REPORT ON A BRIEF VISIT TO OKSAPMIN SUB-DISTRICT TO EXAMINE SUBSISTENCE AGRICULTURE

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INTRODUCTION

Following repeated requests to visit Oksapmin by the Rural Development Officer there, Mr. Nicky Cape, I spent five days in the sub-district in November, 1979. Oksapmin Sub-district is part of Telefomin District and Sandaun Province (formerly West Sepik Province). My itinerary was as follows:

Sunday 4th November:	Drive Aiyura to Mt. Hagen.
Monday 5th November:	Fly Mt. Hagen to Tekin Mission. Walk to the Bak Valley visiting gardens en route in the Upper Tekin Basin.
Tuesday 6th November:	Garden visits in Bak Valley.
Wednesday 7th November:	Walk from Bak to Tekin, visiting gardens in the Upper Tekin Basin en route.
Thursday 8th November:	Walk Tekin to Oksapmin, visiting gardens in the Lower Tekin Basin. Visit gardens in Oksapmin Basin.
Friday 9th November:	In Oksapmin (a.m.). Fly Oksapmin to Goroka.
Saturday 10th November:	Fly Goroka to Aiyura.

Detailed recordings were made on 16 gardens between 1650 and 2100 m above sea level, mostly in the Upper Tekin Basin and Bak Valley. Observations were made on other food gardens. Information comes from discussions with gardeners, my observations, and information provided by Mr. N. Cape who has a very good understanding of the local food production systems. There is very little published information on the sub-district. A report by Dr. Richard Jackson (1978) of the Geography Department, UPNG, gives a lot of background information on the region and refers briefly to gardening.

I am grateful to Nicky Cape, Virginia Guilford (formerly a Ph.D. linguistics student living in the Bak Valley) and the Flatters family (Australian Baptist Mission, Tekin) for their kind hospitality and useful discussion.

BACKGROUND INFORMATION

Population

The people of the sub-district are concentrated in the Oksapmin and Tekin Basins and Bak and Bimin Valleys in one corner of the sub-district. In these basins and valleys live 6900 of the sub-district's 7500 people. A gross population density for these four basins/valleys on all land is 38 persons/km^2. Some other gross densities on land under 2000 m altitude are given in Table 1.

Table 1. Some gross population densities on land under 2000 m above sea level

Area	Density (persons/km^2)
Oksapmin Basin	46
Kusanap area (below Tekin Mission)	92
Kweptanap area (Upper Bak Valley)	36
Divanup area (Upper Tekin Valley)	152

It can be seen that population densities are high but not especially high, except in the Upper Tekin Valley where land pressure is evident.

Male absenteeism is quite high in the sub-district (Table 2). In places absenteeism is much greater. For example, at Kweptanap, information obtained from villagers on men absent indicates that 33% of adult men are now absent from the sub-district.

Table 2. Percentage of males over 18 years old absent in Oksapmin Sub-district (calculated from data in Jackson, 1978)

Census division	Adult male population	% men absent
Bak/Bimin	804	15
Om River	135	13
Teramin Tekin	1084	16
Upper Leonard Schultz	84	0
TOTAL/MEAN	2107	18

People's nutritional status

Malnutrition is very common in the region. For 16 MCH clinics in the Tekin-Oksapmin area, 61% of children aged 0 to 5 years were less than 80% weight for age in February 1978 (Table 3). It is even worse in the Bak Valley where 76% of children in this age group are classified as malnourished (less than 80% weight for age) and 7% as severely malnourished (less than 60% weight for age).

Table 3. Weight for age of children aged 0-5 years in Tekin-Oksapmin area (mean of 16 clinics) and in the Bak Valley (mean of 3 villages)

Weight for age (%)	Tekin-Oksapmin	Bak Valley
80 plus	39	24
60-69	56	69
<60	5	7

Altitude

Most food gardens are found between 1500 and 2100 m above sea level, but they go as low as 600 m and as high as 2200 m. Oksapmin is at c. 1560 m, Tekin Mission at 1700 m and Kweptanap village at c. 1800 m.

Rainfall and temperature

Only very limited rainfall data is available (Table 4). This suggests that rainfall is high, but not excessive for agriculture, and that it is well distributed throughout the year.

Table 4. Monthly rainfall (mm) at Oksapmin and Kweptanap (Upper Bak Valley). Oksapmin data is for two years only and follows McAlpine et al., 1975; Kweptanap data is for one year only (1978-79) and was recorded by Mr. T. Guilford

Month	Oksapmin	Kweptanap
January	285	295
February	233	406
March	326	542
April	213	246
May	243	369
June	136	350
July	226	164
August	239	115
September	293	131
October	236	254
November	150	275
December	201	328
TOTAL	2858	3475

No temperature data is available. Observations on altitudinal limits of crops suggest that temperatures on the sides of the basins/valleys are similar to those in other parts of the highlands where rainfall is similarly high; but that in the bottom of the basins, temperatures are quite low for that particular altitude; for example taro is a major crop on the slopes at 2100 m, aibika is common at 1750 m, and chokoes were seen growing at 2100 m. These crops grow at up to similar altitudes elsewhere in the highlands. On the other hand banana passionfruit were seen at 1700 m at Tekin and nut pandanus (karuka) was common as low as 1650 m on the basin floors. Banana passionfruit rarely grows below 2000 m, and pandanus is rarely seen below 1800-1900 m. At Oksapmin (1560 m) pineapples and oil pandanus (marita) will not grow, although pineapples usually grow up to about 1700 m and marita to 1600-1650 m.

It is likely that cold air drains into these basins, but cannot escape because there are no gullys or valleys where the air can flow. (Water in the Tekin and Oksapmin basins drains out via underground caves. Technically these two basins are called "poljes").

Soils

Soils in the area are derived from three parent materials as follows:

(i) Limestone soils, developed on Darai Limestone. These are generally higher on the slopes as the limestone forms the ridges in the area.

(ii) Mudstone siltstone, developed on Tekin beds.

(iii) Alluvial deposits adjacent to streams or in limestone dolines. Some of these are reasonably deep, for example at Kusanap village below Tekin Mission.

Most of the garden soils seen during my visit were developed on limestone or other alluvial rocks and consisted of a thin organic layer (2-5 cm overlying a sandy clay or clay. They were often poorly drained. Vigour of regrowth suggested that in general soil fertility was low.

Some soil analyses have been done on four samples collected by Mr. Cape within the Oksapmin Basin. A mean of these analyses is given in Table 5. The soils are very acidic and calcium is very low. Other elements appear to be present at satisfactory levels. Carbon (C) and nitrogen (N) percentages are both very high, but the C:N ratio is ideal. The Chief Chemist of DPI has suggested that application of lime or crushed limestone would benefit these soils and make micronutrients more available.

Table 5. Soil analyses, Oksapmin Basin. Mean of four samples

Parameter	Level	Comment
pH	4.5	Acidic
Olsen phosphate (P)	12.9 ppm	Satisfactory
Calcium (Ca)	2.4 m.e. %	Very low
Magnesium (Mg)	0.83 m.e. %	Satisfactory
Potassium (K)	0.53 m.e. %	Satisfactory
Mg:K ratio	1.6	Satisfactory
Ca + Mg:K ratio	6.1	Satisfactory
Cation exchange capacity	34.3 m.e. %	Satisfactory
Carbon (C)	9.3%	High
Nitrogen (N)	0.87%	High
C:N ratio	10.7	Satisfactory

I observed phosphate (P) deficiency symptoms on sweet potato and corn in many gardens. It is not surprising that P should be unavailable to plants despite the apparent satisfactory levels indicated by soil analysis. Fixation of soil P is very common in the highlands and this renders the P unavailable to plants. I also observed apparent potassium (K) deficiency symptoms on soyabeans, winged bean, celery, bananas (?) and spring onion (? at Oksapmin. There is no suggestion from the soil analysis that K is in short supply.

Despite the soil analysis given above, my overall impression is that the soils are not very fertile nor do they have a good physical structure.

Economic activity

The major economic activity in the sub-district is subsistence agriculture and other subsistence activities.

Sources of cash income are restricted, and it is probably true to say that remitted wage earnings outside the region, particularly by plantation labourers, are very significant.

Also significant is sale of introduced vegetables. These are purchased by the Australian Baptist Mission at Tekin and a vegetable co-operative at Oksapmin. Over 200 farmers from 10 villages sell vegetables to these outlets, being paid 20 toea/kg. Approximately 1000 kg are flown from Tekin and Oksapmin to Vanimo, Wewak, Kiunga and Frieda River per week which generates an income of K200 per week for all these farmers (Cape, 1979).

A little coffee is grown but production is insignificant.

FOOD GARDENS

Food crops

Traditionally taro was the staple throughout the sub-district. It is now being replaced by sweet potato, and this process can be seen in different stages in various places. In the Oksapmin Basin, sweet potato is now predominant. In the Upper Tekin Basin sweet potato is more important than taro. The older men still plant taro there, but the younger men plant sweet potato only. Of the 11 gardens where detailed recordings were made in the Upper Tekin Basin, 10 were devoted to sweet potato and only 1 to taro. People here say that taro gardens are planted in the higher forest land because soil fertility is inadequate for taro near the villages and because problems with taro beetle (Papuana spp.) and a white larvae that eat the taro corms are worse here.

In the Bak Valley, replacement of taro by sweet potato started somewhat later than in the Tekin Basin and the process is not as advanced. About 40 years ago, taro was still the staple. As elsewhere in the sub-district, taro gardens are now located in forest land on the slopes of the valley. The sweet potato gardens are located in the lower areas and follow a shorter secondary forest fallow. Of the 5 gardens where detailed recordings were made in the Bak Valley, 3 were devoted to taro and 2 to sweet potato. In the Bimin Valley, taro is still predominant. Extensive taro gardens were seen as high as 2100 m in the Upper Tekin Basin and Bak Valley and Mr. Cape believes that they may be planted as high as 2200 m in places.

Supplementary food crops noted in village and non-village gardens are listed in Table 6. It can be seen that there is a wide range of crops available. Information on wild species that are gathered for food was not collected, apart from nut pandanus. A feature of the crops available was the absence of certain greens that are widely eaten elsewhere in the highlands. Oenanthe and aibika were noted but not Rungia klossii, Nasturtium schlecteri (Rorippa) or Dicliptera papuana. All of these species are present near Nipa in the Southern Highlands, for example.* It may be that these 3 species have been domesticated more recently than Oenanthe and aibika and have not yet crossed the Strickland River. It would be of interest to know whether they occur in highland regions to the west, such as the Baliem River Valley in Irian Jaya.

* Rungia is grown in the Paiela area and N. schlecteri in the Porgera area to the east of Oksapmin in the Enga Province.

Table 6. Food crops noted in gardens

Common name	Scientific name
Staples	
Sweet potato	Ipomoea batatas
Taro	Colocasia esculenta
Important supplementary food crops	
Nut pandanus (karuka)	Pandanus brosimos and P. julianettii
Climbing and dwarf beans	Phaseolus vulgaris
Sugarcane	Saccharum officinarum
Highland pitpit	Setaria palmifolia
Corn	Zea mays
Other supplementary food crops	
Banana	Musa spp.
Taman	Oenanthe javanica
Tomato	Lycopersicon esculentum
Cabbage	Brassica oleracea
Amaranthus	Amaranthus spp.
Spring onion	Allium cepa
Cucumber	Cucumis sativus
Peanuts	Arachis hypogaea
Potato	Solanum tuberosum
Pumpkin	Cucurbita maxima
Silverbeet	Beta vulgaris
Soyabean	Glycine max
Aibika	Abelmoschus manihot
Capsicum	Capsicum annuum
Carrot	Daucus carota
Celery	Apium graveolens
Choko	Sechium edule
Lima bean	Phaseolus lunatus
Lettuce	Lectuca sativa
Ninan	Solanum nigrum
Bottle gourd	Lagenaria siceraria
Chinese cabbage	Brassica pekinensis
Cowpea	Vigna unguiculata
Lablab (?) beans	Lablab purpureus
Ficus	Ficus pungens
Onion	Allium cepa
Passionfruit, purple	Passiflora edulis f. edulis
Shallots	Allium cepa
Tree tomato	Cyphomandra betacea
Yardlong beans	Vigna unguiculata
Zucchini	Cucurbita pepo
Additional crops noted in non-village gardens	
Banana passionfruit	Passiflora antioquiensis
Cape gooseberry	Physalis peruviana
Peas	Pisum sativum
Rice bean	Phaseolus calcaratus
Russian comfrey	Symphytum asperrimun
Winged bean	Psophocarpus tetragonolobus

Farming systems

The crops noted in Table 6 are grown in the main food garden with the staple or in small gardens near the residence. There is no differentiation into open fields of sweet potato and mixed gardens of most other species as is found in many parts of the highlands, although the supplementary crops are generally planted in ash from fires in the gardens. Pandanus seen were mostly planted near residences. Tobacco was also commonly planted in the gardens. The nut pandanus are sometimes planted in the gardens, but most stands are growing in grasslands or regrowth. Some of these may have been planted in food gardens initially.

All of the gardens seen in the Bak Valley followed a secondary forest fallow. In the Upper Tekin Basin, half of the gardens followed a secondary forest fallow and half followed a planted fallow of Casuarina oligodon or a mixture of planted casuarina and natural regrowth. Planting of casuarina trees in the fallow is very common in the Upper Tekin Basin where population pressure on the available land is high. Use of planted casuarinas as fallows is more intensive than I have seen anywhere else in PNG, including theSimbu. People also plant casuarina fallows in the Bak Valley, but not as intensively. This practice is just starting in Bimin Valley, I was told. People said that they grew naturally on the banks of the Tekin River 40 to 50 years ago and later they started planting them in food gardens. People believe that the casuarinas improve soil fertility, although they usually express this as follows: casuarinas grow much faster than a natural tree fallow and hence the land is again fertile enough for gardening sooner than with a natural fallow.

In almost all gardens only one crop of sweet potato or taro is taken before the land is abandoned to fallow. There were exceptions: in the Upper Tekin Basin, small areas were seen that had been replanted to sweet potato. On the river flats at Kusanap village continuous cropping of sweet potato was being practised on the deep alluvial soil there. A short fallow period separates sweet potato crops here.

Apart from the gardens being cropped continuously at Kusanap village, most sweet potato was planted in flat ground and was not mounded. Presumably this reflects the fact that the sweet potato follows a tree fallow rather than a grassy fallow or a previous crop, as elsewhere in the highlands.

Intensification

In the Upper Tekin Basin at Divanap village the farming systems show an evolution from less intensive to more intensive systems because of the land pressure. The following stages can be observed:

(i) Change of staple from taro to sweet potato. The latter is higher yielding than taro and can tolerate much lower levels of soil fertility. Sweet potato has virtually no serious pest or disease problem in this area.

(ii) Planted tree fallow rather than natural fallow being used. Planted casuarina fallows are very common in the Upper Tekin Basin. Normally this change follows others such as gardens being cropped for longer periods.

(iii) Change to higher yielding cultivars of staple crops. Recently introduced sweet potato cultivars, such as "Aviam" (from Aviam Tea Plantation near Mt. Hagen) are being used more in gardens.

(iv) Longer cultivation periods. This is just starting. Examples were seen where land was cropped with two sweet potato crops rather than one.

(v) Mounding. As a consequence of (iv), it becomes possible to make sweet potato mounds. It has been shown at Aiyura that sweet potato grown in mounds significantly outyields crops grown on flat land.

Crop yields

No yields were measured, but a number of estimates were made from the size of sweet potato tubers and taro corms. For both crops, crop yields appeared to be high, for example, 6-8 t/ha for taro, 15-20 t/ha for sweet potato.

Pest and disease problems

Sweet potato scab caused by Elsinoe batatas was noted on sweet potato. People claim to prune diseased plants. It is believed by agriculturists that this disease does not normally cause appreciable crop losses.

More serious problems were apparent on taro however. Three forms of a corm rot are identified by the villagers. Specimens have been forwarded to the Chief Plant Pathologist, DPI, for identification of the causal organism.

Taro beetle (Papuana spp.) is said to be a very serious problem at times. The people say they do not plant other taro crops near the location of an outbreak, but move to a different area.

A small white larvae was claimed to be eating the outside of taro corms in the Upper Tekin Basin. Unfortunately specimens collected were subsequently lost before they could be identified.

The luluai at Divanap (Ale) described a disease of taro, the symptoms of which correspond to the lethal virus disease (alomae) (leaves become chlorotic and then rot, followed by rotting of the petiole). It is said to be an ancient disease and an epidemic occurred about 25 years ago.

Casuarinas grow very poorly in some places whilst nearby casuarina trees are quite healthy. On affected trees, older and younger leaves were red and dieback of the branches was occurring. It is likely the symptoms are caused by a nutritional deficiency.

Seasonality of food supply

I gathered information on this, but no overall picture emerges as to when shortages occur or their cause. The following is a summary:

Crop failure in 1976 (at Oksapmin) due to the dryness (van Groningen, 1978).

In the old times there were certain periods in the year when the food was very scarce due to the fact that people cultivated one garden at the same time and only thought of making a new one when the old one was going to finish (van Groningen, 1978).

Food shortages in 1975-76, most probably due to the extended high rainfall (van Groningen, 1978).

Duvan village, Lower Bak Valley. Food shortage in September 1979 because too many gardens had been planted at the same time (N. Cape).

Kanana village, Lower Bak Valley. Food shortages in 1979 because no gardening was done for 6 weeks following a series of mourning periods (N. Cape).

Divanap village, Upper Tekin Basin. Food shortages in October to November 1978, and April to July, 1979. (Luluai).

Supply of the supplementary crops is also seasonal. Crops of pandanus occurred in February 1978, July 1979 and another is expected in January 1980. It can be seen from these dates that a fruiting is not regular, although people said the season usually occurs about February.

Of the other important supplementary crops, beans and corn are available in good supply for a short period. This is several months after a dry period (such as October-November 1979) when many new gardens are planted. They are then not available in any quantity till further new gardens are planted.

One of the food problems of the region then is a lack of supply of supplementary crops throughout the year.

MALNUTRITION

One of the features of the Oksapmin sub-district is the high malnutrition rates (Table 3). These are worse in the Bak Valley where current standards for malnutrition indicate that three children out of four are malnourished.

What is causing this very high rate in the Bak Valley? Whilst the soil appears to be infertile, the basic agricultural system is sound. Crop yields appear to be reasonably good. This suggests then that garden area per person is inadequate. Male absenteeism is high (for example, 33% at Kweptanap, Upper Bak Valley). An excessive rate of male absenteeism may be causing food gardens to be too small because the work of these men falls on the remaining men and on the women. To test this, the weight for age of children in the Bak Valley was classified by presence/absence of father (Table 7). Statistical analysis done by Mr. D. Moles, DPI biometrician, indicated that for Daburap village an excess of children below 70% weight for age occurs in households with the father absent ($p < 0.05$). This association did not hold for Kweptanap.

The available data then does not support strongly the hypothesis that absenteeism is causing the very high malnutrition rates. A factor that would influence such an analysis is that "begging is a way of life amongst the Oksapmin" (N. Cape). So a family with inadequate gardens and food supply would not necessarily have the most malnourished children, but their begging for food would spread the food shortages amongst other people in the community.

Another explanation for the malnutrition, again a social rather than an environmental problem, is that people simply do not have enough gardens. According to Mrs. Guilford, many people in the Bak Valley have one garden only, and so have to rely on other people's produce when their garden is immature or has finished bearing.

To examine further these hypotheses, a research programme in the Bak Valley is suggested.

Table 7. Number of children of various weight for age categories at Kweptanap and Daburap villages, Bak Valley

Weight for age	Father present	Father just left	Father absent	Total
Kweptanap				
>85	6	2	0	8
70-84	46	11	11	68
<70	16	1	1	18
TOTAL	68	14	12	94
		χ^2 = 4.95 (not significant)		
Daburap				
>85	9	0	1	10
70-84	43	4	7	54
<70	16	2	13	31
TOTAL	68	6	21	95
		χ^2 = 11.64 * (significant at p < 0.05)		

FURTHER INPUTS

To upgrade subsistence agriculture in the sub-district, the following inputs are suggested.

1. A research project in the Bak Valley to determine what is responsible for the high malnutrition rates.

2. Agronomic research on food crops, with particular emphasis on intensification in the Upper Tekin Basin.

3. An extension programme on subsistence agriculture.

It is suggested that the person conducting the research in the Bak Valley be based at the house at Kweptanap, and that two people or a couple working on projects 2 and 3 be based at Oksapmin.

An expansion of these projects is as follows:

1. Research on the causes of high malnutrition rates. This would be suitable for a Ph.D. student or a post doctoral worker, or a sabbatical leave project.

It would involve a detailed description of the agricultural systems and an attempt to relate malnutrition to absenteeism, mean garden area per person, and other social factors.

2. Agronomic research. This should be very applied and draw heavily on work done in other highland areas especially at Aiyura, Nembi Plateau, SHP and Simbu Provinces. It should be made relevant as possible to all highland regions of the Sandaun and Western Provinces.

Components could be as follows:

(i) Measuring sweet potato yield in representative areas of the sub-district to determine where production problems exist.

(ii) Description of agricultural systems in one or two areas, for example, the Upper Tekin Basin.

(iii) Evaluation of high yielding sweet potato cultivars from outside the sub-district, especially from Aiyura.

(iv) Trial work and demonstration plots on intensification, particularly where land pressure is high. This could include the benefits of composting in sweet potato mounds, problems in establishing casuarina fallows, and use of organic fertilizer on household gardens.

(v) Introduction and evaluation of new crops, in particular Rungia and Dicliptera, and better yielding cultivars of existing crops, such as sweet potato.

(vi) Identification and control measures (?) for pest and disease problems.

3. Extension work should concentrate on the following:

(i) Encouraging people to eat better by discussing the three food groups, and the need for an adequate supply of food all year round.

(ii) Encouraging production of crops that bear all year round, for example, lima beans, Rungia, aibika.

(iii) Promotion of methods of agricultural intensification in land short areas, viz.,

- more use of casuarina fallows
- crop replanting and mounding
- composting of bananas and other household garden crops
- composting of organic matter within sweet potato mounds where land use is intensive on river flats
- crop rotation where crop replanting is occurring.

(iv) Working with the primary schools on the following:

- greater use of green vegetables, especially Oenanthe
- more planting of fruit trees such as bananas, tree tomato and guava
- soil fertility aspects of their gardens including the use of compost heaps (made with organic rubbish and pig manure) and casuarina fallows.

(v) Planting material distribution of the following crops:

Potato
Peanuts
Soyabeans
Winged beans
French beans
Lima beans
Rungia
Guava
Tree tomato
Orange
Mandarin

(vi) Extension work should not neglect cash crops, such as vegetables, coffee and chillies. Apart from other considerations, cash can act as a buffer to fluctuations in subsistence food production. It also provides people with the ability to purchase nutritious food such as dripping and tinned fish.

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