, a pig feast is still a traditional part of any celebration or ritual. This is certainly true in Papua and New Guinea, especially in the Highlands.

Pigs in the Territory have always been produced by subsistence methods, the pigs usually grazing during the day and being fed food scraps at night. There are usually plenty of grasslands and old gardens for the pigs to

Plate I.—Pig house made entirely of bush materials

Plate II.—Pig house with bush material walls and roof, and concrete floor

graze, and food scraps do not cost anything. This way of keeping pigs is cheap, but it has its problems.

The greatest problem is that unless the farmer grows special food for his pigs, he does not have enough food for more than two or three pigs. If he tries to keep more, but does not feed them adequately, they may run off into the bush and become wild.

Another problem is that the local pigs are slow-growing and do not have many piglets. When fully grown, they are still quite small compared with imported breeds. Even when they have plenty of food, they are still slow to develop. A third problem is that because they are grazing so much, they pick up parasitic worms from the ground, and from eating earthworms and beetles. For all these reasons, it would be difficult for the subsistence farmer, using traditional methods, to expand and produce more pigs.

For an increase in growth rate and litter size, more food has to be grown for the pigs, especially protein foods such as soyabeans. To get the most out of the extra food that is being fed to the pigs, it is best to use breeds such as the imported Tamworth or Berkshire, which, if well-fed, will grow very quickly. Such pigs can weigh 300 lb at an age of one year, compared with only 100 lb for the local pigs. The imported pigs also have more piglets per litter.

The use of improved breeds is, however, dubious unless it is supported by a general improvement of feeding, housing, management and disease control. Research is directed to improving techniques in these fields, giving results which can be applied at the village level by people with limited technical skills. Research staff are always looking for methods of pig management which use local foodstuffs or local building materials. This means that the farmer will not have to waste money on buying food or materials which he could grow or make himself.

Research on feeding is concerned mainly with finding ways of using crops which can be grown by the farmer himself. These include kaukau, tapioca, corn, sorghum, soyabean, or green feed such as kau kau leaves or pasture legumes. Housing research is directed towards developing the use of local materials such as bush timber, bush rope, bamboo, sago palm and kunai. Floors using dried kunai or sawdust or coffee hulls instead of cement are also being investigated. The manure falls into the litter where it produces heat which kills the parasite worm eggs. Such a system also saves water, as, unlike cement, the floor does not have to be washed every day. On the breeding side, the performance of improved local and half-bred pigs under modern conditions is being studied.

All this research has an economic aim. Its purpose is to give the village farmer an increased cash return for his investment in the purchase of stock, materials and feed, and for his labour in the management of the animals.

Results of the work are passed on to the Livestock Officers and Rural Development Officers who, in turn, pass the information on to the farmers. These officers are always available to assist with the pig farmer's problems.

Cattle Slaughtering

DURING the last 6 months of 1970, 2,011 cattle were processed through Administration killing facilities and a further 1,113 at privately-owned licensed slaughterhouses—a total of 3,124 cattle, which is double the figure for the last 6 months of 1967.

The Administration now has slaughtering facilities at Lae, Port Moresby, Goroka and Mount Hagen. The slaughterhouse at Madang has been completed and one at Wewak is being built and expected to be operational before the end of 1971. A slaughterhouse at Rabaul has been included on the draft works programme for 1971-1972.

The policy of building central killing facilities in areas of cattle development is beginning to pay dividends. They are proving a boost to the cattle industry as farmers can see an orderly market developing which should expand rapidly. Butchering businesses are springing up around the slaughterhouses and offering customers a regular supply of fresh beef which will lead to increased consumption of fresh meat replacing imported frozen meat.

The Administration is encouraging private persons and Local Government Councils to build small rural slaughterhouses in areas where there is not a large cattle population, and the cattle cannot economically be moved to a central killing facility. Detailed plans of a suitable slaughterhouse have been prepared by the Public Works Department and are available through D.A.S.F. offices. Koroba is already proceeding with a building while at Kundiawa, Alotau, Tapini and Kavieng there is interest in erecting slaughterhouses. The Administration has offered to train slaughtermen to kill, dress and butcher the meat if an accompanying butcher's shop is envisaged. Anybody contemplating building a private slaughterhouse in which cattle will be killed and the meat sold are warned that the building must be licensed and has to conform to standards laid down in the Slaughtering Ordinance. They are advised to discuss all aspects with Animal Industry Division officers before proceeding.

Cattle Freight Subsidy

The Minister for External Territories has recently announced an increase in the cattle freight subsidies. The maximum subsidy per head of cattle payable for each category has been increased by $10, *and is now:—*

BULLS: Australian East Coast ports to Territory ports	$110
Tasmanian ports to Territory ports (Dairy breeds only)	$120
COWS: (Over 42 in. at shoulder)	
Australian East Coast ports to Territory ports	$80
Tasmanian ports to Territory ports (Dairy breeds only)	$90
COWS: (Under 42 in. at shoulder)	
Australian East Coast ports to Territory ports	$64
Tasmanian ports to Territory ports (Dairy breeds only)	$74

The subsidy is intended to cover the cost of sea freight, wharfage and handling charges, transport to the wharf, veterinary fees for testing cattle prior to export, cost of feed during the voyage, and any other necessary expenses. The purpose is to allow cattle to be landed at a Territory port for the cost of purchase on the property in Australia.

Needless to say, there are conditions surrounding the payment of the subsidy. The conditions refer to the cattle themselves, and to management matters on the property to which they are going.

The conditions regarding the cattle are:—

1. They must be of a breed suitable for Territory conditions.
2. They must have passed the usual veterinary tests, and they must be inspected on arrival in the Territory by an officer of the department. This inspection is generally carried out during the 15-day compulsory quarantine period.
3. They must have cost the following minimum prices:—

Mature bulls	$300
Young bulls (12 months or under)	$150
Mature female cattle	$80
Heifers	$60

4. Bulls must be registered with their appropriate breed society, or contain at least half Zebu blood.

The conditions regarding the management of the cattle are:—

1. The maximum number of breeders which may be imported for any one property will be one third of the assessed full carrying capacity of the property.
2. The minimum number of breeders which may be imported will depend on the assessed carrying capacity of the property, but in general will be 35 head of beef cattle or 15 head of dairy cattle.
3. Obviously, stock may not be moved from one property to another to evade these conditions. Cows imported under subsidy may not be sold until culled for age or non-breeding. Bulls may be sold after four years.
4. Prior to importation, properties will be inspected by a livestock officer or veterinary officer to check that the property is well-managed, and that fencing and yarding facilities are satisfactory.

Provided that the total amount does not exceed the maximum stated for each class of cattle, any expense necessarily incurred in the importation of cattle from Australia will be refunded. Cattle may be air-freighted, but the same maximum subsidy values apply.

The refund is paid after the cattle have arrived and been inspected, and after the importer has paid all the bills in connection with the importation. Re-imbursement is made only after receipts have been produced.

Because of the complicated conditions, prospective importers are strongly advised to check with the District Livestock Officer or District Veterinary Officer before arranging for the purchase of cattle in Australia. No subsidy will be paid if it is found, after the arrival of the cattle, that the conditions have not been met.

In all cases, whether subsidy is paid or not, prior approval to import cattle must be obtained.

Book Review

COMMERCIAL VEGETABLE GROWING
(H. D. TINDALL, Oxford University Press, London, 1968. 300 pp. 104 illust. $A5.45.)

THE author, who has worked extensively in the tropics, and is present Head of the Agronomy Department at the National College of Agricultural Engineering in England, states in the preface of this book, "It is intended that this handbook will provide the commercial grower of tropical vegetables with useful information on cultivation methods, the kinds and varieties of vegetable which are successfully grown in various parts of the tropics and the techniques which can be adopted to obtain the best results". However, as well as being useful to the commercial grower, this book provides much information that can be used by the agricultural extension worker in Papua and New Guinea.

Although based largely on data from tropical Africa, the information is generally applicable to any tropical country. Although many of the operations used in traditional vegetable growing areas are still carried out by hand, the author has stressed the use of modern techniques, whenever their incorporation into traditional patterns has seemed justified. Data on the nutritional value of the various vegetable crops will be useful in the work of improving the quality and variety of the indigenous diet in this country.

The book is easy to read, being set out clearly and logically, with a comprehensive index. It is divided into three parts each dealing with different aspects of commercial vegetable growing.

Part One, *The Economics of Vegetable Growing* deals with the development of market gardening in a traditional village situation and on the outskirts of urban areas, with costs involved in production, with the planning of a new market garden with regard to the resources available, with marketing including preparation of produce for market, and with handling and storing and methods of selling.

Part Two deals with practical applications under the subsection headings of Site Selection and Preparation, and Cultivation Methods. Under these headings are included such things as irrigation, conservation methods, layout, tools and equipment, both hand and mechanical, propagation techniques, fertilization, cultivation methods, and pests and diseases and their control.

In Part Three, a brief description of each vegetable is given under the following headings: Common name(s), botanical name, environmental requirements, areas where it is widely grown, general description of plant, cultivars, nutritional value, uses and agronomy.

Many of the vegetables described will not be familiar to people brought up in a temperate climate and this book is useful even if only to give one an idea of the wide variety of highly nutritious vegetables to be found in the tropics and how to use and prepare them. However, for those whose work is in agriculture this book should fill a large gap in the literature available on tropical vegetable cultivation and how it can be adapted to provide a substantial income or a more balanced diet for the indigenous farmer.

It is an excellent and up to date publication with the added advantages of being easy to read and consult, and of being written for the tropical situation.

M. PERKINS

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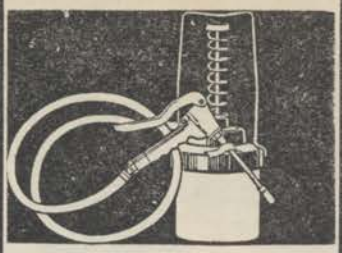

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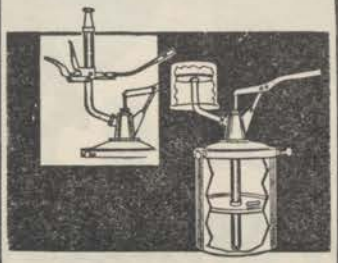

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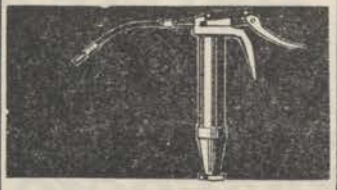

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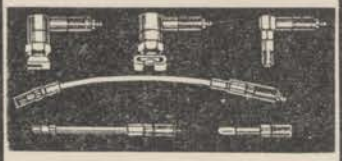

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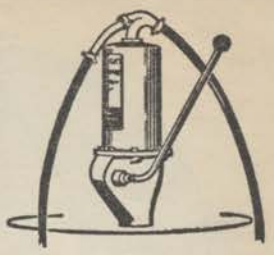

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