GROWING SWEET POTATO FOR SALE IN THE HIGHLANDS

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INTRODUCTION

One of the major food problems faced by Papua New Guinea is the very large amount of rice that is imported each year. One of the best ways to overcome this problem is to help villagers grow sweet potato for sale. This can be sold to institutions and through the urban markets. Already very many village people throughout the highlands are growing sweet potato for sale. It is now a very large industry.

This article is written for completely commercial producers. The farmers who grow sweet potato for sale range from fully commercial ones to those who use their traditional subsistence techniques. So not all the ideas in this article apply to all commercial sweet potato farmers. The ideas must be selected that are most useful to the farmers. This will depend on their growing techniques and traditions.

Most of the ideas here are also relevant to institutional farms such as schools and corrective institutions.

This article is written for highland conditions, but many of the ideas can be applied in the lowlands as well. The ideas discussed here form the basis of a two day course that is run at Aiyura for commercial sweet potato farmers.

This article is based on research work conducted by Aiyura horticulturists and on the experiences of commercial sweet potato producers. Much of the sweet potato research at Aiyura was done by Allan Kimber. Other horticulturists who have contributed to our ideas are: Terry Quinlan, Graham Pritchard, Beka Siki, Will Akus, Euclid D'Souza and Clement Tumana.

SOIL TYPE AND CULTIVATION

Sweet potato grows very well on a wide range of soil types. Well drained soils of a light texture, such as a sandy loam, give the best shaped tubers. If possible, it is better to avoid heavy clay soils because the tuber shape is poor. Also yields can be very low for crops grown under very wet conditions.

It is necessary to cultivate the soil when crops are grown in the grasslands. This can be done by hand or by tractor drawn ploughs. Mechanized cultivation is sometimes practicable for farmers in the Eastern and Western Highlands who have access to flat land. The soil should be cultivated with a disc plough and then disc harrowed two or three times to break down the clods and help the grass to decompose.

Experiments at Aiyura compared planting on flat land with

Aiyura horticulturist Will Akus talks with commercial sweet potato grower Kari Konopa of Aianora village, near Kainantu

planting in ridges or mounds. Flat land planting usually gave low yields. Mounds were better than ridges and big mounds were better than small mounds. We recommend that mounds be used if labour is available to make them.

The best way is to form ridges using a tractor-drawn ridger and then to form the mounds by hand. For further information see the articles by A.J. Kimber (1971, 1976 and 1977). Of course, the technique used will depend on the traditions of the area as they vary a lot throughout the highlands.

When working with commercial sweet potato growers in the Eastern Highlands, we have found that getting access to a tractor in good working order is one of the biggest problems that the farmers face.

TIME OF PLANTING

Sweet potato production can be quite seasonal in the highlands. The period of highest and lowest production changes a lot from year to year. However in general the best supply of sweet potato in the highlands occurs from May to August. The months with the lowest supply are usually between October and February.

It is better for commercial sweet potato growers to concentrate their plantings so that their best supply is over the period October to February. This way they are likely to be able to sell the crop more easily and to obtain higher prices. So commercial growers should be encouraged to plant their crops over the period March to August in the highlands. Over this period, dry spells can be expected, especially in parts of the Eastern Highlands.

Our experiments have shown that in very dry periods, sweet potato can be grown successfully on heavy soils that normally would be too wet for successful sweet potato production. By using these soils, growers can escape the effects of drought. This way they can have tubers for sale when other

growers do not have any. Part of this time is also at the same time as the peak of the coffee harvesting season. This can be a problem for some growers.

We think that growing sweet potato 'out of season' is a very good way for commercial growers to make money from the crop.

FERTILIZER

D.P.I. horticulturists have done very many fertilizer experiments with sweet potato, using both organic and inorganic fertilizers. Organic fertilizers are things like coffee pulp, animal manure and compost. Inorganic fertilizers are man-made ones such as urea or muriate of potash.

The results with the inorganic fertilizers have not been very consistent in the highlands. In some experiments, one fertilizer gives a large increase in yield. In other experiments, another fertilizer gives as increase. For this reason we suggest that inorganic fertilizers should be used carefully on sweet potato.

On the other hand, organic fertilizers have increased sweet potato yield in every experiment in which they have been used in the highlands. They can be used with confidence of increasing the tuber yield. For more information on organic fertilizers, see the paper by Thiagalingam and Bourke (1982).

Both organic and inorganic fertilizer should be mixed in with the soil before planting. The exact way this is done depends on how the soil is cultivated and the type of ridge or mound used. For example, if ridges are formed by a plough and the mounds made from them by hand, the fertilizer can be placed on top of the ridges. Then when the mounds are made, the fertilizer can be mixed in with the soil.

Coffee pulp

If it is available, coffee pulp is an ideal fertilizer for sweet potato as it contains the correct ratio of nitrogen to potassium for sweet potato. It can be applied to the soil either fresh or rotted. The recommended rate is 15 to 30 tonnes per hectare (t/ha), depending on how much is available and how fertile the soil is.

The rate of 30 t/ha is equivalent to 3 kg per square metre. A 9 litre bucket holds enough coffee pulp to fertilize 2 square metres at a rate of 30 t/ha. At 30 t/ha, coffee pulp provides about 70 kg of nitrogen, 5 kg of phosphorus, and 140 kg of potassium per hectare.

Coffee pulp is evaluated by horticulturist Beka Siki as fertilizer for sweet potato in a trial at Aiyura.

These rates for nutrient applied will vary a lot depending on the water content and the origin of the organic fertilizer. For further information on this, see the article by Siki (1980).

The economics of using coffee pulp and other organic fertilizer will depend on the situation. However in most instances, it will be favourable economically to use organic fertilizer if it does not have to be carried too far.

For example, an application of coffee pulp at a rate of 30 tonnes per hectare might give a yield increase of 4 tonnes of extra tubers per hectare. These tubers would be worth K480 if they were sold at 12 toea/kg. This would more than cover the cost of transporting and applying the coffee pulp.

Pig manure

Pig manure also gives large increases in sweet potato yields. Pig manure contains more nitrogen and less potassium than the same weight of coffee pulp. So it is not such a suitable fertilizer for sweet potato as coffee pulp. However, there are very large amounts of pig manure available in the highlands that are not used.

It is sometimes said that people will not eat sweet potato that has been fertilized with pig manure. Perhaps this is so, but people have still stolen the tubers from some of our trials even when they knew the sweet potato was fertilized with pig manure!

The recommended application rate is 15 tonnes of pig manure per hectare. This recommendation is based on experiments done at Aiyura and in the Southern Highlands. A rate of 15 t/ha is the same as 1.5 kg of manure per square metre. This amount of pig manure provides about 85 kg nitrogen, 50 kg phosphorus and 60 kg of potassium per hectare. (For further information on pig manure, see the article by Kimber on pp. 81-82 of this issue.)

We have not tried poultry, sheep or cattle manure as fertilizer for sweet potato in the highlands. However it is almost certain that these manures would also increase sweet potato yield if they were applied at 15-20 t/ha.

Chicken manure should be used at a lower rate because it contains about three times as much nitrogen as other animal manure. An experiment done by U.P.N.G. staff near Port Moresby found that chicken manure applied at 10 t/ha gave a large increase in sweet potato yield.

Compost

In much of Enga and Southern Highlands Provinces, the people make compost in the sweet potato mounds to fertilize the sweet potato. Weeds, green grass, and old sweet potato vines are used to make this compost. This is placed in the mound or in a heap on the soil surface, allowed to rot for 6 to 8 weeks and then covered with soil. Then the sweet potato vines are planted.

Experiments in two areas of the Southern Highlands Province have shown that compost made in this way gives large increases in sweet potato yield. In one experiment done by Euclid D'Souza in S.H.P., compost applied at 40 t/ha increased the sweet potato yield from 4.6 t/ha to 18.4 t/ha!

Village men in Enga place grass for compost on an old sweet potato mound. Compost made this way increases sweet potato yield.

The recommended application rate for fresh grass or weeds is 20 to 30 t/ha. This is the same as 2 to 3 kg per square metre. So for a large mound that occupied an area of 15 square metres, you would use 30 to 45 kg of fresh grass and weeds.

The amount of nutrients the compost provides will depend on the type of vegetation in the compost. If fresh *Ischaemum* grass is used, 20 t/ha of grass provides about 75 kg of nitrogen, 10 kg of phosphorus and 75 kg of potassium per hectare.

Inorganic fertilizer

Results with inorganic fertilizer in trials in the highlands have not been very consistent. However in some trials, inorganic fertilizer has given large yield increases.

The recommended fertilizer is 45 kg nitrogen plus 90 kg potassium per hectare. This is provided by 100 kg (2 bags) of urea plus 150 kg (3 bags) of muriate of potash per hectare. The urea and muriate of potash should be mixed in a 2:3 ratio. After the two fertilizers have been mixed, they should be applied at a rate of 25 grams of mixture per square metre.

A large fish tin of mixture contains enough fertilizer for about 17 square metres of sweet potato. The fertilizer should be dug into the soil after it is applied. Otherwise some of it might be lost into the air.

We do not recommend the use of mixtures such as coffee mix or 12-12-17-2 for sweet potato. This is because these fertilizers contain plant foods such as phosphorus, and sweet potato can usually obtain enough of this from the soil by itself. If these mixes are used, the farmer will be wasting money buying nutrients the plant does not need. However, because fertilizer prices vary a lot, there may be times when a grower can obtain the nutrients that sweet potato needs (nitrogen and potassium) most economically from prepared fertilizer mixes.

Inorganic fertilizers do not increase the tuber yield of all varieties of sweet potato. So inorganic fertilizer should be tested out on a small area of the variety you are using. If it gives a good increase in yield, then it can be used on larger areas. For more information on inorganic fertilizers see the articles by Bourke (1978) and Kimber (pp. 71-76 of this issue).

VARIETIES

There are very many varieties of sweet potato in Papua New Guinea. Four varieties are being recommended from Aiyura because of their high yield and

good quality tubers. These are Merikan, Serenta, Markham 1 and Naveto. For more information on these varieties, see the article by Akus on pp. 63-66 of this issue.

Other varieties can also be used. Tuber colour is not so important to the consumer, although white, cream or yellow flesh tubers seem to be preferred. Varieties used should give a high yield and have tubers with a smooth skin.

PLANTING MATERIAL

Stem cuttings 30 to 40 cm long should be used. Cuttings should not be taken from plants that are infested with sweet potato weevil.

A village woman turns sweet potato vines near Obura in the Eastern Highlands Province. Much of the sweet potato sold in the Highlands is grown using traditional techniques.

SPACING

Plant spacing is not very important for sweet potato. With very wide spacing (low density), the farmer will obtain larger tubers. If very close spacing is used, he will obtain about the same weight of tubers over 100 g (saleable tubers) but more small tubers which can be used for pig feed. Most highlanders use a plant density of 40 000 to 60 000 plants per hectare.

The exact spacing used depends on the mounding technique used. If ridges are used, we suggest that sweet potato cuttings are planted on the ridge with two cuttings per planting position. If the ridges are 1.25 metres apart and the spacing within the ridge is 30 cm between planting positions, this gives a planting density of 53 000 plants per hectare.

FENCING

If pigs are a problem, the sweet potato garden must be fenced. Either traditional fences or ones made from wire and iron posts can be used. Traditional fences do not need cash to build, but they require a lot of work and a source of timber. The main advantage of permanent materials fencing is for the situation where food crops are to be rotated with pastures for grazing animals.

It costs over K100 to buy star pickets, barbed wire and pig wire for 100 metres of fence. A block of one hectare in area (100 m x 100 m) would need 400 metres of fence. This would cost K400 for the materials. The cost of the materials for a block of 4 ha (200 m x 200 m) would be K800 as the fence around the block would be 800 m in length.

WEED CONTROL

Experiments at Aiyura have shown that controlling weeds for the first 8 weeks after planting increases the tuber

yield. These experiments showed that weed control is not necessary after eight weeks. However if a large number of weeds were present after eight weeks, they would still reduce crop yield.

Chemicals can be used for weed control instead of hand weeding. Gramoxone is the recommended chemical. It should be applied at 40 ml of gramoxone per 14 litre knapsack. (40 ml is a third of a small fish tin.) Agral 60 should also be used at a rate of 40 ml per knapsack. Agral 60 helps the weedicide stick on to the plants.

Gramoxone should be applied during the morning because three hours of sunshine are needed for it to be effective. The weedicide should be directed at the weed growing between the sweet potato mounds or ridges. If it is applied to the sweet potato, it will cause some damage, although the plants quickly recover from this.

Gramoxone is a very dangerous chemical and every care must be taken to prevent people from drinking it.

PEST CONTROL

There are three main pests of sweet potato in the highlands. These are rats, weevils and leaf miner.

Rats

Rats can do a lot of damage to sweet potato tubers. We have made traps from bamboo and timber, but they are not very effective. The best way to control rats is probably to place commercial rat poison, such as Ratax, in bamboo tubes and place these in the sweet potato garden.

Weevil

The sweet potato weevil, *Cylas formicarius* , is generally not a problem with sweet potato in the highlands. In drier areas, such as the Benabena and Henganofi areas of the Eastern Highlands, it can be a problem. A description of the pest and recommended control measures are given in the Entomology Bulletin by Sutherland on pp. 90-93 of this issue.

Leaf-miner

Leaf-miner (*Bedellia somnulentella*) is only very occasionally a serious problem of sweet potato. Serious outbreaks of this insect pest are very uncommon. A description of the sweet potato leaf-miner and recommended control measures, are given in the article by Sutherland on pp. 94-98 of this issue.

There are several other types of insect that sometimes damage sweet potato. Notes on these are also given in Sutherland's article on pp. 94-98 of this issue.

DISEASES

A disease called sweet potato scab is often present on sweet potato. This disease makes 'scabs' on the underside of the leaves and on the stem and petiole. This causes the leaves to curl. Varieties that get the disease very badly should not be used. For a full description of sweet potato leaf scab, see the Plant Pathology note by Goodbody on pp. 99-100 of this issue.

HARVESTING AND HANDLING

The crop can be harvested using a potato (or chain) digger or

by hand. Chain diggers do a lot of damage to the tubers and it is better to harvest by hand in Papua New Guinea. Tubers can be harvested as soon as they are big enough.

Tubers can be harvested in single harvest or by progressive harvesting (mumuting in Pidgin). A number of trials have been done which compared the two techniques. Some trials showed that there was no difference when the yield was compared on a per day basis. Other trials have shown that progressive harvesting is superior. The advantage of progressive harvesting over a longer cropping period is that the costs of planting the crop and early maintenance are reduced.

It is best to harvest tubers after a few days of dry weather. This will help the tubers to store better. If possible, tubers should be left on the soil surface for a few days after harvest. This 'cures' the tubers and also helps them to store better. There is no need to wash tubers. All that needs to be done is to brush loose soil off them. Tubers store better if they are not washed.

The most important thing to emphasize with farmers is gentle handling of tubers. One of the biggest problems with marketing fresh food in Papua New Guinea is the rough handling of fresh food by farmers and other people. Sweet potato and other food that is meant for sale cannot be treated in the same way as food that is harvested and eaten on the same day by a subsistence farmer!

MARKETING

Marketing can be a big problem for growers. Possibilities for marketing are as follows:

1. Direct to institutions such as schools, hospitals and corrective institutions. If the grower can guarantee a regular supply, this can be a very good way to sell large quantities of sweet potato at a good price.

2. Through the urban food markets. Prices can be high in these markets, but selling takes a lot of time.

3. Through provincial marketing organizations where they exist (Western Highlands, Morobe and Central Provinces). The disadvantage here is that prices offered are often less than those of other buyers.

4. Directly to consumers in the village.

CROP ROTATION

After a crop of sweet potato has been harvested, it is better to plant a different type of crop, if possible. This is called crop rotation. Village people in the Eastern and Western Highlands Provinces have found that a rotation of sweet potato with peanuts or winged bean helps to maintain sweet potato yields.

The crop that can be rotated with sweet potato depends on what crop can be sold or eaten by the grower. For this reason it is not possible to recommend any single rotation. However, potatoes, corn, peanuts and winged bean are all useful crops to rotate with sweet potato. After another crop has been grown, it is possible to return to growing sweet potato again. A rotation of sweet potato and peanuts can be maintained for several years in the highlands before sweet potato yields decline too much.

For some crops, such as potato, crop rotation is very important so as to prevent disease and insect pest build-up. For sweet potato this is not so important, because there are few serious pest or diseases problems.

Experiments at Aiyura have shown that a six week fallow period between sweet potato crops is very good. After a crop is harvested, the land is left to fallow for 6 to 8 weeks. Then it can be cultivated again for another crop. This results in an increased yield in the following crop. Use of a short fallow between crops of sweet potato is another way that the cropping period can be made longer before a long fallow becomes necessary.

One possibility for crop rotation is to rotate grazed pastures with crops such as sweet potato. After land has been cropped for about 4 or 5 years, it can be planted to pasture and grazed with sheep or cattle. This system is used at H.A.E.S. Aiyura, but it does require a lot of capital (money) for permanent material fencing.

PROBLEMS

Sometimes sweet potato crops give very low yields or no yield at all. This often happens when the vines and leaves grow really well, but the plant does not have many tubers. There are a number of things that can cause this, but the main ones seem to be too much nitrogen in the soil or too much water.

Sometimes when growers apply inorganic fertilizer they apply it at a very high rate. The nitrogen fertilizer makes the leaves and vines grow really well, but tuber growth is poor. This can happen with certain varieties even when the grower only applies the correct amount of fertilizer. This could also happen with organic fertilizer, such as chicken manure, although we have not heard of any cases of this.

The other situation where too much nitrogen seems to be a problem is on organic soils that contain a lot of organic matter. After the soils are cleared, the first crop of sweet potato gives a very high yield.

For example, after some swamps in the Western Highlands were drained, the first sweet potato crop yielded over 50 tonnes per hectare. However, the second crop gave a very poor yield. We think this occurs because the organic matter breaks down and releases too much nitrogen.

Experiments at Kuk near Mount Hagen found that the best way to stop this problem was to grow a crop such as maize or sorghum between sweet potato crops. The leaves and stalks from the grain crop should be buried under the soil. This way the excess nitrogen is soaked up by the extra organic matter that is added. For more information on this problem, see the article by Kimber (on pp. 77-80 of this issue)

Too much water is often a problem for sweet potato growers on the heavy highland soils. Many villagers say that if sweet potato is planted when the soil is very wet, the tuber yields will be very low.

Sometimes we also get reports of very poor tuber yields and tubers that have many root hairs on them. This seems to be associated with very wet

conditions during part of the growth of the crop. The problem is usually found on heavy clay soils, but not always. The only way to prevent this problem is not to plant sweet potato on heavy clay soils when they are very wet.

Drought can be a problem for sweet potato. However once the crop is established, the soil has to be very dry to hurt the crop. During periods of drought, growers should plant sweet potato on heavy wetter soils. These sorts of soils are often found next to small streams. Normally crops grown on these soils would not give a good yield, but during a drought they can give very high yields.

FROST DAMAGE

Frost can damage sweet potato crops in the highlands sometimes. This is more common at very high altitudes above 2300 m. Frost damage is likely following a dry period and when the air is very dry.

There are two things that farmers can do to reduce the effect of frost damage. The first is to cover up the sweet potato mounds with grass in the late afternoon. The grass stops the vines from being killed by the frost. The grass should be removed the next morning. This technique has worked very well in stopping frost damage to sweet potato in the highlands in the past.

The other thing that farmers can do is to light smoky fires in the sweet potato gardens. This has to be done at night. The smoke mixes up the cold air on the ground and helps stop frost damage. The problem with this method is that it uses up precious firewood. Also the farmer has to be outside at night when it is very cold.

ECONOMICS

It is difficult to provide information on the economics of growing sweet potato. The economics depend on crop yield, price received for the crop, labour costs, the amount of mechanization employed, transport and marketing costs.

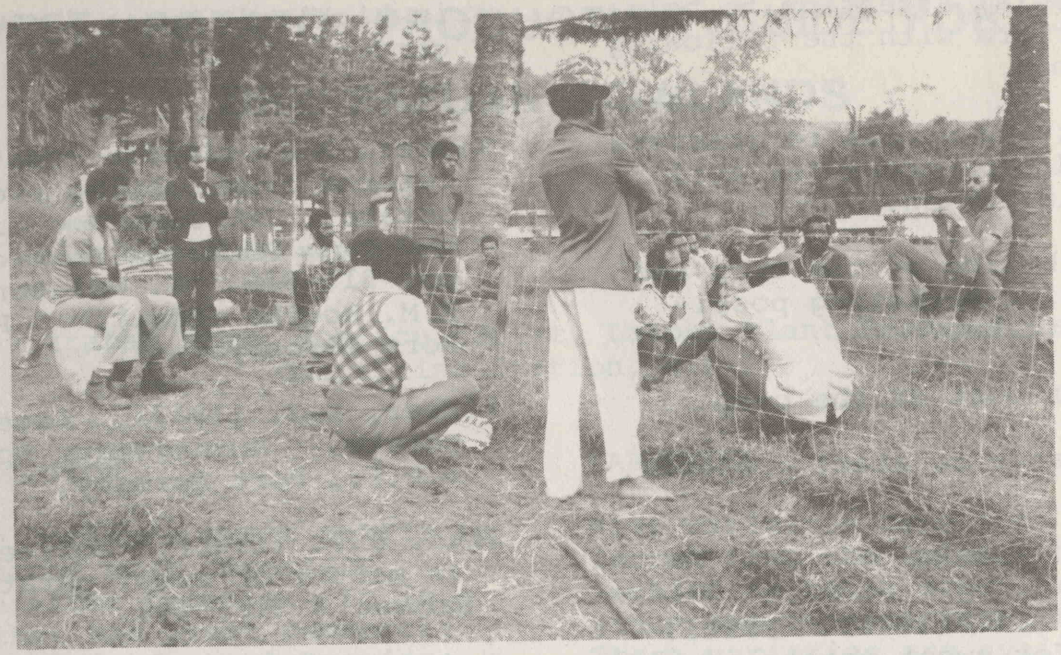
In general it can be said that sweet potato growing in the highlands is not as profitable as growing certain vegetables, such as potatoes or broccoli when these crops are grown under optimum conditions.

However sweet potato production is much more reliable than these vegetables. The crop can be grown on a wider range of soils and it can be grown with less high level inputs such as fertilizer and insecticide. Also marketing is more certain as it is more difficult to oversupply the market.

In other words, growing sweet potato for sale is a more reliable way to make money for the ordinary villager than growing more difficult vegetables. This is because these vegetables need more money and skill to be grown successfully.

In the highlands a 7 month crop grown for sale should yield about 16 t/ha of saleable tubers plus another 4 t/ha suitable for stock feed. Higher yields can be expected in the Waghi Valley and lower yields on some other soils. If the crop is sold at a price of 12 toea per kilogram, the 16 tonnes would give the grower a gross return of K1920 per ha.

For information on labour and tractor cultivation inputs, see the article by Kimber (1976). If we use Kimber's figures for



Southern Highlands farmers talk with the author during a course on commercial sweet potato production at Aiyura. The fence was erected as part of the course.

cultivation time and labour inputs, and assume that cultivation costs K10 per hour and labour K3 per day, the cost of production would be K1150 per hectare. From this has to be deducted costs of transporting the crop to market. If it cost K150 for transport, then the farmer's profit per hectare for a crop that yields 16 t/ha is:

K1920 - K1150 - K150 = K620

We could play with the figures all day to arrive at different answers, but one thing is certain: a lot of Highlanders find that growing sweet potato is a very good way to earn some money!

HELPING FARMERS

The ideas in this article are written as if the farmer was starting from nothing. But this is not so. Highlanders already know a lot about growing sweet potato. So farmers growing sweet potato for sale only need certain information.

Of the things mentioned here, I think the following are the main ones that extension workers should be promoting with growers:

1. Time of planting and out-of-season production.

2. Use of organic fertilizers.

3. Providing new varieties, especially those released from Aiyura.

4. Proper harvesting and handling of the crop for the market. This is extremely important.

When we run courses for commercial farmers at Aiyura, they say that they are happy to learn of new ideas, such as out-of-season production and the use of coffee pulp as fertilizer. However they say that their big problems are in getting tractors for soil cultivation; transporting the crop to market; and marketing problems. Because of this, I think that extension workers should

pay special attention to helping farmers with the following problems:

1. Getting access to tractors and implements for soil cultivation.

2. Marketing of the crop and seeing marketing possibilities.

3. Transport of the crop.

4. Finance to start projects.

FURTHER READING

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