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AGRICULTURAL SYSTEMS OF PAPUA NEW GUINEA

Working Paper No. 10

WESTERN HIGHLANDS PROVINCE

TEXT SUMMARIES, MAPS, CODE LISTS AND VILLAGE IDENTIFICATION

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THE AUSTRALIAN NATIONAL UNIVERSITY

PAPUA NEW GUINEA DEPARTMENT OF AGRICULTURE AND LIVESTOCK

UNIVERSITY OF PAPUA NEW GUINEA

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Cover Photograph:
The late Gore Gabriel clearing undergrowth from a pandanus nut grove in the Sinasina area, Simbu Province (R.L. Hide)

PREFACE

Acknowledgments

The following organisations have contributed financial support to this project: The Research School of Pacific and Asian Studies, The Australian National University; The Australian Agency for International Development; the Papua New Guinea-Australia Colloquium through the International Development Program of Australian Universities and Colleges and the Papua New Guinea National Research Institute; the Papua New Guinea Department of Agriculture and Livestock; the University of Papua New Guinea; and the National Geographic Society, Washington DC.

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Technical advice and encouragement have been provided throughout the project by John McAlpine, Gael Keig and Sue Cuddy, Australian Commonwealth Scientific and Industrial Research Organization.

Support and advice have been received from Geoff Humphreys and Harold Brookfield of the Land Management Project, and Gerard Ward (formerly Director), Research School of Pacific and Asian Studies, The Australian National University. Brookfield's (1971) study of Melanesian agricultural systems has been particularly influential.

The Papua New Guinea Agricultural Systems Project was developed from two previous studies. Michael Bourke began mapping Papua New Guinea agricultural systems in the 1970s while a Senior Horticulturalist with the PNG Department of Primary Industry (Bourke 1976). Robin Hide created an annotated bibliography of information on Papua New Guinea agricultural systems while working with the CSIRO PNGRIS group (Hide and Cuddy 1988).

Participants

The following persons participated in the production of this paper:

Papua New Guinea Department of Agriculture and Livestock: Ted Sitipai and Balthazar Wayi (coordination and planning).

University of Papua New Guinea: David Peter, field mapping.

Australian National University: Bryant Allen, Michael Bourke, Robin Hide (conceptualisation, field mapping, data preparation, writing); Robin Grau (GIS management, ARC/INFO, map preparation); Daniel Fritsch (computer programming and database management); Anne Cochrane, Patricia Hobsbawn, Vivienne Laynne, Elanna Lowes, Deborah Stannard, Stephen Lyon (research assistance); Merv Commons (technical assistance).

Field Survey

Initial field surveys were done in 1980, and initial field mapping in 1982, in the Tambul Basin and the Nebilyer, Baiyer, Wahgi and Jimi Valleys using mostly road traverses. In December 1990, one team visited parts of the Province over 5 days to update the earlier information. Rapid road traverses covered the Tambul Basin, and the Nebilyer and Wahgi Valleys. The Jimi Valley was visited by helicopter, and an aerial survey by light aircraft of the Baiyer Valley was carried out. In February 1993, a 3 day visit to Lumusa mission by air from Mt Hagen, with a road traverse from Lumusa to Kemangle village.

The surveys in this Province were generally more rapid than those elsewhere, and the information is therefore more cursory.

Revised and reprinted version

The Mapping Agricultural Systems Project database was revised in late 1998 (see Introduction to Working Paper Number 1). This working paper was reprinted in 2002. Karen Lummis, Tess McCarthy, Natalie Stuckings, Laura Vallee and Amber Pares were responsible for the production of the revised paper.

CONTENTS

1. INTRODUCTION

The major purpose of the Papua New Guinea Agricultural Systems Project is to produce information on small holder (subsistence) agriculture at provincial and national levels. Information is collected by field observation, interviews with villagers and reference to published and unpublished documents. The information is entered into a computer database (dBase IV), from where it is transferred to a mapping program (ARC/INFO). Methods are described by Bourke et al. (1993). This paper contains a written summary of the information on the Agricultural Systems in this Province, maps of selected agricultural features, a complete listing of all information in the database in coded form, and lists of villages with National Population Census codes, indexed by Agricultural Systems. This information will eventually be available on disk as a map-linked database suitable for use on a personal computer.

Identification of agricultural systems and subsystems

An Agricultural System is identified when a set of similar agricultural crops and practices occur within a defined area. Six criteria are used to distinguish one system from another:

1. Fallow type (the vegetation which is cleared from a garden site before cultivation).

2. Fallow period (the length of time a garden site is left unused between cultivations).

3. Cultivation intensity (the number of consecutive crops planted before fallow).

4. The staple, or most important, crops.

5. Garden and crop segregation (the extent to which crops are planted in separate gardens; in separate areas within a garden; or are planted sequentially).

6. Soil fertility maintenance techniques (other than natural regrowth fallows).

Where one or more of these factors differs significantly and the differences can be mapped, then a separate system is distinguished.

Where variation occurs, but is not able to be mapped at 1:500 000 scale because the areas in which the variation occurs are too small or are widely dispersed within the larger system, a subsystem is identified. Subsystems within an Agricultural System are allocated a separate record in the database, identified by the Agricultural System number and a subsystem number.

Sago is a widespread staple food in lowland Papua New Guinea. Sago is produced from palms which are not grown in gardens. Most of the criteria above cannot be applied. In this case, systems are differentiated on the basis of the staple crops only.

Relationship to PNGRIS

The Papua New Guinea Resource Information System (PNGRIS) contains information on the natural resources of PNG (Bellamy 1986). However PNGRIS contains no information on agricultural practices, other than an assessment of land use intensity based on air photograph interpretation by Saunders (1993), and ECOPHYS which is concerned with predicted crop performance in a specific environment (Hackett 1988). The Agricultural Systems Project is designed to provide detailed information on agricultural practices and cropping patterns as part of an upgraded PNGRIS geographical information system. For this reason the Agricultural Systems database contains almost no information on the environmental settings of the systems, except for altitude and slope. The layout of the text descriptions, the database code files and the village lists are modelled on PNGRIS formats (Cuddy 1987).

The mapping of Agricultural Systems has been carried out on the same map base and scale as PNGRIS (Tactical Pilotage Charts, 1:500 000). It is also done within the areas of agricultural land use established by Saunders (1993) from aerial photography. Except where specifically noted, Agricultural Systems boundaries have been mapped without reference to PNGRIS Resource Mapping Unit (RMU) boundaries. Agricultural Systems are defined at the level of the Province (following PNGRIS) but their wider distribution is recognised in the database by cross-referencing systems which cross provincial borders.

A preliminary view of the relationships between RMUs and the Agricultural Systems in this Province can be obtained from the listing of villages by Agricultural System, where RMU numbers are appended (Section 6.3).

Note for reprinted edition

Most of the fieldwork for this project was conducted over a six year period (late 1990 to late 1996). Over this period, a number of minor inconsistencies arose in data classification and presentation. As well, some changes occurred in conventions for the text fields and in the definitions of data fields, for example, for seasonality, fencing and burning. These changes were noted in the Preface of the Provincial Working Papers (first editions) as they occurred. One of the more important changes was that the cutoff points for the classification of cash earning activities were applied more consistently. Because of these inconsistencies and changes in definitions, it was necessary to revise the database so that it was consistent for all 19 provinces and to incorporate changes in agriculture systems since the original papers were produced.

Most changes, as distinct from definitional changes, relate to cash income. The revisions were done in late 1998. The largest number of changes occurred in the first four provincial working papers: East Sepik, West Sepik, Western and Gulf Provinces. Papers for the five Island Region provinces required the least number of changes. Agricultural systems that cross provincial boundaries have been adjusted so that the information is identical on both sides of the boundary, apart from some minor differences in some of the text fields. However the notes have not been updated to incorporate new publications since the Working Papers were completed.

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Smith, T., G. Keig, J. Marks and R. Grau 1992 Summary Results by Environmental Zone from the 1982-3 National Nutrition Survey of Papua New Guinea: Implications for Future Survey Design. Papua New Guinea Institute of Medical Research, Goroka.

2. DATABASE STRUCTURE, DEFINITIONS AND CODES

Information on agricultural systems is stored in a database, one record per agricultural system (or subsystem where identified) and 108 fields per record. This section lists the field ***names*** and their database abbreviations **[NAMES]**. Summary descriptions, explanatory notes and variable codes are given for each field.

LOCATION AND IDENTIFICATION

1. Provincial Identification **[PROVINCE]:** A two digit National Population Census code. Eg. code 14 = East Sepik Province. Provincial codes are listed in Appendix A.1.

2. System Identification **[SYSTIDNO]:** A two digit number identifying the agricultural system within this province. Eg. code 01 = System 01. Numbers are not assigned to systems within a province in any particular order.

3. Agricultural System **[AGSYST]:** Systems are also identified by a unique Papua New Guinea-wide four digit number. The first two digits are the National Population Census provincial code and the second two digits are the system identification number. Eg. 1401 = System 01 in the East Sepik Province.

4. Agricultural Subsystem **[SUBSYSIDNO]:** Subsystems are identified by a single digit. When referred to in the text they are preceded by the agricultural system number and a hyphen. Eg. 1418-1 is Subsystem 1 of System 1418.

5. Number of Subsystems **[NUMSUBSYS]:** A single digit specifying the number of subsystems that occur within this System.

6. District **[DISTRICT]:** The 1990 National Population Census code for the District within which the System is located. More than one District may be listed. District codes are listed in Appendix A.2.

7. Census Divisions **[CENSUSDIV]:** The 1980 National Population Census code for the Census Divisions that occur within the System. Census Division codes for this Province are listed in Appendix A.2.

ENVIRONMENTAL

8. Lowest Altitude **[ALTLOW]:** The lowest altitude, in metres (rounded), to which the System extends.

9. Highest Altitude **[ALTHIGH]:** The highest altitude, in metres (rounded), to which the System extends.

10. Garden Slope **[SLOPE]:** The average slope of gardens in the System.

1	Flat	(<2^{o})
2	Gentle	(2-10^{o})
3	Steep	(10-25^{o})
4	Very steep	(>25^{o})
5	Multiple classes	

***11. Survey Description* [SURVDESC]:** A text description of the areas visited or not visited within the system, the length of time spent in different areas, traverses undertaken, the mode of transport used, the month and year of the survey, and the sources of any documentary information used.

***12. Summary Description* [SYSSUMM]:** A concise text description of the agricultural system, and subsystems (if any), focussed on the occurrence of the major distinguishing criteria.

***13. System Boundary Definitions* [BOUNDDEF]:** A brief description of how the boundaries between systems were identified and mapped. The boundaries between agricultural and non-agricultural land use were taken from Saunders (1993).

***14. Systems Crossing Provincial Borders* [OTHPROV]:** A logical field (yes/no) which indicates whether the System crosses a provincial border.

***15. Same System in Adjacent Province* [PROVSYS]:** A listing of AGSYST numbers (see Field 3 above) of up to two systems in adjacent provinces which are identical to this system, for systems which cross provincial borders.

***16. Subsystem Extent* [SUBSYSEXT]:** An estimate of the proportion of the area of the total system occupied by a subsystem. In the case of there being no subsystems this field is listed as 100 per cent.

1	25 per cent
2	50 per cent
3	75 per cent
4	100 per cent

***17. Type of Fallow Vegetation Cleared* [FALLTYPE]:** The predominant type of vegetation cleared from garden sites at the beginning of a new period of cultivation. Where short fallows are used (see Field 18 below), fallow type refers to the vegetation cleared after a long fallow.

1	Short grass (*eg. kunai < 1.5 m tall*)
2	Tall grass (*eg. Miscanthus or Saccharum > 1.5 m tall*)
3	Grass and woody regrowth *(dense short or tall grass and short woody regrowth*)
4	Short woody regrowth (*shrubs/trees < 10 m tall*)
5	Tall woody regrowth (*trees > 10 m tall*)
6	Forest (*no indication of previous use*)
7	No long fallow
8	Savanna *(Scattered woody growth with grass ground cover)*

***18. Use of Short Fallows* [SHORTFALL]:** A presence and significance measure which indicates whether short fallows are used. Short fallows are brief periods of less than 12 months between plantings during which land is left fallow.

***19. The Long Fallow Period* [FALLPER]:** An estimate of the length of time (greater than 12 months) land is left to revert to regrowth, before it is cultivated again. Class 0 refers to situations where very long cropping intervals (40 plantings or more) make long fallows not significant.

0	Not significant
1	1 to 4 years
2	5 to 15 years
3	Greater than 15 years

***20. Cropping Intensity* [CROPINT]:** The number of times staple crops are planted in the main gardens before those gardens are returned to a long fallow. Short fallows of less than 12 months (see Field 18 above) are excluded for this purpose: they may occur between plantings without affecting the classification. The class 'More than 40 plantings', refers to situations where land has been planted continuously without a long fallow since the Pacific War (1942-45) or longer. In such cases Field 19, Long Fallow Period, is classed as 'Long fallow period not significant'.

1	1 planting only
2	2 plantings
3	3 to 5 plantings
4	6 to 14 plantings
5	15 to 40 plantings
6	More than 40 plantings

CROP COMPONENTS

***21. The Dominant Staple Crops* [DOMSTAP]:** The most important staple food crops grown in the subsystem. A major staple is defined as a crop estimated to cover more than one-third of staple garden area, and therefore no more than 3 dominant staples may be identified for a system. An important exception occurs when sago is the staple. Sago is extracted from palms which are not cultivated in gardens. In the text accounts (System Summaries and Notes), dominant staples are described as the '*most important crops*'.

***22. The Subdominant Staple Crops* [SUBSTAP]:** Staple food crops of lesser importance grown in the subsystem. A subdominant staple is defined as a crop estimated to cover more than 10 per cent of a staple garden area; up to six crops may be listed. An important exception occurs when sago is the staple. Sago is extracted from palms which are not cultivated in gardens. In the text accounts (System Summaries and Notes), subdominant staples are described as '*important crops*'.

***23. All Staple Crops* [ALLSTAP]:** A list of up to 10 staple crops including crops classed as dominant and subdominant, as well as other staple crops which occur commonly. In the text accounts (System Summaries and Notes), staple crops which are classified as neither dominant nor subdominant are described as '*other crops*'.

01	Mixed staple (no dominant staple: a mix of some or all of: banana, taro, sweet potato Chinese taro, yam, cassava and corn)		
02	Banana *(Musa* cvs*)*	13	Taro *(Colocasia esculenta*)
03	Breadfruit *(Artocarpus altilis)*	14	Yam *(Dioscorea alata*)
04	Cassava *(Manihot esculenta)*	15	Yam *(Dioscorea esculenta*)
05	Chinese taro *(Xanthosoma sagittifolium)*	16	Yam *(Dioscorea pentaphylla*)
06	Coconut *(Cocos nucifera)*	17	Other
07	Corn *(Zea mays)*	18	Queensland arrowroot (*Canna edulis)*
08	Potato *(Solanum tuberosum)*		
09	Sago *(Metroxylon sagu)*	19	Taro (Amorphophallus) *(Amorphophallus paeoniifolius)*
10	Swamp taro *(Cyrtosperma chamissonis)*	20	Yam *(Dioscorea bulbifera)*
11	Sweet potato *(Ipomoea batatas)*	21	Yam *(Dioscorea nummularia)*
12	Taro *(Alocasia macrorrhiza*)		

***24. Other Vegetable Crops* [VEG]:** A list of up to 10 important vegetable crops:

01 Aibika *(Abelmoschus manihot)*
02 Amaranthus *(Amaranthus* spp.*)*
03 Bean, common *(Phaseolus vulgaris)*
04 Bean, lablab *(Lablab purpureus)*
05 Bean, winged *(Psophocarpus tetragonolobus)*
06 Cabbage *(Brassica oleracea var. capitata)*
07 Chinese cabbage *(Brassica chinensis)*
08 Choko tips *(Sechium edule)*
09 Corn *(Zea mays)*
10 Cucumber *(Cucumis sativus)*
11 Ferns
12 Ginger *(Zingiber officinale)*
13 Highland pitpit *(Setaria palmifolia)*
14 Kangkong *(Ipomoea aquatica)*
15 Kumu musong *(Ficus copiosa)*
16 Lowland pitpit *(Saccharum edule)*
17 Nasturtium *(Nasturtium* spp.*)*
18 Oenanthe *(Oenanthe javanica)*
19 Peanuts *(Arachis hypogaea)*
20 Pumpkin fruit *(Cucurbita moschata)*
21 Pumpkin tips *(Cucurbita moschata)*
22 Rungia *(Rungia klossii)*
23 Tulip *(Gnetum gnemon)*
24 Valangur *(Polyscias* spp.*)*
25 Balbal *(Erythrina variegata)*
26 Bamboo shoots
27 Bean, snake *(Vigna unguiculata)*
28 Spring onion *(Allium cepa var. cepa)*
29 Sweet potato leaves *(Ipomoea batatas)*
30 Taro leaves *(Colocasia esculenta)*
31 Watercress *(Nasturtium officinale)*
32 Other
33 Bean, lima *(Phaseolus lunatus)*
34 Bottle gourd *(Lagenaria siceraria)*
35 Dicliptera *(Dicliptera papuana)*
36 Kalava *(Ormocarpum orientale)*
37 Karakap *(Solanum nodiflorum)*
38 Basil *(Ocimum basilicum)*
39 Bean leaves *(Phaseolus* spp.)
40 Cassava leaves *(Manihot esculenta)*
41 Chilli leaves *(Capsicum frutescens)*
42 Eggplant *(Solanum melongena)*
43 Pigeon pea *(Cajanus cajan)*
44 Tomato *(Lycopersicon esculentum)*

***25. Fruit Crops* [FRUIT]:** A list of up to 8 important fruits grown:

01 Avocado (*Persea americana)*
02 Banana *(Musa* cvs*)*
03 Bukabuk (*Burckella obovata)*
04 Coastal pandanus *(Pandanus tectorius)*
05 Malay apple *(Syzygium malaccense)*
06 Mandarin *(Citrus reticulata)*
07 Mango *(Mangifera indica)*
08 Marita pandanus *(Pandanus conoideus)*
09 Orange (*Citrus sinensis)*
10 Passionfruit, banana *(Passiflora mollissima)*
11 Passionfruit, other *(Passiflora* spp.*)*
12 Pawpaw *(Carica papaya)*
13 Pineapple *(Ananas comosus)*
14 Rambutan *(Nephelium lappaceum)*
15 Sugar *(Saccharum officinarum)*
16 Ton *(Pometia pinnata)*
17 Watermelon *(Citrullus lanatus)*
18 Other
19 Custard apple *(Annona squamosa)*
20 Golden apple *(Spondias cytherea)*
21 Granadilla (*Passiflora quadrangularis)*
22 Grapefruit (*Citrus paradisi)*
23 Guava (*Psidium guajava)*
24 Lemon (*Citrus limon)*
25 Lime *(Citrus aurantifolia)*
26 Parartocarpus *(Parartocarpus venenosa)*
27 Pomelo *(Citrus maxima)*
28 Pouteria *(Pouteria maclayana)*
29 Raspberry *(Rubus* spp.)
30 Soursop *(Annona muricata)*
31 Tree tomato *(Cyphomandra betacea)*
32 Watery rose apple *(Syzygium aqueum)*
33 Governor's plum *(Flacourtia indica)*
34 Lovi-lovi *(Flacourtia inermis)*
35 Mon *(Dracontomelon dao)*
36 Rukam *(Flacourtia rukam)*
37 Ficus *(Ficus* spp.)

***26. Nut Crops* [NUT]:** A list of up to 5 important nuts grown or collected:

01	Breadfruit *(Artocarpus altilis)*	09	Karuka, wild *(Pandanus brosimos)*
02	Candle nut *(Aleurites moluccana)*	10	Okari *(T. kaernbachii/ T. impediens*)
03	Castanopsis *(Castanopsis acuminatissima)*	11	Sis *(Pangium edule)*
		12	Pao *(Barringtonia* spp.)
04	Coconut *(Cocos nucifera)*	13	Tulip *(Gnetum gnemon)*
05	Finschia *(Finschia chloroxantha)*	14	Other
06	Galip *(Canarium indicum*)	15	Polynesian chestnut *(Inocarpus fagifer)*
07	Java almond *(Terminalia catappa*)		
08	Karuka, planted *(Pandanus julianettii)*	16	Cycad *(Cycas* spp.)
		17	Entada *(Entada scandens)*
		18	Dausia *(Terminalia megalocarpa)*

***27. Narcotic Crops* [NARC]:** A list of up to 5 important narcotics grown:

1	Betel nut, highland *(Areca macrocalyx)*
2	Betel nut, lowland *(Areca catechu)*
3	Betel pepper, highland (*Piper gibbilimbum*)
4	Betel pepper, lowland *(Piper betle)*
5	Tobacco *(Nicotiana tabacum)*
6	Kava *(Piper methysticum)*

FORMS OF GARDEN AND CROP SEGREGATION

***28. Garden Segregation* [GARDSEG]:** A presence and significance measure of whether individual staple food crops are planted in different gardens. A garden is a contiguous area of land planted with crops under the management of a social unit such as a family or a household. If some gardens are sited in different vegetation zones, and have different fallow periods, cultivation periods or other agronomic characteristics, then they are assigned to a separate subsystem.

All presence and significance measures are coded as follows:

0	None
1	Minor or insignificant
2	Significant
3	Very significant

***29. Crop Segregation* [CROPSEG]:** A presence and significance measure of whether individual staple food crops are planted separately in different parts of the same garden.

***30. Crop Sequences* [CROPSEQU]**: A presence and significance measure of whether the harvesting of one crop species is usually followed by the planting of another, eg. yams followed by sweet potato, or sweet potato followed by peanuts followed by sweet potato (see also Field 33 below).

***31. Mixed Vegetable Gardens* [MIXGARD]:** A presence and significance measure of whether mixed gardens are used. A mixed garden is typically a garden which is subsidiary to that containing the main staple(s). It is planted with a wide range of either subdominant staples and/or other vegetables. It may or may not be distinguished from the main garden types by different fallow and agronomic techniques.

***32. Household Gardens* [HOUSGARD]:** A presence and significance measure of whether house gardens are used. A house garden is typically a garden that is small relative to the main gardens, is located near houses, and which contains a variety of crops. Also known as door yard or kitchen gardens.

SOIL FERTILITY MAINTENANCE TECHNIQUES

33. Legume Rotation **[LEGUMROT]:** A presence and significance measure of whether a leguminous crop (eg. peanuts or winged bean) is grown between plantings of main food crops.

34. Planted Tree Fallow **[TREEFALL]:** A presence and significance measure of whether tree species (eg. *Casuarina oligodon* or *Parasponia* spp.) are planted into gardens or fallows for the stated purpose of improving soil quality during subsequent cultivations. This measure excludes the practice of planting fruit tree species into gardens and fallows, but does not exclude the planted trees being used for timber or firewood.

35. The Use of Compost **[COMPOST]:** A presence and significance measure of whether organic matter is placed beneath the surface of the soil.

36. The Use of Animal Manure **[MANURE]:** A presence and significance measure of whether animal manure is placed on or in the soil. The measure does not include the deposition of manure by the animals themselves, eg. pigs tethered in gardens.

37. The Use of Island Beds: **[ISLBED]:** A presence and significance measure of whether island beds are used. Island beds are beds of soil on which crops are planted and which are raised above the level of a surrounding area of standing or slowly moving water.

38. The Contribution of Silt from Flooding **[SILT]:** A presence and significance measure of whether silt from floods is deposited either regularly or sporadically on the soil surface in gardens. It is assumed the flooding is of natural causes, but the measure does not exclude deliberate manipulation of stream channels in order to enhance the delivery of silt or for the partial control of flood waters.

39. The Use of Inorganic Fertiliser **[FERT]:** A presence and significance measure of whether inorganic fertiliser is applied to gardens. This measure excludes the use of inorganic fertiliser on cash crops, such as coffee or vegetables.

OTHER AGRICULTURAL PRACTICES

40. The Placing of Pigs in Gardens **[PIGSIN]:** A presence and significance measure of whether pigs are placed in gardens between plantings. Pigs may be placed in gardens between plantings for a number of stated reasons, eg. to eat earthworms, to eat unharvested crops, or to till the soil. This measure excludes the deliberate breaking of fences to allow pigs to forage after the cropping phase.

41. Burning **[BURN]:** A presence and significance measure of whether fallow vegetation cleared and cut in a new garden site is burnt before the planting of the staple crops. The measure includes the burning of material which has been heaped. Significance takes into account the frequency of burning relative to the cropping intensity. So, for example, if the majority of the fallow material cleared from the site is burnt at the initial clearing of a garden, and only one or two plantings are made before fallowing, burning is Very Significant. If the same thing occurs at clearing, but a large number of plantings are made before the next long fallow, with little or no burning between plantings, burning is Minor.

***42. Soil Tillage* [TILL]:** A presence and significance measure of whether soil in the staple food gardens is tilled before planting. Tillage includes the breaking up, or turning over, of the whole or the major part of the soil on the garden surface. The measure includes tillage in either the first planting and/or subsequent plantings. The formation of soil mounds and beds (see Fields 53-58 below) involves working the soil into a tilth, but in order to distinguish clearly between these processes, mounds and beds are not automatically classified as soil tillage.

***43. The Use of Deep Holing* [HOLE]:** A presence and significance measure of whether deep holing is used. Deep holing is sometimes used in yam cultivation in order to influence the dimensions and shape of the tubers. Deep (> 50 cm) holes are dug, the soil is broken into a fine tilth and the hole re-filled before planting. The use of this technique is usually restricted to the cultivation of *Dioscorea alata.*

***44. Cutting Fallow Vegetation Onto the Crops* [FALLCUT]:** A presence and significance measure of whether crops are planted beneath standing fallow vegetation, and the vegetation is later cut down onto the growing crops.

***45. The Use of Fences* [FENCE]:** A presence and significance measure of whether gardens are fenced. Fences are linear barriers made of wood, bamboo, cane grass or stones, and may incorporate a ditch or a bank. The measure excludes low ridges which form between fields when stones are thrown to the perimeter during cultivation. In the assessment of the significance of fences, the occurrence of fences around every individual garden is given greater significance than one fence around a large number of gardens.

***46. The Use of Irrigation* [IRRIG]:** A presence and significance measure of whether water is applied to crops by the use of channels or aqueducts.

***47. The Use of Mulch* [MULCH]:** A presence and significance measure of whether a mulch is used to cultivate the staple crops. A mulch is organic material which is applied to the soil surface. If the material is placed beneath the soil surface it is defined as a compost (see Field 35 above).

***48. The Seasonality of Main Crops* [SEASMAJ]:** A presence and significance measure of whether the dominant staples (most important food crops) and the subdominant staples (important food crops) are planted at about the same time each year.

***49. The Seasonality of Other Crops* [SEASMIN]:** A presence and significance measure of whether other staple crops and vegetable crops are planted at about the same time each year.

***50. The Use of Drains* [DRAIN]:** A presence and significance measure of whether ditches are used in and around gardens to remove surface water or to lower the groundwater table.

***51. The Use of Soil Retention Barriers* [SOILRET]:** A presence and significance measure of whether structures (pegged logs, fences or hurdles, stone walls) are constructed along the contour or below individual plants, in order to prevent or reduce the down slope movement of soil.

***52. The Use of Staking* [STAKE]:** A presence and significance measure of whether crops are trained or tied up stakes, trellises or standing dead trees to lift them off the soil surface. The practice is usually applied to yams (*Dioscorea* spp.), beans, sugarcane, and sometimes gourds, cucumber and choko.

MOUNDING TECHNIQUES

In many parts of Papua New Guinea the soil is formed into circular mounds of varying dimensions and crops are planted on them. Mounding should not be confused with composting (see Field 35 above). Mounds may or may not contain compost and composting may take place in the absence of mounds. Mounds are usually re-formed at each new planting. Mound formation usually involves extensive soil disturbance. The effect can be similar to complete soil tillage (see Field 42 above).

The following fields contain presence and significance measures of whether mounds of the specified dimensions are used in the system.

53. Very Small Mounds **[VSMMOUND]:** Mounds up to 10 cm high.

54. Small Mounds **[SMMOUND]:** Mounds 10 to 40 cm high.

55. Medium Sized Mounds **[MOUND]:** Mounds 40-70 cm high and between 1 m and 2.5 m in diameter.

56. Large Mounds **[LRGEMOUND]:** Mounds > 70 cm high and > 2.5 m in diameter.

GARDEN BED TECHNIQUES

In some locations the soil is also raised into beds and crops planted on them. Bed formation usually involves extensive soil disturbance. The effect can be similar to complete soil tillage (see Field 42 above). Two shapes of beds are distinguishable:

57. Square Beds **[BEDSQ]:** Square beds are constructed by digging shallow ditches typically 2 to 4 metres apart on a grid layout, and throwing the soil removed onto the surface to form a bed. The outcome is a characteristic chequerboard or gridiron pattern in gardens.

58. Long Beds **[BEDLONG]:** Long beds are constructed by digging shallow ditches down slope typically 2 to 4 metres apart and over 10 metres in length, and throwing the soil removed to the centre to form a bed.

59. Mechanical Soil Tillage **[MECHAN]:** The use of tractors or hand-held cultivators in the preparation of a garden site for food crops. The measure includes the use of machinery in the cultivation of crops for sale.

CASH EARNING ACTIVITIES

A presence and significance measure of the importance of the following common rural cash income sources. The list includes sources related to agricultural or land based production from the farmers' own resources.

60. Animal Products **[ANSKIN]:** The sale of animal skins, furs and bird plumes, but not fresh meat.

61. Betel Nut **[BETEL]:** The sale of betel nuts (*Areca catechu* or *A. macrocalyx)* and associated items like pepper and lime.

62. Cardamom **[CARDAM]:** The sale of cardamom (*Elettaria cardamomum).*

63. Cattle **[CATTLE]:** The sale of cattle as live beasts or as fresh meat.

***64. Chillies* [CHILLIE]:** The sale of dried chillies (*Capsicum frutescens).*

***65. Cocoa* [COCOA]:** The sale of cocoa (*Theobroma cacao)* beans.

***66. Copra* [CNUT]:** The sale of copra and nuts from coconut palms (*Cocos nucifera).*

***67. Arabica Coffee* [COFFARAB]:** The sale of Arabica coffee (*Coffea arabica*).

***68. Robusta Coffee* [COFFROB]:** The sale of Robusta coffee (*Coffea canephora*).

***69. Crocodile Products* [CROC]:** The sale of freshwater and saltwater crocodile (*Crocodylus* spp.) skins or meat, from managed and wild animals.

***70. Firewood* [FIREWOOD]:** The sale of firewood.

***71. Fish* [FISH]:** The sale of fresh or smoked freshwater or saltwater fish, shellfish or crustacea.

***72. Fresh Food:* [FOOD]:** The sale of fresh vegetables, fruits, nuts and fresh or smoked meat from domesticated or wild animals.

***73. Oil Palm* [OILPALM]:** The sale of palm oil fruit (*Elaeis guineensis).*

***74. Potato* [POTATO]:** The sale of Irish potatoes (*Solanum tuberosum).*

***75. Pyrethrum* [PYRETH]:** The sale of dried pyrethrum flowers (*Chrysanthemum cinerariaefolium).*

***76. Rice* [RICE]:** The sale of rice (*Oryza sativa).*

***77. Rubber* [RUBB]**: The sale of latex from rubber trees (*Hevea brasiliensis).*

***78. Sheep and Wool* [SHEEP]:** The sale of sheep as live animals, or meat and the sale of wool.

***79. Tea* [TEA]:** The sale of unprocessed tea (*Camellia sinensis).*

***80. Tobacco* [TOBACCO]:** The sale of the dried tobacco leaf (*Nicotiana tabacum).*

***81-82. Other* [OTHER1] [OTHER2]:** Other unlisted sources of cash include the sale of copal gum (*Agathis* sp.), massoi bark (*Massoia aromatica*), tigasso oil (*Campnosperma* sp.), salt extracted from plants or natural springs and deposits, mineral oil, bêche-de-mer, insects and butterflies, live birds, marsupials, pigs and horses, house building materials including thatching and sheets of woven cane, canoe hulls, clothing, weapons, string bags, carvings and artefacts. This category excludes other sources of cash income such as wages and salaries, logging or mining royalties, gold mining, banditry, gambling and remittances. These are mentioned in Notes (Field 83) if they are important.

***83. Further Notes* [NOTES]:** Additional notes on particularly outstanding features of the system and further information drawn from published and unpublished documents.

SURVEY DETAILS

Fields ***84-101*** contain details of dates when observations were made of the system for the purposes of this project and the names of the persons who made the observations. Up to three survey visits can be accommodated. The field names are:

Month of a short visit [**SVDATMON**]: Eg. 01 = January.
Year of a short visit [**SVDATYR**]: Eg. 1992.
Period of a longer term study [**SVPERYRA**]: Eg. 1971-72.
Person making the visit [**SURVNAME**]: Initials of person(s). Full names are given in a Key on the relevant page in Section 5.

The type of survey [**SURVTYPE**]

1	Very brief visit to one place (less than an hour), or interviews
2	Short visit to a few places (less than 1 day)
3	Visits to several places (1 to 3 days)
4	Multiple visits to many places (4 to 15 days)
5	Multiple visits to many locations over several years (more than 15 days)

102. Information From the National Nutrition Survey 1982-83 **[NNS]:** The National Nutrition Survey 1982/83, selected families in villages across most of the country from a sampling frame based on environments drawn from PNGRIS classifications. Amongst other questions, people were asked what foods they had eaten during the previous day (NNS 1982/3). For systems in which more than 10 families were interviewed, responses for particular foods are presented as percentages of the total number of families interviewed. Results are presented only for staple foods, fresh fish and purchased rice. The entry includes the number of families and number of villages surveyed, and the month and year of survey.

This information is more than 10 years old and is independent of the information collected by the Agricultural Systems Project. It should be used carefully (Smith et al. 1992). In some Systems the sample size is small and villages sampled may be restricted to one part of the System. It is possible that Chinese taro (*Xanthosoma sagittifolium*) has been included in the general term 'taro', increasing the importance of taro (*Colocasia esculenta*) and decreasing the importance of Chinese taro. Where diets change seasonally, the results may also be unrepresentative.

103. Main References **[REF]:** References to published and unpublished documents that contain substantial information on agriculture in the System.

104. Other References **[REF2]:** References to published and unpublished documents that contain additional information directly relevant to the Agricultural System.

105. The Area of the System **[AREA]**: The area, in square kilometres, occupied by the System. The figure is calculated by the mapping program ARC/INFO.

106. Total Resident Population 1980 **[TOTPOP]:** The total population resident within the area covered by the System at the time of the 1980 National Population Census. The 1990 National Population Census figures are not used because of questions over their reliability, but the 1990 National Population Census maps are used to locate most Census Units.

107. The Number of People Living Outside the System **[ABSPOPPER]:** An estimate of the proportion of the population absent from villages in the system in 1978-79, expressed as a percentage of the total population. The figure is the difference between the 'total' population and the 'resident' population listed in the 1978-79 Provincial Data System (PDS) Rural Community Register for the Province. The 'total' population is the total number of persons listed in the Village Book and the 'resident' population the number living in the village, or who have been absent for less than 6 months at the time of the census. In some cases 'total' and 'resident' populations in the PDS are the same.

108. The Population Density **[POPDEN]:** The number of persons per square kilometre in 1980, calculated by dividing Field 106 (total population) by Field 105 (area). There are two situations where adjusted figures are given (indicated by "*"). In some systems sago is the staple food and there is little or no agriculture or subsistence is based completely on non-agricultural activities (eg. fishing or trading) and no agricultural land use can be identified. For these systems the area has been adjusted to include a 5 kilometre buffer strip around the system boundary, or centred on settlements where no land use is identified. The 5 kilometre buffer zone is assumed to be the area of non-agricultural land, usually forest, in which wild plants and animals are exploited. In the latter case, settlements are identified with point symbols. The second kind of adjustment occurs where the populations of two adjoining systems, both of which use both systems, are unequally distributed in the two system areas due to the locations of the census units. In such cases, adjusted population density figures are shown (for example, Milne Bay Province Systems 0501 and 0502), with explanations in Notes (Field 83).

109. The Intensity of Land Use **[RVALUE]:** The R value (Ruthenberg 1980, 15) is an estimate of the intensity of land use, derived from the ratio of the Cropping Period in years to the length of the cultivation cycle in years. Cropping Period is estimated from the number of plantings of the staple crops before a long fallow (see Field 20 above). The cultivation cycle is the sum of the Cropping Period and the Long Fallow Period (see Field 19 above). The R value is thus:

$$\frac{\text{Cropping Period} \times 100}{\text{Cropping Period} + \text{Long Fallow Period}}$$

Because in this survey both the cropping period and the long fallow period are described as classes, conversion of the class ranges to single year values is necessary in order to calculate R values. The following conversions are used for most crops:

Cropping period	**Years**	**Long fallow period**	**Years**
1 planting only	1	Not used	0
2 plantings	2	1-4 years	3
3-5 plantings	4	5-15 years	10
6-14 plantings	10	>15 years	20
>14 plantings	20		

Triploid banana or Chinese taro may produce for several years from a single planting. In systems in which these crops are dominant staples or subdominant staples with significant land use, the cropping period is adjusted upwards. The adjustment is based on estimates of how long these crops produce from a single planting before a long fallow. Where there is evidence of a cropping period without a long fallow of longer than 20 years, the cropping period is adjusted upwards, to a maximum of 50 years.

3. AGRICULTURAL SYSTEMS: TEXT SUMMARIES

Text summaries take two forms: those for the first or only subsystem in an Agricultural System, and those for subsequent subsystems.

1. The headers on text summaries for the first or only subsystem in an Agricultural System are as follows:

PROVINCE 15 West Sepik	**AGRICULTURAL SYSTEM No**. 1 **Subsystem No** 1 **of** 1	
Districts 4 Telefomin	**Subsystem Extent** 100%	**Area (sq km)** 1259
Population 8,530	**Population Density** 7 **persons/sq km**	**Population absent** 7%

This header contains information in the top right hand corner on the number of subsystems descriptions which follow.

This header also contains information for the *whole* Agricultural System on Districts, area, population, population density and absenteeism.

2. Headers on text summaries of subsequent subsystems are as follows:

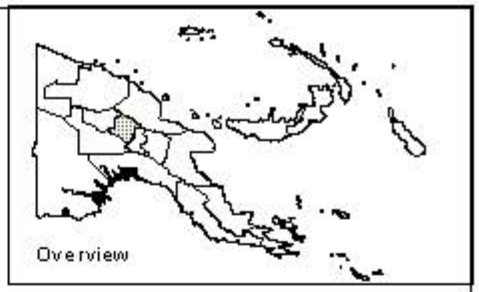
PROVINCE 15 West Sepik	**AGRICULTURAL SYSTEM No**. 3	**Subsystem No** 2 **of** 2
Districts 4 Telefomin	**Subsystem Extent** 25 %	

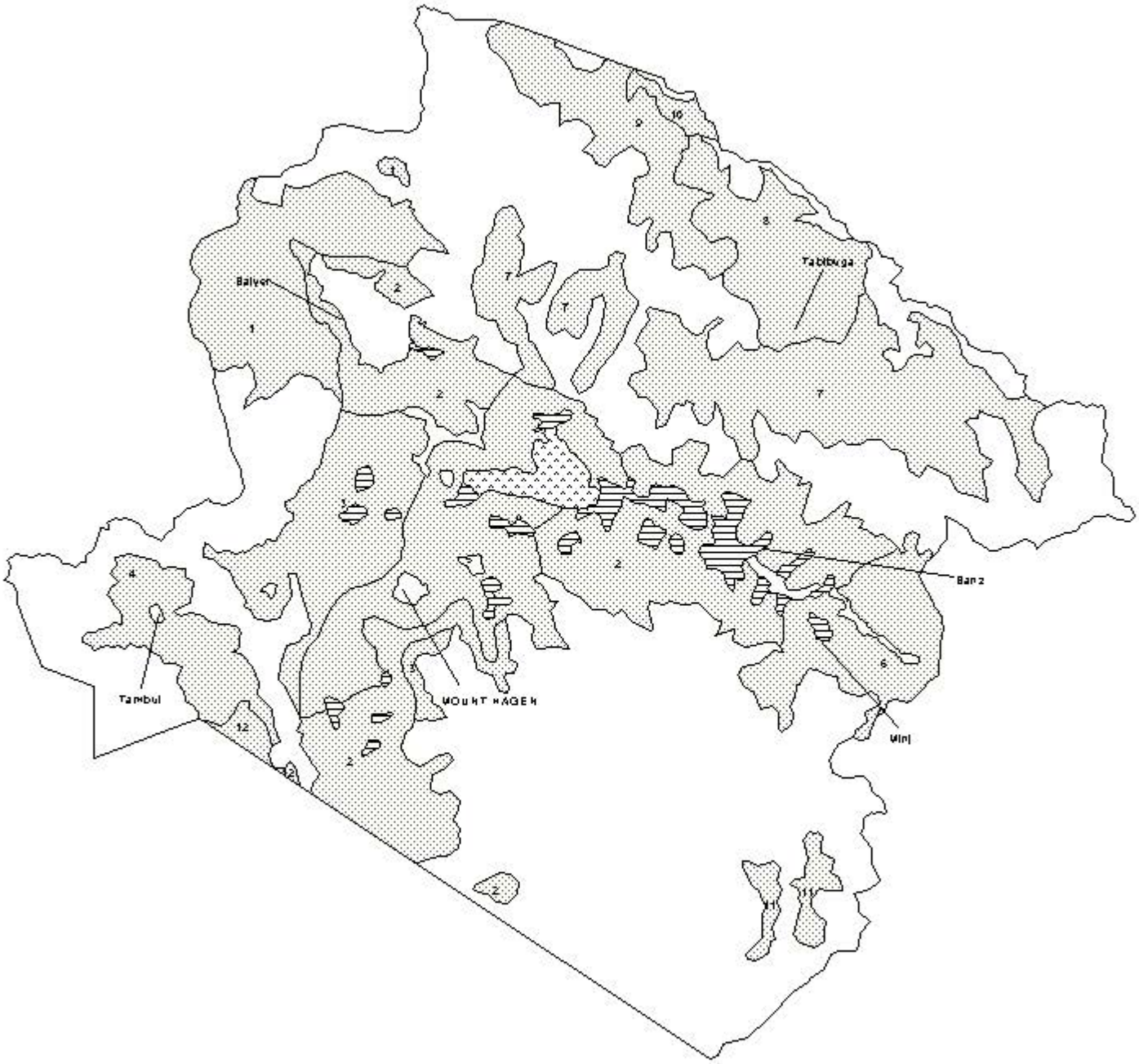
They contain information on Districts and subsystem extent only.

Headers on second and subsequent pages of summaries are as follows:

PROVINCE 15 West Sepik	**AGRICULTURAL SYSTEM No**. 1	**Subsystem No** 1 **of** 1

WESTERN HIGHLANDS PROVINCE
Agricultural Systems





Agricultural system identified by number
Plantation
Swamp
Urban, Other

Subsystems are present in System 10

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 1 **Subsystem No.** 1 **of** 1

Districts 2 Hagen North **Subsystem Extent** 100 % **Area (sq km)** 434
Population 12,637 **Population density** 29 **persons/sq km** **Population absent** 25 **%**

System Summary

Located over an altitudinal range of 1200 m, on the steeply dissected northern slopes of Mt Hagen, west of the Baiyer Valley, and in hills north of Kumbwareta airstrip. Short woody regrowth fallows 5-15 years old are cleared and burnt. Sweet potato is the most important crop; other crops are cassava, Chinese taro, taro, yam (D. alata) and banana. Typically, a first planting of mixed crops is followed by a planting of mainly sweet potato, after which there is a long fallow. Most planting is by dibble. However, depending on the quality and steepness of the land, up to five plantings may be made, separated by short fallows of several months. Sweet potato is commonly grown in separate sections of gardens from other crops. Mixed crop gardens are planted in August-September; sweet potato plantings are less seasonal. Drains and soil retention barriers are often made in gardens. Household gardens are common. Pig husbandry is important.

Extends across provincial border to System(s) None

Altitude range (m) 800-2000 **Slope** Very steep (>25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Cassava, Chinese taro, Sweet potato, Taro (Colocasia), Yam (D. alata)
OTHER VEGETABLES	Aibika, Amaranthus spp., Bean (common), Bean (winged), Cucumber, Highland pitpit, Peanuts, Pumpkin tips, Rungia, Tulip
FRUITS	Marita pandanus, Orange, Passionfruit (yellow), Pawpaw, Pineapple, Sugarcane
NUTS	Breadfruit, Karuka (planted), Karuka (wild)
NARCOTICS	Betel nut (highland), Betel pepper (highland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Short woody regrowth
SHORT FALLOW	Minor
LONG FALLOW PERIOD	5-15 years
CROPPING PERIOD	2 plantings
R VALUE	17 (low)

GARDEN SEGREGATION

GARDEN SEGREGATION	Significant
CROP SEGREGATION	Minor
CROP SEQUENCES	Significant
MIXED VEGETABLE GARDENS	None
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	Significant
2 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Significant
IRRIGATION	Minor
Soil Management:	
PIGS PLACED IN GARDENS	Minor
BURN FALLOW VEGETATION	Significant
TILLAGE	None
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	Significant
Mounding Techniques:	
VERY SMALL MOUNDS	Very significant
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	Minor
SEASONAL SEC'DARY CROPS	Significant

OTHER DOCUMENTATION

Survey description

In September 1980, a vehicle traverse from Mt Hagen down the Baiyer River Valley to north of Kumbwareta airstrip (half day). In December 1990, an aerial reconnaissance from Mt Hagen airport over Wakupei school, Kumbwareta airstrip, Baiyer River airstrip and Nengil police station. In February 1993, a visit to Lumusa mission by air from Mt Hagen with a road traverse from Lumusa south to Kemangle village (3 days).

Boundary definition

The boundary with System 0902 is based on the presence or absence of square beds (present in 0902), and was determined during traverses on the Mt Hagen-Baiyer station road and aerial reconnaissance. The boundary with System 0903 is based on the presence or absence of mounds (present in 0903), and was determined during traverses on the Mt Hagen-Baiyer and Mt Hagen-Togoba-Bukapena roads and aerial observations. The western boundary with Enga System 0803 was taken as the Lai River.

Notes

This system straddles a major language boundary. The land south and west of the Baiyer River is occupied by people speaking the Enga language (Kyaka Enga), and the area northeast of the Baiyer by Melpa speakers. Altitude ranges from around 800 m on the Lai River to 2000 m at the forest edge on Mt Hagen, but most people live between 1300 m and 1600 m. This altitudinal span results in a large variety of supplementary foods, ranging from breadfruit and marita pandanus at lower altitudes, to planted and wild karuka pandanus at higher altitudes. People commonly distinguish between the 'hot' and 'cold' parts of their agricultural system. The other main source of variation is slope. Over most of the system, slopes are steep to very steep, but around Lumusa mission there is a small area of flat, highly productive, land with deep brown, volcanic ash soils. The only written description of Kyaka Enga agriculture is that of Bulmer (1960, 47-85) from Yaramanda village, between Lumusa and Baiyer River airstrips. Early surveys identified what was then considered to be serious malnutrition among children at Lumusa and Kumbwareta (McKay 1960; see also Becroft et al. 1969).

The most important crop is sweet potato, which is grown mainly as a monocrop, on very small mounds. Sweet potato gardens are explicitly distinguished from mixed crop gardens, and commonly sweet potato is segregated from other crops, even when all are planted within the same garden. Almost all gardens are planted at least once in mixed crops, including corn (said to have been introduced around 1945 (McKay 1960, 452)), greens, pumpkin, banana, cassava, winged bean, common bean, peanuts, taro, sugarcane, highland pitpit and yam (mainly D. alata, but some D. esculenta, were observed). Bananas are grown in large numbers around houses.

Garden sites are cleared from May to July and planted in mixed crops from August to September. Sweet potato plantings are less seasonal, but are influenced by the pattern of clearing set up in the mixed crop gardens.

On very steep sites, a single planting of mainly sweet potato and some other crops may be followed by a long fallow. On most sites, a mixed planting is followed by one planting of sweet potato before fallow. On the flat land around Lumusa mission, more than one planting of mixed crops may occur, followed by up to five crops of sweet potato, before a long fallow. Short fallows of up to three months are used between these plantings.

Fallows are similarly varied. On most steep and very steep land, low woody regrowth between 5 and 15 years old is cleared. But on flatter land, fallows of very low woody regrowth and less than 4 years old are sometimes cleared, cultivated for two years, and then fallowed for up to 15 years.

All gardens are protected against pigs by a combined ditch and wooden fence. Many gardens have shallow flat-bottomed drains dug in a zig-zag fashion across the slope. Sticks are laid along the contour to reduce soil wash. Casuarina trees are sometimes planted in fallows.

Very small patches of taro are irrigated with water from springs using bamboo or the bark of a tree to carry the water to the plot.

There is a road connection to Mt Hagen, but highway robbery on the road has caused people at Lumusa to re-open the airstrip there and to travel to Mt Hagen mainly by air. In 1993, however, air passengers at Kumbwareta in the Baiyer Valley were subject to armed hold ups, and inter-group fighting was also restricting movement. Large coffee gardens occur around Lumusa. Most people grow coffee, which is the most important source of cash income.

National Nutrition Survey 1982/83

166 families from 4 villages were asked in June, July or August 1983 what they had eaten the previous day. 95 per cent reported eating sweet potato, 25 per cent banana, 7 per cent taro, 4 per cent cassava, 3 per cent yam, 1 per cent Chinese taro and none coconut or sago. 27 per cent reported eating rice. 1 per cent reported eating fresh fish. This is similar to the crop pattern except for the high banana consumption.

Main References

Bulmer, R.N.H. 1960 Leadership and social structure among the Kyaka people of the Western Highlands District of New Guinea. PhD thesis, Australian National University, Canberra.

Other References

Becroft, T.C., J.M. Stanhope and P.M. Burchett 1969 Mortality and population trends among the Kyaka Enga, Baiyer Valley. Papua New Guinea Medical Journal 12, 2, 48-55.

Bulmer, R. 1966 Birds as possible agents in the propagation of the sweet-potato. The Emu 65, 3, 165-182.

Haantjens, H.A., J.R. McAlpine, E. Reiner, R.G. Robbins and J.C. Saunders 1970 Lands of the Goroka-Mount Hagen area, Papua-New Guinea. Land Research Series No. 27, Commonwealth Scientific and Industrial Research Organization, Melbourne.

Koyati, P. 1978 Coffee growing in the Baiyer River area of the Western Highlands Province. History of Agriculture Discussion Paper No. 14, University of Papua New Guinea and Department of Primary Industry, Port Moresby.

McKay, S.R. 1960 Growth and nutrition of infants in the Western Highlands of New Guinea. Medical Journal of Australia i, 452-459.

PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 2 **Subsystem No.** 1 **of** 1

Districts 1 Hagen Central, 2 Hagen North **Subsystem Extent** 100 % **Area (sq km)** 1030
Population 57,498 **Population density** 56 **persons/sq km** **Population absent** 5 **%**

System Summary

Located in the Wahgi Valley to the west of Minj and east of the North Wahgi swamp; in the Baiyer River Valley; and on the eastern side of the Nebilyer Valley below 1800 m where it extends into Southern Highlands Province. The main sweet potato gardens are usually made in fallow vegetation of cane grass, typically 5-15 years old. There is some use of woody regrowth fallows on the upper slopes around the valleys, as well as for mixed vegetable gardens. Vegetation is cut, dried and burnt. Drains are dug to form square beds (approximately 3 m by 3 m). Soil from the drains is thrown on to the surface of the bed. Large clods are broken down to make a surface into which sweet potato is planted without mounding. Sweet potato is the most important crop; other crops are banana, taro and cassava. Typically, there are 3-5 plantings before long fallowing, but cultivation may be extended. Short fallows of less than 12 months are common between plantings. Rotations with peanuts or winged bean are common. Both mixed vegetable and household gardens are important. In the Wahgi Valley, the system includes, and borders, large areas of former swampland which have been drained for cultivation since 1945. While many of these are under the plantation cultivation of coffee and tea (and thus not included in the system), others are held as smallholder settlement blocks. Pig husbandry is important.

Extends across provincial border to System(s) 0720

Altitude range (m) 1200-2000 **Slope** Gentle (2-10 degrees)

CROPS

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

FALLOW & CROPPING PERIOD

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

GARDEN SEGREGATION

GARDEN SEGREGATION	Minor
CROP SEGREGATION	Minor
CROP SEQUENCES	Significant
MIXED VEGETABLE GARDENS	Very significant
HOUSEHOLD GARDENS	Very significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	Significant
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	Very significant
2 Fresh food	Significant

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Very significant
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	Minor
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	None
LARGE MOUNDS	None
Garden Bed Techniques:	
BEDS SQUARE	Very significant
BEDS LONG	Minor
Other Features:	
FENCES	Significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	Minor

OTHER DOCUMENTATION

Survey description

In September 1980, vehicle traverses from Kundiawa in Chimbu Province to Mt Hagen; from Mt Hagen to Baiyer River station, Mt Hagen to Togoba mission and Mt Hagen to the Nebilyer Valley; and from Mt Hagen to Kerowagi on the old Highway north of the Wahgi River (3 days). In August 1982, a vehicle traverse from Banz to Tabibuga station in the Jimi Valley (half day). In December 1990, aerial surveys from Mt Hagen to the Jimi Valley (helicopter), from Mt Hagen over the Baiyer River Valley and back, via Togoba mission (light aircraft); and vehicle traverses from Mt Hagen to Togoba mission and Bukapena station, and from Tumam village to Kagamuga and to Kerowagi (2 days). Despite the wide coverage of these extensive traverses, detailed site information is limited.

Boundary definition

The boundary with System 0901 in the Baiyer Valley was based on the presence or absence of square beds (absent in 0901) and determined during a traverse on the Mt Hagen-Baiyer station road and by aerial reconnaissance in 1990 and 1993. The boundary with System 0903 at Nengil Police Station north of Mt Hagen was determined from road traverses and aerial reconnaissance, and drawn at approximately the Wahgi-Baiyer watershed. The boundary with System 0903 on the eastern edge of the Nebilyer Valley was determined from aerial observation (composted mounds are present in System 0903 and largely absent in 0902), and extrapolated on the 1800 m contour. The boundary with System 0905 south of Mt Hagen was identified during road traverses in the Wurup and Nebilyer Valleys, by aerial reconnaissance, and based on Saunders (1993). The boundary with System 0718 in the lower Kaugel Valley in Southern Highlands Province was determined from a road traverse from Mt Hagen to Ialibu and drawn on the Kaugel River. In the middle Wahgi Valley, the boundaries with System 0905 were determined during road traverses; south of the North Wahgi swamp, the boundary followed Saunders (1993); and to the north it was drawn on the western end of the Wahgi Land System (Haantjens et al. 1970). In the east, the boundaries with System 0906 were determined during vehicle traverses from Chimbu Province to Mt Hagen on the Highlands Highway; on the Kup mission-Minj road; and from Mt Hagen to Kerowagi on the old Highway north of the Wahgi River. The boundary with System 0907 was determined from a road traverse from Banz to Tabibuga.

Notes

This system occupies the major part of the middle Wahgi, Baiyer and Nebilyer Valleys mainly between 1200 m and 1800 m, though it rises to 2000 m on some valley sides. While the land use pattern is generally very similar to that of System 0905 (sharing the distinctive 'gridiron' pattern of square beds), agriculture in this system is considerably less intensive, with fewer plantings before long fallow. To the east, it differs from System 0906 (which extends into Chimbu Province as System 1001), where small mounds are formed on top of the square beds, and cultivation periods are again longer. In the Baiyer Valley to the west, it contrasts with the less intensive System 0901, where square beds are absent; there are usually only two plantings before long fallow; and the fallow type is short woody regrowth. On the eastern slopes of Mt Hagen, and the eastern edge of the Nebilyer Valley above 1800 m, it differs from System 0903, where square beds are replaced by composted mounds; and cultivation periods are longer. Similarly, over the border in Southern Highlands Province, composted mounds also characterise System 0718.

Throughout the middle and upper Wahgi Valley (in Systems 0906, 0905 and this one), much of the wetlands and flat valley bottomland was not agriculturally used at the time of contact in the 1930s. However, archaeological research at Kuk Swamp indicates that there have been several periods up to 9000 years ago during which drainage systems were employed for cultivation. Since the late 1940s, following alienation, and major drainage works, a core area of plantations and smallholder blocks has developed. In recent years also, there have been substantial movements of population off the valley ridges on to the valley floors, as well as settlers from other provinces (Ploeg 1975; Rambo 1993), for access to land for pig pasturage and cash cropping.

There are useful early accounts of agriculture dating from the 1930s and 1940s (Vicedom and Tischner 1983; Gitlow 1947), but the most substantial description is that of Powell (1970) and Powell et al. (1975). This refers to the late 1960s and early 1970s, and is generalised to include parts of three systems, this one, 0903 and 0905. There is a large amount of related literature.

Three major garden types are recognised: the major sweet potato gardens, mixed vegetable gardens, and household gardens (Powell et al. 1975, 4-12). Separate taro gardens are also sometimes made. Sweet potato gardens are generally made in cane grass fallows, with mixed vegetable gardens often in woody regrowth. Mixed vegetable gardens may revert to long fallow of 5-20 years or more after one or two plantings, or may be followed by several plantings of sweet potato. Sweet potato gardens also commonly include separate sections devoted to mixed crops.

Notes continued

Sweet potato gardens are typically replanted 3-5 times before long fallow (Vicedom and Tischner 1983,188; Nelson 1971, 108-109), but in favourable locations this may be extended considerably (Powell et al. 1975, 9-11).

While cane grass is the most common fallow vegetation, there is also use of short grass (Powell 1970), and some woody regrowth. Woody regrowth is more common on upper slopes surrounding the valleys, and was previously favoured for mixed vegetable gardens (Powell et al. 1975, 4-8). Planted casuarina fallows were also favoured for mixed vegetable gardens (M. Strathern 1972, 22).

The square bed in a 'gridiron' pattern across the whole area of cultivation is the dominant garden form. When the ditches or drains around the square beds are dug, the soil is put onto the beds, and the clods are broken, but there is no complete tillage of the surface (Vicedom and Tischner 1983, 187; Powell et al. 1975, 10). Occasionally, cross-drains are not made and beds become long rather than square. Large ditches surrounding gardens may replace fencing, especially in grassland areas.

Rural incomes are high, especially in the Wahgi Valley. By 1975, incomes in some villages ranked amongst the highest in Papua New Guinea, and there was little out-migration (Clunies Ross 1984, 58-59, 73). The Wahgi Valley includes a considerable area of intensive commercial cultivation of coffee and tea, both under plantation and smallholder production. In 1981, there were some 84 largeholdings or estates in Western Highlands Province (mostly in this system and in Systems 0905 and 0906), using some 35 000 ha (Goldthorpe 1985, 25). In 1977, there were 6 tea estates producing 80 per cent of the Papua New Guinea crop from 3000 ha, and about 400 smallholders accounting for less than 3 per cent (Arthur 1978, 3). Arabica coffee is the major source of cash income for most villagers.

Food crop marketing is also significant throughout most of the system, with a wide range of markets (Jackson and Kolta 1974; Rural Statistics Section 1992, Fresh Produce Development Company 1994). In 1988, sellers at Mt Hagen market from the two Districts of Hagen Central and North Hagen accounted for 64 per cent of all produce (Rural Statistics Section 1992, 21). Other sources of cash income include sale of firewood, cattle and cardamom.

National Nutrition Survey 1982/83

429 families from 10 villages were asked in March, May, June, July or August 1983 what they had eaten the previous day. 97 per cent reported eating sweet potato, 15 per cent banana, 5 per cent taro, 2 per cent cassava and none coconut, Chinese taro, sago or yam. 24 per cent reported eating rice. 2 per cent reported eating fresh fish. This is similar to the crop pattern.

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PROVINCE 9 Western Highlands	**AGRICULTURAL SYSTEM No.** 3	**Subsystem No.** 1 **of** 1
Districts 1 Hagen Central, 2 Hagen North, 5 Tambul	**Subsystem Extent** 100 %	**Area (sq km)** 380
Population 27,508	**Population density** 72 **persons/sq km**	**Population absent** 7 **%**

System Summary

Located above approximately 1800 m on the eastern slopes of Mt Hagen and on the western and eastern fringes of the Nebilyer Valley. After long fallows of generally 10-15 years, mixed cane grass and woody fallow vegetation is cleared, dried and burnt. New gardens are initially prepared with square beds without mounds. For subsequent plantings, the soil in the beds is tilled and composted mounds are made. There are typically 6-14 plantings before long fallow. Short fallows of a few months between plantings are common. Sweet potato is the most important crop; other crops are taro, banana and potato. Household gardens are common. Pig husbandry is important.

Extends across provincial border to System(s) None

Altitude range (m) 1800-2600 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Potato, Sweet potato, Taro (Colocasia)
OTHER VEGETABLES	Bean (common), Bean (winged), Cabbage, Corn, Highland pitpit, 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	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	Minor
PLANTED TREE FALLOW	Minor
COMPOST	Very significant
ANIMAL MANURE	None
ISLAND BED	None
SILT FROM FLOOD	None
INORGANIC FERTILISER	None

CASH EARNING ACTIVITIES

1 Cattle	Minor
2 Coffee Arabica	Minor
3 Firewood	Minor
4 Fresh food	Minor
5 Potato	Minor
6 Pyrethrum	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Minor
TILLAGE	Significant
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	None
SMALL MOUNDS	None
MOUNDS	Significant
LARGE MOUNDS	Significant
Garden Bed Techniques:	
BEDS SQUARE	Minor
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 vehicle traverse from Mt Hagen to Bukapena station (1 day). In December 1990, a vehicle traverse from Mt Hagen to Togoba and Bukapena station (1 day), and an aerial survey from Mt Hagen down the Baiyer River Valley returning via Togoba. In February 1993, aerial observation from Mt Hagen to Lumusa. Detailed site information is limited.

Boundary definition

The boundary with System 0901 is based on the presence or absence of square beds (absent in 0901), and those with Systems 0902 and 0905 on the presence or absence of mounds (largely absent in 0902 and 0905). The latter boundaries largely coincide with the 1800 m contour. These boundaries were determined during road traverses on the Mt Hagen-Togoba-Bukapena, Mt Hagen-Kumdi mission, and the Mt Hagen-Kotna roads; and by aerial observation. The boundary with System 0904 was determined during vehicle traverses on the Mt Hagen-Tambul road.

Notes

This system in the western end of the Wahgi Valley, and Systems 0904 and 0912 in the Kaugel Valley, are all characterised by the use of composted mounds for sweet potato cultivation, a feature which they share with systems further to the west and south in Enga and Southern Highlands Provinces. In the Baiyer Valley to the north, this contrasts with the much less intensive System 0901, where composted mounds (and square beds) are absent, there are only two plantings before long fallow and the fallow type is short woody regrowth. It also contrasts with the major agricultural technique of square beds, which characterises the Wahgi Valley Systems of 0902, 0905 and 0906, mainly below 1800 m. Although square beds are used in this system (unlike systems further to the west), this is generally a minor feature restricted, except at the lower altitude margin of the system, to gardens first cultivated after a long fallow.

Three major garden types are recognised: the major sweet potato gardens, mixed vegetable gardens and household gardens (Powell et al. 1975, 4-12). Separate taro gardens may also occasionally be made. Sweet potato gardens are generally made in cane grass fallows, with mixed vegetable gardens often in woody regrowth. Mixed vegetable gardens may revert to long fallow of 5-20 years or more after one or two plantings, or may be followed by several plantings of sweet potato. Sweet potato gardens also commonly include separate sections devoted to mixed crops. Sweet potato gardens are typically replanted 6-14 times before long fallow, though in favourable locations this may be extended considerably (Powell et al. 1975, 9-11).

While cane grass is the most common fallow vegetation, short grass, and some woody regrowth, are also used (Powell 1970). Woody regrowth is more common on upper slopes and was previously favoured for mixed crop gardens (Powell et al. 1975, 4-8).

Following long fallow, land is usually brought into cultivation using the square bed technique (Powell et al. 1975, 10). When the soil has become 'soft' after a planting of sweet potato, each bed is converted into a composted mound. Cut grass is brought into the garden, and heaped in the centre of the bed. The soil around the bed is tilled and heaped into a mound over the compost. After harvesting, and usually following a short fallow under short grass and weeds, mounds are reformed either in the same location, or in the areas between adjoining mounds (Powell et al. 1975, 11-12).

Information on fallow lengths is limited. It appears that in some areas very extended periods of cultivation using composted mounds and short fallows may be followed by long fallow periods of 30-40 years (Powell et al. 1975, 11), and the relocation of the cultivated area elsewhere.

Sources of cash income are constrained by high altitude. Arabica coffee is of minor importance, as are fresh food sales (to Mt Hagen and other markets), firewood and cattle. The high altitude crops of potato and pyrethrum are also of minor importance.

National Nutrition Survey 1982/83

357 families from 9 villages were asked in March, June, July or August 1983 what they had eaten the previous day. 97 per cent reported eating sweet potato, 3 per cent banana, 1 per cent cassava, 1 per cent taro and none coconut, Chinese taro, sago or yam. 12 per cent reported eating rice. None reported eating fresh fish. This is similar to the crop pattern.

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PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 4 **Subsystem No.** 1 **of** 1

Districts 5 Tambul **Subsystem Extent** 100 % **Area (sq km)** 200
Population 13,412 **Population density** 67 **persons/sq km** **Population absent** 9 **%**

System Summary

Located in the upper Kaugel Valley above 2200 m. The major gardens are under continuous cultivation on flat bottomlands and old lake terraces between 2200 and 2300 m. Sweet potato is planted in large composted mounds. When mounds are re-made, the soil is completely tilled. Cropping is usually continuous with short fallows, sometimes extended for more than 12 months, between plantings. Occasionally, a long fallow occurs, with tall cane grass as the vegetation type. Sweet potato is the most important crop; other crops are taro and potato. Taro is sometimes grown in separate gardens, and potato is grown in large monocropped gardens, with some use of tractors and inorganic fertiliser. Small mixed vegetable gardens are made in woody regrowth, with one planting followed by a 10-15 year fallow. A few gardens are made in the forest edge from 2600 to as high as 2800 m: in these, an initial planting of vegetables or potato may be followed by sweet potato. Household gardens are common. Pig husbandry is important.

Extends across provincial border to System(s) None

Altitude range (m) 2200-2700 **Slope** Gentle (2-10 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Potato, Sweet potato, Taro (Colocasia)
OTHER VEGETABLES	Amaranthus spp., Bean (common), Cabbage, Corn, Highland pitpit, Pumpkin tips, Rungia, Peas
FRUITS	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	>40 plantings
R VALUE	100 (high)

GARDEN SEGREGATION

GARDEN SEGREGATION	Significant
CROP SEGREGATION	Minor
CROP SEQUENCES	Minor
MIXED VEGETABLE GARDENS	Significant
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 Potato	Significant
2 Firewood	Minor
3 Fresh food	Minor
4 Pyrethrum	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Minor
TILLAGE	Very significant
MECHANIZATION	Minor
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	Minor
Mounding Techniques:	
VERY SMALL MOUNDS	Minor
SMALL MOUNDS	None
MOUNDS	Minor
LARGE MOUNDS	Very significant
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

In September 1980, a vehicle traverse from Wabag to Mendi, via Tambul (1 day). In November 1990, vehicle traverses from Mendi, via Tambul station, to Wabag (one hour, observations only); and from Taluma station, via Tambul and Ilkena mission, to Mendi (half day, with garden inspection and interview). Detailed site information is limited.

Boundary definition

The boundaries with System 0903 and Southern Highlands Province System 0717 were determined from traverses on the Wabag-Tambul-Mendi road. The southern boundary with System 0912 was drawn on the 2200 m contour in the lower Kaugel Valley.

Notes

This system shares with the surrounding Systems 0903 and 0912, and Southern Highlands Province System 0717, the use of composted mounds. Here, however, the major sweet potato gardens are concentrated on flat bottomlands and old lake terraces, mounds are typically larger and cultivation is more or less continuous. While there are areas of similar intensity in System 0717, and possibly in 0903, they are of limited extent by comparison.

Bowers (1968) provided a detailed account of agriculture for the period 1961-63 in the upper Kaugel Valley. She distinguished three major garden types: the main sweet potato gardens, located on the bottomlands and terraces between 2200 m and 2300 m; mixed vegetable gardens; and gardens at the forest edge. Segregated taro plots occurred amongst the sweet potato gardens and, in the past, taro gardens may have been more extensive.

According to Bowers (1968, 66-78), the sweet potato gardens were cultivated 'quasi-permanently': that is, they were generally under continuous cultivation with only short fallows between plantings. Although villagers said they did not fallow these gardens, some plots occasionally dropped out of cultivation for reasons varying from declining yield to the outbreak of warfare. Before mounds were re-made, the soil was thoroughly tilled with a digging stick to a depth of at least 15 cm (Bowers 1968, 67). Mixed vegetable gardens were usually made in woody regrowth fallows, with the main crops being highland pitpit, rungia and taro, as well as a range of supplementary crops such as beans, peas, sugarcane, corn and amaranthus (Bowers 1968, 80-88). A single planting before long fallow was usual. Bowers described the forest edge gardens as a sequence during which the forest edge was gradually converted into Miscanthus grassland. The sequence involved forest clearance, planting of mixed vegetables, fallows of 3-10 years, recultivation involving complete tillage and mounding, and up to 4 plantings of sweet potato before the land was abandoned to a Miscanthus grass climax.

In 1961-63, Bowers (1965) found that indices of wealth and marital status were related to landholding. Subclans lacking good agricultural land on river terraces had fewer pigs and much higher proportions of unmarried adult men than subclans with access to terrace land.

Bayliss-Smith (1985) described taro cultivation on the Kaugel Valley floor, and on terrace land, during 1980-81. One fenced wetland area of 4 ha included 295 square beds measuring 8 m by 9 m with a mean of 93 taro plants per bed. This followed a very long fallow of some 60 years, under Miscanthus cane grass vegetation. Taro took 12-18 months to mature at this altitude. The expectation was that the taro crop would be followed by plantings of sweet potato. Data for two trial plots suggested very high labour inputs of over 4500 hours per ha, and very low yields of between 2 and 5 tonnes per ha. A prehistoric wooden 'spade' which was found in an old ditch in 1975 is the oldest wooden artifact (4000 years BP) found in Papua New Guinea, and suggests that the use of drainage ditching for wetland agriculture is a very old technique here (Bayliss-Smith 1985, 291).

Income opportunities in this high altitude area are limited, but include sales of potato, other fresh food and firewood, and pyrethrum production. During the 1970s, this led to high rates of seasonal migration for work on coffee plantations in the Wahgi Valley (Clunies Ross 1984, 71-72). Some pyrethrum was grown in the 1970s and 1980s. Pig sales have been important since at least the 1970s (Clunies Ross 1984, 71-72). During 1992, buyers from Enga Province were purchasing vegetables directly from farmers at the roadside, presumably for resale to the mine site at Porgera (Anon 1992). The 1988 survey of Mt Hagen market indicated that about 30 per cent by weight of produce was sold by sellers from Tambul District (Rural Statistics Section 1992, 20). Tambul sellers specialised in high altitude products, accounting for 82 per cent of all cabbage, 60 per cent of all potato, 89 per cent of broccoli and 78 per cent of all carrots. There is minor use of tractors for the commercial production of potato.

National Nutrition Survey 1982/83

144 families from 3 villages were asked in June, July or August 1983 what they had eaten the previous day. 99 per cent reported eating sweet potato, 3 per cent taro, 1 per cent cassava and none coconut, banana, Chinese taro, sago or yam. 16 per cent reported eating rice. 1 per cent reported eating fresh fish. This is similar to the crop pattern.

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PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 5 **Subsystem No.** 1 **of** 1

Districts 1 Hagen Central, 2 Hagen North **Subsystem Extent** 100 % **Area (sq km)** 508
Population 52,328 **Population density** 103 **persons/sq km** **Population absent** 4 **%**

System Summary

Located in the upper Wahgi and Nebilyer Valleys. The main sweet potato gardens are usually made in fallow vegetation of cane grass, typically 5-15 years old. There is minor use of woody regrowth vegetation, particularly on upper slopes, but also for mixed vegetable gardens. The grass is cut, dried and burnt. Drains, typically 20-30 cm deep, are dug to form square beds (approximately 3 m by 3 m). Soil from the drains is thrown onto the beds. Large clods are broken down to make a surface into which sweet potato is planted without mounding. Sweet potato is the most important crop; other crops are banana and taro. Typically, there are 6-14 plantings before long fallowing, but cultivation may be extended for more than 15 plantings. Short fallows of less than 12 months are common between plantings. Rotations with peanuts or winged bean are common. Near the western border with System 0903, the square beds may be replaced by composted mounds during second or subsequent plantings. Mixed gardens and household gardens are both important. Very large areas of former swampland in the Wahgi Valley have been drained since 1945 for the plantation cultivation of coffee and tea. Pig husbandry is important.

Extends across provincial border to System(s) None

Altitude range (m) 1400-2000 **Slope** Gentle (2-10 degrees)

CROPS

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

FALLOW & CROPPING PERIOD

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

GARDEN SEGREGATION

GARDEN SEGREGATION	Minor
CROP SEGREGATION	Minor
CROP SEQUENCES	Significant
MIXED VEGETABLE GARDENS	Very significant
HOUSEHOLD GARDENS	Very significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	Significant
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	Very significant
2 Fresh food	Significant
3 Cattle	Minor
4 Firewood	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Very 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	None
Garden Bed Techniques:	
BEDS SQUARE	Very significant
BEDS LONG	Minor
Other Features:	
FENCES	Significant
STAKING OF CROPS	Minor
FALLOW CUT ONTO CROPS	None
SEASONAL MAIN CROPS	None
SEASONAL SEC'DARY CROPS	Minor

OTHER DOCUMENTATION

Survey description

In September 1980, vehicle traverses from Kerowagi to Mt Hagen; from Mt Hagen to Baiyer River station, to Togoba station and to the Nebilyer Valley; and from Mt Hagen to Kerowagi on the old Highway north of the Wahgi River (2 days). In December 1990, aerial surveys from Mt Hagen to the Jimi Valley (helicopter), and from Mt Hagen over the Baiyer River Valley and back to Togoba station (light aircraft); and vehicle traverses from Mt Hagen to Togoba station and Bukapena station, and from Tumam village to Kagamuga and to Kerowagi (2 half days). Despite the wide coverage of these extensive traverses, detailed site information is limited.

Boundary definition

The boundary with System 0903 was based on the presence or absence of composted mounds (largely absent in 0905) and determined from traverses on the Mt Hagen-Togoba, Mt Hagen-Bukapena and Mt Hagen-Kotna roads; and by aerial reconnaissance, and extrapolated along the 1800 m contour. The boundary with System 0902 south of Mt Hagen, was identified during road traverses in the Wurup and Nebilyer Valleys and by aerial reconnaissance, and based on Saunders (1993). In the middle Wahgi Valley, the boundaries with System 0902 were determined during road traverses; south of the North Wahgi swamp, the boundary followed Saunders (1993), to the north it was drawn on the western end of the Wahgi Land System (Haantjens et al. 1970). The boundary with System 0907 was based on aerial observation and evidence from Dabrowski (1991), and drawn at the Sepik-Wahgi Divide.

Notes

This very intensive system occupies the upper Wahgi and Nebilyer Valleys mainly between 1500 m and 1900 m. There is minor land use down to 1400 m in the Nebilyer Valley, and up to 2000 m in the north on the Sepik-Wahgi Divide. The major features are the distinctive 'gridiron' pattern of ditched square beds, legume rotations, and mixed vegetable gardens. To the northeast, south and west, this system is surrounded by the similar System 0902 which shares the distinctive pattern of square beds, but is less intensive, with fewer plantings before long fallow. To the north, it contrasts with System 0907 across the Sepik-Wahgi Divide in the Rulna mission area, which is characterised by woody regrowth fallows and only one planting before long fallow. On the eastern slopes of Mt Hagen, it differs from System 0903, where square beds are largely replaced by composted mounds.

Throughout the middle and upper Wahgi Valley (in Systems 0906, 0902 and this one), much of the wetlands and flat valley bottomland was not agriculturally used at the time of contact in the 1930s. However, archaeological research at Kuk Swamp indicates that there have been several periods up to 9000 years ago during which drainage systems were employed for cultivation (Golson 1990). Since the late 1940s, following alienation and major drainage works, a core area of plantations and smallholder blocks has developed. In recent years also, there have been substantial movements of population off the valley ridges on to the valley floors for access to land for pig pasturage and cash cropping (Gorecki 1985).

There are useful early accounts of agriculture dating from the 1930s and 1940s (Vicedom and Tischner 1983; Gitlow 1947), but the most substantial description is that of Powell (1970) and Powell et al. (1975). Powell's account refers to the late 1960s and early 1970s, and is generalised to include parts of three systems, this one, 0902 and 0903. There is a large amount of related literature.

Three major garden types are recognised: the major sweet potato gardens, mixed vegetable gardens, and household gardens (Powell et al. 1975, 4-12). Separate taro gardens are also sometimes made. Sweet potato gardens are generally made in cane grass fallows, with mixed vegetable gardens often in woody regrowth. Mixed vegetable gardens may revert to long fallow of 5-20 years or more after one or two plantings, or may be followed by several plantings of sweet potato. Sweet potato gardens also commonly include separate sections devoted to mixed crops. Sweet potato gardens are typically replanted 6-14 times before long fallow, though in favourable locations this may be extended considerably (Powell et al. 1975, 9-11).

While cane grass is the most common fallow vegetation, short grass, and some woody regrowth, are also used (Powell 1970). Woody regrowth is more common on upper slopes surrounding the valleys, and was previously favoured for mixed vegetable gardens (Powell et al. 1975, 4-8). Planted casuarina fallows were also favoured for mixed vegetable gardens (M. Strathern 1972, 22).

The square bed in a 'gridiron' pattern across the whole area of cultivation is the dominant garden form. When the ditches or drains around the square beds are dug, the soil is put onto the beds, and the clods are broken but there is not

Notes continued

complete tillage of the surface (Vicedom and Tischner 1983, 187; Powell et al. 1975, 10). Occasionally, cross-drains are not made and beds become long rather than square. Large ditches surrounding gardens may replace fencing, especially in grassland areas.

Rural incomes are high. In 1975, incomes in some villages ranked amongst the highest in Papua New Guinea, and there was little out-migration (Clunies Ross 1984, 58-59, 73). The Wahgi Valley includes a considerable area of intensive commercial cultivation of coffee and tea, both under plantation and smallholder production. In 1981, there were some 84 largeholdings or estates in Western Highlands Province (mostly in this system and in Systems 0902 and 0906), using some 35,000 ha (Goldthorpe 1985, 25). In 1977, there were 6 tea estates producing 80 per cent of the Papua New Guinea crop from 3000 ha, and about 400 smallholders accounting for less than 3 per cent (Arthur 1978, 3). Smallholder production had ceased by 1978. Arabica coffee is the major source of cash income for most villagers.

Food crop marketing is also significant throughout most of the system, with a wide range of markets (Jackson and Kolta 1974; Rural Statistics Section 1992, Fresh Produce Development Company 1994). In 1988, sellers at Mt Hagen market from the two Districts of Hagen Central and North Hagen accounted for 64 per cent of all produce (Rural Statistics Section 1992, 21). Local sellers from Hagen Central accounted for all sweet potato sales, and one third of potato sales.

National Nutrition Survey 1982/83

287 families from 8 villages were asked in June, July or August 1983 what they had eaten the previous day. 98 per cent reported eating sweet potato, 18 per cent banana, 1 per cent cassava, 1 per cent taro, 1 per cent yam and none coconut, Chinese taro or sago. 27 per cent reported eating rice. None reported eating fresh fish. This is similar to the crop pattern.

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PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 6 **Subsystem No.** 1 **of** 1

Districts 3 Wahgi **Subsystem Extent** 100 % **Area (sq km)** 284
Population 25,995 **Population density** 92 **persons/sq km** **Population absent** 6 **%**

System Summary

Located in the Wahgi Valley to the east of Minj, and extending into Chimbu Province. The main sweet potato gardens are usually made in fallow vegetation of cane grass, typically 5-15 years old. There is some use of woody regrowth vegetation, particularly on the upper slopes around the valleys, but also for mixed vegetable gardens. The grass is cut, dried and burnt. Drains, typically 20-30 cm deep, are dug to form square beds (approximately 3 m by 3 m). Soil from the drains is thrown on top of the bed. Large clods are broken down to make a tilled surface which is formed into small mounds for planting sweet potato. Between plantings, short fallows of less than 12 months are common, and pigs are allowed to forage in gardens. Sweet potato is the most important crop; other crops are banana, taro, cassava and yam (D. alata). Typically, there are 6-14 plantings before long fallowing, but cultivation may be extended for more than 15 plantings. Rotations of sweet potato with winged bean or peanuts are common. Mixed gardens and household gardens are both important. Pig husbandry is important.

Extends across provincial border to System(s) 1001

Altitude range (m) 1400-2000 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Cassava, Sweet potato, Taro (Colocasia), Yam (D. alata)
OTHER VEGETABLES	Amaranthus spp., Bean (common), Bean (winged), Cabbage, Corn, Highland pitpit, Peanuts, Pumpkin tips, Rungia
FRUITS	Marita pandanus, Pawpaw, Sugarcane
NUTS	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	6-14 plantings
R VALUE	50 (medium)

GARDEN SEGREGATION

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

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	Significant
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	Very significant
2 Fresh food	Significant
3 Firewood	Minor

OTHER AGRONOMIC PRACTICES

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

OTHER DOCUMENTATION

Survey description

In September 1980, vehicle traverses from Kerowagi to Mt Hagen on the Highlands Highway, and from Mt Hagen to Kerowagi on the old Highway north of the Wahgi River (half day). In August 1982, vehicle traverses on the road network (Highlands Highway, Kup, Gumine, Nondugl-Kerowagi and Kundiawa-Gembogl roads) in northern Chimbu Province (1 day). In November 1990, aerial observations in Chimbu Province. In December 1990, vehicle traverses from Tumam to Banz and Banz to Kerowagi on the old Highway; from Kerowagi up the Koronigl Valley; from Kerowagi, via Kup west to the Chimbu-Western Highlands border; and from Mingende mission to the Kondiu bridge across the Wahgi (1 day). Despite the wide coverage of these extensive traverses, detailed site information is limited.

Boundary definition

The boundaries with System 0902 to the west were determined during vehicle traverses from Chimbu Province to Mt Hagen on the Highlands Highway, on the Kup-Minj road, and from Mt Hagen to Kerowagi on the old Highway north of the Wahgi River. The boundaries between the Chimbu Province part of the system (1001) and Chimbu Systems 1002, 1004 and 1008 were determined during vehicle traverses on all major roads in the north Chimbu network.

Notes

This system shares the characteristic 'gridiron' ditch pattern of square beds with Systems 0902 and 0905 further to the west in the middle and upper Wahgi Valley. Here, however, sweet potato is planted in small mounds on top of the beds, a feature which is absent to the west. Also, agriculture is more intensive here than in System 0902 (6-14 plantings instead of 3-5), but similar to that in System 0905. This system becomes System 1001 in Chimbu Province where it contrasts with the adjoining Systems 1002, 1004 and 1008, in all of which square beds are either absent or insignificant.

The two major accounts of agriculture and land use are by Brookfield and Brown (1963, and numerous other publications); and by the Simbu Land Use Project (SLUP) Team, in particular Wohlt and Goie (1986) for land use, Goodbody (in press) for agronomy, and Humphreys (1984) for soils.

The most characteristic feature of gardens is the use of square beds (measuring generally between 2 m and 4 m). These beds have also been described as 'gridiron ditching' (Brookfield and Brown 1963, 44), chess board (Nilles 1942-45) or rectangular grids (Wohlt and Goie 1986, 13). After fallow vegetation has been cleared, lines are marked on the ground and the whole field is divided by crosscutting drains about 20 cm wide and 25 cm deep (but deeper where there is greater moisture). The soil from these drains is thrown onto the bed (where the surface has not been tilled). The soil may sometimes cover cut grass. Clods are broken and, for sweet potato cultivation, small mounds measuring about 25 cm high and 50 cm diameter are formed (Wohlt and Goie 1986, 12; Nilles 1942-45; Brookfield and Brown 1963, 45; Brookfield 1973, 130). Square beds are usually restricted to slopes of less than 16 degrees: on greater slopes there is a mixture of vertical drains (and some horizontal ones) with or without the use of soil retention fences (Wohlt and Goie 1986, 11-13). Although most gardens are made on gently sloping land, some are on steeper slopes.

There is great variability in the periods of cultivation and fallow. In their initial work at Mintima, Brookfield and Brown (1963, 50-53) distinguished between high quality land, which was cultivated for 4-10 years and fallowed for 5-20 years under planted casuarina; and poorer land, where cultivation lasted 1-3 years and fallows from 20-50 years. In an overview of land use covering the period 1958-1967, Brookfield (1973) found that this was not a long enough period to identify a clear cultivation cycle, and argued that the cycle of pig production strongly influenced the pattern of farming activity. Taking account of change to 1984, Brown et al. (1990) show that high quality land has been under semi-permanent cultivation since 1958, with only short fallows.

Near Minj in Western Highlands Province, in the mid 1950s, Reay (1959b, 5-6) noted 3-4 plantings before a planted casuarina fallow of up to 15 years. Twenty years later in 1975-76, Heaney (1989, 75-77, 322-324) also reported 2-4 plantings of sweet potato before a grass fallow near Nondugl at the census units of Milep and Kombulno. He noted that mixed vegetable gardens were made in woody regrowth fallows on steeper slopes on the valley sides, while household gardens were planted with a wide range of subsidiary crops. Much flat, valley bottom, land was uncultivated before 1948 due to seasonal flooding. Following drainage, there was considerable movement of population down from spurs and ridges on to this land (Heaney 1989, 98), and of settlers from elsewhere (Ploeg 1975; Rambo 1993).

Notes continued

A major study of sweet potato agronomy in 1981-83 throughout the northern region of Chimbu Province concluded, amongst other things, that yields below 1900 m did not appear to have declined since an earlier study in the 1960s; that yields tended to be higher from plantings at or before the beginning of the wet season; and that soil fertility, as measured by chemical analysis, did not decline under sweet potato cultivation over periods of one and a half years (Goodbody in press).

Pig husbandry is important. Up to the 1980s, levels of pig production, and hence crop production, varied cyclically in relation to large scale pig killing festivals (Brookfield 1973; Malynicz 1977). The current status of these is unknown. In the early 1960s, it was estimated that pig numbers would not exceed 1.5 adult pigs per person at cycle peaks (Brookfield and Brown 1963, 58-59). In the early 1970s, there were 1.1 pigs per person near Kerowagi (Malynicz 1977, 202). In 1981, Wohlt and Goie (1986, 161, Map D) reported ratios of 0.9-1.2 pigs per person throughout the system. Pigs are commonly pastured in gardens between plantings.

There is considerable variation in local population densities (Wohlt and Goie 1986, Map E). In Chimbu Province, the system includes one area, running westwards from the Lower Chimbu Valley to Mintima. Wohlt and Goie (1986, 195-208) identified this as one of six core areas of high subsistence land use intensity. However, neither of the two SLUP regions (Wahgi Flats and Piedmont) into which the area covered by this system falls, were seen as currently associated with significant agricultural stress (Wohlt and Goie 1986, 188-191). The overall high population densities of the region have been seen as potentially threatening sustainable agriculture for over 30 years; however, population growth rates have been lowered by high out-migration from Chimbu Province (Smith 1975; Harris 1976; Territory of Papua and New Guinea 1967).

Arabica coffee is by far the most important source of income. In 1976 near Nondugl in Western Highlands Province, coffee holdings averaged 0.26-0.28 ha per grower (Heaney, 1989, 107-108), giving annual incomes of about K150 per grower. Other sources increased annual incomes to between K200 and K400. In Chimbu Province, survey data collected by the Coffee Industry Corporation's Extension Service in 1993 gave average family coffee holdings of 0.31-0.59 ha in the East and West Koronigl, and Waiye areas; considerably greater than figures of less than 0.20 ha for other parts of the province (Collett et al. 1994, 17). Spices (cardamom and chillies) are very minor income sources. Cardamom has been grown by a minority of households since the early 1980s. In 1993, production from Kerowagi and Kundiawa Districts in Chimbu Province was estimated at only 0.5 tonnes (Collett et al. 1994, 23). Estimates of chilli production are similarly low. Firewood is sold both in urban areas and at roadsides. Fresh food sales at urban markets (Kundiawa, Kerowagi, Minj) and many other locations are a significant source of income.

National Nutrition Survey 1982/83

231 families from 5 villages were asked in June, July or August 1983 what they had eaten the previous day. 97 per cent reported eating sweet potato, 16 per cent banana, 2 per cent coconut, 1 per cent cassava, 1 per cent taro and none Chinese taro, sago or yam. 23 per cent reported eating rice. None reported eating fresh fish. This is similar to the crop pattern. The coconut was presumably imported from the lowlands.

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PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 7 **Subsystem No.** 1 **of** 1

Districts 2 Hagen North, 4 Jimi **Subsystem Extent** 100 % **Area (sq km)** 780
Population 18,303 **Population density** 23 **persons/sq km** **Population absent** 6 **%**

System Summary
Located north of the Sepik-Wahgi Divide, mainly on the southern side of the Jimi Valley. In the upper Jimi region, there is a small extension into Madang Province. Gardens are cleared from short woody fallows, 5-15 years old. Cut vegetation is dried and burnt. Sweet potato is the most important crop; other crops are taro, banana, cassava, yam (D. alata) and Chinese taro. Only one planting is made before fallowing. The soil is not tilled, and planting is by dibble. Sweet potato is usually planted separately from the other crops. Gardens are commonly cleared and planted between August and October. Below 1500 m, arboriculture is important, particularly plantings of marita pandanus and tulip, and also including breadfruit and Ficus species. Household gardens are common. Pig husbandry is important.

Extends across provincial border to System(s) 1332

Altitude range (m) 600-2200 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Cassava, Chinese taro, Sweet potato, Taro (Colocasia), Yam (D. alata)
OTHER VEGETABLES	Aibika, Amaranthus spp., Bean (common), Corn, Highland pitpit, Kumu musong, Pumpkin tips, Rungia, Tulip, Bean (lima)
FRUITS	Marita pandanus, Pawpaw, Sugarcane
NUTS	Breadfruit, Karuka (planted)
NARCOTICS	Betel nut (lowland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Short woody regrowth
SHORT FALLOW	None
LONG FALLOW PERIOD	5-15 years
CROPPING PERIOD	1 planting
R VALUE	9 (very low)

GARDEN SEGREGATION

GARDEN SEGREGATION	Minor
CROP SEGREGATION	Significant
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	Minor
HOUSEHOLD GARDENS	Very 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 Animal skins	Minor
2 Cardamom	Minor
3 Coffee Arabica	Minor
4 Fresh food	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	Very significant
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 August 1982, a vehicle traverse on the Banz-Tabibuga station road to the end of the road, and by foot to Koinambe mission (half day). In December 1990, a helicopter traverse from Mt Hagen to the Jimi Valley and back to Mt Hagen, with brief stops at Koinambe mission and Togban community school. The upper Jimi Valley was not visited during this survey, but was extensively surveyed during the 1987 Rapid Rural Appraisal (Joughin and Thistleton 1987). In the western part of the system, neither the Rulna mission area nor the Ganz River Valley were visited. The Madang Province part of this system was not visited.

Boundary definition

The boundary with System 0902 was determined from a road traverse from Banz township to Tabibuga station. The boundary with System 0905 was based on aerial observation and evidence from Dabrowski (1991), and drawn at the Sepik-Wahgi Divide. The boundary with System 0908 was determined on a road traverse from Banz to Tabibuga and Koinambe mission. It was extrapolated by reference to the regrowth vegetation boundary mapped by Saunders (1993). To the east, this system was distinguished from Madang Province System 1322 on the basis of traverses in the Bundi area.

Notes

From the air, and on the ground, this system contrasts sharply with the much more intensive agriculture immediately to the south in the Wahgi Valley (Systems 0906, 0902 and 0905). The characteristic square beds, cane grass fallows and repeated plantings of the Wahgi systems are all absent north of the Sepik-Wahgi Divide in this system. To the north across the Jimi River, System 0908 is of a similar low intensity (a single planting only before a long fallow of 5-15 years), but it differs in having several important staple crops.

There are no in-depth studies of agriculture from this system, though much information from System 0908 is relevant. Following identification of the Jimi Valley as an area of poor nutrition in the 1983 National Nutrition Survey, a rapid rural appraisal was carried out to assess agriculture and investigate possible interventions (Joughin and Thistleton 1987). These interventions have generally had little effect (Crittenden et al. 1989).

The wide altitude range covered by this system means that altitude is a significant source of variation in such factors as the crop composition of gardens (more sweet potato at higher altitudes), access to tree crops (less marita pandanus and breadfruit at higher altitudes) and seasonal planting (less significant at higher altitudes).

Near Rulna mission in the early 1980s, gardens were used for 3-4 years, with long fallows of low woody vegetation for 8-12 years (Dabrowski 1991, 38). Marita pandanus and breadfruit were important foods in October-November, and seeds of Pangium edule were apparently gathered (Dabrowski, 1991, 39, 211). Many households cared for captured cassowaries. Boron deficiency was common in casuarina trees between Banz and Tabibuga in 1982.

Arabica coffee has been the major source of cash income for most villagers since the mid 1970s. During 1975-76, Heaney (1989, 107-113) surveyed the coffee holdings of 31 growers at Karap village and reported a mean 0.09 ha per grower. He estimated mean annual coffee income per grower at K77, with other sources, such as pigs, raising this to over K200. In the early 1980s near Rulna mission, the main sources of cash were Arabica coffee and chilli (Dabrowski 1991, 465). In 1987, in the Jimi Valley generally, cash incomes were estimated at K40 per person per year, with the major sources being Arabica coffee, cardamom, fresh food sales, pigs and gold (Joughin and Thistleton, 1987, 6, 23).

National Nutrition Survey 1982/83

222 families from 4 villages were asked in February, March, June, July or August 1983 what they had eaten the previous day. 90 per cent reported eating sweet potato, 35 per cent taro, 22 per cent banana, 5 per cent yam, 4 per cent Chinese taro, 3 per cent cassava, 1 per cent coconut and none sago. 18 per cent reported eating rice. 4 per cent reported eating fresh fish. This is similar to the crop pattern except for the relatively high taro consumption.

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PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 8 **Subsystem No.** 1 **of** 1

Districts 4 Jimi **Subsystem Extent** 100 % **Area (sq km)** 299
Population 8,198 **Population density** 27 **persons/sq km** **Population absent** 7 **%**

System Summary

Located in the middle Jimi Valley, primarily on the north side of the river; and extending into Madang Province on the southeast of the Ramu Plains, especially in the Asai, Tagui and Simbai River Valleys. Typically, tall woody regrowth 8-15 years old is cut, dried and burnt. However, there is some use of primary forest, and older regrowth, as well as some shorter regrowth. Sweet potato is the most important crop; taro and banana are important crops; other crops are cassava, Chinese taro and yam (D. alata and D. esculenta). There is an altitudinal difference in the garden pattern. Above 1200 m, sweet potato tends to predominate in gardens. Below 1200 m, there are separate gardens in which taro, banana and yam (D. alata and D. esculenta) are interplanted. Only one planting is made by dibbling before a long fallow. Many new gardens are cleared and planted between May and September. Arboriculture is important, consisting of plantings of marita pandanus and tulip in particular, and including breadfruit and Ficus species.

Extends across provincial border to System(s) 1315

Altitude range (m) 200-1900 **Slope** Steep (10-25 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	Banana, Taro (Colocasia)
STAPLES PRESENT	Banana, Cassava, Chinese taro, Sweet potato, Taro (Colocasia), Yam (D. alata), Yam (D. esculenta)
OTHER VEGETABLES	Aibika, Choko tips, Corn, Cucumber, Highland pitpit, Kumu musong, Lowland pitpit, Pumpkin tips, Rungia, Tulip
FRUITS	Mango, Marita pandanus, Pawpaw, Pineapple, Sugarcane
NUTS	Breadfruit, Karuka (planted), Karuka (wild)
NARCOTICS	Betel nut (lowland), Betel pepper (lowland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall woody regrowth
SHORT FALLOW	None
LONG FALLOW PERIOD	5-15 years
CROPPING PERIOD	1 planting
R VALUE	9 (very low)

GARDEN SEGREGATION

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

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 Animal skins	Minor
2 Coffee Arabica	Minor
3 Fresh food	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	Very significant
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 August 1982, a vehicle/foot traverse from Banz township, via Tabibuga station, to Koinambe mission in Western Highlands Province (1 day). In December 1990, a helicopter traverse from Mt Hagen to Koinambe mission and back to Mt Hagen (with brief stops at Koinambe mission and Togban community school). Detailed site information is limited in the Western Highlands Province part of the system. In Madang Province, in July 1991, a vehicle traverse on the Simbai-Aiome road from Simbai station to the vicinity of Bokapi; a foot traverse by one party, via Tsungup and Komilaga villages, to Kanainj airstrip (one and a half days); foot traverse by a second party through the Asai Valley, via Arung and Giringiri villages, to Kanainj airstrip (one and a half days; 17 gardens inspected). Traverse by vehicle from Simbai station to Aiome station, and from Aiome to Mambusap village (2 half days; 10 gardens inspected).

Boundary definition

In this province, the boundary with System 0907 was determined from a road traverse from Banz to Tabibuga station and Koinambe mission. It was extrapolated by reference to the regrowth vegetation boundary (woody and short grass to the north, woody to the south) mapped by Saunders (1993). The boundary with System 0909 to the west was also based on the regrowth vegetation boundary (woody and short grass regrowth to the east, woody to the west) distinguished by Saunders (1993). The boundary with System 0910 to the north was based mainly on Clarke (1977). In Madang Province, the boundaries between System 1315 and Systems 1308 and 1316 were determined from a road traverse between Simbai and Aiome, and extrapolated by reference to altitude (System 1308 below 200 m, System 1316 above about 1600 m where it is bordered by System 1315). The boundary with System 1317, in the Gebrau Valley north of Dusin mission, followed the 1600 m contour.

Notes

This system straddles the Madang and Western Highlands Provincial border. It is distinguished from System 0910/1316 to the north, where the fallow periods are shorter, the cropping period longer and planted casuarina is an important part of the fallow; from System 1308 in Madang Province to the east and north, where sago is the most important food; from System 0909/1318 to the west, where the fallow period is longer and taro is a most important crop; and from System 1317 in Madang Province to the southwest, where the important crops are different. It is similar to System 0907 to the south, where banana and taro are less important crops.

Over the last 30 years, several major studies of human ecology, all including accounts of agriculture, have been made in parts of this system. In Madang Province, the major accounts include Rappaport (1984), Clarke (1971), Buchbinder (1977b), Wood (1980) and Vayda (1989). In Western Highlands Province, the major accounts are Healey (1990), Joughin and Thistleton (1987), Lowman (1980) and Manner (1976).

Reported fallow lengths vary. In the early 1960s, in low density areas such as Sipapai at the eastern end of the Simbai Valley, they averaged 16 years, but some were as long as 40 years (Clarke 1966, 349; 1971, 71, 157). Ten per cent of gardens made in 1965 were cleared from previously unused forest (Clarke 1971, 74). By comparison, at Tsembaga in the middle Simbai Valley, only one per cent of gardens made between 1961 and 1963 were cleared from primary forest (Rappaport 1984, 42). At this location, fallows in the early 1960s averaged 15 years in the altitude zone 1000-1300 m, but 25 years above 1300 m (Rappaport 1984, 52-53). Over the range to the south, at Tsuwenkai in the Jimi Valley, there was no tendency for fallow periods to increase with altitude, nor did they become shorter during the 1970s. In this area fallow periods averaged 15-16 years at two surveys in the 1970s, and 18-19 years in 1985 (Healey 1990, 23). In the Gainj area, in the late 1970s, most fallows were in the range 8-12 years (Wood 1980, 36). In 1991, some gardens adjacent to the new Simbai-Aiome road had been made in previously uncut forest. In summary, average fallow lengths reported over the last 30 years fall within the range 10-25 years. Some ecological differences within the area covered by the system seem likely, possibly effecting regrowth vegetation. In the Gainj area of the Tagui and Asai Valleys in 1991, much woody regrowth was less than 10 m high, and tree fern was a marked component. The latter was also apparent from an aerial survey of the lower Asai Valley in 1968 (Bulmer 1968, 2). Some casuarina, but much less than in the neighbouring System 1316, is planted in fallows in the Gainj area, a practice that was apparent in the 1970s (Wood 1980, 36). It may have spread more recently, following the wider use of casuarina as shade for Arabica coffee.

The crop pattern in gardens varies with altitude. Above 800 m, sweet potato interplanted with banana is the major type. Below 800 m, there are two types: gardens planted with sweet potato, banana and cassava; and gardens containing taro, banana, yam (D. esculenta) and sweet potato. Within gardens, taro, banana and yam (D. esculenta and D. alata) are interplanted. Sweet potato is usually segregated. However, in sweet potato, cassava and banana gardens

Notes continued

there is very little crop segregation. At Sipapi, two major named types of gardens were distinguished: taro-yam gardens and unimportant gardens (Clarke 1971, 74-75). The unimportant gardens could be further subdivided into a number of types named after specific crops (for instance, sweet potato gardens or greens garden). Cassava and Chinese taro were usually planted near the edges of gardens. At Sipapi in the far east of the Maring region, there was an increase in the amount of cassava planted between 1965 and 1977 (Clarke 1980, 181). In the middle Simbai Valley where most agriculture occurs between about 900 and 1500 m, two kinds of garden are made: taro-yam gardens below 1300 m and sugarcane-sweet potato gardens between 1300 and 1600 m (Rappaport 1984, 43).

The relative importance of the three major root crops, sweet potato, taro and Chinese taro, has varied both by place and through time. In the early 1960s at the eastern end of the Simbai Valley, crop frequency counts showed sweet potato as the most important crop; however, consumption data showed Chinese taro as slightly more important than sweet potato, and much more significant than taro (Clarke 1971, 71, 179). Consumption data from Tsembaga village in the middle Simbai Valley in 1962-63 showed taro as slightly more significant than sweet potato (Rappaport 1984, 73). In 1968, dietary studies by Buchbinder (1977b, 125-126) in the Simbai Valley also indicated that more taro than sweet potato was eaten. In the 1970s in the Gainj area, Wood (1980, 36) ranked the three most important staples as sweet potato, taro and Chinese taro. One road traverse in 1991 on the Simbai-Aiome road recorded no Chinese taro. Generally, yams (up to 5 species) are of minor importance. However, abrupt differences between neighbouring communities in the significance of, for instance, yam (D. esculenta) have been reported (Clarke 1971, Appendix C). Yam (D. nummularia) was recorded in the Simbai Valley during the 1960s studies, but was not seen in 1991.

Beside the listed vegetables, others reported as present by earlier surveys, or observed as minor occurrences in 1991, include amaranthus, bamboo shoots, beans (lablab, winged and common), bottle gourd, cabbage, Chinese cabbage, ferns, ginger, Nasturtium schlechteri, oenanthe, peanuts, pumpkin fruit, sweet potato leaves (eaten only in northern part of the system), watercress and commelina. Other minor fruits include several Ficus spp., orange and golden apple. Minor nuts include candlenut, castanopsis and galip. Coconut is only present in the lower foothills (below 800 m) to the south of Aiome. Betel nut and betel pepper were not present in the Simbai Valley in the recent past but were grown in the Asai Valley. They have spread recently between Kenainj and Tsungup villages. For the Simbai Valley in the early 1960s, extensive lists of planted crops and edible wild plants are given by Clarke (1971, 207-240) and Rappaport (1984, 44-46, 247-251, 263-269, 270-277).

Crops are planted seasonally to some extent, though the evidence is not unanimous. In the lower Simbai Valley in the 1960s, Clarke (1966, 348; 1971, 130, 160) reported little seasonality, noting that, while some gardens were started sporadically throughout the year, there was more planting, especially of the main taro-yam gardens, in the dry period between May and August. In the middle Simbai Valley also in the 1960s, new major gardens were cleared between April and early June, and burnt and planted between June and September (Rappaport 1984, 42-43). Additional gardens were planted between November and April, largely with greens (Rappaport 1984, 44). In the Gainj area in the 1970s, gardens were cleared in May-June, burnt and fenced between May and August, and planted between July and September (Wood 1980, 39). Sweet potato was most available from November to March, and least between May and September; taro and yam were most available between May and September, and least between October and April (Wood 1980, 39). However, in the Simbai Valley in 1968, the pattern was different; sweet potato was more available between July and September, when taro was relatively scarce (Buchbinder 1977b, 126). Information collected during the 1991 survey also indicated that much new garden preparation occurs in the May-October period, with the planting of taro and yam (D. esculenta and D. alata) between August and September. Taro and yam (D. esculenta and D. alata) are eaten between April and September. However, sweet potato is unlikely to be planted seasonally. The availability of other vegetables is said to be partly seasonal. Aibika, for instance, is said to be most abundant between August and September.

Records of the availability, or fruiting, of tree crops throughout the area also show some variation: breadfruit between June and August in the Gainj area (Wood 1980, 39); but in September-October in the lower Simbai Valley (Clarke 1971, 183). Marita pandanus was most abundant between March and April in the Gainj area (Wood 1980, 39), between December and February in the middle Simbai Valley (Buchbinder 1977b, 125), and in January-February but also throughout the year, except for the driest period (May-August) in the lower Simbai Valley (Clarke 1971, 182, Appendix C).

Yam (D. esculenta) are planted with stakes 2-3 m high. All gardens are stoutly fenced.

Notes continued

Arabica coffee was introduced as a cash crop in the 1970s. By comparison with the Central Highland region, Clarke (1980) and Johnson (1988, 1990) have suggested that most work associated with coffee production has fallen upon women. Using data on household composition changes between 1978 and 1983, Johnson (1988, 108) has argued that, because of the major reliance on womens' labour in coffee production, the structure of more commercially successful households in the Gainj area changed to incorporate significantly more women. Clarke (1980, 183) also suggested that the expansion of coffee might be associated with a decrease in the plantings of marita pandanus, breadfruit and tulip. Some cocoa was planted before 1991 at lower altitudes, but had not been sold by that date. Minor quantities of fresh food and betel nut are sold at Aiome station.

Much of the bio-physical evidence collected in the 1960s and 1970s has been interpreted to mean that nutritional stress was a significant factor for the people using this system (Malcolm 1970; Buchbinder 1973; Wood 1980). In an important regional synthesis, Buchbinder (1977b) showed that adult stature and the nutritional status of children declined from east to west up the Simbai Valley, which she suggested was related to increasing population density, decreasing access to animal protein and possibly declining protein composition of the major root crops.

National Nutrition Survey 1982/83

91 families from 2 villages were asked in July 1983 what they had eaten the previous day. 95 per cent reported eating sweet potato, 42 per cent taro, 7 per cent banana, 2 per cent cassava, 1 per cent yam and none coconut, Chinese taro or sago. 21 per cent reported eating rice. 1 per cent reported eating fresh fish. This is similar to the crop pattern except for the relatively low consumption of banana.

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PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 9 **Subsystem No.** 1 **of** 1

Districts 4 Jimi **Subsystem Extent** 100 % **Area (sq km)** 268
Population 542 **Population density** 2 **persons/sq km** **Population absent** 6 **%**

System Summary

Located in the western part of the Schrader Range, in the lower Jimi Valley; and extending into Madang Province in the lower Kaironk and Aramia Valleys, and to the north of Sangapi station. Tall woody regrowth more than 15 years old is cut, dried and burnt. A few gardens are made in grassland. Two kinds of garden are made: sweet potato gardens usually dominated by that crop, and taro gardens containing other crops. Sweet potato and taro are the most important crops; banana is an important crop; other crops are cassava, Chinese taro and yam (D. alata). One planting is made before fallowing. Planting is by dibble, except in grassland gardens. Sweet potato gardens are made throughout the year. Taro gardens are cleared between May and September, and planted between August and November. Fruit and nut trees, both cultivated and wild, provide important foods. Hunting is important.

Extends across provincial border to System(s) 1318

Altitude range (m) 600-1600 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato, Taro (Colocasia)
STAPLES SUBDOMINANT	Banana
STAPLES PRESENT	Banana, Cassava, Chinese taro, Sweet potato, Taro (Colocasia), Yam (D. alata)
OTHER VEGETABLES	Bean (winged), Corn, Cucumber, Lowland pitpit, Pumpkin tips, Bottle gourd, Tulip
FRUITS	Pawpaw, Mango, Marita pandanus, 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	Very significant
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	None
HOUSEHOLD GARDENS	Minor

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 Animal skins	Minor
2 Coffee Arabica	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	Very significant
SMALL MOUNDS	None
MOUNDS	None
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	Significant
SEASONAL SEC'DARY CROPS	Significant

OTHER DOCUMENTATION

Survey description

This system was not visited (with the exception of a rapid walk in 1967 from Kaironk village in Madang Province, via Tsendiap village, to Koinambe mission in Western Highlands Province). The description is based on information in Jackson (1975), Clarke (1977) and Flanagan (1983), and from interviews at Sangapi and Dusin.

Boundary definition

In Western Highlands province, the northeastern boundary between this system and System 0910 was mainly determined with reference to Clarke (1977), and extrapolation on the 1600 m contour. The boundary with System 0908 to the east was based on the regrowth vegetation boundary (woody and short grass to the east, woody to the west) distinguished by Saunders (1993). In Madang Province, the boundaries between this system and System 1317 to the north were determined with reference to written accounts (Flanagan 1983, 49, 77; Jackson 1975, 33-39), interviews at Sangapi and foot traverses around Dusin mission. They approximately follow the 1600 m contour. The system was also distinguished from Madang System 1319 which occupies two isolated areas of land use to the west and south.

Notes

This is a very low intensity system of long fallow and a single planting, characterized by the combination of sweet potato and taro as most important crops. It is distinguished to the east from the higher altitude System 0910/1316, where the fallow period is shorter, and there is greater use of planted casuarina fallow and tillage. It also differs from System 0908/1315, where fallow periods are shorter and sweet potato is the single most important crop. In Madang Province, this system differs from the higher altitude System 1317, where the fallow period is shorter and sweet potato is the single most important crop. In the western part of the system in Madang Province around Sangapi station, some Wovan people, who mainly use this system, also have gardens between 1600 and 1800 m in System 1317 (Flanagan 1983, 77). Similarly, in Western Highlands Province, some people who occupy this system probably also use land above 1600 m in System 0910.

Gardens are made mostly between 600 m and 1600 m, but occasionally small, unfenced, ill-tended gardens are planted below 600 m. However, the zone below 600 m is more important for hunting and the collection of breadfruit and wild yam (Jackson 1975, 33). The lower altitude part of this system below 600 m is probably similar to System 1319, and to the description by Telban (1988a, b, c) for the Jimi flats, west of Ruti station in this province. The latter area was not mapped by Saunders (1993) as agriculturally used.

Although gardens are typically made in tall woody regrowth, there is minor use of grassland fallows. When Clarke (1977, 32-43) walked through the lower end of the Kaironk Valley, and up the Aramia River Valley to Sangapi in 1965, he noted that grassland covered up to one third of the area in the lower Kaironk but it was not cultivated. However, in 1966-68, at Yhal village (1350 m altitude), some sweet potato gardens were made in grassland (Jackson 1975, 43). After the grass was burnt, the soil was broken with black palm digging sticks and, more recently, with spades. Grassland cultivation of this kind was seen in 1991 in the valley below 1400 m at Dusin. The length of fallow periods under woody regrowth are problematic. According to Jackson (1975, 43), in the late 1960s at Yhal village in the east, fallow periods were 5-10 years or longer, with some less than 5 years. To the west, describing both this system and System 1317, Flanagan (1983, 74) estimated fallows at 10-15 years. Drawing on observations south of Dusin, fallow periods have been classified as typically longer than 15 years. Describing the lower Kaironk area, Clarke (1977, 33) noted that some fallows were composed of strikingly uniform growths of albizzia, a leguminous tree which people said enriched the soil.

One planting is made before fallowing (Jackson 1975, 42; Flanagan 1983, 74). Comparing techniques at Yhal with those used in the upper Kaironk Valley in System 1316, Jackson (1975, 42) noted the absence of a second planting of sweet potato after the harvesting of taro; the absence of irrigation and deep ditches around gardens; and the virtual absence of planted casuarina. Most gardens are fenced.

At Yhal village (1350 m altitude) in 1966-68, the two main crops were sweet potato and taro, with banana and Chinese taro important. Two garden types were made: sweet potato gardens containing mostly that crop, and taro gardens with taro and other crops (Jackson 1975, 40). Chinese taro was grown both in taro gardens and in separate patches (see also Clarke 1977, 40). In the lower Kaironk Valley in 1965, Clarke (1977, 40) noted that gardens (on very steep slopes) contained only a limited mixture of crops, compared to the mixed gardens of the Jimi Valley. Taro

Notes continued
and banana predominated in some gardens, and in foods offered to the patrol. In the Aramia Valley, Flanagan (1983, 77, 81, 83-4) reported gardens named after principal crops (taro and sweet potato the main ones, with taro gardens slightly outnumbering sweet potato gardens), with less intercropping in taro gardens.

According to both Jackson (1975, 40-41) and Flanagan (1983, 78-79), new taro gardens were cleared between May and September, and planted between August and November. Taro was consequently scarce around December (Jackson 1975, 41), when its place was taken either by Chinese taro, or in the Aramia Valley, by corn (Flanagan 1983, 55, 79). At Yhal, crops such as corn, cucumber and gourds were available only for a short period, determined by the planting schedule of new gardens. Sweet potato, unlike taro, was planted, and available, throughout the year.

Arboriculture is important. In 1965 in the lower Aramia Valley, marita pandanus and breadfruit plantings were plentiful, and betel nut was grown (Clarke 1977, 40). Flanagan (1983, 55) described marita pandanus as the most desired food in the Aramia Valley, and in 1991, villagers at Sangapi reported plantings of tulip and banana as well as marita pandanus at lower altitudes in the Aramia Valley. Jackson (1975, 40) noted the importance of breadfruit (seeds only eaten), mango, marita pandanus and Pangium edule in the lower Kaironk Valley. While most food is provided by agriculture, hunting is also a significant activity, especially for wild pig at lower altitudes (Jackson 1975, 38; Flanagan 1983, 58). For the lower Kaironk Valley, other animals eaten included more than 30 species of rodents and marsupials, a python, many kinds of lizards and bats, and at least 150 species of birds and their eggs (Jackson 1975). Collecting was also significant. This included insects and their larvae, the tubers of pueraria and wild yam, 40 kinds of wild fruits and nuts, some 30 kinds of leaves and vegetables, and about 10 kinds of fungi. The only fish eaten are eels.

Cash income is low, with no direct external road connection. In Madang Province, small amounts of Arabica coffee are grown, and sold at Mt Hagen after being flown from Sangapi or Dusin airstrips. There is some trade of animal skins and bird plumes up the Kaironk Valley. In Western Highlands Province, some coffee is flown from Tsendiap or Koinambe airstrips to Mt Hagen, and animal skins and bird plumes are traded to the Wahgi Valley.

National Nutrition Survey 1982/83
No villages from this system were included in the survey.

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PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 10 **Subsystem No.** 1 **of** 3

Districts 4 Jimi **Subsystem Extent** 50 % **Area (sq km)** 30
Population 1,108 **Population density** 37 **persons/sq km** **Population absent** 7 **%**

System Summary

A minor part of this system is located on the northern border with Madang Province on the Schrader Range northwest of Ginjinji village. The major part is located in Madang Province in the middle and upper Kaironk Valley, in the upper Asai Valley and in the basin at the head of the Simbai Valley. Three subsystems are distinguished, mainly on the basis of fallow type. For the entire system, sweet potato is the most important crop; taro and banana are important crops; other crops are Chinese taro, cassava, and yam (D. alata). In this subsystem, which covers approximately half the system, and occurs below 2000 m altitude, gardens are made in fallows of planted casuarina typically 8-15 years old. At clearing, many trees are only pollarded, and cut vegetation is dried and burnt. Two plantings are made before fallowing. Taro is commonly planted in separate gardens. An initial planting of taro is typically followed by a planting of sweet potato. Tillage is usual before planting, but small mounds are not formed. Pigs are let into gardens between crops. Household gardens are common. Most clearing and planting of new taro gardens occurs between May and September.

Extends across provincial border to System(s) 1316

Altitude range (m) 1500-2100 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	Banana, Taro (Colocasia)
STAPLES PRESENT	Banana, Cassava, Chinese taro, Sweet potato, Taro (Colocasia), Yam (D. alata)
OTHER VEGETABLES	Rungia, Sweet potato leaves, Taro leaves, Peanuts, Pumpkin tips, Choko tips, Corn, Bean (lablab), Highland pitpit, Lowland pitpit
FRUITS	Sugarcane, Marita pandanus, Passionfruit (yellow), Avocado
NUTS	Karuka (planted), Karuka (wild), Castanopsis, Elaeocarpus
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall woody regrowth
SHORT FALLOW	None
LONG FALLOW PERIOD	5-15 years
CROPPING PERIOD	2 plantings
R VALUE	17 (low)

GARDEN SEGREGATION

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

SOIL FERTILITY MAINTENANCE

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

CASH EARNING ACTIVITIES

1 Coffee Arabica	Significant
2 Cattle	Minor
3 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	Minor
Soil Management:	
PIGS PLACED IN GARDENS	Significant
BURN FALLOW VEGETATION	Very significant
TILLAGE	Very significant
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	Minor
Mounding Techniques:	
VERY SMALL MOUNDS	Very significant
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

The Western Highlands part of this system was not surveyed; information is taken from Clarke (1977). In Madang Province, one year residence at Simbai mission in 1962-63; and a brief visit in 1967, including a walk from Simbai station, through the Kaironk Valley, to the Jimi Valley (3 days). In July 1991, a foot traverse from Simbai to Kaironk village and return (2 days); and a foot traverse from Dusin mission to Simbai station, via the southeast side of Kaironk Valley through grasslands (1 day).

Boundary definition

In Western Highlands Province, the boundary with System 0908 west of Ginjinji village, and the boundary with System 0908 south of Ginjinji village, were both based on Clarke (1977). The boundary with System 0909 was extrapolated along the 1600 m contour. In Madang Province, the boundary between this System (1316) and System 1315 was determined from a road traverse between Simbai and Aiome, and extrapolated by reference to altitude. The boundary with System 1317 was determined from a foot traverse between Sangapi and Simbai stations (3 days), and by flights from Simbai to Sangapi, and from Dusin mission over the Upper Kaironk Valley.

Notes

This system is distinguished from System 0908/1315 to the southeast, east and north; and from System 1317 to the west, where there are no subsystems, the cropping period is shorter and there is only minor use of planted casuarina fallows. To the west, it differs from System 0909/1318, where the fallow period is longer, planted casuarina tree fallows are insignificant and tillage is not used.

This system is distinctive within the region for the use of a suite of intensive practices including extended cultivation periods, tillage and planted casuarina fallows. Despite prehistoric evidence of settlement in the area for at least 5000 years (S. Bulmer 1977), people claim that several major trends of agricultural change have only taken place during the past century. These include the introduction of pig husbandry, the use of ditches to keep pigs out of gardens and the planting of casuarina fallows. The husbandry of domesticated pigs is said to have been introduced only in the time of grandfathers of current adult men (Majnep and Bulmer 1977, 19). Using oral history, Riebe (1987, 216) has dated the first use of domesticated pigs at a festival in the upper Kaironk Valley to about 1845, with the first pig fences constructed at the end of the 19th century. By the 1960s, the ratio of pigs to people was approximately 1:1, though R. Bulmer (1977, 171-172) suggested that the number may have increased in the early 1970s. Three changes are said to have been associated with the introduction of pig husbandry, or to have occurred at about the same time. The tall cane grass, Miscanthus floridulus, is believed to have arrived from the Maring area in the neighbouring Simbai and Jimi Valleys (Majnep and Bulmer 1977, 23). Also, the large open grassland gardens of sweet potato, bounded by deep drains that also serve as pig ditches, are believed to have begun at the same time that pig husbandry was introduced (Bulmer 1982, 283). Thirdly, people in the Kaironk Valley also believe that systematic planting of casuarina only developed within the lifetime of either the fathers of living men (Bulmer 1982, 283), or perhaps their grandfathers (Majnep and Bulmer 1977, 23). Regular colonial contact only started in the 1950s, and was preceded both by steel tools, and by the arrival of crops such as Chinese taro, corn and cassava in the 1940s.

Planted casuarina fallows are the most distinctive feature of the landscape in this subsystem. Seedlings are transplanted into gardens soon after the planting of food crops. This practise was described in 1963 (Burnett 1963, 80). In gardens where casuarina is unlikely to do well, Majnep and Bulmer (1977, 195) have recorded that people will sometimes disperse the seed and transplant seedlings of the small tree Dodonaea viscosa. Planting of Dodonaea in grassland has also been reported from the neighbouring Jimi Valley (Manner 1976, 63, 141). In the upper Kaironk Valley, almost single species stands of Parasponia regrowth are also common, and are said to indicate fertile soils. Majnep and Bulmer (1977) have published good, dated photographs of agricultural landscapes in the upper Kaironk Valley and some neighbouring areas.

Two main kinds of garden are made, for sweet potato and for taro. There is also very minor use of irrigated taro gardens. Cultivation techniques for the two types of garden are generally similar: initial clearing and burning of grass under the casuarina; pollarding of the casuarina and felling of some; tillage of the soil (previously using sticks, but today mostly spades); and planting without any form of mounding. In 1965, Clarke (1966, 353; 1977, 54-55) observed that good fertile soils were sometimes not tilled before planting. There is some use of drainage in wetter areas, and plot dividers of casuarina and other wood also serve as soil retention devices on steeper slopes. When taro is planted in sweet potato gardens it is planted in separate areas. Two sweet potato crops in succession are common, and a planting of sweet potato frequently follows a taro crop.

Notes continued

Small irrigated taro gardens were described for the Asai Valley in 1962 (Burnett 1963). None were seen during this survey in 1991, though some were viewed in the Kaironk Valley during visits in the 1960s (Clarke 1977, 55). These were cleared and burnt in May, and strongly fenced. They were subdivided into many small plots and planted in June-July with a monocrop of taro (Burnett 1963, 82). There was some planting of aibika, Chinese taro and cassava along the borders. Water was brought, from up to 25 m away, to the garden in small ditches, and, in short parts, by bark flumes. The water is progressively restricted during the wet season, so that by the time of harvesting the garden is dry. Some owners reported an occasional second planting of taro before fallowing.

In 1963, Burnett (1963, 79) reported that while mixed gardens were planted throughout the year, there was 'a more or less seasonal' planting of sweet potato in November-December. In 1991, it was said that taro gardens were mainly cleared and planted between May and September. Some villagers indicated that sweet potato gardens were typically cleared between April and June. In July at the time of the survey, a very significant amount of garden preparation was underway.

Lack of road access limits income opportunities. Coffee is the major source of cash income, but has to be air freighted to Mt Hagen or Madang. Fresh food is sold at numerous small markets and Simbai station. Cattle are run on the grasslands in Subsystem 3. There is some alluvial gold mining in parts of the Simbai Valley.

National Nutrition Survey 1982/83

35 families from 2 villages were asked in June or July 1983 what they had eaten the previous day. 97 per cent reported eating sweet potato, 20 per cent taro, 9 per cent cassava, 6 per cent banana and none coconut, Chinese taro, sago or yam. 6 per cent reported eating rice. None reported eating fresh fish. This is similar to the crop pattern.

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PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 10 **Subsystem No.** 2 **of** 3

Districts 4 Jimi **Subsystem Extent** 25 %

System Summary

In this subsystem, which covers approximately one quarter of the system, gardens are made in fallows of tall woody regrowth at the forest edge, or in previously unused forest. Fallow periods are typically 10-20 years. The subsystem is mostly located at 2000 m altitude and above. Vegetation is cut, dried and burnt. One planting is made by dibble before fallowing. Sweet potato is usually the main crop planted.

Extends across provincial border to System(s) 1316

Altitude range (m) 1500-2100 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Cassava, Chinese taro, Sweet potato, Taro (Colocasia), Yam (D. alata)
OTHER VEGETABLES	Rungia, Sweet potato leaves, Taro leaves, Peanuts, Pumpkin tips, Choko tips, Corn, Bean (lablab), Highland pitpit, Lowland pitpit
FRUITS	Sugarcane, Marita pandanus, Passionfruit (yellow), Avocado
NUTS	Karuka (planted), Karuka (wild), Castanopsis, Elaeocarpus
NARCOTICS	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	Very 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	Significant
2 Cattle	Minor
3 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	Minor
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	Minor
Mounding Techniques:	
VERY SMALL MOUNDS	Very significant
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	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION

Notes

The forest edge in the Kaironk Valley is at about 2000 m altitude; in other valleys it may be lower. The gardens in this subsystem are made in the forest edge zone and thus usually above 2000 m. The woody succession component of fallows is outlined by Majnep and Bulmer (1977, 36), who have also summarised the altitudinal breaks in the Kaironk Valley, and described the main plants which appear in each zone. The forest zone is particularly important both for hunting and for harvesting wild karuka pandanus. At least up to the 1970s, there was a seasonal concentration of hunting in the period May to August (R. Bulmer 1977, 177). Wild karuka pandanus is reported to bear in the dry months between May and August (R. Bulmer 1977, 177). Karuka pandanus is occasionally planted by people (Majnep and Bulmer 1977, 36), but wild karuka pandanus is a more significant crop than planted karuka pandanus (Majnep and Bulmer 1977, 91-97). Other wild plants that are eaten are described by Bulmer (1964), and by Majnep and Bulmer (1977, 193-202; 1983). Many people in the most densely populated part of the upper Kaironk Valley also have land rights in the less populated valleys to the north and south (Majnep and Bulmer 1977, 32). To the north there are two areas of land use at the head of the Aunjang Valley (spelt Aunja on the 1:100,000 topographic map). These gardens are at relatively high altitude (2000-2400 m, according to Majnep and Bulmer (1977, 27-28)), and were first cleared only two generations ago. Some casual gardens are made by hunting parties in such valleys, for instance in the Aunja Valley by people from the Upper Asai (Burnett 1963, 80).

Gardens in this subsystem were not inspected (except at a distance from the valley floor). The description is based on interviews at Kaironk, and on information in Bulmer (1982) and other references. No information is available on the seasonality of planting. Most gardens are fenced.

PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 10 **Subsystem No.** 3 **of** 3

Districts 4 Jimi **Subsystem Extent** 25 %

System Summary

In this subsystem, which covers approximately one quarter of the system, gardens are made in short and tall (Miscanthus) grassland. Fallow periods are in the range 5-15 years, but typically less than 10 years. The grass is cut, dried and burnt. The soil is tilled before planting, but small mounds are not formed. Sweet potato is the most important crop. Two or more plantings are made before fallowing.

Extends across provincial border to System(s) 1316

Altitude range (m) 1500-2100 **Slope** Multiple classes

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Cassava, Chinese taro, Sweet potato, Taro (Colocasia), Yam (D. alata)
OTHER VEGETABLES	Rungia, Sweet potato leaves, Taro leaves, Peanuts, Pumpkin tips, Choko tips, Corn, Bean (lablab), Highland pitpit, Lowland pitpit
FRUITS	Sugarcane, Marita pandanus, Passionfruit (yellow), Avocado
NUTS	Karuka (planted), Karuka (wild), Castanopsis, Elaeocarpus
NARCOTICS	Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Short grass
SHORT FALLOW	None
LONG FALLOW PERIOD	5-15 years
CROPPING PERIOD	2 plantings
R VALUE	17 (low)

GARDEN SEGREGATION

GARDEN SEGREGATION	None
CROP SEGREGATION	Minor
CROP SEQUENCES	None
MIXED VEGETABLE GARDENS	None
HOUSEHOLD GARDENS	Very 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	Significant
2 Cattle	Minor
3 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	Minor
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	Significant
BURN FALLOW VEGETATION	Very significant
TILLAGE	Very significant
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	Minor
Mounding Techniques:	
VERY SMALL MOUNDS	Very significant
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	None
SEASONAL SEC'DARY CROPS	None

OTHER DOCUMENTATION

Notes

There is a marked difference between the vegetation on the northern and southern sides of the middle and upper Kaironk Valley, with extensive grasslands covering the latter. The southern slopes of the Kaironk Valley are believed by villagers to have always been covered in grass (Majnep and Bulmer 1977, 28). The grass is maintained by regular burning. Gardens made in the grassland are mainly planted with sweet potato. As noted in the general description in the Notes for Subsystem 1, the technique of making gardens in grassland is believed to have been adopted relatively recently. Cultivation periods appear to be irregular, and may be longer than in gardens made in casuarina fallows. The fallow periods are often shorter (Majnep and Bulmer 1977, 31). Gardens are fenced or surrounded by deep ditches. Deep ditches around gardens to exclude pigs are an adaptation to the lack of timber for fencing (Majnep and Bulmer 1977, 24). The ditches are made both by digging, and by directing water from streams into them in order to scour them deeper. No information is available on the seasonality of planting.

Cattle are run on the grasslands. On some ridgetops, their movement has dug deep grooves into the subsoil. When Clarke (1966, 352; 1977, 54-57) visited the upper Kaironk Valley in 1965, he considered that the extensive grasslands, and visible yellow clay subsoil on many slopes to be indicative of 'degradation and the presence of ecological pressure'.

PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 11 **Subsystem No.** 1 **of** 1

Districts 3 Wahgi **Subsystem Extent** 100 % **Area (sq km)** 126
Population 1,151 **Population density** 9 **persons/sq km** **Population absent** 3 **%**

System Summary

Located mainly below 1400 m on the southern fall of the Kubor Range, in river valleys to the north and west of Mt Au, and on the northern plateau of Mt Au, and extending into Chimbu Province on the southern plateau of Mt Au and the plateau around Mt Karimui. Gardens are cut from tall woody regrowth, typically more than 15 years old. After underbrushing, trees are cut, the vegetation cleared, dried and burnt. The first crop is usually planted by dibbling. Before a second planting of sweet potato, a short fallow may intervene. For a second planting, the soil is usually tilled and small mounds made. Sweet potato is the most important crop. Other crops are banana, taro, Chinese taro, cassava, yam (D. alata) and sago. Tree crops, particularly breadfruit (seeds only eaten), marita pandanus, tulip and Pangium edule are very important. Household gardens are common. Hunting is a significant activity.

Extends across provincial border to System(s) 1010

Altitude range (m) 900-1400 **Slope** Gentle (2-10 degrees)

CROPS

STAPLES DOMINANT	Sweet potato
STAPLES SUBDOMINANT	None
STAPLES PRESENT	Banana, Cassava, Chinese taro, Sago, Sweet potato, Taro (Colocasia), Yam (D. alata)
OTHER VEGETABLES	Aibika, Amaranthus spp., Corn, Highland pitpit, Kumu musong, Lowland pitpit, Pumpkin tips, Rungia, Tulip
FRUITS	Avocado, Marita pandanus, Pawpaw, Pineapple, Sugarcane
NUTS	Breadfruit, Okari, Pangium edule
NARCOTICS	Betel nut (lowland), Betel pepper (lowland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Tall woody regrowth
SHORT FALLOW	Minor
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	None
HOUSEHOLD GARDENS	Significant

SOIL FERTILITY MAINTENANCE

LEGUME ROTATION	Minor
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
2 Coffee Arabica	Minor
3 Fresh food	Minor

OTHER AGRONOMIC PRACTICES

Water Management:	
DRAINAGE	None
IRRIGATION	None
Soil Management:	
PIGS PLACED IN GARDENS	None
BURN FALLOW VEGETATION	Very significant
TILLAGE	Significant
MECHANIZATION	None
DEEP HOLING	None
MULCHING	None
SOIL RETENTION BARRIERS	None
Mounding Techniques:	
VERY SMALL MOUNDS	Significant
SMALL MOUNDS	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	None
SEASONAL SEC'DARY CROPS	Minor

OTHER DOCUMENTATION

Survey description

The Western Highlands Province part of this system was not visited. The description is based on information from the part of the system in Chimbu Province (System 1010). In Chimbu, most parts of the system were visited during 1980-82, with detailed information collected at Noru and Yuro villages (Hide with Goodbody and Gertru 1984). Further information was obtained from subsequent research (Groos and Hide 1989; Finlayson et al. 1991; McComb 1992). In June and November 1989, two visits (2 days each) to Karimui District, with foot traverses between Masi and Negabo villages, and between Boisamalu and Yuro villages.

Boundary definition

In this province, four areas of land use on the south fall of the Kubor Range, below 1400 m, were assigned to this system on the basis of altitude. In Chimbu Province, the northern boundary with System 1009 was based on visits to the Bomai Plateau, and to Dege DPI base camp and Nondri mission south of the Marigl Divide. The southern boundary with System 1012 was based on information from the Karimui Plateau and on a visit to Haia airstrip; the boundary was extrapolated along the 900 m altitude contour.

Notes

This is a mid-altitude system located between more intensive systems to the north in Western Highlands Province (System 0906) and in Chimbu Province (System 1009), and less intensive systems at lower altitudes to the south where sago is the staple (Chimbu Province System 1012). Although separated from the heavily populated highlands to the north by unpopulated, rugged terrain, the regions are linked by extensive trade routes requiring 1-3 days walking. The people living in the western part of this system in Western Highlands Province are linked westwards to the Kaimbi people of the eastern Nebilyer Valley and northwards to the Minj area (Nelson 1971, 35-36, 38). From the Bomai and Karimui Plateaux in Chimbu Province, there are links north to Gumine District and east into the Gimi region of Eastern Highlands Province. Since the 1960s, a significant number of informal settlers from the north of Chimbu Province have moved to the plateau near Karimui station.

Detailed agricultural information is only available for locations on the Karimui Plateau, and to a limited extent for the Bomai area. Information is absent or poor for other scattered locations, especially for those areas around, and to the west of, Mt Au in Western Highland Province.

It has been suggested that, until recently, sago was the major food crop for the Daribi speaking people of the Karimui Plateau (Wagner 1967, 5-6, 12-14), but this seems unlikely given the altitude of the plateau and the extent of secondary growth as shown by 1948 aerial photography (Hide 1984b, 19-22). Without question, however, there has been widespread adoption of more intensive cultivation practices since 1960. Instead of a single planting of sweet potato before long fallow, two plantings are now common. Whereas the first planting is typically made by dibbling, the second now usually involves tillage and planting in small mounds. Occasionally, more than two plantings occur. Between plantings, short fallows or a peanut rotation may occur (Hide with Goodbody and Gertru 1984, 207-209, 217-219; Finlayson et al. 1991, 70-71).

In 1980-82, fallow lengths were estimated at Yuro village as ranging from 10-34 years, with an average of about 17 years (Hide with Goodbody and Gertru 1984, 218). Analysis of soil fertility status during cultivation revealed significant losses during a single planting, associated with rainfall (Hide with Goodbody and Gertru 1984; Wood 1979).

Hunting is important, though it is unlikely to supply significant quantities of food to the daily diet (Hide, Pernetta and Senabe 1984). Although pig husbandry is extensive in terms of human effort, the pig to human ratio was 0.7:1 at one survey (Hide with Goodbody and Gertru 1984).

There is no road access to the main Highlands road network and all cash crops have to be transported by air. All sources of cash income are typically of minor importance. Income levels vary with access to regular air services, and sources of wage income (Groos and Hide 1989, 83-89). Ranked in approximate significance, income sources include Arabica coffee, fresh food sales, animal skins, fur and bird plumes, cardamom and chillies. The ranking fluctuates in relation to prices. Cardamom production from the region probably peaked in 1986 when the plantation near Karimui station produced 80 tonnes (Finlayson et al. 1991, 26). In 1993, smallholder production from Karimui District was estimated at only 2 tonnes of cardamom and 4 tonnes of chillies (Collett et al. 1994, 23). In 1987, 86 per cent of

Notes continued
households surveyed at three villages near Karimui grew coffee (averaging 0.033 ha per adult equivalent), while only one third grew cardamom (averaging 0.015 ha per adult equivalent) (Finlayson et al. 1991, 73). Fresh food is sold at station markets, such as Karimui and Bomai, and other smaller locations.

National Nutrition Survey 1982/83
55 families from 2 villages were asked in July 1983 what they had eaten the previous day. 100 per cent reported eating sweet potato, 4 per cent banana, 2 per cent Chinese taro, 2 per cent yam and none coconut, cassava, taro or sago. 2 per cent reported eating rice. None reported eating fresh fish. This is similar to the crop pattern.

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PROVINCE 9 Western Highlands **AGRICULTURAL SYSTEM No.** 12 **Subsystem No.** 1 **of** 1

Districts 5 Tambul **Subsystem Extent** 100 % **Area (sq km)** 31
Population 799 **Population density** 26 **persons/sq km** **Population absent** 16 **%**

System Summary

Located mainly in Southern Highlands Province in Ialibu Basin and on the southern and eastern flanks of Mt Giluwe, but including the lower Kaugel River Valley in Western Highlands Province. Miscanthus cane grass with low woody regrowth is the most common fallow type. Some cane grass and some tall woody regrowth fallows are also used. Fallow periods range from one to more than 30 years, but 5-15 years is the most common range. Sweet potato is the most important crop; other crops are banana, potato and taro. Fallow vegetation is cut, dried and burnt in heaps and mounds are formed without compost. Prior to the second and subsequent plantings, weeds and sweet potato vines are placed between the old mounds and covered with soil to form composted mounds. Usually up to six plantings are made before fallowing, but sometimes over 20 are made. After tall woody regrowth fallows, two plantings only are made. Plantings are commonly interspersed with short fallows of less than 12 months. Household gardens and pig husbandry are important.

Extends across provincial border to System(s) 0718

Altitude range (m) 1200-2400 **Slope** Gentle (2-10 degrees)

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	Passionfruit (yellow), Sugarcane
NUTS	Karuka (planted), Karuka (wild)
NARCOTICS	Betel pepper (highland), Tobacco

FALLOW & CROPPING PERIOD

FALLOW TYPE	Grass/woody regrowth
SHORT FALLOW	Very significant
LONG FALLOW PERIOD	5-15 years
CROPPING PERIOD	3-5 plantings
R VALUE	29 (low)

GARDEN SEGREGATION

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

The Western Highlands Province part of this system was not visited. In Southern Highlands Province, in May 1980, a traverse on the Mendi-Ialibu-Kagua road, with brief garden visits (1 day). In September 1980, a traverse on the Mt Hagen-Ialibu-Pangia road and some garden visits (1 day). In November 1990, traverses on the Mendi-Ialibu-Pangia and Ialibu-Kagua roads and numerous garden visits in four villages (2 days).

Boundary definition

The northern boundary with System 0904 was taken as the 2200 m contour. The northeast boundary with System 0902/0720 was determined from a road traverse from Togoba mission to Kaupena station and extrapolated southeast along the Kaugel River. In Southern Highlands Province, the boundaries with System 0721 were determined from a road traverse from Ialibu to Pangia; and interviews at Apenda village, Muli mission and in the Kagua area. The boundaries with System 0719 were determined from traverses on the Mendi-Kaupena, Lake Onim-Ialibu-Pangia and Ialibu-Kagua roads. Boundaries with System 0714 were determined from traverses on the Mendi-Kaupena and Ialibu-Kagua roads.

Notes

This system, where crops are planted in composted mounds, has been distinguished from Southern Highlands System 0714 to the south, where crops are planted in long drained beds; and from System 0720/0902 to the northeast, where they are planted in gridiron square beds. To the southeast, System 0721 is characterised by the use of some short woody regrowth fallows, fewer plantings and partial use of composted mounds. System 0719 is similar to this one, but it has been distinguished because only one planting is made before fallowing there. To the north, in the upper Kaugal Valley, composted mounds are used in System 0904, but cropping is usually continuous.

The system extends over an altitudinal range of 1200 m to 2400 m, but most people live and garden between 1800 m and 2200 m. Frost damage occurs every few years in the Ialibu Basin, but it is generally not as severe as at higher altitude locations in Southern Highlands and Enga Provinces.

When land is brought into cultivation from tall woody regrowth fallows, some separate gardens are made for taro, corn, rungia, oenanthe, cabbage and other vegetables. Wormsley (1978, 31) terms these 'bush gardens'. Household gardens are planted with a little sweet potato and sugarcane, beans, tobacco and occasionally banana (Wormsley 1978, 34). Wormsley (1978, 35) referred to a minor garden type he termed 'platform gardens'. These are planted on top of the foundations of destroyed pig houses, and pig excreta fertilises the crops. Taro, beans and cabbage are grown in them.

In the southern part of the system, land is cultivated for up to 30 years before long fallows. These plantings are commonly separated by shorter fallow periods, usually of less than 12 months (Burkins 1984, 100). Some casuarina trees are planted in fallow land. Chicken manure is very occasionally used to fertilise sweet potato gardens.

Ditches are used to exclude pigs from gardens and some internal garden drains are made (Wormsley 1978, 30). Occasionally, soil retention fences are made below sweet potato mounds on steep slopes. Mounds are typically 2-2.5 m, and occasionally up to 2.8 m, in diameter. Self-sown highland betel pepper is consumed with lowland betel nut, but was not used traditionally. Highland betel nut is now occasionally consumed, but was not previously used. Tobacco is planted near houses.

Some fresh food, including potato, is sold at Ialibu station, at Kaupena in the Kaugel Valley and at other roadside markets. The Kaupena area has reasonable access to Mt Hagen market, but most locations in the system have poor access for marketing fresh food. Coffee is grown in the Kaupena area, but there is very little coffee above 1800 m altitude.

About 20 ha of smallholder tea and a tea estate were established in the Kaupena area in the early 1970s. Some villagers produced tea for up to three years before abandoning it as a cash crop. Between 1978 and 1986, the Southern Highlands Rural Development Project rehabilitated tea estates and built a tea and coffee processing factory at Kaupena. Villagers produced and sold coffee and some cardamom, but no tea. The factory was closed in 1986 (Crittenden et al. 1988; Clark et al. 1990, 61-76).

National Nutrition Survey 1982/83
No villages from this system were included in the survey.

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4. AGRICULTURAL SYSTEMS: MAPS

The maps show the location of the Agricultural Systems identified in the Province and selected important characteristics of the systems. Where subsystems exist within an Agricultural System, the maps display information from the first subsystem only. Subsequent subsystem information is not displayed, but it is available in the text summaries. For crop combinations, cash income activities, population density and population absent, the maps show information for the entire system. A note in the key on the Agricultural Systems map lists the systems in which subsystems occur. Maps can be produced from computer files at any scale down to 1:500 000.

The following notes explain the classes used on the maps.

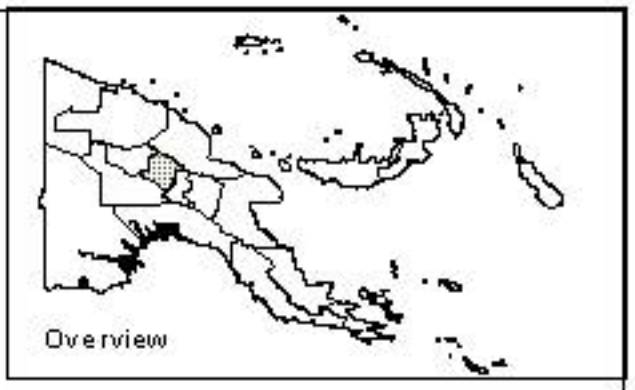
Map title	Notes
1. Agricultural Systems	Boundaries and identification numbers (eg. 1 = System 1401). See key for subsystem occurrences.
2. Fallow vegetation	The vegetation cleared from garden sites at the beginning of a new period of cultivation (8 classes).
3. Long fallow period	An estimate of the length of time land is left fallow before it is cultivated again (4 classes).
4. Number of plantings before fallow	The number of times staple crops are planted in the main gardens before those gardens are returned to a long fallow (5 classes).
5. Intensity of land use	Ratio of the cropping period (estimated from the number of plantings) to the length of the complete cultivation cycle, ie. cropping period plus fallow period (4 classes based on Ruthenberg's R factor)[1]. Very low: (R < 10) Low: (R = 10 - 32) Medium: (R = 33 - 66) High: (R > 66).
6. Crop combinations	Combinations of the most important (dominant staple) and important (subdominant staple) crops in this Province.

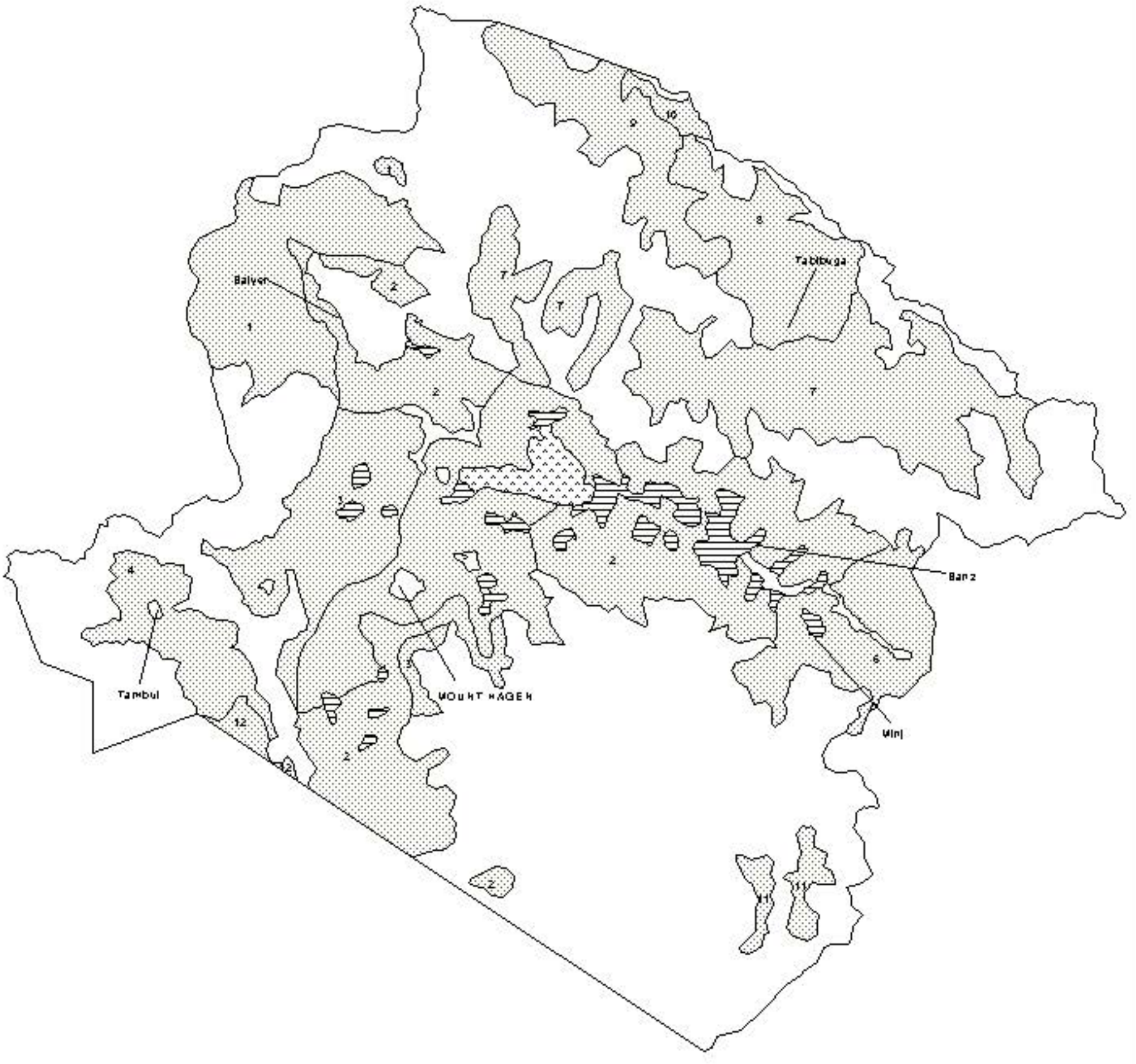
[1] R = (Number of years of cultivation x 100) / (Number of years of cultivation + Number of years of long fallow), (Ruthenberg 1980, 15)

Map title	Notes
7. Garden and crop segregation	Separation of crops into different gardens or into different plots within a garden (4 classes). A combination of Fields 28 and 29. For both fields, 'nil' and 'minor or insignificant' are defined as 'absent'; and 'significant' and 'very significant' as 'present'. Classes are: both absent = 'No segregation'; garden segregation present only = 'Garden segregation'; crop segregation present only = 'Crop segregation'; both present = 'Garden and crop segregation'.
8. Soil fertility maintenance	The presence or absence of the following: legume rotation, planted tree fallow, composting and mulching. For all features, 'nil' and 'minor or insignificant' are defined as 'absent'; and 'significant' and 'very significant' as 'present'.
9. Soil tillage	The use of tillage in the preparation of land for cultivation (4 classes).
10. Fallow clearing practices	A combination of the practices of burning fallow vegetation before planting, and cutting down fallows onto crops after planting. For both features, 'none' and 'minor or insignificant' are defined as 'absent'; and 'significant' and 'very significant' as 'present' (3 classes).
11. Soil mounds and beds	A combination of measures of significance for mounds and beds: Medium and large mounds are classed together as 'large mounds'. Square and long beds are classed together as 'beds'. Very small mounds are excluded. Absent = 'none' and 'minor or insignificant' for all mounds and beds. Present = 'significant' and 'very significant' for all mounds and beds (6 classes).
12. Water management techniques	The presence or absence of the following: drainage, irrigation and soil retention barriers. For all features, 'nil' and 'minor or insignificant' are defined as 'absent'; and 'significant' and 'very significant' as 'present' (4 classes).

Map title	Notes
13. Cash income activities	Combinations of cash earning activities specific to this province. For all activities, 'nil' and 'minor or insignificant' are defined as 'absent'; and 'significant' and 'very significant' as 'present'.
14. Seasonality of the main food crops	Whether the dominant staple (most important) crops and the subdominant staple (important) are planted at about the same time each year. 'Nil' and 'minor or insignificant' are defined as 'absent'; and 'significant' and 'very significant' as 'present' (2 classes).
15. Population density	Persons per square kilometre, based on the 1980 National Population Census and the area occupied by the System (6 classes). 'Not applicable' refers to Systems where there are no census points.
16. Population absent	The proportion of the 'total' population listed in the 1979 Provincial Data System Rural Community Register as being 'absent 6 months or more' from the Census Unit (5 classes). 'Not applicable' refers to Systems where either there are no census points, or where the PDS data do not distinguish between the 'total' and 'resident' populations.

WESTERN HIGHLANDS PROVINCE
Agricultural Systems





Agricultural system identified by number
Plantation
Swamp
Urban, Other

Subsystems are present in System 10

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Fallow vegetation

- Tall grass
- Grass and woody regrowth
- Short woody regrowth
- Tall woody regrowth

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Long fallow period

- Not significant
- 5 to 15 years
- Greater than 15 years

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Number of plantings before fallow

- 1 planting only
- 2 plantings
- 3 to 5 plantings
- 6 to 14 plantings
- More than 40 plantings

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Intensity of land use

Ratio of cropping period to fallow period

- Very low
- Low
- Medium
- High

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

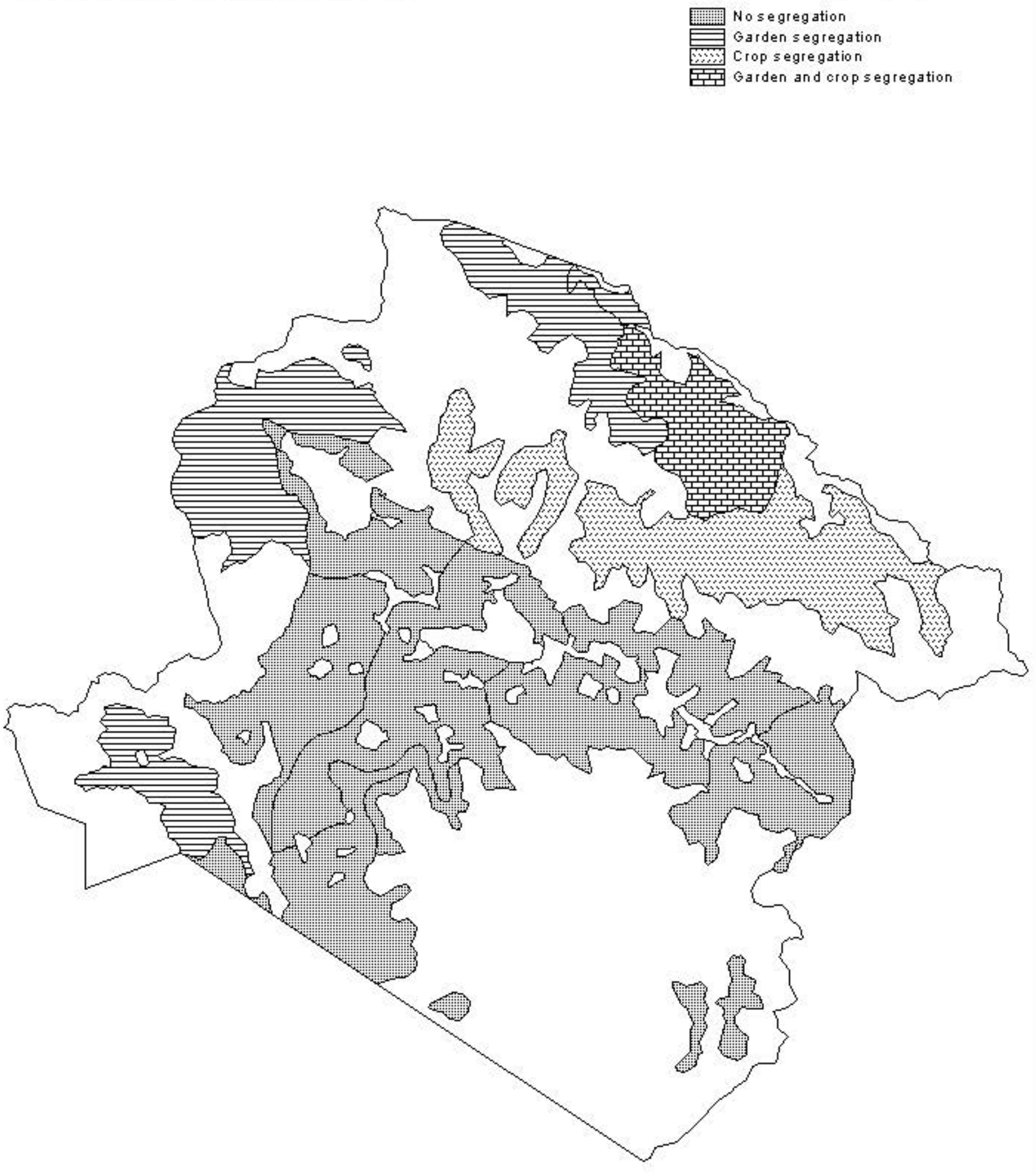
Crop combinations

	Most important crops	Important crops
	Sweet potato	None
	Sweet potato	Banana/taro
	Sweet potato/taro	Banana

10 0 10 20 Kilometers

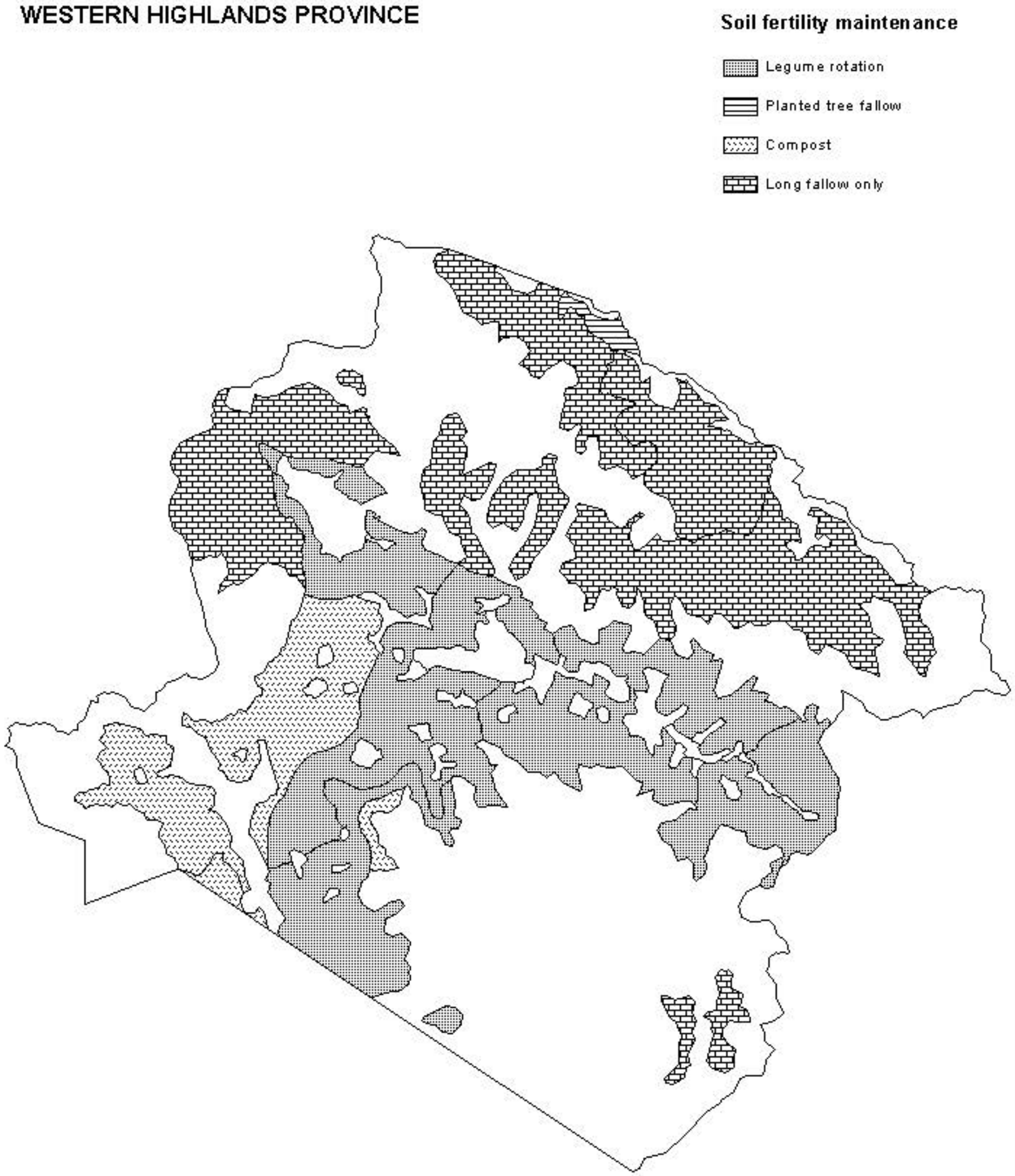
Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE



Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE



Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Soil tillage

None
Significant
Very significant

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Fallow clearing practices

Fallow cut amd not burnt
Fallow cut and burnt

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Soil mounds and beds

- Mounds and beds absent
- Mounds absent and beds present
- Small mounds present and beds absent
- Small mounds and beds present
- Large mounds present and beds absent

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Water management techniques

- No water control
- Drainage
- Drainage and soil retention barriers

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Cash income activities

- No significant cash income
- Arabica coffee
- Arabica coffee, fresh food
- Potato

10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Seasonality of main food crops

No seasonal planting
Planted seasonally

10 0 10 20 Kilometers

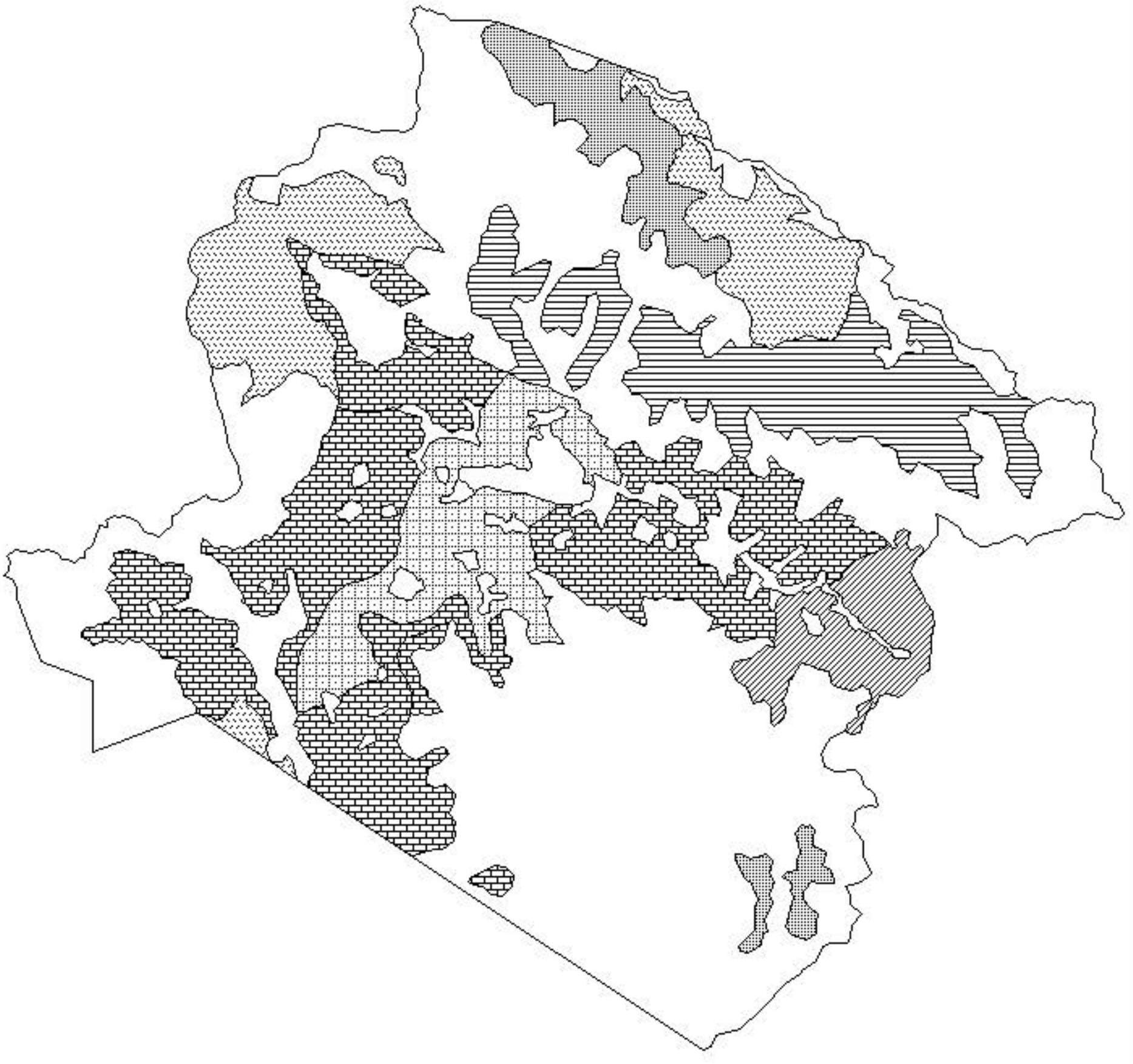
Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE

Population density

Persons per square kilometre

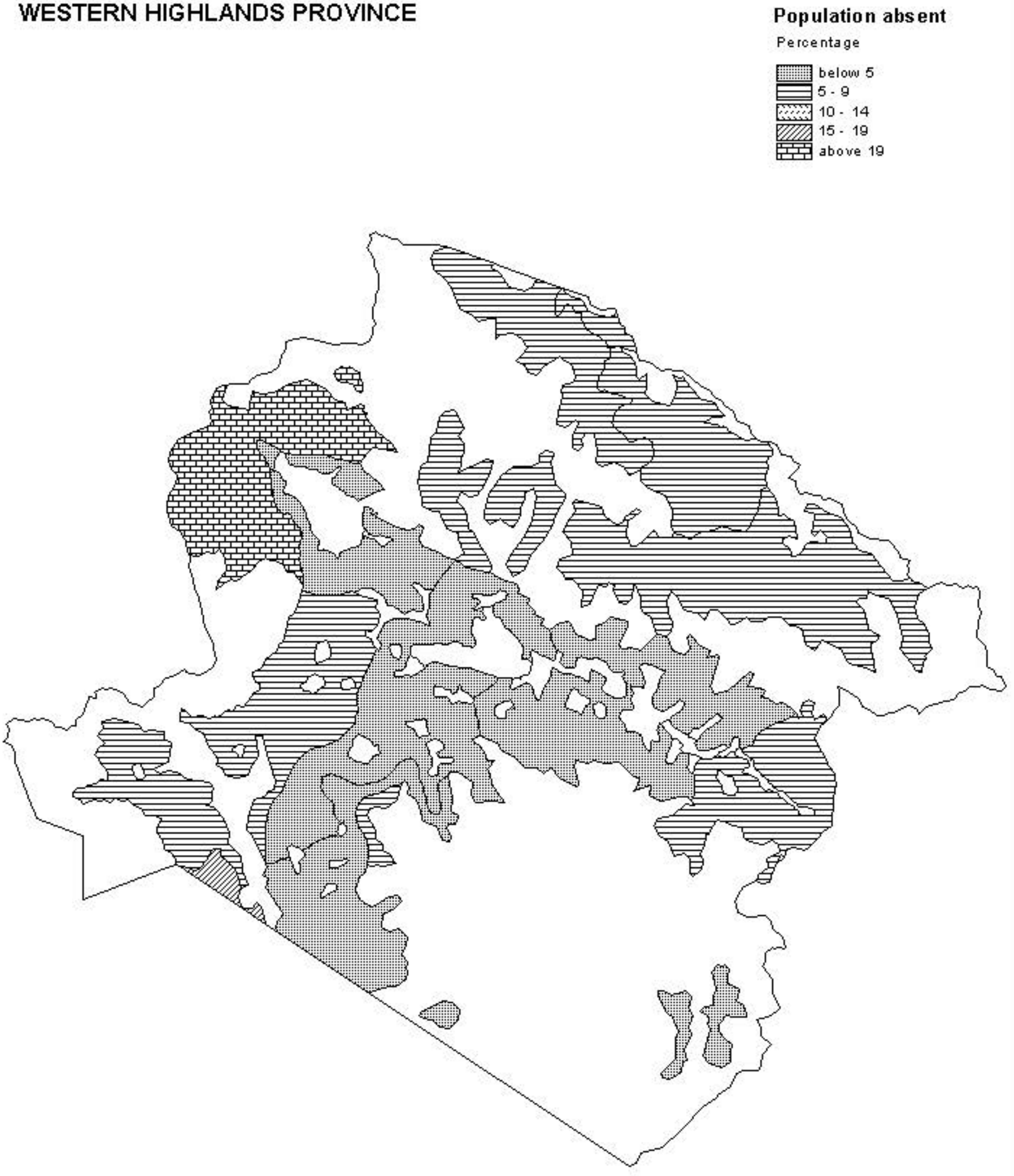
- below 10
- 10 - 24
- 25 - 49
- 50 - 74
- 75 - 99
- above 99



10 0 10 20 Kilometers

Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

WESTERN HIGHLANDS PROVINCE



Mapping Agricultural Systems Project, Human Geography, ANU; PNG DAL; Geography, UPNG, 1999

5. AGRICULTURAL SYSTEMS: DATA LISTING BY CODES

The following tables list all of the information contained within the database in coded form. The codes are contained in Section 2, Database Structure, Definitions and Codes.

AGRICULTURAL SYSTEM DATA LISTING - CODES **Province: 09 Western Highlands**

System	Sub sys	No. of subsys	Subsys extent	Same sys oth prov	Districts	Census Divisions
901	1	1	4		2	06-07
902	1	1	4	0720	1-2-3	02-03-04-05-06-08-09
903	1	1	4		1-2-5	01-04-14
904	1	1	4		5	14
905	1	1	4		1-2	01-02-03-05
906	1	1	4	1001	3	08-09
907	1	1	4	1332	2-4	05-11-12
908	1	1	4	1315	4	12-13
909	1	1	4	1318	4	13
910	1	3	2	1316	4	13
910	2	3	1	1316	4	13
910	3	3	1	1316	4	13
911	1	1	4	1010	3	10
912	1	1	4	0718	5	14

KEY

Subsys	Subsystem
Same sys oth prov	Same system in other province

AGRICULTURAL SYSTEM DATA LISTING - CODES **Province: 09 Western Highlands**

System	Sub	Area	Population			Altitude range m		Slope	Fallows		
	sys	km^2	Total	Abs	Den	Low	High		Veg	Sht	Per
901	1	434	12637	25	29	800	2000	4	4	1	2
902	1	1030	57498	5	56	1200	2000	2	2	3	2
903	1	380	27508	7	72	1800	2600	5	3	3	2
904	1	200	13412	9	67	2200	2700	2	2	3	0
905	1	508	52328	4	103	1400	2000	2	2	3	2
906	1	284	25995	6	92	1400	2000	5	2	3	2
907	1	780	18303	6	23	600	2200	5	4	0	2
908	1	299	8198	7	27	200	1900	3	5	0	2
909	1	268	542	6	2	600	1600	5	5	0	3
910	1	30	1108	7	37	1500	2100	5	5	0	2
910	2	0	0	0	0	1500	2100	5	5	0	3
910	3	0	0	0	0	1500	2100	5	1	0	2
911	1	126	1151	3	9	900	1400	2	5	1	3
912	1	31	799	16	26	1200	2400	2	3	3	2

KEY

Subsys Subsystem
Area km^2 Area of System

Population
Total Resident population 1980
Abs Absent population (%)
Den Population density (persons/km^2)

Fallows
Veg Type of Fallow vegetation
Sht Short fallows
Per Long fallow period

AGRICULTURAL SYSTEM DATA LISTING - CODES **Province: 09 Western Highlands**

System	Sub sys	Staple crops			Narcotic crops
		Most import	Important	Present	
901	1	11	00	02-04-05-11-13-14	1-3-5
902	1	11	00	02-04-11-13	5
903	1	11	00	02-08-11-13	5
904	1	11	00	08-11-13	5
905	1	11	00	02-11-13	5
906	1	11	00	02-04-11-13-14	3-5
907	1	11	00	02-04-05-11-13-14	2-5
908	1	11	02-13	02-04-05-11-13-14-15	2-4-5
909	1	11-13	02	02-04-05-11-13-14	2-5
910	1	11	02-13	02-04-05-11-13-14	5
910	2	11	00	02-04-05-11-13-14	5
910	3	11	00	02-04-05-11-13-14	5
911	1	11	00	02-04-05-09-11-13-14	2-4-5
912	1	11	00	02-08-11-13	3-5

KEY

Subsys Subsystem

AGRICULTURAL SYSTEM DATA LISTING - CODES **Province: 09 Western Highlands**

System	Sub sys	Vegetable crops	Fruit crops	Nut crops
901	1	01-02-03-05-10-13-19-21-22-23	08-09-11-12-13-15	01-08-09
902	1	02-03-05-09-13-18-19-21-22	08-12-13-15	08-09
903	1	03-05-06-09-13-18-22	15	08-09
904	1	02-03-06-09-13-21-22-32	15	08-09
905	1	02-03-05-09-13-18-19-21-22	08-12-13-15	08-09
906	1	02-03-05-06-09-13-19-21-22	08-12-15	08-09
907	1	01-02-03-09-13-15-21-22-23-33	08-12-15	01-08
908	1	01-08-09-10-13-15-16-21-22-23	07-08-12-13-15	01-08-09
909	1	05-09-10-16-21-34-23	12-07-08-15	01-11
910	1	22-29-30-19-21-08-09-04-13-16	15-08-11-01	08-09-03-14
910	2	22-29-30-19-21-08-09-04-13-16	15-08-11-01	08-09-03-14
910	3	22-29-30-19-21-08-09-04-13-16	15-08-11-01	08-09-03-14
911	1	01-02-09-13-15-16-21-22-23	01-08-12-13-15	01-10-11
912	1	03-06-07-09-13-17-18-21-22	11-15	08-09

KEY

Subsys Subsystem

AGRICULTURAL SYSTEM DATA LISTING - CODES **Province: 09 Western Highlands**

System	Sub	Segregation		Crop	Gard types		Soil fertility maintenance techniques						
	sys	Gar	Crp	Seq	Mix	H'ld	Leg	Tre	Com	Man	Isl	Sil	Fer
901	1	2	1	2	0	2	0	1	0	0	0	0	0
902	1	1	1	2	3	3	2	1	0	0	0	0	0
903	1	0	1	0	1	3	1	1	3	0	0	0	0
904	1	2	1	1	2	2	0	0	3	0	0	0	1
905	1	1	1	2	3	3	2	1	0	0	0	0	0
906	1	0	1	2	2	3	2	1	0	0	0	0	0
907	1	1	2	0	1	3	0	1	0	0	0	0	0
908	1	2	2	0	0	1	0	1	0	0	0	0	0
909	1	3	1	0	0	1	0	1	0	0	0	0	0
910	1	2	1	2	0	3	0	3	0	0	0	0	0
910	2	0	1	0	0	3	0	1	0	0	0	0	0
910	3	0	1	0	0	3	0	1	0	0	0	0	0
911	1	0	1	0	0	2	1	0	0	0	0	0	0
912	1	1	1	0	0	3	0	1	3	0	0	0	0

KEY

Subsys Subsystem

Segregation

Gar Garden

Crp Crop

Crop seq Crop sequences

Gard types **Garden types**

Mix Mixed vegetable gardens

H'ld Household gardens

Soil fertility maintenance techniques

Leg Legume rotation

Tre Planted tree fallow

Com Compost

Man Animal manure

Isl Island bed

Sil Silt from floods

Fer Inorganic fertilizer

AGRICULTURAL SYSTEM DATA LISTING - CODES Province: 09 Western Highlands

System	Sub sys	Management techniques											
		Water		Soil						Fallow		Other	
		Irr	Drn	Pig	Till	Hol	Bar	Mul	Mec	Brn	Cut	Fen	Stk
901	1	1	2	1	0	0	2	0	0	2	0	3	1
902	1	0	3	1	0	0	0	0	0	2	0	2	1
903	1	0	1	0	2	0	0	0	0	1	0	2	1
904	1	0	1	0	3	0	1	0	1	1	0	2	1
905	1	0	3	1	0	0	0	0	0	1	0	2	1
906	1	0	3	2	3	0	1	0	0	1	0	2	1
907	1	0	0	0	0	0	1	0	0	3	0	3	1
908	1	0	0	0	0	0	0	0	0	3	0	3	1
909	1	0	0	0	0	0	0	0	0	3	0	2	1
910	1	1	1	2	3	0	1	0	0	3	0	3	1
910	2	0	1	0	1	0	1	0	0	3	0	3	1
910	3	0	1	2	3	0	1	0	0	3	0	3	1
911	1	0	0	0	2	0	0	0	0	3	0	3	1
912	1	0	1	0	0	0	0	0	0	2	0	2	1

KEY

Subsys Subsystem

Management techniques

Water management

Irr Irrigation

Drn Drainage

Soil management

Pig Pigs placed in gardens

Till Tillage

Hol Deep holing (for yams)

Bar Soil retention

Mul Mulching

Mec Mechanized soil tillage

Fallow management

Brn Burning of cut vegetation

Cut Fallow cut onto crops

Other

Fen Fencing

Stk Staking of crops

AGRICULTURAL SYSTEM DATA LISTING - CODES **Province: 09 Western Highlands**

System	Sub sys	Management techniques						Crop planting seasonality		Cropping intensity	R value
		Soil mounds				Garden beds					
		Vsm	Sm	Md	Lge	Sq	Lg	Maj	Min		
901	1	3	1	0	0	0	0	1	2	2	17
902	1	0	0	0	0	3	1	0	1	3	29
903	1	0	0	2	2	1	0	0	0	4	50
904	1	1	0	1	3	0	1	0	0	6	100
905	1	0	0	0	0	3	1	0	1	4	50
906	1	1	3	0	0	3	1	0	1	4	50
907	1	3	0	0	0	0	0	2	2	1	9
908	1	3	0	0	0	0	0	2	2	1	9
909	1	3	0	0	0	0	0	2	2	1	5
910	1	3	0	0	0	0	0	2	2	2	17
910	2	3	0	0	0	0	0	0	0	1	5
910	3	3	0	0	0	0	0	0	0	2	17
911	1	2	2	0	0	0	0	0	1	2	9
912	1	0	0	3	0	0	0	0	0	3	29

KEY

Subsys Subsystem

Management techniques

Soil mounds

Vsm Very small
Sm Small
Md Medium
Lge Large

Garden beds

Sq Square
Lg Long

Crop planting seasonality

Maj Dominant
Min Other crops

AGRICULTURAL SYSTEM DATA LISTING - CODES Province: 09 Western Highlands

System	Sub sys	Cash income sources											
		An	Bet	Crd	Cat	Chi	Coc	Cnt	CfA	CfR	Crc	Fwd	Fsh
901	1	0	0	0	0	0	0	0	2	0	0	0	0
902	1	0	0	0	0	0	0	0	3	0	0	0	0
903	1	0	0	0	1	0	0	0	1	0	0	1	0
904	1	0	0	0	0	0	0	0	0	0	0	1	0
905	1	0	0	0	1	0	0	0	3	0	0	1	0
906	1	0	0	0	0	0	0	0	3	0	0	1	0
907	1	1	0	1	0	0	0	0	1	0	0	0	0
908	1	1	0	0	0	0	0	0	1	0	0	0	0
909	1	1	0	0	0	0	0	0	1	0	0	0	0
910	1	0	0	0	1	0	0	0	2	0	0	0	0
910	2	0	0	0	1	0	0	0	2	0	0	0	0
910	3	0	0	0	1	0	0	0	2	0	0	0	0
911	1	1	0	0	0	0	0	0	1	0	0	0	0
912	1	0	0	0	0	0	0	0	1	0	0	0	0

KEY

Subsys Subsystem

Cash Income Sources

An	Animal skins	Chi	Chillie	CfR	Coffee Robusta
Bet	Betel nut	Coc	Cocoa	Crc	Crocodile
Crd	Cardamom	Cnt	Coconut	Fwd	Firewood
Cat	Cattle	CfA	Coffee Arabica	Fsh	Fish

AGRICULTURAL SYSTEM DATA LISTING CODES

Province: 09 Western Highlands

System	Sub sys	Cash income sources										
		Fod	Op	Pot	Pyr	Ric	Rub	Shp	Tea	Tob	Ot1	Ot2
901	1	1	0	0	0	0	0	0	0	0	0	0
902	1	2	0	0	0	0	0	0	0	0	0	0
903	1	1	0	1	1	0	0	0	0	0	0	0
904	1	1	0	2	1	0	0	0	0	0	0	0
905	1	2	0	0	0	0	0	0	0	0	0	0
906	1	2	0	0	0	0	0	0	0	0	0	0
907	1	1	0	0	0	0	0	0	0	0	0	0
908	1	1	0	0	0	0	0	0	0	0	0	0
909	1	0	0	0	0	0	0	0	0	0	0	0
910	1	1	0	0	0	0	0	0	0	0	0	0
910	2	1	0	0	0	0	0	0	0	0	0	0
910	3	1	0	0	0	0	0	0	0	0	0	0
911	1	1	0	0	0	0	0	0	0	0	0	0
912	1	1	0	1	0	0	0	0	0	0	0	0

KEY

Subsys Subsystem

Cash Income Sources

Fod	Fresh food	Ric	Rice	Tob	Tobacco
Op	Oil Palm	Rub	Rubber	Ot1	Other 1
Pot	Potato	Shp	Sheep	Ot2	Other 2
Pyr	Pyrethrum	Tea	Tea		

AGRICULTURAL SYSTEM DATA LISTING - CODES **Province: 09 Western Highlands**

System	Sub sys	Survey 1				Survey 2				Survey 3			
		Date mth yr	Period yrs	Sv tp	Sv in	Date mth yr	Period yrs	Sv tp	Sv in	Date mth yr	Period yrs	Sv tp	Sv in
901	1	09 80	-	2	RMB	02 93	-	3	BJA	- -	-	-	
902	1	09 80	-	3	RMB	08 82	-	2	RMB	12 90	-	3	A/H
903	1	09 80	-	3	RMB	12 90	-	2	A/H	- -	-	-	
904	1	09 80	-	2	RMB	11 90	-	2	H/H	- -	-	-	
905	1	09 80	-	3	RMB	12 90	-	3	A/H	- -	-	-	
906	1	09 80	-	2	RMB	08 82	-	3	RMB	12 90	-	2	A/H
907	1	08 82	-	2	RMB	- -	-	-		- -	-	-	
908	1	08 82	-	3	RMB	12 90	-	2	A/H	07 91	-	4	BHL
909	1	- -	-	-		- -	-	-		- -	-	-	
910	1	07 91	-	3	HLN	- -	-	-		- -	-	-	
910	2	07 91	-	3	HLN	- -	-	-		- -	-	-	
910	3	07 91	-	3	HLN	- -	-	-		- -	-	-	
911	1	- -	1980-82	5	RLH	06 89	-	3	RMB	11 89	-	3	RMB
912	1	05 80	-	2	RMB	09 80	-	2	RMB	11 90	-	3	BKV

KEY

Subsys	Subsystem
Sv tp	Survey type
Sv in	Surveyor initials

A/H	B.J. Allen/ R.L. Hide
BHL	R.M. Bourke/R.L. Hide/M.P. Levett
BJA	B.J. Allen
BKV	R.M. Bourke/B. Konabe/A. Varvaliu
H/H	R.L. Hide/G.S. Humphreys
HLN	R.L. Hide/M.P. Levett/T. Nen
RLH	R.L. Hide
RMB	R.M. Bourke

6. LISTINGS OF RURAL VILLAGES (CENSUS UNITS) INDEXED TO AGRICULTURAL SYSTEMS

All rural village Census Units in the 1980 National Population Census which are locatable on either the 1980 or 1990 Census Maps are assigned to an Agricultural System. The village name, National Population Census identification codes (Province, District, Census Division, Census Unit), population and Agricultural System number for each village is held as a single record in a population database (AGPOP). District and Census Division codes for this Province are listed in Appendix A.2.

This section provides three different listings from that database of rural villages indexed by Agricultural Systems:

6.1 Rural villages listed in census order (District, Census Division).

6.2 Rural villages listed in alphabetical order.

6.3 Rural villages listed by Agricultural System number (alphabetically within agricultural systems) with PNGRIS Resource Mapping Unit (RMU) numbers.

Abbreviations used are:

Dist	District name and number (see Appendix A.2)
Div	Census Division number (see Appendix A.2)
Population	1980 National Population Census count of population in a Unit
RMU	Provincial Resource Mapping Unit number (PNGRIS)
System	Agricultural System number
Village	Census Unit name
Unit	Census Unit number

6.1 RURAL VILLAGES WITH AGRICULTURAL SYSTEM NUMBERS IN CENSUS ORDER
Province: 9 Western Highlands

	Village	Population	System
DISTRICT	1 Hagen Central		
Division	1 Hagen Central		
1	ANGA	510	0903
2	BEABERI	821	0905
3	KAGAMUGA	684	0905
4	GEBINA	1064	0905
5	KELUA 1	2111	0905
6	KELUA 2	1437	0905
7	KELTIGA	868	0905
8	KETIGA	1055	0905
9	KIK	1390	0905
10	KOGE	1210	0903
11	KOGLAMP	1345	0905
12	KOGMUL	1022	0903
13	KORABUG	551	0905
14	KUG	1214	0905
15	KUGURAMP	303	0905
16	KUMUNGA	1084	0903
17	KUNGALDI	1194	0905
18	KUNGUMA	990	0905
19	MINIMP	794	0903
20	MULGA	1167	0905
21	OGELBENG	560	0903
22	PALIMP	1939	0905
23	PITS	393	0903
24	PULGIMP	753	0903
25	PUNGAMINGA	605	0905
26	TEGA 1	1437	0905
27	TILING	1075	0905
28	TOGOBA 1	1186	0905
29	TOGOBA 2	748	0905
Division	2 Angalimp		
1	DOBINDOP	1600	0902
2	KAIP	1434	0902
3	KETIBAM	1026	0902
4	KETIBUNG	1127	0902
5	KILIGA 1	1857	0905
6	KILIGA 2	757	0905
7	KINDENG 2	1011	0902
8	KUJABUK	726	0902
9	ROGUMP	1274	0902
10	WUREP 1	801	0905
11	WUREP 2	1170	0905
Division	3 Nebilyer		
1	AGEGA	1061	0902
2	ALIMP	586	0902
3	AROWA	769	0905
4	DUMAGONA	1285	0905
5	KAILGE	724	0905
6	KOBUGA	528	0905
7	KONGMUL	453	0902
8	KONGRA	964	0905
9	KUGUMBAGA	1577	0902
10	KUMBIA	654	0905
11	MALDA	982	0902
12	OLK	697	0902
13	PABARABUK	1147	0902
14	PAPAKOLA	938	0902
15	PUGANJIBUK	858	0905
16	TEGA NO.2	1015	0905
17	WAIBIP	1110	0905
18	YUMBIGA	712	0905
19	WEST KAMBIA	1368	0902
DISTRICT	2 Hagen North		
Division	4 Mul		
1	ANGIGI	531	0903
2	BALK 1	357	0903
3	BALK 2	695	0903
4	BALK 3	543	0903
5	BUKAPENA	535	0903
6	EBUNGA	319	0903
7	ELIPUNGA	449	0903
8	KILIG	653	0903
9	KILIGA	363	0903
10	KIUMP	511	0903
11	KILIMP	375	0903
12	KOIBUGA 1	552	0903
13	KOIBUGA 2	625	0903
14	KOIBUGA 3	405	0903
15	KWINGA 1	365	0903
16	KWINGA 2	632	0903
17	KWINGA 3	397	0903
18	KWIP 1	317	0903
19	KWIP 2	473	0903
20	MABULGA 1	249	0902
21	MABULGA 2	383	0902
22	MABULGA 3	516	0902
23	MABULGA 4	517	0902
24	MURIP 1	477	0903
25	MURIP 2	635	0903
26	RUGU 1	684	0903
27	RUGU 2	437	0903
28	RUGU 3	456	0903
29	TONDOMON 1	424	0903
30	TONDOMON 2	426	0903
31	WARA 1	473	0903
32	WARA 2	473	0903
33	WUREP 1	436	0903
34	WUREP 2	654	0903
35	WUREP 3	401	0903
36	WUREP 4	441	0903
Division	5 Dei		
1	AMBUGA	745	0905
2	BUK 1	1103	0902
3	BUK 2	365	0902
4	BUK 3	291	0902
5	GUMANTS 1	735	0905
6	GUMANTS 2	1054	0905
7	KEIA	700	0907
8	KENEMBO 1	628	0905
9	KENEMBO 2	472	0905
10	KENEMBO 3	665	0905
11	KENEMBO 4	712	0905
12	KEREMANGA	622	0902
13	KETA	751	0905
14	KINJIBI	503	0902
15	KINJIBI 1	854	0902
16	KINTS 1	562	0905
17	KINTS 2	379	0905

6.1 RURAL VILLAGES WITH AGRICULTURAL SYSTEM NUMBERS IN CENSUS ORDER
Province: 9 Western Highlands

Village		Population	System
18	KOMOPANA 1&2	1090	0905
19	KONDAPINA	271	0905
20	KORALDUNG	581	0905
21	KOTNA 1	398	0905
22	KOTNA 2	706	0905
23	KUTINGA	504	0905
24	MALA 1	490	0905
25	MALA 2	389	0905
26	MALA 3	682	0905
27	MENJIM 1	322	0907
28	MENJIM 2	266	0907
29	MOGA	480	0905
30	MUGLAMP 1	710	0905
31	MUGLAMP 2	266	0905
32	NUNGA.1	791	0905
33	NUNGA 2	402	0905
34	NUNGA 3	735	0905
35	PALGI	681	0902
36	PENDA	742	0905
37	RANK	593	0907
38	RODLNA	814	0907
39	TIGI 1	545	0902
40	TIGI 2	370	0902
41	TIGI 3	1064	0902
42	TIGI 4	246	0902
Division	6 Baiyer		
1	GEGL	863	0902
2	IKI 1	871	0901
3	IKI 2	907	0901
4	JUGUNA	584	0902
5	KIMARIP 1	599	0902
6	KIMARIP 2	664	0902
7	KUL	514	0902
8	KULIMP	709	0901
9	LAGA 1	189	0901
10	LAGA 2	715	0901
11	LAGA 3	494	0901
12	MAINJIP 1	376	0902
13	MAINJIP 2	925	0902
14	MAINTS	1181	0902
15	MANKI	396	0901
16	PAKALIS 1	469	0901
17	PAKALIS 2	519	0901
18	TAIPIAGAMA	674	0901
20	TSIPIN-PANIA	344	0901
21	YARAMANDA	647	0901
Division	7 Lumusa		
1	LUMIS 1	844	0901
2	LUMIS 2	658	0901
3	LUMIS 3	948	0901
4	NEKIRAP 1	557	0901
5	NEKIRAP 2	551	0901
6	NEKIRAP 3	543	0901
7	PINYAPAIS 1	868	0901
8	PINYAPAIS 2	734	0901
DISTRICT	3 Wahgi		
Division	8 South Wahgi		
1	ALUA	830	0906
2	ANGAMIL	1239	0906
3	AVIAMP 1	1752	0902
4	AVIAMP 2	1060	0902
5	DANAL	1308	0906
6	DJEK	876	0906
7	GABINGAL	859	0906
8	KAMANG 1	1106	0906
9	KAMANG 2	1222	0906
10	KAUWI	1359	0902
11	KUBAGANG	1159	0902
12	KUGMAL	1005	0906
13	KUNGAR 1	1123	0902
14	KUNGAR 2	1286	0902
15	KUNGAR 3	624	0902
16	KURUMUL 1	1145	0902
17	KURUMUL 2	913	0902
18	NGUMBA TSENS	1191	0906
19	PUGAMIL	1304	0906
20	TISGMAL	1392	0906
21	TOMBIL 1	838	0906
22	TOMBIL 2	805	0906
23	TUMBA	892	0906
24	WARABUNG	575	0906
951	GAMAR	1002	0906
Division	9 North Wahgi		
1	BAMANA	1163	0906
2	BOLIMBA	976	0902
3	BUNOMWO	1562	0902
4	DOMIL	1193	0906
5	DUMBOLA	1168	0902
6	KABALKU	824	0902
7	KAMANG	828	0906
8	KENDU	1557	0902
9	KIMIL	1226	0902
10	KOMBULNO	1431	0906
11	KOSKAL 1	857	0902
12	KOSKAL 2	826	0902
13	KWIENA 1	898	0902
14	KWIENA 2	437	0902
15	MILEP 1	571	0902
16	MILEP 2	842	0906
17	MOLKA	2329	0902
18	MUNUMUL	1652	0906
19	NONDUGLE	1060	0906
20	NUMBAKORA	823	0902
21	ONLIT	758	0906
22	TALU	2001	0902
951	MOROMA RH	624	0906
Division	10 East Kambia		
1	AU	311	0911
2	MIRU	227	0911
3	OLATE	224	0911
4	WUSINGA	78	0911
5	YEU	311	0911
DISTRICT	4 Jimi		
Division	11 Upper Jimi		
1	BUBGILE	974	0907
2	BUBULSUNGA	920	0907
3	GEBBAL	379	0907
4	IAWARAMUL	867	0907

6.1 RURAL VILLAGES WITH AGRICULTURAL SYSTEM NUMBERS IN CENSUS ORDER
Province: 9 Western Highlands

	Village	Population	System
5	KAUNIMKUL	388	0907
6	KOL	1904	0907
7	KOSAP	308	0907
8	KURUNGA	200	0907
9	MAME	497	0907
10	MANTS	648	0907
11	MEGINPAL	481	0907
12	MONGGUM	877	0907
13	OLNA	1240	0907
14	OMUN	254	0907
Division	12 Middle Jimi		
1	KARAP	826	0907
2	KAUIL	499	0907
3	KORENDIU	1108	0907
4	KORIOM	456	0907
5	KWIBUN	747	0908
6	KWIOP	372	0908
7	MAEGMOL	256	0907
8	MAGIN	260	0907
9	MANEMP	549	0907
10	MOGINI	272	0907
11	ONGOMOL	510	0907
12	TABIBUGA	787	0908
13	TOLI	239	0907
14	TSENGA	525	0907
15	TSINGOROPA	565	0908
16	WUM	171	0907
Division	13 Lower Jimi		
1	BOKOPAI	564	0908
2	GINJINJI	363	0910
3	GONDOMBEN	169	0910
4	KANDAMBIAMP	508	0908
5	KOINAMBE	444	0908
6	KOMPIAI	819	0908
7	KUPENG	639	0908
8	KWIMA	1014	0908
9	MEREN	110	0909
10	TIMBUNKI	226	0909
11	TOGBAN	899	0908
12	TSARAP	302	0910
13	TSEMBANT	199	0908
14	TSENDIAP	206	0909
15	TSUWENKAI	350	0908
16	WAIM	274	0910
17	YIMBUGEMA	291	0908

	Village	Population	System
DISTRICT	5 Tambul		
Division	14 Tambul		
1	ALKENA 1	816	0904
2	ALKENA 2	325	0904
3	BONGA	675	0904
4	GIA	856	0904
5	GOROKA	359	0904
6	IAPAGUA 1	730	0904
7	IAPAGUA 2	428	0904
8	KABO	676	0904
9	KAGOP 1	673	0904
10	KAGOP 2	529	0904
11	KAMENDI	481	0904
12	KAMUGA 1	302	0903
13	KAMUGA 2	606	0903
14	KEREMUG	696	0903
15	KIRIPIA 1	371	0904
16	KIRIPIA 2	522	0904
17	KOMBUGA	450	0912
18	KOPINI	540	0904
19	KUMBAGABUG 1	639	0904
20	KUMBAGABUG 2	490	0904
21	LAIAGAM	573	0904
22	MALGI	502	0904
23	MALTAGA	598	0904
24	MARABUG	349	0912
25	MUGU	482	0903
26	MUNJIGA	213	0904
27	OPIABUG	454	0904
28	PAGAPENA	629	0904
29	PAIAGONA 1	485	0903
30	PAIAGONA 2	423	0903
31	PAIAGONA 3	264	0903
32	PALNUL	487	0904
33	PUGUMUNG	846	0904
34	TSINSIBAI 1	477	0903
35	TSINSIBAI 2	604	0903
36	TSINSIBAI 3	473	0903
37	TOMBA	607	0903

6.2 RURAL VILLAGES WITH AGRICULTURAL SYSTEM NUMBERS IN ALPHABETICAL ORDER
Province: 9 Western Highlands

Village	Dist	Div	Unit	System
AGEGA	1	3	1	0902
ALIMP	1	3	2	0902
ALKENA 1	5	14	1	0904
ALKENA 2	5	14	2	0904
ALUA	3	8	1	0906
AMBUGA	2	5	1	0905
ANGA	1	1	1	0903
ANGAMIL	3	8	2	0906
ANGIGI	2	4	1	0903
AROWA	1	3	3	0905
AU	3	10	1	0911
AVIAMP 1	3	8	3	0902
AVIAMP 2	3	8	4	0902
BALK 1	2	4	2	0903
BALK 2	2	4	3	0903
BALK 3	2	4	4	0903
BAMANA	3	9	1	0906
BEABERI	1	1	2	0905
BOKOPAI	4	13	1	0908
BOLIMBA	3	9	2	0902
BONGA	5	14	3	0904
BUBGILE	4	11	1	0907
BUBULSUNGA	4	11	2	0907
BUK 1	2	5	2	0902
BUK 2	2	5	3	0902
BUK 3	2	5	4	0902
BUKAPENA	2	4	5	0903
BUNOMWO	3	9	3	0902
DANAL	3	8	5	0906
DJEK	3	8	6	0906
DOBINDOP	1	2	1	0902
DOMIL	3	9	4	0906
DUMAGONA	1	3	4	0905
DUMBOLA	3	9	5	0902
EBUNGA	2	4	6	0903
ELIPUNGA	2	4	7	0903
GABINGAL	3	8	7	0906
GAMAR	3	8	951	0906
GEBBAL	4	11	3	0907
GEBINA	1	1	4	0905
GEGL	2	6	1	0902
GIA	5	14	4	0904
GINJINJI	4	13	2	0910
GONDOMBEN	4	13	3	0910
GOROKA	5	14	5	0904
GUMANTS 1	2	5	5	0905
GUMANTS 2	2	5	6	0905
IAPAGUA 1	5	14	6	0904
IAPAGUA 2	5	14	7	0904
IAWARAMUL	4	11	4	0907
IKI 1	2	6	2	0901
IKI 2	2	6	3	0901
JUGUNA	2	6	4	0902
KABALKU	3	9	6	0902
KABO	5	14	8	0904
KAGAMUGA	1	1	3	0905
KAGOP 1	5	14	9	0904
KAGOP 2	5	14	10	0904
KAILGE	1	3	5	0905
KAIP	1	2	2	0902
KAMANG	3	9	7	0906
KAMANG 1	3	8	8	0906
KAMANG 2	3	8	9	0906
KAMENDI	5	14	11	0904
KAMUGA 1	5	14	12	0903
KAMUGA 2	5	14	13	0903
KANDAMBIAMP	4	13	4	0908
KARAP	4	12	1	0907
KAUIL	4	12	2	0907
KAUNIMKUL	4	11	5	0907
KAUWI	3	8	10	0902
KEIA	2	5	7	0907
KELTIGA	1	1	7	0905
KELUA 1	1	1	5	0905
KELUA 2	1	1	6	0905
KENDU	3	9	8	0902
KENEMBO 1	2	5	8	0905
KENEMBO 2	2	5	9	0905
KENEMBO 3	2	5	10	0905
KENEMBO 4	2	5	11	0905
KEREMANGA	2	5	12	0902
KEREMUG	5	14	14	0903
KETA	2	5	13	0905
KETIBAM	1	2	3	0902
KETIBUNG	1	2	4	0902
KETIGA	1	1	8	0905
KIK	1	1	9	0905
KILIG	2	4	8	0903
KILIGA	2	4	9	0903
KILIGA 1	1	2	5	0905
KILIGA 2	1	2	6	0905
KILIMP	2	4	11	0903
KIMARIP 1	2	6	5	0902
KIMARIP 2	2	6	6	0902
KIMIL	3	9	9	0902
KINDENG 2	1	2	7	0902
KINJIBI	2	5	14	0902
KINJIBI 1	2	5	15	0902
KINTS 1	2	5	16	0905
KINTS 2	2	5	17	0905
KIRIPIA 1	5	14	15	0904
KIRIPIA 2	5	14	16	0904
KIUMP	2	4	10	0903
KOBUGA	1	3	6	0905
KOGE	1	1	10	0903
KOGLAMP	1	1	11	0905
KOGMUL	1	1	12	0903
KOIBUGA 1	2	4	12	0903
KOIBUGA 2	2	4	13	0903
KOIBUGA 3	2	4	14	0903
KOINAMBE	4	13	5	0908
KOL	4	11	6	0907
KOMBUGA	5	14	17	0912
KOMBULNO	3	9	10	0906

6.2 RURAL VILLAGES WITH AGRICULTURAL SYSTEM NUMBERS IN ALPHABETICAL ORDER
Province: 9 Western Highlands

Village	Dist	Div	Unit	System
KOMOPANA 1&2	2	5	18	0905
KOMPIAI	4	13	6	0908
KONDAPINA	2	5	19	0905
KONGMUL	1	3	7	0902
KONGRA	1	3	8	0905
KOPINI	5	14	18	0904
KORABUG	1	1	13	0905
KORALDUNG	2	5	20	0905
KORENDIU	4	12	3	0907
KORIOM	4	12	4	0907
KOSAP	4	11	7	0907
KOSKAL 1	3	9	11	0902
KOSKAL 2	3	9	12	0902
KOTNA 1	2	5	21	0905
KOTNA 2	2	5	22	0905
KUBAGANG	3	8	11	0902
KUG	1	1	14	0905
KUGMAL	3	8	12	0906
KUGUMBAGA	1	3	9	0902
KUGURAMP	1	1	15	0905
KUJABUK	1	2	8	0902
KUL	2	6	7	0902
KULIMP	2	6	8	0901
KUMBAGABUG 1	5	14	19	0904
KUMBAGABUG 2	5	14	20	0904
KUMBIA	1	3	10	0905
KUMUNGA	1	1	16	0903
KUNGALDI	1	1	17	0905
KUNGAR 1	3	8	13	0902
KUNGAR 2	3	8	14	0902
KUNGAR 3	3	8	15	0902
KUNGUMA	1	1	18	0905
KUPENG	4	13	7	0908
KURUMUL 1	3	8	16	0902
KURUMUL 2	3	8	17	0902
KURUNGA	4	11	8	0907
KUTINGA	2	5	23	0905
KWIBUN	4	12	5	0908
KWIENA 1	3	9	13	0902
KWIENA 2	3	9	14	0902
KWIMA	4	13	8	0908
KWINGA 1	2	4	15	0903
KWINGA 2	2	4	16	0903
KWINGA 3	2	4	17	0903
KWIOP	4	12	6	0908
KWIP 1	2	4	18	0903
KWIP 2	2	4	19	0903
LAGA 1	2	6	9	0901
LAGA 2	2	6	10	0901
LAGA 3	2	6	11	0901
LAIAGAM	5	14	21	0904
LUMIS 1	2	7	1	0901
LUMIS 2	2	7	2	0901
LUMIS 3	2	7	3	0901
MABULGA 1	2	4	20	0902
MABULGA 2	2	4	21	0902
MABULGA 3	2	4	22	0902
MABULGA 4	2	4	23	0902
MAEGMOL	4	12	7	0907
MAGIN	4	12	8	0907
MAINJIP 1	2	6	12	0902
MAINJIP 2	2	6	13	0902
MAINTS	2	6	14	0902
MALA 1	2	5	24	0905
MALA 2	2	5	25	0905
MALA 3	2	5	26	0905
MALDA	1	3	11	0902
MALGI	5	14	22	0904
MALTAGA	5	14	23	0904
MAME	4	11	9	0907
MANEMP	4	12	9	0907
MANKI	2	6	15	0901
MANTS	4	11	10	0907
MARABUG	5	14	24	0912
MEGINPAL	4	11	11	0907
MENJIM 1	2	5	27	0907
MENJIM 2	2	5	28	0907
MEREN	4	13	9	0909
MILEP 1	3	9	15	0902
MILEP 2	3	9	16	0906
MINIMP	1	1	19	0903
MIRU	3	10	2	0911
MOGA	2	5	29	0905
MOGINI	4	12	10	0907
MOLKA	3	9	17	0902
MONGGUM	4	11	12	0907
MOROMA RH	3	9	951	0906
MUGLAMP 1	2	5	30	0905
MUGLAMP 2	2	5	31	0905
MUGU	5	14	25	0903
MULGA	1	1	20	0905
MUNJIGA	5	14	26	0904
MUNUMUL	3	9	18	0906
MURIP 1	2	4	24	0903
MURIP 2	2	4	25	0903
NEKIRAP 1	2	7	4	0901
NEKIRAP 2	2	7	5	0901
NEKIRAP 3	2	7	6	0901
NGUMBA TSENS	3	8	18	0906
NONDUGLE	3	9	19	0906
NUMBAKORA	3	9	20	0902
NUNGA 2	2	5	33	0905
NUNGA 3	2	5	34	0905
NUNGA.1	2	5	32	0905
OGELBENG	1	1	21	0903
OLATE	3	10	3	0911
OLK	1	3	12	0902
OLNA	4	11	13	0907
OMUN	4	11	14	0907
ONGOMOL	4	12	11	0907
ONLIT	3	9	21	0906
OPIABUG	5	14	27	0904
PABARABUK	1	3	13	0902
PAGAPENA	5	14	28	0904
PAIAGONA 1	5	14	29	0903

6.2 RURAL VILLAGES WITH AGRICULTURAL SYSTEM NUMBERS IN ALPHABETICAL ORDER
Province: 9 Western Highlands

Village	Dist	Div	Unit	System
PAIAGONA 2	5	14	30	0903
PAIAGONA 3	5	14	31	0903
PAKALIS 1	2	6	16	0901
PAKALIS 2	2	6	17	0901
PALGI	2	5	35	0902
PALIMP	1	1	22	0905
PALNUL	5	14	32	0904
PAPAKOLA	1	3	14	0902
PENDA	2	5	36	0905
PINYAPAIS 1	2	7	7	0901
PINYAPAIS 2	2	7	8	0901
PITS	1	1	23	0903
PUGAMIL	3	8	19	0906
PUGANJIBUK	1	3	15	0905
PUGUMUNG	5	14	33	0904
PULGIMP	1	1	24	0903
PUNGAMINGA	1	1	25	0905
RANK	2	5	37	0907
RODLNA	2	5	38	0907
ROGUMP	1	2	9	0902
RUGU 1	2	4	26	0903
RUGU 2	2	4	27	0903
RUGU 3	2	4	28	0903
TABIBUGA	4	12	12	0908
TAIPIAGAMA	2	6	18	0901
TALU	3	9	22	0902
TEGA 1	1	1	26	0905
TEGA NO.2	1	3	16	0905
TIGI 1	2	5	39	0902
TIGI 2	2	5	40	0902
TILING	1	1	27	0905
TIMBUNKI	4	13	10	0909
TISGMAL	3	8	20	0906
TOGBAN	4	13	11	0908
TOGOBA 1	1	1	28	0905
TOGOBA 2	1	1	29	0905
TOLI	4	12	13	0907
TOMBA	5	14	37	0903
TOMBIL 1	3	8	21	0906
TOMBIL 2	3	8	22	0906
TONDOMON 1	2	4	29	0903
TONDOMON 2	2	4	30	0903
TSARAP	4	13	12	0910
TSEMBANT	4	13	13	0908
TSENDIAP	4	13	14	0909
TSENGA	4	12	14	0907
TSINGOROPA	4	12	15	0908
TSINSIBAI 1	5	14	34	0903
TSINSIBAI 2	5	14	35	0903
TSINSIBAI 3	5	14	36	0903
TSIPIN-PANIA	2	6	20	0901
TSUWENKAI	4	13	15	0908
TUMBA	3	8	23	0906
WAIBIP	1	3	17	0905
WAIM	4	13	16	0910
WARA 1	2	4	31	0903
WARA 2	2	4	32	0903
WARABUNG	3	8	24	0906
WEST KAMBIA	1	3	19	0902
WUM	4	12	16	0907
WUREP 1	1	2	10	0905
WUREP 1	2	4	33	0903
WUREP 2	1	2	11	0905
WUREP 2	2	4	34	0903
WUREP 3	2	4	35	0903
WUREP 4	2	4	36	0903
WUSINGA	3	10	4	0911
YARAMANDA	2	6	21	0901
YEU	3	10	5	0911
YIMBUGEMA	4	13	17	0908
YUMBIGA	1	3	18	0905

6.3 RURAL VILLAGES LISTED BY AGRICULTURAL SYSTEM Province: 9 Western Highlands

Village	Dist	Div	Unit	RMU
SYSTEM 0901				
IKI 1	2	6	2	41
IKI 2	2	6	3	41
KULIMP	2	6	8	42
LAGA 1	2	6	9	42
LAGA 2	2	6	10	42
LAGA 3	2	6	11	42
LUMIS 1	2	7	1	121
LUMIS 2	2	7	2	121
LUMIS 3	2	7	3	122
MANKI	2	6	15	41
NEKIRAP 1	2	7	4	122
NEKIRAP 2	2	7	5	121
NEKIRAP 3	2	7	6	122
PAKALIS 1	2	6	16	44
PAKALIS 2	2	6	17	44
PINYAPAIS 1	2	7	7	121
PINYAPAIS 2	2	7	8	121
TAIPIAGAMA	2	6	18	44
TSIPIN-PANIA	2	6	20	127
YARAMANDA	2	6	21	127
SYSTEM 0902				
AGEGA	1	3	1	50
ALIMP	1	3	2	50
AVIAMP 1	3	8	3	64
AVIAMP 2	3	8	4	64
BOLIMBA	3	9	2	60
BUK 1	2	5	2	52
BUK 2	2	5	3	51
BUK 3	2	5	4	23
BUNOMWO	3	9	3	59
DOBINDOP	1	2	1	54
DUMBOLA	3	9	5	59
GEGL	2	6	1	29
JUGUNA	2	6	4	44
KABALKU	3	9	6	60
KAIP	1	2	2	54
KAUWI	3	8	10	70
KENDU	3	9	8	59
KEREMANGA	2	5	12	59
KETIBAM	1	2	3	54
KETIBUNG	1	2	4	71
KIMARIP 1	2	6	5	43
KIMARIP 2	2	6	6	44
KIMIL	3	9	9	59
KINDENG 2	1	2	7	54
KINJIBI	2	5	14	59
KINJIBI 1	2	5	15	56
KONGMUL	1	3	7	50
KOSKAL 1	3	9	11	19
KOSKAL 2	3	9	12	60
KUBAGANG	3	8	11	64
KUGUMBAGA	1	3	9	50
KUJABUK	1	2	8	81
KUL	2	6	7	29
KUNGAR 1	3	8	13	64
KUNGAR 2	3	8	14	68
KUNGAR 3	3	8	15	66
KURUMUL 1	3	8	16	64
KURUMUL 2	3	8	17	64
KWIENA 1	3	9	13	19
KWIENA 2	3	9	14	19
MABULGA 1	2	4	20	47
MABULGA 2	2	4	21	47
MABULGA 3	2	4	22	47
MABULGA 4	2	4	23	47
MAINJIP 1	2	6	12	47
MAINJIP 2	2	6	13	43
MAINTS	2	6	14	43
MALDA	1	3	11	50
MILEP 1	3	9	15	61
MOLKA	3	9	17	60
NUMBAKORA	3	9	20	60
OLK	1	3	12	50
PABARABUK	1	3	13	103
PALGI	2	5	35	51
PAPAKOLA	1	3	14	103
ROGUMP	1	2	9	71
TALU	3	9	22	59
TIGI 1	2	5	39	43
TIGI 2	2	5	40	43
TIGI 3	2	5	41	51
TIGI 4	2	5	42	51
WEST KAMBIA	1	3	19	97
SYSTEM 0903				
ANGA	1	1	1	46
ANGIGI	2	4	1	50
BALK 1	2	4	2	46
BALK 2	2	4	3	46
BALK 3	2	4	4	46
BUKAPENA	2	4	5	46
EBUNGA	2	4	6	50
ELIPUNGA	2	4	7	47
KAMUGA 1	5	14	12	132
KAMUGA 2	5	14	13	132
KEREMUG	5	14	14	46
KILIG	2	4	8	46
KILIGA	2	4	9	46
KILIMP	2	4	11	46
KIUMP	2	4	10	46
KOGE	1	1	10	46
KOGMUL	1	1	12	50
KOIBUGA 1	2	4	12	47
KOIBUGA 2	2	4	13	50
KOIBUGA 3	2	4	14	50
KUMUNGA	1	1	16	50
KWINGA 1	2	4	15	46
KWINGA 2	2	4	16	46
KWINGA 3	2	4	17	47
KWIP 1	2	4	18	46
KWIP 2	2	4	19	46
MINIMP	1	1	19	46
MUGU	5	14	25	46
MURIP 1	2	4	24	50
MURIP 2	2	4	25	46
OGELBENG	1	1	21	50
PAIAGONA 1	5	14	29	46
PAIAGONA 2	5	14	30	46
PAIAGONA 3	5	14	31	46
PITS	1	1	23	46

6.3 RURAL VILLAGES LISTED BY AGRICULTURAL SYSTEM **Province: 9 Western Highlands**

Village	Dist	Div	Unit	RMU
PULGIMP	1	1	24	50
RUGU 1	2	4	26	47
RUGU 2	2	4	27	47
RUGU 3	2	4	28	47
TOMBA	5	14	37	132
TONDOMON 1	2	4	29	46
TONDOMON 2	2	4	30	46
TSINSIBAI 1	5	14	34	46
TSINSIBAI 2	5	14	35	46
TSINSIBAI 3	5	14	36	46
WARA 1	2	4	31	46
WARA 2	2	4	32	46
WUREP 1	2	4	33	46
WUREP 2	2	4	34	46
WUREP 3	2	4	35	46
WUREP 4	2	4	36	46
SYSTEM 0904				
ALKENA 1	5	14	1	111
ALKENA 2	5	14	2	111
BONGA	5	14	3	109
GIA	5	14	4	112
GOROKA	5	14	5	109
IAPAGUA 1	5	14	6	111
IAPAGUA 2	5	14	7	111
KABO	5	14	8	112
KAGOP 1	5	14	9	111
KAGOP 2	5	14	10	112
KAMENDI	5	14	11	109
KIRIPIA 1	5	14	15	112
KIRIPIA 2	5	14	16	112
KOPINI	5	14	18	111
KUMBAGABUG 1	5	14	19	111
KUMBAGABUG 2	5	14	20	111
LAIAGAM	5	14	21	112
MALGI	5	14	22	112
MALTAGA	5	14	23	111
MUNJIGA	5	14	26	111
OPIABUG	5	14	27	112
PAGAPENA	5	14	28	109
PALNUL	5	14	32	111
PUGUMUNG	5	14	33	111
SYSTEM 0905				
AMBUGA	2	5	1	26
AROWA	1	3	3	50
BEABERI	1	1	2	50
DUMAGONA	1	3	4	50
GEBINA	1	1	4	50
GUMANTS 1	2	5	5	54
GUMANTS 2	2	5	6	54
KAGAMUGA	1	1	3	54
KAILGE	1	3	5	50
KELTIGA	1	1	7	50
KELUA 1	1	1	5	50
KELUA 2	1	1	6	50
KENEMBO 1	2	5	8	54
KENEMBO 2	2	5	9	53
KENEMBO 3	2	5	10	53
KENEMBO 4	2	5	11	54
KETA	2	5	13	54
KETIGA	1	1	8	54
KIK	1	1	9	50
KILIGA 1	1	2	5	54
KILIGA 2	1	2	6	54
KINTS 1	2	5	16	54
KINTS 2	2	5	17	54
KOBUGA	1	3	6	50
KOGLAMP	1	1	11	50
KOMOPANA 1&2	2	5	18	52
KONDAPINA	2	5	19	59
KONGRA	1	3	8	50
KORABUG	1	1	13	50
KORALDUNG	2	5	20	54
KOTNA 1	2	5	21	26
KOTNA 2	2	5	22	26
KUG	1	1	14	50
KUGURAMP	1	1	15	50
KUMBIA	1	3	10	50
KUNGALDI	1	1	17	118
KUNGUMA	1	1	18	118
KUTINGA	2	5	23	56
MALA 1	2	5	24	26
MALA 2	2	5	25	26
MALA 3	2	5	26	26
MOGA	2	5	29	100
MUGLAMP 1	2	5	30	50
MUGLAMP 2	2	5	31	50
MULGA	1	1	20	46
NUNGA 2	2	5	33	26
NUNGA 3	2	5	34	26
NUNGA.1	2	5	32	26
PALIMP	1	1	22	54
PENDA	2	5	36	56
PUGANJIBUK	1	3	15	50
PUNGAMINGA	1	1	25	106
TEGA 1	1	1	26	50
TEGA NO.2	1	3	16	50
TILING	1	1	27	54
TOGOBA 1	1	1	28	50
TOGOBA 2	1	1	29	50
WAIBIP	1	3	17	50
WUREP 1	1	2	10	101
WUREP 2	1	2	11	101
YUMBIGA	1	3	18	50
SYSTEM 0906				
ALUA	3	8	1	66
ANGAMIL	3	8	2	64
BAMANA	3	9	1	62
DANAL	3	8	5	65
DJEK	3	8	6	67
DOMIL	3	9	4	60
GABINGAL	3	8	7	64
GAMAR	3	8	951	66
KAMANG	3	9	7	62
KAMANG 1	3	8	8	72
KAMANG 2	3	8	9	66
KOMBULNO	3	9	10	62
KUGMAL	3	8	12	65
MILEP 2	3	9	16	62
MOROMA RH	3	9	951	62

6.3 RURAL VILLAGES LISTED BY AGRICULTURAL SYSTEM Province: 9 Western Highlands

Village	Dist	Div	Unit	RMU
MUNUMUL	3	9	18	61
NGUMBA TSENS	3	8	18	66
NONDUGLE	3	9	19	62
ONLIT	3	9	21	62
PUGAMIL	3	8	19	65
TISGMAL	3	8	20	65
TOMBIL 1	3	8	21	64
TOMBIL 2	3	8	22	64
TUMBA	3	8	23	66
WARABUNG	3	8	24	66
SYSTEM 0907				
BUBGILE	4	11	1	22
BUBULSUNGA	4	11	2	22
GEBBAL	4	11	3	22
IAWARAMUL	4	11	4	22
KARAP	4	12	1	22
KAUIL	4	12	2	22
KAUNIMKUL	4	11	5	22
KEIA	2	5	7	27
KOL	4	11	6	22
KORENDIU	4	12	3	22
KORIOM	4	12	4	22
KOSAP	4	11	7	22
KURUNGA	4	11	8	22
MAEGMOL	4	12	7	32
MAGIN	4	12	8	22
MAME	4	11	9	22
MANEMP	4	12	9	22
MANTS	4	11	10	22
MEGINPAL	4	11	11	22
MENJIM 1	2	5	27	37
MENJIM 2	2	5	28	32
MOGINI	4	12	10	22
MONGGUM	4	11	12	23
OLNA	4	11	13	22
OMUN	4	11	14	22
ONGOMOL	4	12	11	22
RANK	2	5	37	28
RODLNA	2	5	38	28
TOLI	4	12	13	22
TSENGA	4	12	14	35
WUM	4	12	16	32

Village	Dist	Div	Unit	RMU
SYSTEM 0908				
BOKOPAI	4	13	1	6
KANDAMBIAMP	4	13	4	6
KOINAMBE	4	13	5	4
KOMPIAI	4	13	6	4
KUPENG	4	13	7	12
KWIBUN	4	12	5	22
KWIMA	4	13	8	12
KWIOP	4	12	6	18
TABIBUGA	4	12	12	22
TOGBAN	4	13	11	18
TSEMBANT	4	13	13	6
TSINGOROPA	4	12	15	22
TSUWENKAI	4	13	15	6
YIMBUGEMA	4	13	17	4
SYSTEM 0909				
MEREN	4	13	9	4
TIMBUNKI	4	13	10	34
TSENDIAP	4	13	14	5
SYSTEM 0910				
GINJINJI	4	13	2	7
GONDOMBEN	4	13	3	6
TSARAP	4	13	12	6
WAIM	4	13	16	6
SYSTEM 0911				
AU	3	10	1	92
MIRU	3	10	2	89
OLATE	3	10	3	94
WUSINGA	3	10	4	89
YEU	3	10	5	94
SYSTEM 0912				
KOMBUGA	5	14	17	112
MARABUG	5	14	24	109

APPENDIX A.1

NATIONAL POPULATION CENSUS PROVINCIAL CODES

Province	Abbreviation	Code
Western	WES	01
Gulf	GUL	02
Central	CEN	03
National Capital District	NCD	04
Milne Bay	MBP	05
Oro (Northern)	ORO	06
Southern Highlands	SHP	07
Enga	ENG	08
Western Highlands	WHP	09
Simbu (Chimbu)	SIM	10
Eastern Highlands	EHP	11
Morobe	MOR	12
Madang	MAD	13
East Sepik	ESP	14
West Sepik (Sandaun)	WSP	15
Manus	MAN	16
New Ireland	NIP	17
East New Britain	ENB	18
West New Britain	WNB	19
Bougainville	NSP	20

APPENDIX A.2

NATIONAL POPULATION CENSUS CODES FOR DISTRICTS AND CENSUS DIVISIONS, WESTERN HIGHLANDS PROVINCE[1]

Code	Division
01	**HAGEN CENTRAL**
01	HAGEN CENTRAL
02	ANGALIMP
03	NEBILYER
02	**HAGEN NORTH**
04	MUL
05	DEI
06	BAIYER
07	LUMUSA
03	**WAHGI**
08	SOUTH WAHGI
09	NORTH WAHGI
10	EAST KAMBIA
04	**JIMI**
11	UPPER JIMI
12	MIDDLE JIMI
13	LOWER JIMI
05	**TAMBUL**
14	TAMBUL

[1] The Census Division names and codes are from the 1980 National Population Census. However, because the district definitions in some provinces changed between the 1980 and 1990 censuses, and because districts are important for provincial administrative purposes, the district names and codes are from the 1990 National Population Census. Some provinces have further changed district definitions since 1990 but these are not shown.

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