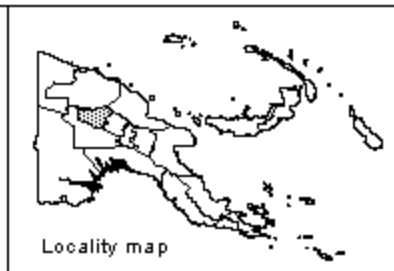





ENGA PROVINCE Agricultural systems



-  No agriculture
-  Agricultural system identified by number
-  Swamp

Subsystems are present in systems 1, 6, and 13



PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 1	Subsystem No. 1 of 2
Districts 2 Wabag, 3 Wapenamanda	Subsystem Extent 75 %	Area (sq km) 320
Population 48,239	Population density 151 persons/sq km	Population absent 8 %

System Summary

Located mainly on flat to gently sloping terraces and fans, dissected by deep gullies, in the Lai, Ambum, Minyamb and Tsak Valleys. Two subsystems are distinguished on the basis of fallow vegetation and intensity of land use. For the entire system, sweet potato is the most important crop; other crops are banana, potato, taro and yam (*D. alata*). This subsystem is located on the terrace surfaces and occupies around 80 per cent of the total land. The second subsystem occurs on slopes on gully sides and terrace edges. Sweet potato is cultivated on large composted mounds for more than 40 years before a long fallow. Short fallows of up to four months occur between plantings. Crops other than sweet potato are grown in special mixed vegetable gardens; on land being brought back into cultivation after a long fallow; in small enclosed areas within the larger sweet potato fields; and in household gardens. Pig husbandry is important. Mixed vegetable gardens are planted between October-December.

Extends across provincial border to System(s) None

Altitude range (m) 1600-2200 **Slope** Gentle (2-10 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Potato, Sweet potato, Taro (<i>Colocasia</i>), Yam (<i>D. alata</i>)
OTHER VEGETABLES	Aibika, Bean (common), Bean (lablab), Bean (winged), Corn, Highland pitpit, Nasturtium spp., Oenanthe, Pumpkin fruit, Rungia
FRUITS	Sugarcane
NUTS	Karuka (planted)
NARCOTICS	Betel pepper (highland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall grass
SHORT FALLOW	Very significant
LONG FALLOW PERIOD	Not significant
CROPPING PERIOD	>40 plantings
R VALUE	100 (high)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Very significant
HOUSEHOLD GARDENS	Very significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	Very significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Significant
2 Fresh food	Significant
3 Firewood	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	None
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	Minor
BURN FALLOW VEGETATION	Minor
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	None
LARGE MOUNDS	Very significant
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	Significant

OTHER DOCUMENTATION**Survey description**

In 1979 and 1980, observations at many locations accessible by road (Bourke and Lea 1982). Between April and June, 1980, a two month study of agriculture and population near Birip mission in the Lai Valley, in the Tsak Valley and at Murisoas school between Lake Sirunki and Laiagam township (Allen 1982). In November 1990, road traverses from Wapenamanda township to Paware mission, from Wabag town to Kompiam station, and Wabag to Laiagam (2 days).

Boundary definition

The characteristic large mounds used in this system give rise to easily observable boundaries with other systems. The boundaries with System 0802 were determined by ground observation and air photographs, some taken from a light aircraft during fieldwork in 1980. The boundary with System 0803 was determined from a road traverse on the Wapenamanda to Paware mission road.

Notes

This system is distinguished from Systems 0802 and 0803 where fallow periods are longer and cropping periods are shorter. Subsystem 2 is similar to System 0803.

The two subsystems which make up this system characterise all Enga agriculture: this subsystem, open fields, in which the soil is mounded, are known as 'ee mondo'. They are used almost solely for the continuous cultivation of sweet potato. From time to time, small areas of land go out of cultivation, often for other than agronomic reasons. Intergroup fighting, a number of deaths in a family, or the failure of pig fences can all cause abandonment of a piece of land. Long fallows last for 10 to 15 years and are mainly tall cane grass with scattered, low *Dodonea* trees. The mounded gardens make up between 57 and 82 per cent of the total cultivated area (Wohlt 1986). They are located only on flat to gently sloping land. Harvesting is continuous; tubers are removed from the plants as they mature. Mounds at all stages of the cultivation cycle are found in one garden. Large areas, which contain many gardens, are fenced to exclude pigs.

The second subsystem, which makes up the balance of the cultivated land, is a shifting cultivation system with frequent long fallows. It is usually located on sloping land in gully sides or on the terrace edges, and is known as 'ee yukusa'. 'Yukusa' gardens contain sweet potato on small mounds and a mixture of other crops. They have been called 'yukusi' by Waddell (1972), 'mixed crop gardens' by Allen (1982) and 'long fallow gardens' by Wohlt (1986). They should not be confused with the mixed vegetable gardens described below, which occur within the larger mounded gardens and contain very little sweet potato.

In 1968, a detailed study near Wapenamanda estimated that 64 per cent of sweet potato production was used for feeding pigs. The ratio of pigs to humans was as high as 2.5:1 (Waddell 1972, 60-62). Pigs remain an extremely important item of exchange, trade and compensation. A larger survey in 1985 found pig to person ratios of between 1.3 and 1.5 (Wohlt 1986, 11). The historical development and the modern functioning of this system is closely related to the production of large numbers of pigs for economic and social purposes. Oral historical evidence suggests that within that within the last 200 years this system has expanded upslope as System 0802, and into the Sau Valley as System 0806 (Wiessner and Tumu 1990, 33-35). There are a number of detailed descriptions of this system: Territory of Papua New Guinea (1967), Freund (1968), Waddell (1972), Allen (1982) and Wohlt (1986). The results of trials of composting rates and the intercropping of potato with sweet potato are described in Preston and Kowor (1988). The social organization and exchange systems of the people using this system are described by Meggitt (1958a; 1974) and Feil (1984).

The mounds used in this system are large. Measurements by Wohlt found the mounds were on average between 300 cm and 330 cm in diameter and between 75 cm and 85 cm high. There were between 650 and 770 mounds per ha. There were 16 planting stations per mound, and between 39,000 and 46,000 sweet potato vines per ha (Wohlt 1986, 7). After the harvest is completed, the mounds are opened and take on a characteristic 'bomb crater' shape. Composting material comes from sweet potato vines, weeds and grasses which grow during the short fallow, and from materials carried into the gardens from outside. Composting material is accumulated in the hollow in the centre of the mounds and when sufficient material is in place, the mound is reformed over the compost. The position of the mound in the field does not change, which is not the case in other highlands systems using smaller mounds. The average period of cultivation was between 45 years and 54 years, the short fallow period 4.5 months and the long fallow period 11 to 16 years (Wohlt 1986, 14).

Apart from sweet potato, the mounds contain scattered plantings of highland pitpit, sugarcane and potato. However, within the larger sweet potato fields, mixed vegetable gardens are planted in small fenced enclosures. They contain sugarcane, banana, taro, highland pitpit, common beans, winged bean, lablab bean and yam (*D. alata* and *D. bulbifera*)

and a range of greens (nasturtium, oenanthe and rungia). Mixed vegetable gardens are commonly cleared from a planted

Notes continued

casuarina tree fallow and are planted between October and December (Bourke and Lea 1982, 77-80). Some land previously reserved for mixed gardens has been planted in coffee since about 1970. Household gardens are also important. Waddell (1972, 43) found they occupied around 4 per cent of cultivated land near Wapenamanda. They are often fertilised with pig manure or coffee skins. It is common for these gardens to be extended and planted in vegetables intended for sale, such as cabbage, lettuce and carrots.

The most outstanding changes in this system since the 1950s have been a significant reduction in the importance of taro. This is reported to be caused by reduced soil fertility, pests and diseases, and the planting of coffee and vegetables for sale on land previously used for growing taro and mixed vegetables (Waddell 1972, 63; Allen 1982, 105, 110; Bourke and Lea 1982, 82); the extension of household gardens into areas for the growing of vegetables for sale; and the planting of relatively large areas in Arabica coffee, between 3 and 9 per cent of the total cultivated land area (Allen 1982, 99; Waddell 1972, 43).

Population densities in this system are high for Papua New Guinea, between 130 and 160 persons per square kilometre (Allen 1982, 120; Wohlt 1986, 17). In 1968 Waddell (1972, 43) found the area of cultivated land per person was between 0.14 ha and 0.17 ha. In 1980, Allen found this figure at two sites was 0.24 ha and 0.27 ha, with the area of mounded gardens 0.17 to 0.18 ha per person. The proportion of land suitable for mounded gardens which was under cultivation was between 64 and 67 per cent (Allen 1982, 120). The balance was in a tall cane grass fallow.

This system is rarely affected by frost, but from time to time, sweet potato production is very much reduced. The causes are firstly, variation in sweet potato tuber yield, often associated with extended wet periods, and secondly, large changes in the planting rate of sweet potato in response to variations in the supply of sweet potato (Bourke 1989). It is estimated these events occur on average every 13 years (Allen et al. 1989, 301-302).

Access to most parts of this system by road is good, but cash incomes are relatively low. Cash incomes from the sale of coffee, firewood and food were estimated by Wohlt (1986, 19) at between K40 and K80 per person per year. Some sheep and cattle are sold, especially in the Tsak Valley.

National Nutrition Survey 1982/83

413 families from 9 villages were asked in June 1982, or April, May, June, July, August, October or December 1983, what they had eaten the previous day. 98 per cent reported eating sweet potato, 3 per cent banana, 3 per cent taro, 1 per cent cassava and none yam, Chinese taro, sago or coconut. 22 per cent reported eating rice. 1 per cent reported eating fresh fish. This is similar to the crop pattern.

Main References

- Allen, B.J. 1982 Subsistence agriculture: three case studies. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 93-127.
- Waddell, E. 1972 *The Mound Builders: Agricultural Practices, Environment, and Society in the Central Highlands of New Guinea*. Seattle, University of Washington Press.
- Wohlt, P.B. 1986 Subsistence systems of Enga Province. Department of Enga Province, Technical Bulletin No. 3, Subsistence Unit, Division of Primary Industry, Wabag.

Other References

- Allen, B., H. Brookfield and Y. Byron 1989 Frost and drought through time and space, Part II: The written, oral, and proxy records and their meaning. *Mountain Research and Development* 9, 3, 279-305.
- Binns, C.W. 1976 Famine and the diet of the Enga. *Papua New Guinea Medical Journal* 19, 4, 231-235.
- Bourke, R.M. 1989 The influence of soil moisture extremes on sweet potato yield in the Papua New Guinea Highlands. *Mountain Research and Development* 9, 3, 322-328.
- Bourke, R.M. and D.A.M. Lea 1982 Subsistence horticulture. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 76-92.
- Calcinai, B.L. and R.M. Bourke 1982 Institutional food production and consumption in Eastern Highlands and Enga Provinces. In Bourke, R.M. and V. Kesavan (eds), *Proceedings of the Second Papua New Guinea Food Crops Conference: Part One*. Port Moresby, Department of Primary Industry, 184-190.
- Feachem, R. 1973 The Raiapu Enga pig herd. *Mankind* 9, 25-31.
- Feil, D.K. 1984 *Ways of Exchange: The Enga Tee of Papua New Guinea*. Brisbane, University of Queensland Press.
- Freund, R. 1968 Agriculture then and now. In, *Anthropological Study Conference*. Amapyaka, New Guinea Lutheran Mission, 1-13.

Other References continued

Harris, G.T. 1976 Some responses to population pressure in the Papua New Guinea Highlands, 1957-74. Economics Department, University of Papua New Guinea, Discussion Paper No. 23, Economics Department, University of Papua New Guinea, Port Moresby.

Meggitt, M.J. 1958 The Enga of the New Guinea Highlands. *Oceania* 28, 253-330.

Meggitt, M.J. 1974 'Pigs are our hearts!'. *Oceania* 44, 3, 165-203.

Oldfield, F., A.T. Worsley and A.F. Baron 1985 Lake sediments and evidence for agricultural intensification: a case study from the Highlands of Papua New Guinea. In Farrington, I.S. (ed), *Prehistoric Intensive Agriculture in the Tropics*. Oxford, BAR International Series, 385-391.

Perry, R.A., M.J. Bik, E.A. Fitzpatrick, H.A. Haantjens, J.R. McAlpine, R. Pullen, R.G. Robbins, G.K. Rutherford and J.C. Saunders 1965 Lands of the Wabag-Tari area, Papua-New Guinea. Land Research Series No. 15, Commonwealth Scientific and Industrial Research Organization, Melbourne.

Preston, S. and A. Kowor 1988 Composting, intercropping and potato production on volcanic ash soils in Enga Province. In Pitt, A.J. and H.R. Yandanai (eds), *Working Papers of the 1987 Potato/Sweet Potato Workshop*. Port Moresby, Department of Agriculture and Livestock, 68-80.

Rutherford, G.K. 1964 The soils and land use of the area occupied by the Enga of the New Guinea Highlands. *Canadian Geographer* 8, 3, 142-146.

Territory of Papua and New Guinea 1967 Report on intensive agricultural surveys in the Wabag sub-district, 1962-64. Unpublished paper, Port Moresby.

Wiessner, P. and A. Tumu 1990 The oral history of trade and ceremonial exchange in Enga. Paper delivered to the conference 'The Mek and Their Neighbours', sponsored by the Max-Planck-Gesellschaft at Seewiesen, Bavaria.

System Summary

This subsystem occupies around 20 per cent of the total land area. It is used on slopes on gully sides and terrace edges. Short woody regrowth and planted casuarina trees, 20-25 years old, are cleared and burnt. Sweet potato is the most important crop; other crops are banana, taro, potato and yam (*D. alata*). Sweet potato is cultivated in small mounds. Only one planting is made before fallowing. Gardens are cleared between June and August and planted between September and December.

Extends across provincial border to System(s) None

Altitude range (m) 1600-2200 **Slope** Steep (10-25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Potato, Sweet potato, Taro (<i>Colocasia</i>), Yam (<i>D. alata</i>)
OTHER VEGETABLES	Aibika, Bean (common), Bean (lablab), Corn, Highland pitpit, Nasturtium spp., Oenanthe, Pumpkin fruit, Rungia
FRUITS	Sugarcane
NUTS	Karuka (planted)
NARCOTICS	Betel pepper (highland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Short woody regrowth
SHORT FALLOW	None
LONG FALLOW PERIOD	>15 years
CROPPING PERIOD	1 planting
R VALUE	5 (very low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	None
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	None
HOUSEHOLD GARDENS	Minor

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Significant
COMPOST	None
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Significant
2 Fresh food	Significant
3 Firewood	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	None
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Very significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	Very significant
MOUNDS	None
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	Very significant
SEASONAL SEC'DARY CROPS	Very significant

OTHER DOCUMENTATION**Notes**

This subsystem is located on sloping land on gully sides or on terrace edges, and is known as 'yukusa'. 'Yukusa' gardens contain a mixture of crops and have been called 'yukusi' by Waddell (1972), 'mixed crop gardens' by Allen (1982) and 'long fallow gardens' by Wohlt (1986). They should not be confused with the mixed vegetable gardens described in Subsystem 1, which contain very little sweet potato. Subsystem 1 gardens are in open fields, in which the soil is mounded, and are known as 'mondo'. They are used for the continuous cultivation of sweet potato. Gardens in Subsystem 2 are very similar to the gardens of System 0803, where there is no 'mondo' subsystem, except that in System 0803, small mounds are not used. The 'yukusa' gardens make up between 18 and 43 per cent of the total cultivated area in this system (Wohlt 1986).

Wohlt (1986, 8) found the small mounds were on average, 57 cm in diameter and 23 cm in height; were spaced 120 cm apart; and there were about 7000 mounds per ha, with a sweet potato planting density of 24,500 vines per ha.

Casuarina trees are planted in the fallows of many of these gardens. All gardens are fenced. There are few drains and no soil retention devices.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 2	Subsystem No. 1 of 1
Districts 2 Wabag, 3 Wapenamanda	Subsystem Extent 100 %	Area (sq km) 367
Population 11,999	Population density 33 persons/sq km	Population absent 7 %

System Summary

Located in slump hollows and depressions on steep hillslopes on the upper sides of the Lai, Ambum, Minyamb and Tsak Valleys. This is an extension of Subsystem 1 of System 0801 on to steeper slopes and up to a receding forest margin. Grass and woody regrowth, more than 15 years old, is cut and burnt. The site is fenced and composted mounds for sweet potato production are established. On steeper slopes, small mounds are used. Cultivation becomes continuous for up to 15 years, with short fallows between plantings. Sweet potato is the most important crop; potato is an important crop; other crops are banana and taro, which are grown together with sugarcane, corn, beans and greens, in restricted areas within the mounded gardens. Household gardens are common. Pig husbandry is important.

Extends across provincial border to System(s) None

Altitude range (m) 2000-2400 **Slope** Steep (10-25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	Potato
STAPLES PRESENT	Banana, Potato, Sweet potato, Taro (Colocasia)
OTHER VEGETABLES	Amaranthus spp., Bean (common), Cabbage, Corn, Highland pitpit, Nasturtium spp., Oenanthe, Rungia
FRUITS	Sugarcane
NUTS	Karuka (planted), Karuka (wild)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Grass/woody regrowth
SHORT FALLOW	Very significant
LONG FALLOW PERIOD	>15 years
CROPPING PERIOD	6-14 plantings
R VALUE	33 (medium)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Minor
HOUSEHOLD GARDENS	Very significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	Very significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Significant
2 Firewood	Minor
3 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	None
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	Minor
BURN FALLOW VEGETATION	Minor
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	Minor
MOUNDS	Significant
LARGE MOUNDS	Significant
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	Significant

OTHER DOCUMENTATION**Survey description**

In 1979 and 1980, observations at many locations accessible by road (Bourke and Lea 1982). Between April and June, 1980, a two month study of agriculture and population near Birip mission in the Lai Valley, in the Tsak Valley and at Murisoas school between Lake Sirunki and Laiagam township (Allen 1982). In November 1990, road traverses from Wapenamanda township to Paware mission, from Wabag town to Kompiam station, and Wabag to Laiagam (2 days).

Boundary definition

The boundaries with Systems 0801, 0803 and 0804 were determined by road and foot traverses and aerial observation, and from air photographs, some taken from a light aircraft during fieldwork in 1980.

Notes

Land use in this system is less intensive than in Systems 0801 and 0804 where cropping periods exceed 40 years; it is more intensive than System 0803 where only one planting is made before fallowing.

This system falls into Wohlt's (1986) 'slope garden' category. It does not have the separation of composted mounds and shifting cultivation gardens found in System 0801. Rather, there is a mixture of composted mounds, small mounds and, to a lesser extent, an interplanting of crops, depending on the local terrain. In addition, land is sometimes brought into cultivation from previously uncultivated forest, and a ragged forest margin is receding upslope.

Wohlt (1986, 14) found the average cropping period was between 11 and 15 years. The length of short fallows between crops averaged between 2.5 and 3.5 months. Long fallow periods were between 18 and 22 years on average. Where forest which has not been previously cultivated is cleared, small mounds are used for the first two or three plantings, to grow sweet potato, mixed with banana, and yam (*D. alata*), and in some favoured sites, taro. By the third or fourth planting, mounds have been formed. Small mounds continue to be used on steeper slopes. Mounds are around 270 cm to 300 cm in diameter, between 60 and 70 cm high, and are denser than in System 0801, at around 1000 per ha (Wohlt 1986, 7).

Sweet potato vines from a previous crop, grasses and weeds are buried in the centre of the mounds. Some composting material is grown in the garden during the short fallow and some is brought in from outside the garden. Sweet potato is the most important crop and is grown almost as a monocrop in the mounds. Harvesting is continuous; tubers are removed from the plants as they mature. After the final harvest, the garden is left for a short fallow of up to eight weeks. The mounds are then opened, the vegetation placed in the centre and covered, and a new crop of sweet potato is planted. Mounds at all stages of the cultivation cycle are found in one garden.

Apart from sweet potato, the mounds often contain scattered plantings of highland pitpit, sugarcane and potato. However within the larger sweet potato gardens, other crops are planted in small fenced enclosures. They include sugarcane, banana, pitpit, common bean, winged bean, yam (*D. alata*) and a range of greens (nasturtium, oenanthe and rungia). Household gardens are also important. They are often fertilised with pig manure or coffee skins. It is common for these gardens to be extended and planted in vegetables intended for sale, such as cabbage, lettuce and carrots.

Some casuarina trees are planted in fallows and within the mounded gardens. All gardens are fenced.

Every 13 years on average, repeated frosts over a number of months, associated with periods of low rainfall and clear skies, cause sweet potato production to fail (Allen et al. 1989). In addition, from time to time, sweet potato production may be very much reduced. The causes are firstly, variation in sweet potato tuber yield, often associated with extended wet periods, and secondly, large changes in the planting rate of sweet potato in response to variations in the supply of sweet potato (Bourke 1989).

Arabica coffee is planted beneath casuarina tree shade in numerous shallow depressions. The sale of coffee, firewood and fresh food are the main sources of cash income.

National Nutrition Survey 1982/83

93 families from 2 villages were asked in June 1983 what they had eaten the previous day. 99 per cent reported eating sweet potato, 1 per cent banana, 1 per cent cassava and none taro, yam, Chinese taro, sago or coconut. 13 per cent reported eating rice. None reported eating fresh fish. This is similar to the crop pattern.

Main References

Wohlt, P.B. 1986 Subsistence systems of Enga Province. Department of Enga Province, Technical Bulletin No. 3, Subsistence Unit, Division of Primary Industry, Wabag.

Other References

Allen, B.J. 1982 Subsistence agriculture: three case studies. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 93-127.

Allen, B., H. Brookfield and Y. Byron 1989 Frost and drought through time and space, Part II: The written, oral, and proxy records and their meaning. *Mountain Research and Development* 9, 3, 279-305.

Bourke, R.M. 1988 Taim hangre: variation in subsistence food supply in the Papua New Guinea Highlands. PhD thesis, Australian National University, Canberra.

Bourke, R.M. 1989 The influence of soil moisture extremes on sweet potato yield in the Papua New Guinea Highlands. *Mountain Research and Development* 9, 3, 322-328.

Bourke, R.M. and D.A.M. Lea 1982 Subsistence horticulture. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 76-92.

Harris, G.T. 1976 Some responses to population pressure in the Papua New Guinea Highlands, 1957-74. Economics Department, University of Papua New Guinea, Discussion Paper No. 23, Economics Department, University of Papua New Guinea, Port Moresby.

Lea, D.A.M. 1969-70 Activities studies in New Guinea villages. *Papua and New Guinea Agricultural Journal* 21, 3-4, 118-126.

Territory of Papua and New Guinea 1967 Report on intensive agricultural surveys in the Wabag sub-district, 1962-64. Unpublished paper, Port Moresby.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 3	Subsystem No. 1 of 1
Districts 3 Wapenamanda, 6 Kompiam	Subsystem Extent 100 %	Area (sq km) 540
Population 11,410	Population density 21 persons/sq km	Population absent 12 %

System Summary

Located in the Lai Valley gorge, downstream of Immanue mission north to Lapalama mission, and around Laialam mission in the headwaters of the Tarua River. Tall grass and tall woody regrowth, more than 25 years old, is cut and burnt. Sweet potato is the most important crop; taro is an important crop; other crops are banana, Chinese taro, potato, cassava and yam (*D. alata*). One planting is made before fallow. In a number of areas, casuarina trees are planted in fallows, and pollarded when land is cleared for cultivation. Gardens are cleared between June and August and planted between September and December. Sweet potato, yam and taro are planted in separate sections of gardens. Drains are often made in gardens. Household gardens are common.

Extends across provincial border to System(s) None

Altitude range (m) 1000-1800 **Slope** Steep (10-25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	Taro (<i>Colocasia</i>)
STAPLES PRESENT	Banana, Cassava, Chinese taro, Potato, Sweet potato, Taro (<i>Colocasia</i>), Yam (<i>D. alata</i>)
OTHER VEGETABLES	Aibika, Bean (common), Bean (winged), Cabbage, Choko tips, Corn, Highland pitpit, Lowland pitpit, Nasturtium spp., Peanuts
FRUITS	Marita pandanus, Passionfruit (purple), Pawpaw, Pineapple, Sugarcane
NUTS	Karuka (planted)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Grass/woody regrowth
SHORT FALLOW	None
LONG FALLOW PERIOD	>15 years
CROPPING PERIOD	1 planting
R VALUE	5 (very low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Significant
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Minor
HOUSEHOLD GARDENS	Significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	None
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Minor
2 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Significant
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Very significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	Minor
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	None
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	Significant
SEASONAL SEC'DARY CROPS	Significant

OTHER DOCUMENTATION**Survey description**

In February 1980, a road traverse between Wapenamanda township and Paware mission, and a half day visit by aircraft to Labalama mission. In November 1990, a one day traverse by road from Wapenamanda to Paware mission; from Wabag, a two day traverse by road to Ogowanda school via Kompiam station; and students from Lapalama and Laialam were interviewed at Kompiam high school.

Boundary definition

The boundaries with Systems 0801 and 0802 were determined on a road traverse from Wapenamanda to Paware mission. The boundary with System 0805 was determined from visits to Yenkis and interviews at Kompiam high school. The boundary with System 0806 between Lapalama and Kompiam was determined at Ogowanda school and Paware mission; and the boundary between Laialam and Kompiam was extrapolated along the watershed between the Sau River and the Tarua River.

Notes

Land use in this system is much less intensive than in Systems 0801, 0802 and 0806. It is very similar to System 0805, but there fallow vegetation is tall woody regrowth.

This is a low intensity shifting cultivation system located on steep slopes. The one planting only before fallow, the 25 year fallow periods and the absence of a short fallow, are similar to the 'yukusa' subsystem gardens of the neighbouring System 0801, but there are no composted mounded gardens (see also Feil 1984, 18). For 158 'long fallow' gardens surveyed in the Wapenamanda District between 1982 and 1986, the average cultivation period was 1.2 years and the average fallow period 24 years (Wohlt 1986, 75).

The system ranges over 800 m in altitude. There is variation within the system across this altitudinal range in the agricultural intensity of land use. This is expressed as differences in the type of fallow vegetation, the planting of casuarina in fallows, the number of plantings before fallow, and the use of small mounds. At higher altitudes, fallows tend to be a mixture of tall grass and low woody regrowth, but at lower altitudes woody regrowth is more common. Patches of short grass in the Lai Valley are not used for cultivation. Casuarina planting in fallows is best developed on steep slopes west of the Lai River, between Immanue mission and Paware mission, and continues west into System 0806 south of Kompiam. Casuarina are planted in fallows elsewhere in the system, but not at the same densities. At lower altitudes, sweet potato is dibbled directly into the soil and only one planting is made before fallowing. However, at higher altitudes there is a greater tendency for a second planting of sweet potato to be made. Sweet potato is planted in small mounds when it is a second planting.

During clearing, following an initial burn, cane grass roots and casuarina cuttings are burnt in heaps placed regularly across the garden site, and greens are planted in the ashes. Sweet potato and taro tend to be planted in separate blocks. Yam is always planted in a separate block. Household gardens are important. They contain greens, beans and bananas. After the harvest, pigs are placed in gardens to forage. Gardens commonly have shallow, rectangular-shaped internal and perimeter drains. In many gardens, barriers of light poles are laid on the contour, or horizontal ditches are dug, to prevent soil movement down slope. Sugarcane and winged beans are staked. People have access to a little sago.

The Lai Valley gorge has relatively good road access. Here the sale of Arabica coffee, firewood and fresh food are income sources. Elsewhere access is by walking, and cash incomes are very low.

National Nutrition Survey 1982/83

110 families from 3 villages were asked in June or July 1983 what they had eaten the previous day. 94 per cent reported eating sweet potato, 25 per cent taro, 15 per cent banana, 4 per cent cassava, 2 per cent Chinese taro, 1 per cent yam, 1 per cent sago and 1 per cent coconut. 5 per cent reported eating rice. None reported eating fresh fish. This is similar to the crop pattern.

Main References

Feil, D.K. 1984 *Ways of Exchange: The Enga Tee of Papua New Guinea*. Brisbane, University of Queensland Press.
Wohlt, P.B. 1986 *Subsistence systems of Enga Province*. Department of Enga Province, Technical Bulletin No. 3, Subsistence Unit, Division of Primary Industry, Wabag.

Other References

Jentsch, T. and R. Doetsch 1986 *Keman, eine Siedlung im Hochland von Papua-Neuguinea: bestandsaufnahme und untersuchung des kulturellen wandels*. Kölner Ethnologische Studien, Band 11, D. Riemer Verlag, Berlin.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 4	Subsystem No. 1 of 1
Districts 1 Lagaip, 2 Wabag, 3 Wapenamanda, 4 Kandep	Subsystem Extent 100 %	Area (sq km) 607
Population 21,065	Population density 35 persons/sq km	Population absent 7 %

System Summary

Located on the Sirunki Plateau, Lagaip Valley, Kandep Basin, Lai Valley and the upper Wage Valley on undulating plateaus and saddles, in the Southern Highlands and Enga Provinces. Some gardens are brought into cultivation from fallows of tall grass 10-12 years old. Gardens are cultivated with composted mounds for up to 40 years before another long fallow. 'Short' fallows are used between plantings. Short fallows are longer than those used at lower altitudes and may last for up to three years. A minority of gardens are brought into cultivation from forest not previously used for agriculture. Sweet potato is the most important crop; potato is an important crop. They may be planted together on the same mounds. Household gardens are common. Pig husbandry is important; and pigs are allowed to forage in gardens between plantings. Altitude is an important constraint; it restricts the range of crops which can be grown and exposes crops to the risk of frost.

Extends across provincial border to System(s) 0713

Altitude range (m) 2000-2800 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	Potato
STAPLES PRESENT	Potato, Sweet potato
OTHER VEGETABLES	Bean (common), Cabbage, Chinese cabbage, Corn, Highland pitpit, Nasturtium spp., Oenanthe, Pumpkin tips, Rungia
FRUITS	Passionfruit (banana), Passionfruit (purple), Sugarcane
NUTS	Karuka (planted), Karuka (wild)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall grass
SHORT FALLOW	Very significant
LONG FALLOW PERIOD	Not significant
CROPPING PERIOD	15-40 plantings
R VALUE	80 (high)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	None
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	None
HOUSEHOLD GARDENS	Significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	None
COMPOST	Very significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	Minor

CASH EARNING ACTIVITIES

1 Firewood	Minor
2 Fresh food	Minor
3 Potato	Minor
4 Pyrethrum	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	Significant
BURN FALLOW VEGETATION	Minor
TILLAGE	None
MECHANIZATION	Minor
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	Minor
MOUNDS	Very significant
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	Minor
Other Features:	
FENCES	Significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Survey description**

Between early 1979 and November 1980, visits to many locations on the Sirunki Plateau, Lagaip Valley, Kandep Basin and upper Wage Valley in Enga Province (Bourke and Lea 1982). Between February and May 1980, a three week long study of agriculture near Murisoas school (Allen 1982). In May 1981, a one day visit to Yumbisa village by helicopter and a one hour visit to Murisoas school. In November 1990, road traverses from Tambul to Wapenamanda; Wabag to Laiagam, via Sirunki and Murisoas; Laiagam to Kandep; and Kandep to Winja school (on the Southern Highlands Province border). In November 1990, a road traverse from Nipa to Magarima return, via Yongo, Yuoma and Ugu census points (2 days).

Boundary definition

The boundary with Enga System 0802 was determined from a road traverse on the Wabag to Sirunki road. Boundaries with Enga System 0808 were determined from road traverses between Sirunki and Laiagam. The boundary with Enga System 0807 was determined from ground and helicopter traverses west of Kandep. The boundary with System 0714 was defined on a road traverse from Nipa to Magarima. The boundary with System 0716 was taken as the 2200 m contour.

Notes

This system is distinguished from System 0714 to the south where crops are planted in long composted beds. It is distinguished from System 0716 where composting is not used. It is distinguished from Systems 0802 and 0808 where fallow vegetation is grass and woody regrowth. It is identical to System 0807, except that extensive drains are used there.

The higher altitudes at which this system is located place it above the altitudinal limits of a number of common crops grown in Enga (Bourke and Lea 1982, 89-90). The highest gardens observed in Papua New Guinea, at 2850 m on the Sirunki Plateau-Lagaip Valley divide, occur in this system. Taro and Chinese taro, beans, banana, cassava and yam are rarely seen in this system. Light frosts may occur every year. Repeated severe frosts occur on average about every 13 years (Allen et al. 1989). Prior to colonisation, major frosts caused the complete abandonment of the system, and the migration of all residents to lower altitudes for up to two years while gardens were re-established with new sweet potato vines (Goie 1986; Wohlt 1989; Waddell 1989; Clarke 1989). Potato is a very important introduction because of its short growing period relative to sweet potato and consequent quicker recovery from the frosts. It is grown as a monocrop on long beds, or with sweet potato on composted mounds.

The forest margins are heavily degraded by cutting for building material, fencing and firewood. Forest land which has not previously been cultivated is cleared of trees, with the exception of pandanus trees which are left standing. The perimeter of the cleared land is heavily fenced with cordyline, which takes root and becomes a living fence. For the first two years, sweet potato, potato, corn, highland pitpit, cabbage, carrots, peas, rungia, solanum and oenanthe (greens) are planted in unrounded gardens. In the third year, mounds are made. The first mounds contain large lumps of clod and soil. After two or three plantings, the soil is worked into a fine tilth. Sweet potato is cultivated on the mounds for more than 40 years before a long fallow. Mounds in this system have different dimensions to mounds in Enga Systems 0801 and 0802. Wohlt (1986, 7) found mounds here were on average 63 cm high and 203 cm diameter. Around 8 vines were planted per mound, there were 1360 mounds per ha and 43,500 vines per ha. C. Tumana independently recorded a mean of 43,000 plants per ha at Sirunki (Bourke 1985, 98). Highland pitpit, corn, sugarcane and greens are grown around the base of the mounds. Potato is planted on the top of the mound and in beds.

Altitude also affects the rate at which crops mature. Potato matures within six months, but only one crop of sweet potato is produced in a year. Between crops, 'short' fallows are used to maintain soil fertility. At Murisoas in 1981, 'short' fallows were two years long (Allen 1982, 118); at Sirunki they were said to be one year long (Sinnott 1975, 27); while at Yumbisa, gardens were cultivated for three years and fallowed for three years (Wohlt 1978, 215). At the end of the short fallow, weeds and grasses are pulled up and placed on the ground between the old mounds. The old mounds are then broken up to create new mounds over the top of the heap of weeds and grasses. In this way the mounds are moved every time they are re-formed, which is not the case with the large mounds in Enga Systems 0801 and 0802. The lower limit of the system is 2200 m in Enga Province and 2000 m in Southern Highlands Province. Banana and taro are grown in the Magarima area, but are less common at higher altitudes in Enga.

Household gardens are important and are fertilised with household scraps, pig manure and ashes from the hearth.

Notes continued

Coffee will not grow at these altitudes. The most important source of cash is the commercial cultivation of potato, usually in tall grass fallows. Tractor drawn ploughs and inorganic fertilisers are used. At altitudes above 2400 m, the sale of dried pyrethrum flowers is also a source of cash. Pyrethrum is grown as a monocrop on mounds and beds, or is intercropped with sweet potato and potato. Vegetables, such as carrots and cabbages, are also grown for sale. Inorganic fertilisers are also applied to pyrethrum and vegetables, and sometimes to sweet potato and potato grown for subsistence consumption. The sale of firewood is another source of cash. Wohlt (1986, 19) estimated average cash income between 1981 and 1985 was K43 per person per year. Pigs are a major source of income in some areas, for example around Magarima. Cattle are farmed in a few areas, especially in the Lagaip Valley headwaters and the Sirunki Plateau (Carrad 1982).

National Nutrition Survey 1982/83

136 families from 4 villages were asked in January, June, July or October 1983 what they had eaten the previous day. 96 per cent reported eating sweet potato, 2 per cent cassava and none banana, taro, yam, Chinese taro, sago or coconut. 11 per cent reported eating rice. None reported eating fresh fish. This is similar to the crop pattern.

Main References

- Allen, B.J. 1982 Subsistence agriculture: three case studies. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 93-127.
- Wohlt, P.B. 1986 Subsistence systems of Enga Province. Department of Enga Province, Technical Bulletin No. 3, Subsistence Unit, Division of Primary Industry, Wabag.
- Wohlt, P. 1989 Migration from Yumbisa, 1972-1975. *Mountain Research and Development* 9, 3, 224-234.

Other References

- Allen, B.J. 1988 Adaptation to frost and recent political change in Highland Papua New Guinea. In Allan, N.J.R., G.W. Knapp and C. Stadel (eds), *Human Impact on Mountains*. Totowa, NJ, Rowman and Littlefield, 255-264.
- Allen, B., H. Brookfield and Y. Byron 1989 Frost and drought through time and space, Part II: The written, oral, and proxy records and their meaning. *Mountain Research and Development* 9, 3, 279-305.
- Bourke, R.M. 1985 Sweet potato (*Ipomoea batatas*) production and research in Papua New Guinea. *Papua New Guinea Journal of Agriculture, Forestry and Fisheries* 33, 3-4, 89-108.
- Bourke, R.M. and D.A.M. Lea 1982 Subsistence horticulture. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 76-92.
- Brown, M.J.F. and J.M. Powell 1974 Frost and drought in the Highlands of Papua New Guinea. *Journal of Tropical Geography* 38, 1-6.
- Carrad, B. 1982 The economy. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 146-178.
- Clarke, W.C. 1989 The Marient Basin, 1972-1976: recovery or adaptation? *Mountain Research and Development* 9, 3, 235-247.
- Goie, A. 1986 Natural disasters, surveys and studies: frost. Department of Enga Province Technical Bulletin No. 1, Division of Primary Industry, Subsistence Unit, Wabag.
- Meggitt, M.J. 1956 The valleys of the Upper Wage and Lai Rivers. *Oceania* 27, 90-135.
- Perry, R.A., M.J. Bik, E.A. Fitzpatrick, H.A. Haantjens, J.R. McAlpine, R. Pullen, R.G. Robbins, G.K. Rutherford and J.C. Saunders 1965 Lands of the Wabag-Tari area, Papua-New Guinea. Land Research Series No. 15, Commonwealth Scientific and Industrial Research Organization, Melbourne.
- Preston, S. 1988 Investigation of compost x fertilizer interactions in sweet potato in Enga Province. In Pitt, A.J. and H.R. Yandanai (eds), *Working Papers of the 1987 Potato/Sweet Potato Workshop*. Port Moresby, Department of Agriculture and Livestock, 105-113.
- Scott, G.A.J. and C.F. Pain 1982 Land potential. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 128-145.
- Sinnett, P.F. 1975 *The People of Murapin*. Faringdon, E.W. Classey.
- Waddell, E. 1975 How the Enga cope with frost: responses to climatic perturbations in the central Highlands of New Guinea. *Human Ecology* 3, 4, 249-273.
- Waddell, E. 1989 Observations on the 1972 frosts and subsequent relief program among the Enga of the Western Highlands. *Mountain Research and Development* 9, 3, 210-223.
- Walker, D. 1966 Vegetation of the Lake Ipea region, New Guinea Highlands: I. Forest, grassland and 'garden'. *Journal of Ecology* 54, 503-533.
- Walker, D. 1972 Vegetation of the Lake Ipea region, New Guinea Highlands: II. Kayamanda Swamp. *Journal of Ecology* 60, 2, 479-504.

Other References continued

Wiessner, P. and A. Tumu 1990 The oral history of trade and ceremonial exchange in Enga. Paper delivered to the conference 'The Mek and Their Neighbours', sponsored by the Max-Planck-Gesellschaft at Seewiesen, Bavaria.

Wohlt, P.B. 1978 Ecology, agriculture and social organization: the dynamics of group composition in the Highlands of Papua New Guinea. PhD thesis, University of Minnesota.

Wohlt, P.B., B.J. Allen, A. Goie and P.W. Harvey 1982 An investigation of food shortages in Papua New Guinea: 24 March to 3 April, 1981. IASER Special Publication No. 6, Institute of Applied Social and Economic Research, Port Moresby.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 5	Subsystem No. 1 of 1
Districts 2 Wabag, 6 Kompiam	Subsystem Extent 100 %	Area (sq km) 465
Population 6,148	Population density 13 persons/sq km	Population absent 10 %

System Summary

Located along the border between the East Sepik and Enga Provinces, in the Yenkis and Maramuni areas. The area is very lightly populated. Tall woody regrowth, more than 15 years old, is cleared. Trees are felled or pollarded and vegetation is burnt. Sweet potato is the most important crop; taro is an important crop; other crops are banana, sago, cassava and yam (*D. alata*). Only one planting is made before fallowing. Within gardens, taro and yam are grown in separate sections from sweet potato. Gardens are planted between October and December each year. Household gardens are common. Hunting is important.

Extends across provincial border to System(s) 1416

Altitude range (m) 300-1900 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	Taro (<i>Colocasia</i>)
STAPLES PRESENT	Banana, Cassava, Sago, Sweet potato, Taro (<i>Colocasia</i>), Yam (<i>D. alata</i>)
OTHER VEGETABLES	Bean (common), Corn, Cucumber, Lowland pitpit, Peanuts, Pumpkin tips
FRUITS	Marita pandanus, Pawpaw, Pineapple, Sugarcane
NUTS	Breadfruit, <i>Pangium edule</i>
NARCOTICS	Betel nut (lowland), Betel pepper (lowland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall woody regrowth
SHORT FALLOW	None
LONG FALLOW PERIOD	>15 years
CROPPING PERIOD	1 planting
R VALUE	5 (very low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Significant
CROP SEQUENCES	Minor
MIXED VEGETABLE GARDENS	None
HOUSEHOLD GARDENS	Significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	None
COMPOST	None
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Animal skins	Minor
----------------	-------

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	None
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Very significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	Minor
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	Minor
MOUNDS	None
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	Significant
SEASONAL SEC'DARY CROPS	Very significant

OTHER DOCUMENTATION**Survey description**

In February and November 1980, one day visits by helicopter to Yenkis, Lapalama, Rum and Kompam. In November 1990, information was collected by interviewing students from the area, at Kompam high school but the system was not visited. The small part of the system that lies in East Sepik Province was not visited.

Boundary definition

The boundary with System 0803 was determined from visits to Yenkis and interviews at Kompam high school. In East Sepik Province, the northern boundary with System 1415 is based on the 800 m contour because sago, an important food in System 1415, but not in this system, is not common above that altitude.

Notes

This system is distinguished from System 0803 to the south where fallow vegetation is tall grass and tall woody regrowth. It contracts with the system to the north (System 1415) where sago and taro are the most important foods.

Information about this system is of poor quality. The system ranges in altitude between around 300 m on the Yuat River to 1900 m, and extends across the East Sepik Province border.

The system is an extensive shifting cultivation system, in contrast to the majority of systems in Enga Province. Gardens are said to be cleared between July and September and planted between October and December. Taro and yam are said to be segregated from sweet potato within the garden. After the harvest, pigs are placed in gardens to forage, and fences are repaired. Hunting is said to be important. Sago is planted at lower altitudes and is infrequently used as food.

National Nutrition Survey 1982/83

66 families from 2 villages were asked in May 1983 what they had eaten the previous day. 98 per cent reported eating sweet potato, 12 per cent taro and none banana, cassava, yam, Chinese taro, sago or coconut. 5 per cent reported eating rice. 2 per cent reported eating fresh fish. This is similar to the crop pattern.

Main References

None.

Other References

Bourke, R.M. and D.A.M. Lea 1982 Subsistence horticulture. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 76-92.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 6	Subsystem No. 1 of 2
Districts 6 Kompiam	Subsystem Extent 75 %	Area (sq km) 229
Population 8,464	Population density 37 persons/sq km	Population absent 5 %

System Summary

Located on the steep, mid-slopes of the Sau Valley and the Lai Valley, southeast of Kompiam station. Two subsystems are distinguished on the basis of fallow vegetation and cropping interval. For the entire system, sweet potato is the most important crop; other crops are taro and banana. This subsystem covers about 60 per cent of the total area. Fallow vegetation of tall woody regrowth, about 25 years old, is cleared and sweet potato is cultivated continuously for up to 15 years on composted mounds and on small mounds. Short fallows are used between plantings. Managed fallows of *Parasponia*, and some *albizzia* trees, are common. Sweet potato is the most important crop; other crops are banana and taro. Gardens are fenced and drained with shallow ditches. Household gardens are important. Pig husbandry is important.

Extends across provincial border to System(s) None

Altitude range (m) 1400-2300 **Slope** Steep (10-25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Sweet potato, Taro (<i>Colocasia</i>)
OTHER VEGETABLES	Aibika, Bean (common), Bean (winged), Corn, Cucumber, Highland pitpit, Lowland pitpit, <i>Nasturtium</i> spp., Pumpkin tips, Karakap
FRUITS	Marita pandanus, Pawpaw, Sugarcane
NUTS	Karuka (planted), Karuka (wild)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall woody regrowth
SHORT FALLOW	Very significant
LONG FALLOW PERIOD	5-15 years
CROPPING PERIOD	6-14 plantings
R VALUE	50 (medium)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Minor
HOUSEHOLD GARDENS	Very significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	Very significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Significant
2 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	Minor
BURN FALLOW VEGETATION	Minor
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	Minor
MOUNDS	Significant
LARGE MOUNDS	Very significant
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Survey description**

In February 1980, a road traverse from the Ambum Valley to Kompiam station. In November 1990, a two day traverse by road from Wabag to Ogowanda School via Kompiam station. The Laialam area was not visited. Students from Lapalama and Laialam were interviewed at Kompiam high school.

Boundary definition

The boundary with System 0802 was determined on a road traverse from Wabag to Kompiam. The boundary with System 0803 between Lapalama and Kompiam was determined at Ogowanda school and Paware mission on the basis of interviews at Sauanda on the Wabag to Kompiam road. The boundary with System 0803 at Laialam was drawn along the watershed between the Sau River and the Tarua River.

Notes

There are a number of indications that this is a system undergoing change from a low intensity, single planting, long fallow system similar to System 0803, towards a medium intensity, continuous cropping, composted mounding system like System 0802. A long fallow subsystem is still observed on steeper slopes. Oral historical accounts suggest that the Sau Valley was the destination for a number of groups that moved out of the Lai and Tsak Valleys, following increases in pressure on land, and in fighting, less than 200 years ago (Feil 1984, 27; Weissner and Tumu, 1990, 33-35). It seems probable that with increased population densities in the valley, the pre-existing long fallow system was intensified.

Many gardens contain both large mounds and small mounds, distributed according to depth of topsoil. Feil's (1984, 18) comment on 'the absence of mounding' in the 'Kompiam area' must refer to his field site at Mamagakini in the lower intensity System 0803 to the east of Kompiam. All gardens observed in 1990, between Unis census point east of Kompiam, to Birip census point to the west, contained some large mounds. However, many older informants commented that their parents had not used mounds, and that mounding had become common within their lifetime. They said declining soil fertility was the reason why mounding had to be adopted. Wohlt (1986, 7) found Kompiam large mounds were on average 340 cm in diameter and 83 cm tall. There were 688 mounds per ha.

The management of *Parasponia* and *albizzia* tree fallows in gardens under active cultivation is common in this subsystem. In Subsystem 2, planted *casuarina* fallows are more common. Cultivation periods are between 20 and 40 years. There is considerably more burning of fallow material in this system than in other mounding systems in the province. Grass and woody regrowth is slashed and burnt after fencing is completed, and a second burn of heaped material is common. Greens are planted in the heaps of ash left by this practice. All gardens are fenced. Household gardens are important. No burning occurs following short fallows between plantings.

The sale of Arabica coffee, firewood and fresh food are sources of cash in this system, but per capita incomes are relatively low. Wohlt (1986, 58) estimated cash income in Kompiam District to be K42 per person per year.

National Nutrition Survey 1982/83

130 families from 3 villages were asked in June or July 1983 what they had eaten the previous day. 96 per cent reported eating sweet potato, 21 per cent taro, 12 per cent banana, 2 per cent cassava, 1 per cent Chinese taro and none yam, sago or coconut. 9 per cent reported eating rice. 3 per cent reported eating fresh fish. This is similar to the crop pattern except for the higher than expected taro consumption.

Main References

Wohlt, P.B. 1986 Subsistence systems of Enga Province. Department of Enga Province, Technical Bulletin No. 3, Subsistence Unit, Division of Primary Industry, Wabag.

Other References

Feil, D.K. 1984 Ways of Exchange: The Enga Tee of Papua New Guinea. Brisbane, University of Queensland Press.

Scott, G.A.J. and C.F. Pain 1982 Land potential. In Carrad, B., D.A.M. Lea and K.K. Talyaga (eds), Enga: Foundations for Development. Armidale, University of New England, 128-145.

Wiessner, P. and A. Tumu 1990 The oral history of trade and ceremonial exchange in Enga. Paper delivered to the conference 'The Mek and Their Neighbours', sponsored by the Max-Planck-Gesellschaft at Seewiesen, Bavaria.

System Summary

This subsystem, which covers about 40 per cent of the total area, occurs on steeper slopes on the valley sides, and at the bottom of the Sau Valley near the river. Short woody regrowth fallows, around 25 years old, are cleared and burnt. Only one planting is made before fallowing. Sweet potato is the most important crop; other crops are taro, Chinese taro, banana, cassava and yam (*D. alata*). Sweet potato is planted on small mounds. Casuarina trees are planted and Parasponia trees, and some albizzia trees, are managed in fallows and gardens. Gardens are planted in June-July.

Extends across provincial border to System(s) None

Altitude range (m) 1400-2300 **Slope** Steep (10-25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Cassava, Chinese taro, Sweet potato, Taro (<i>Colocasia</i>), Yam (<i>D. alata</i>)
OTHER VEGETABLES	Amaranthus spp., Bean (common), Bean (winged), Cabbage, Corn, Highland pitpit, Nasturtium spp., Oenanthe, Pumpkin fruit, Rungia
FRUITS	Marita pandanus, Sugarcane
NUTS	Karuka (planted), Karuka (wild)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Short woody regrowth
SHORT FALLOW	None
LONG FALLOW PERIOD	>15 years
CROPPING PERIOD	1 planting
R VALUE	5 (very low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Minor
HOUSEHOLD GARDENS	Significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Significant
COMPOST	None
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Significant
2 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Very significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	Minor
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	Very significant
MOUNDS	None
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	Significant
SEASONAL SEC'DARY CROPS	Significant

OTHER DOCUMENTATION**Notes**

This subsystem occurs on steeper slopes, on the lower valley sides near the Sau River, and the upper valley sides along the base of a scarp. It is similar in almost all aspects to System 0803, which surrounds this system to the northwest, north and east.

Casuarina trees are planted in fallows, and Parasponia trees, and to a lesser extent albizzia, are protected and encouraged. Casuarina planting is especially important on steep slopes along the base of a limestone cliff on the south side of the Sau Valley, extending into System 0803 in the lower Lai Valley. Parasponia seed cannot be germinated artificially. Naturally occurring trees are protected from fire, and carefully pollarded during cultivation, in order to enhance soil fertility, and to encourage the rapid return of woody regrowth in the fallow.

Gardens are cleared and planted around the same time each year. Clearing begins in May and planting takes place during June and July. The gardens contain a range of crops, in contrast to gardens in Subsystem 1, where sweet potato is almost the only crop in some gardens. However there is a tendency for yam (*D. alata*) and taro to be planted apart from other crops.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 7	Subsystem No. 1 of 1
Districts 4 Kandep	Subsystem Extent 100 %	Area (sq km) 247
Population 17,813	Population density 72 persons/sq km	Population absent 7 %

System Summary

Located in the Kandep and Marient Basins, and the upper Wage Valley, on lower valley slopes, running down to extensive swamps. Only the very outer margins of the swamps are cultivated. Fallow vegetation is tall grass. Sweet potato is the most important crop; potato is an important crop. Sweet potato and potato are cultivated continuously on composted mounds for up to 40 years, with short fallows of about eight months between plantings. All gardens are fenced and drained with large ditches. Altitude is an important influence on the system. It restricts the range of crops which can be grown and exposes crops to the risk of frost. Household gardens are common. Pig husbandry is important and pigs are tethered in gardens between plantings.

Extends across provincial border to System(s) None

Altitude range (m) 2300-2800 **Slope** Steep (10-25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	Potato
STAPLES PRESENT	Potato, Sweet potato
OTHER VEGETABLES	Bean (common), Cabbage, Chinese cabbage, Corn, Highland pitpit, Nasturtium spp., Oenanthé, Pumpkin tips, Rungia, Karakap
FRUITS	Passionfruit (banana), Sugarcane
NUTS	Karuka (planted), Karuka (wild)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall grass
SHORT FALLOW	Very significant
LONG FALLOW PERIOD	Not significant
CROPPING PERIOD	15-40 plantings
R VALUE	80 (high)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	None
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	None
HOUSEHOLD GARDENS	Significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	None
COMPOST	Very significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	Minor
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Fresh food	Minor
2 Potato	Minor
3 Pyrethrum	Minor
4 Pigs	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Very significant
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	Significant
BURN FALLOW VEGETATION	Minor
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	Very significant
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Survey description**

Between early 1979 and late 1980, four visits of one to two days duration to parts of the Kandep and Marient Basins. In March 1981, a road traverse from Lake Sirunki to Kandep and two days of garden observations of frost damage at Supi, Tindjipaka, Lumbipaka, Maru and Biyako; from Biyako to Yumbisa via Ugu by helicopter; one day of garden observations at Yumbisa, Auipaka and Karekare census points on foot. In November 1990, a road traverse from the upper Lagaip River bridge to Kandep, and from Kandep to Winja school on the Southern Highlands Province border.

Boundary definition

Boundaries with System 0804 were determined by road and air observations.

Notes

This system is identical to System 0804, but is distinguished because of the extensive drains used here.

The most prominent features of the landscape in this system are the swamps. Around 66 per cent of all gardens are located on the edges of the swamps and on slightly higher terraces and fans. Cultivation periods average 38 years, and the average short fallow is 8 months (Wohlt 1986a, 35). The lowest gardens are often flooded. Large drains run through the garden areas and out into the swamps. The swamps are used for pig foraging. Pig production, for sale and for customary exchanges, is important. Women fish with locally made nets in small lakes, which occur in the centre of some swamps.

All of the gardens in this system are above 2300 m altitude. Light frosts occur every year. Repeated severe frosts, which occur every 13 years on average, previously caused the complete abandonment of the system, and the migration of all residents to lower altitudes for up to two years, until gardens could be re-established with new sweet potato vines (Goie 1986; Wohlt 1989; Waddell 1989; Clarke 1989). Mearns (1986, 53-56) reported that four of six clans studied in the Upper Mendi area of Southern Highlands Province, one days walk to the south, claimed land in the Kandep Basin. Previously, some clan members resided permanently in the basin, and others moved between the two locations, but this practice was in decline. Potato is a very important introduction because of its short growing period relative to sweet potato and consequent quicker recovery after frost. Potato is grown for sale as a cash crop on long beds, or intercropped with sweet potato on composted mounds for subsistence. About 30 per cent of gardens are made in on higher and steeper slopes above swamps, where frost is less of a threat because of better cold air drainage. Here the average cultivation period is about half of that in the lower gardens at 16 years. Short fallows here average 5 months in duration (Wohlt 1986a, 35).

All gardens in the system are mounded. Mound dimensions are smaller than elsewhere, around 200 cm in diameter and between 50 cm and 80 cm tall. There are about 1360 mounds per ha (Wohlt 1986a, 33). The amount of compost placed in mounds in this system is greater in proportion to the size of the mound than elsewhere in the province. The large amount of compost is said to prevent sweet potato tubers rotting in saturated soil (Wohlt 1986a, 32). From time to time, small areas of land go out of cultivation, often for other than agronomic reasons. Intergroup fighting, a number of deaths in a family, or the failure of pig fences can all cause abandonment of a piece of land. Long fallows last for 10 to 15 years and are mainly tall cane grass.

Altitude prevents the cultivation of some crops and reduces yields in others. In a survey of 100 gardens between 1981 and 1984, Wohlt (1986a, 38) found sweet potato in every garden; potato in 42 per cent; English cabbage in 37 per cent; sugarcane, taro and corn in 31 per cent; and highland pitpit in 17 per cent, together with nasturtium, common bean, spring onion and Chinese cabbage. Banana, yam, winged bean and peanuts were not observed. Sweet potato yields at Tindjipaka were found to be 70 per cent of yields from similar gardens in System 0801. Wohlt believes pig numbers are lower than elsewhere in the province, at around 1 pig per person.

The main sources of cash income are the sale of pigs, potato, pyrethrum and fresh food, in that order of importance. Wohlt (1986a, 28) estimated incomes at K37 per person per year.

National Nutrition Survey 1982/83

100 families from 2 villages were asked in April, May or June 1983 what they had eaten the previous day. 100 per cent reported eating sweet potato and none banana, taro, cassava, yam, Chinese taro, sago or coconut. 6 per cent reported eating rice. 16 per cent reported eating fresh fish. This is similar to the crop pattern.

Main References

Clarke, W.C. 1989 The Marient Basin, 1972-1976: recovery or adaptation? *Mountain Research and Development* 9, 3, 235-247.

Wohlt, P.B. 1986 Kandep: challenge for development. Department of Enga Province Technical Bulletin No. 2, Division of Primary Industry, Subsistence Unit, Wabag. Wohlt, P. 1989 Migration from Yumbisa, 1972-1975. *Mountain Research and Development* 9, 3, 224-234.

Other References

Brown, M.J.F. and J.M. Powell 1974 Frost and drought in the Highlands of Papua New Guinea. *Journal of Tropical Geography* 38, 1-6.

Goie, A. 1986 Natural disasters, surveys and studies: frost. Department of Enga Province Technical Bulletin No. 1, Division of Primary Industry, Subsistence Unit, Wabag.

Mearns, R. 1986 Upper Mendi land appraisal: a clan-based survey in Papua New Guinea. BA (Hons) thesis, Cambridge University, Cambridge.

Preston, S. 1988 Investigation of compost x fertilizer interactions in sweet potato in Enga Province. In Pitt, A.J. and H.R. Yandanai (eds), *Working Papers of the 1987 Potato/Sweet Potato Workshop*. Port Moresby, Department of Agriculture and Livestock, 105-113.

Waddell, E. 1975 How the Enga cope with frost: responses to climatic perturbations in the central Highlands of New Guinea. *Human Ecology* 3, 4, 249-273.

Waddell, E. 1989 Observations on the 1972 frosts and subsequent relief program among the Enga of the Western Highlands. *Mountain Research and Development* 9, 3, 210-223.

Wohlt, P.B. 1986 Subsistence systems of Enga Province. Department of Enga Province, Technical Bulletin No. 3, Subsistence Unit, Division of Primary Industry, Wabag.

Wohlt, P.B., B.J. Allen, A. Goie and P.W. Harvey 1982 An investigation of food shortages in Papua New Guinea: 24 March to 3 April, 1981. IASER Special Publication No. 6, Institute of Applied Social and Economic Research, Port Moresby.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 8	Subsystem No. 1 of 1
Districts 1 Lagaip	Subsystem Extent 100 %	Area (sq km) 208
Population 18,182	Population density 87 persons/sq km	Population absent 3 %

System Summary

Located in the Lagaip Valley. Fallow vegetation is cane grass, with planted casuarina, 10-15 years old. Gardens of large composted mounds are cultivated continuously for up to 40 years before a long fallow. Short fallows are used between plantings. Sweet potato is the most important crop; other crops are potato, taro and banana. Shallow ditches are common in gardens. Small areas of gardens without mounds occur along the forest margin, where vegetables are grown for sale. Household gardens are common. Pig husbandry is important.

Extends across provincial border to System(s) None

Altitude range (m) 2200-2500 **Slope** Steep (10-25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Potato, Sweet potato, Taro (Colocasia)
OTHER VEGETABLES	Bean (common), Cabbage, Chinese cabbage, Choko tips, Corn, Highland pitpit, Nasturtium spp., Oenanthe, Pumpkin fruit, Rungia
FRUITS	Passionfruit (banana), Sugarcane
NUTS	Karuka (planted), Karuka (wild)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Grass/woody regrowth
SHORT FALLOW	Very significant
LONG FALLOW PERIOD	Not significant
CROPPING PERIOD	15-40 plantings
R VALUE	80 (high)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	None
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Minor
HOUSEHOLD GARDENS	Very significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	Very significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Minor
2 Firewood	Minor
3 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Significant
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	Minor
BURN FALLOW VEGETATION	Minor
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	None
LARGE MOUNDS	Very significant
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Survey description**

In 1979 and 1980, several road traverses between Sirunki Plateau and Pumas, Laiagam and Kandep stations. In February 1980, a road traverse from Wabag to Porgera. In March 1981, a road traverse from Lake Sirunki to Kandep. In November 1990, road traverses from Murisoas school to the upper Lagaip River bridge via the northern loop road; to Laiagam via the Laiagam-Kandep road; and from Laiagam to Porgera.

Boundary definition

The boundaries with System 0804 were determined on road traverses from Laiagam to Sirunki, Kandep and Porgera. The boundary with System 0809 to the east of Rumbaperes village was defined by vehicle traverse on the Laiagam-Porgera road.

Notes

This system is similar to System 0804, but is distinguished because of the use of planted casuarina here. The fallow vegetation is the same here as in System 0809 to the west, but only 3-5 plantings are made before fallowing in that system.

Mounds are on average 270 cm in diameter and 80 cm tall (Wohlt 1986, 7). They are moved with each planting. Weeds and grasses which have grown during the short fallow are pulled up and placed on the ground between the mounds. The four corners of adjacent mounds are used to form a new mound over the top of this material. Sweet potato and potatoes are planted on the mounds. Corn is planted between the mounds. Small mounds are not used in this system.

From time to time, small areas of land go out of cultivations, often for other than agronomic reasons. Intergroup fighting, a number of deaths in a family, or the failure of pig fences can all cause abandonment of a piece of land. Long fallows last for 10 to 15 years and are mainly tall cane grass and low woody regrowth.

In places casuarina trees are planted in mounded gardens, and dense plantations occur around houses and in fallows on hill slopes. Small areas are cleared from previously unused land on the edge of the forest, and used for growing vegetables for sale, mainly cabbage and carrots. All gardens are fenced, commonly with cordyline, which forms a living fence. Shallow ditches occur in many gardens. Household gardens are important and are fertilised with pig manure and ash. Various green vegetables, banana, corn and beans are grown in them.

Cash is earned from the sale of Arabica coffee and vegetables, but the most important source is the sale of firewood to residents of Wabag, Laiagam and Porgera.

National Nutrition Survey 1982/83

208 families from 5 villages were asked in April, June, July or September 1983 what they had eaten the previous day. 99 per cent reported eating sweet potato, 1 per cent taro, 1 per cent cassava, 1 percent banana and none yam, Chinese taro, sago or coconut. 20 per cent reported eating rice. 2 per cent reported eating fresh fish. This is similar to the crop pattern.

Main References

None.

Other References

Kutal, J. 1975 Gardening at Laiagam. Oral History 3, 9, 20-23.

Scoullar, B. 1973 Pyrethrum and the Highlander, Extension Bulletin No. 3. Department of Agriculture, Stock and Fisheries, Port Moresby.

Wohlt, P.B. 1986 Subsistence systems of Enga Province. Department of Enga Province, Technical Bulletin No. 3, Subsistence Unit, Division of Primary Industry, Wabag.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 9	Subsystem No. 1 of 1
Districts 1 Lagaip, 5 Porgera	Subsystem Extent 100 %	Area (sq km) 91
Population 3,598	Population density 40 persons/sq km	Population absent 1 %

System Summary

Located in the upper part of the Porgera Valley above about 1800 m altitude. Fallow vegetation is mainly cane grass and tall woody regrowth, with significant planted casuarina trees. After fallows of more than 15 years, vegetation is cut, dried and burnt. Sweet potato is the most important crop; other crops are banana and taro. Sweet potato is planted in composted mounds, with typically 3-5 plantings before fallowing. Between plantings, short fallows of less than 12 months are common. Household gardens are common.

Extends across provincial border to System(s) None

Altitude range (m) 1800-2300 **Slope** Steep (10-25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Sweet potato, Taro (Colocasia)
OTHER VEGETABLES	Amaranthus spp., Bean (common), Cabbage, Corn, Highland pitpit, Oenanthe, Pumpkin tips, Rungia
FRUITS	Sugarcane
NUTS	Karuka (planted), Karuka (wild)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Grass/woody regrowth
SHORT FALLOW	Significant
LONG FALLOW PERIOD	>15 years
CROPPING PERIOD	3-5 plantings
R VALUE	17 (low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	None
HOUSEHOLD GARDENS	Significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	Very significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Fresh food	Minor
--------------	-------

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	Very significant
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Survey description**

In February 1980, a road traverse from Laiagam station to Porgera, with garden inspections (2 days). In March 1981, visit by team surveying frost damage and road traverse from Porgera to Tipinini school (1 day). In November 1990, a vehicle traverse from Laiagam station to Porgera and a helicopter traverse to the Paiela Valley (1.5 days).

Boundary definition

The boundaries with System 0810 in the Porgera Valley were defined by vehicle traverse on the Laiagam-Porgera road and by inspection of the Kaiya Valley, and extrapolated with reference to Saunders (1993). The boundary with System 0810 across the Lagaip Valley north of Laup school was defined by inspection from the Porgera road. The boundary with System 0808 to the east of Rumbaperes village was defined by vehicle traverse on the Laiagam-Porgera road.

Notes

Land use in this system is less intensive than in Systems 0801, 0802, 0804, 0806, 0807, 0808 in the main valleys further east (Meggitt 1957, 36; Hughes and Sullivan 1987, 13; Wohlt 1986, 16). One possible cause is the absence of ash soils west of the Lagaip Valley. Compared to System 0808, immediately to the east in the Lagaip Valley, this system has a shorter cultivation period, more woody regrowth in the fallow vegetation, and, most characteristically, smaller mounds. However, this system is more intensive than System 0810, which surrounds it to the north and west, where the cultivation period is shorter.

Before the onset of mining, the upper altitudinal limit of agriculture in the Porgera Valley was at around 2300 m. Compared to other nearby high altitude areas, there is less risk of frost damage to crops (Wohlt et al. 1982, 33). In the past, the Porgera Valley was a refuge area for people suffering frost damage to crops, particularly those from the Upper Wage area (Goie 1986, 18-23).

Hughes and Sullivan (1987, 9) described a range of fallow vegetation in the Porgera Valley, with tall cane grass and minor shrub regrowth as the most extensive type; similar proportions of tall grass and shrub mostly on the eastern side of the valley; and some occurrence of shrub and woody regrowth.

After a brief visit to the Porgera Valley in 1957, Meggitt (1957-58, 36) described fallow periods of 15-20 years (one cultivation per generation), composted mounds around 1 m in diameter, sweet potato gardens that were larger than elsewhere in Enga. He noted that in good soil, first plantings were not always composted, though second plantings were. Around each woman's house were household gardens containing crops such as banana, taro and tobacco.

The Enga Subsistence Systems Study during 1982-86 (Wohlt 1986, 6-8, 13-14) reported that Porgera mounds were smaller than elsewhere in Enga: averaging 146 cm in diameter and 60 cms high, with 7.6 planting stations per mound. Three kinds of garden were distinguished on the basis of location, soils and intensity. Primary gardens occurred on low slopes (deep soils, 27 years cultivation period, 11 year long fallow period), and were most common (65 per cent of 63 gardens); slope gardens were located on sloping land with deep soils (11 years cultivation period, 22 years fallow period), and accounted for 18 per cent of gardens; and long fallow gardens (11 per cent) on poorer soils (3 years cultivation period, 45 years fallow period). Wohlt (1986, 35) considered that soils at Porgera were of low fertility.

There has been minor alluvial mining activity at Porgera since 1948, providing some cash income. In association with the activities surrounding the establishment of the Porgera gold mine in the 1980s, several studies have examined aspects of agriculture in and around the mining lease area (Hughes and Sullivan 1987; Jackson 1986; Banks 1994a, 1994b). The major themes include: the effects of loss of land to mining activity, the substantial in-migration of non-Porgerans, and the effects of the very large cash payments for compensation, royalties and wages on landowners.

Mining activities have affected land use in the area of the mine site since the 1970s (Hughes and Sullivan 1987, 11-12). Banks (1994b, 6; 1994a, 19, 21-23) found an increase in the cultivated area in the Kaiya River Valley between 1971 and 1993; an increase in the cultivated area in the Apalaka relocation area between 1986 and 1991; and an upward expansion of new gardens into previously uncut forest in the Kulapi area. Surveys up to mid-1993 suggested that an increasing number of families in the Special Mining Lease Area were not making gardens (Banks 1994a, 12; Bonnell 1994, 28-30).

Notes continued

In the early 1980s, cash income from either coffee or pyrethrum, was estimated at K81 per person (Wohlt 1986, 35, 58). In recent years, however, mine-related income (compensation and royalty payments, wages, sales and gifts) has been substantial. For instance, between 1987 and 1992, almost K26 million was paid out in compensation, and by 1993, Porgerans living near the mine received an average fortnightly income of K143 (Banks 1994a, 26, 30). The demand for fresh vegetables by the mine is not fully met by local growers, and some food is purchased from as far away as Tambul in the Western Highlands (Anon 1992a, 1-2; 1992b, 4).

National Nutrition Survey 1982/83

40 families from 1 village were asked in May 1983 what they had eaten the previous day. 98 per cent reported eating sweet potato, 3 per cent taro, 3 per cent coconut and none banana, cassava, yam, Chinese taro or sago. 20 per cent reported eating rice. 15 per cent reported eating fresh fish. This is similar to the crop pattern.

Main References

Wohlt, P.B. 1986 Subsistence systems of Enga Province. Department of Enga Province, Technical Bulletin No. 3, Subsistence Unit, Division of Primary Industry, Wabag.

Other References

Anon 1992 Golden opportunities for Engan farmers. Fresh Produce News 54, 1-2.

Anon 1992 Outside buyers at Tambul. Fresh Produce News (20 March 1992) 58, 4.

Banks, G. 1994 Economic modelling project, second report: gardens and wantoks. Porgera Social Monitoring Programme Report No. 3, Unisearch PNG, Port Moresby.

Banks, G. 1994 Kaiya River LMP: socio-economic baseline study. Porgera Social Monitoring Programme Report No. 4, Unisearch PNG, Port Moresby.

Bonnell, S. 1994 Dilemmas of development: social change in Porgera, 1989-1993. Porgera Social Monitoring Programme Report No. 2, Subada Consulting, Thornlands.

Goie, A. 1986 Natural disasters, surveys and studies: frost. Department of Enga Province Technical Bulletin No. 1, Division of Primary Industry, Subsistence Unit, Wabag.

Hughes, P.J. and M.E. Sullivan 1987 Land use study. In, The Porgera Gold Project Environmental Plan, Volume C. Port Moresby, Natural Systems Research, Appendix 7.

Hughes, P.J. and M.E. Sullivan 1988 Population, land use and goldmining in Papua New Guinea. Yagl-Ambu 15, 2, 40-62.

Jackson, R. 1986 Social Survey - Porgera: Draft Report to Placer Pacific. Townsville, Geography Department, James Cook University.

Meggitt, M.J. 1957 The Ipili of the Porgera Valley. Oceania 28, 31-55.

Pacific Agribusiness 1987 Social and Economic Impact Study - Porgera Gold Mine: Volume 1. Impact. Report to Department of Minerals and Energy, and Placer (PNG). Melbourne, Pacific Agribusiness.

Talyaga, K.K. 1984 Porgera Gold Mine: Socio-economic Impact Study. Interim Report Volume Two, The Porgera District and the Mine Development. Unpublished report to National Planning Office, Wabag.

Wohlt, P.B., B.J. Allen, A. Goie and P.W. Harvey 1982 An investigation of food shortages in Papua New Guinea: 24 March to 3 April, 1981. IASER Special Publication No. 6, Institute of Applied Social and Economic Research, Port Moresby.

PROVINCE 8 Enga		AGRICULTURAL SYSTEM No. 10	Subsystem No. 1 of 1
Districts 1 Lagaip, 2 Wabag, 5 Porgera	Subsystem Extent 100 %	Area (sq km) 414	
Population 9,864	Population density 24 persons/sq km	Population absent 3 %	

System Summary

Located in the Paiela area, the north and east parts of the Porgera Valley, and in the lower Lagaip Valley. Fallow vegetation is typically cane grass and tall woody regrowth, more than 15 years old. Vegetation is cleared and burnt. Sweet potato is the most important crop; other crops are taro, banana and yam (*D. alata*). Crops are planted in mounds, which are usually composted. There are two plantings before fallowing. Between plantings, there may be short fallows of less than 12 months.

Extends across provincial border to System(s) None

Altitude range (m) 1200-2200 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Sweet potato, Taro (<i>Colocasia</i>), Yam (<i>D. alata</i>)
OTHER VEGETABLES	Aibika, Amaranthus spp., Bean (winged), Choko tips, Highland pitpit, Oenanthe, Pumpkin tips, Rungia
FRUITS	Sugarcane
NUTS	Castanopsis, Karuka (planted), Karuka (wild)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Grass/woody regrowth
SHORT FALLOW	Significant
LONG FALLOW PERIOD	>15 years
CROPPING PERIOD	2 plantings
R VALUE	9 (very low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Minor
HOUSEHOLD GARDENS	Minor

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	Significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Fresh food	Minor
--------------	-------

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Very significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	Very significant
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Survey description**

The Paiela area was visited briefly twice (each visit less than 1 hour). In January 1980, by helicopter to Anjuia village, with garden inspection; and in November 1990, by helicopter from Porgera to a ridge south of Paiela station, with interview and garden inspection. The east side of the Porgera Valley was traversed by vehicle on three occasions, each with garden inspections: in February 1980, from Laiagam station to Porgera; in March 1981, from Porgera to Tibinini school; and in November 1990, from Laiagam station to Porgera. No visits were made to the other areas lying mainly to the north of the Porgera Valley included within this system; that is, the lower Lagaip Valley, Walia and a number of scattered areas of land use.

Boundary definition

The boundaries with System 0809 in the Porgera Valley were defined by vehicle traverse on the Laiagam-Porgera road and by inspection of the Kaiya Valley, and extrapolated with reference to Saunders (1993). The boundary with System 0809 across the Lagaip Valley north of Laup School was defined by inspection from the Laiagam-Porgera road. The boundary with System 0811 is based on altitudinal differences with System 0811 mostly below 1200 m. The system was distinguished from 0702/0812 after field visits in the Lake Kopiago area.

Notes

While this system is closely similar to System 0809, which it borders in the Porgera and Lagaip Valleys, it is characterised by a generally lower intensity of land use. In particular, the cultivation period is shorter. Further to the west, near the border with the Southern Highlands in the lower Lagaip Valley, agriculture in System 0811 is even less intensive and composting is not practised.

Following a brief visit to the Porgera Valley in 1957, Meggitt (1957-58, 33, 36) described the lower third of the valley (called 'Wapi') as an uninhabited, lower altitude zone, which was visited by residents from further up the valley to hunt, harvest marita pandanus, and to cultivate small taro and yam gardens.

The Enga Subsistence Systems Study 1982-86 (Wohlt 1986, 6-8, 13-14) collected information on agriculture at five census units in the Porgera Valley. Only one, Tibinini, was located within this system, and the rest were located within System 0809. However, the information remains relevant. Mounds were smaller than elsewhere in Enga: averaging 146 cm in diameter and 60 cms high, with 7.6 planting stations per mound. Three kinds of garden were distinguished on the basis of location, soils and intensity. Primary gardens occurred on low slopes (deep soils, 27 years cultivation period, 11 year long fallow period), and were most common (65 per cent of 63 gardens); slope gardens were located on sloping land with deep soils (11 years cultivation period, 22 years fallow period), and accounted for 18 per cent of gardens; and long fallow gardens (11 per cent) on poorer soils (3 years cultivation period, 45 years fallow period). Wohlt (1986, 35) considered that soils at Porgera were of low fertility.

The large Porgera gold mine is located in adjacent System 0809 at the head of the Porgera Valley. There are no direct impacts on land use in this system, but mining and associated activities have been important sources of cash income here (Pacific Agribusiness 1987; Jackson 1986). Many people from Paiela were involved in the Mt Kare gold rush in 1988 and 1989, when cash incomes became extremely high for a short time (Ryan 1991). Some fresh food is sold at the mine.

National Nutrition Survey 1982/83

66 families from 2 villages were asked in June 1983 what they had eaten the previous day. 97 per cent reported eating sweet potato, 8 per cent taro, 3 per cent cassava, 2 per cent banana, 2 per cent coconut and none yam, Chinese taro or sago. None reported eating rice. None reported eating fresh fish. This is similar to the crop pattern.

Main References

Wohlt, P.B. 1986 Subsistence systems of Enga Province. Department of Enga Province, Technical Bulletin No. 3, Subsistence Unit, Division of Primary Industry, Wabag.

Other References

- Goie, A. 1986 Natural disasters, surveys and studies: frost. Department of Enga Province Technical Bulletin No. 1, Division of Primary Industry, Subsistence Unit, Wabag.
- Hughes, P.J. and M.E. Sullivan 1987 Land use study. In, The Porgera Gold Project Environmental Plan, Volume C. Port Moresby, Natural Systems Research, Appendix 7.
- Hughes, P.J. and M.E. Sullivan 1988 Population, land use and goldmining in Papua New Guinea. *Yagl-Ambu* 15, 2, 40-62.

Other References continued

Jackson, R. 1986 Social Survey - Porgera: Draft Report to Placer Pacific. Townsville, Geography Department, James Cook University.

Meggitt, M.J. 1957 The Ipili of the Porgera Valley. *Oceania* 28, 31-55.

Pacific Agribusiness 1987 Social and Economic Impact Study - Porgera Gold Mine: Volume 1. Impact. Report to Department of Minerals and Energy, and Placer (PNG). Melbourne, Pacific Agribusiness.

Ryan, P. 1991 *Black Bonanza: A Landslide of Gold*. Melbourne, Hyland House.

Wohlt, P.B., B.J. Allen, A. Goie and P.W. Harvey 1982 An investigation of food shortages in Papua New Guinea: 24 March to 3 April, 1981. IASER Special Publication No. 6, Institute of Applied Social and Economic Research, Port Moresby.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 11	Subsystem No. 1 of 1
Districts 5 Porgera	Subsystem Extent 100 %	Area (sq km) 148
Population 121	Population density 1 persons/sq km	Population absent 2 %

System Summary

Located east of the Strickland River in the valleys of the Lagaip, Pori and Ura Rivers, and extending into Southern Highlands Province. Tall woody regrowth, typically more than 20 years old, is cleared and burnt. Some gardens are made in previously uncut forest. Sweet potato is the most important crop; banana and taro are important crops; other crops are cassava and sago. Only one planting is made before fallowing. Fruit and nut tree crops (especially marita pandanus, breadfruit and Pangium) are important. Hunting is a significant activity.

Extends across provincial border to System(s) 0701

Altitude range (m) 600-1400 **Slope** Very steep (>25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	Banana, Taro (Colocasia)
STAPLES PRESENT	Banana, Cassava, Sago, Sweet potato, Taro (Colocasia)
OTHER VEGETABLES	Aibika, Corn, Cucumber, Highland pitpit, Lowland pitpit, Peanuts
FRUITS	Marita pandanus, Pawpaw, Pineapple, Sugarcane
NUTS	Breadfruit, Pangium edule
NARCOTICS	Betel nut (lowland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall woody regrowth
SHORT FALLOW	None
LONG FALLOW PERIOD	>15 years
CROPPING PERIOD	1 planting
R VALUE	5 (very low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	None
HOUSEHOLD GARDENS	None

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	None
COMPOST	None
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

None

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	None
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Very significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	Minor
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Very significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Survey description**

This system was not visited in Enga Province. In March 1991, a five day walking traverse was made as part of a health survey through the South Hewa area, from Waike village via Wanakipi, Wisika and Ambi villages. Information also taken from a study in 1966-69 by Steadman (1971). The Bogaia area (Bulago Valley) was not visited and information was taken from Sillitoe (1994).

Boundary definition

The western boundary with System 1505 in West Sepik Province and System 0102 in Western Province is the Strickland River, which is also the provincial boundary. The southern boundary with System 0702 was defined on a walking traverse from Waike village to Ambi village. The eastern boundary with Enga System 0810 is based on altitudinal differences. System 0810 occurs above 1200 m.

Notes

This is a low intensity system and contrasts with more intensive systems at higher altitudes to the south and east. It is similar to System 0102/1505 on the western side of the Strickland River where agriculture is also low in intensity. However, in that system, taro was previously the most important crop, but it has been replaced by a combination of staple crops in recent decades. This system is distinguished from those to the east and south where composted mounds are used.

In 1991, people in the south Hewa area claimed that, around 70 years ago, sweet potato replaced sago as their most important food. Sweet potato is now the most important food. Sago palms are located in the Lagaip Valley. In 1966-69, they were described by Steadman (1971, 39) as rare, and used for thatching only. In 1991, sago was said to be eaten, but only when other food was short. In the Bogaia area, sago is also eaten irregularly (Sillitoe 1994, 21).

Since 1980, the mounding technique used by the Duna people (System 0702) had been adopted by some Hewa villagers in the Wanakipa area. This is still only a minor practice, said to have been adopted to produce more sweet potato for pig fodder in response to inflation in the numbers of pigs required for bride price. Mounds are 40-60 cm high and 100-150 cm in diameter. It is not known if they are composted. Similarly, in the Bogaia area, only a few gardens contained mounds (Sillitoe 1994, 21, 59). In this area, people say that they only make mounds for second or subsequent plantings or where the top soil is especially thin.

Although most cultivation is located below 1400 m in the Bogaia area, people have access to higher altitudes and thus to karuka pandanus (Sillitoe 1994, 11).

National Nutrition Survey 1982/83

No villages from this system were included in the survey.

Main References

Sillitoe, P. 1994 The Bogaia of the Muller Ranges, Papua New Guinea: Land Use, Agriculture and Society of a Vulnerable Population. Sydney, Oceania Monograph 44.

Steadman, L. 1971 Neighbours and killers: residence and dominance among the Hewa of New Guinea. PhD thesis, Australian National University, Canberra.

Other References

Dyke, T., C. Ballard, S. Flew, M. Mai, J. Crocker and S. Lutz 1991 The health of the Hewa. Unpublished paper, Papua New Guinea Health Services and Papua New Guinea Institute of Medical Research, Port Moresby.

Volrath, K. 1985 Hewa ethnography. Unpublished report, Summer Institute of Linguistics, Ukarumpa.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 12	Subsystem No. 1 of 1
Districts 5 Porgera	Subsystem Extent 100 %	Area (sq km) 16
Population 0	Population density 0 persons/sq km	Population absent 0 %

System Summary

Located north and west of Koroba station in the Tumbudu, Poru and Auwi River Valleys, and between Lake Kapiago and the Strickland Gorge in Southern Highlands Province and extending a short distance into Enga Province. Gardens are typically cleared from tall woody regrowth more than 15 years old. Some fallows include cane grass. Vegetation is cleared, piled, dried and burnt. Commonly, many trees are left standing after pollarding or ringbarking. Mounds are made containing small amounts of compost. Sweet potato is the most important crop; other crops are banana and taro. There are 3-5 plantings before fallowing. Short fallows of less than a year commonly occur between plantings. Household gardens are common. Pig husbandry is important.

Extends across provincial border to System(s) 0702

Altitude range (m) 800-2100 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Sweet potato, Taro (Colocasia)
OTHER VEGETABLES	Amaranthus spp., Bean (common), Cabbage, Choko tips, Corn, Highland pitpit, Peanuts, Pumpkin tips, Rungia, Bean (lima)
FRUITS	Marita pandanus, Pawpaw, Pineapple, Sugarcane
NUTS	Karuka (planted), Karuka (wild)
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall woody regrowth
SHORT FALLOW	Significant
LONG FALLOW PERIOD	>15 years
CROPPING PERIOD	3-5 plantings
R VALUE	0 (very low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	None
HOUSEHOLD GARDENS	Significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	Significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Minor
2 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	Very significant
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Survey description**

In September 1980, a traverse on the Tari-Poru-Lake Kopiago-Kelabo-Koroba-Tari roads (2 days). In November 1990, separate road traverses on the southern (Tari-Koroba-Kelabo-Lake Kopiago) and northern (Tari-Poru-Lake Kopiago) roads (2 teams, 2 days each). The small area of this system that is in Enga Province was not visited.

Boundary definition

The boundary with System 0701/0811 to the north was determined from a walking traverse from the south Hewa area to Lake Kopiago. The eastern boundary with System 0705 was determined from road traverses on the Tari-Koroba-Lake Kopiago and Tari-Pori-Lake Kopiago roads. The system was distinguished from 0810 in Enga Province after visits to the Paiela area.

Notes

Agriculture here shares the characteristic composted mounds (known as 'mondo' in the Duna language) of System 0705 and others further to the east, but is considerably less intensive, as indicated by the shorter cropping period and the woody fallow vegetation. The practice of pollarding or ringbarking trees when clearing fallow regrowth results in distinctive gardens containing many standing trees (Modjeska 1977, 114; Steensberg 1993, 74-75). This system is distinguished from System 0701/0811 to the north where composted mounds are not used. Agriculture in the Paiela area to the east (System 0810) is based on cane grass and woody regrowth fallows.

Three studies have been made of aspects of agriculture in this system: Modjeska (1977, 1982) in the early 1970s at Horaile in the middle Tumbudu Valley; Marecek (1977, 1979) in 1975 at Yokona on the edge of the Strickland Gorge; and a rapid survey by Bell (1984) at Hagini near Lake Kopiago in 1984.

The area covered by this system falls in altitude from the east to the Strickland Gorge in the west. Population density also declines from east to west (Modjeska 1977, 64). Some variation in agriculture is associated with these declines. At the very small community of Yokona in the far west, there was typically only one planting before fallowing in 1975, and a greater area of sweet potato was planted by dibbling than in mounds (Marecek 1977, 84-5). Elsewhere, although some dibbling ('tse' in the Duna language) is used, most sweet potato is planted in mounds which are typically 40 cm high by about 200 cm in diameter. Mound density is about 1800 per ha (Modjeska 1977, 115). The extent of soil preparation prior to making mounds after a long fallow is not clear. Some evidence suggests that the surface is completely tilled, but further information is needed. Mounds are reformed in the space between previous ones. Most mounds include compost. The quantity of compost applied appears to be less than in higher altitude locations elsewhere in the Southern Highlands and Enga; but comparable with rates at similar altitudes elsewhere in the Southern Highlands.

Variation in fallow vegetation includes some low stunted woody regrowth (for instance in the Pori River Valley); some cane grass and woody regrowth (particularly near the two roads leading to Lake Kopiago); and some cane grass in swampy areas such as the margins of Lake Kopiago. Common fallow regrowth trees include albizzia and *Dodonaea*. While there were no casuarina trees in fallows west of Lake Kopiago in the early 1970s, by 1990 casuarina appeared sporadically around Lake Kopiago and in the upper Tumbudu Valley east of the lake. Some variation may be due to more recent factors. The siting of service facilities (schools and aidposts) near the two roads leading to Lake Kopiago over the last three decades has led to people moving down from the backslopes of the limestone hogback ridges towards the roads. This has probably resulted in some restricted areas of more intensive land use (marked by grass fallows and longer cropping periods) nearer the roads. Swampy areas under cane grass and woody regrowth are brought into cultivation by means of major drainage ditches on the margins of Lake Kopiago.

In 1990, older informants at Lake Kopiago said that sweet potato yields (and those of other crops) had declined from previous levels. One reason cited was the arrival of an exotic earthworm. In the past, special taro gardens were said to be cultivated in forest fallows, but they were no longer made by the early 1970s (Modjeska 1977, 128). Although formal mixed gardens are not made, a survey of the gardens of over 30 families at Hagini near Lake Kopiago found distinct mixed garden plots within larger garden areas (Bell 1984, 45, Appendix 1).

Reported cropping periods range considerably. In favourable areas, gardens in the early 1970s and 1980s were said to be cultivated for more than 12 years (Modjeska 1977, 42; Bell 1984, 44), though Modjeska considered that three to five years was typical. In 1990, two plantings of sweet potato before fallowing were reported from several sites, with over three plantings from favourable locations.

Notes continued

Enclosure patterns vary. In some parts, every garden is enclosed, in others, many adjoining individual gardens are included in one fencing system. In the southeast, there is widespread use of combined fencing and ditching, which is also characteristic of the Huli cultural area (Systems 0704, 0705, 0706). Breadfruit is grown below 1300 m and minor quantities are eaten, particularly in the western part of the system. *Pangium edule* grows below 1000 m and reasonably large amounts are eaten during the harvest (June-July).

In the far west, below 1400 m altitude, Marecek (1977, 80, 82) described a seasonal pattern of garden clearing (May-August) and planting (August-October). In 1975, food was scarce in the small community of Yokona between June and August, and extra sweet potato supplies were acquired from a neighbouring community (Maracek 1979, 164).

Pig husbandry is significant, with a pig:person ratio of 1:1 reported from both the early 1970s and 1984, and daily sweet potato rations of 2-3 kg per pig (Modjeska 1977, 41, 138; Bell 1984, 53). Hunting is generally of minor importance, but there is access to wild pig and cassowary at lower altitudes (Marecek 1979, 35). Women fish using nets in Lake Kopiago.

Cash incomes are generally low. Arabica coffee and food market sales are minor sources only. Some pigs are sold. A very small number of cattle are produced in the Tumbudu Valley. Although the majority of the population live relatively close to the loop road, which traverses both the north and south of the system, road access is often disrupted by lack of bridge maintenance. Lake Kopiago station is also serviced by air. A project to encourage the production of vegetables for sale to the Ok Tedi mine had failed by 1984 (Bell 1984, 61).

National Nutrition Survey 1982/83

No villages from this system were included in the survey.

Main References

Bell, J. 1984 The causes and consequences of change: implications of an emergent cash economy on the people of Hagini, Papua New Guinea. BA (Hons) thesis, Cambridge University, Cambridge.

Marecek, T.M. 1977 Shifting cultivation among the Duna of Papua New Guinea. *Tools and Tillage* 3, 2, 78-90.

Modjeska, C.J.N. 1977 Production among the Duna: aspects of horticultural intensification in Central New Guinea. PhD thesis, Australian National University, Canberra.

Other References

Bogan, K. and R. Crittenden 1987 Environment, economic development and the nutritional status of children in the Southern Highlands of Papua New Guinea in 1983. *Ecology of Food and Nutrition* 20, 1, 29-49.

Bourke, R.M. 1988 Taim hangre: variation in subsistence food supply in the Papua New Guinea Highlands. PhD thesis, Australian National University, Canberra.

Marecek, T.M. 1979 Social relationships in a Papua New Guinean community. PhD thesis, Arizona State University, Tempe.

Modjeska, N. 1982 Production and inequality: perspectives from central New Guinea. In Strathern, A. (ed), *Inequality in New Guinea Highlands Societies*. Cambridge, Cambridge University Press, 50-108.

Perry, R.A., M.J. Bik, E.A. Fitzpatrick, H.A. Haantjens, J.R. McAlpine, R. Pullen, R.G. Robbins, G.K. Rutherford and J.C. Saunders 1965 Lands of the Wabag-Tari area, Papua-New Guinea. Land Research Series No. 15, Commonwealth Scientific and Industrial Research Organization, Melbourne.

Steensberg, A. 1993 Fire-Clearance Husbandry: Traditional Techniques Throughout the World. Herning, Poul Kristensen.

Stürzenhofecker, G. 1994 Visions of a landscape: Duna pre-meditations on ecological change. *Canberra Anthropology* 17, 2, 27-47.

Waller, J.M. 1984 Diseases of smallholder food crops in the Southern Highland Province of Papua New Guinea. Unpublished report, Commonwealth Mycological Institute, Surrey.

PROVINCE 8 Enga	AGRICULTURAL SYSTEM No. 13	Subsystem No. 1 of 2
Districts 5 Porgera	Subsystem Extent 50 %	Area (sq km) 4
Population 0	Population density 0 persons/sq km	Population absent 0 %

System Summary

Located in the Mendi Basin north of Mendi town and extending a short distance into Enga Province. Two subsystems are distinguished, mainly on the basis of different cropping periods. For the entire system, sweet potato is the most important crop; other crops are potato, taro and banana. This subsystem, which occupies about half of the system, occurs mainly on volcanic ash plains, swamp margins and river floodplains. Fallow vegetation of tall cane grass, 5-15 years old, is cut, dried and burnt. The soil is formed into mounds and planted with sweet potato. For subsequent plantings, mounds are reformed with compost. Cultivation is extended for more than 20 years. Short fallows occur between plantings. Frost is a significant hazard to agriculture. Household gardens are very common. Pig husbandry is important. Major drains are constructed.

Extends across provincial border to System(s) 0717

Altitude range (m) 1700-2500 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Potato, Sweet potato, Taro (Colocasia)
OTHER VEGETABLES	Bean (common), Cabbage, Chinese cabbage, Corn, Highland pitpit, Nasturtium spp., Oenanthe, Pumpkin tips, Rungia
FRUITS	Sugarcane
NUTS	Castanopsis, Karuka (planted), Karuka (wild)
NARCOTICS	Betel pepper (highland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall grass
SHORT FALLOW	Very significant
LONG FALLOW PERIOD	5-15 years
CROPPING PERIOD	15-40 plantings
R VALUE	67 (high)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Minor
HOUSEHOLD GARDENS	Very significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	Very significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Minor
2 Fresh food	Minor
3 Potato	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Significant
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Minor
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	Very significant
LARGE MOUNDS	Minor
Garden Bed Techniques:	
BEDS SQUARE	None
BEDS LONG	None
Other Features:	
FENCES	Significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Survey description**

Several brief visits were made between 1978 and 1980. In September 1980, a road traverse from Mendi to the Lai Valley (1 day). In November 1990, a road traverse by one team from Mendi to Map and Bela villages on the west bank of the Mendi River and to the Lai Valley (half day); and by another team from Mendi to a few kilometres beyond Lake Egari (half day). The small part of the system that lies in Enga Province was not visited.

Boundary definition

The boundary with Western Highlands System 0904 to the northeast was determined from a road traverse on the Tambul-Mendi road. The boundary with System 0714 to the south was determined from road traverses on the Mendi-Nipa and Mendi-Ialibu roads. The boundary with System 0716 to the west was determined from a road traverse on the Mendi-Lai Valley road.

Notes

This system is located in the Mendi Basin, rising from about 1700 m just south of Mendi town to 2500 m in the north. Although the area is occupied by people speaking two major languages, Mendi and Imbong'gu, this linguistic division is not paralleled by agricultural differences. There is a major difference within the system between gardens which are cultivated for very long periods, and those with considerably shorter cropping periods. Two subsystems are distinguished to reflect this.

Subsystem 1, with almost continuous cultivation, is similar to System 0807 to the north in Enga Province, and to System 0904, to the northeast in the Tambul area of Western Highlands Province. The shorter cropping period of the second subsystem, which contrasts with these adjacent northern systems, is generally similar to that of System 0716 in the Lai Valley to the west. In the Lai Valley, however, mounds are not composted, and there are large mixed gardens in the valley bottom. To the south of Mendi town, agriculture in System 0714 is characterised by long beds for sweet potato cultivation; short grass fallows; and shorter cropping and fallow periods.

Substantial parts of the system lie above 2100 m altitude where there is significant risk of frost: one year in ten for severe frosts, and one year in every two or three years for milder frosts (Radcliffe 1985, 9-12). Even the latter can result in significant crop damage. Some people living in the north also use land one day's walk away in the Kandep Basin in System 0807 in Enga (Mearns 1986, 53-56). While some Mendi clan members resided permanently in Kandep, others moved between the two locations, though the numbers doing so were reported to have declined.

Two main, named, garden types occur in this subsystem (Radcliffe 1984, 38-40; Mearns 1986, 78-87; Quinn n.d.). These are, firstly, gardens on floodplains and around the swamp margins (known as 'poiem' (Mendi language) or 'kul-kala' (Imbong'gu)). These are characterised by major drains and very extended cropping periods. The second type are gardens on moderately sloping, cane grass grassland ('sepiem' (Mendi) or 'ga-kala' (Imbong'gu)). The cropping period of these grassland gardens can range from four years on poorer soils to more than 20 years on better soils; fallows range from 3 years to usually many more (Radcliffe 1984, 39). Soil retention barriers are made very occasionally.

Agricultural change in the past 40-50 years has not had a dramatic impact on the environment. Comparison of airphotos taken in 1948 and in 1981 indicated little loss of forest above 2400 m in the upper Mendi area (Radcliffe 1984, 29). There was extensive planting of casuarina trees after 1959 near the Mendi River in a few small areas (Simpson 1978, 21). At Mulim village, there was concern in the mid-1970s that overgrazing by cattle was leading to land degradation (Simpson 1978, 86-94).

Agronomic research, focussing on soil fertility, was carried out at a number of sites in the upper Mendi area in the early 1980s (Floyd et al. 1987a, 1987b, 1988). This identified soil fertility as the major constraint to sweet potato yields (inadequate phosphate and potash) (Floyd et al. 1987b, 21). Phosphate application had considerable effects on yields. In trials of the effect of differing rates of compost application (up to 100 t/ha) on sweet potato yield, all but one trial showed a linear response (Floyd et al. 1987a; 1988).

In 1990, farmers in the Mendi Valley claimed that sweet potato yields had been declining, which they suggested might be associated with increased numbers of earthworms in the soil. In the northeast also, yields are said to have been larger in the past (Puri 1982, 161).

Notes continued

While sweet potato planting occurs throughout the year, a study of planting rates by 20 families in 1981-83 showed considerable variation, some of which appeared to be due to the effects of severe frost (Crittenden et al. 1988). The mean area planted per family each year in 1981-83, was 0.246 ha (Crittenden et al. 1988, 54). For a sample of 15 families at Mulim in 1976, Simpson (1978, 6, 86-7) found an average 0.79 ha under cultivation per family, or 0.18 ha/person.

Pig husbandry is important, with estimates of pig holdings of just over 1 pig per person at two locations (Simpson 1978, 105; Lederman 1986, Appendix). During the 1960s, cassowaries were in great demand in the local ceremonial exchange economy. Reid (1978/79) estimated that some 400 birds were held by a population of 15,000 people in 1974-75, but demand later dropped. Highland betel nut is sometimes consumed in very small quantities at lower altitude locations in this system, but it was not used traditionally.

Cash sources are limited. Arabica coffee is only grown below about 2000 m. Potato, and other fresh foods, are sold at Mendi market. Pig sales are important, and firewood is a minor cash source. Since the early 1970s, there have been a number of small cattle projects.

National Nutrition Survey 1982/83

No villages from this system were included in the survey.

Main References

Mearns, R. 1986 Upper Mendi land appraisal: a clan-based survey in Papua New Guinea. BA (Hons) thesis, Cambridge University, Cambridge.

Radcliffe, D.J. 1984 The land resources of Upper Mendi. Agricultural Field Trials, Studies, Extension and Monitoring Unit Technical Report No. 8, Southern Highlands Rural Development Project, Mendi.

Simpson, G. 1978 The Mulim: a case study of the potential and limitations for rural development in a marginal agricultural area, Southern Highlands Province, Papua New Guinea. BA (Hons) thesis, University of Papua New Guinea, Port Moresby.

Other References

Anon n.d. Upper Mendi/Karint farming and food production system. Unpublished report, Southern Highlands Rural Development Project, Mendi.

Bogan, K. and R. Crittenden 1987 Environment, economic development and the nutritional status of children in the Southern Highlands of Papua New Guinea in 1983. *Ecology of Food and Nutrition* 20, 1, 29-49.

Bourke, R.M. 1988 Taim hangre: variation in subsistence food supply in the Papua New Guinea Highlands. PhD thesis, Australian National University, Canberra.

Bridge, J. and S.L.J. Page n.d. Plant nematodes of Papua New Guinea: their importance as crop pests. Report of a plant nematode survey in Papua New Guinea: 18 October - 20 December, 1982, Tropical Plant Nematology Advisory and Research Unit, Commonwealth Institute of Parasitology, St Albans.

Crittenden, R., C.N. Floyd, R.D.B. Lefroy, M.A. Anders, E.J. D'Souza and D. Lehmann 1988 Gardening activity, food supply and nutritional status in the Southern Highlands of Papua New Guinea. *Ecology of Food and Nutrition* 21, 45-68.

Crittenden, R., C.N. Floyd, R.D.B. Lefroy and R.A. Urben 1985 A study of gardening activity and bodyweights in the Southern Highlands of Papua New Guinea. Technical Report 85/12, Department of Primary Industry, Port Moresby.

Crittenden, R. and F.M. Quin 1987 Agricultural research and extension in the Southern Highlands Province: the development of agricultural extension centres with special reference to Kuma in the Upper Mendi. Technical Report 87/16, Department of Agriculture and Livestock, Port Moresby.

Floyd, C.N., E.J. D'Souza and R.D.B. Lefroy 1987 Composting and crop production on volcanic ash soils in the Southern Highlands of Papua New Guinea. Technical Report 87/6, Department of Primary Industry, Port Moresby.

Floyd, C.N., E.J. D'Souza and R.D.B. Lefroy 1987 Phosphate and potash fertilisation of sweet potato on volcanic ash soils in the Southern Highlands of Papua New Guinea. Technical Report 87/7, Department of Primary Industry, Port Moresby.

Floyd, C.N., R.D.B. Lefroy and E.J. D'Souza 1988 Soil fertility and sweet potato production on volcanic ash soils in the Highlands of Papua New Guinea. *Field Crops Research* 19, 1-25.

Harrison, S. 1976 A study of the diets of four families in the Mendi Sub-Province. Unpublished paper.

Kanua, M.B. and C.N. Floyd 1988 Sweet potato genotype x environment interactions in the Highlands of Papua New Guinea. *Tropical Agriculture (Trinidad)* 65, 1, 9-15.

Lederman, R. 1986 *What Gifts Engender: Social Relations and Politics in Mendi, Highland Papua New Guinea*. Cambridge, Cambridge University Press.

Other References continued

Oldfield, F., A.T. Worsley and P.G. Appleby 1985 Evidence from lake sediments for recent erosion rates in the Highlands of Papua New Guinea. In Douglas, I. and T. Spencer (eds), *Environmental Change and Tropical Geomorphology*. London, G. Allen and Unwin, 185-196.

Perry, R.A., M.J. Bik, E.A. Fitzpatrick, H.A. Haantjens, J.R. McAlpine, R. Pullen, R.G. Robbins, G.K. Rutherford and J.C. Saunders 1965 Lands of the Wabag-Tari area, Papua-New Guinea. Land Research Series No. 15, Commonwealth Scientific and Industrial Research Organization, Melbourne.

Puri, T.P. 1982 Soil conservation and gardening in Egari village, Southern Highlands Province. In Morauta, L., J. Pernetta and W. Heaney (eds), *Traditional Conservation in Papua New Guinea: Implications for Today*. Monograph No. 16. Port Moresby, Institute of Applied Social and Economic Research, 159-161.

Quinn, M. n.d. Garden types in the Upper Mendi. Unpublished report, Southern Highlands Rural Development Project, Mendi.

Radcliffe, D.J. 1985 The land resources of Kuma Experimental Farm. Technical Report 85/11, Department of Primary Industry, Port Moresby.

Reid, B. 1978-79 History of domestication of the cassowary in Mendi Valley, Southern Highlands, Papua New Guinea. *Ethnomedizin/Ethnomedicine* 5, 3-4, 407-433.

Ryan, D.J. 1961 Gift exchange in the Mendi Valley: an examination of the socio-political implications of the ceremonial exchange of wealth among the people of the Mendi Valley, Southern Highlands District, Papua. PhD thesis, University of Sydney, Sydney.

Thistleton, B.M. and R.T. Masamdu 1985 Surveys of Insects Associated with Food Crops in Three Study Areas in the Southern Highlands Province. Research Bulletin No. 36. Port Moresby, Department of Primary Industry.

Waller, J.M. 1984 Diseases of smallholder food crops in the Southern Highland Province of Papua New Guinea. Unpublished report, Commonwealth Mycological Institute, Surrey.

System Summary

This subsystem occupies about half the system. It occurs mainly on hills and steep-sided mountains. The major fallow vegetation is tall cane grass, 5-15 years old, but there is also some use of woody regrowth and previously uncultivated forest. Vegetation is cut, dried and burnt. Typically, the soil is tilled and formed into mounds which are not composted for the first two plantings. They are composted for subsequent plantings. Usually, 3-5 plantings are made. Short fallows may occur between plantings. Frost is a significant hazard to agriculture. Pig husbandry is important.

Extends across provincial border to System(s) 0717

Altitude range (m) 1700-2500 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Potato, Sweet potato, Taro (Colocasia)
OTHER VEGETABLES	Bean (common), Cabbage, Chinese cabbage, Corn, Highland pitpit, Nasturtium spp., Oenanthe, Pumpkin tips, Rungia
FRUITS	Sugarcane
NUTS	Castanopsis, Karuka (planted), Karuka (wild)
NARCOTICS	Betel pepper (highland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall grass
SHORT FALLOW	Significant
LONG FALLOW PERIOD	5-15 years
CROPPING PERIOD	3-5 plantings
R VALUE	29 (low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Minor
HOUSEHOLD GARDENS	Very significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	None
PLANTED TREE FALLOW	Minor
COMPOST	Significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Coffee Arabica	Minor
2 Fresh food	Minor
3 Potato	Minor

OTHER AGRONOMIC PRACTICES**Water Management:**

DRAINAGE	Minor
IRRIGATION	None

Soil Management:

PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None

Mounding Techniques:

VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	Very significant
LARGE MOUNDS	Minor

Garden Bed Techniques:

BEDS SQUARE	None
BEDS LONG	None

Other Features:

FENCES	Significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION**Notes**

This second subsystem separates the less intensive parts of the system from the almost continuous cultivation of Subsystem 1. Three named garden types occur in the subsystem (Radcliffe 1984, 38-40; Mearns 1986, 78-87; Quinn n.d.). The main garden type is that made on moderately sloping cane grassland ('sepiem' (Mendi) or 'ga-kala' (Imbong'gu)). These also occur in Subsystem 1. There are typically 3-5 plantings before fallowing. Fallow periods range considerably, but are estimated to usually fall in the 5-15 year range. After tillage, mounds are formed (40-70 cm high and 2 m in diameter) (Radcliffe 1984, 39), but composting is not common in the first two plantings.

There are two more minor garden types, those made on steep grassland slopes ('sunem' (Mendi) or 'waru-kala' (Imbong'gu)), and those made in woody regrowth ('ewan' or 'erisonde' (Mendi) or 'kond-kala' (Imbong'gu)). Both usually involve only two plantings before fallowing. Quinn (n.d., 1-2) suggested a single planting in the western part of the system, with two plantings more common in the east. Planting techniques include dibbling, small mounds or, in later plantings, mounds. Fallow periods range from two to ten years (Quinn n.d., 2).