

Harvest

volume 10 no.4 1985



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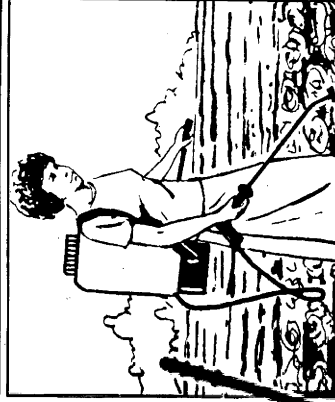
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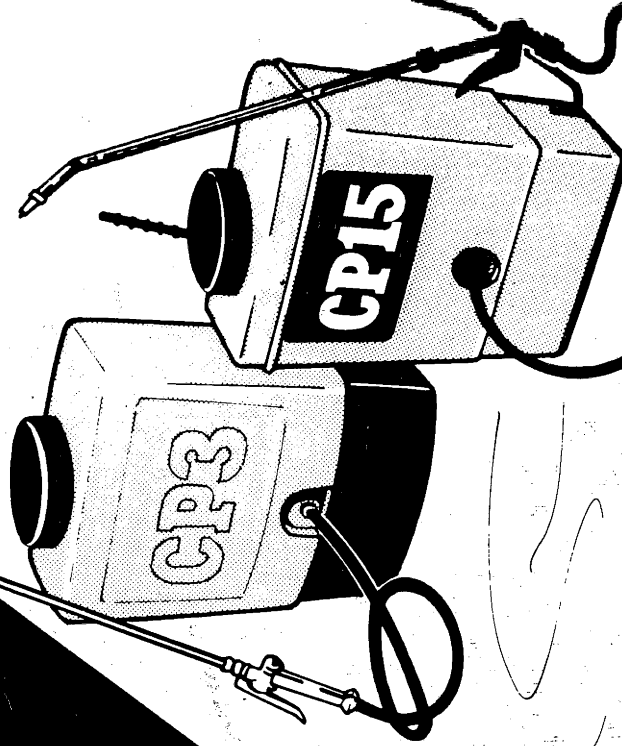


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HARVEST

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WRITE AN ARTICLE FOR HARVEST

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.

Readers' comments on articles in HARVEST or on the magazine in general are welcomed. Please address any letters to the Editor, HARVEST, Publications Section, D.P.I., P.O. Box 417, Konedobu.

SOME GUIDELINES FOR GROWING RICE UNDER UPLAND (DRYLAND) CONDITIONS

By J. Wohuinangu, Agronomist, Bubia Agriculture Research Centre, Lae

VARIETY

Successful rice farming greatly depends on the wise choice of high yielding varieties. The variety recommended for dryland rice culture in Papua New Guinea is called 'Senis'. Senis is an early to medium maturing variety, with short plant height and high tillering capacity (i.e. the plants will form many heads of grain).

WHERE TO GROW RICE

To grow rice there should be about 1250 mm of rainfall over the growing period. For the first 3 months after sowing, and in the month before harvest at least 250 mm of rain per month are needed for the best yields. Low rainfall, especially during the flowering stage of rice, will reduce the yield of grain.



A crop of rice ready for harvest

The best soils for dryland rice are clay or clayey loam soils which hold water. For best results, plant rice in fertile soils which have not been cropped for many years, or on newly cleared bush.

Rice will grow in temperatures between 20°C and 40°C, but the best temperature for high yields is 22°C. Coastal areas of Papua New Guinea have average maximum daytime temperatures of 28-32°C. So in coastal areas where the rainfall and soils are suitable, temperature does not limit rice production. Using the rice varieties at present available in Papua New Guinea, successful rice production is limited to below 800 m a.s.l. Varieties tolerant to cold are needed above this altitude.

WHEN TO PLANT

Because of the high rainfall requirements of rice, it should be planted early in the wet season, so that the dry season comes late in the fourth month.

PLANTING

Seed

Plant 80-100 kg of rice seed per hectare. Before planting, spread the seed out in the sun to dry. This makes it easier to handle.

You can buy seeds at 10 toea per kilogram from the Agriculture Research Centre, Bubia. Seed can be saved from each year's crop for about 3 years, before you need to buy new seed from Bubia.

This article first appeared as Bubia Information Bulletin No. 45, June 1983.

Spacing

Plant the rice in rows 25-30 cm (or the width of a man's handspan) apart for the best yield and least weeding. Drill the seeds evenly along each row and cover to 2-3 cm deep. If the rice is planted with a dibbling stick, make holes 20-25 cm apart on the square. Plant 3 to 6 good seeds in each hole, and cover.



Preparing rows for drill seeding of rice

WEED CONTROL

The rice garden must be kept free of weeds for the first 9 weeks of rice growth, as weeds can cause a big reduction in grain yield. In newly-cleared gardens planted at the spacing recommended above, only two weedings are necessary before the rice plants are big enough to stop weeds growing. Three weedings may be needed on previously cleared land.



The plot of rice on the left has been hand-weeded. Compare it with the plot on the right!

The first weeding should be done 3 weeks after sowing; the second weeding should be done 3-4 weeks later, depending on the amount of weeds growing.

Chemical weed control is not economical for smallholder rice cultivation.

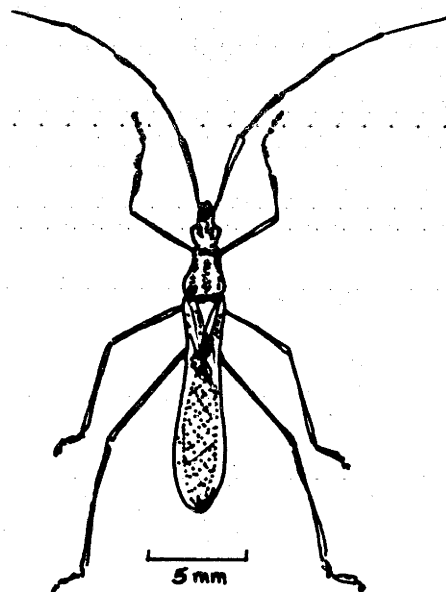
The use of crop rotation helps to control weeds, as well as reducing the build-up of insect pests and diseases of rice. Rotations with legumes such as peanuts, mungbeans or cowpeas are recommended. Legume crops also add nitrogen to the soil which is useful for the next crop of rice.

PESTS AND DISEASES

Because rice is not widely grown in Papua New Guinea, and because of strict quarantine regulations, many destructive pests and diseases of rice are not found here. Some insects which can be a problem are listed below.

Rice bugs (*Leptocorisa* sp.)

The 3 species of *Leptocorisa* found in Papua New Guinea (*L. solomonensis*, *L. oratorius* and *L. acuta*) are the most serious and widespread insect pests of rice in the country. They suck the sap of the developing grains, causing reduced yields and discoloured grains. Usually rice bugs attack a wide range of grass seeds, so rice production may be risky near grasslands.



Adult rice bug, Leptocorisa

Recommended methods of control are either spraying carbaryl at 0.9 kg a.i./ha or orthene (acephate) at 1.0 kg a.i./ha. In areas which have a fairly long dry season, *Leptocorisa* is effectively controlled by its natural enemies. Therefore insecticides must be used very carefully to kill *Leptocorisa* only, and not the other insects.

Stemborers

The pink stemborer (*Sessamia inferens*) is the most widespread of the stemborers. These insects bore into the stem of the rice, and chew out the centre portion. The damage is easy to recognise - during the vegetative (leaf-growing) stage the central leaf (youngest one) dies and turns brown. This is known as 'Dead heart'. If the plants have headed, the glumes turn white and this is often re-called 'White head'.

Usually chemical control of stemborers is not necessary. If stemborers are causing serious damage to your rice they can be controlled by applying Diazinon granules at a rate of 1 kg per ha. Make sure you apply Diazinon granules when there is enough rainfall to dissolve the granules.

Leaf-folders (*Cnaphalocrocis medinalis*) and leaf-rollers (*Marasmia poeyalis*)

Leaf-folders and leaf-rollers 'sew' together the two edges of leaves as houses for their larvae. This reduces the area of leaf available to make plant food and so also reduces the grain yield.



Young rice plants

Except for rice bugs, most insect pests are not usually a serious problem on the crop, and chemical control is not necessary. If an insect pest is damaging your rice badly, then you should consult your nearest D.P.I entomologist. The addresses of entomologists appear in all entomology bulletins (see p. 162 of this issue).

Rice diseases

Because of strict quarantine rules and the fact that very little rice is grown in Papua New Guinea, this country is still free from many serious diseases of rice. Rice blast has recently been reported in some rice plantings in the Rigo district of Central Province. See Plant Pathology Note No. 25 in HARVEST 10 (2).

HARVESTING

Time of harvesting

The rice variety Senis should be harvested 35-40 days after flowering. The flowering stage is taken to be when about 50% of the panicles have emerged. Do not wait longer than 35-40 days after flowering before harvest, or birds and rats will start to eat the crop. It can also be damaged by the sun.

Harvesting procedure

To harvest rice it is best to cut off the whole plant at ground level, using a knife or sickle. A sickle is a special knife which has teeth to make it easier to cut the stems with a single stroke.

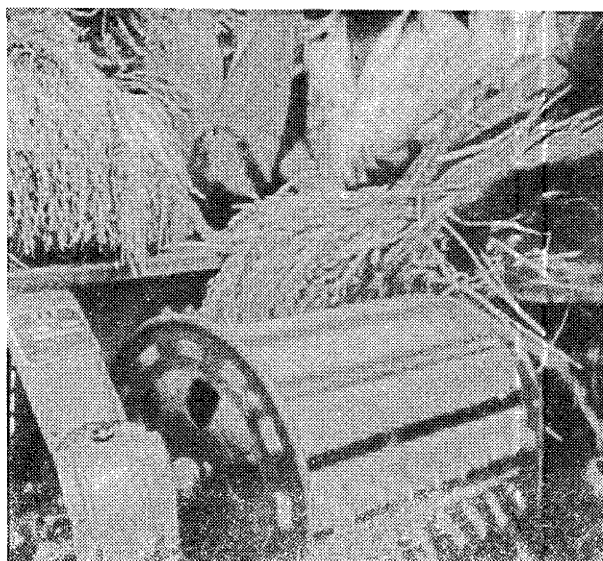
THRESHING

Threshing is a way of separating the grain from the rest of the plant. Rice should be threshed immediately after harvest. Even if it is left overnight, fungus may begin to grow. A threshing frame is shown in the diagram.

Build your threshing frame from bush materials such as wood, pitpit or split bamboo poles. The table is made from poles lashed together with bush ropes. It should be as high as the level of your hands when you stand upright with your hands by



Harvesting rice using sickles



Threshing using a foot operated thresher

your sides. The walls of the threshing frame can be made of plastic sheeting, sacking, blinds or sleeping mats. Place canvas or some other covering on the floor beneath the frame, to catch the rice grains.

To thresh your rice, hold a bundle in two hands, at the base of the stems, then swing the heads hard against the table. Give the bundle a couple more short swings to release any loosened grains. Repeat this two or three times for each bundle, until all the grains have been shaken from the straw.

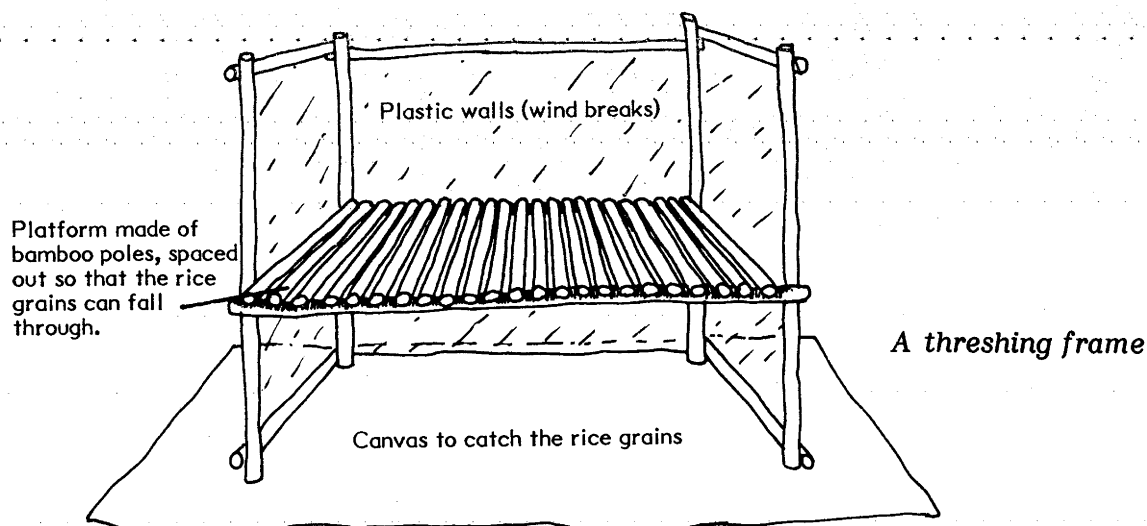
Threshing can also be done using machines, such as the foot thresher shown in the photograph.

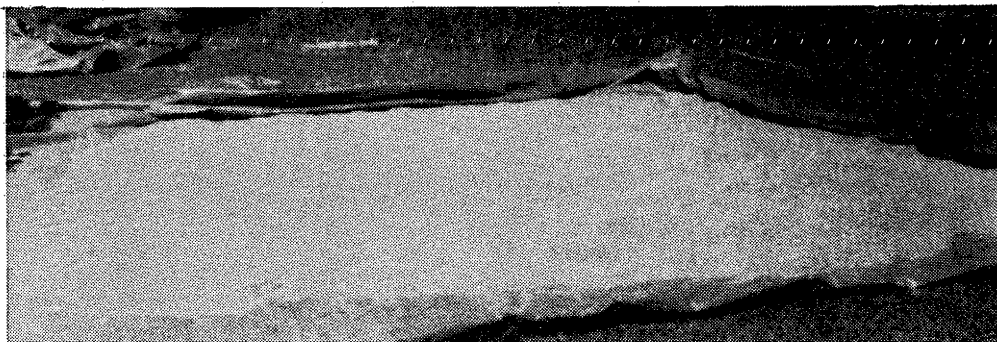
DRYING

At harvest, rice usually has a moisture content of 23-25%. It is not safe to store rice until the moisture content is below 14%.

To dry your rice, spread it over a large sheet of plastic or tarpaulin, in a sunny place, in a layer 1 to 3 cm deep. The drying will take 3 days under full sun, if the rice is stirred regularly. Allow more time if the weather is wet or overcast.

To check if your rice is dry enough to store, bite one of the grains in your teeth. If it snaps with a sharp sound, then the rice is dry. Check grains from different parts of the pile.





Threshed rice spread out in the sun for drying

WINNOWING

Winnowing is done by throwing the rice into the air and letting it fall in the wind so that the light straw, dust and empty grains are blown away. Big pieces of straw should be removed by hand. After winnowing the rice should be clean.

BAGGING

Store rice in clean jute bags. Pour the rice into the bags and shake to let the grains settle. If only 2-3 bags are produced, the rice can be processed on the farm. If more bags are produced, it is best to take them to a rice mill for processing into white rice. Paddy rice (unprocessed rice) is bought by D.P.I. at 13 toea/kg, whilst the milled rice is bought at 30-40 toea/kg.

RICE MILLING

Rice milling is the process of separating the husk and bran from the paddy rice to get white rice. The husk and bran form layers over the white rice grain.

Equipment for milling rice varies from simple pestles and mortars to foot and wind-mills, to modern rice mills which use a fuel generator. A pestle and mortar will produce 10-15 kg per day of polished rice.

A foot mill will produce 100-150 kg per day. Modern rice mills will produce about 1200-1600 kg in a day. Usually small farmers use pestles and mortars, while the modern mills are owned by D.P.I. or a farmers' association.

FURTHER READING

De Datta, S.K. (1981). *Principles and Practices of Rice Production*. International Rice Research Institute. John Wiley & Sons, Inc., USA.

Bubia Information Bulletin No. 41 (1982). Newly developed high yielding the variety 'Senis'.

International Rice Research Institute (1975). *Major Research in Upland Rice*. Los Banos, Philippines.

McAlpine, J.R. and Keig, G., with Falls, R. (1983). *Climate of Papua New Guinea*. CSIRO, Canberra.

Sands, D.P.A. (1977). The biology and ecology of *Leptocorisa* (Hemiptera: Alydidae) in Papua New Guinea. *Research Bulletin* No. 18. D.P.I., Port Moresby.

Tomlinson, D. (1983). Rice blast. *Plant Pathology Note* No. 25. *Harvest* 10 (2): 87-89.

PAPUA NEW GUINEA'S PRAWN FISHERY IN 1983

By David J. Doullman* and Ursula M. Kolkolo, Chief Fisheries Economist and Fisheries Biologist, Fisheries Division, D.P.I., Kanudi

INTRODUCTION

1983 was a very successful year for Papua New Guinea's prawn fishery. There was an increase in total landings, and a big increase in 'catch per unit effort' (CPUE) - that is, the amount caught per hour spent fishing. There was also a strong Japanese market. This article summarises developments in the fishery in 1983, and gives some information about government policy on the management of the prawn fishery.

LANDINGS

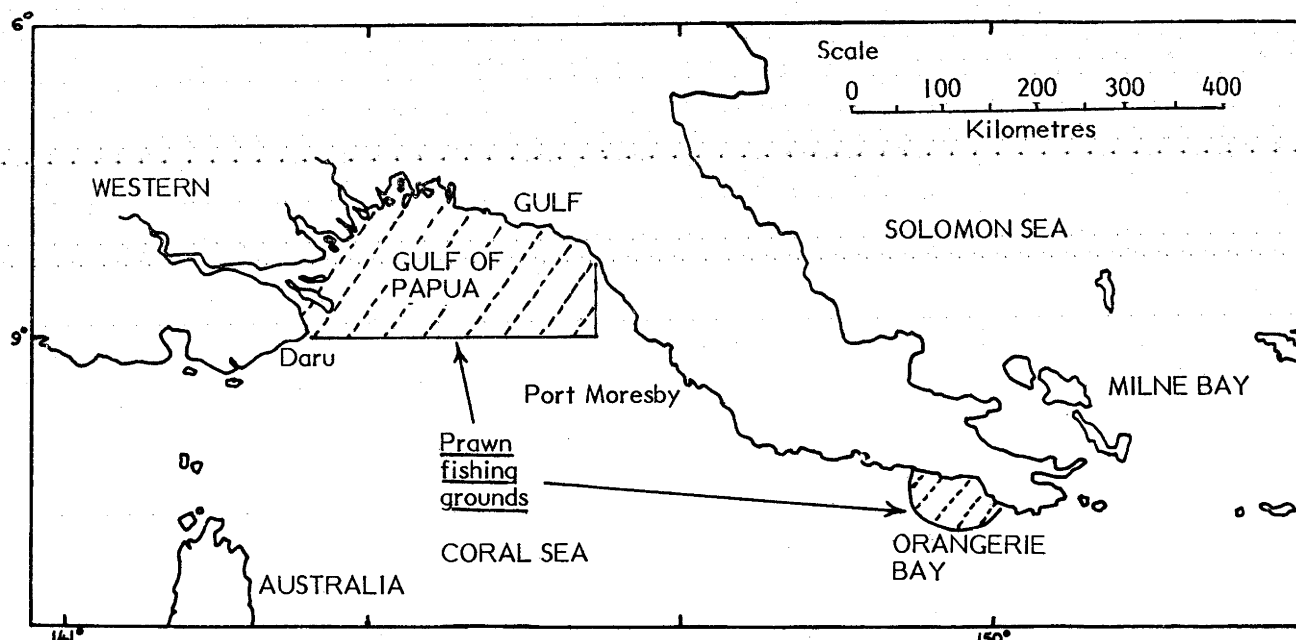
In 1983 trawlers operating in Papua New Guinea's prawn fishery landed a total of 1,190 tonnes (tailweight) of prawns. This was the largest catch since the fishery began, and was 33% more than the 1982 catch of 894 tonnes.

The prawn fishery in Papua New Guinea operates in two separate areas: the Northern Gulf of Papua area, and the Orangerie Bay area. The positions of these areas are shown on the map below.

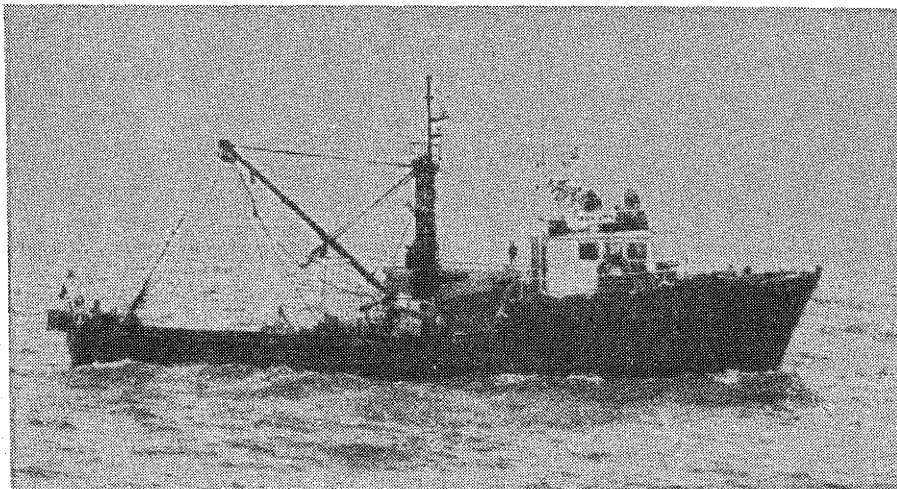
Northern Gulf of Papua area

The Northern Gulf of Papua is the most important area of the prawn fishery, with 97% of the catch being taken there in 1983. The area is fished by larger class vessels (greater than 100 GRT - Gross Registered Tonnes), most of which are owned by companies.

* Present address: PIDP East West Centre, 1777 East West Road, Honolulu, Hi 96848, U.S.A.



Locations of the main prawn grounds in Papua New Guinea



*A typical prawn trawler
in the Gulf of Papua
prawn fishery*



*Emptying the net on the
deck of the trawler*

A major development in the fishery in 1983 was the formation of a 'joint venture company'. By contributing 3 vessels and shore assets, the Papua New Guinean Government took up a 33% share in the largest prawn company, New Guinea Marine Products Pty Ltd. The other two partners in the company are Japanese: Hokoku Marine Products Co and Nippon Suisan Kaisha Ltd. The joint venture company owns 6 vessels altogether.

While there was a big increase in total landings in the Northern Gulf of Papua in 1983, the fishing effort was less than in 1982. In 1982 the fishing effort was 60,307 hours spent fishing. In 1983 it fell to 56,977 hours. The main reason for the fall was the withdrawal of 3 trawlers from the fishery until the new 'joint venture company' was

formed. Two of the vessels re-entered the fishery in October, making a total of 13 vessels by the end of the year.

Catch per fishing effort (measured in kg prawns landed per hour of fishing time) increased in 1983 to a record level of 20.5 kg. This was 40% higher than the CPUE in 1982 (14.6 kg).

Orangerie Bay area

The Orangerie Bay area of the prawn fishery is fished by 2 smaller class vessels, owned and operated by Papua New Guinean groups who claim a traditional property right over marine (sea) resources in the area. In 1983, fishing effort was 1,393 hours, CPUE 28.1 kg, and total landings a little more than 39 tonnes.

SPECIES CAUGHT

The main commercial species of prawns caught in the Papua New Guinea prawn fishery are as follows:

- Banana prawns (*Penaeus merguensis*, *P. indicus*)
- Black Tiger prawns (*P. monodon*)
- Tiger prawns (*P. semisulcatus*)
- Endeavour prawns (*Metapenaeus ensis*, *M. demani*, *M. eboracensis*)
- Mixed prawns (other species not mentioned above)

The four species groups mentioned make up most of the catch. The main species in both fishing areas is the Banana prawn. In 1983, Banana prawns made up 55% of the catch in the Northern Gulf of Papua, and 98% in Orangerie Bay. The proportion of each species in the catch has stayed fairly stable over recent years.

TABLE 1: PERCENTAGE COMPOSITION OF THE CATCH (TAIL WEIGHT) FOR THE GULF OF PAPUA PRAWN FISHERY

Species Group	Average 1977 - 1982	1983
Banana	53.9	55.4
Black Tiger	7.4	8.7
Tiger	0.8	2.6
Endeavour	18.6	15.8
Mixed	19.4	17.4
Total	100.0	100.0

THE BY-CATCH

By 'by-catch' we mean all the other kinds of fish which are caught at the same time as the prawns. In Papua New Guinea almost all of the trawl by-catch is thrown back into the sea. However, most of it could be sold in Port Moresby for human and animal consumption. At present, the by-catch is sorted, and the larger, more easily sold species are frozen and transported back to



Sorting the catch, which sometimes includes lobsters, on the trawler

Port Moresby. The amount of by-catch fish kept on each fishing trip depends on the length of the trip, on how large the prawn catch is, and on how much freezer storage space is available on the boat.

In 1983, about 350 tonnes of by-catch was landed in Port Moresby by the prawn fleet. This fish sells at 60 to 90 toea per kg, depending on species and market conditions. The estimated value of the by-catch was K265,000.

EXPORTS

In 1983, Papua New Guinea exported a total of 1,109 tonnes of prawns (tailweight). This was 22% more than in 1982 (912 tonnes). Most of the exported prawns went to Japan, though smaller quantities of lower valued species were sold in the United States, Australia, Hong Kong and Singapore.

Japan will continue to be Papua New Guinea's main market for prawns. However we are trying to find stable markets elsewhere, especially for those species of prawns which are less valuable in Japan.

The total value of prawn exports from Papua New Guinea in 1983 was K8.1 million - 69% higher than the 1982 value of K4.8 million. In Japan the average price was K8.20 per kg.



Packing prawns in master cartons on the trawler before being stored in the vessel's freezer

DOMESTIC SALES

Papua New Guinea's domestic prawn market is small compared to the export market. It is estimated that no more than 150 tonnes of prawns could be sold on the domestic market per year. The reason for this is that prawns are a very expensive food item.

In 1983 about 150 tonnes of prawns were sold locally. The average price was K6.65 per kg. Most of these sales were from retail outlets run by the fishing companies, and from the Government-owned Fish Marketing Corporation. The outlet run by the new joint venture company sold 60% of the total.

EMPLOYMENT AND TRAINING

Each of the larger class vessels are crewed by 2 or 3 foreign deck and engine officers and 10-15 Papua New Guinean deck and engine hands and trainee officers. A total of 204 Papua New Guineans and 32

foreigners were employed on all the vessels operating in the prawn fishery in 1983. Also, 27 Papua New Guineans and 11 foreigners worked in shore support services, management and marketing.

The Government, through the Department of Labour and Industry, requires that the companies operating in the fishery have training programmes and localization plans. The companies pay for training at institutions within this country and for specialist training overseas. In general, the training and localization programme has been successful. However, the suggestion that most management and crew positions could be localized by 1987 is probably too optimistic.

TAXES AND PROFITS

Apart from company tax and personal income tax which the fishing companies and their employees must pay, the companies must also pay export tax. This tax is charged on all marine products exported from Papua New Guinea.

Export tax is set at 5% of the value of the catch. It was introduced to the prawn fishery in 1982. In 1983 about K405,000 was collected in export tax payments.

Vessel and crew licence fees are set at very low levels. In 1983 about K1,130 was collected from this source.

All the taxes collected from the fishery are paid into the Government's Consolidated Revenue Fund.

The companies operating in the fishery made reasonable profits in 1983.

MANAGEMENT

As in previous years the Fisheries Division of the Department of Primary Industry continued to check very carefully the stocks of prawns in the fishing areas in 1983. This has been a fairly easy task because of the small number of vessels operating in the fishery. In order to keep their fishing licences, vessels must report their catches and fish only in permitted areas. The operators of the vessels have

usually obeyed these rules, therefore catch data and other related data are very accurate.

CPUE data show that the prawn fishery could handle a higher fishing effort. However, if fishing effort increases too much, the CPUE could fall. For this reason, very careful thought is being given before licencing new vessels in the fishery.

Government policy suggests that it is unlikely that any more foreign-owned boats will be licenced. Preference will be given to existing national companies to expand their operations and to Papua New Guinean individuals to enter the fishery on a commercial basis. Also Papua New Guineans are being encouraged to buy shares in the foreign controlled companies. For example, in 1983, Gulf Marine Pty Ltd, the Papua New Guinean share holders, took over the shares of their Japanese partner in the company Gulf Sobhu Pty Ltd. Gulf Marine Pty Ltd was renamed in 1984. It is now known as Gulf Papua Fisheries Pty Ltd and is wholly owned by the Gulf Provincial Government. It now operates 3 vessels in the Northern Gulf of Papua.

THE FUTURE OF THE FISHERY

Because the prawn fishery in Papua New Guinea is mostly foreign-controlled, and most production is exported, the management policy now is to keep the prawn catch as high as possible, without reducing the stocks. In this way, export earnings for Papua New Guinea are as high as possible, and the prawn stocks are being conserved.

As the foreign presence in the fishery is gradually reduced, this policy may be changed. However, Papua New Guinea's prawn fishery will stay as a limited entry fishery as it has done in the past.

FURTHER READING

Branford J.R. (1982). The Gulf of Papua Prawn Fishery 1977-1981. *Fisheries Research Report No. 81-08*. Department of Primary Industry, Port Moresby. 22 pp.

Frusher, S. (1984). The distribution and abundance of juvenile Penaeid prawns in the Northern Gulf of Papua, Papua New Guinea, with particular references to *P. merguensis* De man. *Fisheries Research Report No.84-06*. Department of Primary Industry, Port Moresby. 27 pp.

Gwyther, D. (1980). Commercial and biological aspects of the Gulf of Papua prawn fishery. *D.P.I. Research Bulletin No. 21*. Department of Primary Industry, Port Moresby. 72 pp.

Kolkolo, U. (1983). The Gulf of Papua Prawn Fishery 1977-1982. *Fisheries Research Report No. 83-15*. Department of Primary Industry, Port Moresby. 13 pp.

Rapson, R.M. and McIntosh, C.R. (1971). Prawn Surveys in Papua New Guinea. *Fisheries Research Bulletin No. 3*. Department of Agriculture, Stock & Fisheries, Port Moresby. 126 pp.

Tenakanai, C.D. (1980). Some aspects of the biology and fishery for endeavour prawns in the Gulf of Papua. *D.P.I. Research Bulletin No. 28*. Department of Primary Industry, Port Moresby. 103 pp.

Wilson, M.A. and Tatamasi, M. (1976). Some Aspects of Papua New Guinea Prawn Fishery. Presented to the 10th Waigani Seminar, 2-8 May, University of Technology, Lae. 12 pp.

A SIMPLE WATER SUPPLY SYSTEM

By John Yamarak, District Rural Development Officer
Koroba, Southern Highlands Province

INTRODUCTION

The article describes how we installed a very simple water supply system for Koroba District Agricultural Demonstration Projects. You can use this system where there is a small creek or spring which does not dry out in the dry season and which runs higher up than your projects. We found this an easy way to get water to our projects without any labour.

MATERIALS NEEDED

The following materials are needed to install the water supply:

- . 1 x 200 litre empty oil drum
- . Polythene or PVC pipe, 25 mm and 12 mm. The length depends on the distance from the pond to the projects. Note that PVC pipe is cheaper.
- . Taps, 12 mm
- . Joiners, 25 mm and 12 mm
- . Tees, 25 mm (Poly or PVC)
- . Reducers, 25-12 mm (Poly or PVC)
- . EITHER: 8 pieces of 70 x 100 mm timber, cut to the length of the oil drum, for the platform.
OR: Arc mesh and angle iron for a more long-lasting platform.
- . EITHER: An old plastic benzene pump, plain wire, glue suitable for glueing plastics
- . OR: A 50 x 25 mm reduction bush (to fit drum); 25 mm hose 'tail' (to join the pipe to the oil drum).
- . Tools - hammer, pliers, cold chisel.

METHODS

Here are the steps that we followed in installing the water supply:

1. At the site of the water supply we dug our pond - about 5 m x 5 m and 2 - 3 metres deep.
2. A barret (channel) was dug from the pond to the project area.
3. To strengthen the sides of the pond and barret, and to prevent landslides we used posts, and planted grasses around the sides.
4. We cut a rectangular hole in the side of the oil drum in the position shown in the diagram. Mosquito netting covers this hole, to prevent rubbish from entering the drum and blocking the pipes.
5. We made a platform for the oil drum, using the 8 pieces of timber, lashed together as shown in the diagram.
6. We laid the platform at the centre of the pond and attached the drum to it firmly, using wire. The platform holds the drum in position under the water.
7. The old plastic benzene pump was screwed into the large hole in the top of the oil drum.

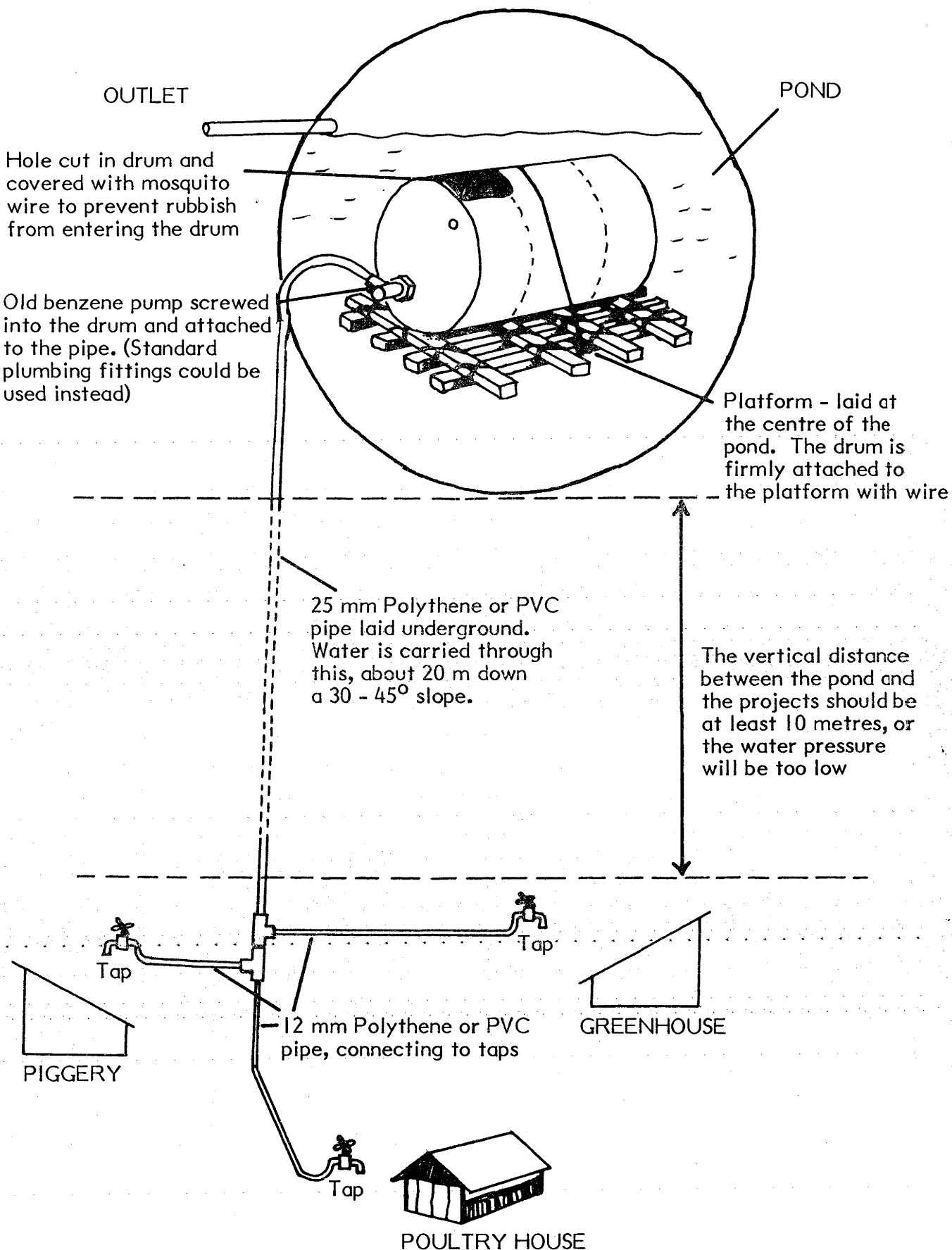


Diagram of the water system at Koroba



The water system at Koroba - the pond has just been drained. Note the vegetation growing at the sides to make the walls stronger.



The drum in position on its platform in the middle of the pond.

8. 25 mm polythene pipe was laid from the pond to the projects through the barret.
9. We then joined the polythene pipe to the open end of the pump. We used Super Glue, then tightened the joint with clean wire wound on tightly using pliers.
10. At the projects we fitted the taps to the polythene pipe, using lengths of 12 cm pipe. This makes higher water pressure through the taps.
11. Finally we covered up the barrets so that the polythene pipes were buried underground.

HOW THE SYSTEM WORKS

Since our water supply is constant, the pond fills up, covering the oil drum and filling it. Water also fills the pipes leading to the projects. So when you open the taps at the project, there is water.

At Koroba, we use this method to pipe water down a slope of 30-45°, over a distance of 20 metres. We think that water could be piped from 500 m to 1 km, depending on the slope of the land down to the taps.

This simple water supply system works very well, so why not give it a try yourself?

SOME FURTHER SUGGESTIONS

1. Distance from water supply

The water supply needs to be at least 10 m higher up (measured vertically) than the projects if the water is to be used for jobs like washing down a piggery floor. If the height is less than 10 m, then the water pressure will be too low.

At the same time, to keep costs down, the water supply should be nearby. If this means that the difference in height has to be less than 10 m, then you can use a tank to store water before it is used.

2. Costs

PVC pipe is cheaper than the Polythene pipe used in the system at Koroba. It is sold in 6 metre lengths. 25 mm PVC pipe costs about K4.00 per 6 m length; 12 mm PVC pipe costs about K2.50 per 6 m length.

Instead of using an old plastic benzene pump, you could use the standard plumbing fittings as listed in 'Materials Needed'.

Using PVC pipes and standard plumbing

fittings, the system at Koroba would cost about K60.00 - that is, water piped 20 metres from the pond, to 3 taps, as shown in the diagram. The cost of the oil drum and platform is not included. You should contact your nearest plumbers supplier for prices and advice.

3. Make a longer-lasting platform

Instead of using timber to make the platform, you can use arc mesh and angle iron. This will last a lot longer.

Another way to hold the drum in position under the surface of the water would be to drive 4 star pickets into the bottom of the pond, and tie the drum to these using wire.

TESTING FISH AGGREGATING DEVICES IN THE HUON GULF.

CAN THEY HELP VILLAGE FISHERMEN?

By N.J. Quinn and H. Lekisi
Fisheries Department, Papua New Guinea University of Technology, Lae

INTRODUCTION

Fish Aggregating Devices (FADs) are used by fishermen in various parts of the world to help gain better catches. They work because objects drifting in the sea tend to attract certain species of pelagic fish. Pelagic fish are those which swim near to the surface of the sea. There are several possible reasons why the fish are attracted to floating objects. These reasons include:

- They are attracted to the shade of the object.
- Fish are attracted to food such as smaller fish, algae, etc. which are found by the FAD and may be easier to see by the shade of the object.
- The floating object offers shelter from predators.
- The object could be used as a spawning place.
- Fish may go to the floating objects to have their parasites removed by the other fish there.

Man made Fish Aggregating Devices usually consist of a raft which floats on top of the water, and which is anchored. Below the raft, under the water, hang a number of weighted lines. Vegetation, or artificial vegetation is attached to these lines to attract the fish.

In 1982, the Fisheries Department of the Papua New Guinea University of Technology began studies to test the use of a low-cost, low-maintenance, non-traditional Fish Aggregating Device. In this article, we give information about the device and an

account of its effect on a local fishing village. The numbers of fish and the order in which they arrived at the FAD were noted for 1 year.

THE FISH AGGREGATING DEVICE

The design of our Fish Aggregating Device was based on one used in the Northern Marianas in 1978. This design was used because it is made of angle iron and steel drums which are readily available in Papua New Guinea, and because it is not too costly to make.

The Appropriate Technology Development Institute, Lae helped with the construction of the FAD.

In this project we painted the angle iron with silver marine primer, then coated it with Durotar to prevent rust. The FAD was made with three steel drums.

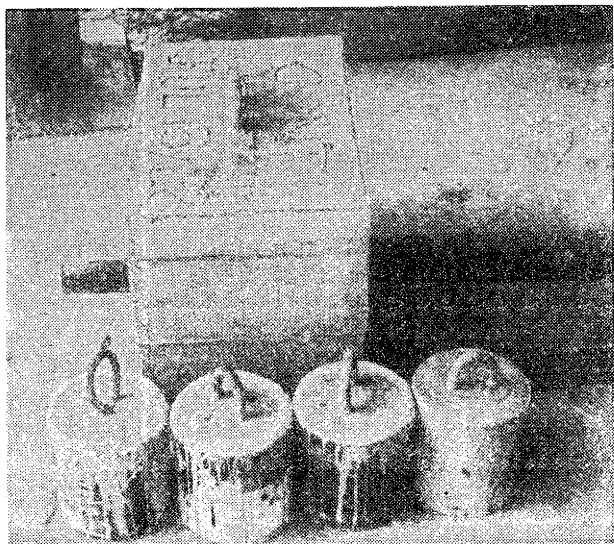
A radar reflector was attached to help in locating the FAD, and for safety in navigation.

The FAD was anchored using a 200 kg engine block encased in concrete. The anchor line consisted of 20 m lengths of 8 mm stainless steel chain at the top and bottom. The chains were linked with swivels to a 50 m length of 18 mm polypropylene rope. The chain was attached to the anchor using shackles. Because the rope floats in water, the chain at the top is needed to stop the rope becoming tangled with the material hanging beneath the FAD.

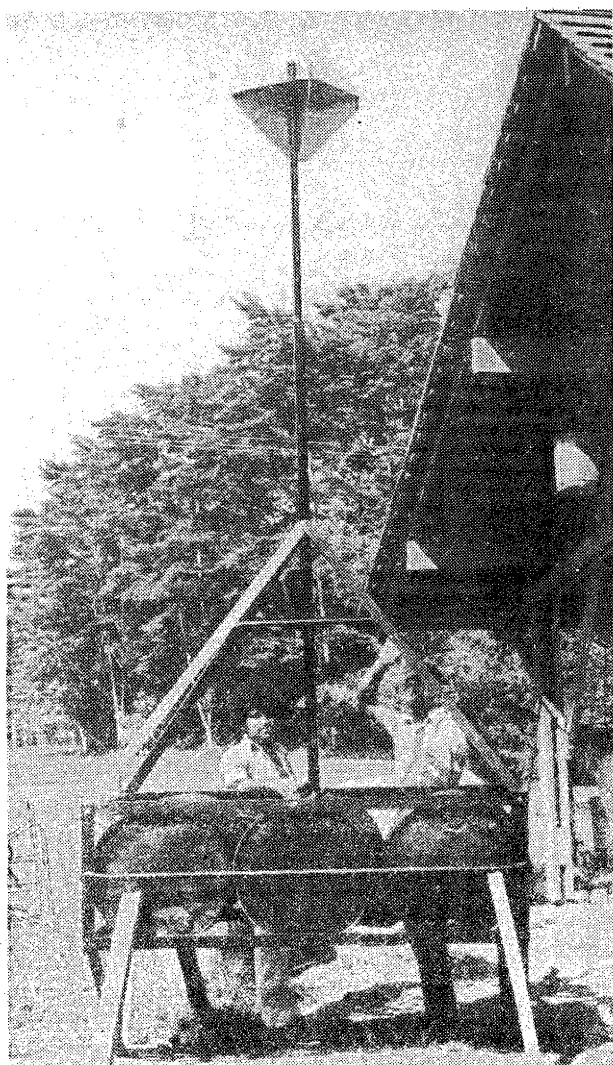
This FAD cost K374.00 in early 1982. This was quite cheap, as it cost over K4,500 for a larger Hawaiian Fish Aggregating Device.



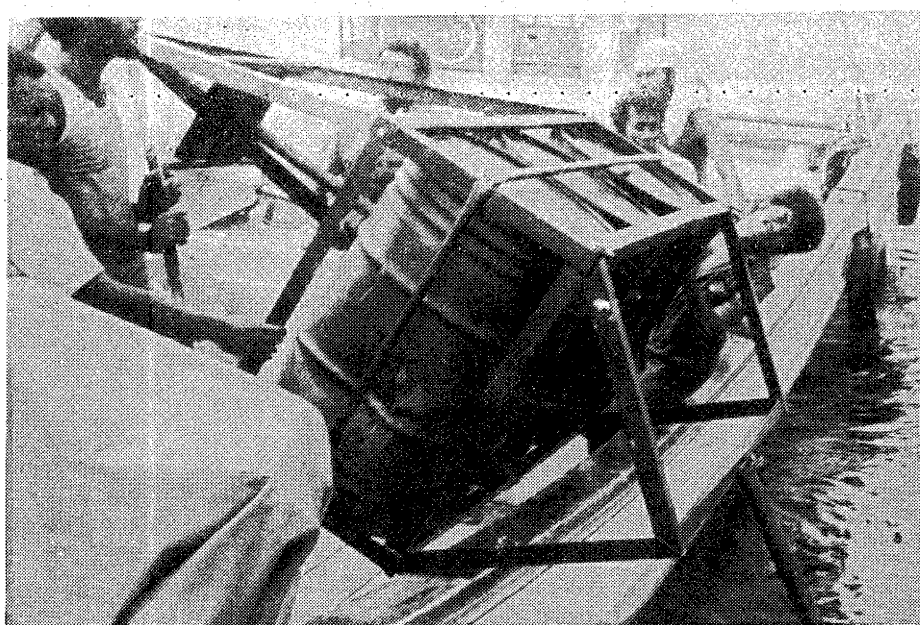
Welding the frame which holds the drums



An old engine encased in concrete is used as an anchor. The smaller anchors weigh down the lines holding the coconut fronds

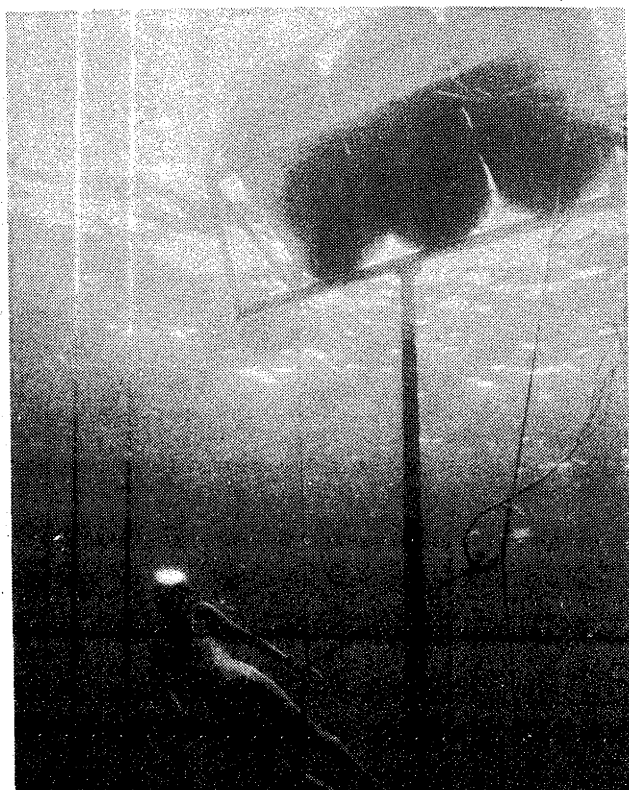


The 3-drum FAD, 190 x 90 x 150 cm. The galvanised pipe which serves as a counterweight under the water is not shown.

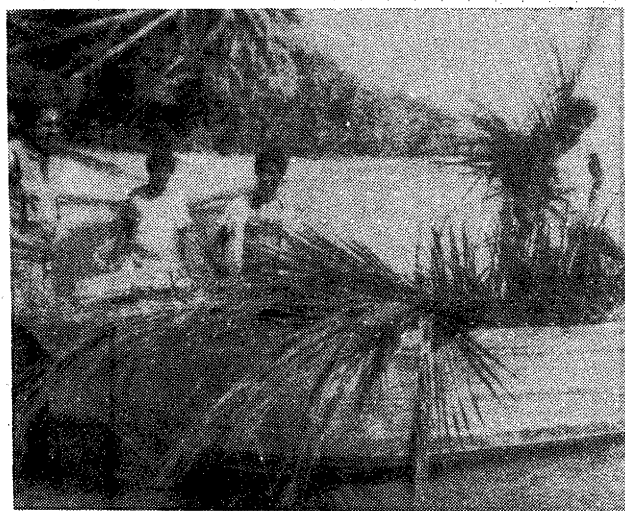


Setting the first FAD in the Huon Gulf, July 1982

The first FAD was anchored on 24 July 1982, after being transported to the site on the University of Technology training vessel 'Scomber'. Four 12 m weighted nylon ropes were attached to the FAD. Vegetation was tied to the ropes. After trying green coconut fronds, coconut husks and bamboos as appendages, without much success, we found that dry coconut fronds worked better. They needed replacing every 2-3 months.



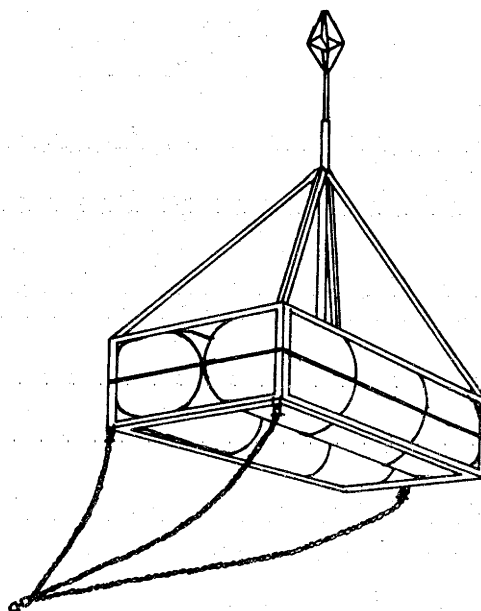
An underwater photograph of the FAD, without appendages



Coconut fronds (appendages) attached to the FAD attract fish to the device

Seven months after anchoring one of the drums developed a leak and the FAD was replaced. The second FAD consisted of two 200-litre drums filled with epoxy foam. The use of foam ensures that the drums will float even after they rust through. It was made in the same way as the first except that the V-shaped structure and pipes below the surface were replaced with 3 lengths of chain.

The second FAD cost K420. The extra cost was because foam was used. However the foam helps the FAD last longer, making it cheaper in the long run. This FAD was anchored in April 1983.

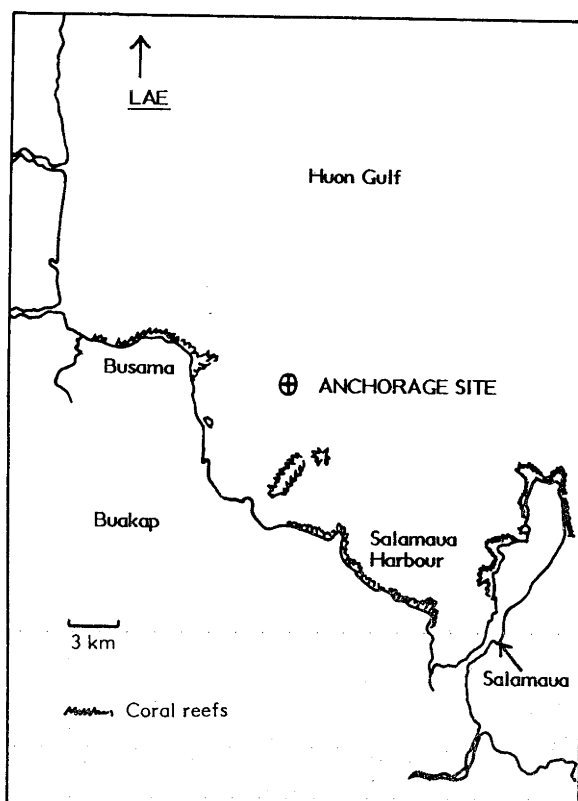


Drawing of the second FAD, anchored in 1983. Instead of a pipe as a counterweight, there are 3 chains attached to a swivel.

ANCHORAGE SITE

With the help of Mr E. Mueller of the Lutheran Economic Service we found an active family fishing co-operative in Buakap who were willing to help with the study. The anchorage site was chosen after discussion with the villagers. The position is shown on the map on page 150.

The site chosen was in 90 m of water, but within easy reach of the village. It is in a partly sheltered area as it is protected from the southeasterly winds by the Salamaua peninsula.



Map of the site of the FAD in the Huon Gulf, Morobe Province

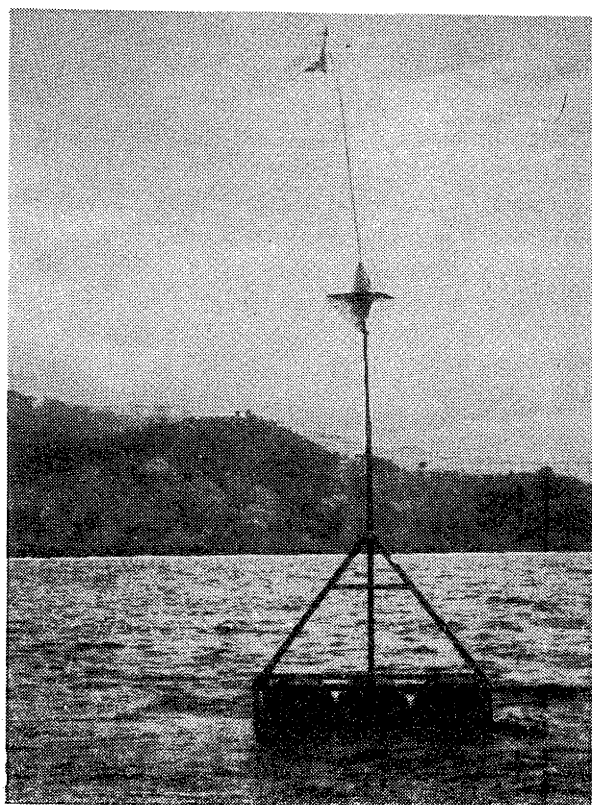
RESULTS

We visited the first FAD at least once a month to check the appendages and to record the species and numbers of fish present. Fish counts were done by divers using masks and snorkels. This method cannot give accurate counts as pelagic fish move away from the area as a boat approaches and a diver enters the water. However the divers could estimate the numbers of smaller fish present. We assumed that these attracted large predatory fish such as sharks, skipjack tuna and Spanish mackerel.

Fish counts were carried out from July 1982 until February 1983. The results of the fish counts are shown in Table 1 opposite.

The first fish (sergeant majors) were seen after about 3 weeks. By October, a school of baitfish (about 50,000 fish) arrived. At this time, local fishermen reported catching more dolphin fish around the FAD.

The fish attracted to the FAD can be divided into two groups:



The first FAD on site at Buakap, Morobe Province

1. Residents - small fish which stay around the FAD. They are either herbivorous, feeding on the organisms settled on the FAD and appendages; or they are plankton feeders. Plankton are very tiny organisms which live in the sea. Residents include sergeant majors, leather jackets, drummers, juvenile crescent bass and baitfish.
2. Visitors - usually larger pelagic fish which stay at the FAD for only a short time. They are usually predators, feeding on the resident fish. Visitors include sharks, rainbow runners, dolphin fish, Spanish mackerel and skipjack tuna.

As the number of resident species increased, the number of visitors increased too. Changes in the populations present over the months could be caused by changes in water temperature and clearness, natural changes in populations, and the condition of the appendages.

Other species used the FAD as a breeding

TABLE 1. FISH COUNTS AT THE FAD IN THE HUON GULF

Month	Date of observation	Number of observation	Fishes observed	Estimated number of individuals
July		1	Nil	Nil
August	3	2	Sergeant major	1
	17	3	Sergeant major Leather jacket	4 3
September	3	4	Sergeant major Leather jacket Rainbow runner	10 7 2
	24	5	Sergeant major Leather jacket Rainbow runner	13 8
October	7	6	Sergeant major Leather jacket Drummer fish Sardines Rainbow runner	17 11 12 50 000 2
	21	7	Sergeant major Leather jacket Drummer fish Sardines	50 20 100 100 000
November	17	8	Sergeant major Leather jacket Drummer fish Sardines	100 20 70 500 000
December	22	9	Sergeant major Leather jacket Squid Drummer fish Indian mackerel Sardines	150 22 2 40 5 000 600 000
January	4	10	Sergeant major Leather jacket Drummer fish Squid Sardines	200 15 80 6 600 000
	19	11	Sergeant major Leather jacket Drummer fish Shark Dolphin fish Squid Sardines Indian mackerel	100 15 100 1 1 4 1 000 000 10 000
February	3	12	Sergeant major Leather jacket Drummer fish Sardines Squid	200 29 100 900 000 3
	15	13	Sergeant major Leather jacket Drummer fish Squid Sardines Dolphin fish	200 30 100 6 900 000 1
	24	14	Sergeant major Leather jacket Drummer fish Scad Rainbow runner Crescent bass Sardines	200 33 100 30 4 100 12 000 000



A dolphin fish (Family: *Corphaenidae*) caught near the FAD by a villager

station. Squid were seen from December to February and their egg masses were seen on the appendages.

As of January 1985 the second foam-filled FAD is still in position in the Huon Gulf - 19 months after it was put in place. When we stopped regular visits to the FAD in September 1983 it supported a large community of baitfish and pelagic fish around the appendages. However, the villagers did not replace the appendages as they wore out. By March 1984, the baitfish and pelagic fish were gone. We put new appendages in position in August 1984, but within a month the lines and lead weights had been removed.

DISCUSSION

How useful are FADs for Papua New Guinea's village fishermen?

Our FAD definitely attracted many baitfish and several species of pelagic fish. However the villagers did not make good use of it. Why not?

- The village fishing group made most of its income from handline and beach seine fishing. They had no gill nets or long lines suitable for catching the fish at the FAD.
- Although demonstrations of other fishing methods were given to the villagers, they were not willing to try them out.
- The villagers said that they do not fish pelagic fish much because the fish spoil quickly and do not fetch a good price in the market. The fishermen's cooperative had a diesel generator and a deep freezer, but freezer space was saved for bottom fish like snapper which could be sold for over K2 per kg at the local restaurants and supermarkets. Any pelagic fish were smoked and sold in the local market for less than K1 per kg.
- Using dry coconut leaves hung from weighted ropes as appendages meant that the FAD had to be maintained regularly. The villagers were not prepared to do this.

When we visited the village, the villagers were keen to help us set the FAD and attach the coconut fronds. They even defended the FAD from other villagers who tried to fish near it. However when our regular extension visits stopped, they lost interest. Even though we tried to involve the villagers in making and anchoring the FAD, we believe that they felt they only had to protect the device, rather than maintain it and use it.



Buakap villagers preparing the beach seine for fishing

CONCLUSION

We believe that the Fish Aggregating Device described in this article is an effective low cost, low maintenance structure for attracting large numbers of baitfish and pelagic fish. However our efforts to get the villagers to use the FAD failed probably because they did not feel they owned it and therefore were not interested in maintaining it.

More extension work on how to catch fish around FADs, and market development for the type of fish caught is necessary. Village fishermen will need help to exploit the urban market for these fish.

We strongly recommend that in any future projects, the devices are designed and made in the villages, with the help of the villagers who will use and maintain them.

FURTHER INFORMATION

For further information about this project you can contact:

Dr N. J. Quinn
Fisheries Department
Papua New Guinea University of
Technology
Private Mail Bag
LAE

Another article about Fish Aggregating Devices is in this issue of HARVEST.

FURTHER READING

Mala, S. (1984). Payao construction and setting. *Harvest* 10 (4): 154-157.

EDITORIAL NOTE

The Fisheries Division of D.P.I. would like to make the following comment about Fish Aggregating Devices:

'Whilst FADs have had some success in other regions, their usefulness in Papua New Guinea is not clear at present. In particular, the economics of making them and using them under conditions found in Papua New Guinea are not well understood.

Before FADs are recommended for use, it must be shown that these devices produce increased fish catches, reduce fishing time and effort, and reduce fuel costs. These benefits must also be shown to be greater than the costs involved.

Therefore, at the moment FADs should not be regarded as an economic proposition; but research into their use should be continued by Government Departments and Institutions'.

PAYAO CONSTRUCTION AND SETTING

By Sylvester Mala, R.D.O., Fisheries,
Rabaul, East New Britain Province

INTRODUCTION

Natural and man-made objects which drift in the sea often attract certain species of pelagic fish (fish which swim near the surface of the sea).

The payao is a specially made raft which is used to attract schools of pelagic fish such as tuna.

Payaos (also known as Fish Aggregating Devices) are used in the Philippines, Malaysia and other Asian countries. They are very effective when used during purse seining (see Harvest 5(3)) or trolling operations. They have not been used traditionally in Papua New Guinea.

The Fisheries Section of D.P.I. in Rabaul has made and set several payaos to find out how effective they are in Papua New Guinea's waters.

MAKING THE RAFTS

The most important feature of the payao is a weighted hanging line or 'lag-bong'. The lag-bong is 10-15 m long and has artificial seaweed tied to it. Each payao has 6-10 lag-bongs.

The artificial seaweed becomes colonized with algae (kinds of simple plants, including the seaweeds). The algae attract small pelagic fish which come to the lag-bong for food and shelter. In turn, the small fishes attract schools of larger pelagic fish.

This article describes our work with payaos. We made 3 different types of raft:

1. Cylinder-shaped payao

We made a cylinder type of payao

using two tyres, with bamboos pushed through the middle. The tyres were medium sized, about 50 cm diameter inside and 90 cm outside. About 12 bamboos 6-10 m long were required. These were held together with strong ropes.

We found that the cylinder-shaped payaos generally lasted longer.

2. V-shaped payao

To make the V-shaped raft, 8 pieces of bamboo 6-10 m long were lashed to three logs about 1 m apart at the wide end of the V-shape. The bamboos were put through a tyre at the other end, and lashed together. A second tyre was used at the wide end.

3. Square payao

The square raft was made with 10 pieces of plastic pipe 6 m long. These were lashed together with 7 logs at 90 cm intervals, so that the raft is 3 m wide at one end and about 2.2 m at the other.

Two large grade 4 floats were fastened to the top of the raft at the widest end.

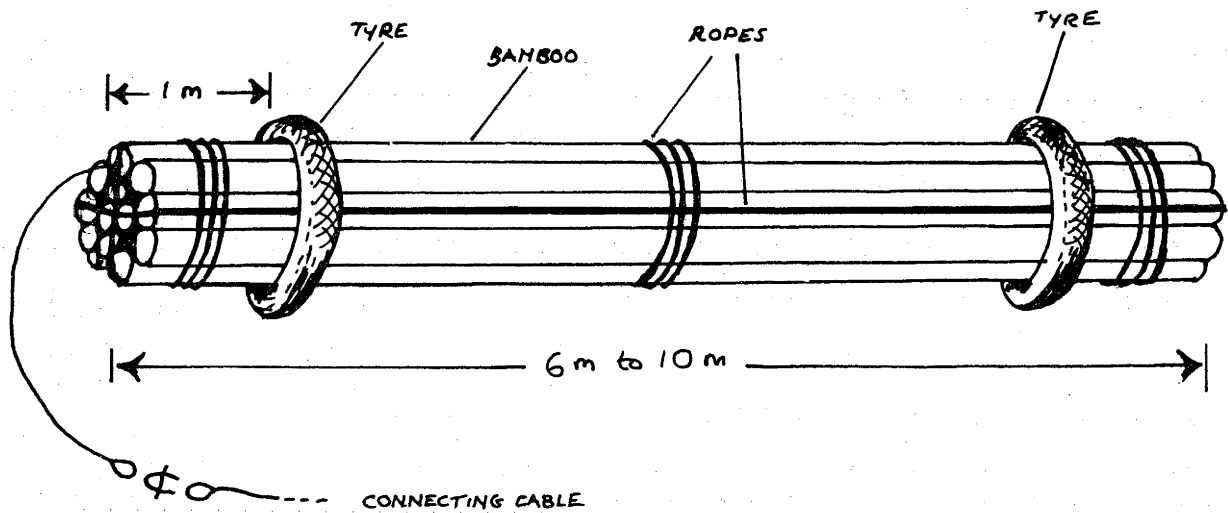
In all three types of payao the artificial seaweed consisted of strips of plastic material (plastic sheeting).

SETTING THE PAYAO

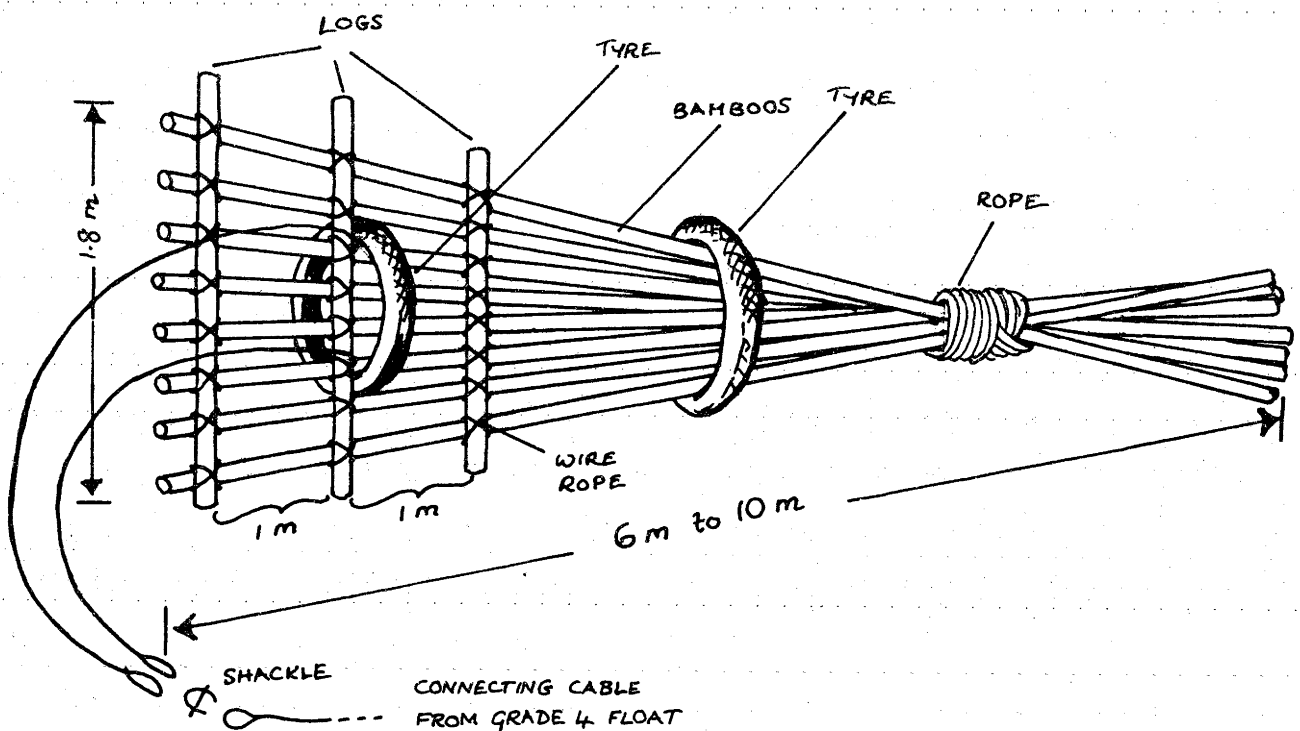
The layout for setting the payao is shown in the diagram on page 156.

The anchor is made of two 100 litre drums filled with cement.

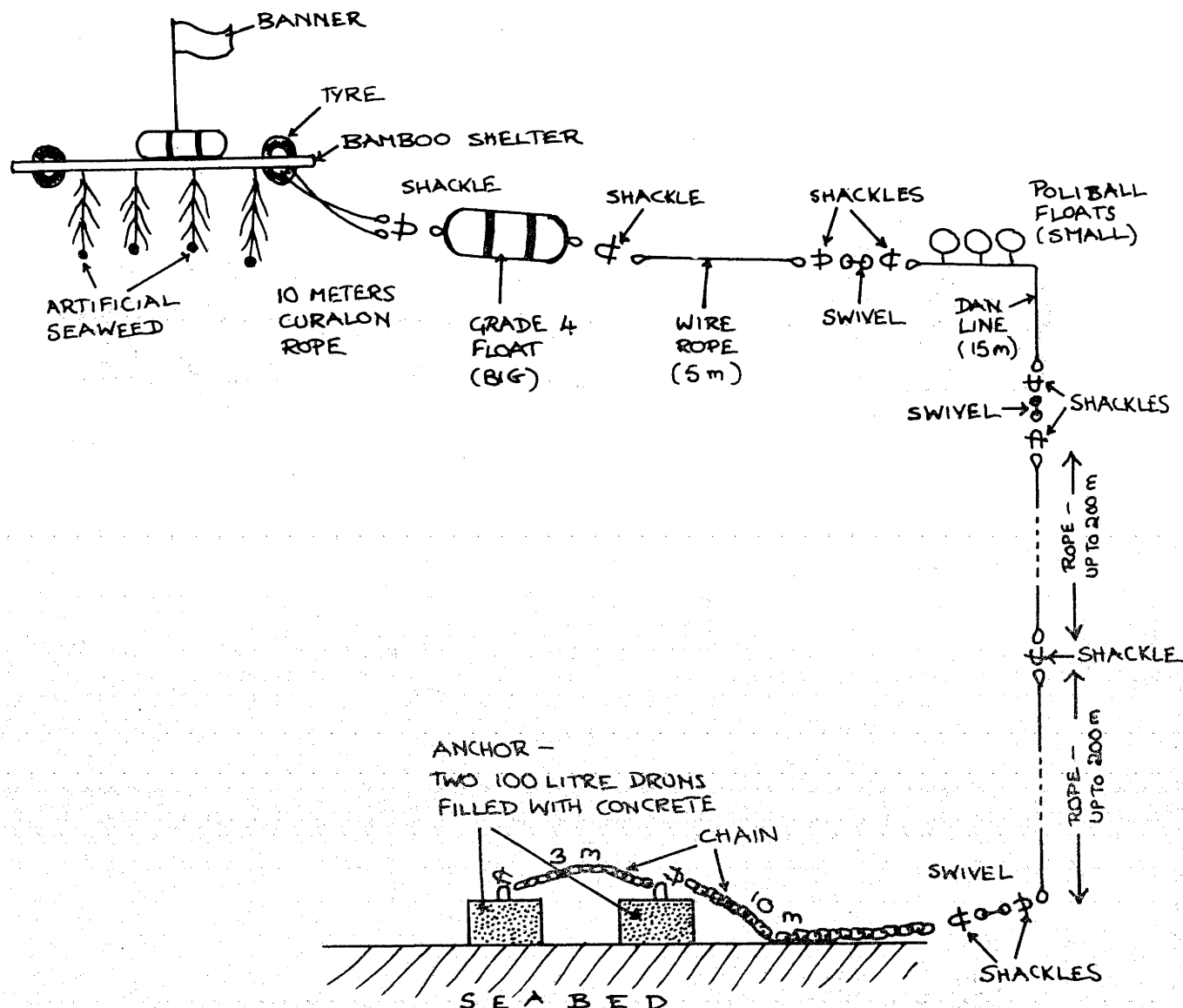
TWO TYPES OF PAYAO



A cylinder-shaped payao. This type normally lasts longer than the V-shaped or square types



A V-shaped payao



Layout of equipment used to set a payao at depths of up to 400 m.

A large float is connected to the bamboo raft and to the anchor line, so that the anchor line will not be lost during strong winds.

We set the rafts in depths varying from 50 m to 300 m at various places along the coast of East New Britain Province. Five were set in August 1982 along the Livuan Coast in the Ataliklikun Bay. Four more were set in June 1983, one off the Livuan coast, one near Urar Island, one near Massikonapuka Island and one near Watom Island.

Before setting the payaos we first found the depth of the fishing ground. We also found

out whether tuna normally migrated to the area or not.

FINDINGS

We found that the payaos seemed to increase the catches early in the mornings (6 am to 8.30 am) and late in the afternoon (3 pm to 6 pm). The catch could be 80-100 kg per day. The fish caught were mainly pelagic fishes such as tuna, mackerel, rainbow runner, trevally and barracuda.

We used the trolling method, but we think that hand lining near the payaos would also

give improved catches. So far not many local fishermen have shown interest.

Wankowski, J.W.J. (1979). The Japanese purse seine tuna fishery. *Harvest* 5(3): 140-151.

POSSIBLE IMPROVEMENTS

1. Use plastic pipes instead of bamboo. Bamboo rots quickly and must be replaced every 4-5 months.
2. Make the lag-bongs longer and use heavy sinkers so that the payao does not get carried away in strong currents.

MORE WORK ON PAYAO'S

The Fisheries Department of the Papua New Guinea University of Technology, Lae, have carried out a study on the use of Fish Aggregating Devices and their effect on a fishing community in the Huon Gulf. A report of this study appears in this issue of *HARVEST*.

FURTHER READING

Quinn, N.R. (1984). Tests on Fish Aggregating Devices in the Huon Gulf. Can they help village fishermen? *Harvest* 10(4): 143-153.

EDITORIAL NOTE

The Fisheries Division of D.P.I. would like to make the following comments about Fish Aggregating Devices (payaos):

'Whilst payaos have had some success in other regions, their usefulness in Papua New Guinea is not clear at present. In particular, the economics of making them and using them under conditions found in Papua New Guinea are not well understood.

'Before payaos are recommended for use, it must be shown that these devices produce increased fish catches, reduce fishing time and effort, and reduce fuel costs. These benefits must also be shown to be greater than the costs involved.

'Therefore, at the moment, payaos should not be regarded as an economic proposition; but research into their use should be continued by Government Departments and Institutions.'

BOOK REVIEW

KAIKAI ANIANI: A GUIDE TO BUSH FOODS, MARKETS AND CULINARY ARTS OF PAPUA NEW GUINEA.

By R.J. May. Published by Robert Brown and Associates, Australia, 1984.
(Available from Gordon & Gotch (P.N.G.) Pty. Ltd). K19.95.

By Janis Baines, Regional Nutritionist, Highlands Area, P.N.G.

Kaikai Aniani, as the foreword suggests, provides an excellent reference book on bush food in Papua New Guinea, both for the identification of foods and their use in cooking.

There are three main sections. The first describes the three main regions of Papua New Guinea - highlands, lowlands and fringe areas - and the main food crops in these areas. It is important that food is placed in a historical and cultural context in Papua New Guinea, as it is in this section, since food is very much part of the ceremonial as well as the everyday life of the villager.

Clear photographs in the second section enable the uninitiated reader to identify an extensive range of market and bush foods from all parts of the country. The book is therefore particularly useful for people new to Papua New Guinea who wish to buy local foods but have no idea what to buy; and indeed the third and last section of recipes, is good for those who don't know what to do with the foods once bought! With any luck the book might also persuade more expatriates living in Papua New Guinea to experiment with local food. One hopes that they won't be tempted to try the food item on page 87 - people!

There are some minor criticisms. From a nutrition point of view I would have liked to have seen more use of beans in the recipes as an alternative source of protein instead of meat.

The information on bush foods appears to be limited to areas the author visited. Many of these foods are much more widespread - for example, megapodes, mushrooms and berries. Also, there is little information and no photograph of one of the most nutritious of the highlands green leaves, *Rungia klossii*, which is a personal favourite as well as the 'namba wan kumu' for many parts of the highlands.

It would have been preferable too if the tables of food values had referred to more recent publications, such as 'Food Composition Tables for Use in the Pacific Islands'. SPC, 1983, rather than to older texts.

The use of blenders, and ingredients such as cream and wine in many of the recipes may restrict the usefulness of the recipe section. True 'fieldworkers' often do not have access to such luxury items.

There is however a good mixture of traditional recipes, recipes for the bush and recipes which use Papua New Guinea foods in new and imaginative ways. I am looking forward to trying 'flying fox with prunes' one of these days!

Finally, the most basic criticism is the limited market for the book due to its very high price - K19.95.

Overall, though, *Kaikai Aniani* is a book well worth having.

HELIOTHIS CATERPILLARS

By B.M. Thistleton, Senior Entomologist,
Kuk Agricultural Research Station, Mt. Hagen,
and F.M. Dori, Senior Entomologist, D.P.I., Konedobu

INTRODUCTION

Caterpillars of *Heliothis armiger* are serious pests of a wide range of crops in Papua New Guinea. Crops which are often badly damaged include corn (maize), sorghum, tomato, capsicum, tobacco and a range of legumes. *Heliothis* caterpillars also feed on cabbage, cocoa, carnation, coffee, lettuce, potato, pumpkin, rice, sweet potato, taro, tea and watermelon. The caterpillars feed on the leaves, young developing shoots, flower buds, flowers and developing seeds and fruits. *Heliothis* caterpillars as a pest of sorghum are discussed in Entomology Bulletin No. 35. This bulletin deals with *heliothis* caterpillars as pests of other crops.

NAMES

Because *heliothis* caterpillars feed on such a wide range of crops they have been given many different common names according to the crop on which they are found. Common

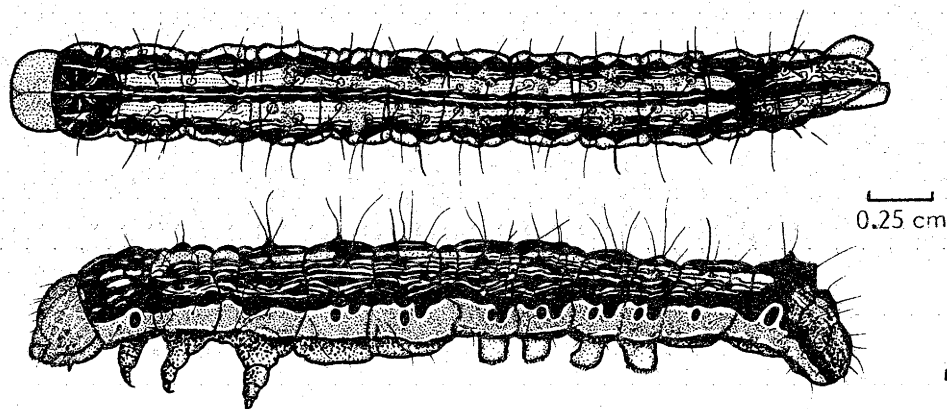
names in use in Papua New Guinea include: corn earworm, tomato grub, tomato fruitworm, tomato caterpillar, sorghum caterpillar, tobacco budworm, bean podborer and flower caterpillar. In this bulletin they are called *heliothis* caterpillars.

DESCRIPTION

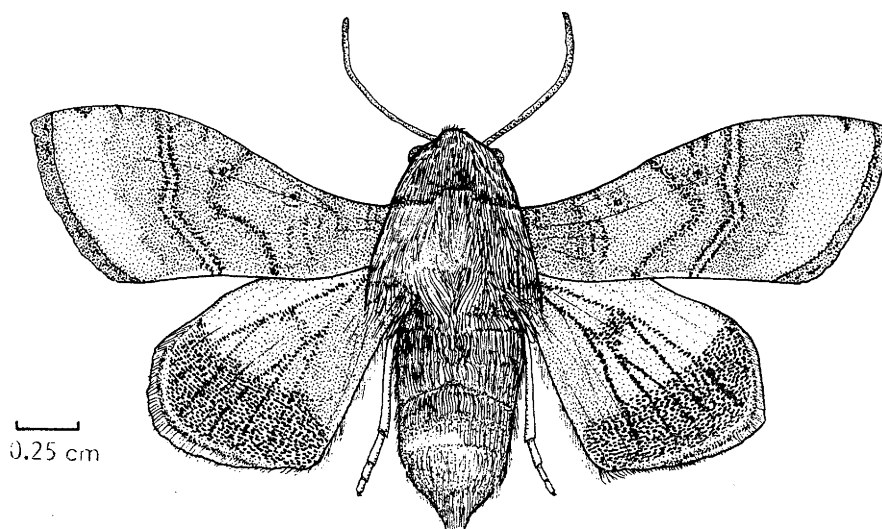
Fully grown *heliothis* caterpillars can be almost black, brown, green, light brown or pink. There are 3 dark lines along the body: one along the back and the other two along the sides. The dark lines are separated by broader pale bands. These are shown in the picture below.

BIOLOGY

The female moths lay their eggs at night, singly, on the leaves, shoots or flower buds of the host plants. The eggs are shiny-white at first, changing to light greenish-yellow. They are dome shaped and ribbed.



A fully grown *heliothis* caterpillar, viewed from the top and the side to show the pattern of dark and pale bands (About 3 times natural size.)



Heliothis armiger - the adult moth (About 3 times natural size.)

After they hatch, the small *heliiothis* caterpillars first eat their egg shells. They then start to feed on various parts of the host plant, often causing severe damage. As they grow they moult (change their skins) four or five times. Fully grown caterpillars are about 4 cm long.

The fully grown *heliiothis* caterpillars then burrow into the soil where they pupate (enter the resting stage). Sometimes they pupate on the host plant, for example inside corn cobs or pods of legumes.

The adult moths emerging from the pupae have stout bodies, yellowish-grey to orange-brown or reddish-brown forewings marked with fine dark wavy lines, and pale brown hindwings with a dark border. The wing span is about 3.5 cm. The adults are nocturnal (active during the night) and are not often seen during the daytime.

The length of the life cycle varies according to temperature. In the Lae area *heliiothis* eggs hatch in 3-4 days, the caterpillar stage lasts 23-25 days and the pupal stage 14-17 days. In the highlands the length of these stages is longer.

ECONOMIC IMPORTANCE

Heliothis caterpillars cause economic damage to the growing shoots, flower buds, flowers and developing seeds and fruits of several different crops:

Corn

The eggs are usually laid on the silks although later they may be laid at the tip of the cob. The young larvae feed on the silks and then move on to the developing grains. Usually only grains at the tip of the cob are damaged. The damage often allows moisture to enter the cob and moulds can then develop. Other insects may also follow *heliiothis* caterpillars and cause further damage to the cob.

Tomato and capsicum

Eggs are laid on young foliage or on parts of the flowers. The small caterpillars may damage the flowers and so prevent the fruit



A fully grown *heliiothis* caterpillar feeding on a tomato fruit

from developing. They can bore into the very small fruits and either destroy them immediately or feed inside them as they grow. Later the large caterpillars emerge from the fruits and bore into other fruits nearby. At this stage the entrance holes are quite obvious and the caterpillars are often found feeding with the rear ends of their bodies projecting from the holes. The damage allows entry of the organisms which cause rotting and the fruit often ends up as a foul smelling liquid mess.

Tobacco

On young plants the eggs are laid on the under surface of the leaves. The young heliothis caterpillars feed on the buds or folded leaves which become badly damaged. Later eggs are laid on flower buds and seed pods and the caterpillars bore into these.

Legumes

Heliothis caterpillars feed on a range of legumes including peas, dwarf beans, mung beans, pigeon peas and soya beans. Eggs are laid on young tissue and the young caterpillars feed on the growing points and leaves. Later they eat the flowers and feed on the outside of the pods, or they bore into the pods to feed on the developing seeds. Often they can be found with the rear part of their bodies projecting from the entrance holes.



Damage to peas caused by heliothis

Sorghum

See Entomology Bulletin No. 35.

CONTROL

When control is necessary the application of insecticides is the only method recommended at the present time. The insecticides currently recommended by the Department of Primary Industry are acephate, carbaryl and permethrin. The recommendations for each crop are as follows:

Corn

Heliothis caterpillars usually only damage the ends of the cobs. This damage makes the cob look unattractive, but if the damaged portion is removed it is often found that the actual loss of edible grain is small. Therefore it is often not worth spraying corn with insecticides to control heliothis caterpillars. In addition, the application of insecticides is difficult, because fully grown corn is so closely spaced and is very tall.

However if, in certain circumstances, insecticide control is required, the current recommendation is to apply a small amount of 5% carbaryl dust to the end of the cob at silking.

Tomato and capsicum

There are two different recommendations for the control of heliothis caterpillars on tomato and capsicum.

1. acephate 0.1%
2. permethrin 0.01%

Whichever of these you decide to use, it should be sprayed onto the plants every week from the start of fruit set.

Tobacco

D.P.I. has no recommendations at present for the control of heliothis caterpillars on tobacco.

Legumes

To control heliothis caterpillars on legumes

use one of the following:

1. acephate 0.1%
2. permethrin 0.01%

These should be sprayed as the pods appear.

Sorghum

The recommended insecticide for control of heliothis is acephate sprayed on at a concentration of 0.1%. For details of the control of heliothis on sorghum, see Entomology Bulletin No. 35.

How to mix the insecticide

The above recommendations are given as particular concentrations of spray mix expressed as a percentage (e.g. acephate 0.1%). The following are instructions for mixing the various concentrations recommended.

1. To obtain acephate 0.1% mix together:

13 g Orthene 75% SP
10 litres of water

2. To obtain permethrin 0.01% mix together:

10 ml Ambush 10% EC
10 litres of water

OR

2 ml Ambush 50% EC
10 litres of water

A commercial wetting agent should be added to each of the above at the rate specified on the label. If this is not available 2.5 ml of washing up liquid can be added to each 10 litres of spray.

The waiting period (the minimum period between the last application and harvest of the crop) for each of the above is 3 days.

For corn the recommendation is 5% carbaryl dust. When you buy this it will already be mixed to the correct concentration. It should be applied as a dust. You should NOT mix it with water so that you can spray it.

For further details on the mixing and spraying of insecticides you should consult Rural Development Handbook No. 18, 'The Safe and Efficient Use of Pesticides' by J.A. Sutherland. This is available from D.P.I. Publications Section (address below).

FURTHER READING

- Anon. (1976). Heliothis caterpillars. *Entomology Branch Insect Pest Bulletin* 26. New South Wales Department of Agriculture.
- Barrett, J.H. (1967). *Heliothis* species (Lepidoptera:Noctuidae) in Papua and New Guinea. *Papua and New Guinea Agricultural Journal* 19 (2): 61-66.
- Broasly, H.H. (1977). *Heliothis*... serious agricultural pests in Queensland. Advisory leaflet No. 1394. Division of Plant Industry, Department of Primary Industries, Queensland. (Reprinted from *Queensland Agricultural Journal* 103 (6)).
- Dori, F.M. (1984). heliothis caterpillars - a pest of sorghum. *Entomology Bulletin* No. 34. *Harvest* 10 (4): 164-166.
- Sutherland, J.A. (1983). *The Safe and Efficient Use of Pesticides*. Rural Development Series Handbook No. 18, D.P.I., Port Moresby.

FURTHER INFORMATION

Further information on Heliothis caterpillars can be obtained by contacting the D.P.I. entomologist or didiman nearest to you. Entomologists are based at:

PORT MORESBY
D.P.I., P.O. Box 417,
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(Illustrations: R.E. Sutherland)
(Photographs: B.M. Thistleton)

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Lowlands Agricultural Experiment Station
P.O. Keravat, E.N.B.P.
Tel: 926251

ENTOMOLOGY BULLETIN: NO. 35

HELIOTHIS CATERPILLARS - A PEST OF SORGHUM

By F.M. Dori, Senior Entomologist, D.P.I., Konedobu

INTRODUCTION

Caterpillars of *Heliothis armiger* are serious pests of a wide range of crops in Papua New Guinea. This bulletin deals with them as a pest of sorghum. On this crop they are sometimes called sorghum caterpillars. Damage to other crops is dealt with in Entomology Bulletin No. 34.

DESCRIPTION

Fully grown heliothis caterpillars can be almost black, brown, green, light brown or pink. There are 3 dark lines along the body: one along the back and the other two along the sides. The darker lines are separated by broader pale bands. These are shown in the pictures below.

BIOLOGY

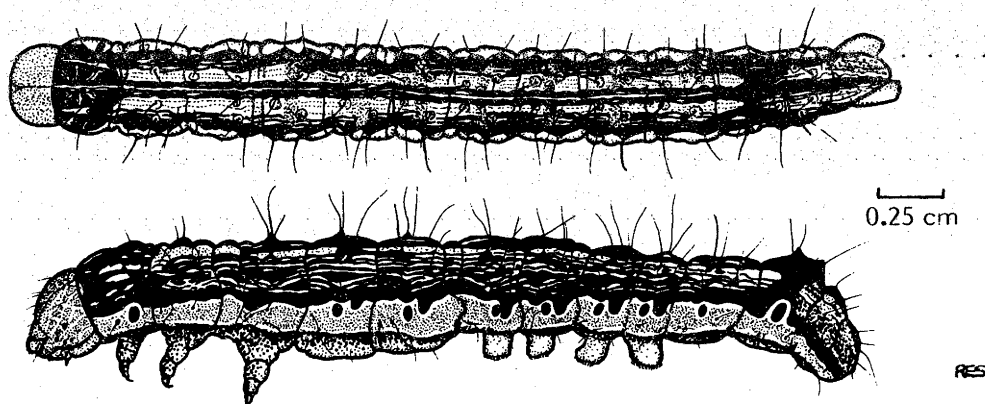
The female moths lay their eggs at night, singly, on the leaves, shoots or flower buds of the host plants. The eggs are shiny-

white at first, changing to light greenish-yellow. They are dome shaped and ribbed.

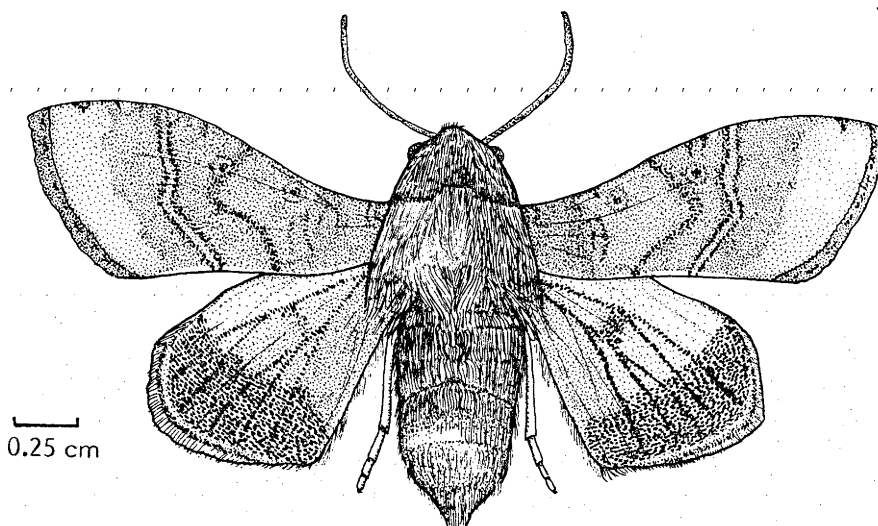
After they hatch, the small heliothis caterpillars first eat their egg shells. They then start to feed on various parts of the host plant. As they grow they moult (change their skins) four or five times. Fully grown caterpillars are about 4 cm long.

The fully grown heliothis caterpillars then burrow into the soil where they pupate (enter the resting stage). The adult moths emerging from the pupae have stout bodies, yellowish-grey to orange or reddish-brown forewings marked with fine dark wavy lines, and pale brown hindwings with a darker border. The wing span is about 3.5 cm. The adults are nocturnal (active during the night) and are not often seen during the day.

The length of the life cycle varies according to temperature. In the Lae area heliothis eggs hatch in 3-4 days, the caterpillar stage lasts 23-25 days and the pupal stage 14-17 days. In the highlands the length of these stages is longer.



A fully grown heliothis caterpillar, viewed from the top and the side to show the pattern of dark and pale bands (About 3 times natural size.)



Heliothis armiger - the adult moth (About 3 times natural size)

ECONOMIC IMPORTANCE

Egg laying begins when the sorghum heads are fully emerged and reaches a peak at the yellow flower stage. The young larvae first feed on the flowers and unopened leaves and then later on the developing sorghum grains. The plants can tolerate some damage to leaves at the early stage of growth. However damage to the grain can be serious if many caterpillars are present. A large reduction in both yield and quality often results. The partially eaten grains also become infested with fungus and other insects. In areas where humidity is high, sorghum heads often become completely covered with mould.

CONTROL

The recommended insecticide for the control of heliothis caterpillars on sorghum is acephate. This is sprayed at a concentration of 0.1%.

To obtain this concentration mix together:

13 g Orthene 75% SP
10 litres water
Wetting agent at rate specified

There are two different ways that control can be obtained with this insecticide:

1. The crop can be sprayed immediately after flowering has finished. At this stage egg laying should have been completed and the young larvae will have hatched.

Control should therefore be obtained with one spray only.

2. The second method uses a scouting system to decide if control is necessary. A spray is applied only if the heliothis caterpillars are present at, or above, a certain number per sorghum head. If this method is used, the insecticide is sprayed only when damage is likely to result and you will save money by not having to apply insecticide to all your sorghum crops.

The scouting system consists of inspecting the sorghum heads at flowering and then each week for a further three weeks. Count the number of heliothis caterpillars using one of the following methods:

1. Inspect several sorghum heads selected randomly in several parts of the crop. Count the number of heliothis caterpillars; and note their size.
2. Take at least four samples of 20 heads, selected at random from four different sites in the block. Shake the heads into a bucket or plastic bag so that the heliothis caterpillars fall off. Alternatively, hold the stems of the sorghum heads between the palms of your hands, then rub your hands together to spin the heliothis caterpillars off of the heads. Count the number of heliothis caterpillars and note their size. Divide the total number of caterpillars by the number of heads sampled to give the number of caterpillars per head.

When carrying out the inspection you should also note whether the larvae appear healthy (i.e. are moving about and feeding on the plant normally) or whether they are sick (i.e. moving slowly, not feeding, look abnormal). If they do look sick they are probably infected with a fungal disease. If this is so they will die and there is no need to spray them.

After the inspection you should know the number of heliothis caterpillars per head, how big they are, and whether they are healthy or sick. You can now decide whether you need to spray. This should be done if there are more than three healthy caterpillars, more than 1.5 cm long, per head of sorghum.

For further details on the mixing and spraying of insecticides you should consult Rural Development Handbook No. 18, 'The Safe and Efficient Use of Pesticides' by J.A. Sutherland. This is available from D.P.I. Publications Section (address below).

FURTHER READING

Anon. (1976). Heliothis caterpillars. *Entomology Branch Insect Pest Bulletin* 26. New South Wales Department of Agriculture.

Anon. (1977). Recommendations for grain sorghum growing in the Morobe and Central Provinces. *Information Bulletin* No. 29. Buba Agriculture Research Centre, Lae.

Barrett, J.F. (1967). *Heliothis* species (Lepidoptera: Noctuidae) in Papua New Guinea. *Papua and New Guinea Agricultural Journal* 19 (2): 61-66.

Broasley, H.H. (1977). *Heliothis*... serious agricultural pests in Queensland. Advisory leaflet No. 1394. Division of Plant Industry, Department of Primary Industries, Queensland. (Reprinted from *Queensland Agricultural Journal* 103 (6).

Ironside, D.A. (1979). Insect pests of grain sorghum, part 1. *Queensland Agricultural Journal* 105 (4): xix - xxii.

Ironside, D.A. (1979). Insect pests of grain sorghum, part 2. *Queensland Agricultural Journal* 105 (5): xxv - xxvii.

ral Journal 105 (5): xxv - xxvii.

Sutherland, J.A. (1983). *The Safe and Efficient Use of Pesticides*. Rural Development Series Handbook No. 18. D.P.I., Port Moresby.

Thistleton, B.M. and Dori, F.M. (1984). Heliothis caterpillars. *Entomology Bulletin* No. 34. *Harvest* 10 (4): 159-163.

Twine, P.H., Kay, I.R. and Llyod, R.J. (1983). Heliothis in sorghum. *Queensland Agricultural Journal* 109 (4): 185-188.

FURTHER INFORMATION

Further information on Heliothis caterpillars can be obtained by contacting the D.P.I. entomologist or didiman nearest to you. Entomologists are based at:

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(Illustrations: R.E. Sutherland)

HORTICULTURE NOTE: NO. 5

CHINESE CABBAGE AND PAK CHOI

By P.B. Bull*, Senior Horticulturist, D.P.I., Laloki

Common names: Chinese cabbage -
develops a firm head.
Pak choi -
develops an open head.

Botanical names: Chinese cabbage -
Brassica campestris
ssp. *pekinensis*
Pak choi - *B. campestris*
ssp. *chinensis*

WHAT THE PLANT LOOKS LIKE

Chinese cabbage is grown for its large heads, with loosely or tightly packed leaves. The leaves are usually light green in colour. The leaves are crinkled in appearance and soft to cut.

Pak choi has dark green leaves with thick white leaf stalks. White veins can be seen

on the leaves. It does not form a firm head.

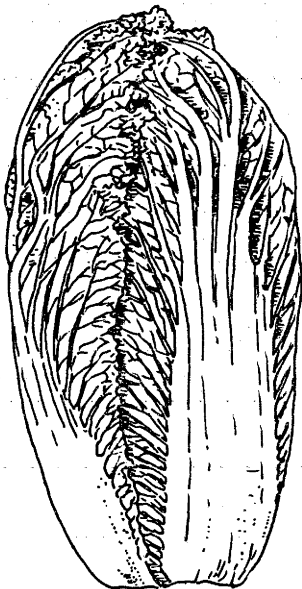
WHERE IT GROWS

The original types of Chinese cabbage came from China and Japan.

Chinese cabbage and pak choi can be grown all year round in both the lowlands and highlands. Both types grow best where the average daily temperature is 15 to 20°C.

Tying a string around the head of Chinese cabbage will make it form a firm head. Better still, tropical varieties have been bred in Japan and Taiwan, which form good firm heads in the lowlands.

* Present address: Yates Research, P.O. Box 587, Pukekohe, New Zealand.



Chinese cabbage



Pak choi

SOILS AND FERTILIZERS

The best soil for Chinese cabbage and pak choi is a deeply dug, rich, sandy loam. For best results, plenty of decaying organic matter should be mixed with the soil. This will hold moisture during dry weather. The soil pH should be between 6 and 7. Growing on raised ridges during the wet season improves drainage.

Nitrogen is particularly necessary for good plant growth. An application of 200 kg per ha of 12.12.17 fertilizer before transplanting can be followed one month later, with up to 100 kg/ha of urea.

VARIETIES

In the lowlands, the best variety of Chinese cabbage to grow is Tropical Delight. It is heat tolerant and not as susceptible to bacterial soft rot as other varieties.

In the highlands many varieties can be grown. Preferred varieties include:

Tropical Delight (also known as Tropical King)
Saladeer
Wong Bok.

Pak choi variety Kwang Moon is the variety available in Papua New Guinea. It grows well both in the lowlands and in the highlands.

HOW IT IS GROWN

Seed

The best Chinese cabbage varieties are F1 hybrid, so seed cannot be saved from these types, even if they flower in Papua New Guinea. Seed must be imported from overseas, and bought in shops.

Pak choi will flower and set seed even in lowland Papua New Guinea. An article on producing and saving seed can be found in HARVEST 9 (2), pp. 1-4.

To sow 0.1 ha with Chinese cabbage, 25 g (about 7500 seeds) of seed is needed. To sow 0.1 ha with pak choi 40 g of seed (about 12 000 seeds) is needed.

Sowing

Seed can be sown into Jiffy 7's, plastic cups or trays. Sow two seeds per hole and thin to one plant after 7 to 10 days.

Transplanting

Transplant after 4 weeks, when the seedlings have 4 true leaves.

Seed sowing, nursery care and transplanting are described in Farming Note No. 10, Vegetables.

Plant spacing

Prepare ridges 1.2 to 1.3 m apart before transplanting. Two rows of plants are planted down each ridge. Space plants of Chinese cabbage 40 cm apart along each row with 40 cm between the two rows on each ridge. Pak choi should be spaced 30 cm apart along each row, with 30 cm between the two rows.

Irrigation

During periods of low rainfall, the crop should be irrigated once or twice every week. Either spray or flood irrigation can be used.

Weeding

The crop should be kept free of weeds, by hoeing between the plants and between the rows.

TIME TO MATURITY

From transplanting, Chinese cabbage takes about 6 weeks to maturity in the lowlands and about 8 weeks in the highlands.

From transplanting, pak choi takes about 4 weeks to maturity in the lowlands, and about 6 weeks in the highlands.

From a single sowing, pak choi and Chinese cabbage can be harvested over 2 weeks in the lowlands and about 3 weeks in the highlands. To grow these vegetables to supply the market all the time, a new crop should be sown every 2 weeks in the lowlands and every 3 weeks in the highlands.

HARVESTING, STORAGE AND YIELDS

Pak choi should be harvested when the plant is fully grown, but before the seedstalk starts to grow. Chinese cabbage is harvested when the head fills out and feels firm.

Chinese cabbage and pak choi will keep for a few days after harvesting, if they are kept in a cool, dark and well aired place. Sprinkle with water straight after harvesting and after transporting. This will help Chinese cabbage and pak choi stay fresher for longer when stored. If left in a pile with no ventilation, they will go bad very quickly. It is not good to store Chinese cabbage and pak choi in plastic bags as this causes them to sweat and become slimy. In a cold store at 0°C and high humidity, they can be kept for about 3 weeks. Do not freeze.

In the lowlands, yields for pak choi range from 1 to 2 kg per square metre, and for Chinese cabbage from 2 to 3 kg per square metre. In the highlands yields for pak choi range from 2 to 3 kg per square metre, and for Chinese cabbage, from 3 to 6 kg per square metre.

HOW IT IS USED

The dark green leaves of pak choi contain vitamins A and C and iron. The white stems do not have so much food value. The main food value in Chinese cabbage is vitamin C. Vitamin C is easily destroyed by cooking and is washed away by water. These vegetables should only be cooked for a short time, and eaten while they are still slightly crisp. (See recommended method for cooking English cabbage: Horticulture Note No. 3, Volume 10, No. 3). Another way of cooking Chinese cabbage is to boil it in coconut milk, then eat the cabbage and milk soup.

INSECT PESTS

The main difficulties in growing Chinese cabbage and pak choi are the leaf eating caterpillars, diamond back moth (*Plutella xylostella*) and cluster caterpillars (*Crociodolomia binotalis*). The young larvae of these insects eat the leaves of all the cabbage family.

Diamond back moth grows faster at warmer temperatures, so it is a bigger problem in the lowlands than the highlands. Because new larvae grow so quickly, spraying plants with an insecticide does not always give good control of the insect. Particularly in the lowlands it is best to grow just one crop of the cabbage family, then remove and compost, bury or burn all the old plants before sowing seed for a new crop. The new crop should be planted on different ground.

Spraying every week with Orthene 75% SP (7 ml per 10 litres of water) or Ambush 10% (1.3 mls per 10 litres of water) is recommended for control of both these insects.

TAKE CARE: Do not harvest cabbage for 3 days after using these sprays.

Diamond back moth is discussed in Entomology Bulletin No. 8 (HARVEST Volume 8, No. 1).

Soil insects can do considerable damage to Chinese cabbage and pak choi. These include cut-worms, crickets and taro beetles. They can be controlled with a spray of DDT (mix 40 g DDT 25% in 10 litres of water) or lindane (mix 13 ml of Gammaphex 16% EC in 10 litres of water).

This recommendation will be changed when results of research are available.

Apply the spray as a soil drench before planting or around the base of young seedlings, not to the plants themselves. Cut-worms are discussed in Entomology Bulletin No. 7 (HARVEST Volume 8, No. 3).

Other insecticides which can be used on Chinese cabbage or pak choi are listed by Thistleton (1983).

DISEASES

In the lowlands Chinese cabbage often becomes infected with bacterial soft rot, which causes the plant to die a few days before it is ready for harvest. The variety Tropical Delight, recommended for use in the lowlands is almost resistant to this disease. This disease is discussed in Plant Pathology Note No. 18 (HARVEST Volume 8, No. 3).

FURTHER READING

- Bull, P.B. (1984). Horticulture Note: No. 3. Cabbage. *Harvest* 10 (3): 122-125.
- Farming Note No. 10. *Vegetables*. Department of Primary Industry, Port Moresby. Revised, 1982.
- Fitzgerald, J. and Bull, P.B. (1983). Producing and saving your own vegetable seeds. *Harvest* 9 (1): 1-4.
- Thistleton, B.M. (1982a). Entomology Bulletin No. 7. Protection of seedlings from cutworm damage. *Harvest* 8 (3): 131-133.
- Thistleton, B.M. (1982b). Entomology Bulletin No. 8. Control of diamond back moths in brassicas. *Harvest* 8 (1): 26:28.
- Thistleton, B.M. (1983). Recommendations for the Control of Pests. *Technical Report* 83/4. Department of Primary Industry, Port Moresby.
- Tomlinson, D. (1982). Plant Pathology Note: No. 18. Bacterial soft rot of vegetables. *Harvest* 8 (3): 141-143.
- Van Greve, J.E.van S. (1983). Safe storage for small quantities of seed. *Harvest* 9 (1): 5-10.

FURTHER INFORMATION

For further information and advice on vegetable growing contact the Area Horticulturist in your region. The addresses for the Area Horticulturists are as follows:

New Guinea Islands Region

Lowlands Agricultural Experiment Station
P.O. Keravat, E.N.B.P.
Tel: 926251 or 926252

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P.O. Box 73, LAE
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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 (not more than about 3000 words, or 6-7 typed pages) with plenty of black and white photographs or other illustrations, if possible.

Two copies of each articles, typed with double spacing and wide margins, should be sent to the Editor, HARVEST, Publications Section, Department of Primary Industry, P.O. Box 417, Konedobu.

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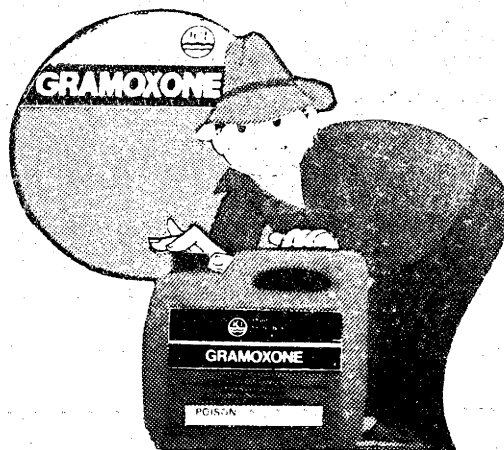
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