SUGGESTED FARMING SYSTEMS FOR LOWLAND FOREST AREAS WHERE LAND IS SCARCE

By R. Michael Bourke, Senior Horticulturist, Highlands Agricultural Experiment Station, Aiyura, Eastern Highlands Province.

The long forest fallow (bush fallow or shifting cultivation) is the basis of the traditional farming system used in the lowlands for food production. Under the system the forest is cleared, a garden is planted and after the garden is harvested, the forest is allowed to grow back again. The garden usually lasts for one or two years and the fallow is 10 years long or more.

The system is a very good one for Papua New Guinean conditions. Yields obtained for the work needed are high; weed growth is kept down; and pest and disease problems and soil erosion are often less than under more intensive systems. (Charles, 1976). However the system uses a lot of land. Population increases, cash cropping and land alienation reduce the amount of land available for gardening. If land is too scarce, the system can no longer be used.

This is now happening in some places, such as on some small islands, on the Gazelle Peninsula of New Britain and around Maprik in the East Sepik Province. It is going to happen in more places in the future because there is a very high rate of population increase. When land becomes too scarce to continue with the traditional system, it must be changed or new systems found.

This article makes some suggestions as to what changes can be made or new systems used. These ideas are for village farmers who are mainly producing for subsistence rather than for cash sales. Another article has been written for institutional farmers such as schools ("Growing Food at institutions in the lowlands," Bourke), and some of the ideas in that article should be useful for farmers growing a lot of food for sale and who are using machinery for cultivation. D.P.I. has been concerned with alternatives to the long forest fallow system since before the war. The ideas in this article come from seeing what village people who are short of land are doing; the Department's experiments; and what is done in places overseas that have a similar climate and are short of land, such as Eastern Nigeria.

Alternatives to shifting cultivation for highland areas and dryer lowland grassland areas are easier to find than for lowland forest areas. Highlands and lowland grassland areas are not considered here, although most of the ideas discussed here can be used in these two situations, including some that do not work in lowland forest areas.

SUGGESTED MODIFICATIONS AND ALTERNATIVES

It was once believed that a single, simple, and practical

alternative could be found to the long forest fallow farming system. We now know that this is not so. Such alternatives as a short term legume fallow, or a rotation of grazed pastures, or inorganic fertilizers are not as efficient as the long forest fallow; or they are impractical for subsistence farmers. Most of the suggested modifications and alternatives are already used in areas where land shortages occur.

Mixed cropping and crop rotations are traditional practices often used by farmers. These two practices are often superior to monoculture and should be retained if possible as systems are changed. Some of the advantages of mixed cropping can be:

better weed control
higher yields
more stable yields
fewer pests and disease problems
less soil erosion

1. *Use of higher yielding varieties.*

One of the first changes that can be made when land is short is to use more of the high yielding varieties. These give more food for the work needed to grow them and for the same fallow period. High yielding varieties can come from research stations, but they can also come from the gardeners themselves. People are often aware that some varieties of their crops yield better than others, but they keep lower yielding ones for other reasons, such as good taste. The cost of using more of the high yielding varieties is the loss of varieties valued for other reasons.

In some areas where land pressure is high, people have made the change to high yielding varieties. For example, in the Wosera area near Maprik the high yielding "Asagwa" mami *(Dioscorea esculenta)* is the main food grown in the gardens (see Plate 1). On Petats Island off Buka where land is also short, the people grow a lot of one high yielding sweet potato variety.

Plate 1. Dioscorea esculenta c.v. Asagwa.

2. *Shorter fallow period.*

Fallows can often be shortened without damaging the system. For example, there will be little difference between one year of cropping and 15 years of fallow, and a system based on one year of cropping and 10 years of fallow.

As the length of the fallow period is reduced, the amount of work needed to grow a certain amount of food increases. This is because the soil fertility is not increased so much under a shorter fallow; and more weeds, insects and diseases will remain in the soil. Yields per crop are lower under shorter fallows, but actual food production will increase because there are more crops taken from the land (see Plate 2).

If the fallow is too short for the trees to grow and set seed, grasses will replace the forest as the fallow vegetation. When this happens, people have to work much harder to make gardens and yields are lower. This is the situation that we want to avoid. Research in Africa has shown that most of the improvement in soil fertility occurs in the first 5 years of a fallow, but this period will be different for different types of soil.

The gardening period can be extended instead of shortening the fallow period. As the gardening period becomes longer, it becomes more difficult for the forest to grow again, so it should not be extended beyond two or three years if the gardener wants a forest fallow to follow the garden.

Plate 2. Taro and bananas in the Markham Valley.

There are certain things that gardeners can do to help the forest grow quickly again. When the forest is cleared, all trees should be cut low down. This will help the stump to grow quickly again when the garden is finished. The other thing is that rubbish should not be burnt on stumps when the garden is cleared as this might kill the stumps.

3. *Planting at closer spacing.*

Generally use of closer spacing results in greater yield per garden, but lower yield per plant. Most gardeners seem to prefer a larger yield per plant, and therefore they plant at slightly wider spacings. However if they are short of land, wider spacing is not a good idea.

As well as reducing the average yield per plant, closer spacing has another disadvantage. This is that the crop is more likely to be damaged if there is a drought. Spacing should not be too close or yield per garden will be reduced. Closer spacing will increase the yields of most crops but it makes little difference to sweet potato yields. It will not make much difference where intercropping is used, such as Chinese taro ("taro kong kong") grown under bananas, but it has the greatest effect when most of a garden is taken up by one crop such as taro or yams.

4. *Growing food crops with plantation crops.*

Food crops can be planted with young plantation crops such as coconuts, cocoa, coffee, oil palm and rubber. They can also be planted with young forestry plantations of trees such as kamarere, teak and pine. This system needs much less work than growing food gardens and young plantation crops in separate areas. Sometimes it might reduce the growth of the plantation crops a little, but this is a small disadvantage compared with the advantages. On the Gazelle Peninsula, Tolai people have worked out a new system where food crops such as cooking bananas and Chinese taro provide shade for young cocoa and *Leucaena*. As the food crops die or are cut down, they are replaced by the *Leucaena* and cocoa and sometimes coconuts. The ground is always covered by one or more crops and this keeps the weeds out. (Bourke, 1976). In many areas of Papua New Guinea new coconut plantations are always planted in with a food garden (see Plate 3).

With most of the plantation crops, it is not possible to grow food crops under them when they are mature. However this is possible with coconuts. A wide range of crops can be grown under mature coconuts. Some of these are certain bananas, Chinese taro, cassava, pineapples and ginger. (Gallasch, 1976).

In Papua New Guinea cocoa and coffee are usually planted under shade trees, but in other places overseas these crops are successfully planted under bananas. Sometimes other crops such as beans are also planted under the bananas and coffee.

Plate 3. Coconuts in a kau-kau garden.

5. *Change of staples.*

Another thing gardeners can do when they are short of land is to change from lower yielding traditional crops such as taro and diploid bananas to higher yielding ones such as sweet potato, triploid bananas,Chinese taro and cassava (see Plate 4).

This is a big change to make because the traditional crops are part of people's lives and often have great spiritual significance. Such changes may also result in a drop in the quality of people's diets. Yams and taro for example are richer in protein than sweet potato, bananas and cassava.

Plate 4. A variety of high yielding staples; Chinese taro, triploid bananas, and cassava.

6. *Greater use of perennial crops.*

Perennial crops are ones that remain in an area for many years. They are usually trees. Yields of perennial crops are usually less per year than short term crops such as sweet potato and yams. Their big advantage is that they stay in the same area and keep producing food for many years. Fairly high yields can be had for a small amount of work. This is because perennial crops like bananas, fruit trees or plantation crops are more similar to the natural forest than annual crops and they protect the soil better. If a farmer tried to grow annual crops in the same land for many years without fallows, yields would become very low and weeds would be a big problem.

People who are short of land can grow more perennial crops. The main perennial food crop is triploid bananas. Villagers around Rabaul who are very short of land now grow triploid bananas on any land that is not planted to coconuts and cocoa. Other perennial food crops are breadfruit, coconuts and fruit and nut trees.

Some people who are really short of land might find it better to grow plantation crops such as cocoa or coconuts for sale and to buy their food from the markets or stores. The problem with doing this is the prices of the plantation crops go up and down a lot, so sometimes they will not receive much money. Also if their crop is badly damaged by a disease like cocoa dieback or an insect like coconut leafhopper, they could be left with nothing to sell and no food. I think it is always better for people to grow at least some of their food needs.

7. *Use of natural fertilizers.*

There are a number of natural fertilizers that can be used by gardeners to increase the soil fertility. These are ash from fires, kitchen scraps, other plant waste and animal manure. If a lot of these fertilizers are applied to the soil, gardeners can use a short fallow or even no fallow.

The problem with this system is that most farmers only have a little of these natural fertilizers. So they can only be used on a small area, such as the gardens around a house. Gardeners with cattle, buffaloes or goats that graze in other areas might have enough manure to fertilize larger gardens. This would be possible perhaps in the Wosera area where buffaloes could graze the large areas of infertile grass lands and their manure be used on the fertile alluvial soils that are used for gardening.

Farmers who are buying in food for animals, such as poultry or pig feed, may have enough manure to fertilize larger areas of their gardens (Quartermain, 1976).

OTHER CHANGES AND ALTERNATIVES

There are a number of other possible changes and alternatives to the long forest fallow system. It is considered that these are not suitable for subsistence gardeners in Papua New Guinea lowland forest areas, except in a few cases. These are discussed below:

1. *Use of inorganic fertilizers.*

Inorganic fertilizers such as urea have given large yield increases with food crops like sweet potato, bananas and taro in our experiments at Keravat. It has also been found that reasonably high yields can be maintained where food crops are fertilized in a rotation.

Because inorganic fertilizers have to be bought for cash, they are generally only useful where the garden produce is sold for cash. The only situation where they might be used by subsistence gardeners is where the gardener is very keen to keep a traditional food, such as taro, and is prepared to buy inorganic fertilizer using money obtained from other sources. Another problem is that the correct fertilizers are not available in many areas.

2. *Rotation of food gardens and planted legume fallows.*

In temperate climate countries, planted legume fallows are sometimes an important part of farming systems. However in other countries with hot humid climates, they have been shown to be no more effective than natural forest fallows in maintaining yields (Newton, 1960). There are also problems with establishment, maintenance and incorporation of residues into the soil because of the work needed (Bourke, 1974).

A planted tree fallow, such as pigeon pea, should be useful where mechanical cultivation is used and possibly also in grassland areas.

3. *Rotation of food gardens and grazed pastures.*

This system is also a part of farming systems in certain temperate climate countries and tropical highlands areas.

Such a system requires large areas of land, machinery for cultivation, and a lot of capital to buy livestock and fencing unless the animals are tied up. It is beyond the resources of most subsistence farmers, although it may be practical for large institutional farmers such as an agricultural college. Systems based on a rotation with grazed pastures have not yet been proved possible in the wet lowlands of other countries with a climate similar to that of Papua New Guinea.

4. *Irrigated rice.*

In Asia and elsewhere in the humid lowland tropics, the farming systems are based on irrigated rice. Because of the special conditions that exist in irrigated rice fields, soil fertility can be maintained for hundreds of years without long fallows or fertilization. The water also assists weed control.

Despite the technical success of this system, it is not considered suitable for Papua New Guinean farmers at this stage. The economics of growing rice are not favourable in PNG ; a lot of work is needed to make the paddies; and the change from rain-fed root crop based systems to an irrigated grain crop based one is so great that it would take great pressure to make people want to adopt it.

DISCUSSION

As well as the changes and alternative farming systems discussed above, there are other things people can do when land pressure stops them using the traditional long forest fallow. These include population movements to other areas; use of land other than traditional land; and purchasing most of their food needs with money from cash employment.

Most people who can no longer use the long forest fallow system will probably find that a mixture of the methods discussed above suits them. People who are short of land might firstly reduce the fallow period and use higher yielding varieties and closer spacing; later they might plant their food gardens and plantation crops together; then they might change to higher yielding food crops; and finally they might decide to have some areas growing perennial banana gardens and other areas growing plantation cash crops, a poultry project using purchased feeds, and fairly small food gardens where the soil fertility is maintained with the manure from the poultry project. People must start making changes before the traditional systems break down completely. Once this happens change is more difficult.

The choices must be made by each family. What people will decide will depend on what resources and markets are available to them. Gardeners on a small island a long way from a town will choose

different systems from those chosen by gardeners just outside a town.

This article has discussed possible changes and alternatives to the long forest fallow system. It is the agriculturalist's job to explain these to gardeners who are short of land and to help provide higher yielding varieties and technical advice to them when needed.

FURTHER READING AND REFERENCES

Bourke, R.M. (1974). The Role of Legumes in Soil Fertility Maintenance in the Lowlands of Papua New Guinea; A Legume Evaluation Study at Keravat, New Britain; and Notes on the Use of Legumes as Food in Papua New Guinea. *Science in New Guinea* 2 (1);63-69.

This article discusses legume fallows in farming systems in the lowlands. It concludes that they do not have an important role.

Bourke, R.M. (1976). Food Crop Farming Systems Used on the Gazelle Peninsula of New Britain. *1975 Papua New Guinea Food Crops Conference Proceedings*. K.Willson and R.M. Bourke (Eds.) Department of Primary Industry, Port Moresby, pp81-100.

Some of the Tolai farmers on the Gazelle Peninsula are very short of land and this paper describes the changes these farmers have made in their farming because of this.

Bourke, R.M. Growing food at institutions in the lowlands. *Harvest*, 4 (3).

In this, suggestions are made how institutions should grow food crops in the lowlands. Some of the ideas, such as the fallows needed, are useful to village farmers who are using machinery for cultivation.

Charles, A.E. (1976). Shifting Cultivation and Food Crop Production. *1975 Papua New Guinea Food Crops Conference Proceedings*. K. Willson and R.M. Bourke (Eds.) Department of Primary Industry, Port Moresby, pp75-78.

This discusses shifting cultivation and concludes that it is the best farming system where land is not short. The advantages and disadvantages are discussed.

Gallasch, H. (1976). Integration of Cash and Food Cropping in the Lowlands of Papua New Guinea. *1975 Papua New Guinea Food Crops Conference Proceedings*. K. Willson and R.M. Bourke (Eds.) Department of Primary Industry, Port Moresby, pp101-115.

An experiment at LAES has shown that it is very profitable to grow food crops and coconuts together. It is described in this paper. This same work was also written up in *Nutrition and Development* 2 (1):22-25.

Newton, K. (1960). Shifting Cultivation and Crop Rotations in the Tropics. *Papua New Guinea agric. J.*, 13(3):81-118.

In this paper the author reviews research work seeking alternatives to shifting cultivation (bush fallow), especially systems based on legume fallow.

Quartermain, A.R. (1976). Roles for Animals in Food-Crop Production Systems. *1975 Papua New Guinea Food Crops Conference Proceedings*. K. Willson and R.M. Bourke (Eds.) Department of Primary Industry, Port Moresby, pp137-146.

This paper discusses the role of animals in food crop farming systems, using mostly African examples.

Ruthenberg, H. (1971). *Farming Systems in the Tropics*, Clarendon Press, Oxford.

This book describes different farming systems found in the tropics, including some based on shifting cultivation. There is a chapter on development of new systems from traditional ones.