RHB
00290

harvest

FOURTH QUARTER

1972

VOLUME 2; NUMBER 4

PAPUA NEW GUINEA

Registered at the G.P.O., Port Moresby, for transmission by post as a qualified publication.

Harvest is published quarterly by the Department of Agriculture, Stock and Fisheries under the authority of the Minister of Agriculture, Stock and Fisheries. It is distributed free to primary producers and other qualified persons.

Minister for Agriculture, Stock and Fisheries

IAMBAKEY OKUK, M.H.A.

Director— W. L. Conroy

Editorial Committee—

D. R. J. Densley

G. K. Graham

T. W. Langton

J. Natera

D. J. Purdy

Editor— C. A. Fowler

harvest

Information for Advertisers

Printing: Letterpress
Paper Quality: Super Calendar
Dimensions: International B5
Block width 33 ems
Block depth 48 ems
Bleed Pages: Not accepted
Advertising Charges: $20 per page per issue

COVER PHOTO

A view of the Kuk Tea Research Station, near Mount Hagen. The pink flowers in the foreground belong to *Hibiscus* bushes, not to the tea. A description of the work of the Station begins on page 134.

(Photo—J. G. Morgan)

Department of Agriculture, Stock and Fisheries,
Konedobu
Papua New Guinea

R. M. BOURKE

harvest

Vol. 2, No. 4 Fourth Quarter 1972

CONTENTS

Trade Names

To simplify the information given, it is sometimes necessary to use trade names of products or equipment. No preferential endorsement of named products is intended, nor is criticism implied of similar products not mentioned.

Department of Agriculture, Stock and Fisheries,
Konedobu,
Papua New Guinea.

Widespread Damage by Insect Pests in Highlands Sweet Potato Gardens

A. J. KIMBER, Agronomist
Highlands Agricultural Experiment Station, Aiyura

Because of frost and drought, 1972 *has been a very bad year for sweet potato* (Ipomoea batatas), *particularly in the Highlands. This is very serious as sweet potato* (*kaukau*) *is the major food item of subsistence farmers in most parts of Papua New Guinea. In many areas, the situation has been made worse by damage caused by two insect pests, the sweet potato weevil, and the sweet potato leaf miner. This article describes the damage done by these two insects, and outlines DASF's recommendations for their control.*

I. SWEET POTATO WEEVIL

(*Cylas formicarius*)

This pest is sometimes called the ant weevil, because the adult, which is a weevil, also looks like an ant. The adult is about 5 to 6 mm ($\frac{1}{4}$ in) long, the body a dark metallic blue colour, and the thorax and legs reddish brown (*Plate I*). Although when seen it seems to

Plate I.—The adult sweet potato weevil is about $\frac{1}{4}$ inch long
(Photo: D.I.E.S)

spend most of its time walking, it is, in fact, also able to fly. The adult will feed on leaves, vines, roots and tubers of the sweet potato, and it is able to reach the tubers through cracks in the soil. This is why the weevil can be a very bad problem in dry weather, when cracks appear in the soil. The adult does not do much damage to the leaves and stems of the sweet potato plant, but when it reaches a tuber it chews small feeding holes on the surface of the tuber, and in these holes it lays its eggs (*Plate II*). The eggs of course, hatch into larvae (grubs) and it is the larvae which cause by far the most damage. They make tunnels in the tuber, eating as they go. The larvae are white in colour, about 7 to 8 mm (just over $\frac{1}{4}$ in) long, and take about 3 weeks to reach full size. If an infested tuber is broken open, the larvae will be seen inside (*Plate III*). After the full size is reached, each larva eats out a small hole at the end of its tunnel and here it pupates (changes into the adult form of the weevil). The adult can live for several months and it is possible to get as many as eight generations in a year.

Damage by this pest can be so bad that it causes a complete loss of the crop. Over the years there have been a number of outbreaks reported at various places, including Wau, Bulolo, Kainantu, Henganofi, Goroka and Kundiawa. No doubt there have been many unrecorded outbreaks also. In fact, outbreaks occur regularly every year in some of the drier areas. Somehow the people are able to grow enough sweet potato for themselves and the weevils as well.

METHODS OF CONTROL

What can be done to control the sweet potato weevil? It is difficult to kill the weevil once it has got into a garden, so control methods are largely concerned with trying to keep the weevil out of the garden altogether. In some areas it may not be possible to prevent outbreaks occurring every year, but by simple common-sense measures, the amount of damage can be greatly reduced. The control measures recommended are the same, not only for the whole of Papua New Guinea, but also for the whole South Pacific region.

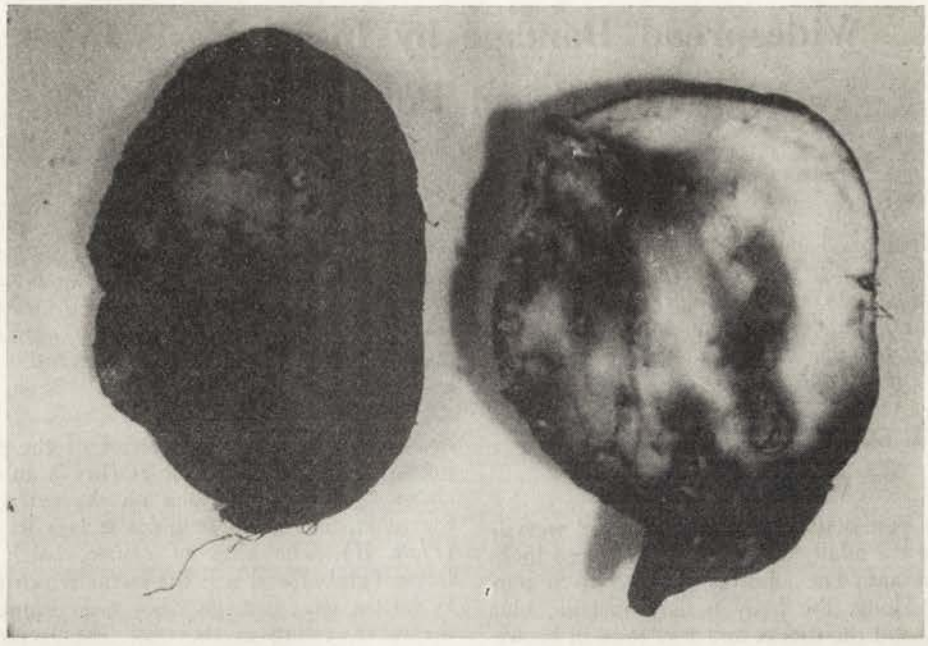


Photo (D.I.E.S.)

Plate II.—Feeding holes can be seen on the surface of the tuber. The eggs laid in these holes develop into larvae

Preventive Methods

(1) Build-up of the pest can be prevented by crop rotation, that is by planting some other crop, not sweet potato, on the land. Once land has become infested with weevils, sweet potato should not be planted on that land again for at least a year. Since the weevils can only live on sweet potato or other very similar plants, they will all die or go somewhere else in 12 months. It is important, however, that all sweet potato and other plants that look like sweet potato should be dug out. Even a few tubers left in the soil by accident would provide food for new generations of weevils. One common plant which can provide a home for the weevils is "Morning Glory" (a creeping vine with trumpet-shaped flowers). This must be dug out also, and destroyed.

(2) When a new sweet potato garden is being planted, cuttings should only be taken from a garden which is known to have no weevils in it. If a garden has the weevil, then the pest can be transported to a new garden very easily, because the adults often feed on the vines.

(3) To make doubly sure that no weevils are carried over into a new garden, cuttings can be dipped in an insecticide mixture before being planted. The dip mixture should contain 284 cc ($\frac{1}{2}$ pint) of 25 per cent DDT liquid concentrate in 18 litres (4 gallons) of water. Cuttings should be completely dipped, allowed to drain over the dip, and planted as soon as possible afterwards. A steel or plastic container is suitable for holding the dip mixture. The mixture will last up to 3 days. After that it will lose its strength and a new mixture should be made up. Old dip mixture must not be emptied into or near drains, creeks or ponds. People dipping cuttings or planting them must wash thoroughly when work is finished for the day, and before eating, drinking or smoking.

(4) New sweet potato gardens should be planted as far away as possible from the old gardens to make it hard for adult weevils to reach the new garden.

(5) It has been explained above that the most serious damage is done when an adult weevil gets into a tuber. It is not easy for a weevil to dig through the soil, so the deeper the tuber is in the soil, the less chance there is of damage by weevils. Vines should therefore be planted as deep as possible.

(6) One final method of control is to use soils which do not develop cracks in dry weather. Of course, this is not always possible, but if soils which do crack open have to be

Photo (D.I.E.S.)

Plate III.—An enlargement of *Plate* II, showing the larvae in the tuber. A larva is about ¼ inch long

used, then it is a good idea to put a layer of grass about 5 to 8 cm (2 to 3 in) thick on the top of to soil, and so stop it from drying out too much.

Eradication Methods

What can one do if the weevil is already in a garden and it is likely to result in a serious loss of the crop? Certain products are available which are known to kill the weevil, but there are a number of reasons why it is better not to use them. Firstly, they are very poisonous chemicals, and as well as killing the weevils, they may remain in the tuber, and do some harm to the person who eats the tuber. Secondly, to be really effective, they must be applied to the soil as well as the leaves, and this is very difficult to do in a sweet potato crop where the leaves cover the ground. Probably the most sensible idea would be to harvest the crop as soon as possible, rather than leave it to be damaged any more by the weevils.

II. SWEET-POTATO LEAF-MINER
(*Bedellia somnulentella*)

This pest is not nearly as serious as the sweet potato weevil, but outbreaks have been recorded this year in a number of locations in the Highlands. Outbreaks of the leaf-miner do not usually cause a complete loss of the crop, but yields can be reduced very much and there is usually a delay before tubers can be harvested.

The adult is a very small moth, usually grey in colour, and only about 3 mm (just over $\frac{1}{8}$ inch) long. When it is flying with its wings spread out, it is about 8 mm (1/3rd of an inch) across. The moths lay their very small eggs on the surface of a leaf and when the larvae hatch out, they go inside the leaf and move about in there, eating as they go. This is the reason for the name "leaf-miner". The remains of the leaf turn brown and often go hard and brittle in the sun. The larvae then come out of the leaf and start spinning threads among the leaves, as a spider does. These threads can be easily seen, especially early in the morning when the plants are still wet and the sun is low in the sky. At this stage the larvae

(Photo: T. L. Fenner)

Plate IV.—The sweet potato leaf-miner causes much damage to a crop. The larval threads and pupae are seen on the right of the photo. The leaves at the tip of each stem seem to be unaffected, but those farther down the stem are brown and withered

are about 5 to 6 mm ($\frac{1}{4}$ in) long and can be seen moving about the threads and leaves in a looping fashion. The larvae become pupae, hanging in the threads, and these can be seen as small, dark cigar-shaped objects about 5 to 6 mm ($\frac{1}{4}$ in) long (see *Plate* IV). The adult moths hatch from the pupae and soon start laying eggs again. The time from egg-laying to adult is only 3 to 4 weeks, so a build-up of this pest can be very rapid.

Methods of Control

Although the threads and dead leaves in an infested sweet potato garden can look very bad, the pest does not usually spread very far. It is often kept under control by other insects, which eat it. However, it does cause many people a lot of worry, because it can reduce yields very much.

Apart from natural control by other insects, there are two useful chemicals which can be used, but they are toxic and must be used with great care, if possible by people especially trained for the job. One of these chemicals is marketed as "Septene liquid". For control, mix 28 cc of the product, plus 15 cc of a cheap wetting agent such as teepol or a detergent, in a 14-litre (3-gallon) knapsack, and spray over the sweet potato plants. This should be done again 7 to 10 days later. The first spraying will kill any moths and larvae which are present, but it will not kill the eggs. Ten days later the eggs which survived the first spraying will have hatched into larvae. The second spraying will kill these larvae. The other product is "Malathion", which is cheaper than "Septene liquid". If 20 cc of the product, plus 15 cc of a cheap wetting agent are mixed in a 14-litre (3-gallon) knapsack, it will again give control in two applications, 7 to 10 days apart.

Chemical control has been successful at Aiyura, and has also been done successfully by Mr D. Birmingham in subsistence gardens in the Goroka area. In this case, the sweet potato gardens were sprayed by two trained operators and the owners were charged a fee. This would certainly be the best method of control for most subsistence gardens.

Further Reading

Entomology Section, DASF (1969). "Insect Pest Survey for the Year Ending 30th June 1967". *Papua New Guin. agric. J.*, 21:66.

O'Connor, B. A. (1969). "Exotic Plant Pests and Diseases". A handbook of plant pests and diseases within the area of the South Pacific Commission. S.P.C. Noumea.

Sherman, M. and Tamashiro, N. "The sweet potato weevils in Hawaii: their biology and control". *Hawaii agric. Expt. Stn.* Tech. Bull. No. 23.

Smee, Lance (1965). "Insect pests of sweet potato and taro in the Territory of Papua and New Guinea: their habits and control". *Papua New Guin. agric. J.*, 17:99.

Stapley, J. H. (1972). "Principal pests of crops in the Solomon Islands". *Pans*, 18:192.

Pasture Work in the Grasslands of the Northern District—Part II

J. F. Clancy, Livestock Lecturer
Popondetta Agricultural Training Institute

In Part I of this article, the author outlined the early pasture trial work at P.A.T.I. in which it was found that the species which performed best were Paspalum plicatulum, *Kazungula Setaria, Stylo and Greenleaf Desmodium. Further trials were then established using these species and some others. Since the object of this work was to find pastures most suitable for village cattle projects, attention was concentrated on increasing carrying capacity with the minimum use of agricultural machinery.*

1. *Establishment of Stylo into Kunai Complex*

Project cattle, ranging on natural grassland, keep in good condition if the stocking rate is one beast to eight acres. But because of the relatively small acreages available, a higher stocking rate than this is needed. It was decided to try to raise the carrying capacity of the natural grassland by introducing a vigorous legume at the lowest possible cost.

The natural grassland in this area is a complex mixture of kunai (*Imperata cylindrica*), cane grass (*Pennisetum macrostachyum*) and wild pit pit (*Saccharum edule*). This type of grassland is known as "Kunai Complex".

An area of typical grassland (20 acres) was selected at P.A.T.I. It was rolled and burnt. Rolling prior to burning produced an excellent burn. Deep cultivation was not contemplated as previous cultivation on this type of ground produced a serious weed problem.

Twenty pounds of Stylo were broadcast into the burn. A set of disc harrows, without set or weights, was pulled lightly over the paddock to cover the seed. This was proved unnecessary in later trials, especially when good follow-up rains occurred.

Germination and establishment of Stylo were excellent (see *Plate* V). The original burn changed the complex of the natural species. The better species, *Imperata cylindrica* (kunai), tended to thicken up and compete more favourably with less desirable species such as cane grass and wild pit pit.

The first grazing took place 8 weeks after sowing. Forty cows were grazed for seven days. The pasture was eaten down to about 4 in. Stylo is considered to be unpalatable to cattle but there was no evidence of that in this trial. It was grazed well and was certainly not left.

After the seven days' grazing the paddock had a 28-day rest period. Recovery was excellent.

During the wet season the kunai complex grew faster than the cattle could graze it. The Stylo also grew well and competed well with the kunai complex. In order to control the cane grass, the paddock was rolled. This helped the Stylo and the *Imperata cylindrica* to grow better than the other species which are not such good food for cattle. The paddock is now rolled three times a year. During the dry season, the Stylo seeds vigorously.

With cattle project management it is suggested that this type of pasture would carry a beast to six acres quite safely in this area.

2. Paspalum plicatulum *and Stylo*

Simultaneously with the work just described, it was decided to attempt to establish an improved pasture mixture on an area completely dominated by *Digitaria longiflora*. This was originally a 10-acre kunai paddock, but continual slashing had allowed the creeping Digitaria to take over, resulting in a completely useless paddock.

The Digitaria was burnt in the dry season and ripped with a time implement. Roots and runners brought to the surface required a second burn.

A mixture of Stylo (2 lb/acre) and *Paspalum plicatulum* (2 lb/acre) was broadcast into the second burn. The paddock was then rolled.

Fortunately good rain followed. Stylo germination was excellent, while *P. plicatulum* germination was disappointing. This was possibly due to the age of the seed, as it had been held up for 3 months in transit. Grazing started 8 weeks after sowing. Again, 40 cows

Plate V.—A 3-year-old stand of Stylo and Kunai. The Stylo is seeding

were grazed for seven days, followed by a 28-day rest period. *P. plicatulum* proved very palatable and stood up well to the grazing.

Towards the end of the first rest period, the *P. plicatulum* showed signs of seeding. The paddock was then locked up (that is, not used for grazing) and allowed to seed. Seeding was heavy and uniform. The actual seed fall lasted 2 weeks. The paddock was then subjected to rotational grazing again.

The natural seed fall gave spectacular results. Six months after planting the paddock consisted of a pure stand of Paspalum and Stylo (*Plate* VI).

In the wet season this paddock requires a heavy stocking density to prevent it becoming too rank.

This mixture is easily established and stands very heavy grazing. Both Stylo and *P. plicatulum* will seed if allowed (Stylo in the dry season, and *P. plicatulum* in the wet). It is definitely recommended for this area.

3. *Improving Kunai Complex/Stylo Pasture*

The next trials studied the possibility of introducing improved grasses into a kunai complex/Stylo pasture, after the Stylo was well established. The two grasses previously tested were used again—*Paspalum plicatulum* and Kazungula Setaria (*Setaria anceps* cv Kazungula). In addition Nunbank Buffel (*Cenchrus ciliaris* cv Nunbank) was used as it showed promising qualities, especially in the dry season.

Fifteen acres of kunai complex/Stylo pasture were grazed heavily, nearly to ground level. The area was then disc-harrowed once to a depth of no more than 2 in.

The seed used was:—
P. plicatulum 5 lb
Kazungula Setaria 3 lb
Nunbank Buffel 15 lb

The 23 lb mixture was mixed with sand and broadcast over the fifteen acres. Due to the lightness of the Buffel seed, it was necessary to harrow the paddock again after sowing.

Plate VI.—A 3-year-old stand of *Paspalum plicatulum* and Stylo

Germination was good, and the grasses were allowed to seed.

P. plicatulum and Setaria spread well, and the paddock stood the same stocking rate as used in the previous trials.

Both Stylo and Buffel established well. The Buffel proved to be valuable in the dry season, recovering more quickly than the other introduced grass species. It does not, however, produce the bulk, nor does it have the carrying capacity of the other two grasses. It has the further drawback that its natural seed fall is not viable. Seed must be collected and dry-stored to improve its viability. For these reasons Buffel would not be suitable as the main grass for native cattle projects in this area.

In cases where a project had a legume/kunai stand, it would be economical to harrow and introduce improved grasses by seed, especially free-seeding species such as *P. plicatulum* or Setaria.

4. *Greenleaf Desmodium and Kunai Complex*

Fifteen acres of kunai complex were rolled and burnt. Fifteen pounds of Greenleaf Desmodium (*Desmodium intortum*) seed was

inoculated and broadcast into the burn. This was done at night, as direct sunlight kills the inoculum. A piece of airstrip matting was pulled over the area immediately to cover the inoculated seed. Good rain followed.

Germination and establishment were excellent and the legume stood up to grazing exceptionally well. Although Greenleaf can survive a normal dry season quite well, it suffered severe leaf-fall and stopped growing during the exceptional dry season of 1972. After only 40 points of rain, however, it recovered well (see *Plate* VII). There had been no other rain for 2 months when this photo was taken.

It is intended to introduce Setaria into this pasture as soon as seed is available. The method will involve heavy grazing and broadcasting straight onto the grazed sward.

5. *Dolichos axillaris and Kunai Complex*

Eight acres of kunai complex were rolled, burnt and broadcast with *Dolichos axillaris*. Germination was good, but establishment was very slow, compared to Stylo and Greenleaf Desmodium. This species seems to be less palatable than the other two, but unlike Greenleaf Desmodium, it thrived through the 1972 drought. So far it has not seeded. Observations are continuing.

Plate VII.—Greenleaf Desmodium and kunai complex. This has been under rotational grazing for 10 months

6. *Brachiaria decumbens*

This grass has shown good promise in small grazing trials but has not been tried under paddock conditions, using this crude method of establishment. It is intended to plant six acres using runners from previous trials as planting material. Due to its high protein content and ability to thicken up vegetatively, it could be used on the better projects, especially those established on secondary regrowth bush areas.

Conclusion

It is possible to establish improved pastures into the local kunai merely by burning the kunai and broadcasting the new seed. It is better, however, to put a roller over the paddock first (if a tractor is available) as this will give a better burn. To ensure good germination the seed should be covered after sowing. This can be done in several ways; one way is to drag a piece of airstrip matting over the ground after broadcasting the seed.

Deep cultivation is to be avoided on virgin ground as it produces a serious weed problem. Alternate paddocks could be locked up for short periods annually to allow seed fall. This will give a good ground cover.

The species currently recommended for this type of establishment programme are Stylo/*Paspalum plicatulum* or Stylo/Setaria. For wet areas Greenleaf Desmodium and Para Grass (*Brachiaria mutica*) are suitable. Para Grass was not included in these trials as it has previously proved suitable for wetter conditions.

At the present time the above pasture species on P.A.T.I. are carrying one beast per two acres per year. It is unlikely that this would be possible under the average project management. Although no specific trials have been carried out, generally speaking it would be expected that a kunai/legume (Stylo) mixture would safely carry one beast to six acres. Stocking rate trials carried out by the Animal Industry Branch at the Beef Cattle Research Centre, Erap, have shown that rates of one beast to three acres are possible under reasonable management conditions. A kunai/*Paspalum plicatulum*/Stylo mixture would carry one beast to four acres safely.

Projects in the Northern District are currently following these recommendations for pasture improvement. Instead of using a roller, a heavy chain-mesh was substituted which not only flattens the kunai for burning but also has a light cultivation effect as well. Stylo and Setaria are being used as the initial combination, as seed for these species is most readily available.

Trials are continuing and results will be reported in future issues of *Harvest*.

Quarantine Booklet

D.A.S.F. has recently issued a booklet entitled *Animal and Plant Quarantine in Papua New Guinea—A Guide for Importers*. It gives a brief outline of quarantine regulations concerning specific plants and animals, including timber, straw packing and animal products such as lard and bristles.

The booklet indicates which items may be imported without restriction, which require a permit and which are totally prohibited. Conditions surrounding the issue of permits are given.

Copies of the booklet may be obtained from D.A.S.F. offices at each district headquarters, from all D.A.S.F. Quarantine Officers, and from the Collector of Customs in each port throughout Papua New Guinea. In Port Moresby copies are also available at Jackson's Airport (D.A.S.F. Quarantine Officer) and at D.A.S.F. Headquarters, Konedobu from the reception desk.

Biltong and Charqui

MILOS ONDRASEK, Senior Veterinary Officer

(Inspection Services)

The spoilage of meat is caused by micro-organisms, bacteria, moulds and yeasts. By removing the conditions under which they thrive—moisture and high temperature—preservation can be achieved.

These days there are two ways commonly used to preserve meat: cold—refrigeration, and heat—canning. We tend to forget that other methods were used long before cooling, freezing and canning were technical possibilities. These other methods can still be used. Two methods of drying meat are given in this article.

There is an increasing amount of beef and pork being produced in Papua New Guinea but all of it is sold and eaten soon after slaughtering. As the total meat production of the country increases and new slaughterhouses are constructed, however, a simple method of meat preservation may be useful.

Perhaps, in the not-too-distant future, some indigenous entrepreneur will start to preserve meat by drying it. There should be a ready sale amongst villagers for such a product, if the taste is acceptable.

A carcass slaughtered at a registered slaughterhouse and found fit by a Meat Inspector must be hygienically treated, not only during dressing procedures but also during the entire subsequent operations from the slaughterhouse to the consumer, particularly in the area of processing (if any), transport, storage, sale and kitchen preparation.

It cannot be over-emphasized that flesh from an animal that has been seriously sick, or died before it could be slaughtered, should not be eaten in any form. Consumption of such meat results in illness or death.

The four general processes widely used in the preservation of meat are: drying (including smoking); curing; refrigeration; and heat sterilization (canning). Drying and curing, often combined, have been used since early times; freezing and canning have been developed on large industrial scales during the last 100 years. More recently, much attention has been given to the use of various radiations and to some microbial inhibitors, such as ozone, carbon dioxide and antibiotics, usually combined with ice-cooling or refrigeration of the meat.

BILTONG

Biltong is meat which has been preserved by drying. It is used extensively in Africa. Because of the simplicity of its preparation, it is found to be very convenient in countries where fresh meat is not always available or where there is a lack of keeping facilities.

How is it made?

The carcass should be hung and cooled before being cut up. In cutting up the carcass, the aim should be to produce long strips of muscle of equal thickness. Care should be taken to cut the muscles lengthwise. The best dried meat is produced by tearing the muscles into pieces so that a group of muscle fibres can be dried as a unit. Normally, the thickness of the muscle strips should not be more than 1 to 2 in in cross-section. When the climate is very hot and dry, thicker strips may be used. Weather conditions are important; meat can be properly dried only in hot, dry weather. When attempts are made to dry pieces of meat which are too large, or when the weather is unsuitable, bacterial decomposition begins inside the meat strips or else they become infested by fungus. Offal (heart, liver, etc.) should not be dried.

Meat for drying is salted, using clean, preferably coarse salt, which may be rubbed into the strips before they are hung, or they may be covered with a layer of salt and left overnight. When the strips are covered with salt, considerable amounts of serum ooze into the brine.

Spices such as pepper or ground chillies are sometimes added; and saltpetre (potassium nitrate) may also be used. It acts as a mild preservative and imparts a bright red colour to the meat. Some people marinate the meat in vinegar for a day before salting and hanging it out to dry. This gives it a delicate, mouth-watering flavour.

Drying

Drying is carried out by hanging the salted meat strips on strands of galvanized wire, the longer pieces being hung over the wire and the shorter pieces hooked into the barbs. When only a small amount of meat is to be dried, wire "S" hooks about 2 to 3 in long may be used, one hooked into each strip of meat and hung over a wire or rope. It is important that one strip does not touch another; the air must be able to circulate freely around the strips. After one day's drying, the strips should be taken off the wire, straightened out and hung with the other end uppermost. The time required for drying depends entirely on the weather. The biltong is ready when a piece, broken or cut off, shows a uniform structure. The meat should be hung under cover where there is wind access but where flies and rain cannot touch it. A gauze cage hung under a roof would do the trick for the meat cut from the saddle or back of a carcass.

Dried meat is subject to attack by insects from 4 to 6 weeks after drying. To prevent this, small amounts may be stored in plastic bags or in sacks hanging on a wire. For large amounts, other forms of protection are necessary (smoking, or suitable chemicals).

If properly protected from insects and moisture, dried meat can be kept for more than a year. It may be consumed in different ways; after soaking in water, it resembles and can be treated as fresh meat. It is palatable when eaten dry and raw. There is no loss of mineral matter and most of the vitamins are retained, unchanged.

On the other hand, all types of dried meat are subject to spoilage through exposure to air and light which cause rancidity of the fat; through wetting and coming into contact with moisture which leads to decomposition and growth of moulds; and through unprotected handling which leads to infestation by insects.

CHARQUI

Meat preserved by another method is called charqui. The nutritional value of biltong is slightly superior to that of charqui because it contains more protein and has more of the vitamin B group. On the other hand, charqui contains more fat and moisture than biltong, its salt content is higher and thus it has good keeping qualities and is resistant to insects and fungi.

The method of charqui preparation, briefly, is to cut fresh raw meat into slabs 2 to 6 lb in weight and not more than ½ to 1 in thick. The slabs are hung in the shade for about one hour to cool. The pieces are then submerged in a saturated salt solution for about an hour. After removal from the salt, the meat is allowed to drain, and for curing, the meat is built into a heap or pile on a sloping concrete slab, under a roof. Next day the pile is turned over so that the top pieces go to the bottom of the new pile. Fresh salt is used in making the new pile. This process is repeated for five consecutive days. The salted meat is now prepared for drying. It should first be passed through a kind of mangle, consisting of two rollers with an opening between them of about 1 in. This squeezing may also be done by a press. The operation is not necessary in dry climates. Drying must be very carefully carried out to avoid the possibility of the meat becoming hot enough to melt the fat. The meat should be spread on drying racks under cover. The meat should be turned every two hours during the first day and later, as drying proceeds, every four and then every six hours. It may be necessary to protect the meat from insects. The salt on the surface of the dried meat must be fine and perfectly white, free from any reddish colour to avoid "red heat" spoilage due to microbial infection.

The Lowa Marketing Co-operative Ltd of Goroka

D. NICHOLLS, R.D.O., Goroka

The Lowa Marketing Co-operative is an organization formed by indigenous farmers (with the assistance of DASF) to help them sell their produce. There is considerable potential for sale of kaukau and other staple foods in Goroka, particularly to institutions such as the hospital, schools and the Teachers College.

Subsistence agriculture in this area is based on kaukau (sweet potato—*Ipomoea batatas*) with subsidiary crops of taro, yams, manioc (tapioca), bananas, corn and many green-leaf plants. Coffee supplies a substantial part of the income. On average there are 66 coffee bushes per person, which gives an income of about $10 per year. For most people this is about half their cash income for the year.

The number of people living in Goroka is rising fast, and this means the amount of fresh vegetables consumed is also rising fast. The Eastern Highlands Co-ordinating Committee asked DASF to see what could be done to increase the production of foodstuffs locally and to decrease the importation of other foods, especially rice.

Local farmers who had started to grow kaukau for sale in Goroka found they had marketing problems, and in 1968 they asked DASF to help them. Other local producers were drawn into the meetings by the original members until a group of 80 farmers was involved, and they were holding monthly meetings. Associated with

(Photo: D.I.E.S)

Plate I.—Kaukau is almost always grown on mounds in the Highlands

(Photo: D.I.E.S)

Plate II.—Tubers are washed before being collected by the Co-operative truck

the major problem of selling were other problems of capital required for fencing and for tractors, and purely agricultural problems also.

The aim of people in these meetings was:—

(1) To satisfy completely the kaukau requirements of the Government establishments in Goroka.

(2) To market their produce through a co-operative marketing organization set up with their own funds.

To achieve the first objective, it was necessary to increase production of kaukau considerably, especially in view of the fact that production normally is seasonal. This meant more land had to be gardened, and with pigs being allowed to graze freely around villages, a lot of money and effort were needed to fence in the new areas. Wetter ground near creeks and the river also had to be enclosed so that planting could take place in the dry season.

To achieve the second goal, it was estimated that an investment of $50 per person would be required. It was decided to delay the collection of this money until all the members had received payment for the sale of their coffee for the season.

TRIAL CO-OPERATIVE

In the interim period, DASF conducted a "trial co-operative". The system of marketing was similar to that intended for the co-operative when it was set up. It worked like this—

The grower harvested his kaukau just before the truck was expected, cleaned the tubers, and put them into hessian bags. Although garden weighing was tried for a short period, produce was mainly weighed (and sometimes sorted) in the store. Payment was by cheque from the DASF office. Only good quality kaukau was accepted. The price paid to the grower was 1 cent per lb and the price paid by the buyer in Goroka was 1½ cents per lb. The margin of half a cent per lb was sufficient to cover costs of the truck, the driver's and buyer's wages and other overhead expenses.

This trial period provided answers to some questions which had been raised:—

(1) Will the growers be content with a price of 1 cent per lb at their gardens instead of 1½ cents per lb at Goroka market?

(2) Will the growers understand that only good quality kaukau can be sold even if they are not personally facing the buyers?

(Photo: D.I.E.S)

Plate III.—A wide variety of foods is sold at Goroka Market

(3) Will the growers realize that they must harvest a lot of kaukau in one day to fill up the truck?

(4) Will they be able to maintain supplies of kaukau through both the wet and dry seasons?

1. *Price*

The price of 1 cent per lb at the village was fairly well received, although some of the older men complained. The reason for the easy acceptance of the price may have been that a few months earlier large quantities of kaukau were bought at 1 cent per lb by patrol officers, for use at a large "singsing" arranged for the visit of the Duke and Duchess of Kent. Many village people sold kaukau to the Government on that occasion. Within a few weeks, the price was accepted as standard and was not questioned, even though they knew that this was lower than the price they could get if they took the produce to Goroka themselves (to the market).

2. *Quality*

In group meetings before sales actually commenced, everyone agreed that only good tubers could be offered for sale. This worked out in practice fairly well. The tubers were all inspected before being accepted, and any unacceptable tubers were returned to the grower. Other members of the group had strong words for defaulters and some shame was attached to the receipt of rejects. Within a few weeks of operation, there were very few tubers of poor quality being offered for sale.

3. *Large Quantities*

The question of large quantities being available on one day was a much harder problem. Initially the produce available was only that surplus to subsistence requirements, and in very small quantities in any garden. Farmers were willing to harvest an area completely to fill the bags but their ability to plant sufficient quantities in advance was in question. For this reason, throughout the whole period of the "trial co-operative" the trucks were never completely filled so the cost of transport per lb was higher than it should have been.

4. *Continuity of Supply*

This is still a serious problem; it requires continuous effort by DASF extension officers to encourage the people to maintain a steady supply of sweet potato throughout the year. During the trial period the supply ceased in November, 1969 and no more was available until the following March. During periods of general shortage, villagers may be obliged to give food to their relatives rather than keep up the supplies for sale through the co-operative. Such shortages need to be allowed for when planning dry season plantings. In general, such shortages should mean increased sales for the co-operative.

FORMATION OF COMPANY

Collection of money for shares was made from June to October, 1970 and the meeting to form the company was held in December, 1970. The Lowa Marketing Co-operative Ltd was formally registered with the Department of Trade and Industry in February, 1971. There were 80 paid-up members of the co-operative at the time of registration. Of these, 65 members had full voting rights, having invested $50 or more. These paid-up members represented other relatives who were growers but not members. The total number of growers involved in the scheme was about 250 men (plus wives).

Fencing

The idea of keeping pigs inside a fenced area is contrary to traditional practice in this district, so the best way to stop the pigs eating the kaukau was to put a fence around the kaukau. Fencing thus became an expensive item involving considerable capital outlay. There was a shortage of suitable bush materials, so most clan groups decided on wire fences which can be erected more quickly than traditional fences but are more expensive. Development Bank loans were granted for the purpose. Over 70 loans for market garden enterprises have been approved for members to date.

Cultivation

Mechanical equipment was used on less than 25 per cent of the total area where cash crops were grown. This was mainly ploughing, the ground being broken in preparation for hand cultivation. The remaining 75 per cent was cultivated only by hand, using spades. Hand cultivation was used primarily because no machinery was available, and also because cheaper village labour was available to members through social obligations. All groups, however, have set a goal of cultivation by machinery. The Lowa Co-operative is not designed to hire out machinery to its members, nor do the members have the necessary experience to operate tractors safely and efficiently. There is an opening for a local entrepreneur

to start a tractor-operating business, but the members may decide on some other solution to the problem.

Planting Schedules

No form of planting control has been discussed yet. With such a large unsatisfied market for sweet potato the problems of oversupply have not yet arisen. Planning of planting periods is largely determined by the local climate and soil conditions. The well-drained humic soils are suited to planting in the wet season (October to May) while the poorly-drained alluvial soils beside creeks and the river are suited to planting in the dry season (June to September).

The Future

The project is certainly proving successful, and should continue to be a success. When the demand for kaukau in Goroka is met, if the number of members of the Society continues to grow, other cash crops can be planted. There is certainly a market, as yet unsatisfied, for English potatoes (*Solanum tuberosum*). This crop keeps well and can be transported without serious damage so has a great potential. The main problem at present is getting sufficient planting material. A wide range of other vegetables can be grown, but marketing and transport arrangements would have to be carefully checked out before any large-scale plantings were commenced. The main thing is that the farmer members have an organization in which they can talk about their problems and so find the answers for themselves.

Buffalo Research Project

The Animal Industry Branch of the Department has established a Buffalo Research Project at the Sepik Plains Livestock Station, Urimo. The project is part of an overall programme to study the grazing potential of the Sepik Plains using Urimo as the basis of the investigations. This programme is supervised by John Schottler, the acting O.I.C. of the Beef Cattle Research Centre at Erap, and is being carried out by Livestock Officer, Ruki Kalaing and Urimo Station Manager, Rob Shaw.

The object of the research project is to see whether buffalo can be successfully grazed on the natural pastures of the Sepik Plains and, if so, the level of performance which can be expected. The research staff will measure parameters such as growth rate, calving rate, the area of pasture required to support each animal and labour requirements for a small herd. With this information they will then be able to decide whether smallholder farms based on buffalo are likely to be economically successful.

Different management systems for cattle are also being examined at Urimo and the results obtained from the buffalo experiments will enable direct comparisons to be made between cattle and buffalo under the different management systems. It is known that buffalo can digest very poor quality pastures (such as those occurring on the Sepik Plains), but they grow more slowly than cattle and take longer to mature, so that under good pasture conditions cattle are more efficient. The work now being carried out at Urimo will help us to decide whether it will be best to fertilize the ground and plant improved pastures for cattle, or whether we should graze cattle on the natural pastures and supplement the cattle with protein and phosphate, or whether we can simply graze buffalo on the natural grasses without supplementation of any kind.

Kuk Tea Research Station

J. G. MORGAN

Agronomist-in-Charge, Kuk

Although tea is a comparative newcomer to Papua New Guinea, it has already proved to be a satisfactory cash crop, given certain conditions. To gain much needed information on cultural techniques suitable for the local environment and to attempt to improve the quality of planting material, a research station has been established by D.A.S.F. at Kuk, 12 miles from Mount Hagen.

Since experience at Garaina proved that tea could be grown commercially in Papua New Guinea a small industry has been established in the Highlands. All the tea grown at present is located in the vicinity of Mount Hagen, much of it on reclaimed swamps of the Wahgi Valley, and in the Southern Highlands near Mendi and Ialibu.

The crop is grown both by smallholders who would have, on average, about 1 acre planted to tea, and large estates of 800 acres or more employing 500 to 600 labourers.

IMPROVEMENT OF PLANTING MATERIAL

Populations of plants grown from seed are very variable as a seed results from the union of male and female factors and even if the two parents are known it is not possible to predict how the characteristics of the two parents will

Photo: D.I.E.S.

Plate 1.—Plucking on a tea estate. In Papua New Guinea, plucking is done by men, not women

Photo: D.I.E.S.

Plate II.—Two and a bud, the classical plucking standard. The finest teas can only be made from young tender leaves

be combined in the offspring. Tea is self-sterile, and pollen must be carried by wind and insects from one tree to another for seeds to develop. Pollen from a very vigorous tree may fertilize flowers on another very vigorous tree and the resulting seed may produce very weak plants. The opposite is also possible. In fact very little is known about the genetics of tea.

For this reason, the plant improvement programme at Kuk is based on the selection of high yielding medium to high quality clones. A clone is a population of plants all derived from the same seedling mother bush by means of vegetative propagation. Thus the resulting plant inherits all its characteristics from only one plant. With tea, the most common method of vegetative propagation is the single leaf cutting technique which involves planting a short piece of green stem about 4 cm long with a full leaf attached.

All tea at present planted in this country has grown from seed. Yields for mature seedling tea are expected to vary between approximately 450 and 1,100 kg per hectare. Thirty to forty years ago the average yield in Ceylon was about 480 kg per hectare. Now, largely through plant selection work, the average yield has doubled and yields as high as 3,600 kg/ha are possible on clonal experimental plots. It is not uncommon for selected areas on some estates to average 1,800 kg/ha. The aim of the selection programme at Kuk is to produce clones which will yield above 1,800 kg/ha per annum of made tea under average conditions. The quality of this tea will not be lower than that at present being obtained from seedling tea and hopefully it will be higher. The figures given above are for "made tea", which means the dried leaf that you buy in a shop. Approximately 5 lb of green leaves must be picked to make 1 lb of made tea. In other words, the green leaves contain roughly 80 per cent moisture.

The most rapid way of building up numbers of cuttings is by grafting scions taken from the selected clones onto seedling rootstocks. Various techniques have been tried at Kuk, some of these with reasonable success.

It is expected that both cuttings and scions will be available for off station trials in the near future.

FERTILIZER TRIALS

It is possible to achieve and maintain high yields only if fertilizer is applied to the tea. In some cases fertilizer may be necessary to provide elements not naturally occurring in sufficient quantities in the soil to supply the

needs of the tea bush. Fertilizer is also required to replace elements taken away in the harvested leaf.

The questions which need to be answered are: what elements are or are likely to become in short supply, what is the best fertilizer to apply to make up these deficiencies, how much and how often?

Apart from various fertilizer trials on the station itself, "off station" trials on estates are being established on the various soil types on which tea is grown commercially. At present, four major elements, nitrogen, phosphorus, potassium and sulphur are involved in these trials. While it is not possible to make any definite recommendations at this stage, recommendations on fertilizer practice will almost certainly be different for the different soil types.

Besides other elements, both nitrogen and sulphur appear to be necessary for high yields and ammonium sulphate is a convenient fertilizer as it supplies both elements. However, continued application of this fertilizer can be detrimental to the soil and results in reduced quality of the made teas. Other possible sources are being investigated.

For best results, newly planted tea, and tea not in production, probably benefits most from a fertilizer mixture different from that which gives the best response in tea in plucking. Trials are being conducted on fertilizer mixtures most suitable for newly planted stumps on two soil types.

It is not expected that phosphate fertilizers will be necessary in the foreseeable future and as mentioned earlier, work is proceeding to confirm this assumption. On the other hand there is evidence that potash deficiency will become a problem after four to five years plucking, unless this element has been provided in the fertilizer mixture.

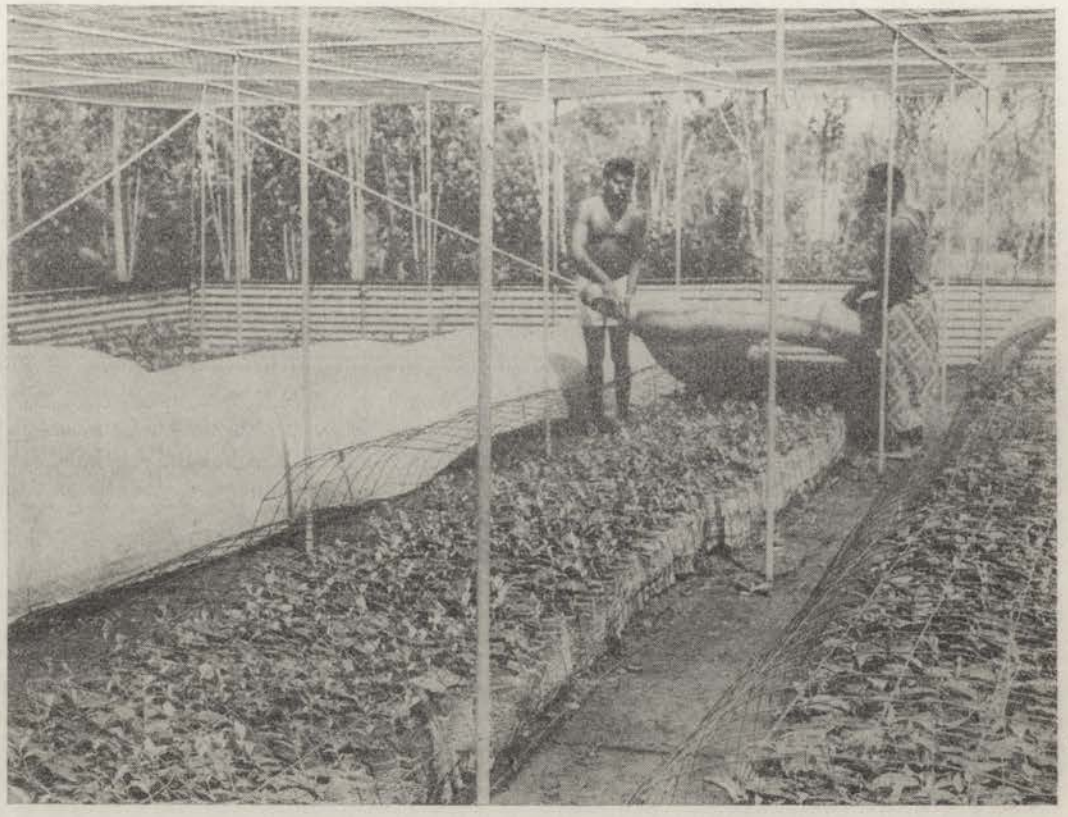


Plate III.—Young clonal plants in the nursery at Kuk. Before being transplanted to the field, the young plants must be "hardened off" by decreasing shade

CULTURAL TECHNIQUES

Spacing

Work carried out overseas has indicated that increasing the density of planting up to certain limits increases yield per hectare. Populations in Papua New Guinea vary between 6,600 and 12,000 bushes per hectare.

Overseas, very high densities are being used now for some new plantings, in some cases as many as 24,000 plants per hectare.

A trial at Kuk comparing 14 various spacings is in progress. Two methods of frame formation are included in this trial.

Frame Formation

A low wide spreading frame is a desirable characteristic in a tea bush as this increases the area over which the young shoots can be plucked. The aim should be to have the area being plucked in a field the same area as the field itself—that is, aim for a 100 per cent ground coverage. As the pluckers move through the tea it should open in front of them and close behind them. The sooner this is obtained the better as higher yields are obtained earlier and weeds cease to be a problem once light to them is cut off.

Frame formation can be done by a series of prunings which lead to branching or by a technique known as layering which involves bending young branches over sideways and pegging them into place. Vertical shoots then grow upwards from the buds on the bent branches. The layering technique gives earlier and higher yields and there is reason to believe that these higher yields are maintained in mature tea, at least for many years.

There are however, some disadvantages to layering. First of all weeding is made more difficult during the time the canopy is developing. The cost of layering in itself is higher than that for pruning.

On clonal plants that have been layered, tipping (the establishment of a level plucking table) can commence 18 months after the cutting was planted. This corresponds to the time seedling tea would normally be transplanted from the nursery to the field.

It is felt that while layering may not be worthwhile for seedling tea, it will definitely be worthwhile for high yielding clonal tea. Experiments to confirm or disprove this are progressing.

Herbicides

When herbicides are used, there is always some danger that the chemical will kill or severely damage the crop. Investigations at Kuk have shown that herbicides do exist which give excellent weed control and which even when sprayed directly onto the foliage tea at high concentrations have no detrimental effect.

Pests and Diseases

Tea is remarkably free of both pests and diseases in Papua New Guinea but some pests and diseases, which could develop into major problems, are present. Departmental staff are keeping a constant watch on the situation and would appreciate being advised of any unusual outbreaks which may occur. Staff at Kuk work in close liaison with the pathology laboratories in Port Moresby. An entomologist is stationed at Kuk.

MANUFACTURE

At present the only tea manufactured at Kuk is from small clonal plots so that an indication of quality can be obtained.

In commercial factory, manufacture consists essentially of four stages. First leaf is initially allowed to wither for 12-15 hours after which it is macerated so that cells are ruptured and the cell juices can come into contact with the oxygen in the air. This allows the leaf to ferment or oxidize. Following this the leaf is dried and sorted into various size grades.

It is unlikely that research into manufacturing techniques will be carried on at Kuk in the foreseeable future. Equipment to carry out such work is expensive and it is considered that the limited resources available would be put to more efficient use in solving more pressing problems.

Only small areas of tea are at present being plucked. This tea is not sold as the marketing expenses would be greater than the return obtained. No doubt, as large areas are brought into production, the leaf will be sold to recoup some of the expenditure on the station.

VISITORS WELCOME

The above is only a brief outline of what Kuk is all about. Visitors are always welcome and the staff are always keen to meet tea-growers, to discuss problems, to learn from them and to offer what help they can to those interested.

Feeding Sweet Potatoes to Pigs

IAN R. WATT, Pig Husbandry Adviser

Tropical Pig Breeding and Research Centre, D.A.S.F., Goroka

*Since the establishment of the Pig Production Section in mid-*1969, *a considerable amount of research into the value of sweet potatoes as a pig food has been undertaken at the Tropical Pig Breeding and Research Centre, Goroka. This work has been conducted by Dr G. L. Malynicz, Senior Veterinary Officer—Pig Production, with the assistance of Mr H. Nad, Assistant Livestock Officer. In all, seven research projects involving sweet potatoes have been completed which provided much interesting and valuable information suitable for village pig production.*

The initial experiments were aimed at finding suitable protein additives because sweet potato is very low in protein. Part I of this article describes work done with pigs under intensive management, while Part II outlines experiments on pigs grazing on sweet potato.

This article summarizes the work which has been carried out at Goroka over the past three years. A more detailed account of the work will appear in the P.N.G. Agricultural Journal during 1973.

Part I—INTENSIVE MANAGEMENT

Because not much grain is grown in Papua New Guinea, and because the small amount which is grown can be expensive when landed in certain of the pig producing areas, sweet potato (kaukau—*Ipomoea batatas*) appeared to be the only food readily available for feeding to pigs. However, it was known that sweet potatoes on their own were not suitable for intensive pig production, as they do not provide sufficient protein.

Sweet Potato with High Protein Plant Foods

Three reasonably high quality protein-rich foods (raw peanuts, soyabeans, raw or cooked, and soyabeans with salt and bone ash) were fed to pigs with raw and cooked sweet potatoes.

1. *Peanuts*

Peanuts were fed raw at a daily rate of up to 1½ lb with raw sweet potatoes fed *ad lib* (as much as the pigs wanted). The pigs in this group had an average daily liveweight gain of 0.2 lb and consumed less than half the food of any other group. When the cost or value of the peanuts was taken into consideration, it became apparent that the feeding of raw peanuts and raw kaukau was impracticable and uneconomical.

2. *Soyabeans*

Soyabeans were also investigated as a suitable protein supplement for feeding with raw sweet potato. In this experiment one group was fed raw soyabeans while the other was fed cooked soyabeans. Both lots of soyabeans were fed to a maximum of 1.2 lb per day with sweet potato fed *ad lib*.

The pigs fed on raw soyabeans consumed an average of 0.24 lb per day over the fifty day period of the experiment, while those on cooked soyabeans consumed an average of 0.36 lb per day.

The average daily liveweight gain of the two groups showed that the cooked soyabean diet produced a gain of 0.44 lb while the raw soyabean group produced a gain of only 0.13 lb. This result was more or less expected as it is known that soyabeans contain a growth inhibitor which is rendered harmless when the beans are cooked. The growth inhibitor is a chemical substance which stops pigs growing normally. So, although soyabeans contain plenty of protein, they will not help pigs to grow bigger unless the beans are cooked.

3. *Soyabeans plus salt and bone ash*

Another experiment was undertaken to determine the effect of adding salt and bone ash to soyabean and sweet potato rations. The straight *soyabean/sweet potato* group achieved an average daily liveweight gain of 0.63 lb. The same ration with common salt added and fed *ad lib* improved the average daily liveweight gain to 0.93 lb. The addition of bone ash did not increase the daily gain, nor did it reduce it. The addition of bone ash is therefore not recommended at this stage.

Sweet Potato with Commercial Concentrate

The peanuts and soyabeans mentioned above are food plants which can easily be grown by a pig farmer in Papua New Guinea; only the salt and bone ash would have to be bought.

There are, however, various high protein foods specially prepared for pigs which pig owners can buy. This kind of food is called "pig concentrate" or "commercial concentrate". It is made in Australia and imported into Papua New Guinea. It is usually a mixture of fishmeal, meatmeal, cottonseed meal and feather meal, with the addition of vitamins and minerals. When mixed with grain it is supposed to give a complete and balanced ration. It varies in protein content from 45 per cent to 55 per cent. This product is available in Papua New Guinea under several brand names, all of which are similar in content.

The initial experiment using pig concentrate involved the feeding of 1 lb per day per pig with *ad lib* raw sweet potato. The pigs grew at an average daily liveweight gain of 0.72 lb over the 84-day period of the trial. This result was encouraging as the normal station ration used at Goroka (sorghum and concentrate) achieved an average daily liveweight gain of 1.25 lb. This method of feeding 1 lb per day per pig regardless of age or size was a modification of a system devised by Lehmann in Germany at the turn of the century.

The Lehmann system worked on the knowledge that pigs eat for energy and not for protein. Pigs have an increasing energy requirement while their protein requirement stays at about the same level. This means that as the pig grows, both in size and in age, its requirement for energy increases and so it consumes more sweet potatoes. This is why there must be sufficient sweet potatoes available for the pig to eat. The 1 lb of concentrate per day is sufficient to meet the pig's protein requirements regardless of age or size, except when sows are lactating in which case they require 2 lb per pig per day.

Cooked Sweet Potato with Commerical Concentrate

The system of feeding described above has been widely advocated by the Pig Production Section and has gained acceptance in most areas as being satisfactory and practical. However, it became apparent over the 12 months or so after its introduction that producers were not very keen on maintaining the concentrate level at 1 lb per day. A further experiment was therefore conducted using three levels of protein supplementation—1 lb, 0.5 lb, and 0.25 lb per pig per day. At the same time the sweet potatoes were boiled, whereas previous experiments had been on raw sweet potatoes. It was thought that cooking the sweet potatoes could improve palatability and digestibility, thereby improving the growth rate. The results of the experiment were quite impressive. The group fed 1 lb concentrate per pig per day with *ad lib* boiled sweet potatoes, grew at an average daily liveweight gain of 1.30 lbs. The second group fed on 0.5 lb concentrate gained at the rate of 0.96 lb per day while the third group (0.25 lb) grew at 0.70 lb per day. The result was clear—pig concentrate should be fed at the 1 lb per pig per day rate for maximum results.

To assess the value of cooked sweet potato as against raw sweet potato, an experiment was recently conducted. This showed that cooking increased growth rate by about 40 per cent over that achieved by the raw sweet potato group. At the same time as this factor was being investigated, two groups of pigs were fed 1 lb of concentrate mixed with 10 lb of cooked sweet potatoes with this mixture being fed *ad lib*. The average daily liveweight gain of this group was better than either of the two other groups.

Economic Return

Mr D. Clark, Regional Economist, studied the costs involved in these feeding systems. Some people want to have pigs in order to sell them and make money. Other people are not so interested in making money; they just want to have more pigs and bigger pigs than other people, so that they can use them for bride price payments or traditional ceremonies. These experiments show that those people who want to make money should feed each pig 1 lb of commercial concentrate per day plus *ad lib* cooked sweet potato. They will have to pay out money to buy the concentrate, but they will get a lot more money back when they sell the pigs.

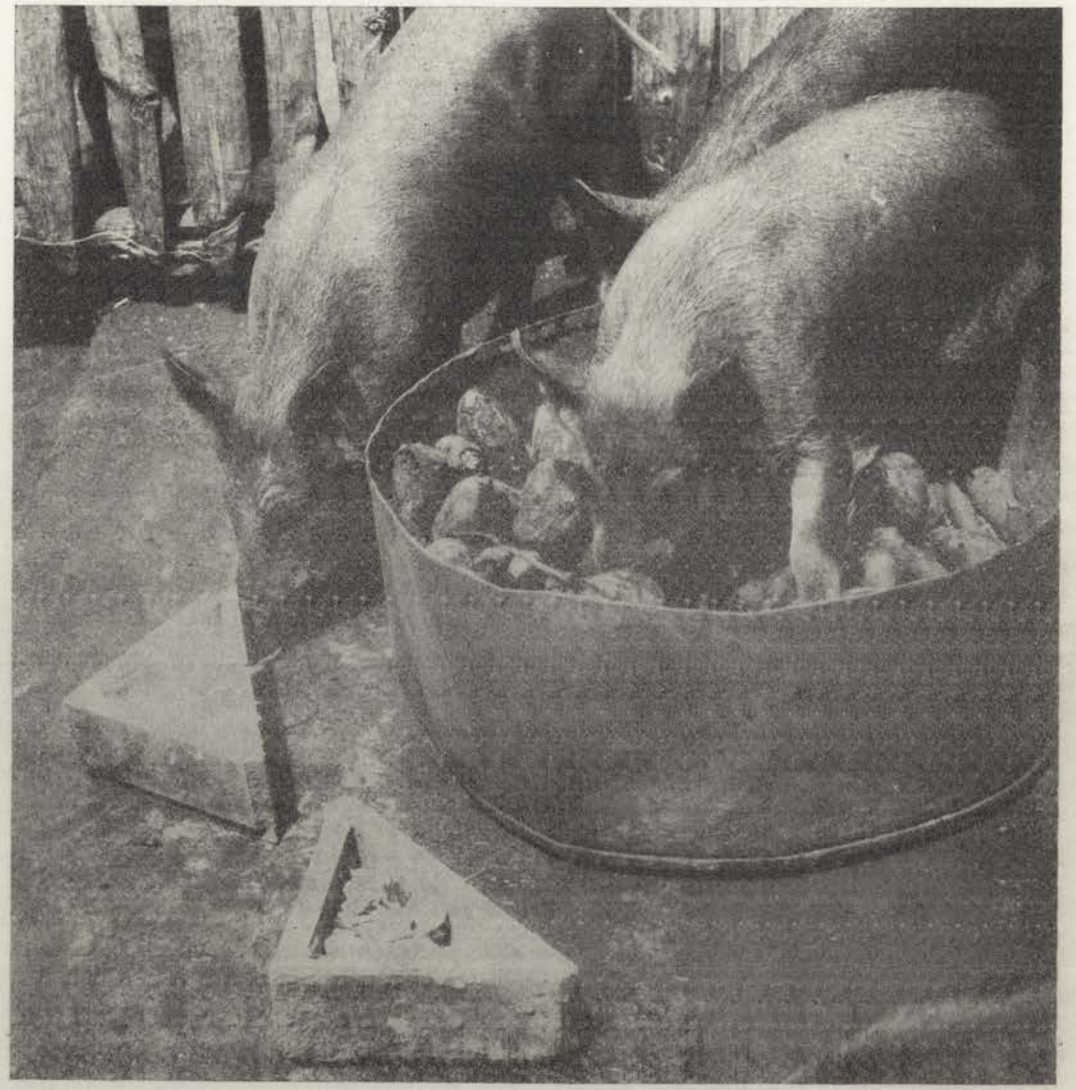
For people who are not interested in making money, but want to have bigger pigs than other people have, they also should feed their pigs 1 lb of commercial concentrate per day. A man who doesn't want to spend much money can give his pigs only 0.5 lb or 0.25 lb of concentrate per day. If he does this, however, his pigs will not grow as big as those on the full ration of 1 lb of concentrate per day.

As well as the cost of the concentrate, the cost of cooking the sweet potato must be considered. In the experiment described above, the sweet potato was cooked in a mumu (earth oven). It was noted that 1 lb of firewood was sufficient to cook seven pounds of sweet potatoes. If the firewood has to be purchased, then it is doubtful whether there is any economic gain in cooking the sweet potato.

Part II—GRAZING

All the work described in Part I of this article was done in an intensive unit, with pigs housed on either concrete or deep litter floors, and the sweet potato fed by hand (*Plate* I). Grazing of pigs on sweet potato was investigated as an alternative to intensive housing.

Part I described work done to establish the fact that some kind of protein supplement is needed for pigs which are being fed largely on sweet potato. In Part II, the first three experiments describe the use of different kinds of protein supplement, with the pigs in each getting the sweet potato by grazing. In the



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

Plate I.—Pigs being fed sweet potatoes under intensive management. Supplementary feeding is provided in the triangular boxes in the foreground

third and fourth experiments, the same supplement was used, but in the last case, a system of rotational grazing was tried.

Grazing with Various Supplements

In the first experiment the pigs grazed on sweet potatoes and in addition they were fed supplements of:

1. Salt: mineral block.
2. ½ lb margarine per pig per day.
3. 1.2 lb meatmeal (50 per cent protein) per pig per day.
4. No supplementation.

Only the meatmeal group gained weight at an average daily gain of 0.76 lb while the other three groups all lost weight.

Grazing with Reduced Concentrate Supplement

The second experiment involved five groups of pigs. All pigs grazed sweet potatoes, but three of the five groups had additional high protein food. These were:

Group 1. 0.68 lb of protein concentrate (55 per cent protein) per pig per day.

Group 2. No additional food

Group 3. 0.46 lb of whole peanut kernels per pig per day.

Group 4. No additional food.

Group 5. 0.9 lb concentrate per pig per day.

Results. As expected, the pigs in Groups 2 and 4 did not increase in weight at all; in some cases they lost weight. Group 1 pigs gained weight at the rate of 0.57 lb per day, Group 3 at 0.3 lb per day, and Group 5 at 0.82 lb per day.

Grazing with Full Concentrate Supplement

In the third of this series of experiments, one group of pigs grazed sweet potatoes with no supplementation, while a second group was fed 1 lb concentrate per pig per day. Once again, the groups grazing the sweet potatoes without any supplementation lost weight, while the second group had an average daily weight gain of 0.9 lb.

As a continuation of these experiments, it was decided to conduct a similar trial at a different location using 1 lb concentrate per pig per day as supplement.

Rotational Grazing with Full Concentrate Supplement

This experiment was conducted at Banz with three consecutive groups of pigs grazing one area of sweet potato. The area was of one acre subdivided into ten equal paddocks, which were planted at one month intervals. The pigs were allowed to stay on one of these paddocks until it was grazed out, and then moved on to the next paddock. After moving, the paddock was immediately replanted. The pigs were provided with adequate shelter in which they were fed the supplement. The acre was stocked with five growers. The first group achieved an average daily liveweight gain of 1.2 lb, the second group 1.4 lb, and the third group 1.1 lb. These results were very satisfying in that the managerial skill and effort is lower in this type of enterprise than in an intensive unit. There was no appreciable drop in yield of sweet potato over the three crops.

SUMMARY AND RECOMMENDATIONS

It is quite apparent that sweet potatoes have a definite value as a pig feed, but they must be supplemented with some form of protein. Both peanuts and soyabeans must be cooked before feeding. Pig concentrate is a satisfactory supplement and should be fed either at 1 lb per pig per day, or in the ratio of 1 lb of concentrate to 10 lb of sweet potato. Cooking the sweet potato gives increased average daily liveweight gains as well as increased consumption, but against this must be considered the cost of the actual cooking.

As a result of this research work, the following recommendations have been made:

1. Soyabeans and peanuts must be cooked before feeding to pigs.
2. Salt should be fed with soyabeans.
3. Sweet potato is not a suitable food on its own.
4. Cooking sweet potatoes increases the daily liveweight gain and food consumption when compared with raw sweet potatoes.
5. Protein concentrate should be fed at the rate of 1 lb per pig per day for maximum results.
6. The mixing of 1 lb of concentrate with 10 lb cooked sweet potatoes gives slightly better results than feeding cooked sweet potatoes under the Lehmann system.
7. Grazing sweet potatoes is a satisfactory method of feeding.
8. Pigs grazing sweet potatoes require protein supplement of 1 lb concentrate per pig per day.

Produce Inspection

G. W. GASKELL, Senior Produce Inspector
Port Moresby

One of the services provided by D.A.S.F. is quality control of agricultural products exported from this country. This function is performed by the Produce Inspection section of the Department.

There was a produce inspection service in this country prior to World War II, but this was discontinued during hostilities. In 1952 legislation was brought down to provide for the reintroduction of copra inspection, but it was not until a year or two later that a full scale inspection service at the major ports began functioning.

In 1959 cocoa inspection was introduced, and by this time recruitment of inspectors with plantation experience in both copra and cocoa had provided adequate personnel for the section to inspect both of these products in all major ports.

Copra and cocoa are both inspected under the provisions of their respective ordinances. These ordinances specify standards which must be met. However producers are safeguarded by the right of appeal, in the event of their disagreeing with an inspector's decision. Such appeals are uncommon, especially in latter years. This would seem to reflect acceptance by producers of the service provided.

Complaints by both producers and buyers are always investigated, and every effort is made to ensure harmony amongst all concerned.

(Photo: C. A. Fowler)

Plate I.—Produce Inspector Eiasi Saoia examines a shipment of copra

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

Plate II.—No, he is not playing draughts! Part of the procedure for inspecting cocoa is to place 100 beans (selected at random) on the board and count the number showing evidence of defects such as mould or insect attack

COPRA

Copra from this country is classified into three grades at the time of inspection and copra which does not meet any of these grades is rejected. Where possible, rejected copra is reconditioned so that it then meets one of the required standards.

The qualities taken into consideration in copra grading include moisture content, insect infestation, free fatty acid content, foreign matter, cleanliness and colour. Objectionable moulds are not allowed in any of the three grades. Top quality copra must have a moisture content not exceeding 6 per cent and must be dried by hot air, or Ceylon type driers. Smoke-cured or smoke-permeated copra meets only lowest grade's requirements.

COCOA

At present this country's cocoa is classified into two classes only: *Export Quality* and *Non-Export Quality*. Cocoa beans must meet a fairly high standard of quality to be accepted as *Export Quality*. They must have been processed in an approved manner. They must be free of foul, foreign or hammy odours, and must meet fairly stringent requirements regarding mould, insects and foreign matter. Of course they must be sufficiently dried.

It is most important that it should be known that bags of cocoa beans which meet the standards of *Export Quality* are branded with a red triangle at the mouth of the bag and sealed by attaching a metal seal to the twine sewing the bag.

Cocoa beans which do not meet the standard of *Export Quality* can still be exported, but bags containing such cocoa are not branded with the red triangle, nor are they sealed.

This off-grade cocoa is usually sold on sample, because, whilst buyers should be aware that it has not conformed to the accepted standard of *Export Quality* they would not know

to what extent the defect occurred or on what grounds the cocoa was not accepted for the top grade.

WORK OF INSPECTORS

Functions of the produce inspectors, in addition to carrying out inspections aimed at quality control of both products, include surveillance of storage sheds used for holding copra or cocoa, to ensure that no deterioration is brought about by weather or insect infestation. Certain standards of construction and hygiene are stipulated for sheds used for storing inspected cocoa or copra.

Produce inspectors are well versed in production methods of the products they inspect. They are therefore able to offer advice particularly to indigenous producers, aimed at rectifying faults noted in the finished product.

The training of new inspectors is continuous. Local officers are being trained by experienced inspectors, and this should ensure that the service they provide will continue to maintain an acceptable standard of quality of this country's important agricultural exports.

Now Your Dog Can "Go Finish" With You

Following an announcement by the Commonwealth Minister for Health on 13th February, 1973, dog and cat owners will be permitted to export their animals from Papua New Guinea to Australia, provided they fulfil these conditions:—

1. The animal must have been in Papua New Guinea continuously during the six months preceeding export and must not, during that time, have been in premises used for quarantine.
2. Permission in writing must be obtained from the Chief Quarantine Officer (Animals) in Brisbane.
3. A health certificate for each animal must be signed by the Government Veterinary Officer at the port of export.
4. The animal must spend 9 months in quarantine in Brisbane.

Owners intending to export their pets to Australia should take the following steps:—

1. Write to the Chief Quarantine Officer (Animals) Department of Primary Industries, William Street, Brisbane, Queensland 4000, seeking his permission to import the dog or cat and a booking for the necessary nine months quarantine. He will need to know the species, breed, sex, age and number of animals to be sent, together with the proposed date of import and the flight number. The permit will be issued accordingly with a latitude of five days' validity. Permits will not normally be issued for export on aircraft which will arrive in Australia at weekends or holiday periods.
2. On receipt of permission from Australia, collect a declaration form from the nearest office of the D.A.S.F. and fill in the first part. This declaration must be signed by the owner and handed to a Livestock or Veterinary Officer for his counter-signature.
3. Make an appointment with the Regional Veterinary Officer, D.A.S.F., Kila Kila, Port Moresby, for examination and treatment of the animal and the issue of a health certificate. This appointment must be made at least 14 days before the animal is to depart. Appointments will only be made when a firm booking on a specified flight is held. This examination will only be done at the Regional Veterinary Centre, Kila Kila, Port Moresby.
4. The animal must be delivered to the Regional Veterinary Centre, Kila Kila, Port Moresby together with a suitable cage. The Regional Veterinary Officer will examine the animal, and sign the necessary papers. The owner (or agent) will then deliver the animal to the Airport Quarantine Officer, who will place the animal on board the aircraft. A fee of $5.00 per animal will be charged. Further information on suitable cages may be obtained from the airline companies.

Quality Control Testing of Pepper

T. J. PIPER, Agricultural Chemist

Pepper is probably the world's most important spice, both in terms of total production and value of production. The 1958 *production of* 65,000 *tons was valued at* $US70,000,000 *and current production is around* 100,000 *tons. World consumption of pepper is increasing, and the supply at present is only just meeting the demand. Thus the crop has good potential as a cash crop for Papua New Guinea, being comparatively easy to grow and process.*

Black pepper is produced by drying the green, unripe berries of *Piper nigrum*, a vine-like shrub of the *Piperaceae* family native to southern India. (see *Plate* I). White pepper is produced from the same plant but from riper orange-red berries. These berries have the cortex or skin removed before drying, leaving the white berry.

In commercial food processing such as meat canning, pie and sausage making, etc., whole pepper is rarely used. The manufacturer prefers to use an extract of the pepper known as oleoresin and/or the volatile oils of pepper.

Oil of pepper, obtained by steam distillation of the ground spice, is used to provide the aroma and some of the flavour of natural pepper. It has none of the pungency of pepper, however, since the pungent principles are not steam volatile. Oleoresin, on the other hand, contains the pungent principles (most important of which is piperine), the volatile oil and various resins. To prepare oleoresin, the ground pepper is extracted with a solvent such as alcohol, ether or acetone. Subsequent evaporation of the solvent leaves the viscous semi-solid pepper oleoresin. This can be standardized according to its pungency and flavour, and thus offers a uniform concentrated product that is more easily handled than the natural spice.

(Photo: D.I.E.S)

Plate I.—A pepper vine. The peppercorns grow close together on a stem about 6 in long

The need for quality testing

For a pepper to be accepted on the world markets, it has to meet certain analytical standards. It also has to measure up to other peppers in taste and aroma, which are not as easy to measure. Commercial processing companies evaluate pepper samples on the basis of yield of oleoresin, the amount of piperine in the oleoresin, the yield of volatile oil and its chemical composition. Naturally, the peppercorns also have to be of good colour and appearance and free from mould and insect damage.

The standards set by large processors such as Stafford Allen of England and the Essential Oil Association of America, are as follows:

Oleoresin content of pepper—8-11%

Piperine content of oleoresin—55-65%

Volatile oil content of pepper—2.3% min.

Volatile oil content of oleoresin—15-35%

Values recorded for Papua New Guinea peppers have ranged over the following limits:

Oleoresin—7-18%

Piperine—41-80%

Volatile oil—1.7-3.9%

Volatile oil in oleoresin—11-38%

It is obvious that there is a need for quality control of pepper, in order to produce the best possible product and so ensure that potential markets are not jeopardized by the supply of inferior grades of spice.

QUALITY CONTROL METHODS

Oleoresin: Finely ground pepper (about 10 g) is extracted with acetone in a Soxhlet extractor which permits continuous unattended extraction of the spice to be carried out. A description of the apparatus was given in *Harvest* Vol. 1, No. 4 of 1971 page 143. The solvent is then removed from the extract by drying at room temperature, usually under vacuum. Oleoresin remains behind as a viscous, greenish-black mass. A simple calculation then enables the oleoresin content of the pepper to be determined.

Piperine: There are several methods, of varying accuracy, that are used for estimating piperine.

One method employed measures the amount of nitrogen in the pepper oleoresin. As piperine contains 4.9 per cent nitrogen, multiplying the total nitrogen by a factor of 20.36 gives an estimate of the piperine content of the pepper. Most of the nitrogen in oleoresin comes from piperine but nitrogen in other compounds will also be measured so the piperine estimate may be slightly high.

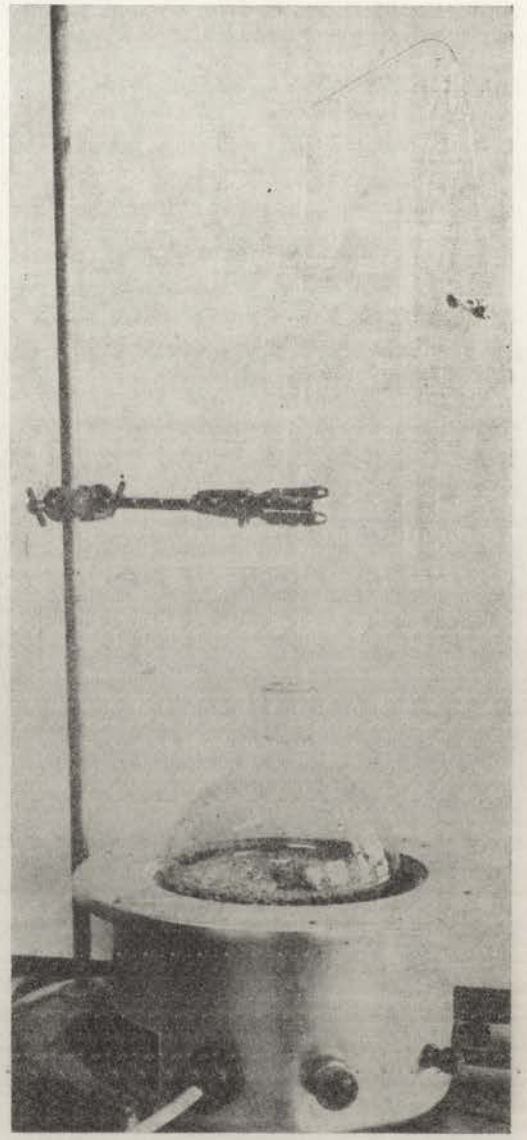
Another method employs sulphuric acid to break up the piperine molecule to produce formaldehyde and other by-products. The formaldehyde then reacts with chromotropic acid to produce a purple colour, which can be accurately measured by a spectrophotometer. Unfortunately, the chromotropic acid may also react with some other compounds present in pepper, so that the results obtained can be appreciably higher than they should be.

A third method which is very simple, and is the one used at our laboratory, is based on the fact that piperine absorbs ultraviolet (U.V.) light. The piperine in a sample of pepper is extracted with a suitable volume of alcohol and the amount of U.V. light absorption measured in a spectrophotometer. By also measuring the absorption of a series of solutions containing different but known amounts of piperine, we can calculate how much piperine there is in the pepper oleoresin.

Volatile oil: Ground pepper (about 50 g) is boiled with water in a flask fitted with an essential oil still (*Plate* II).

The pepper oil is volatile with steam and so passes up and over the condenser. Here the vapours are condensed and separated into oil and water. The oil floats on top of the water layer, while the water is continuously returned to the distilling flask. After the volume of the oil has been measured, it can be recovered and analysed.

Quality of Volatile Oil by TLC: Thin layer chromatography (TLC) is an analytical technique of great value to chemists. It utilizes



(Photo: C. A. Fowler)
***Plate* II.—An essential oil still**

a very thin layer of finely ground powder such as alumina (aluminium oxide) coated on the surface of a flat glass plate. A small drop of the substance to be examined (in this case pepper oil) is placed near the bottom of the plate and the plate is then stood in a shallow layer of solvent (in this case toluene) in a glass tank. Capillary action draws the toluene up the thin layer of alumina, through the spot of pepper oil and then further along the layer. Each compound in the pepper oil tends to flow with the moving toluene, but is held back more or less strongly by the alumina. Thus the individual compounds are spread out up the plate. By drying the plate and spraying it with a suitable reagent to make the compounds coloured, we can produce a pattern characteristic of the pepper oil. Several pepper oils can be analysed on the one plate simultaneously so comparisons of Papua New Guinea pepper oil with commercially acceptable oils from overseas can be readily made (*Plate* III).

Composition of Volatile Oil by Gas Chromatography: Gas chromatography (GC) is an even more sensitive analytical method than TLC. The gas chromatograph (*Plate* IV) operates with a slow stream of nitrogen gas flowing through the coiled tubular column,

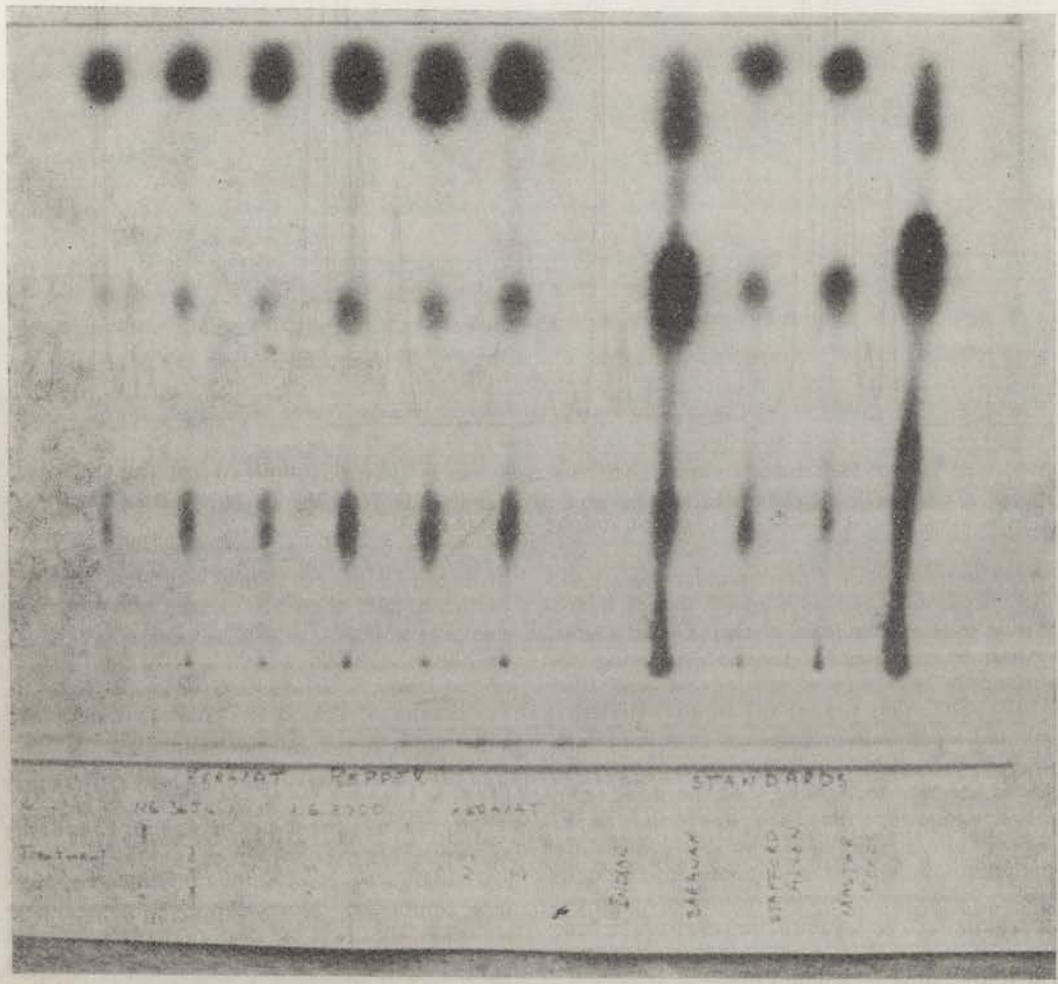


Plate III.—A thin layer chromatography plate. The different components in the pepper oil spread out on the plate, making it possible to compare the relative amounts of components in different samples of oil

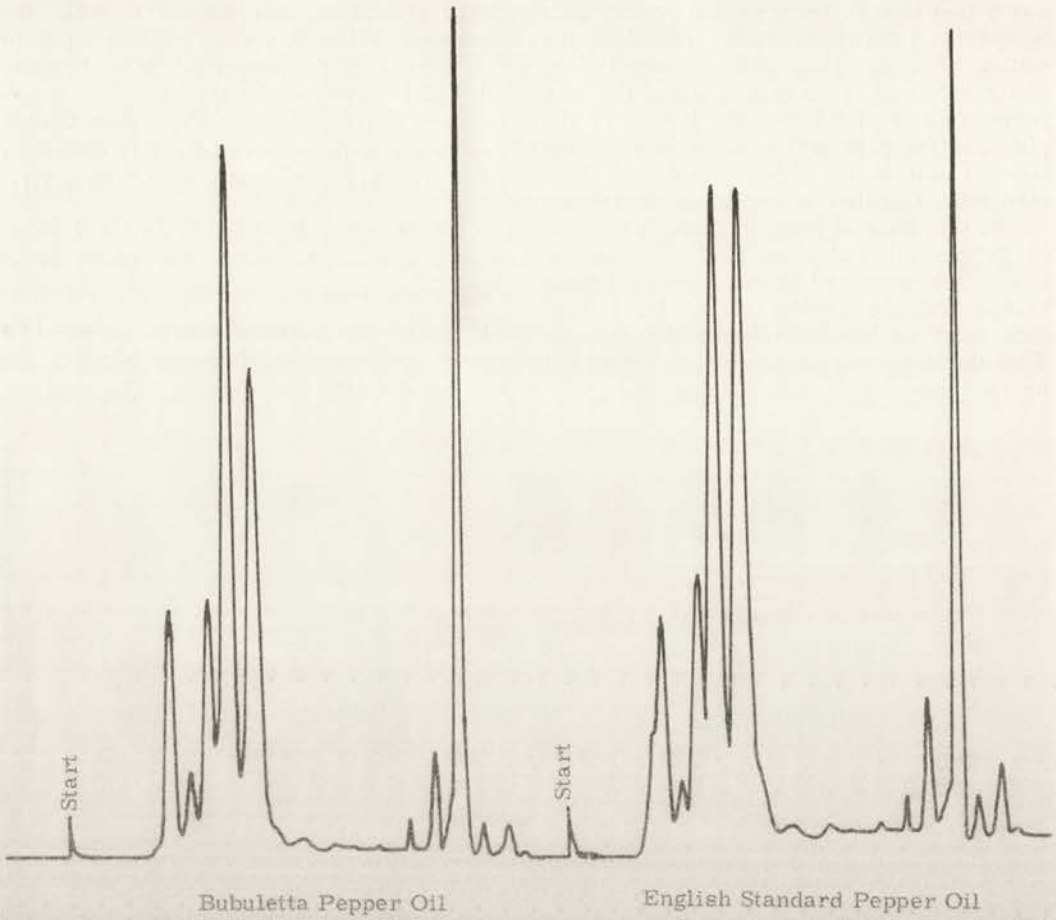


Figure 1.—A gas-liquid chromatograph trace of two pepper oils. Note the similarity between the PNG sample and the overseas standard

which is filled with a fine granular silica packing coated with a thin film of special hydrocarbon grease (stationary phase). Under normal operating conditions the oven containing the column is heated to something between 100° and 200°C. The pepper oil to be analysed is injected by hypodermic syringe onto the beginning of the column and immediately vaporises. These vapours are carried past the packing by the flowing nitrogen. Each compound in the pepper oil vapour tends to dissolve in the stationary phase, but also tends to evaporate and move with the flowing nitrogen. These two opposing factors separate the individual components, with the more volatile compounds emerging from the column first.

The end of the column is connected to a small jet of burning hydrogen. Normally a hydrogen flame contains very few ionized particles, but when an organic compound is present and burnt, it produces ions which make the flame conducting. The electrical conductance of the flame, which is directly proportional to the amount of compound present, is amplified and traced out by a recorder to give a chromatograph of the components in the pepper oil (*Figure* 1).

When testing first began, the TLC patterns of Papua New Guinea pepper oils bore little resemblance to those of oils provided by overseas companies. Now, however, they closely resemble the best of the overseas standards in both piperine and volatile oil content. Thus Papua New Guinea at present can produce pepper of a high standard, which should be readily saleable.

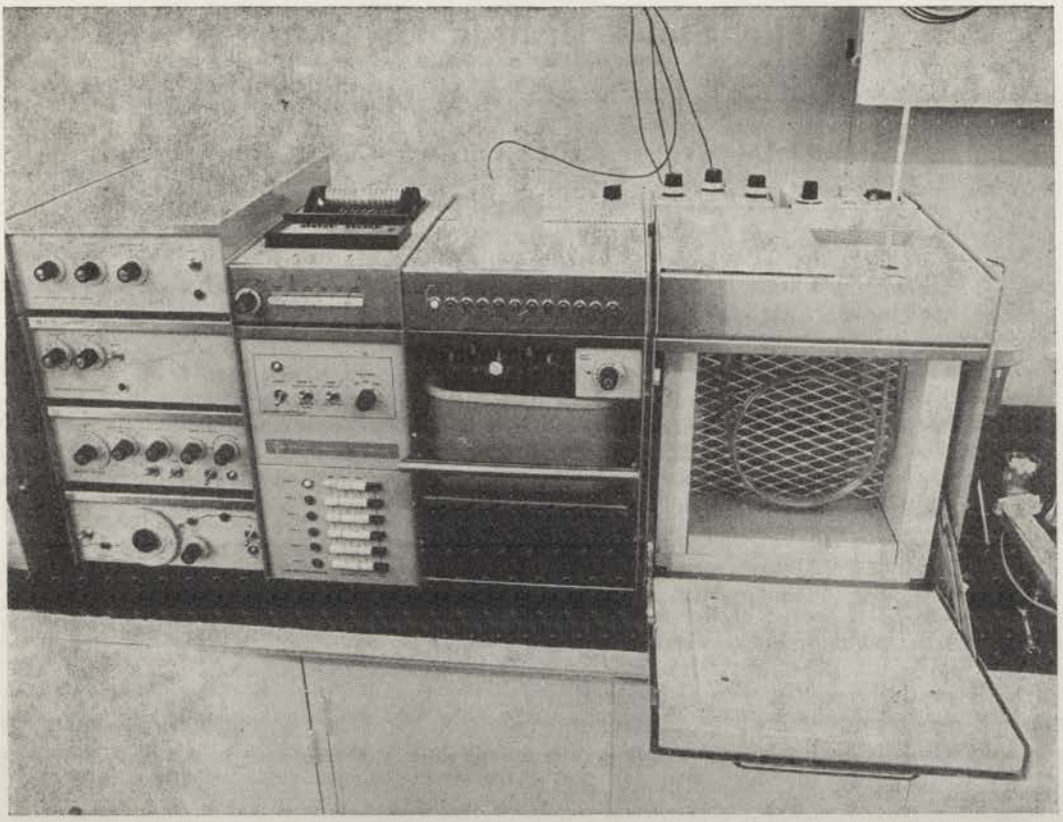


Plate IV.—The gas chromatograph (Photo: D.I.E.S)

The Fishes of New Guinea

BY IAN S. R. MUNRO

This book contains the most up-to-date information on local fishes yet published. It contains over 700 pages with 6 colour plates, 78 plates in black and white and 23 figures in text, and is published by D.A.S.F. Copies of *The Fishes of New Guinea* are available from the Government Printer, P.O. Box 3280, Port Moresby. The price is $14.50 retail plus 50 cents postage within Papua New Guinea, surface mail. Postage to Australia is 75 cents.

The Stock Brands Ordinance

No. 1 of the Series "Know Your Ordinance"

D. E. MURRAY, Senior Livestock Officer, D.A.S.F. Headquarters

Stock are branded for two main reasons—to assist in providing a legal identification of ownership, and to provide a rapid and readily available means of checking essential information such as age, herd number, etc. The branding of stock is not compulsory in Papua New Guinea. If a stock-owner wishes to brand his stock, however, he must by law register the brand.

The branding of stock in Papua New Guinea is covered by the Brands Ordinance of 1962. All branding of cattle and horses, as a means of identification of ownership, must be carried out in accordance with the provisions of this Ordinance. When a stock-owner wishes to register a brand, he must apply on a special form to the Registrar of Brands at D.A.S.F. Headquarters, Konedobu. The Ordinance states that a brand shall consist of three letters, or two letters and a number, or one letter and two numbers. It also states that the letters or numbers should be not less than 1½ inches high and not more than 2½ inches high. Government-owned cattle have a broad arrow instead of of one letter.

An application to register a brand must be accompanied by a fee of $4.00. On receipt of the application to register a brand, the Registrar will issue a Certificate of Registration if the brand application is in order and the brand is not the same or similar to any brand already issued. A brand which is very similar to one already registered will not be accepted; instead the Registrar will advise the applicant to select another brand. In deciding on similarity, the Registrar considers whether one brand mark could be easily changed into another. The Registrar keeps a list of all registered brands and from time to time he publishes a Brands Directory, illustrating all registered brands. (See *Figure* 1).

The Ordinance also specifies the positions where a brand can be impressed. These positions are the near (left side) neck, near shoulder, near thigh, near ribs and near rump in that order. It is illegal to brand an animal in any other position than that specified in the brand certificate.

If a branded animal is sold, the new owner can cross-brand the animal by putting his own brand either immediately below the existing brand or (if there is not sufficient space) on the next position specified in the Ordinance.

In addition to the registered brands, cattle may also carry "distinctive brands" to denote age, breeding, etc. These do not have to be registered but the position of the distinctive brand must be nominated on the Application to Register.

The Brands Ordinance also makes provision for the transfer or cancellation of brands, for inspectors to guard against the illegal branding of stock, and provides penalties for illegal branding.

The Ordinance makes provision for the registration of earmarks as well as brands. An earmark consists of one or more cuts made in the ear or ears of cattle. The earmark must be made with special pliers of an approved pattern and must always be placed in the position specified in the Registration Certificate. Once a beast has been earmarked (one or both ears) it cannot have any more such marks. It is illegal to cut a second earmark on a beast, even though one ear was previously unmarked.

While it is not a legal requirement that all cattle and horses should be branded, it is obviously to the owner's advantage to have his stock branded. In cases of disputed ownership, an ownership brand is the first evidence to be considered by a court.

Livestock owners wishing to register a stock brand may obtain application forms (and advice on filling them in) from any Livestock Officer or Rural Development Officer.

Design of Brand or Earmark	Type of Brand or Earmark	Position of Application of Brand or Earmark	Name of Owner and Location of Run
↑A2 Numerals 1 to 8 *  Pattern "Z"	Horse and Cattle Brand	Horse - Near side shoulder Cattle - Near side rump	Department of Agriculture, Stock and Fisheries, Moitaka, Central District
	Distinctive Brand	Cattle - Near side thigh	As above
	Cattle Earmark	Tip of near side ear (position 5)	As above
1AW	Horse and Cattle Brand	Near side rump	Andrew Wabiria Hare Village, Koroba, via Tari, Southern Highlands District
DP2  Pattern "F"	Horse and Cattle Brand	Cattle - Near rump Horses - Near shoulder	Dumpu Pastoral Co. Dumpu, Madang, Madang District
	Cattle Earmark	Lower nearside ear (position 6)	As above

Figure 1.—Some entries in the Brands Directory

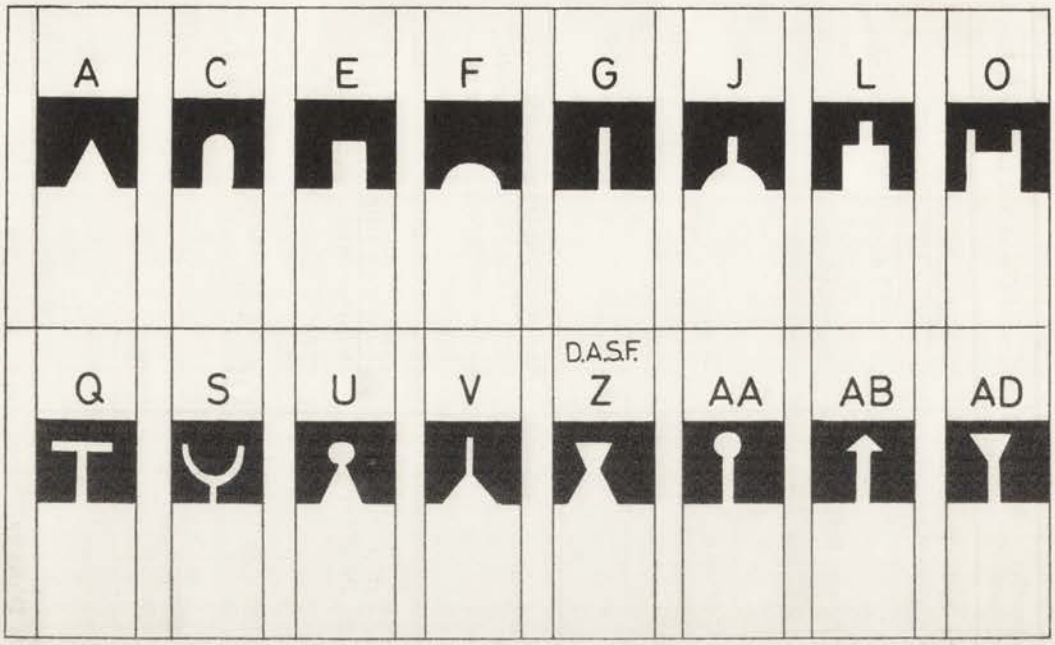


Figure 2.—Shape patterns of some cattle earmarks. Each shape has a letter code for easy reference

This plantation shows the benefit of applying Shell Weedkiller B80 for shade thinning.

Shade thinning made easy!

How Shell Weedkiller B80* works 6 ways as a hormone poison to save time and money on coffee plantations

Take the easy way out of this tough, time consuming task by using Shell Weedkiller B80. Here are the 6 proven advantages which result from hormone poisoning when applied to Leucaena glauca.

1. Shell Weedkiller B80 is certain. There is no chance of re-growth if applied correctly.

2. Shell Weedkiller B80 is better than conventional axe stumping. Less labour units are required per acre to thin the same amount of shade.

3. Shell Weedkiller B80 gives a gradual thinning of the shade canopy, giving the underlying cacao or coffee a chance to adjust itself to the change in light intensity.

4. Shell Weedkiller B80 lessens the risk of falling Leucaena damage in cacao as is occasioned in axe thinning. The poles may be left to rot where they stand...or removed when dry for firewood.

5. Shell Weedkiller B80 is economical. The cost for materials is in the region of 15 cents per acre depending on the amount of shade treated and the size of the shade.

6. Shell Weedkiller B80 is safe. It is non-toxic to humans and livestock...yet remains poisonous to shade trees.

FOR READY SUPPLIES OF SHELL WEEDKILLER B80, PLUS ADVICE AND DIRECTIONS ON ITS USE, CONTACT:

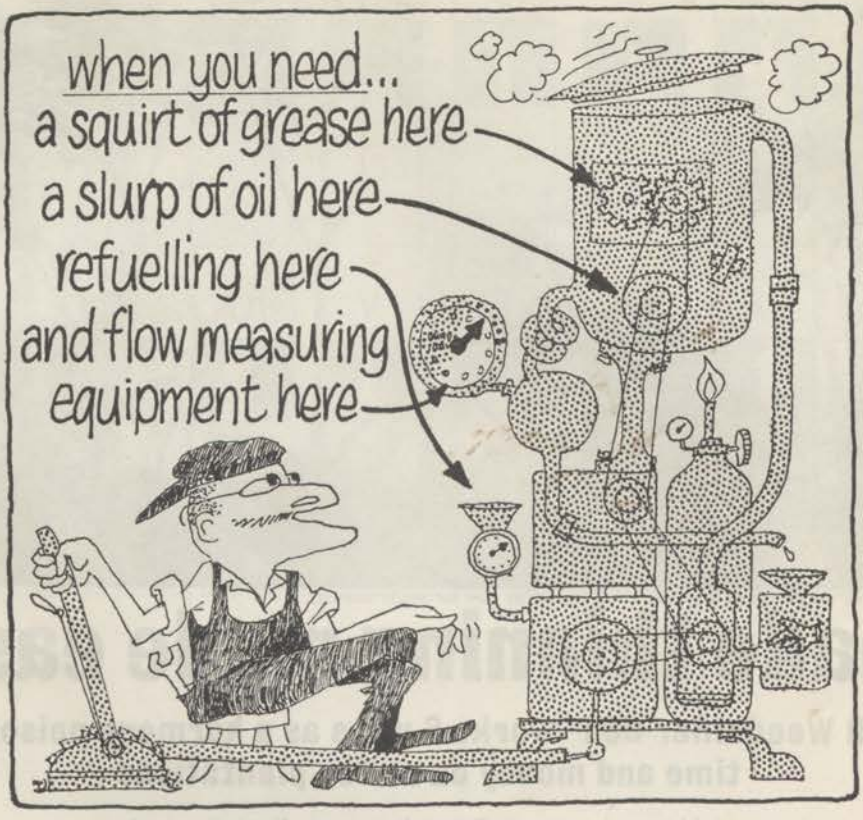
N. J. Camps — Mt. Hagen
P. Harbeck — Banz
Collins & Leahy — Kundiawa
Shell Company (Pacific Islands) Ltd; or Burns Philp (N.G.) Ltd. — Goroka.
Booij Bros. — Kianantu
Wau Valley Motors — Wau
Shell Company (Pacific Islands) Ltd., P.O. Box 169, Port Moresby.

Shell Chemicals SHELL

*Registered Trade Mark

SC705/SP1108

"BURNS PHILP NEW GUINEA LTD."



Macnaught's got it made!

Macnaught make grease guns, pumps, lubricators and liquid flow measuring equipment. The best available.

Whatever you do, Macnaught can help you do it better. Their maintenance systems ensure clean fuel, clean oil, clean grease for your machinery, your trucks and cars, your materials handling equipment.

Macnaught maintenance systems help keep your business running trouble-free.

Macnaught maintenance systems include a range of hand-operated lubricators for 5 and 45lb tins, grease guns, measuring equipment and grease, oil and fuel handling pumps.

MACNAUGHT
MAINTENANCE SYSTEMS

Distributed throughout Australia by CASTROL AUSTRALIA PTY. LIMITED

MAC 2420.24