IMPROVING SUBSISTENCE AGRICULTURE ON THE NEMBI PLATEAU

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INTRODUCTION

The Nembi Plateau is a limestone plateau about 20 km south west of Mendi in the Southern Highlands Province. Many of the children who live on the plateau are very malnourished. The 1978 National Nutrition Survey showed that people on the Plateau have one of the highest rates of malnutrition in the Southern Highlands.

In 1978, a team of people of different professions spent three weeks on the Plateau doing a survey on subsistence agriculture, land use and child nutrition. The team made the following conclusion: There are a lot of people living on the Nembi and not enough land. Therefore sweet potato is grown in the same gardens for very many years without a fallow. This results in very low sweet potato yields. Because the sweet potato does not give good yields, there is not enough energy food for the people. This is the reason that so many children are malnourished. (The report is written by B. Allen and others (1978)).

In 1979 Euclid D'Souza was employed by D.P.I., Aiyura to do research to find out how the gardens could be improved so as to improve people's nutrition. For 22 months he lived on the Plateau and did many trials in people's gardens. This research is now finished and results are available that can be used to help people grow more food on the Plateau. Some of the results are given in the article by Bourke and D'Souza (1982). The full results have been submitted for publication in the *Papua New Guinea Agriculture Journal*.

This article describes the main results of the research.

This is the first time that D.P.I. has done team research based in a village. More of this type of research will be done in the future.

Some of the ideas in this article should be useful in other parts of Papua New Guinea as well.

AGRICULTURE ON THE PLATEAU

The plateau is on limestone rocks, and this gives the land surface a special shape. The

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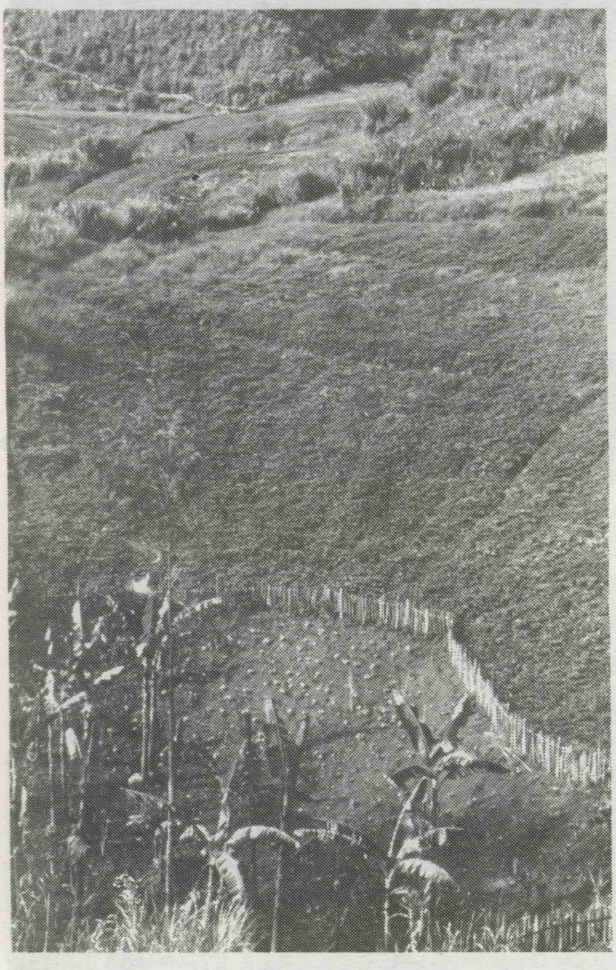
water goes underground through 'sinkholes' and people make their vegetable gardens in these sinkholes. Sweet potato gardens are made on the slopes.

The soils are different on the slopes and the sinkholes, but the soils are all fairly fertile before they are used for agriculture, and have a good structure. Our research has shown that boron and potassium are deficient (in short supply) in the soils. This deficiency of boron does not seem to be a problem for sweet potato, but it affects the growth of tree crops such as casuarina. Potassium is in short supply because the gardens have been cropped for so many years without a fallow and a lot of the potassium has been taken out of the soil.



Sweet potato gardens (top) and a mixed vegetable garden (bottom) on the Nembi Plateau, S.H.P. Sweet potato gardens are planted for up to 30-40 years before fallow.

Sweet potato is the people's main food. Crops are planted for up to 30 to 40 years in the same land with no fallow or only short fallows of a few months. The yields are some of the lowest ever recorded in sweet potato gardens in Papua New Guinea.

Most of the other foods are grown in mixed vegetables gardens. All of these crops, such as highlands pitpit, rungia, beans and corn, are planted seasonally from October to December.

There is still not much coffee on the Plateau, but the mixed gardens are being interplanted with coffee and casuarina seedlings. This means that they are being turned into coffee gardens and the land will no longer be available for mixed vegetable gardens.

People keep pigs in the village areas and kill these in large numbers during irregular pig kills. There is not much forest near the hamlets (groups of houses), so hunting is not an important source of meat for people. Women and children catch some rats and insects in the gardens.

Agriculture is very settled because the gardens are not fallowed. This means that most of the garden work is done by the women. The work that men usually do in the highlands, such as digging new ground and making fences for new gardens, is not done very often.

There is not much money on the Plateau. People earn a little money from the sale of baskets woven by the men, and coffee, and from working on the roads.

IMPROVING AGRICULTURE

People's attitudes

Later on we will be talking about some of the changes that people could make to get more food from their gardens.

However, we think it is very important to talk to people and help them face their problems. Many of the ideas about extension talked about in the article 'Improving food production and people's nutrition', by R.M. Bourke (HARVEST Volume 9, No. 1, pp. 11-23), could help on the Nembi Plateau.

The people on the Plateau know that all is not well in their lives. They compare their sweet potato with that in Tari or Mount Hagen and say how small their own tubers are. They comment on the fact that their children are often ill and sometimes die. It seems that the Nembi Plateau people are ready to make changes in their agriculture because they see that they have problems.

Some of the things that D.P.I. extension officers, missionaries, school teachers, aid post orderlies, nurses and nutritionists could discuss with the people are:

1. The very low sweet potato yields and the reasons for this.
2. The poor nutrition, illness and high death rate amongst children on the Plateau.
3. Seasonality of sweet potato and other foods throughout the year.
4. The unusually heavy work load of the women.
5. Land use. This is discussed below.
6. Sources of cash income apart from coffee.

A villager shows the tiny tubers from the gardens. Sweet potato yields on the Nembi Plateau are some of the lowest ever recorded in Papua New Guinea.

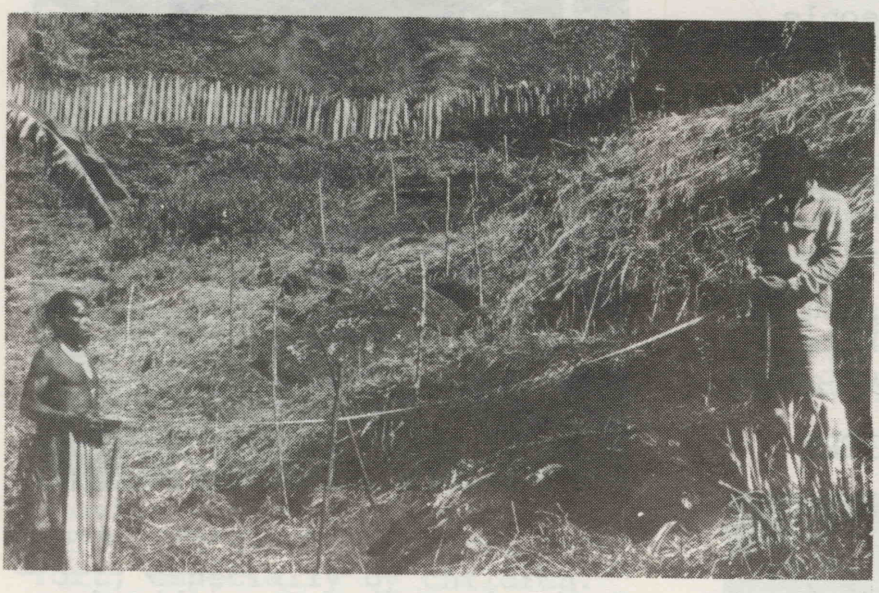
Land use

Land use means what land is used for. If people change the way they use land, they can improve the supply of food.

One problem on the Plateau now is that timber for fencing, firewood and building houses is not available near the hamlets. People have to walk a long way to obtain timber, so this makes fencing a really big effort. The men are not keen to make new gardens because it is so much trouble to collect timber for fencing.

To have timber easily available, people should be encouraged to plant casuarina trees near the hamlets. Near the houses some land is available that is too poor for gardening. People may

Malnourished children stand beside a child's grave on the Plateau. Many of the small children are malnourished and also die young because there is not enough sweet potato and other food to eat.



Horticulturist, Euclid D'Souza, measures out land in a village garden for a sweet potato trial. The authors did research on the Nembi Plateau for nearly 3 years to find ways to improve subsistence agriculture.

A coffee/banana garden with some casuarina shade. Mixed vegetable gardens are being changed into coffee gardens. Then the land cannot be used for further food production. Extension officers need to talk to villagers about these changes.

have to be shown how to make a simple casuarina nursery. Boron deficiency may be a problem for casuarina in some places. Borax fertilizer applied at 5 grams per seedling will solve this.

There are small areas of unused land on the Plateau that could be used for new gardens. Extension agents should talk with the men about opening up this land for gardens more often. Then it would not be necessary to make gardens on the same land for so long.

Many mixed vegetable gardens are being turned into coffee gardens. Coffee is very useful cash crop for the people, but it is also important that people have their vegetable gardens. It would be useful for extension agents to talk to people about this change of land use and what it means for their future food supplies. There are other ways in which people can earn money, such as weaving and selling baskets. People need to think about this.

New varieties and new crops

Sweet potato. High yielding varieties of sweet potato were introduced from Aiyura. Some of the results from 3 of the trials are shown in Table 1.

It can be seen that the Aiyura selection Markham 1 gave the highest yield in all 3 trials. Markham 1 has proved to be popular on the Plateau. In fact, one of the problems in trials was that people took the vines of this variety for planting material even before the trial had been harvested! Planting material of Markham 1 should be distributed widely on the Plateau. Further information on this variety can be obtained from the article in HARVEST by W. Akus (1982).

A woman harvests sweet potato tubers. New varieties of sweet potato, such as Markham 1, can improve yield and should be promoted on the Plateau.

TABLE 1. YIELDS IN TONNES/HECTARE OF SOME SWEET POTATO VARIETIES IN THREE TRIALS ON THE NEMBI PLATEAU

Variety	Trial 1	Trial 2	Trial 3
Markham 1	13.6	16.2	13.5
Sokol	12.8	-	5.3
Sumbil	12.6	-	7.8
Ma'alua	11.9	-	6.6
Goroka	11.4	-	9.0
Naveto	11.3	-	9.3
Merenge	-	9.6	6.7

Potato. Only a few potatoes are grown on the Nembi Plateau. We tried potatoes in a number of places and found that the yields are a little higher than sweet potato yields. The advantage of potatoes over sweet potato is that they mature faster. So potatoes can provide food faster than sweet potato. Their disadvantage is that disease can be a big problem.

We suggest that seed of the variety Sequoia be sold to people on the Plateau. People should be encouraged to plant them in fertile locations in the sweet potato gardens.

Avocado. Avocado is a fruit tree that grows well on the Plateau. The fruit is a good source of energy food and is rich in oils. Avocado fruit contain almost as much energy as the same weight of sweet potato. Our experience elsewhere in Papua New Guinea is that people do not like the taste of avocado at first, but they gradually get to like it.

Trees planted near hamlets can provide a rich food that can be collected with very little effort, especially by children.

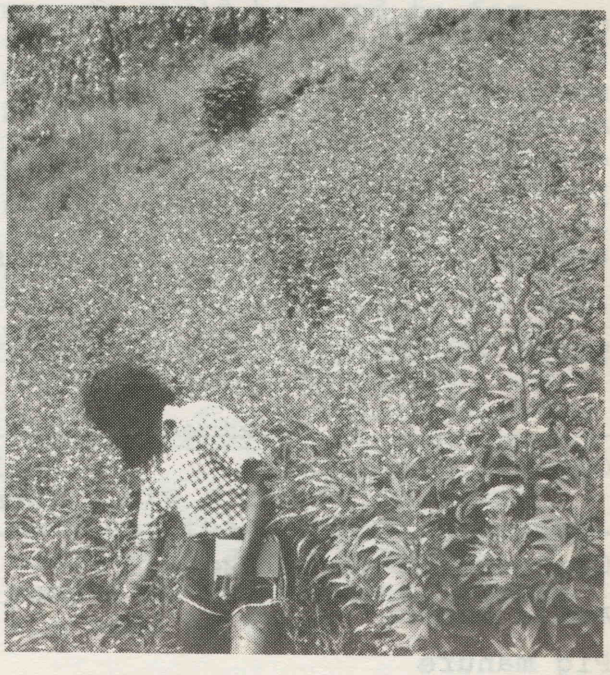
Avocados only grow well on well drained soils. Seedlings should be raised and distributed on the Plateau for planting.

Peanuts. We tried out 5 grain legume crops in sweet potato gardens. Peanuts gave the highest yield and are also very popular with the people. We then did 3 trials to see if peanuts improved the yield of the following sweet potato crop planted in the same ground. The peanuts did not have any effect on the next crop of sweet potato.

However, peanuts are a good source of plant protein. Protein, as well as energy, is likely to be short in people's diet on the plateau. Peanut seeds should be distributed and people encouraged to grow them and cook the nuts. They seem to be one of the few crops that will grow well in the old sweet potato gardens.

Corn. We have not done any experiments with corn on the Plateau. However it is almost certain that selected varieties such as Piwa, will give a greater yield than the corn already on the Plateau. Corn seed also should be distributed to the people.

Pigeon pea. Pigeon pea is a legume crop. The green pod and seeds are fairly rich in protein. Pigeon pea grows well in the mixed gardens and on the better soils. They will keep growing and producing when other foods from the mixed gardens have finished. People have already accepted this new crop to some degree. Seeds or seedlings should be distributed.



A good crop of pigeon peas. Planting of pigeon peas should be encouraged in mixed gardens.

Improving sweet potato gardens

A lot of research has been done on the Nembi Plateau to find ways of increasing sweet potato yields. It is now possible to recommend different organic fertilizers that will improve sweet potato yield.

Compost. The results of 3 trials using compost in sweet potato mounds are given in an article by E.D'Souza and R.M. Bourke (HARVEST Volume 8, No. 4, pp. 171-175). In all 3 trials, the sweet potato yield was increased.

We suggest that the composting technique should be promoted on the Plateau. The application rate is 20 tonnes per hectare or 2 kg fresh grass and weeds per square metre (2 kg/m^2). This sounds a lot, but it is what people in Enga and other parts of the Southern Highlands do already. Measurements in Enga show that people use a rate of 17 to 29 tonnes of fresh grass per hectare for composting.

Coffee pulp. In one trial on the Plateau, coffee pulp, pig manure and a water fern called *Azolla pinnata* were tried as organic fertilizers for sweet potato. The results are given in Table 2. You can see that coffee pulp applied at 30 tonnes per hectare gave the greatest increase in yield. It gave almost twice as much sweet potato as the plots that did not receive any organic fertilizer.

Coffee pulp is an ideal fertilizer for sweet potato as it contains a lot of potassium. Sweet potato needs a lot of potassium to give a good tuber yield. We recommend that all available coffee pulp on the Plateau be used to fertilize sweet potato.

Unfortunately coffee pulp is available only in very limited quantities on the Plateau. There is only enough pulp to fertilize a few square metres of sweet potato for each person. The recommended application rate is up to 30 tonnes per hectare (3 kg/m^2). A 9 litre bucket holds enough coffee pulp to fertilize 2 m^2 at this rate. See the article by B. Siki (1980) for further information on coffee pulp.

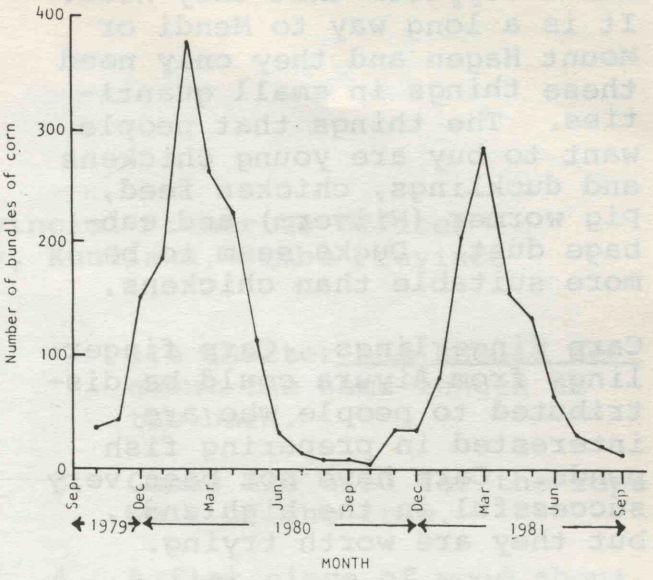
Pig manure. There is a large quantity of pig manure available on the Plateau. In the trial mentioned above, pig manure also gave a large increase in sweet potato yield, although not as large as coffee pulp. Pig manure is not such a good fertilizer for sweet potato because it contains a lot of nitrogen and not so much potassium. It is said that people

TABLE 2. RESULTS FROM AN ORGANIC FERTILIZER TRIAL ON SWEET POTATO ON THE NEMBI PLATEAU

Organic fertilizer	Application rate (tonnes/hectare)	Sweet potato yield (tonnes/hectare)
Control (no fertilizer)	0	17.1
Azolla pinnata	30	22.2
Pig manure	20	25.4
Coffee pulp	30	31.5

will not eat sweet potato that has been fertilized with pig manure. However, people still stole tubers from some of our trials even when they knew it had been fertilized with pig manure!

We think the most useful role for pig manure might be to fertilize a crop such as corn that is grown in rotation with sweet potato. This might overcome people's dislike of eating sweet potato that had been fertilized directly with pig manure. More research is needed to test this. Meanwhile pig manure could be promoted on a trial basis as a direct fertilizer for sweet potato at a rate of 15 to 20 tonnes per hectare (1.5 to 2 kg/m^2).



The number of bundles of corn at Hol market, Nembi Plateau, over a two year period

Improving mixed gardens

In general the mixed vegetable gardens on the Plateau do not appear to have the same problem that the sweet potato gardens have. The major problem that we see is the conversion of mixed garden land into coffee gardens. This was discussed above.

Food production from the mixed gardens is very seasonal. So supplementary foods are more seasonal than usual in the highlands because they are produced mostly in the mixed gardens. The supply of corn at Hol market on the Plateau is given in the graph to show this. It is in good supply from January to April, and in very poor supply from July until November. This pattern applies to almost all of the supplementary foods. So, in general, the food supply for July to November is much poorer than for January to May.

Such a seasonal pattern is not desirable for good nutrition. It should be possible to reduce the seasonality of supply of many food items by planting mixed gardens at different times.

Out-of-season mixed gardens would have to be made on the better drained soils. Pig manure could be used to fertilize these gardens if the soil was poor. Then sweet potato could be planted when the mixed vegetable gardens have been harvested. At the moment sweet potato gardens follow mixed gardens when the mixed gardens are made on well drained fertile soils. So this would not be a big change in local land use patterns.

Other aspects

There are a number of other services that extension agents could provide to help the people on the Plateau. These are some of them:

Selling agricultural supplies

It is difficult for people on

the Plateau to get the agricultural supplies that they need. It is a long way to Mendi or Mount Hagen and they only need these things in small quantities. The things that people want to buy are young chickens and ducklings, chicken feed, pig wormer (Nilverm) and cabbage dust. Ducks seem to be more suitable than chickens.

Carp fingerlings. Carp fingerlings from Aiyura could be distributed to people who are interested in preparing fish ponds. Carp have not been very successful in the highlands, but they are worth trying.

Selling baskets. Weaving and selling cane baskets is an alternative cash source to coffee growing on the Plateau. However, it is difficult to transport baskets into Mendi for sale. This is a service that could help people obtain some cash. If weaving developed as an industry for men it would relieve the pressure of coffee planting from the mixed garden land.

CONCLUSIONS

The children on the Nembi Plateau are amongst the most malnourished in the Southern Highlands. A village-based research programme has found a number of things that could be applied to improve subsistence agriculture on the Plateau. These have been discussed in this article. One of the major things that extension agents can do is to make people more aware of their problems and help them find solutions to these problems themselves. Technical changes such as new varieties of sweet potato, planting peanuts, composting, use of pig manure or out-of-season planting should be introduced by discussion and the use of demonstration plots.

FURTHER READING

Akus, W.L. (1982). Sweet potato releases from Aiyura. *Harvest* 8 (2): 63-66.

Allen, B.J., Bourke, R.M., Clarke, L.J., Coghill, B., Pain, C. F. and Wood, A.W. (1978). A preliminary report on a child nutrition and agricultural survey of the Nembi Plateau, Southern Highlands Province. Office of Environment and Conservation, Port Moresby.

Bourke, R.M. (1983). Improving food production and people's nutrition. *Harvest* 9 (1): 11-23.

Bourke, R.M. and D'Souza, E. (1982). Intensification of subsistence agriculture on the Nembi Plateau: preliminary results. In *Proceedings of the Second Papua New Guinea Food Crops Conference*. R.M. Bourke and V. Kesavan (Eds). Department of Primary Industry, Port Moresby, pp 202-207.

D'Souza E. and Bourke, R.M. (1982). Compost increases sweet potato yields in the highlands. *Harvest* 8 (4): 171-175.

Siki, B.F. (1980). Coffee pulp as manure on sweet potato. *Harvest* 6 (1): 1-4.