



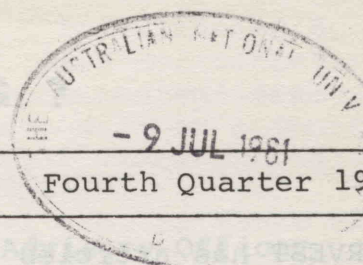
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Harvest

volume 6 no. 4
fourth quarter 1980

HARVEST

A LESSON FOR P.N.G.



Vol. 6, No. 4

Fourth Quarter 1980

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Editor: Catherine Kilroy
with Kath Perry and Carole Ismay

Cover: Koyasi Studio

WRITE AN ARTICLE FOR HARVEST

Fourth Quarter 1980

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HARVEST has articles on all aspects of primary industry including agriculture, fisheries, forestry and livestock. It is read by researchers, extension workers, students and teachers all over Papua New Guinea and overseas.

Because of this, HARVEST articles help to keep everyone in touch with new developments in primary industry in Papua New Guinea.

This means that writing an article for HARVEST is a very good way of letting people know about your work and about the primary industries of your area.

There is more information on how to write for HARVEST at the end of this issue. If you have any problems about writing an article then the HARVEST editor will be pleased to help.

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Readers' comments on articles in HARVEST or on the magazine in general are welcomed. Please address any letters to The Editor, HARVEST, D.P.I. Publications Section, P.O. Box 2417, Konedobu.

PEASANT FARMERS' RESEARCH IN NIGERIA

A LESSON FOR P.N.G. ?

By Samuel B. Lahis, Formerly, Extension Advisory Officer
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INTRODUCTION

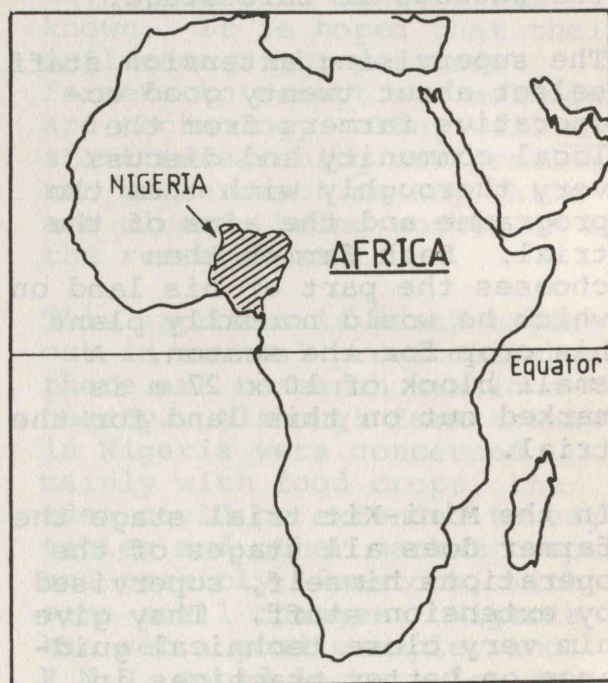
Nigeria is a country on the west coast of Africa. Like Papua New Guinea, it is mainly an agricultural nation with 70% of its 72 million people living on subsistence farms. Most of these are scattered small farm holdings. Extension and Research Services are important in changing subsistence to practical commercial farming.

This change has been made difficult over the years by a number of problems. Among these are the lack of enough properly trained extension workers, and the unwillingness of rural farmers to make changes because they are afraid of the risk.

In trying to solve such problems, the Nigerian Federal Government launched the National Accelerated Food Production Project (N.A.F.P.P. or 'Peasant Farmers' Research').

AIMS OF N.A.F.P.P.

The first aim is to speed up the production of six major food crops (rice, maize, cassava, sorghum, millet and wheat) by using a field-tested package of improved practices which will produce more food for the people and more money for the farmers.



This map of Africa shows the position of Nigeria.

As well as organising research on a community basis, the N.A.F.P.P. lets the farmers know the results of research. It will encourage them to share technical information and to use better seeds.

ORGANIZATION OF N.A.F.P.P.

As the project is a Federal project, it has the responsibility of making guidelines for the states taking part. It also trains staff and co-ordinates the state activities.

N.A.F.P.P. is organised in three stages, namely:

1. Mini-Kit Trial
2. Production Kit
3. Mass Awareness

1. The Mini-Kit Trial Stage

This stage is very important because the farmer's willingness to go into the next two stages will depend entirely on the success of this stage.

The supervising extension staff select about twenty good co-operative farmers from the local community and discuss very thoroughly with them the programme and the aims of the trial. Each farmer then chooses the part of his land on which he would normally plant his crop for the season. A small block of 10 x 27 m is marked out on this land for the trial.

In the Mini-Kit trial stage the farmer does all stages of the operations himself, supervised by extension staff. They give him very close technical guidance on better practices in land preparation, field layout, times for planting, culture, the right amount, method and time of fertiliser application, proper weeding and when to harvest.

The farmers taking part are given four to five improved varieties of seeds, fertilisers, crop protection chemicals, and other 'agricultural inputs' in small packs called 'Mini-Kits'. These are all free of charge.

The farmers are encouraged to call the improved varieties by local code names which can be easier for them than the scientific code names.

After receiving the kits, the farmers are encouraged to hold

simple, non-replicated (each is unlike all the others) variety trials, on their own farms. They plant the improved seed varieties and their local varieties on different, equal, strips of the 10 x 27 m plot they have chosen.

Agu and Akinlawo (See 'Further Reading', below) report that the Mini-Kit trial stage gives a unique opportunity for a farmer to judge the performance of improved varieties when grown under local conditions and following the recommended practices. It also helps him to compare the yield from the improved varieties with the yield from his best local varieties.

Some farmers have obtained ten times the yield of their local variety from some of the improved varieties. These farmers quickly realised that the new recommended practices were better than those which they had used before.

This project has proved successful in many farming communities in Nigeria.

2. The Production Kit Stage

In this stage the farmers are helped to see the economic advantage of the new improved package over their traditional farming methods. They go through the processes all over again but the inputs (seeds, fertilisers and crop protection chemicals) are given to them at subsidised costs, no longer free of charge. This helps them to work out their real profits.

3. The Mass Awareness Stage

When the first two stages have been well planned and supervised, the 'mass awareness' (all the people knowing what

has been done) happens almost by itself. It happens quickly through spreading the news from farmer to farmer, much more than through the extension agents or being in the newspapers or on the radio.

It is reported that N.A.F.P.P. has been a very successful applied research project in the Nigerian Agricultural Extension Service, and is capable of greatly improving agricultural production in that country.

CAN P.N.G. LEARN FROM THIS EXPERIENCE?

The report from Nigeria is certainly encouraging as far as the Extension-Research Services liaison is concerned, in giving better agricultural production. Though this type of project has not been actively encouraged in P.N.G. perhaps it is time to look again at the situation, and learn something from what has been done in Nigeria.

In P.N.G., traditionally research into our major export crops and other products has been done by the department's research stations throughout the country. However, the Horticulture Section has now appointed Field Horticulturalists who are working more directly with extension workers and farmers. An important part of their work is to arrange trials and demonstrations of promising varieties or farming

practices in farmers' fields. As it takes a long time to get results of research and to tell people about them, these trials involving extension officers and farmers will be a short-cut way of publicising the results of research programmes.

On-farm trials use the results of research, whether in crops or livestock, and so would certainly help in making them known. It is hoped that their influence might persuade farmers to accept new methods and technology. They will not start researching new problems, nor do research on any which are already being worked on by the research stations.

This approach is worth trying out in several provinces where there are research stations nearby. Although farm trials in Nigeria were concerned mainly with food crops, the idea could be extended to vegetables and other market crops, and possibly livestock, with some small changes. Nigeria has set a good example, and P.N.G. could learn a lot from it.

FURTHER READING

Agu, E.C.P. and Akinshaw, C.B. (1977). Peasant farmers' research in Nigeria. *Extension Forum* No. 14. N.S.W. Department of Agriculture.

BROILER CHICKENS FOR SEMI-INTENSIVE PROJECTS

By Fred Bauer

Poultry Officer, Poultry Research Centre, Labu

INTRODUCTION

Broiler chickens are specially bred to grow quickly. They are sold for eating and are usually ready for market at eight to ten weeks old.

To grow this fast, they have to eat special food called Broiler Finisher.

Many broiler chicken projects are unsuccessful because they are not managed properly. Some of the ways in which poor management can cause a project to fail are given below.

1) Chickens need special care when they are very young. If people do not look after them properly, many die.

2) If the chickens are not given enough feed or are not given the right kind of feed, they will not grow well.

3) If the chickens are not given enough water, they will not grow well.

4) If the chickens are not looked after well, they will be more likely to catch a disease.

5) If too many chickens are ordered for the project it may be hard to sell them all when they are ready and more money will have to be spent on feed.

6) If too much money is spent on building the chicken house,

the profits from the project will be very small.

Good management is therefore very important if a broiler project is to be successful. One good management system which is suitable for small-scale projects near to main centres, is described in this article.

THE CHICKEN HOUSE

Bush material makes very good chicken houses which are cheap to build. Round timber can be used for the frame and traditional roofing materials such as saksak, or kunai for the roof. It is easiest to use chicken wire for the walls but bamboo sticks or split timbers placed every five centimetres are also good.

The bottom part of the wall (about the first 60 cm) must be made wind proof. There are many kinds of suitable bush material for this, such as bamboo, pitpit and pandanus leaves.

The size of the house and the number of rooms inside it will depend on the number of chickens ordered and on how often they are ordered. The basic rule is to count one square metre of space (1 m²) for each ten birds and then to add another half to one metre for feed and water troughs. An

extra room to keep the feed in is also needed.

It is not a good idea to make a cement floor for the chicken house. It will cost a lot of money and the posts will rot very quickly inside the cement. It is much better to have an earth or gravel floor and to cover it with a thick (10-15 cm) layer of sawdust, wood shavings or coffee husks. The chickens will scratch this material and mix it with their droppings to make a fine, dry mixture called 'deep litter'.

The presence of the deep litter will help to prevent diseases and to provide the right temperature for the chickens. Deep litter must always be kept dry because, if it gets wet, the chickens may become sick.

After one year, the deep litter must be removed from the house and new material must be put in. The old deep litter is a very good fertiliser and can be put on the garden where it will help plants to grow well.

FEED

Broiler chickens will not grow well unless they are given the right feed. This is called broiler finisher.

Often, broiler finisher is made up of small, round pieces which are called pellets. When the chickens are very young, i.e. between one day and two weeks old, they cannot eat these pellets as their beaks are too small. It will therefore be necessary to break the pellets into very small pieces for the first two weeks so that the young chickens can eat them.

On big projects where there is a very large number of young chickens, it may be too much

work to break up enough pellets each day. In this case a special feed for very young broiler chickens, called broiler starter, can be used.

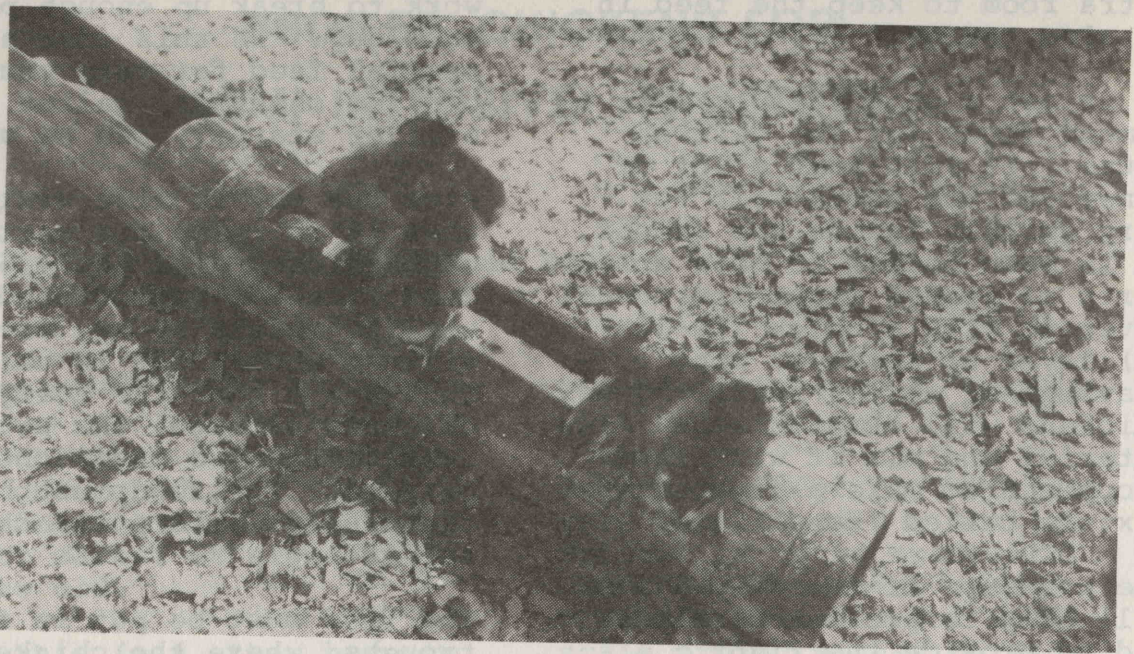
From one day to nine weeks old, when it is ready for market, each chicken will eat 4.5 kg of feed. As one bag of feed usually weighs 50 kg, one bag will be enough for 10 chickens. This means that for every ten chickens ordered, the project owner must also order one bag of feed. The feed must be at the project before the chickens arrive.

The feed must be put in feed troughs, where the chickens can easily eat it. Bamboo makes very good, cheap feed troughs. For the first two weeks, troughs made with small bamboo should be used, so that the chickens can reach the feed easily. For bigger chickens, troughs made out of bigger bamboo can be used. For each 10 chickens, there should be one 40 cm length of trough.

There must be feed in the troughs all the time so that every time the chickens feel hungry, they can go and eat. This is the only way to make sure that the chickens will grow quickly. The troughs should be checked regularly to make sure that they are not empty.

WATER

Water is very important for a broiler project. If the chickens can drink every time that they are thirsty, they will grow well. If they are short of water, they will stay small and light, and some of them will die. (This is shown in the experiment described in HARVEST 5(1):77-79).



Stones have been put into this water trough to stop the young chickens falling in.

Because water is so important, it is best to put the project near a creek. Then the people who look after the project will not have to carry the water a long way and they will not become tired of doing so.

The bamboo troughs described in the section on feed also make very good water troughs.

Very often, when young chickens go to drink, they fall in the water. If this happens, they may drown or get very wet when they will become sick and may die. To prevent this from happening, stones are put in the troughs so that they are just level with the water surface. The chickens can then stand on the stones to drink and will not fall in. After two weeks, the stones are removed.

After four weeks, the water troughs should be raised above the ground. This can be done easily by tying them to the walls with wire or bush rope. All the chickens must be able to reach the water.

The troughs must be cleaned every day. When washing or filling the troughs, the project owner must make sure that no water falls on the deep litter. If deep litter gets wet, it can cause disease.

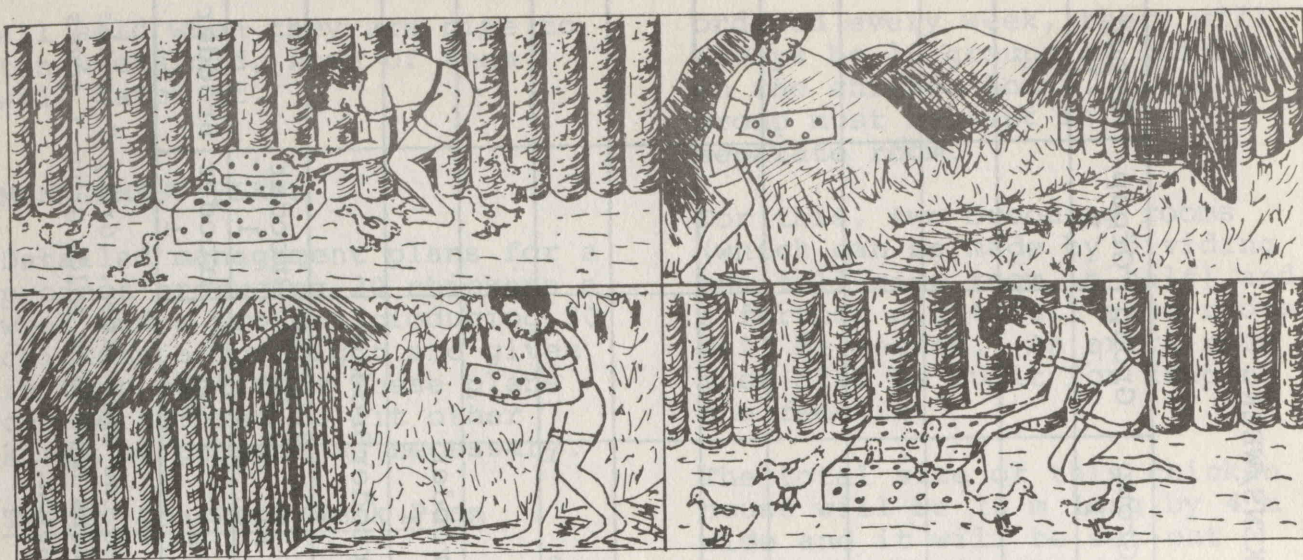
BROODING

Chickens need special care and warmth for the first two weeks of their lives. This is called brooding. The best way of brooding chickens in a village is described below.

A small brooding room of about one or two square metres in area is built in the chicken house. The walls are made carefully so that they are wind proof and they should be about 80 cm high. Half of the room is covered over with bags or woven bush materials.

During the day, the young chickens are left in this room with plenty of feed and water.

At night, the chickens are put into a cardboard box such as a



In the Highlands, or when it is very cold, the young chickens are taken into the owner's house at night. In warmer places, they can stay in the chicken house as long as they are put in their cardboard box.

tinned fish box or a beer carton and the box is closed. The box is then left in the little room unless it is very cold or the project is in the Highlands when it is taken into the owner's house which is warmer.

In the morning, the chickens are taken out of the box and put back in the brooding room with plenty of feed and water.

This is done every day until the chickens are two weeks old when they are big enough to live in an ordinary room in the chicken house.

ORDERING CHICKENS

For a broiler project it is important to order special broiler chickens. No other kind will be of any use.

The project owner should ask to have the chickens vaccinated against fowl pox. This will make them cost a little bit more but will stop them from catching this disease.

The number of chickens that should be ordered depends on

how many can be sold in one or two weeks. If many people in the area like to buy chickens, then a lot can be ordered. If only a few people buy them, then only a few should be ordered.

Experience has shown that in most places it is difficult to sell more than 20 chickens in one week.

A big mistake, which a lot of people make, is to order 50 or 100 chickens at one time. When they are ready for market at 9 weeks old, the project owner finds that he cannot sell them all in one week but that it takes three to six weeks before they are all sold. By this time all the feed will have been used up and he will have to buy more to stop the chickens from losing weight and dying. This will take up all his profit.

If the chickens are not sold quickly, there is also a danger that they will catch a disease called Marek's disease and die. This disease never starts when the chickens are younger than twelve weeks, so if they are

TABLE 1. USE OF ROOMS IN CHICKEN HOUSE PRODUCING 20 CHICKENS/WEEK

WEEK	Group A	Group B	Group C	Group D	Group E	Group F	Group G	Group H	Group I	Group J	Group K	Group L
1	Brooder 1											
2	Brooder 1	Brooder 2										
3	R1	Brooder 2	Brooder 1									
4	R1	R2	Brooder 1	Brooder 2								
5	R1	R2	R3	Brooder 2	Brooder 1							
6	R1	R2	R3	R4	Brooder 1	Brooder 2						
7	R1	R2	R3	R4	R5	Brooder 2	Brooder 1					
8	R1	R2	R3	R4	R5	R6	Brooder 1	Brooder 2				
9	R1	R2	R3	R4	R5	R6	R7	Brooder 2	Brooder 1			
10	Being Sold	R2	R3	R4	R5	R6	R7	R8	Brooder 1	Brooder 2		
11		Being Sold	R3	R4	R5	R6	R7	R8	R1	Brooder 2	Brooder 1	
12			Being Sold	R4	R5	R6	R7	R8	R1	R2	Brooder 1	Brooder 2

Group A is the first group of chickens ordered, Group B is the second group, ordered one week later. Group C is the third group ordered another week later..... and so on, when all the Group A chickens have been sold, Group I moves into R1, when all the Group B chickens are sold, Group J moves into R2..... and so on.

all sold when they are nine to ten weeks old, none of them will catch it.

MANAGEMENT PLANS

Detailed management plans for a project producing 20 chickens a week and a project producing 30 chickens a fortnight are given in this section. These plans can be altered to fit other kinds of project as necessary.

Twenty Chickens/Week Plan

Since 10 chickens need 1.0 m² of space, 20 chickens will need 2.0 m². In addition to this, they will need 0.5 to 1.0 m² for their feed and water troughs.

This means that a room for 20 chickens must be between 2.5 and 3.0 m² in area. One way to get the right size of room is to build the room 1.5 m wide and 2.0 m long. This will give an area of 3 m² (1.5 x 2 m).

The chickens will be kept for 9 weeks and then be sold. Once the project is established, and if a new group of chickens is

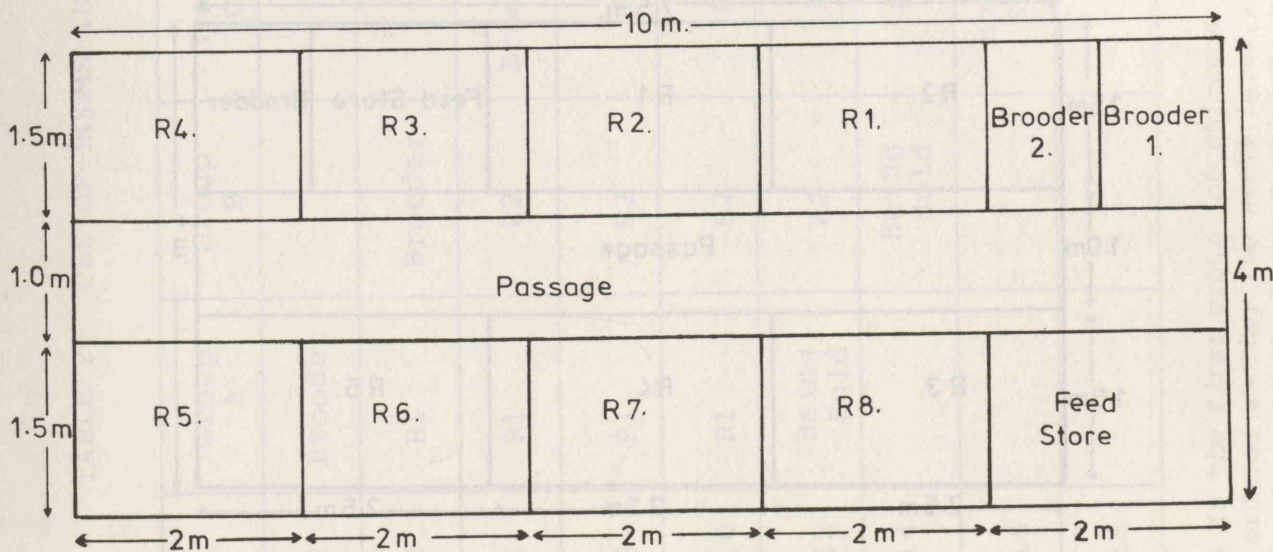
ordered every week, there will always be 10 groups of chickens in the chicken house. Each group must be kept in a separate room.

For this, two brooding rooms (which can be made by dividing one full-size room in half) and a further eight full size rooms will be needed. An extra room must also be built for keeping the feed in.

The total size of this chicken house will be 10 m long by 4 m wide and it will be set out like the one in the diagram below.

As the project becomes established, more and more of the rooms will be filled. Finally, as each group of chickens reaches 9 weeks old and is sold, a new group will be moved into the empty room from one of the brooding rooms. A new group of young chickens will then be put in this brooding room. The table opposite shows how this works.

The budget for each group of chickens will look like this:-



Design of a chicken house for a project producing 20 chickens/week

Costs:

20 chickens at 50 t = K10.00
2 bags feed at K13 = K26.00
Total = K36.00

Returns:

(assuming death of 1 chicken in 10)

18 chickens at K3 = K54.00

Profit:

K54 less K36 = K18 per week or
K36 per fortnight

This budget is based on prices in Lae. The costs in other places may be higher but returns may be higher there too. In some places, chickens sell for K4.00 or even as much as K7.00.

Thirty Chickens/Fortnight Plan

Since 10 chickens need 1.0 m² of space, 30 chickens will need 3.0 m². They will also need 0.5 to 1.0 m² for their feed and water troughs.

This means that a room for 30 chickens must be between 3.5 and 4 m² in area. A room which

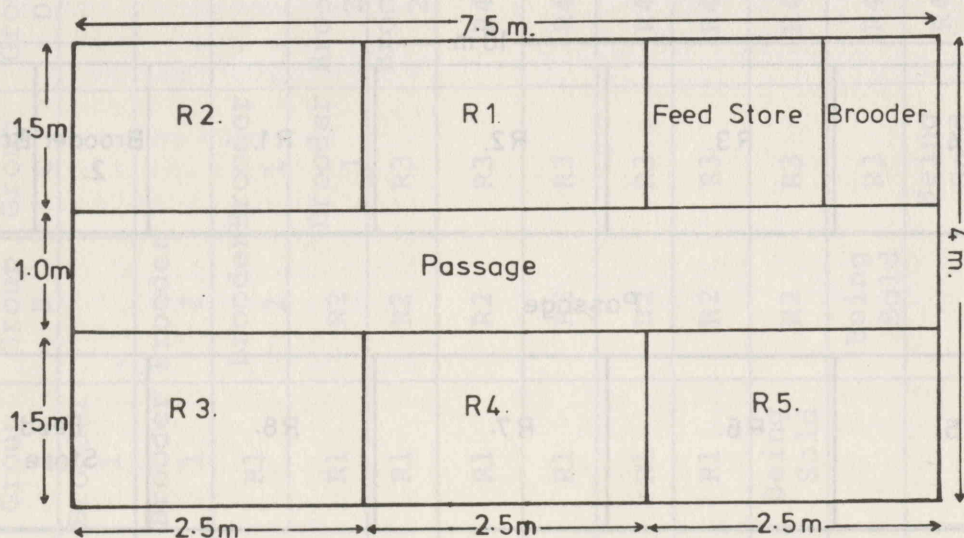
is 2.5 m long and 1.5 m wide will therefore be suitable. This room will have an area of 3.75 m² (2.5 m x 1.5 m).

These chickens will also be kept for 9 weeks and then be sold. Once the project becomes established, and if a new group of chickens is ordered every fortnight, there will always be 6 groups of chickens in the chicken house. Again, each group must be kept in a separate room.

For this, one small brooding room, five full sized rooms and one room for storing feed will be needed. As the rooms for brooding and storing feed do not need to be as big as the others, six full sized rooms can be built and one can be divided to make both the brooding room and the feed store.

The total size of this chicken house will be 7.5 m long and 4 m wide. It will be set out like the one in the diagram below.

As the project becomes established, more and more of the rooms will be filled. Finally, as each group of chickens is



Design of a chicken house for a project producing 30 chickens/fortnight

TABLE 2. USE OF ROOMS IN CHICKEN HOUSE PRODUCING 30 CHICKENS/FORTNIGHT

WEEK	Group A	Group B	Group C	Group D	Group E	Group F	Group G	Group H	Group I
1 + 2	Brooder								
3 + 4	R1	Brooder							
5 + 6	R1	R2	Brooder						
7 + 8	R1	R2	R3	Brooder					
9 + 10	R1	R2	R3	R4	Brooder				
11 + 12	Being Sold	R2	R3	R4	R5	Brooder			
13 + 14		Being Sold	R3	R4	R5	R1	Brooder		
15 + 16			Being Sold	R4	R5	R1	R2	Brooder	
17 + 18				Being Sold	R5	R1	R2	R3	Brooder

Group A is the first group of chickens. Group B is the second group, ordered two weeks later, Group C is the third group, ordered another two weeks later..... and so on. When all the Group A chickens have been sold, Group F moves into R1, when all the Group B chickens have been sold, Group G moves into R2..... and so on.

sold at 9 weeks old, a new group will be moved into the empty room from the brooding room. A new group of chickens will then be put into the brooding room. The table opposite shows how this works.

The budget for each group of chickens on this project will look like this:-

Cost:

30 chickens at 50t	= K15.00
3 bags feed at K13	= K39.00
Total	= <u>K54.00</u>

Returns:

(assuming death of 1 chicken in 10)

27 chickens at K3 = K81.00

Profit:

K81 less K54 = K27 per fort-

night.

Again, this budget is based on prices in Lae. Costs and returns in other places may be higher as explained in the first plan.

CONCLUSION

Providing that they are managed properly and that the chickens are looked after well, very good profits can be made from small brooder projects. The important thing is to have a good market for the chickens. This is because the profit depends on selling the chickens very quickly once they are 9 weeks old. If too many chickens are produced, then there will be little profit and the project may make a loss.

BORON DEFICIENCY

IS WIDESPREAD IN THE HIGHLANDS

By R. Michael Bourke, Senior Horticulturalist
Highlands Agricultural Experiment Station
Aiyura, Kainantu, E.H.P.

WHAT DOES BORON DO?

Boron (B) is a nutrient (plant food) that plants need to grow properly. Only a very small amount is needed. When a plant has too little of a certain plant food, we say it has a deficiency. Too much boron in the soil can easily harm plant growth. In plants, boron helps the growing point of the shoot and root to develop properly. Also it helps cell walls to form, flowers to be fertilised and fruit to develop.

Root crops, vegetables and tree crops are more likely than grain legumes and members of the grass family to show symptoms (signs) of boron deficiency. This is because grain legumes and grasses do not need so much boron for proper growth.

BORON DEFICIENCIES IN P.N.G.

Boron deficiency was first reported in P.N.G. by staff of the Office of Forests who found it on pine trees.

Boron deficiency is very common in the highlands. It is very bad in the Southern Highlands in places like Ialibu, Kagua, Mendi, Upper Mendi, and Nipa. It is fairly bad in parts of Enga and Western Highlands, and not so bad in Simbu, Eastern Highlands and the Wau-Bulolo area. Boron deficiency is also reported near Port Moresby, in

the Markham Valley and on the Lelet Plateau of New Ireland.

SYMPTOMS

When there is not enough of a plant food in the soil, plants show symptoms which mean that the plant does not have enough of that particular plant food. The symptoms depend on the plant food needed and also on the particular crop. Symptoms which show boron deficiency are:

1. Growing tips or buds die, with bushy growth near the tip. The internodes (length of the stem between leaves) are short.
2. Leaves are often misshapen and wrinkled, thick and brittle, but are not usually yellow in colour.
3. Water soaked, 'dead' spots or holes in root crops and in the pith (centre) of stems.
4. Fruit small and poorly formed often with corky lumps and lesions (marks).
5. Low seed production because of poor fertilisation.

Boron deficiencies are more likely to occur during or after a drought. This is because plants get most of their boron needs from organic matter in the topsoil. In a drought the soil dries out, so the roots go down deeper in the soil to

get water and plant food. There is less organic matter there and so the plant may not get enough boron.

Symptoms on some highland crops are as follows:

Yar (*Casuarina oligodon*)

Growth is stunted and plants look rounded and bushy. Internodes are short. The growing tips die. When boron fertiliser is applied, the main shoot grows tall as in a healthy plant. Boron deficiency is easy to see in casuarina and is widespread in the highlands.

Sweet potato

Hard brown spots form inside the tubers. This ruins their eating quality. We have only seen this in the Southern Highlands on poor soils.

Cabbage, cauliflower and broccoli

The stem of the plant is hollow. This has been reported from the

Wapenamanda (Enga) and Laloki (Port Moresby) areas.

Coffee

The growing tip of the stem dies and branches growing below the tip develop. This gives a fan effect and the top of the plant becomes bushy. Also the internodes are short. Leaves have a 'leathery' feel to them.

Pine trees (*Pinus caribaea* and *Pinus patula*)

The terminal (top) shoot dies. Plants are short and have very many dead shoots. New shoots grow from buds and from the tip (apex). Office of Forests staff have found boron deficiency occurs in pine trees wherever they have been planted in Papua New Guinea. Usually pine trees will not grow to maturity unless the seedlings are given a little boron fertiliser.

Cape gooseberry (*Physalis peruviana*)

Plants suffering from boron



Casuarina showing boron deficiency symptoms. It is stunted and has a rounded, bushy appearance



These Cape Gooseberry plants had symptoms of boron deficiency. Those on the left were treated with a little borax fertiliser and have recovered. The ones on the right have not been treated. They are stunted, the tips are dead and very few fruit are being produced.

deficiency do not grow strongly. The tips of the growing stem die back, and in severe cases eventually the entire plant can die. Leaves are less green and smaller than on healthy plants. In an experiment at Aiyura, plants treated with boron fertiliser produced 52 grams of berries per metre-row per week. Untreated plants produced 33 g/metre-row/week. So the boron fertiliser increased the fruit yield by over 50%.

Pawpaw

The youngest leaves bend downwards and the leaf tips and leaf margins (edges) die back. The leaves are hard and tough to feel. The fruit develop bumps on them.

Black raspberry (*Rubus lasiocarpus*)

Many sick branches develop on the canes. The fruits are hard, small, and not juicy.

Hibiscus

The growing point of the shrub dies and side shoots grow up to replace it. The plant is

stunted and in severe cases, it will not grow at all. Symptoms on decorative hibiscus hedges at Aiyura have been cured by using boron fertiliser.

HOW TO PREVENT AND CURE BORON DEFICIENCY

Organic matter in soil gives boron to the growing plant. So a good way to prevent boron deficiency occurring is to add a lot of organic matter to the soil before planting or as a mulch to a perennial crop. To increase the organic matter in the soil, you can use compost, (made either where you are going to plant the crop, or in a separate heap) or coffee pulp, rotten cocoa pods, or animal manure.

Coffee pulp or rotten cocoa pods applied at 30 t/ha provide about 0.12-0.14 kg of boron per ha. This is about one eighth the amount of boron that plants need to grow well. Of course, these organic fertilisers also give lots of other plant foods. At 30 t/ha, coffee pulp also

gives 80 kg of nitrogen, 6 kg of phosphorus, and 150 kg of potassium as well as other plant foods.

Another way to prevent or cure boron deficiency is to apply boron fertiliser. Borax is the fertiliser most used in P.N.G. Another way is to use a mixed fertiliser that contains boron, such as coffee mix. Borax containing 11% boron should be applied at 10-20 kg borax per ha. This is a very low rate. Where symptoms are very severe, such as in the Southern Highlands, borax could be tried experimentally at rates as high as 50 kg/ha. It is important that not too much boron fertiliser is put on because even rates as low as 20 kg borax per ha can be too much, causing toxicity (poisoning). If a plant has too much boron

(toxicity) a yellow colour appears on the tip or edges of the leaves. Later this part of the leaf dies.

ACKNOWLEDGEMENTS

Information on boron deficiency in pine trees was provided by Mr. Jack Simpson of the Forest Research Station, Bulolo. Mrs. Mavis Herman, formerly of WASO at Wapenamanda, supplied information on deficiencies in brassicas in the WASO gardens.

FURTHER READING

Shorrocks, V.M. (1974). *Boron Deficiency - Its Prevention and Cure*. Borax Consolidated Limited. (Obtainable free from Borax Consolidated Limited, Borax House, Carlisle Place, London SW1P 1HT, United Kingdom).

Photographs: B. Calcinai

PRIANGON SHEEP IN THE PAPUA NEW GUINEA LOWLANDS

By *J.H.G. Holmes, Formerly, D.P.I., Erap
and G. Mott, D.P.I., Erap, Morobe Province

INTRODUCTION

Sheep were among the first grazing animals brought into East New Britain by German colonists. Some sheep were imported into Morobe Province before the Second World War. The Priangon from Java was the most successful breed. Some Australian breeds have also been imported, including Romney Marsh and Corriedale, both before and after the Second World War. These have been crossbred to Priangons, which remain more common in the lowlands. Since 1975, nearly 2,000 sheep of three different breeds have been imported from New Zealand, as a result of a major New Zealand foreign aid project. With good management, these sheep have done well in the Highlands. They did not do so well at Erap, in the lowlands of Morobe Province. A group of New Zealand crossbreds and Priangon x New Zealand crossbreds were kept at Erap for a year, but they did not breed well and many died.

In 1979, 130 Border-Leicester x Merino females (ewes) were sent from Australia to Erap. Nearly 60% of these lambed when bred to Priangon rams, but ewes and lambs did not do well under the conditions of heat and middle-quality pasture at Erap.

In this way, we can see that temperate zone sheep, and even temperate zone x Priangon

crossbreds cannot adapt to the hot lowlands of P.N.G.

In contrast, flocks of Priangon and crossbreds which are mainly Priangon, have been kept for a number of years in lowlands environments. They are at Popondetta Agricultural College in Northern Province, Vudal Agricultural College, East New Britain, The University Farm, Lae, Morobe Province and also the Veterinary Laboratory, Port Moresby. There are privately-owned flocks in the Markham Valley and at Wau. Breeding and growth is claimed to be adequate at all these places.

Several experimental flocks have been established in Morobe Province and one in East Sepik. Information has been collected from these and from some of the privately owned flocks.



A group of Priangon sheep at Erap

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FIRST STUDIES

Trials were carried out on two privately owned flocks on the foothill country above Erap. In each case, the sheep grazed out each day over a wide area, so were able to select a varied diet of grasses and legumes. These included Kangaroo grass (*Themeda australis*), Siratro (*Macroptilium atropurpureum*), Kunai (*Imperata cylindrica*), Dicanthium, Leucaena, and others.

The average growth rate of lambs with their mothers was 0.52 kg per week. Weaners grew 0.45 kg per week, giving a live weight of 28 kg at 12 months, and slaughter weight of 42 kg at 19-20 months. The breeding rate was very good. Ewes weighing less than 18 kg rarely bred in the next year, but ewes over 18 kg at the start of the year had a lambing rate of 177%, with 18% triplets and 17% twin births. However, survival of triplets was only 39%, while 80% of twins and 95% of singles lived till weaning. Overall, weaning was 122%. This is a very high reproductive rate. After allowing for herd replacements, this gives an average 'turn off' of nearly one sale animal per ewe, each year.

SECOND STUDIES

One of the major problems of sheep kept at high stocking rates in P.N.G. is heavy infestation with stomach and intestinal worms. This did not seem to be a problem in those flocks of sheep which grazed over large areas near Erap. Flocks of castrated males (wethers) were placed at Urimo, in the Sepik Plains, and at Bugandi High School in Lae. Both places have very wet, hot climates and a great deal of grass, mainly Para grass, where

the sheep grazed. Some of the sheep were drenched for worms every month, some every two months, some every 4 months and others not at all.

Sheep which were drenched grew faster and had fewer worm eggs in the faeces, but there was no difference between the sheep drenched every month or those which were drenched every two or four months. So one drench every four months was enough for Priangon sheep under these conditions. The drenched sheep grew 0.47 kg per week, about the same as in the previous trial. This seems to be the maximum growth rate for Priangons in the lowlands.

The biggest effect of drenching was with the smallest lambs, so a lot of drench can be saved by drenching only small or sick-looking sheep. If no drench was used, the sheep grew only a little more slowly (0.40 kg per week), provided they had a large grazing area.

CONCLUSION

These trials showed that the Priangons can do very well in the hot wet lowlands of P.N.G. Further trials are going on or have been carried out at Situm, Wantoat, Mumeng, Menyamya, Kaiapit and other places in Morobe Province with the same result. If sheep are allowed enough green feed, especially if they can be herded out by day, they will grow and breed well. It is necessary to pen the sheep up at night for several reasons:

1. To protect them from theft and attacks by village dogs and wild dogs.
2. To inspect them frequently and to treat any disease, especially screw worm.

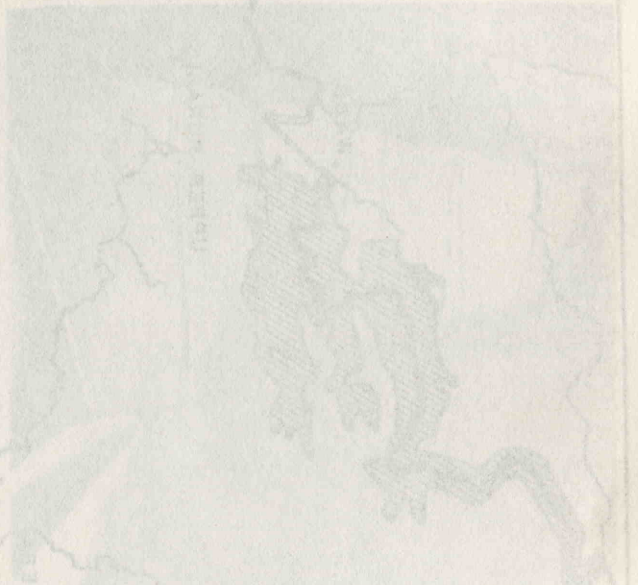


A house suitable for sheep at Bugandi High School, Lae

WHAT HAPPENS NEXT?

More work is being carried out, based at Erap, to try sheep in the hills of Morobe Province. There are not many Priangan sheep in P.N.G. and a lot of attempts to develop a small-holder sheep industry have failed. So distribution will begin only slowly and development of each project will have to be checked carefully by a Sheep Husbandry Officer. A lot more research is still needed before a lowlands sheep industry can develop.

3. To keep them tame and easy to control
4. To keep the sheep out of the night rain and to allow the fleece and hooves to dry out properly each night



A sheep and its owner from the hills of Morobe Province

Sago was produced commercially until the Second World War and formed the basis of the diet.

This information was first published in Papua River (Mabo) Survey, Diets of the People of the Highlands, Volume 13, published by the Office of Environment and Conservation and the Department of Minerals and Energy.

GULF PROVINCE

PEPIKE

WABO

UPPER PURARI

IKOBI
KAIRI

KIKORI KAIRI

GOPE

ERA

Purari River

KIKORI

Pie River

BATMURU

BAIMURU

BAROI

KORIKI

IARI

UPPER VAILALA

IVORE
SWANSON

Bevan Sound

Pai-i Inlet

Era Bay

Port Romilly

KALMARD

Purari River

Vailala River

KABEROPE

GOARIBARI

URAMA
DECEPTION BAY

LOWER
TURAMA

WEST COAST
VAILALA

MAIPUA

OROKOLO
BAY

IHU

EAST
COAST VAILALA

KEREMA

GULF OF PAPUA

KEREMA

THE AGRICULTURE AND FISHERIES OF THE PURARI DELTA

By Richard Stevens, Department of Primary Industry, Baimuru

INTRODUCTION

The Purari River drains a large area of the Papua New Guinea Highlands and then flows south into the Gulf of Papua. Before the river enters the Gulf, it splits into a number of smaller rivers which spread out over a wide area called a delta.

The agricultural and fishing activities of the Purari Delta are mostly carried out at subsistence level. Efforts have been made, however, to help the people to develop a cash economy and a cash income was earned from agriculture and fisheries between November 1978 and October 1979.

This article describes the agriculture and fisheries projects in the area, their contribution to the cash income and plans for further development.

AGRICULTURE

Agricultural development has been slow in the Delta. This is due partly to health problems such as malnutrition and malaria, which often prevent people from working, and partly to a lack of government interest in the area.

Some of the main agricultural products of the Purari Delta are described below.

Sago

This is the main subsistence crop and also provides material to make walls, roofs, fish traps and other articles.



A fish trap made from sago frond mid-ribs and split cane

Sago was produced commercially until the Second World War and formed the basis of the Hiri.

This information was first published in Purari River (Wabo) Hydro-electric Scheme Environmental Studies Volume 13, Published by the office of Environment and Conservation and the Department of Minerals and Energy.

This was the annual movement of people from the Port Moresby area into the Gulf to exchange clay pots and shell jewelry for sago. Attempts to start the sago industry up again after the war were not successful but some sago is still produced for sale in Port Moresby.

Copra

This is the chief cash crop of the Purari Delta. It has been produced there for many years but only in small quantities. This low production caused problems for the village farmers because, by the time they had enough copra to sell, some of it had already gone mouldy or been attacked by insects.

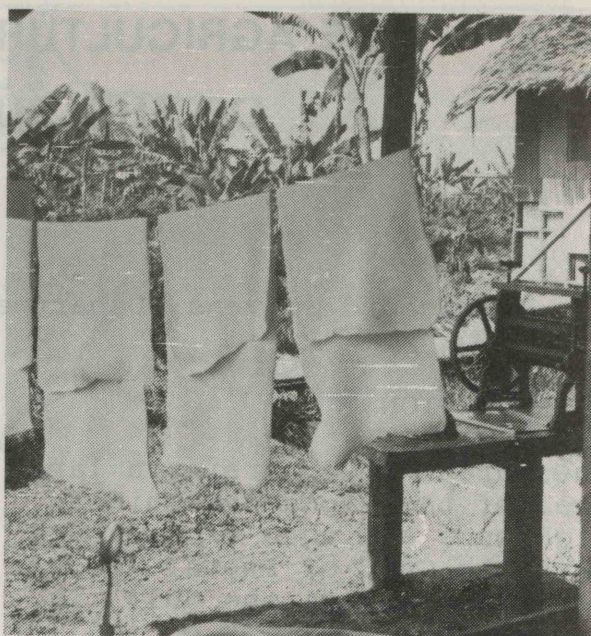
In October 1978, D.P.I. started to buy copra in small quantities from smallholders and, at the same time, the price paid for copra increased greatly. This resulted in a great increase in production. Less than 400 kg was sold to D.P.I. in November 1978, but this had risen to over 10,000 kg by April 1979 when it earned K2,358 for the growers.

In July 1979, D.P.I. stopped buying smallholder copra from this area so as not to compete with a village businessman who had started buying it.

A number of producers who were encouraged by the increase in price and by D.P.I.'s interest in their product, have started to send copra direct to Port Moresby. It is not known exactly how much copra is sold in this way, but at least 66,000 kg were shipped from the area between July and October 1979.

Rubber

This crop grows well in the Purari Delta and five smallholder rubber blocks have



Sheets of rubber hanging up to dry

been planted in recent years. One of these, a community block at Karararua near Baimuru was in production in 1979.

Unfortunately, the long wet season reduced the number of days on which trees could be tapped between June and October 1979. There were also some labour difficulties. As a result of these two factors, production during the year was only 1,164 kg instead of the expected 5,000 kg (2kg/tree).

The value of this rubber was still high enough, however, to keep up with the Development Bank loan repayments and the group was also able to buy shares in the PNG Investment Corporation.

The D.P.I. rubber demonstration block of 280 trees was cleared of bush growth during July, 1979 and tapping started in October. These trees produce an average of 12 kg per day's tapping.

Coffee

Robusta coffee can be grown in

the Purari Delta and, in 1979, coffee nurseries were started at Baimuru and Wabo, and at the D.P.I. extension bases in the Iari Census Division to promote coffee growing in the area.

Only one smallholder block was in production during the twelve months covered in this article. It was run by one farmer working part-time. The production from the block during this time was worth K527 which is a high proportion of the minimum rural wage.

Chilli

This crop grows very well in the Purari Delta and active encouragement was given to the people to grow Medium and Birds-eye chillies in 1978/9. This resulted in an increased production of dried chilli during the year. Total production for the twelve months covered by this article was 369 kg. This was worth K420 to the growers.

Rice

This is a new crop to the Purari Delta and seems to hold great potential. Three crops of rice were harvested from a trial at Baimuru during twelve months in 1978/79.

In February and March 1979, the D.P.I. office at Baimuru sold 25 kg of hybrid rice seed to 30 smallholder farmers. By the end of October, over 1000 kg of grain had been produced and sold to D.P.I.

Unfortunately, the return to the farmers is only 13 toea/kg. This is too low to encourage them to continue with rice production.

Future Development

In the next few years, it is

hoped that copra production will increase again, this time due to the introduction of hybrid coconuts which have been specially bred to give high yields. A hybrid coconut seed-bed and nursery were planted out at Baimuru in October 1979. The plants growing there will be ready to sell as seedlings in September 1980 and should start producing nuts in 1983/4.

More than 500 seedlings were distributed from the Baimuru rubber nursery in 1979, and one more of the smallholder blocks will begin production this year.



Hybrid coconut nursery

The D.P.I. station at Kikori has now started milling rice. It is hoped that this can be done on a contract basis so that the farmers can sell the finished product themselves. This will give them better profits and make the crop more interesting to grow.

A cocoa nursery was also planted in the Purari Delta in 1979. This crop should do well here and can be intercropped with coconuts or rubber.

Another possible crop under investigation in the area is nypa palm. This is thought to cover about 22,000 hectares of land in the Delta, between the coastal mangroves and the freshwater swamps. Traditionally the leaves are used to make thatch for houses but the palm also has a sweet sap which can be tapped from the flower stalk. This sap can be used to make vinegar for pickling fish, alcohol for industrial processes, or sugar. A three year investigation to find out if this would be economic was started this year (1980).



Nypa flower

Ginger and balsa may also be established as cash crops in the future. Ginger is a native plant of the Purari Delta and grows well there, and balsa could be used as a shade tree in cash nurseries before being

felled for its valuable timber.

FISHERIES

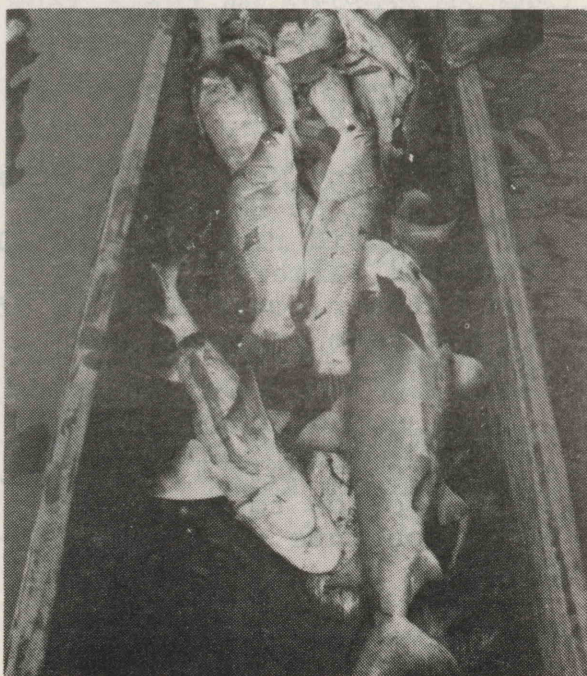
Traditionally, fishing in the Purari Delta has not been as important as the processing of sago except on Urama Island where sago does not grow and the people trade crabs and smoked fish for it.

Fisheries development projects currently running in the Delta are described below.

Smoked Fish

Smoked fish (smokpis) is seen as the best way of introducing commercial fishing to the villagers. The fish can be smoked in a copra drier and so can be produced by copra farmers with very little extra effort.

In 1978, the New Zealand Government contributed K11,099 towards the establishment of a smoked fish programme in the Delta. This money was used to buy equipment for village fishing groups.



A good catch

This programme has run into two main problems. The first is low earnings for the fishing groups because of low prices paid for smoked fish. While 5 kg of fresh fish are needed to make 1 kg of smoked fish, the price for smoked fish is only three times as high as that for fresh fish. At present prices, 1 tonne of fish must be caught and smoked to earn enough money to buy a new net.

The second problem is that quarrels within the fishing group often lead to the gear being left unused or unrepaired for long periods of time. This problem would probably be less serious if family or clan fishing groups had been formed rather than village groups. Unfortunately, there was not enough money for equipment to be supplied on such a large scale.

In future, it is expected that netting will be imported directly into Baimuru and that new nets will be made on site. This will lower their cost. It is also hoped to get a grant from F.A.O. to extend the scope of the project. Additionally, as the fishermen get more experience, production will increase and in turn lead to increased profit.

The advantages of the smoked fish project are that no knowledge of sophisticated technology is required and there are no processing or storage costs. Smoked fish is also seen as having an important place in the solution of the country's nutrition problems as it is very high in protein and a good source of iodised salt (salt with iodine in it). Iodine is a very important chemical in the diet.

Since smoked fish is light, it is also easy and cheap to transport

whether by aeroplane from Baimuru to the highlands or by foot from the trade store to a remote village.



Fish ready for smoking

Freezer Barge

A freezer barge was chartered as a pilot project for four months in 1978. It went around the villages, staying for four or five nights in each. During this time, nets were lent to the villagers and the fish they caught were bought from them.

A total of K3,839 was paid to villagers during this period and a first class product was obtained since the fish were frozen immediately on purchase.

During future operations, villagers will be encouraged to catch fish for the village smoke house between visits by the barge. This should help the villagers to keep their interest in fishing and, eventually, a group of full-time fishermen will develop who can pass on their skills to their children.

A combined smoked fish and

freezer barge programme is seen as the best fishing system for the Purari Delta.

Baimuru Fishplant

Baimuru is the most suitable place in the Gulf Province for the development of fish processing facilities (a fishplant), this is because there is no bar across the Pie River to prevent ships getting right to the station. There is also a 1000 m airstrip which is only 1 hour's flying time from the highland towns where there is a good market for fish and fish products.

The old Gulf Hotel at Baimuru is the site of the fishplant and has a number of advantages. For example:-

- a) It is central to local fishing grounds.
- b) It has abundant fresh water.
- c) It is alongside the Pie river which is deep enough to take vessels up to 1500 tonnes.
- d) It is alongside the airstrip.
- e) It is on land which has already been purchased and so there are no land dispute problems.

The fishplant opened in February 1979 for the purchase of fresh fish from villagers for freezing. All species of fish are bought and the fishplant is open to accept delivery 24 hours a day.

Barramundi is frozen whole after removal of the head and guts or is filleted and frozen in 10 kg blocks or 1 kg retail packs. Threadfin salmon is frozen whole and then sawn into cutlets. Flake fillets are sold in 10 kg blocks to 'fast food' outlets in the highlands where it competes successfully with barracuda fillet from New Zealand. Flake is also made up into fishcakes which are again proving popular for 'take-away' food.

Crabs were originally sent to the highlands alive, but this was not very economical so now they are also sold as retail packs of cooked meat. This means that freight charges are now much lower per crab since no waste (usually about 75%) is sent.

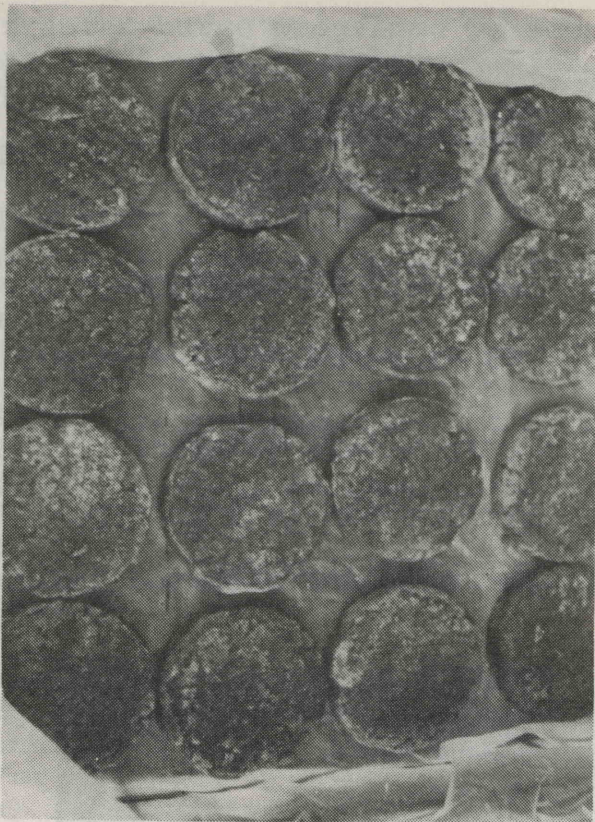


The big, white building on the right in this photograph is the old Gulf Hotel - now the Baimuru fishplant.



Traditional fishing
methods





Flake and sago fishcakes produced at the Baimuru fishplant

While there are some difficulties in marketing the fishplant products, the worst of which is the high cost of air freight, the plant has so far proved successful in showing that a number of high quality local products can be made with only a little investment, trainee management and local labour.

The profit made by the fishplant will be used in expanding the scope of its operations. A net making shop and a bulk fuel installation have been under construction since mid-1980, while future plans include an outboard motor repair workshop and some accommodation facilities.

Future Developments

The outlook for fisheries in the Purari Delta is very encouraging. There will soon be 3 collection vessels operating

in the area to pick up fish and crabs from the villages, and a freezer barge should be in regular service by 1981.

New products which could be developed include freshwater prawns (*Macrobrachium* sp.), clams (*Geboina coaxans*), mangrove oysters (*Saccostrea echinata*) and scallops. The prawns could be sold as frozen, uncooked tails and the others alive, frozen or processed into fritters.

It may also be possible to make more use of the Gulf's prawn stocks by using a fleet of trawlers operating from Baimuru. This would lead to the production of export quality prawns and a large quantity of trash fish (fish caught in the net with the prawns - usually about 84% of the catch). These fish could probably be sold in the highlands.

Fish waste is being used for feeding pigs, ducks and crocodiles on projects set up near to the fishplant.

CONCLUSION

During the period November 1978 to October 1979, the people of



Clams

the Purari Delta made K21,160 from the sale of their fisheries and agricultural products. This only includes sales recorded in Baimuru and quite a lot more money was probably made from direct sale to Port Moresby of sago, betelnut, copra, artifacts, logs and other products.

The National Government's policy of helping less developed areas of Papua New Guinea may lead in future, to more money and more trained staff being

made available for agriculture and fisheries in the Purari Delta. The fact that the area has considerable potential for development in these fields is clearly shown by the work reported in this article. With a little help, this potential could be realised to the benefit, not only of the people who live in the Delta, but of the country as a whole.

STABILISING SHIFTING AGRICULTURE

By Wayne C. Gagné, Wau Ecology Institute
Morobe Province

INTRODUCTION

Although they get plenty of rain and sun, the lowland, humid tropics are not agriculturally very productive. This is mostly due to difficulties in preventing soil fertility from dropping and in keeping weeds under control.

Over many centuries, a system of agriculture, called shifting agriculture, has developed to overcome these difficulties.

In this system, crops are grown on small plots of land which have been partly cleared of forest. The cut vegetation is burned and the crops are planted in the ashes. The plots are used for one to three years and then the forest is allowed to grow back. The plots stay under this forest fallow for up to 20 years before they are cleared again.

Because the land is used for crops for only a short time and is fallowed for a long time, moisture, organic material and plant nutrients are not lost from it, serious erosion does not occur and weeds do not grow there in large numbers.

There are very few problems due to insect pests of crops in shifting agriculture. One reason for this is the large number of different crops grown on each plot. Because there

are only a few plants of any one type, their pests find it hard to spread from one plant to another. Natural enemies of pests can enter the plots easily from the surrounding forest and kill any pests which may be there.

In the past, shifting agriculture has been very successful, but a lot of land is needed for this system in which up to 15 hectares are used to feed one person. Now, in many areas of the world, including parts of Papua New Guinea, populations are increasing rapidly and there is no longer enough land for plots to be left fallow for long periods. This means that the forest does not have time to grow back on the plots before they are cleared and burned for the next garden.

Instead of forest, the land becomes covered with grass and the fertility and structure of the soil becomes very poor. This is made worse by repeated burning of the grass.

This article reports work carried out at the Wau Ecology Institute to find an agricultural system which can replace

The information in this article was first published in the winter/spring, 1978/1979, issue of the International Voluntary Services Inc. magazine Dialogue.

shifting agriculture in heavily populated areas of Papua New Guinea.

THE WORK AT WAU

The aim of the project described here was to find a way of using traditional shifting agriculture practices on a site-stable (non-shifting) plot. The new system had to be carefully designed to prevent any loss of soil fertility or increase in pest or weed problems. It was also necessary that the system gave high productivity but kept social and environmental damage to a minimum.

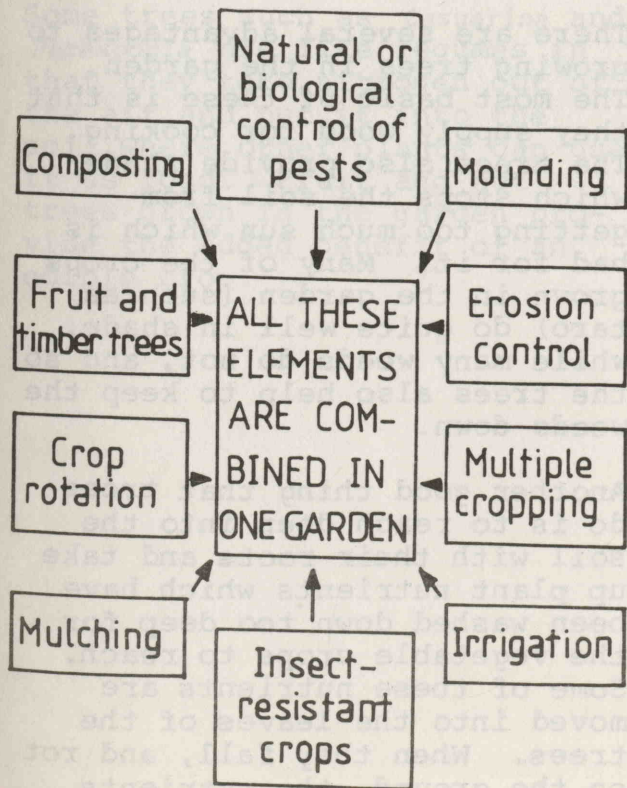
It was decided to test a system based on agro-forestry in which tree and field crops are grown together. As many traditional subsistence gardening methods as possible were used in the system. This is shown in the diagram below.



Mixed cropping

The two main problems with non-shifting subsistence agriculture are keeping pest numbers down and keeping fertility levels up. Natural pest control, as used in traditional systems, is enough to keep pest damage low on traditional crops, but some introduced crops need extra pest control measures such as insecticides. Only those introduced crops which are resistant enough to insect attack to grow well without extra pest control were included in this trial.

It was very difficult to find a good method of keeping the soil fertile over several years. Artificial fertilisers do not fit in well with the traditional aspects of the system and animal and kitchen wastes



The traditional subsistence gardening methods used in the system



Long mounds of compost following the contours of the land. Trees were kept to give shade (to the crops and soil) and firewood.

are both in short supply. However, there are unused wastes from cash cropping available in many parts of P.N.G. Near Wau, these wastes are in the form of coffee pulp which is usually dumped into the rivers. The pulp from the Institute's coffee plantation, together with grass cuttings and weeds, was therefore used to make compost for the experimental garden.

Compost is traditionally made in the Papua New Guinea Highlands from garden waste and is put into round mounds into which the crops are planted. For this experiment, long mounds were used to make the application of the compost easier. These mounds were made to follow the contours of the land to keep soil erosion to a minimum.

Three different crops were grown in each mound as a pest control measure. These three crops included a legume in each case because legumes supply nitrogen, an important plant

food, to the soil. The three crops were planted together in such a way as to make both weeding and harvesting as easy as possible.

There are several advantages to growing trees in the garden. The most basic of these is that they supply wood for cooking. The trees also provide shade which stops the soil from getting too much sun which is bad for it. Many of the crops grown in the garden (such as taro) do quite well in shade, while many weeds do not, and so the trees also help to keep the weeds down.

Another good thing that trees do is to reach deep into the soil with their roots and take up plant nutrients which have been washed down too deep for the vegetable crops to reach. Some of these nutrients are moved into the leaves of the trees. When they fall, and rot on the ground, the nutrients are returned to the top layers of the soil where the smaller plants can reach them.



Building the mounds of compost

Some trees such as *Casuarina* and *Parasponia* are like legumes in that they take nitrogen out of the air and put it into the soil where other plants can use it as food. Fruit and nut trees grown in the garden provide the added benefit of an edible crop.

The garden has now been on the same site for over four years and has not declined in productivity or fertility during that time. After the last crop on each mound has been harvested, the mound is remade in the position of the old furrow and, again, plenty of compost is put inside.

CONCLUSION

The preliminary experimental work on this system is now over.

Although many aspects of the method still remain to be investigated, the compost contour mound technique for stabilising shifting agriculture has been shown to work.

The next step is to introduce it to local people and persuade them to use it in their gardens. It could be that they are in for a nice surprise.

FURTHER DETAILS

Further details of this method and, in particular, of the effect it has on insect pest numbers, are given in the article 'Natural control of insect pests in an organic garden' also by Wayne Gagné, in HARVEST 6 (1): 5-13.

PHOSPHORUS DEFICIENCY IN CATTLE IN THE SEPIK PLAINS

By *J.H.G. Holmes, Formerly, D.P.I., Erap
Morobe Province

INTRODUCTION

It has been obvious from the beginning that the D.P.I. Sepik Plains Livestock Station, 'Urmo', was not good cattle country. This was partly due to the high temperature and humidity and the low quality pastures. However, the main limit on raising cattle is the lack of enough phosphorus, as was shown by Dr. J. Copland of the Veterinary Laboratory, Kila Kila.

If cattle production was to continue, it was essential to supplement (add to) the feed with a phosphorus lick. We used 'Ultraphos' which is made by I.C.I. However, a low level of production could be maintained by water buffalo without this addition (see Schottler, Boromana and Williams, 1977)

'Ultraphos' supplements in 1978 cost K5.50 per cow per year. Three trials were carried out between 1973 and 1978 to see if any other minerals were too low (deficient) and to see if the amount of 'Ultraphos' fed could be made smaller because it was so expensive.

TRIAL 1

This lasted three years. Heifers in groups of 20 were supplemented with either nothing, copper, cobalt, copper and cobalt or 'Ultraphos' (which contains phosphorus,

copper and cobalt). The group receiving 'Ultraphos' grew 0.27 kg per day, while all the others grew 0.06 kg per day. This showed that copper and cobalt were not too low in the normal diet.

When phosphorus-deficient cattle were given 'Ultraphos' after being without it for 15 months, they did not grow very quickly. Even two years later, they had not caught up with the heifers that had had phosphorus supplement all the time. The heifers which had not had supplements before did not breed as well, and their calves grew more slowly. This meant that phosphorus was necessary for growth, breeding and calf growth. If the heifers went without it for 15 months, they never recovered completely.

TRIAL 2

Four groups of 20 heifers were used. One group received no phosphorus. One group received all the phosphorus they would eat. One group received half as much as they would eat, and the fourth group received phosphorus in the dry season only. Table 1 shows that heifers receiving some phosphorus bred faster and had better weaning percentages.

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TABLE 1. RESPONSE OF CATTLE TO VARIOUS AMOUNTS OF PHOSPHORUS SUPPLEMENT IN TRIAL 2

	Amount of phosphorus supplement:			
	None	Unlimited	Half of unlimited	Unlimited in dry season
Number of blocks per cow per year	0	0.55	0.28	0.35
Cost, per cow per year	0	K5.50	K2.80	K3.50
Months till breeding	12	7	6	10
Weaning % over next two years	35%	55%	52%	52%
Growth of calves kg per day	0.23	0.37	0.30	0.35
Death of cows	20%	0%	30%	10%
Additional return	-	K14.50	K2.20	K8.90
Additional profit per cow per year	-	K9	-K0.60	K5.40



A typical phosphate-deficient cow. The signs are: the animal is not alert; bones sticking out; hollow flanks; rough, matted, coarse and discoloured coat; hindquarters hunched forward or 'tucked up'.

It also shows that growth of the calves was best in those taking unlimited phosphorus supplement. In all of the other groups some of the heifers died.

When we worked out the money gained by using phosphate supplements, the group receiving unlimited phosphorus supplement gave a far greater profit.

This shows that breeding stock should get all the phosphorus they will eat. Phosphorus is needed for bone growth and calves need a lot of phosphorus in the milk to help them to grow strong bones. If the cow does not have enough phosphorus in the feed, phosphorus from her own bones will go into the milk. Then the cow will have weak bones which may break easily, or she may die.

TRIAL 3

Twenty-two steers were grazed at Urimo for a year. Samples were taken of blood and saliya from the steers, and of grasses and legumes from the paddock, to see if there were any other mineral deficiencies. Minerals checked were copper, cobalt, calcium, magnesium, zinc, sodium and iodine: none of these was deficient.

CONCLUSION

The only mineral deficiency at Urimo is a deficiency of phosphorus. Deficient animals grew slowly and were slow to conceive. Their calves grew slowly, and some calves and cows died. Animals needed all the phosphorus supplement they could eat. They needed phosphorus supplement available at all times, not just now and again. This gave the best cow survival and breeding, calf growth and maximum profit.

HOW TO MAKE A SALT LICK

Phosphorus supplements can be made from bones of slaughtered cattle. The bones should be burnt over a hot fire. The bone ash crumbles easily and it can be ground by hand and mixed with salt. This makes a loose salt lick which can be fed in wooden troughs to cattle.

BONES ARE WORTH MONEY

The bones of a well-grown steer will weigh about 60-70 kg and contain 2.7-3 kg of phosphorus. This is the same as the amount of phosphorus in a 20 kg phosphorus salt block (these are usually about 15% phosphorus). So the bones of a steer, burnt, ground up and mixed with salt, are worth about K10. Only head and shin bones are available at an abattoir but the other bones could be recovered from the butchers. It may be worthwhile to put in an incinerator and hand crusher in association with Provincial abattoirs, to recover this phosphorus. This would reduce costly imports of phosphorus licks which have been difficult to obtain on a regular basis at Wewak.

FURTHER READING

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Schottler, J.H., Boromana, A. and Williams, W.T. (1977). Comparative performance of cattle and buffalo on the Sepik Plains, P.N.G. *Australian Journal of Experimental Agriculture and Animal Husbandry* 17, pp. 550-554

COFFEE DISEASE IN THE WESTERN HIGHLANDS

By G.R. Kula and D. Clarkson
Plant Pathology Section, D.P.I., Konedobu

INTRODUCTION

In the first half of 1980 there was a lot of publicity about a disease of coffee which many people thought was new. This disease was reported to be seriously affecting coffee trees in the Whagi Valley, Western Highlands Province. This article has been written to explain the situation and to show that the disease was neither new nor particularly serious.

SYMPTOMS

Symptoms of the disease were only seen on side branches bearing fruit. Generally, the tips of these branches and the cherries on them were dead or dying. Occasionally, the cherries were seen to be infected with fungus.



Overbearing die-back symptoms

The resulting brown-black, sunken areas were most obvious on mature cherries but were also sometimes seen on green, immature fruit.

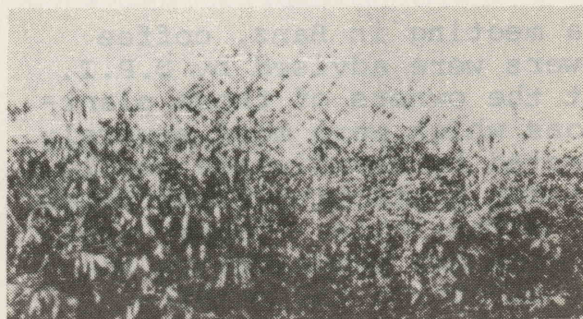
When diseased tissue was examined under the microscope, two types of fungi were found:- *Colletotrichum* sp. and *Cercospora coffeicola*.

The bearing branches of badly affected trees lost all their leaves and this led some people to confuse the disease with lightning strike. However, in lightning strike, only the branches right at the top of the tree are affected.

The wood of affected branches was often stained brown-red under the bark and another fungus, *Fusarium solani* was often found in this wood.

D.P.I. INVESTIGATIONS

In January, 1980 two specimens of diseased coffee were sent to the Plant Pathology Section at Konedobu.



Trees affected by lightning strike

Two fungi were found on these specimens: *Colletotrichum* sp. and *Fusarium* sp. We found that both of these fungi are saprophytic or only weakly pathogenic. This means that they can only attack plants which are already unhealthy. This was confirmed by experts from the Commonwealth Mycological Institute (C.M.I.) in the United Kingdom.

D.P.I. plant pathologists visited the Whagi Valley after further reports were received showing that plantation owners were very worried that the disease would seriously harm their trees. A detailed survey of affected sites was carried out including both plantations and smallholder blocks.

During the survey, it was found that many trees were in poor condition and so more likely to be attacked by saprophytic or weakly pathogenic fungi. It was concluded that the problem was widespread and needed watching carefully but that it was not a new or serious threat to the coffee harvest.

More diseased specimens were collected at various sites and sent directly to C.M.I. and to Konedobu for further investigation. From their work on these and later specimens, scientists at C.M.I. concluded that the type of *Colletotrichum* which causes Coffee Berry Disease was absent and that only saprophytic species were present.

At a meeting in Banz, coffee growers were advised by D.P.I. that the owners of those plantations which were most severely affected by the disease should consider protecting their trees with a fungicide. Copper oxychloride was suggested as the most effective and readily available chemical for this treatment.

It was also explained at the

meeting that one cause of the disease problem was the unusually heavy crop since it was weakening the trees and making them more susceptible to fungal attack.

FURTHER INVESTIGATIONS

Some of the larger plantations invited overseas coffee disease experts to look at the problem as well as the D.P.I. staff, and to give their opinion of the causes of the outbreak. These private experts all agreed with the D.P.I. findings that the major cause of the stress in the coffee trees was the very heavy crop. They also agreed that the type of *Colletotrichum* which causes Coffee Berry Disease was absent.

Another factor which the overseas pathologists felt was adding to the stress on the coffee trees was their poor state of nutrition. This poor nutrition was found in trees on very large areas of coffee and was thought to be due to plantation owners removing shade trees without increasing fertiliser application to make up for the resulting loss of nutrients.

CONCLUSIONS

It was concluded that the symptoms were the result of attacks on the trees by two weakly pathogenic fungi, *Colletotrichum* sp. and *Cercospora coffeicola*.

These fungi are common in all coffee growing areas of the world but are not usually economically important on healthy trees. The problem occurred in the Western Highlands because the trees were under stress.

There are several possible reasons for this, including:-

- 1) the unusually heavy crop,

- 2) the failure of the growers to carry out control by pruning the excess cherries earlier in the season,
- 3) the removal of shade trees,
- 4) the failure to compensate for shade removal by increasing fertiliser applications.

In order to deal quickly with any future coffee problems, it is important that close contact is maintained between the Government and the private sector and that high levels of co-operation continue. One possible joint venture which has been suggested is the establishment of a Coffee Research Institute in the Western Highlands Province.

A SICKNESS OF COCONUTS CAUSED BY A LEAFHOPPER

By E.S.C. Smith, Senior Entomologist,
Lowlands Agricultural Experiment Station, Keravat, E.N.B.P.

INTRODUCTION

During the early 1960s many coconut palms in the Finschhafen area of Morobe Province became affected by an unknown sickness. Affected fronds of the palms turned yellow, and in severe cases young palms died. The sickness was linked to the sucking bug *Zophiuma lobulata*.

SIGNS OF DAMAGE

Unhealthy palms were first noticed near Finschhafen in 1960, but the problem was not thought to be very serious. However, in 1965 many older palms began to die and the condition spread to other areas. In the area where it was first noticed, up to 10% of older palms died as a result of the sickness and at least 80% of all palms showed symptoms (signs).

The early stages of the sickness are difficult to recognise. They may be confused with normal yellowing of fronds due to extreme weather conditions, shortage of certain nutrients (plant foods), insect damage, or other reasons. Within several months however, the palm appears to be ageing very quickly.

First, leaflets become yellow at the tip and then the yellowing advances towards the trunk.

This yellowing spreads much more rapidly at the tips of the fronds than in the area near the trunk. The leaflet tips die and the dead area spreads gradually until all the yellow area is dead. The signs are most evident in lower fronds, but later extend upwards to the younger ones.

In severe cases the stalk of the frond bends where it grows out from the trunk. This causes an affected frond to droop much more than a healthy one. The lower fronds die earlier than normal and dead fronds often stay hanging from the palm crown. There is a big decrease in nut production as the problem gets worse.

Palms which have recovered from an attack have a large amount of dead tissue on otherwise healthy fronds.

LINKS BETWEEN THE SICKNESS AND LEAFHOPPERS

1. In the Finschhafen area, leafhoppers were found in large numbers on affected palms but only in small numbers on healthy ones.
2. Both nymphs (immature bugs) and adult bugs fed on the fronds and were found mostly on the oldest frond of the palm. Sometimes large numbers of insects



The young coconut palms on the left were kept with the leafhopper, and those on the right without. The palms on the right are growing much more strongly.

were noticed in unaffected areas several months before the sickness appeared. More than 1000 insects per frond have occasionally been recorded.

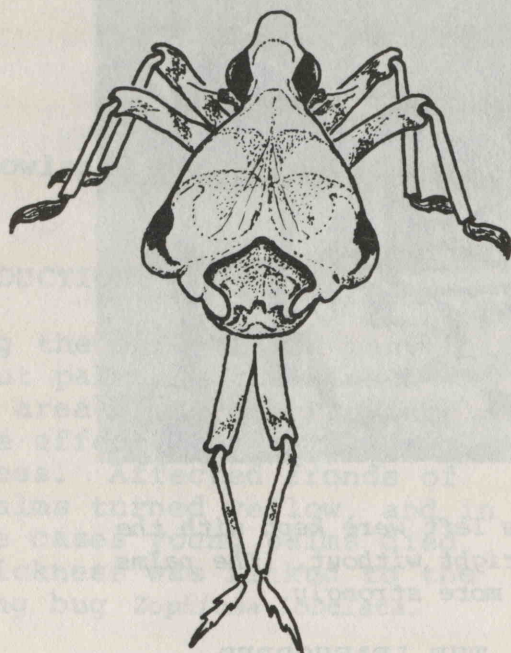
3. When a badly affected young palm was taken from Finschhafen to Port Moresby and grown in its own soil without any leafhoppers, all the newly emerging fronds were perfectly healthy.
4. Leafhoppers kept with potted coconut seedlings at Popondetta, developed similar symptoms to those at Finschhafen in 6-7 months. After 14-15 months the coconuts were very stunted, many fronds had died and the palms looked very sick. All the fronds had turned dark yellow. However, other seedlings planted at the same time and kept without leafhoppers were growing strongly and all had dark green fronds. These palms were almost twice the height of those which were kept with leafhoppers.

THE LEAFHOPPER

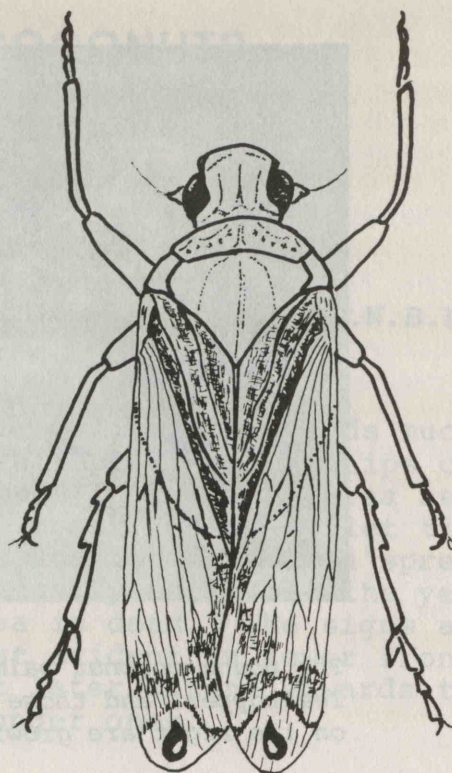
Adult leafhoppers are brown and 16-18 mm in length. They have a black spot near the tip of their wings. Eggs are laid in batches of 35-40, usually on the fibrous material of the trunk or on the lower surfaces of leaflets. The eggs, covered by a white woolly secretion, are pale green and about 2 mm long and 1 mm wide. They are frequently heavily parasitised by a small wasp. There are five nymphal stages. Each of these has two very long waxy threads sticking from its body.

The life cycle of the bug is about 4 months, of which 8-9 days are in the egg stage, about 12 weeks in the nymphal stages and four weeks as adults before eggs are laid.

Although this leafhopper occurs on coconuts along the North Coast from Alotau to Finschhafen, the sickness has been seen only in the Finschhafen and Popondetta areas. Leafhoppers are also known to feed on betelnut, pandanus and granadilla.



2 mm



1 cm

The leafhopper, *Zophiuma lobulata*. The youngest stage is shown on the left, and the adult on the right.



A coconut palm suffering from the sickness at Finschhafen. The frond marked with an arrow shows clearly the dark area at the centre, where the leaflets are still green. The lighter area is the part of the frond which has turned yellow.

CONTROL OF THE LEAFHOPPER

Effective controls for many coconut pests are often not economic since the crop has a relatively low value per hectare. Insecticide treatments, either applied as sprays or as trunk injections would almost certainly be effective, but the high costs involved would probably prevent treatment except in very damaging attacks or in a small outbreak area.

Attempts at biological control may prove successful and are preferable. It may be possible

to collect parasitised leafhopper egg masses from 'non-outbreak' areas and release the emerging parasites in badly affected coconut blocks elsewhere. Other parasites could also be introduced.

FURTHER READING

Smith, E.S.C. (1981). *Zophiuma lobulata* Ghauri (Homoptera: Lophopidae) and its relation to the Finschhafen coconut disorder in Papua New Guinea. *Papua New Guinea Agricultural Journal* (in press).

SENDING SPECIMENS FOR PATHOLOGICAL EXAMINATION

By Mike Nunn, Acting Chief Veterinary Research
Officer, Central Veterinary Laboratory, Kila Kila

INTRODUCTION

The pathology section of the Central Veterinary Laboratory examines the health of animals by looking at samples of tissues, blood or other body fluids like urine and saliva.

When samples are sent for pathological examination, a Veterinary Specimen Advice Card must be sent too. As we said in an earlier article (see HARVEST Volume 6 (3): 134-138) this card should include notes on the history of the problem, the clinical signs shown by the sick animals, and any post-mortem (after death) findings.

This article shows in detail how to collect, store and send specimens for examination in the pathology section of the laboratory.

HISTOPATHOLOGY

Histopathology is the study of fixed (preserved) tissues. By examining different tissues or parts of the body under a microscope, the type of sickness affecting an animal can be worked out.

There are 3 reasons for sending tissues. Most are sent after an animal has died, when an officer performs a post-mortem examination, and collects

samples of unusual-looking tissues. Some are sent from live animals after a biopsy (sample) such as a tumour (unusual swelling), is removed, and some are received from slaughtered animals when a meat inspector notices a lesion (abnormal tissue).

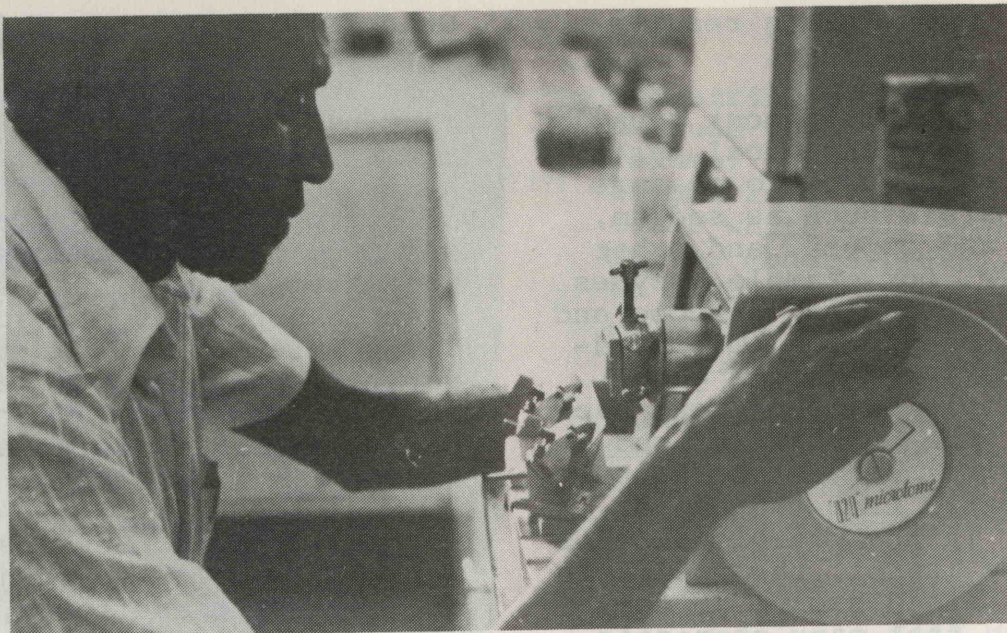
How to 'fix' tissues

All tissues for histopathological examination must be fixed, in order to stop them decaying after death. Autolysis (post-mortem decay) will hide important changes in tissues so that a diagnosis may be missed.

To fix tissues, thin slices (less than 1 cm, or the width of the tip of a person's little finger) of tissues are placed into 10% formalin or 70% alcohol. Formalin is commonly used and 10% solution is made by mixing 1 part of commercial formalin with 9 parts of water. To allow enough formalin to fix all the tissues, make sure there is at least five times more formalin than tissue in each sample jar.

What to send

Tissue slices should include some normal as well as abnormal tissue, and samples of all unusual-looking tissue should be sent. If you do not see any lesions when you examine an



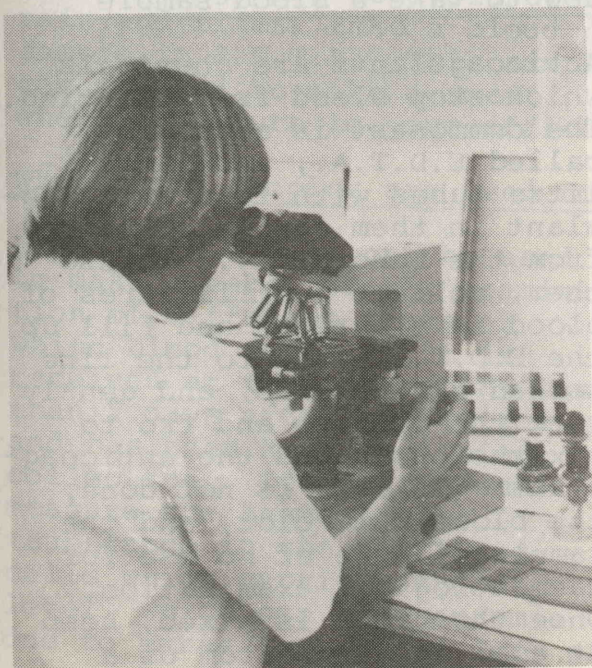
Before examination under the microscope in the laboratory, tissue slices must be cut into very thin sections, using this machine.

animal which dies of an unknown cause, send samples of as many parts of the body as possible. Many changes cannot be seen with the naked eye but may be seen under the microscope. Always include samples from the liver, lung, kidneys, and heart from mammals, and of the cloacal bursa (sac) and sciatic (leg) nerve as well from birds.

Remember to estimate how long the animal has been dead, and to describe the size, shape, colour, feel and place where you find any abnormalities. Always take faeces and stomach contents, as discussed in the earlier article on parasitology (see HARVEST Volume 6(3):139-144), in case worms are the cause of death.

CLINICAL PATHOLOGY

Clinical pathology or biochemistry is the study of the health of animals by examining the chemistry of serum, urine, peritoneal (from the lining of the abdomen) and other body fluids. Clinical pathology is a very precise science because many chemicals in body fluids are present in very, very small amounts. Therefore it is very important that samples sent for biochemical studies are collected without getting them wet or dirty, and then treating and storing them correctly. If samples are made dirty, or damaged by incorrect treatment and storage, any tests done on



Preparing slides for histopathology

them will give wrong results and will be useless.

Serum is the fluid most usually sent in for biochemical tests, and it can be used to measure many minerals such as sodium, calcium and copper, and other chemicals, for example enzymes and other proteins, glucose and other carbohydrates. The hardest thing in getting a good serum sample is to prevent haemolysis (the bursting of red blood cells) before the serum is separated from the blood sample. If the red blood cells haemolyse (burst) the chemicals they contain dissolve in the serum, so that many chemicals, especially phosphorus, will show high levels when the serum is tested, and the sample will be of little use.

How to take a serum sample

To collect a good serum sample, collect 10 ml of blood (for poultry 2-5 ml is enough) into a plain tube or syringe. Leave it to clot for 30 minutes at room temperature. Once the clot (jelly) has formed, separate it from the tube by gently tapping the side of the tube or by pressing around the edge of the clot with a pipette or wooden applicator stick.

Wait a further 5 or 10 minutes to allow the clot to settle, then gently pour or pipette off the serum (clear fluid), without any red blood cells. Put it into a new plain tube, and store it, if possible in a refrigerator.

If a centrifuge is available, spin the tube at 1,500 r.p.m. (revolutions per minute) for 3 minutes after the clot is separated and collect the serum in the same way. Urine, saliva and other body fluids should be collected as cleanly as possible and stored in a refrigerator.

Other fluids may be needed

Serum can be used to measure many minerals and other chemicals, and the levels found can help decide what condition is affecting a group of sick animals. Serum alone is enough to measure some minerals (for example copper and phosphorus). To measure some of the others, further specimens are required as well (for example serum, saliva and urine for measuring sodium).

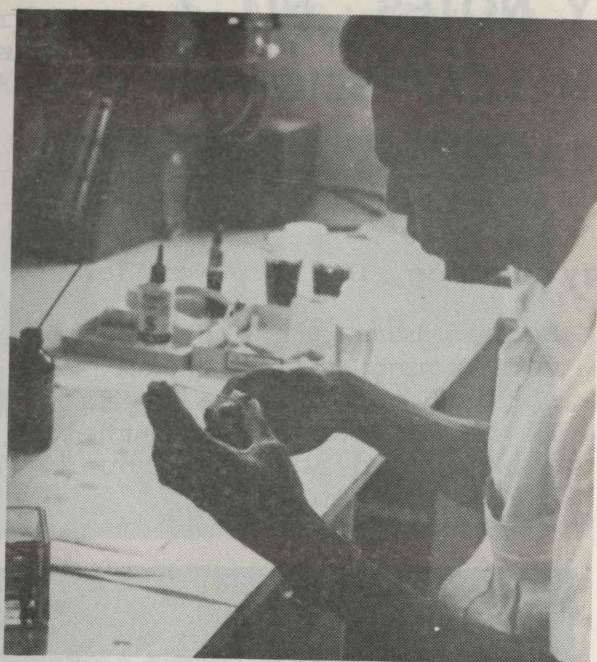
Specially washed needles, syringes and tubes are needed for some of these tests, so you should telephone the Laboratory and arrange with the Senior Veterinary Pathologist or the Biochemist to forward the correct equipment if you wish to test animals for minerals or other chemicals.

HAEMATOLOGY

Haematology is the study of blood. Blood can be sent for examination as either blood with an anticoagulant added, or as blood smears.

How to take a blood sample

Anticoagulants are chemicals which stop blood from clotting. The commonest is a chemical called E.D.T.A., and 5-millilitre tubes with this anticoagulant in them can be obtained from the Laboratory. To use them, collect 5 millilitres of blood in a syringe and fill up the E.D.T.A. tube to the line marked on the side, and gently rock the tube to and fro to mix the blood and the anticoagulant. If this is not done, the blood will clot, and the sample will be of no use for haematological examination. Once the blood is mixed, keep it cool in the bottom of a refrigerator, or in an 'esky' with an ice brick.



Examining blood samples

How to take a blood smear

Blood smears are made by spreading the blood across a clean glass slide, as described in the earlier article on parasites (see HARVEST Volume 6 (3): 139-144). You can either make a smear of a drop of fresh blood at the project where you are working, or, to avoid dust, rain and flies, take a blood sample in E.D.T.A. This sample can be used to make a smear when you return to your office.

What blood samples are used for

Blood in E.D.T.A. can be used to make smears for the examination of different types of white blood cells if it is received at the laboratory less than 5 days after collection, and has been kept cool since collection. It is also used to measure the haemoglobin (substance in the red blood cells which carries oxygen) level, which can show anaemia due to parasites, blood loss or

malnutrition. Other tests include the P.C.V. (packed cell volume) which measures if an animal is dried out or not, and total white cell count, which may be abnormally high or low in different diseases.

What blood smears are used for

Blood smears are used to count the percentage of different types of white blood cells present. This can give useful information about the animal's health. For example, high numbers of the type of white blood cell called neutrophils show that a bacterial infection is present, while the presence of a different type of cell, called eosinophils, usually indicates a parasitic infestation.

CONCLUSION

Specimens for histopathological examination are easy to take and submit in 10% formalin, and should be taken from lesions seen at slaughter or whenever an animal dies on a project. Specimens for clinical pathology must be taken carefully and stored correctly to be of any value, and further advice can be obtained from laboratory staff. Specimens of blood in E.D.T.A. are easy to collect for haematological examination, but must be sent quickly if worthwhile results are to be obtained.

If you need further information or supplies of specimen jars, specimen advice cards, tubes or glass slides for blood, please contact the Central Veterinary Laboratory at P.O. Box 6372, Boroko, or telephone 25 3588 or 25 4510.

PLANT PATHOLOGY NOTES : NO. 7

SOUTH AMERICAN LEAF BLIGHT OF RUBBER

By D. Clarkson, Plant Pathology Section, D.P.I., Konedobu

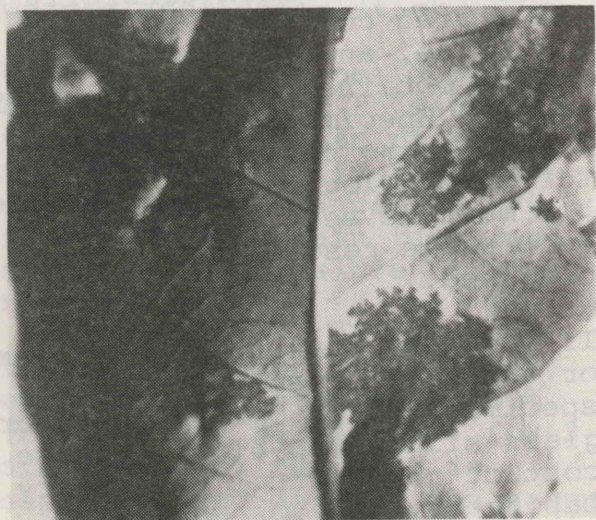
South American Leaf Blight of Rubber (SALB) is a very destructive disease of rubber which is at present found only in Central and South America. The disease is caused by the fungus *Microcyclus ulei*. Although SALB does not occur in Papua New Guinea it is essential that people working in the rubber industry know that it exists and how destructive it can be.

SYMPTOMS

There are two stages of SALB: the primary or conidial stage, and the secondary or perithecial stage.

Primary Stage

This occurs generally on young leaves. Black-brown lesions (spots) are found, mostly on the lower surface. These contain a large number of powdery fungal spores (conidia).



Lesions on a leaf producing spores (conidia)

Leaves that are infected while very young will blacken, shrivel and eventually fall. If the leaves survive they will look ragged and have round holes in them.

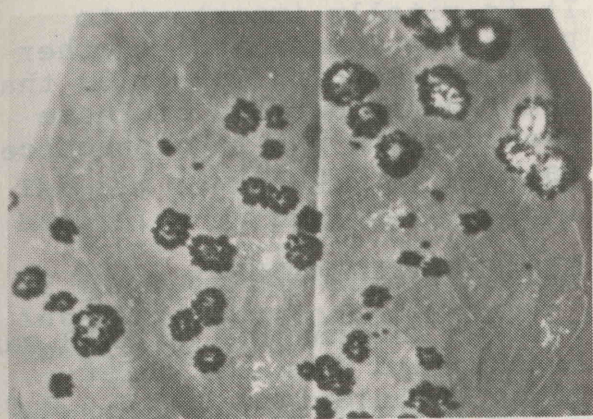


Infected young leaves

Secondary Stage

This develops on leaves that have survived the primary infection. As the leaves become fully grown, a large number of small, round, black bodies (perithecia) develop around the edges of the old primary stage spots. This development takes place especially on the upper surface of the leaves. The perithecia are hard and stick up above the

surface of the leaf. They can change the feel of the leaf making it rough to touch.



Perithecia on the upper surface of an infected leaf.

CONTROL

Control of SALB using chemicals is a very expensive process, and it does not always work. Chemical control has been used only in nurseries where weekly application of zineb in wet periods is effective. Usually however, resistant material provides the greatest insurance against infection. High resistance from wild populations has now been bred into some of the older Asian commercial clones. Many resistant clones are therefore now available but, as yet, their yields are low.



Susceptible clone (centre) and resistant clones of Hevea.

Selection, testing and breeding against SALB is continuing in Brazil, Guatemala, Liberia, Malaysia and Sri Lanka.

QUARANTINE PRECAUTIONS

Links between natural rubber producing countries in the eastern and western hemispheres, particularly through the exchange of staff, carry the danger of spreading SALB. It is of the highest importance that this danger is made as small as possible and that the disease is confined to tropical Central and South America. The following procedures are recommended, by the Rubber Research Institute of Malaysia, for plantation staff and research workers following visits to any of the rubber growing countries of Central of South America.

1. The visit should be planned so that the return journey to the east is made through Europe or temperate North America.
2. Before leaving the affected area, pockets and footwear should be brushed clean.
3. All used clothing should be washed at a stop-over point in Europe or North America. Shoes should be cleaned again or be disinfected. Other personal belongings, including cameras, brief cases and suitcases should be wiped with disinfectant.
4. Papers and books that cannot be thrown away should be sterilised by ultra-violet radiation. This also applies to all letters and parcels received from rubber plantations in America.

CO-OPERATION

To help to make sure that SALB stays out of the Asian rubber producing countries, the Asso-

ciation of Natural Rubber Producing Countries (A.N.P.R.C.) has formed a technical committee which deals specifically with this disease. This committee will make it easier to maintain close contact between member countries and improve regional and international co-operation. Topics discussed by the committee at a recent meeting in Kuala Lumpur included:

1. The formation of Country Committees for SALB.
2. The standardising of phytosanitary certificates issued by different member countries.
3. Measures regarding the import of plants of the genus *Hevea* from the American tropics.
4. Current SALB Research Programmes.

5. Current disease control measures.

It is vitally important to Papua New Guinea and to other rubber producing countries that the recommendations of these meetings are put into practice as soon as possible.

FURTHER INFORMATION

Further information on SALB can be obtained from the chief Plant Pathologist, D.P.I., P.O. Box 2417, Konedobu.

Copies of this Plant Pathology Note, and of others in the series, are available from Publications Officer, Publications Section, D.P.I., P.O. Box 2417, Konedobu.

CONTRIBUTIONS TO HARVEST

The aim of HARVEST is to help keep everybody informed about what is happening in primary industry all around Papua New Guinea.

If there is any work going on in your area which you think would be interesting to other HARVEST readers, we would be pleased to hear about it.

Articles can be about a single topic or project, the work of a group of people, or the primary industry of a particular area.

Articles should be presented simply and be fairly short (about 2 000 to 3 000 words) with plenty of black and white photographs or other illustrations, if possible.

Two copies of each article, typed with double spacing and wide margins, should be sent to The Editor, HARVEST, Publications Section, Department of Primary Industry, P.O. Box 2417, Konedobu.

ORGANISATIONS

- C.S.I.R.O. Commonwealth Scientific and Industrial Research Organisation
- D.P.I. Department of Primary Industry
- F.A.O. Food and Agriculture Organisation of the U.N.
- U.N. United Nations
- W.H.O. World Health Organisation

ABBREVIATIONS USED IN HARVEST

UNITS

L	litres	mm	millimetres
g	grams	cm	centimetres
kg	kilograms	m	metres
t	tonnes	V	volts
s	seconds	W	watts
min	minutes	in	inches
h	hours	ft	feet
y	years		

LATIN ABBREVIATIONS

c.	<i>circa</i> (= about)	et al.	<i>et alia</i> (= and others)
cf.	<i>confer</i> (= compare)		

OTHER ABBREVIATIONS

c.d.a.	controlled drop application	var.	variety
sp.	species	>	more than
spp.	species (plural)	<	less than
ssp.	subspecies	%	percentage
u.l.v.	ultra low volume		

ORGANISATIONS

C.S.I.R.O.	Commonwealth Scientific and Industrial Research Organisation
D.P.I.	Department of Primary Industry
F.A.O.	Food and Agriculture Organisation of the U.N.
U.N.	United Nations
W.H.O.	World Health Organisation