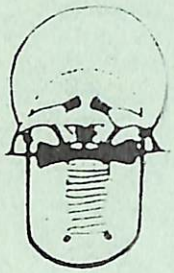
DEPARTMENT OF ENGA PROVINCE

TECHNICAL BULLETIN No. 1



NATURAL DISASTERS
SURVEYS AND STUDIES:
FROST

DIVISION OF PRIMARY INDUSTRY

SUBSISTENCE UNIT

Anton Goie

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PREFACE

This is the report of a survey of various factors relating to frost, conducted between September 1983 and April 1984 for the Enga Provincial Government.

The Enga Provincial Government provided the funds for the study. The Subsistence Unit of the Division of Primary Industry (an Enga Yaaka Lasemana project) provided most of the administration, transportation, office space and equipment. The Division of Primary Industry also provided an assistant for the survey.

ACKNOWLEDGEMENTS

We are greatful to the Division of Primary Industry, (Edison Paugari - Assistant Secretary, Nick Pasumbi - DRDO Laiagam, Tatakali Tangui - RDO Laiagam, Abraham Nane and staff at Kandep station) for the many ways they helped us. Also the DPI Subsistence Unit (Dr. Wohlt, J. Kaptigau, the two Ruths) for their unfailing help, advice and encouragement. They all provided office space, equipment and vehicles.

Thanks to the Institute of Applied Social and Economic Research for the provision of a vehicle for part of the time at an incredibly low rental fee.

We thank the people of Enga who generously gave their time to provide information and hospitality. We especially want to thank the people from the frost areas of Enga. A special thanks to Akulya of Tinjipaka for providing land, help and hospitality towards the establishing of our monitoring site. And a special thanks to the staff and students of Wambup community school for their help.

Timothy Pyaku and James Mapao, two Medical students, will never be forgotten for their help. They bore the pains of most of our field surveys.

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1. INTRODUCTION

Following frequent occurrences of food shortage resulting from frost and drought in the last ten years (of which the 1971-72 frost was the worst) many people who were involved in food distribution and others who were observers, called for provincial level contingency plans and programmes to monitor effects of frost on people and their food gardens. Monitoring was to be done so that authorities would have better information on which to base decisons about subsequent frosts. In response to these calls, the Enga Provincial Government set aside K20,000 in its 1983 budget for such a project.

The availibility of this money came to the notice of the DPI Land Use Officer who drew up a brief proposal on how to use this money. The proposal (see Appendix I) outlined several activities. The main focus of the project was to carefully establish a solid data base on which decisions and actions could be made during subsequent frosts and food shortages.

The proposal also suggested that a monitoring system for frost be established with a fieldsite house, an automatic weather station and foodcrop experimental gardens. Alongside these, a target community was to be chosen and measurements were to be taken regularly to keep track of adult body weight fluctuations.

The survey from which most of this report derives was designed in two parts. Part one was carried out in the actual areas where frost is experienced. The main focii were: how often frost has been experienced, how people have been able to cope with it through the ages, and whether these options are still available to them after the 1971-72 government intervention. About 190 male household heads were interviewed, 65% of which were old enough to remember something of the 1941 frost.

The second part of the survey was aimed at frost free areas where frost victims take refuge. This was basically intended to find out if these people were still willing to support frost victims when they know that frost victims now have other options (e.g. cash savings, government aid).

We also wanted to know whether the government, in distributing rice in 1971-72, disrupted the traditional methods previously employed by frost victims to cope with food shortages. Was the government right to step in because the 1972 frost was too severe and widespread for the long established traditional mechanism of combating frost and hunger to operate adequately? We also hoped to establish whether these mechanisms were still available, or could be revived if they had been disrupted. We also wanted to find out the magnitude of damage done to people, food gardens and livestock.

2. HISTORY OF FROST

Frost causing food shortages only came strongly to the notice of government bodies and others since 1972. Although it may look like a recent phenomenon, it has undoubtedly been present in the highlands for hundreds of years. The lack of written records makes it difficult to say how often it has occurred, how severe it could be and where it has occurred.

Old men we talked to remember frost occurrences prior to outside contact. It seems, from these stories, there had been major frosts, similar to or worse than the 1971-72 frost, prior to contact. Although one can not place complete trust in these stories, it is evident enough to argue that frosts and food shortages are not unfamiliar to highlands farmers. However, it is hard to guess their severity, areal extent and the frequency of these unrecorded frosts.

The earliest recorded frost was in about 1941, around the time when 'kiaps', prospectors, explorers and missionaries were wandering through the highlands, establishing contact. The 1941 frost lingers quite clearly in the minds of older men and women who survived it because a lot of their relatives and friends died of hunger (so they say) at the time. Wohlt (1978), who was in Yumbisa in the Upper Wage during the 1972 frost, recorded 46 deaths attributed to the 1941 frost in Yumbisa alone, although all deaths from any cause around the time of a frost tend to be recalled as frost related. Danny Lea, who went on a carrier recruiting patrol through the area in 1943 noted the lack of able enough men and a small population (Powell, J.M. & J.P. 1974). These bits of information give us some idea of the calamity of the 1941 frost, which also confirms that the 1971-72 frost and the food shortage that followed were not the first of their kind.

Many, when asked, also remember stories of a long period of food shortage that occurred in about the mid-1920s (Wohlt 1978). However, we have no idea how severe it may have been and what caused it. We assume that the shortage was bad enough for people to talk about a generation later. It is therefore, probable that frost as severe as the 1941 and 1972 frosts might be experienced every 30 to 50 years in these high altitudes areas (Wohlt et al, 1982).

In other reports, there were frosts in 1949, 1950 and 1962, (Brookfield, 1964). Heavy frost was reported in 1961 for the Mariant and the Upper Kaugel valleys, and again, moderate frost was reported in the same valleys in 1963 (Bowers, 1968).

Approximately eight years after the 1971-72 frost, there was a significant reoccurrence. In 1980 Lagaip, Kandep, Tambul, and parts of Southern Highlands Province received frost. Wohlt and Goie driving through Margarima, Kandep, Yumbisa-Karekare and the Lagaip Headwaters in November 1980, noted moderate to severe damages in the Mariant, Byaka and parts of Yumbisa-Karekare areas. Imapiaka and Kindirep were reportedly badly hit and families were moving out to lower altitudes. Elsewhere the damages were irregular as is typical of light to moderate frost (Wohlt & Goie, 1980).

The Enga Provincial Government that year, provided supplementary food and planting materials following repeated requests from leaders in those frost areas.

Not very long after the 1980 frost, another one followed (July 1982). This time, Simbu Land Use Project (SLUP) workers reported that places above 2100 m in Simbu had also received some scattered light frost. Places in the Upper Mai Valley, Gembogl, Nogar, Upper Koronigl and the Kilau areas received light frost. Major Maisa (PNG Defence Force), T.Kapui (NPO) and A.Goie (SLUP) driving

around the provinces noted moderate to heavy frost in the Tambul Valley and light to moderate frost in the Lagaip Headwaters. Kandep and parts of Southern Highlands Province were reported to have been hit also.

DPI officers in Wabag reported villagers saying that this frost (1982) was far more severe than the 1971-72 and 1980 frosts. Trees and plants (e.g. pyrethrum) which survived previous frosts were reported to have been affected. This is rather unlikely over the whole area although in small, local areas there could have been unusual damage. Families in the Kandep and Lagaip districts were reportedly moving out to upper Mendi, Wabag, Western Highlands Province and other lower altitude areas.

In the same year, between the 3rd and 5th of August, frost occurred again in some of these areas, damaging newly planted gardens.

3. FROST: EFFECTS AND VICTIMS

Places in the highlands above 2000m can expect frost almost any year. Occassionally however, a severe frost may be experienced that can spread below the 2000 meter mark. For example, in 1972, light frost fell on the lower slopes of the Upper Lai, Wabag, and Wapenamanda areas and the Wahgi Valley. Some of these places are as low as 1600 meters above sea level (Brown and Powell, 1972).

Frost is more likely during the dry months of each year, from June to September, whenever there is a prolonged period of dry weather. In 1972, frost occurred as late as October and November in places. Farmers in frost areas worry whenever there is a long period of dry weather because in their experience dry days and clear skies seem to be the prerequisite for frost.

High altitude valleys with poor air drainage like the Mariant and Kandep basins and similar but smaller valleys in the Upper Wage area, seem to be the most susceptible areas. In these types of poorly drained basins and valleys, light frost can be expected almost every year. Sometimes other well drained areas can also be affected by frost, e.g., the Upper Simbu Valley experienced frost in 1982, but it is not as common as the above. The only time older men and women in Simbu remember a frost was somewhere around the period of first contact (SLUP 1982).

As mentioned above, the ideal environments for frost are, high altitude, grass covered, valley floors with poor air drainage. The Tambul basin, Lai-Mariant, Yumbisa, Kindrep, and Yapai Valleys are prime examples. On clear nights when there is no cloud cover over these basins and valleys, the cold air from the hills and mountains surrounding them descends to settle on the valley floor and freeze up the dew that forms on the leaves of crops and other plants - thus creating frost or what Engans call pip or kalapita.

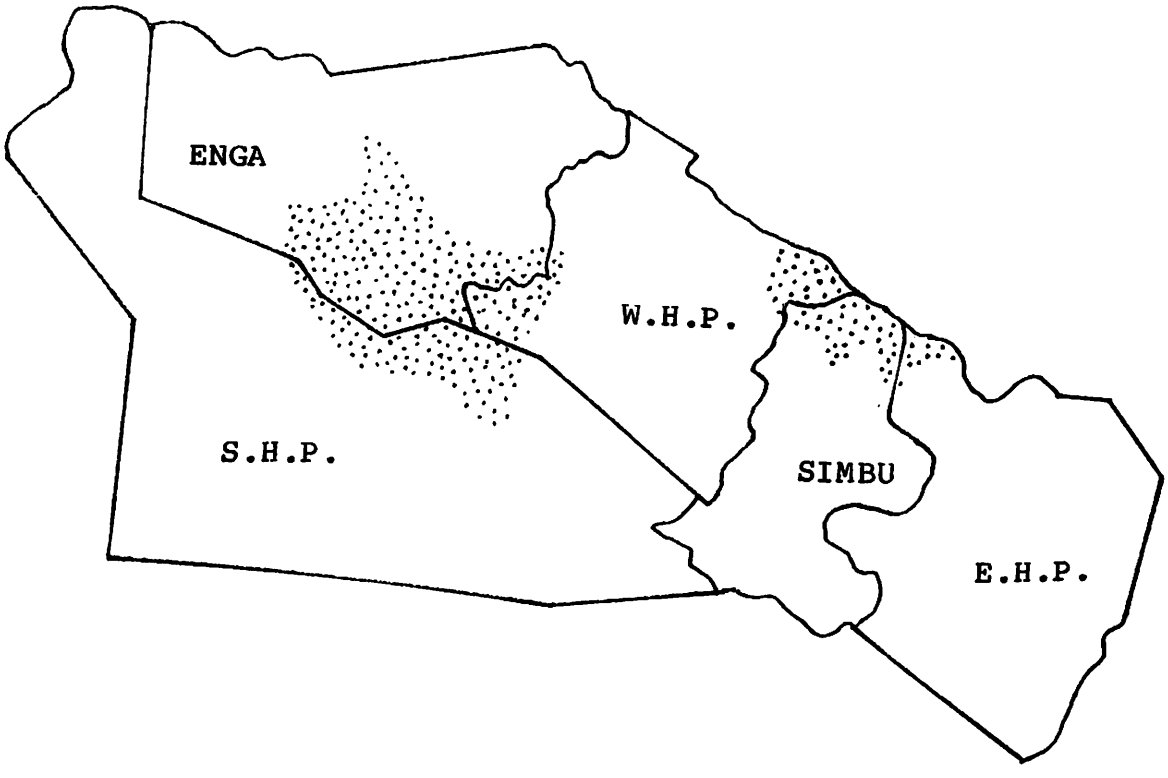
Temperatures below 7 degrees celsius are not uncommon in the highlands. McAlpine et al (1975), worked out an annual extreme minimum of 2.7 degrees C and an annual mean minimum of 11.1 degrees C for Wabag from records kept between 1950 and 1970. Therefore, if Wabag, at 2000 m.a.s.l., can achieve as low a temperature as the above, one can expect lower temperatures in much higher places like Sirunki.

Brookfield (1964) and Waddell (1968) note that frost can occur with screen temperatures of 4.4 degree celsius. During the 1972 frost at Tambul, temperatures went down to 4.4 degrees C for 25 days, 0 degrees celsius for 5 days and -1.1 degrees C on two nights between August and October 1972 (Brown and Powell 1972).

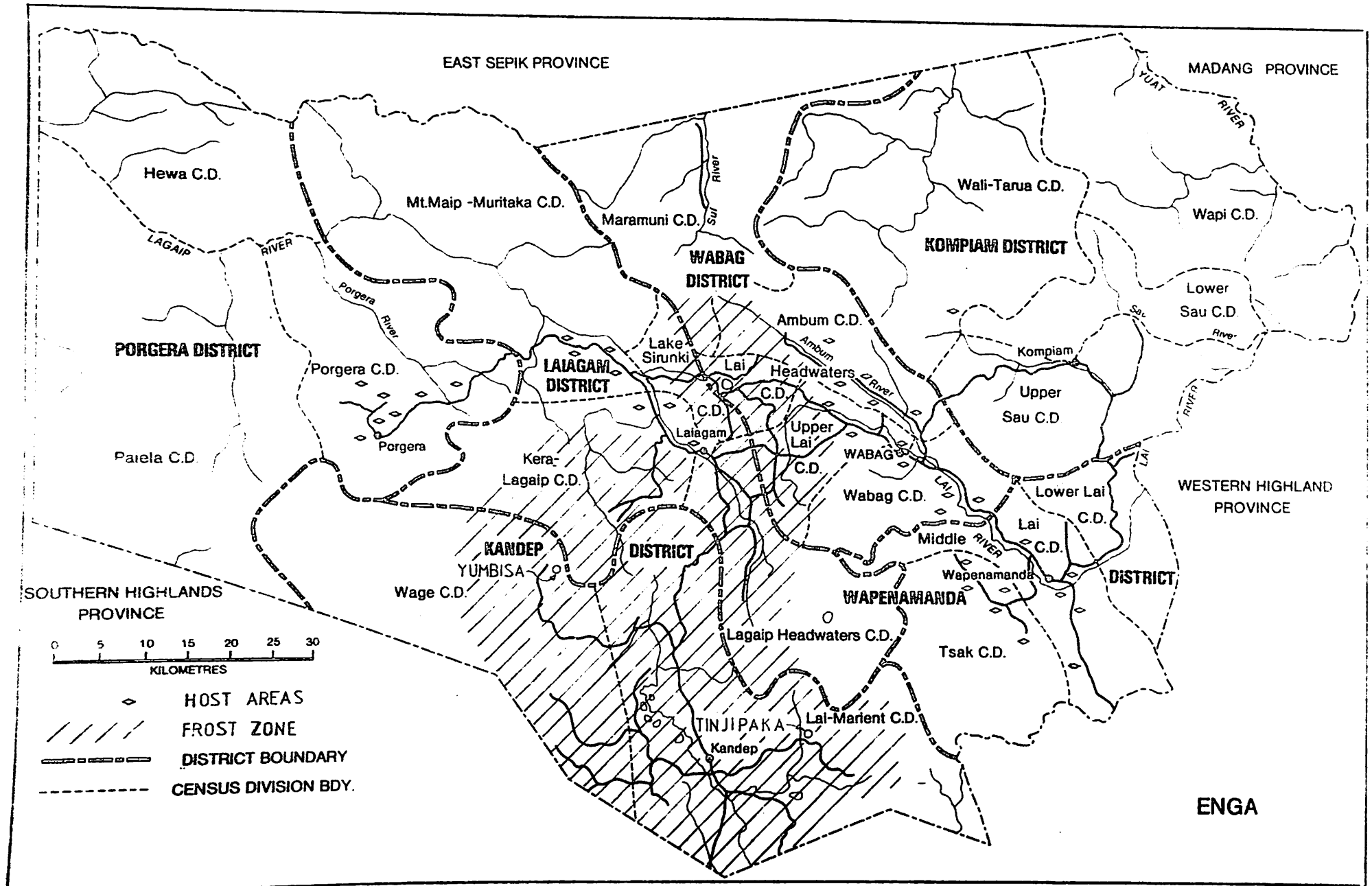
From Yumbisa data, Wohlt and Humphreys worked out an annual minimum of 9.3 degree C and 8.5 degrees C for drier months - May to October (Wohlt and Humphreys 1982). During the frost in 1972, Wohlt recorded the following temperatures: -0.8 degrees C on 1 Aug, 17 and 30 Sept, 1 and 3 Oct, - 1.7 degrees C on 2 Oct. (These are daily temperatures as recorded.) The monthly means for these three months were 6.8, 8.1 and 7.5 degrees C in that order. (Wohlt & Humphrey 1981). Although these means are near to the usual temperatures of this area, you only need one or two nights with lower temperatures for it to frost.

In the last 40 to 50 years it is known (through recall, stories and some written records) to have frosted in parts of the Eastern Highlands, Simbu, Western Highlands, Enga and the Southern Highlands Provinces (see Map I). Old people in these areas remember very well the long food shortages that followed these frosts. There was scattered light to moderate frost again in 1982 in all the above places (also shown on Map I). In some places, like the Tambul basin, Kandep and the Upper Lagaip the frost was much more severe.

MAP I Known frost areas in the Highlands



Areas frosted at least twice in the last 40 years.



MAP II Frost and host areas in Enga Province

The frost zone in Enga Province has probably experienced 14 to 15 significant frosts in the last 40 to 50 years. This zone includes, Sirunki, Upper Lagaip, Kandep (Lai) Valley, Mariant, and Wage areas (see Map II). The worst of these frosts seem to be (according to the people) the 1940-41, 1971-72, 1980 and 1982 frosts. The latter 2 are probably included more from a freshness of memory than careful comparison. Local variability confuses the issue as well. Some information concerning the details of the severity, geographical extent, number of occurrences, etc, can be found in some libraries and in Provincial Government files.

Effects of Frost

What one actually sees the day after a night of frost is a picture similar to that of a landscape where a bushfire has just passed over. Early in the morning, before the sun comes up, one cannot tell very much. However, at a closer look, the leaves and tops of plants and food crops will be shrivelled up and darker green in color as if they have been near a fire. Gradually, as the sun comes up, anything that has been affected will turn black and by mid-morning the whole country side will show patches of black. After a few days everything will look brown and dry.

Frost is capable of killing almost any growing plant that it touches whether it is light or heavy. Some crops (e.g. cabbages) and tree plants may escape light to moderate frost but there is no guarantee that they will survive a continous heavy frost. The 1972 frost, for example, killed forest trees on the mountains between the Lagaip and Kandep Districts. Passing through, one can still witness the remnants. Brown and Powell (1972) describe the crops and plants that are affected and those that are not affected at all or only slightly. This, however, does not mean that some crops and plants are

totally frost resistant. In my opinion, plants with young, hairy growing tips that are capable of collecting dew cannot escape frost. Even if only the growing tips are killed, the plant is retarded or stops growing for some time. Retardation is much more evident in food crops. Villagers in 1982 were reported to have said that even pyrethrum and eucalyptus trees, which survived the 1971-72 frost were affected (DPI 1982). In sum, frost has no mercy for anything which means it will be a longtime before anyone can find a plant that is completely frost resistant, even more so, a starchy food crop.

Food Crops

As we all know, "kaukau" (*Ipomea batatas*) is a very important crop in PNG but relatively little is known about it. In the last 15 years, it has been a victim of frost, causing major food shortages in many places in the highlands but very little could be done about it . Although other food crops are grown in these frost zones, 'kaukau' is the major subsistence crop for both humans and livestock.

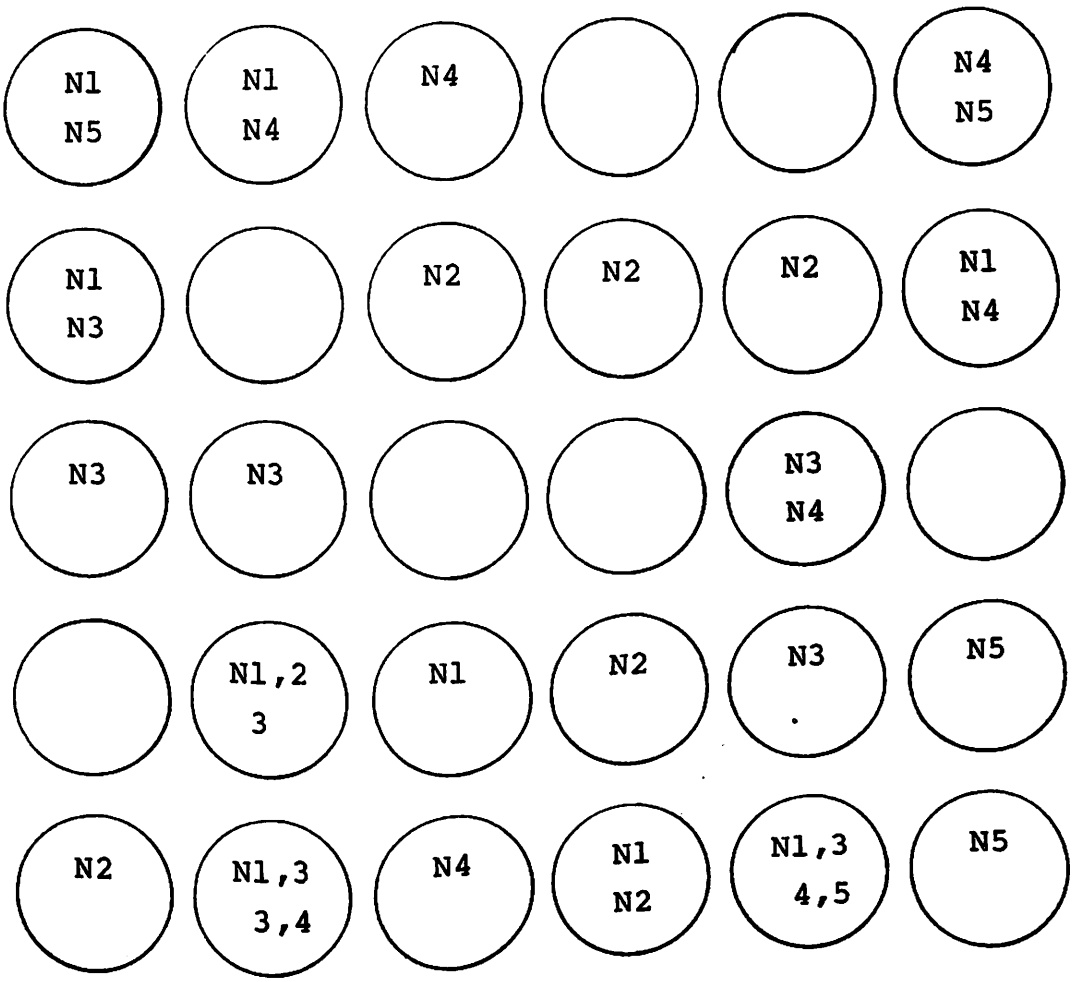
Sweet potato plants frosted at different stages of development react in different ways but the fact remains that they are affected and the end product is not nearly the same as in ordinary times. Only the mere growing tips of a 'kaukau' plant need to be burnt (as is often the case) for the young 'kaukau' to be retarded, the fully matured tubers to begin rotting in a matter of weeks, and the partly mature to stop growing for a time. Therefore, as discussed earlier, because of the importance, of 'kaukau' any amount of loss is worthy of concern.

A characteristic of light to moderate frost, however, is that it hits patches rather than spreading out over the whole ground surface. It is typical to see several mounds/gardens in one corner of a garden/valley affected

and other parts untouched. A second night of frost will also follow more or less the same pattern hitting some mounds/gardens but leaving others (see Figure 1). Therefore, light to moderate frosts are not so alarming as one would think. However, consecutive nights of light to moderate frost are as bad as a heavy frost.

Figure 1

Example of light to moderate frost damage



Note: Each circle represents a 'kaukau' mound or a garden.

Figure 1 should give one an idea of how a light to moderate frost affects a garden. The first night of frost (N1) affects only nine mounds (many times only part of a mound) in the whole garden. If it frosts again a second night or a third night, the same thing happens. On the 3rd night (N3), for example, it only falls on three mounds that have not been affected and five mounds that have already been, probably wiping those mounds out altogether.

Other Crops

There are a limited number of other food crops that are grown in frost areas: sugarcane, taro, peas, cabbages, corn, Irish potato, pumpkin, *Rungia*, *Setaria*, and a few assorted beans and greens (see Appendix II c). Out of all these crops, cabbages and peas seem to be able to withstand light to moderate frosts. Irish potatoes loose their leaves in a frost but the tubers are not affected, unless it is a very severe, heavy frost.

Pigs

It is common knowledge that pigs play an important role in the livelyhood of the Enga and other highlanders. Unfortunately, this very important animal is fed on 'kaukau'. During times of food shortage, pigs are affected much more than humans. Whatever 'kaukau' is available is eaten by humans while pigs as well as other livestock get very little or nothing. Many times these livestock are killed and eaten, sometimes to fill empty stomaches or many times to lessen the number of mouths to feed.

People affected by frost and food shortage often do the following with their pigs. (Figures are from the Survey - percentages of all reported pigs for all frosts.)

1. Fully grown pigs are killed and eaten. Some pigs or pork may be given away to repay debts. More recently, some can be sold for cash (together 49%).

2. Families who move out to host areas take breeding stock (26%) plus some to pay for food (21%).

3. A few are turned into the bush to forage for themselves (4%).

It is clear that pigs are an important factor in deciding whether to move or stay. People who don't have pigs to pay their hosts may be hesitant to move while those who have a small herd may decide to move as quickly as possible in case their breeding stock are lost. In more densely populated areas where there is less grazing and foraging space during food shortages, people may likewise have to move out in order to save their pigs.

We see, then, that it is possible for people to migrate for two separate reasons. Some move to save their own skins but may lose a lot of their pigs in the process. Others, move to save their pigs as well as saving their own skins.

People in the Lagaip district are generally closer to places they can move to at times of frost (e.g. the Lower Lagaip, Upper Lai, Ambum and mid-Lai areas). The distances between these areas and the Lagaip frost areas are comparatively shorter than migration distances for Kandep. People from the Kandep district migrate to the Tsaka, Porgera, Kera-Lagaip areas or the Southern Highlands province (see Table 3). The Kandep people have to move much further and because of the distance they might have to pay more to their rather more distantly related hosts. Similarly, one might expect that Lagaip people would have more "non-local" gardens in frost free areas and closer ties with their hosts which should mean that they give fewer pigs to their host as payments.

Our evidence suggests that this is the case. Table 1 summarizes the reported pig losses from 1941, 1972 and 1982 by proportion of pigs lost for the Mariant and Wage areas compared to the rest of the frost zone. This stratification is choosen to compare the worst frosted areas to the rest of the frost zone. The severity of frost is inferred from the percentage of families who migrated at least once as well as observations by Wohlt and Goie since 1972. The 1941 figures for Wage and Mariant are based on a very small sample in the Wage area. Judging from Wohlt's (1978) work there in 1972, this figure should probably be higher.

Table 1

Reported pig losses in three frosts

	% of pigs lost		% families migrated	
Date	Wage and Mariant	Rest of frost zone	Wage and Mariant	Rest of frost zone
1941	77 *	81	94	88
1972	79	69	(1972 and 1982)	
1982	57	53	(94	81)

* probably higher (see text)
( ) 1972 and 1982 together

Pig losses in the most severely affected areas appear to be slightly higher than in other areas and the proportion is comparable to the differences in severity implied by the proportions of frost migrants. The implications are that the whole frost zone (as defined here) is similarly at risk with respect to pig losses.

Food Availibility

It is not totally correct to think that automatically after a frost everyone is short of food. Frosted 'kaukau' tubers deteriorate but it takes weeks for the tubers to rot completely. In protected patches (e.g, near bush, hillside) some gardens remain untouched. Frosted 'kaukau' tubers rot much slower without rain. Whatever 'kaukau' is harvested can be stored in houses up to four weeks.

Corn, which grows and yields fairly well in these cold areas is very much like other crops in leaf damage, but the fully mature corn cobs are not affected by the frost. They can be left on their stalk for a fairly long time (eight weeks). Although villagers do not like dry corn very much, it can be dried and stored for a very long time (reportedly 18 to 24 months). It can be eaten when one is desperate.

'Irish potato' if properly covered will keep in the ground much longer than 'kaukau' even if its leaves have been destroyed. The taste and structure of the tuber may be affected but deterioration is much more gradual. Harvested potatoes stored properly in dry cool places can last much longer than 'kaukau'.

Taro, though not widely grown, may either keep developing or retain its food value so long as the leaves and the growing tops are chopped off in time, either before or soon after the frost. In many cases taro is grown in ditches where it frequently escapes frost. In Yumbisa, in 1982, where only a few people were growing taro, the leaves and growing tops were chopped off the morning after a frost.

Other crops, especially greens, are killed very quickly by frost (except cabbages) but some can grow back to edible size in about four to six weeks. (See Wohlt et al, 1982, for more detailed description.)

Bush foods are also available during times of frost (as at all times) but reliability of continous supply is questionable. (See Appendix II for the list of bush foods.) Marsupials, birds, grubs and, in places, fish can be hunted and collected but there is no guarantee of continous plentiful supply. (See also Wohlt, 1978, pp 124-128.)

Pigs, cassowaries, chickens and other livestock are available and people usually kill them off and eat them when they have to in a bid to save food supplies. Pigs are the major animals kept by farmers that can also be used to buy food from fellow farmers in other unaffected valleys.

In more recent times, tradestores are available in most areas for people to buy food. Money saved from pyrethrum and other sales and donations from 'wantoks', relatives who earn wages, salaries in government, companies, private business, etc. can be used to buy trade store foods.

Although not all these options of food sources are available to every farmer, there is always an alternative source of food supply. No matter how small these food supplies may be, we are not worried about "full bellies" but to stay alive untill the next harvest. And for 'kaukau' it means a waiting time of eight to ten months.

In short, frost does damage to almost everything that it touches but does not eradicate completely all sources of local food supply. People now have more alternative sources of food supply than in pre-contact times.

4. HOSTS AND MIGRANTS

Movement of people from one place to another can take place for all kinds of reasons: marriages, jobs, education etc. These movements could be permanent or temporary. The kind of movements we want to talk about here are mostly temporary movements that are caused by food shortages after gardens are destroyed by severe frosts. People migrate from these frost zones temporarily to lower, warmer altitudes to avoid starvation. Wohlt who was in the Upper Wage at the time of the frost in 1972 discusses in great detail these kinds of movements by the Yumbis people (see Wohlt, 1978, pp. 108-123). People who move, live in their hosts' places but go back and forth to their homes reestablishing their gardens (often with planting material from the host area) until their own gardens are ready for harvesting. In most cases people stay away for 9 or 10 months but may come and go for 2 years. Others may come back to their own places earlier but usually have to make regular trips back to their hosts for food supplies. In a very few cases some settle for good. As mentioned earlier on, 'kaukau' matures after 8 to 9 months in these frost zones so 'kaukau' planted straight after frost takes the same number of months. The migrants wait for more or less the same number of months in their host areas too.

In Enga, the following areas are known frost zones from which people usually migrate after frost: the Wage, Lai-Mariant, the Upper Lagaip, Sirunki and some places like Yapai, Yengyeng and places on the upper slopes of the Kera-Lagaip area (see Map II). In these places most men over the age of 50 would have seen up to ten different frosts. Most of these men would have migrated at least two times in their lives, maybe first with their father and another time with their own families.

Men over 50 would certainly have migrated in the 1940s with their fathers, some in 1972 and others in the 1980-82 frosts where relief feeding did not reach as many people as it did in 1972. In our survey in the frost areas, we tended to choose older men to get maximum time depth. Sixty-five percent of those interviewed were born before the 1941 frost.

In the last 45 years, of the total men interviewed, 90% of those alive in 1941 and 86% of the younger men had migrated at least once. Many would have migrated twice. In the upper Wage area, 96% of the total interviewed, moved at least once in their life. Table 2 summarizes migration rates for the different areas and this measure serves as an indicator of the relative impact of frost in those places.

Table 2

Rates of frost migration

	Percent migrated from					
Year	Wage	Kandep Mariant	Sirunki	Kandep Lai	Upper Lagaip	No. Cases
1941	96	93	87	82	90	136
1972 & 1982	97	92	82	83	79	189
All	96	92	84	83	84	189

The Wage and Mariant areas show the greater impact while Sirunki, Kandep and Upper Lagaip are only slightly better off.

Migrants tend to go to several host areas from any given source area. Table 3 shows these patterns.

Table 3

Frost: migration patterns 1940's - 1982

Migrated to:	Percent migrated from Wage	Kandep Mariant	Sirunki	Kandep Lai	Upper Lagaip	No. Cases
U/Lai	-	-	36	-	17	16
Wabag	-	2	13	18	27	21
Ambum	-	-	19	9	13	12
Mid-Lai	3	-	19	-	25	19
Lower Lai	-	14	-	-	-	7
Tsak	-	33	-	18	8	23
Kera-Lagaip	37	-	13	9	7	18
Porgera	57	-	-	27	-	20
Other CD	-	-	-	-	3	2
Mendi	-	51	-	9	-	26
Tari	3	-	-	-	-	1
W.H.P.	-	-	-	9	-	1
No. cases	30	49	16	11	60	166

Of all those who migrated from the Upper Lagaip, 51% moved to the Upper Lai, Kera-Lagaip and Wabag areas which are immediately adjacent. The Ambum valley, Middle Lai and Tsak received 46% and the rest went elsewhere (see Map II). From Sirunki, 81% moved to nearby Upper Lai, Ambum, Kera-Lagaip and Wabag areas while 19% went to the Mid-Lai.

Some 87% from the Wage area moved to Porgera and Kera-Lagaip. Tari and Mid-Lai received 3% each. From the Mariant, 84% went into the Upper Mendi area and the Tsak valley. The rest moved to the lower Lai area and Wabag. Finally, from the Kandep Valley (Lai), 54% moved to Porgera, Tsak and Mendi. The rest were evenly distributed among Wabag, Ambum valley, Kera-Lagaip and Western Highlands province.

The largest numbers of people who migrate seem to go to the upper Mendi, Tsak valley, Wabag and Porgera areas respectively but Mid-Lai, Kera-Lagaip and Upper Lai are close behind.

Looking from the other end, we find from our sample of 114 hosts, that between them they have hosted 124 families in the last 40 years. Some of them have hosted twice while most of them have hosted once. The biggest number of families seem to have been hosted in the 1972 frost. Tables 4 and 5 show the distributions by number of families and number of migrants.

Table 4

Number of cases of migrants hosted, 1941-1982

Date	Porgera	Kera Lagaip	Upper Lai	Tsak	Upper Lagaip	Total	%
1941	16	3	2	10	0	31	25
1972	6	33	9	8	1	57	46
1980	0	1	0	0	0	1	1
1982	1	1	17	16	0	35	28
Total	23	38	28	34	1*	124	100
%	19	31	23	27	1	100	

Table: 5

Number of people hosted, 1941-1982

Date	Porgera	Kera Lagaip	Upper Lai	Tsak	Upper Lagaip	Total	%
1941	89	9	2	59	0	159	24
1972	29	195	42	18	4	288	44
1980	0	16	0	0	0	16	2
1982	9	16	84	79	0	188	29
Total	127	256	128	156	4*	651	100
%	20	36	20	24	1	100	

* Very small sample.

In Tables 4 and 5 you will find that, between the 114 hosts, a total of 651 people were hosted - about 5.7 persons per host excluding the exceptional case in 1980. Out of this total, 44% were hosted in the 1972 frost despite the government relief feeding. (It could be that recent memories are fresher in our informants minds and, of course, there are fewer families now that existed in 1941.) The number of people hosted in 1941 and 1982 are similar while very few are known to have moved in the other frost years.

These movements of people during food shortages seem to follow:

a) place of ancestral origin, e.g. most Mariant migrants go to the upper Mendi where they are believed to have originated,

b) traditional links, e.g., tee net works,

c) blood ties and

d) the geographically nearest area where there is food available. It is most sensible, for example, for the Mariant people to move to the Tsak valley and upper Mendi areas than any other places. The same goes for the upper Wage people who mostly move to the Porgera district.

The usual way these people move is by foot and it would be much harder for the Upper Wage people to walk the other way into the Tsak or the Upper Mendi area. Recently, however, some have been able to move much further than before because of the availability of motor transport. Some Kandep people that I talked to, for instance, said they had moved to relatives living in settlement blocks in the Western Highlands.

5. HOST - MIGRANT RELATIONSHIP

In 1972 "...Lenge... took his family to stay with his WiMoSiSnSnWiMoFaSiSnDaHu" (wife's mother's sister's son's sons's wife's mother's father's sister's sons's daughter's husband - Wohlt 1978 p113).

Relationships between hosts and migrants can be quite complicated as in the above example of a relationship between a migrant from Yumbisa in the Upper Wage and his host somewhere in Porgera. Almost all migrants are likely to be related to their host one way or another. Wohlt describes different relationships in greater detail (1978: p 111-123).

In this report, I arrange relationships into five general catogories: affines (Aff), blood relatives (BR), common ancestor (CA), trade partner (TP), and none or others (N/O). In brief, affines are host and migrants related by marriage. Blood relatives are related by blood, being lineal descendants of either the same parents or of the same grandparents (agnates). Hosts and migrants who are related through a common ancestor can be both of the above where genealogical ties are much more distant and too tenous to describe or trace. The two can easily identify by legends or folk tales. Trade partners can be any of the more obscure relationships above but the strength of their relationship lies in the continuity and frequency of their exchange relationship e.g. tee. This relation can also be an exchange relationship through an introduction by another common trade partner or an exchange relationship resulting from a meeting in another situation e.g., labourers in a plantation.

Other relationships can be of the 'good samaritan' sort: hosts who take in families just with the hope of starting up a new relationship or for straight forward wealth payments later.

Table 6

Migrants' relationship to host: migrants' view.

Relationship	Percent interviewed that migrated from: Kandep Mariant	Wage	Upper Lagaip	Sirunki	Kandep Lai	No. Cases
Blood relative (8%)	11	10	5	14	0	13
Affines (32%)	49	28	27	21	21	53
Common ancestor CA (23%)	9	34	24	50	14	38
Trade partner TP (13%)	16	7	15	0	29	22
None/others N/O (23%)	16	21	29	14	36	38
No. cases	45	29	62	14	14	164

CA - Relationship either a) unclear to explain
b) too complicated to trace
c) same place of origin

TP - a) friends from work
b) friends through another friend

N/O - a) Good Samaritan host
b) Casual friends

Looking at Table 6, we find that of all the people in the above catagories (in our sample) that ever migrated, most of them have affinal relationships with their hosts. The highest percentage of this type of relationship in any one census division was 49% from the Mariant census division while the others varied little (21-28%). Upper Lagaip and Kandep-Lai both show a high incidence of

relationships of the None/others type. The Upper Lagaip also has many affinal and common ancestor ties but Kandep relies on Trade Partners and None/others for 65% of the migrations. As these ties, especially the None/other are the weakest Kandep would seem to have the least secure hosting resources.

Sirunki and Wage depend strongly on Common Ancestor relationships and Affines secondarily. We know that most of the Wage people migrate to Porgera and we also know that (from oral history) many of the groups from Porgera are decendants of the Wage people. Therefore, it is quite understandable that most of the migrants and hosts fall into the Common Ancestor type of relationship.

Table 7

Migrants' relationship to host: hosts' view.

	Percent hosts at indicated place:					
Relationship:	Upper Lai	Kera Lagaip	Tsak	Porgera	Upper Lagaip	No. cases
Blood rel. (11%)	25	14	3	5	0	13
Affines (35%)	63	36	29	14	0	40
Common ances. CA (27%)	4	42	10	50	100	31
Trade partner TP (10%)	8	6	29	27	0	19
None/others N/O (10%)	0	3	29	5	0	11
No. cases	24	36	31	22	1 *	114

*Very small sample.

In Table 7 there is a comparison of relationship types from the host's viewpoint. The biggest percentage of migrants hosted in the Upper Lai area were the affinal type of migrants (with 63%) and this is also the highest for all the host areas recorded. Next on the ladder seem to be the CA type migrants, with 50% hosted in Porgera and 42% hosted in the Kera-Lagaip area. The TP type of migrant comes next with the highest percentages hosted (29,27) in Tsak and Porgera. The blood group type of migrant comes up with 25% hosted in the Upper-Lai area. And finally the N/O type of migrant goes to the Tsak Valley. Tables 6 & 7 agree quite closely in the total distribution of relationships except for N/O which shows a higher percentage from the migrants view.

Repayments and Future Hostings.

Most relationships between groups or individuals are kept alive by the physical exchange of goods and valuables. Many such relationships date back generations. Many may dwindle off in time but during frost periods such old relationships are revived with fresh exchanges. Other relations that never existed may be initiated at such times as well.

As many others have pointed out before, exchanges of food, goods, valuables, etc, as well as social interactions must occur frequently between groups and individuals for these relationships to be continously effective. Hosts readily take in migrants with whom they have had exchange relationships and/or other soical interactions. Many who do not have such relationships are given refuge by or through those who have. Wohlt (1978) gives very good examples of such new introductions.

Prior to outside contact, interactions would have been hindered somewhat by tribal warfare and physical distance.

After contact one would expect increased interaction between groups and individuals, migrants and hosts because of better access, e.g. road transport, less frequent warfare, etc. (Whether this is the case or not, is yet to be found out.)

We found in our survey that many people paid nothing to their hosts at the time of migration. Of the 214 families that were hosted, 32% did not pay their hosts immediately. This however does not mean that they never repaid their hosts. They may have stayed with their host because he either owed the migrant from previous times or the migrants hoped to make it up to him later. In short, repayment can be delayed or advanced. The time of the actual repayment does not seem to matter so long as it is done within and at a time that is agreeable to both parties. The majority of payments were made up of pigs while some were accompanied by other valuables, e.g. tree oil, shell etc. There is mention of cash but it is most probably a much more recent addition which might claim a bigger percentage later. Table 8 represents the cases of repayments reported by hosts from four of the hosting areas.

Repayments are necessary, as noted earlier, because they pave the way for their next movement. Hosts who had not received payments from their previous guests may be reluctant to host them again. However, that can be rectified by fresh payments (Wohlt 1978:120). Migrants who pay very well for their hosts hospitality may put their host in debt. For example, a migrant paying 5 pigs may expect the host to give him back some pigs in future. The same may go for very big mature pigs paid. Wohlt in describing this type of interaction says "one tries to have his pig and eat it too"(1978:121).

Table 8

Exchange relationships: payments from migrants to host

Place	No. cases/ No. pigs	Cash	Traditional Wealth	Other	None	Total
Lagaip	49/93	3	7	0	38	97
Kandep	62/92	6	15	3	31	117
Total	111/185	9	22	3	69	214
%	52	4	10	1	32	

1. Traditional wealth: tree oil, salt, etc.
2. Payments other then mentioned: garden, house, etc.
3. Fifteen of the above cases were payments of a combination of items mentioned: pigs plus cash, traditional wealth plus pig etc.

In the Lagaip, a mean of 1.9 pigs per family was paid and a mean of 1.5 pigs per family was paid by migrants from the Kandep district.

Almost all the hosts we interviewed implied that they would be willing to host again. One hundred and ten out of the 114 (96%) in all areas said they would host again. On the other hand a mere 5% of migrants said they felt comfortable enough to go back to their hosts in subsequent frost or food shortages. This is a clear contradiction but I would have more faith in what the hosts say because:

a) if the frost and food shortage victims are forced to move, the people who will bear the pains of providing food and shelter (hosts) are more than willing to help and

b) since government help had been received several times at no cost to these people, they were probably hoping to mislead us (the interviewers and whoever we represented).

6. SUMMARY

1. Food shortage, either through drought, frost or other natural causes is not a recent phenomenon in the highlands. It has probably been present right through the history of human existence in the region. It only came to be discussed with concern at the government and administrative level after the 1972 frost. Although it had been mentioned many times in earlier literature by such people as anthropologists, patrol officers, missionaries, etc, it never aroused any major interest until 1972.

2. The 1972 frost and subsequent foodshortage caused a major stir in the country. The administration appear to be in a state of "panic". The "panic" was mainly due to the lack of knowledge of such things as frost or major food shortage on which to base plans and actions. Therefore, various people suggested that plans be made at provincial level to acquire knowledge on how similar disasters could best be handled.

3. It is clear from our interviews and literature written by other people, (e.g. Waddell, 1973) that highlands societies have fairly adequate mechanisms, kept alive through generations, to absorb such food shortages. The questions now are: how big a food shortage can these mechanisms absorb and how long can they be kept alive now that people know there is an easier alternative available to them at very little cost or effort on their part (i.e. government handouts).

4. It seems to me, however, that since the 1972 frost nothing very much has been done to understand and to prepare for future food shortages, especially those caused by frost. The provinces that should be most concerned are the Southern Highlands, Western Highlands and Enga provinces.

5. Enga has now established a small frost monitoring site out on the Mariant in Kandep. The monitoring station is equipped with Automatic Weather Measuring equipment, a well furnished bush house and land for crop trials and experiments. It is hoped that this monitoring station will be maintained and expanded by the Division of Primary Industry.

7. CONCLUSION

This is only a very brief report of a very small project. However, it is hoped here that further such projects will be carried out in future on a larger scale. These should be done with the aim that eventually, someday, we will gain a better understanding of our natural phenomena and will develop systems to handle them.

We must always remember that such disasters as frost and drought are here to stay. Their unpredictable nature makes it hard for us to plan for them. Therefore, we must be prepared for them at all times. One cannot make the environment adapt to him but must adapt to the environment.

To prevent future panic and embarrassments (as in 1972) we have to carry out research projects to find out the best ways to prepare for such natural disasters as frost.

8. RECOMMENDATIONS

1. No more direct food relief be handed out free. Even as a last resort, a return for whatever is handed out must be sought. e.g., road maintenance, repairs and/or construction of school buildings.

2. The government must seek alternative long-term means of attacking the frost and food shortage problem, e.g., establishing storage systems for locally grown foods, like corn and "Irish potato".

3. The Enga government/administration should budget and set aside money every year for incidents of frosts and other food shortages.

4. Since most of the frost zone covers the peripheral areas of Enga Province, it of utmost importance that all access roads leading to or near these places must be keep in passable condition at all times. This will enable any form of quick government intervention in cases of frost.

5. People in the villages must be encouraged to move to lower altitudes during frosts (as they have always done in the past).

6. The Division of Primary Industry (DPI) should establish in its base camps material banks of food crops, especially 'kaukau'. Seeds and vines from these banks should be the first thing distributed to farmers after a frost.

7. Village groups should be encouraged to establish their own frost relief funds and/or measures.

9. SUGGESTIONS FOR FURTHER WORK

Research

1. Simple maturation, yield and seasonality trials on local subsistence crops can be carried out by DPI staff on out stations, with minimum supervision from professional staff, e.g. 'kaukau', "Irish potato", beans, corn and all kinds of local vegetables.

2. Leading from the above, seeds of fast maturing food crops can be multiplied distributed and held in seed banks for distribution after frost.

3. Research and trials can easily be done on more temperate food crops. e.g., apples, grapes, etc. It could generate some cash income for the villagers as well as being substitute food at times of frost.

4. Research and trials can be done into small scale storage systems for locally grown food crops. "Irish potatoes" can easily be dried and stored. The University of Technology in Lae is presently doing some work on food preservation and it could be invited to demonstrate some of its products.

Extension

1. Better varieties of subsistence food crops developed elsewhere, e.g., Southern Highlands Rural Development Project, Kuk DPI research station, Aiyura, etc, can be trialled, demonstrated, multiplied and distributed.

2. Men must be encouraged to spend more time in gardening. At present, it seems, to me that men in most parts of Enga spend minimum time in gardening.

3. It has been noted many times that gardens on hill slopes escape frost damage to some degree. People in frost areas should therefore be encouraged to garden on these slopes. Demonstrations and trials can easily be carried out by Rural Development Technicans on hill slopes.

4. Pyrethrum should now be encouraged again in places that do not grow it anymore. The price has been good lately. Cash is an important buffer during food shortage.

Monitoring

1. Nutritional status of communities can be monitored by measuring body weights of adults and children. Community school children and their parents, who come to the school once a week for school day, can easily be weighed once a month. Mothers who attend child clinics once a month can also be weighed with their babies.

2. Food availibility in areas can be monitored by way of periodic market surveys and garden inventories in selected places and communities.

3. The 'Village Book' system should be re-introduced so that village socio-economic situations can be more easily monitored.

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APPENDIX I

A PROPOSAL FOR NATURAL DISASTER SURVEY AND STUDIES

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I. Background and Objectives

After the severe frost of 1972, many observers called for Provincial contingency plans, programmes to monitor nutritional stress during food shortages and basic research into the effects of frost on food crops. For several years no further significant frosts occurred.

Then in 1980 and again in 1982, light to moderate frosts resulted in food shortages.

Although some provinces had contingency plans none had established base lines for monitoring programmes beyond MCH data and virtually no direct frost related research had been done. As a result, relief efforts were again mounted (as in 1972) on the basis of hurried and frantic observations rather than a carefully pre-establish data gathering system which would provide solid evidence on which to base action. Food was supplied to some areas when not needed, then later not supplied where it could have been used. Accusations of misappropriation, theft and political influence were common.

Many of these problems derive from the lack of sufficent, objective information on the extent, severity and effect of frost. Yet many thousands of people have been repeatedly affected and many tens of thousands of Kina have been repeatedly spent. Whether these efforts were properly and efficiently handled can not now be adequately ascertained for lack of information. But one thing is certain. Sooner or later frost will occur again causing food shortage over large areas.

This proposal outlines a programme which can easily be established, at modest cost, to provide objective information for future frosts. It would provide a permanent and reliable means of evaluating the extent and severity of frost and begin basic research into frost effect on food crops. This would be accomplished through a geographical survey examining past frost occurrence and related social factors, the establishment of a frost research and monitoring station, the development of a monitoring programme for nutritional stress and the establishment of uniform, integrated forms and proceedures for frost impact evaluation. The principle benefit of this programme would be the provision of information for efficient response to frost thus minimizing expenditure

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while protecting the population involved and at the same time contributing to the development of frost mitigation plans.

II. Programme

The programme would require an appropriately qualified Scientific Officer working full time for approximately ten (10) months and one field technician. The officer would work closely with DPI, Health, Provincial Affairs, OSD and probably Education and Office of Information. The Subsistence Unit of DPI would undertake the supervision of technical aspects of the programme. The following activity outline describes the programme and provides a synopsis of the Officer's duties.

Existing staff would be trained to carry on the monitoring and frost response activities that were established under this programme.

Activity 1 - Preparations: All available reports, papers or other documentation relating to frost to be acquired, collated and examined. Technical details of the programme (questionnaires, sample frame etc.) to be developed in conjunction with Subsistence Unit. Officer to liaise with relevant divisions in headquarters Wabag and AFTSEMU of the Southern Highlands. (2 weeks)

Activity 2 - Surveys: A survey to be conducted throughout the frost prone area (concentrating on 20-30 sample points) to gather agronomic and social information on frost occurrence, impact and responses to frost stress. A shorter survey in selected places (perhaps 10) that traditionally receive migrants from the frost areas to evaluate the status of that coping mechanism. Location of regular sweet potato plantings to be identified (e.g. schools, missions) for post-frost observation and dating records to be arranged. (15 weeks)

Activity 3 - Analysis: Data to be analysed and (about) 5 sites selected as monitoring points to represent the variability in frost related factors. (6 weeks).

Activity 4 - Monitoring: Nutritional monitoring to be begun. Approximately 100 adults in each of the 5 sites to be weighted repeatedly to augment existing MCH data. (Weights taken every three months the first year, twice a year thereafter, monthly in case of frost.)

Agricultural monitoring to be begun. A sample of families in each of these sites to be examined in detail as to their agricultural, social and economic resources twice yearly. (This activity can be co-ordinated and augmented, to some extent, by Subsistence Unit personel who will be

doing similar surveys in the area anyway.) DPI, Health and Provincial Affairs Staff to take over the monitoring activity. (Two rounds of observations, 8 weeks.)

Activity 5 - Research Site: One of these sites with high frost probability to be selected as a semi-permanent observation point for frost related research. Station to be established and trials planted with different sweet potato cultivars under varying conditions.

An automatic recording weather station to be purchased and installed at this site. A further trial site at extreme altitude to be sought for yearly frost trials (if feasable).

The research work would be incorporated into the duties of the Subsistence Unit Research Horticulturalist but would also require assistance from the District DPI staff. (6 weeks.)

Activity 6 - Training: Current Frost contingency plans to be reviewed. Forms and proceedures both for monitoring and frost evaluations to be developed. "Teams" to be organized from DPI, Health and Provincial Affairs for monitoring and frost evaluation. In co-ordination with OSD, inservice training sessions to be held (probably in Wabag, Kandep and Laiagam) for these "teams". Technical analysis of monitoring and frost evaluation data would be done by Subsistence Unit personel. (4 weeks)

Activity 7 - Report: A brief report to be submitted to the Secretary outlining activities accomplished, analysis of survey results and recommendations, the latter to include suggestions for further work.

III. Funding

The 1983 budget allocated K20,000 (on vote no. 101-9-1) for Natural Disaster Survey and Studies which are to be studies in effect of frost and experiments of crops etc .

A budget to support this proposal is as follows:-

ITEM 1	SO-2 for 43 weeks @ 294.18/fn	6325
ITEM 2	Southern Highlands trip-acomm. and fd.-3 days.	150
	Fieldsite all.-20 days @ 2.75/n	55
	Patrol allowance-135 days @ 6.75/n	920
		1125
ITEM 3	Post and Telephone	75

ITEM 4	Note books, paper etc	100
	Recording Charts-Climatic Station	100
	Computer expenses(Subsistence Unit)	150
	Field Supplies	100
		450
ITEM 5	Vehicle rental (IASER Car @ 50/fn)	1075
	Repairs	500
	Fuel	700
	Insurance	400
		2675
ITEM 7	Field site materials	200
	Scale for weighing adults (2)	1300
	Recording climatic station	5000
		6500
ITEM 10	Field Assistant (100/fn)	2000
	Interpreting (30/fn)	450
	Carriers	100
	Field site laborers	300
		2850
	T O T A L	20,000

Accomodation would have to be provided for the officer during his times in Wabag.

IV. Alternative approach and Staff Problems

I know of only one office in PNG properly qualified and experienced to do this work. He is the Team Leader of Simbu Land Use Project. With the termination of that project, he is currently available but he will undoubtedly move on to something else soon. Hence, if we were to employ him it would have to be done very soon.

If he, or some other qualified officer, were only available, say, 5 months, it would be possible to modify the above programme so that the Scientific Officer could train someone currently employed by the Department of Enga who could complete the programme. This might actually be an advantage since the trained person would remain in the Province.

APPENDIX IIa

Bush foods that are gathered.

Enga name	Common name	Botanical name
Nakat	'kumu'	Solanum nigarum
Warakarit	watercress	Nasturtium officinale
Auwa ++	'kumu'	Nasturtium sp.
Takai	'kumu'	Oenanthe javanica
Yakati	'kapiak'	Ficus dammaropsis
Brus	banana passionfruit	Passiflora ligularis
Loli	cape gooseberry	Physals peruviana
Taumbu	fern	Athyrium esculentum ?
Anga	'karuka'/pandanus	Pandanus jiulianettii
Kema	bamboo shoots	P. brosimos + Bambus spp.
Kola	pitpit	Miscanthus sp.
Sambai	pitpit	Miscanthus floridulus
Mamuni	red raspberry	Rubus rosaefolius

++ - Refers specifically to a cultivated crop but many times used as a general reference to all leafy greens.

+ - The varieties found in Enga may not yet have been identified properly.

APPENDIX IIb

Animal sources of bush foods.

Eels	*Anguilla japonica* +
Carp	*Cyprinus carpio*? ++
Rainbow trout	*Salmo gairneri*, *S. rideus* ++
Birds	Many species
Marsupials	Many species

\+ Not in high altitude areas.
++ Introduced: carp before 1972 frost, trout after.

APPENDIX IIc.

A List of food crops grown in the frost areas.

Common name	Botanical name	Notes
Tuber Crops.		
'Kaukau'	Ipomea batatas	staple crop
Taro	Colocasia esculenta	little grown
Carrot	Daucus carota	mostly for sale
Potato	Solanum tuberosum	a lot for sale
Leafy Greens		
Cabbages	Brassica oleracea var. capitata	common
Spring onion	Allium cepa	very few grown
Choko	Sechium sp.	rare
Broccoli	Brassica oleracea	most for sale
Lettuce	Lactuca sativa	most for sale
Takai	Oenanthe javanica	favored raw with pork
Auwa	Nasturtium sp.	several var.
Takan	Rungia sp.	little grown
Others		
Sugarcane	Saccharum officinorum	poor
Maize (corn)	Zea mays	small but good
Peas	Pisum sativum	popular
Pumpkin	Cucurbita moschata	few grown
Capsicum	Capsicum annum	for sale
Pitpit(highlands)	Setaria palmifolia	quite a few grown

Note: this list is not exhaustive, a lot more minor crops can be added.

KAUKAU VARITIES GROWN AT TINJIPAKA

Name	Antiquity	Popularity	Tuber Size	Notes *
Mandang	Introduced	good	big	trial
Sol/Kusa	Introduced	good	big	trial
Kika	Introduced	good		trial
Konema	Introduced			
Masol	Introduced	good		trial
Lepo	Introduced		big	trial
Tuki	Traditional			trial
Angapu	Traditional			trial
Tapito	Traditional			
Taia	Traditional			trial
Porte	Traditional			
Tagior	Traditional			
Mandiam	Traditional			
Tinorup	Traditional			
Kumbia	Traditional			

* - Not all are tried now but should be done later.