An overview of edible fruit and nuts in Papua New Guinea

R. Michael Bourke
Department of Human Geography
Research School of Pacific and Asian Studies
The Australian National University
Canberra
Email: mike.bourke@anu.edu.au

Abstract

This paper provides an overview of what is known about edible fruit and nuts in Papua New Guinea (PNG). Firstly, a case is made for why there needs to be more effort on research and development on fruit and nuts in PNG, focusing on both the domestic and overseas markets. A broad overview is given on current knowledge about fruit and nuts, including the species grown, where they grow, their altitudinal range, the population growing each species and number of trees per household. Aspects of production, consumption and marketing that are reviewed include crop agronomy, pest and disease problems, production levels, changes over time, general marketing constraints, consumption and consumer demand. Lastly, some main papers that review fruit and nut species in PNG are listed.

Introduction

This paper provides an overview of what is known about edible fruit and nuts in Papua New Guinea (PNG). The focus is on information that development workers, researchers and planners can readily access, not on knowledge by villagers, which is extensive, but is not readily accessible to outsiders. The paper does not give a summary of all existing information nor claim to be comprehensive. There are some topics where we have a reasonable amount of available information and others where we have very little. Firstly, I want to make a case for greater research and development efforts on fruit and nuts in PNG.

Why more research and development effort on fruit and nuts in PNG?

There are a number of reasons why more effort needs to be directed at promoting fruit and nut production and sales within PNG and to overseas markets. I first consider the domestic market.

The domestic market within PNG

Production of fruit and nuts for sale within PNG is already a significant activity for many people. I suggest that this should be expanded for the following reasons:

1. There is a significant urban and non-village rural population and these people buy most of their food needs, either from locally grown or imported sources. Based on a growth rate of 2.7% per year, the total population of PNG will be six million in 2006 or 2007. Of these, 81% are rural villagers, 13% live in urban centres and 6% live in 'rural non-village' locations, that is, in small stations, missions, plantations, schools, logging camps and mines. Thus there are a significant number of non-villagers (about one million people).

2. Domestically marketed food already provides significant amounts of cash income to rural villagers. More rural Papua New Guineans live in households where income is derived from selling food than from any other activity (Allen et al. 2001).

3. Imports of grains and other food into PNG are static or declining because of the low exchange rate of the PNG kina against the United States dollar. This has created greater opportunities for people to grow and sell food within PNG and villagers have responded to increased demand by producing more locally grown food.

4. There are marked ecological differences within PNG, especially between the highlands and lowlands, but also within the lowlands and within the highlands. This creates many opportunities for selling fresh food within PNG.

5. Most fruit in the highlands is not very sweet, for example, purple passionfruit, tamarillo (tree tomato), pineapple, pawpaw and strawberry. Highlanders like sweet foods and this explains why production of one fruit that is very sweet, *suga prut* (*Passiflora ligularis*), has expanded greatly over the past 30 years.

6. There is high demand for snack foods, especially in urban centres and in the highlands. The indigenous nuts can be processed and sold as snack foods.

7. Several of the indigenous edible nuts have been successfully developed commercially in Vanuatu and in Solomon Islands. *Galip* (*Canarium* spp.) is sold as

a processed snack food in Honiara and Port Vila. Sea almond or *talis* (*Terminalia catappa*) and *pao* (*Barringtonia* spp.) are also sold in Port Vila (Long Wah 1996).

Export markets

There is considerable potential for production of indigenous nuts to overseas markets. The case for much greater effort into developing these products is based on:

1. The current crop base for exports is narrow and is limited to several tree crops and a few spice crops. This can create economic instability as the prices of oil palm, coffee, cocoa and copra change over time. A broader economic base provides a greater buffer from such variation.

2. There is currently a strong focus on oil palm in PNG. However, oil palm is dependent on extensive areas of land and the conversion of high diversity tropical forest into very low diversity oil palm plantations. High value products, including some of the indigenous nuts, do not demand so much land and hence help conserve forests.

3. Land for further expansion of large-scale agriculture in PNG is limited. Currently, one-quarter of the total land mass of PNG (460,000 km^2) is used for agriculture (including fallows). Most of the remainder is too mountainous, swampy, or too high for crop production. Future expansion will have to come mostly from more intensive land use, better quality produce and high-value crops. The indigenous nuts provide a high value product.

4. The village agricultural sector is growing reasonably fast, despite assertions to the contrary. Villagers are responsive to new economic opportunities, as demonstrated in recent years by the boom in vanilla production and the rapid expansion of domestically marketed food following the loss of value of the PNG kina in 1997.

5. Fruit and nut trees do not need large areas of land; they fit into existing agricultural systems and trees of certain species already exist in significant quantities in many locations.

6. Some of the indigenous edible nuts, including *galip* and *okari*, have received a favourable reaction when market-tested in Australia, the USA and Europe.

Knowledge about fruit and nuts in PNG

The species being grown and where they grow in PNG

Species grown. The species of fruit and nuts that are grown and eaten in PNG are known. There is no single document that covers all species, but relevant information is available in a series of review papers. Some are more general and cover species used for other purposes, in particular Powell (1976) and French (1986). Others cover groups of fruit and nut species, for example, Bourke (1996) gives a list of 44 species of edible indigenous nuts with an indication of their significance in village agriculture and discusses six of these species in detail. The main papers which review the various fruits and nuts are listed in Table 1.

As well as knowing what is grown in PNG, and has been tried experimentally, we also have a good idea as to how well different species grow and what does not grow well. For example, despite repeated attempts, we know that the following fruit do not grow

well in PNG: apples, blueberries, date palms, grapes, kiwifruit, Mediterranean figs, nectarines, olives, persimmons and plums.

Distribution. The distribution of the more important species is known from the Mapping Agricultural Systems of PNG (MASP) database. This was a national-level survey of village agricultural systems conducted over a six-year period (1990–1995), where land used for agriculture was allocated to one of 342 agricultural systems (Bourke et al. 1998). Using this database, it is possible to generate maps showing where a given species is common or important (as distinct from being merely present). This is illustrated with maps showing the distribution of mango, *marita* pandanus, *galip* nut and *karuka* nut (Figures 1 to 4). There are some limitations in using this database to map the distribution of fruit and nuts. This is because the boundaries of the agricultural systems were drawn on criteria other than the distribution of fruit and nut species. As well, the decision as to whether a species is important or merely present in an agricultural system is subjective. Nevertheless, the patterns that emerge from this database are reasonably accurate, at least for the better-known species.

Regional-level distribution. There is some limited regional-level data on the relative importance of fruit and nuts that complements the MASP database. An exercise was conducted in 1995 on the island of New Britain, excluding the Gazelle Peninsula, where people in 16 villages were asked to rank the relative importance of fruit and nut trees in their diet (R.M. Bourke, unpublished data). The results are presented in Table 2. Allowing for some differences in species that are grown on New Britain and the New Guinea mainland (such as *marita* pandanus which is unimportant on New Britain) and the fact that this survey excluded non-tree species, the ranking by villagers is broadly similar to the national-level data derived from the MASP database. For example, breadfruit was ranked as the most important species by villagers on New Britain and the MASP exercise found that breadfruit was the most commonly grown nut species at the national level (Tables 2 and 3).

Altitudinal range. The altitudinal range of fruit and nuts in PNG is known from an extensive national-level survey conducted by the author from 1979 to 1984 (Bourke 1989). Results for 56 fruit and 20 nut species are presented in Tables 4 and 5 respectively. Data are presented for the usual range and the extreme range. The former figure is the mean of a number of observations (minimum four locations) of the minimum and maximum altitude at which a crop bears its main economic product. The extreme minimum or maximum is based on a single figure for a location where the crop was grown in an unusual situation. For example, pineapple is normally grown from sea level to an upper limit of 1800 m. The latter figure is the mean of observations at 25 locations and has a standard deviation of ±110 m. It is grown occasionally as high as 2380 m altitude (Table 4). Cashew grows from sea level up to 1400 m under extreme conditions, but we do not have sufficient observations to define its usual upper altitudinal limit (Table 5).

The data on crop altitudinal limits were recorded before the impact of global climatic change had a significant affect on PNG. Over the period 1970 to 1999, the mean temperature in the PNG lowlands and highlands increased at a rate of 0.2 °C per decade (R.M. Bourke and G. Humphreys, unpublished data). Since these data were collected, the upper limit of a number of species has increased by an amount that is consistent with the temperature rises in PNG over the past 30 years. Thus it is likely that the

potential upper altitudinal limit of many crops could now be about 100 m higher than the figures in Tables 4 and 5 indicate.

Population growing each species. Because the MASP database is linked to spatial information on the rural population, it is possible to calculate the number of people who live in an agricultural system where a particular species is important (see Tables 3 and 6).[1] Again, there are limitations to the accuracy of this exercise because of the subjective distinction between a species being important, present or unimportant. However, the ranking of the relative importance of species from such an exercise is likely to be reasonably accurate.

Number of trees per household. There is only limited information on the number of trees managed by households. A survey of the number of economic tree crops (coffee, fruit, nuts and highland betel nut) was done by the author for twenty households in two highland villages in 1984 (Bourke 1988:29–31, 44). The results are summarised in Table 7. For example, in Asiranka village in Kainantu District, there were an average of 176 *karuka* nut pandanus, 19 *marita* pandanus trees and 5 avocado trees per household.

Production, consumption and marketing

Crop agronomy. Many aspects of crop agronomy are poorly known for most introduced and traditional fruit and nut species in PNG. These include: propagation techniques, yield patterns, responses to fertiliser, storage processing and handling for commercial production. The paper titled 'What we don't know about indigenous nuts in Melanesia' by Evans (1996b) unfortunately remains almost as true now as it was when written a decade ago.

Pest and disease problems. The most important insect pests and diseases of fruit and nuts in PNG are known. See papers or monographs by Brough (1982), Masamdu (1991), Smith and Thistleton (1982) and Kumar (2001) on insect pests; and those by Pearson (1982), Shaw (1984) and Philemon and Muthappa (1991) for plant pathogens. Despite having reasonably good information on the main pest and disease problems, economic impacts of the various insects and pathogens are poorly understood.

Superior cultivars selected by villagers. There is some scattered information on the location of superior cultivars that have been selected by villagers. Aburu (1982:104), for example, notes that there is a variety of *galip* nut with a soft shell on Misima Island; and Bourke (1996:53) makes the same comment for sea almond for Iwa Island in the Marshall Bennett Group in Milne Bay Province. More generally, it is clear that selection of superior cultivars has been made for various fruit and nut species on many small islands. This has happened on, for example, the Arawe Islands and Unea Island off New Britain; Nissan and Pinipel islands between Bougainville and New Ireland; Boisa (Aris) Island off the mouth of the Ramu River in Madang Province; and Mussau Island, the Feni (Anir) Islands and the Tanga Islands off New Ireland.

Superior introduced cultivars. Cultivars of a number of fruit species have been introduced into PNG for evaluation. These include avocado (Rogers 1992), carambola, durian, mango, pawpaw, rambutan (see papers by T. Neventino, B. Watson and S. Woodhouse in this proceedings), and various citrus species (Rogers and Movis 1991).

[1] More correctly, these figures are the proportion of rural villagers who live in agricultural systems where each fruit or nut species was classed as common or important. Not all people in any agricultural system grow each species and people living in other systems may grow them, so the figures are approximate.

Production patterns. Information has been published on the production patterns, seasonal or otherwise, for 75 species of fruit and 25 species of nuts (Bourke et al. 2004). (Also see the paper in this volume: Production patterns for fruit and nut species in Papua New Guinea and some implications for marketing).

Production levels. With the exception of banana and *galip* nut, there is little information on the quantity of fruit and nuts produced in PNG. Bourke and Vlassak (2004) estimated production of banana (used in cooking and as fresh fruit) as 436,000 tonnes per year in 2000. Banana provided 7% of the food energy derived from locally grown staple (energy) foods. Evans (1996b:17) estimated that there were one million edible *Canarium* (*galip* nut) trees in PNG, with total production of 7200 tonnes of kernel per year. He assigned a farm gate value of US$22 million to this in 1996.

Changes in production and consumption over time. There is some information on changes in production over time. For example, in the highlands, production and consumption of avocado has increased over the past 40 years, as has that for *suga prut*. Durian was once shunned by Papua New Guineans at Keravat, but is now reported as being popular. Mangosteen is a recent introduction to food markets on the Gazelle Peninsula, where it has become a popular fruit (Tio Nevenimo, pers. comm. 2005). The quantity of fruit moved from the highlands to lowland urban centres has increased over the past 20 years. For example, banana passionfruit, tamarillo (tree tomato) and *suga prut* are now sold by highlanders to hotels in Madang, whereas these species were not sold there in the 1980s.

General marketing constraints for fresh food. A number of constraints affect marketing of fresh food in PNG and limit development of fruit and nuts as well as other fresh food. These constraints include:

- poor state of maintenance of many roads and bridges, especially away from main routes
- limited and expensive shipping within PNG
- low standards for handling fresh food
- inadequate linkages of individuals in the marketing chain, including poor communication, inadequate development of business skills in key individuals and insufficient intermediate traders (middlemen)
- limited propagation and distribution of improved planting material
- inadequate dissemination, to growers and those involved in marketing, of information on improved methods for production, handling and processing of fresh food.

Consumer demand. Information on demand for fruit and nuts is limited. We know in broad terms that there is unsatisfied demand for sweet fruit in the highlands and that sweet fruit, such as mandarins grown at 800–1200 m altitude, can be readily sold in highland markets. We also know that fruit and nuts are sold in significant quantities in urban markets. Beyond this, there is only limited information on volumes produced, volumes sold or consumer demand.

Consumption. Some data exists on consumption. I have not done a comprehensive literature survey, but my impression is that fruit and nuts are often classified as 'other' in nutrition surveys. The exception is for *marita* and *karuka* pandanus, where the quantities consumed are often significant. For example, on the Sirunki Plateau in Enga

Province, males and females in different age brackets consumed an average of 1–17 grams of *karuka* nuts per day (Sinnett 1975:30).[2]

Odani (2002) conducted a food intake study in a village on the Great Papuan Plateau in the Mt Bosavi area, Southern Highlands Province. He recorded that *marita* pandanus contributed almost half (44%) of the fat in the villagers' diet, ahead of pig meat (22%) and bandicoot (8%). *Marita* also provided 15% of food energy, after banana (32%) and sago (27%); and 11% of protein, after banana (20%) and equal with bandicoot (11%). A study by Philip Harvey and Peter Heywood in a village in Sinasina District in Simbu Province found that *karuka* nut and *marita* pandanus (combined data) contributed 8% of energy and 8% of protein at the time of their 1981 study. The figures were 10% for protein and 6% for energy in a study in the same village in 1975 (Harvey and Heywood 1983:103).

Experience elsewhere in Melanesia. The experience with commercialisation of indigenous nuts in Solomon Islands and Vanuatu can be used as a guide for commercialisation in the future, as can the limited PNG experience with *galip* nut in New Britain (Evans 1994; Henderson 1996; Wissink 1996) and *okari* nut on the Managalas Plateau in Oro Province (Ase 1996; Houghton 1996; Olsson 1996).

Literature on fruit and nuts in PNG

Despite a large body of literature on fruit and nuts in PNG, there are numerous significant gaps in our knowledge, as noted above. As well as papers that review more than one species (Table 1), a number of papers cover aspects of individual crops, for example, for apple (Willson 1982), avocado (Rogers 1992; Watson et al. 2001), banana (Fooks 1991), cashew (Allen 1991), durian (Ngere 2002), *galip* nut (Akus 1996; Maima 1996), *karuka* nut (Rose 1982), mandarin and orange (Rogers and Movis 1991), mango (Tarepe 1991), naranjilla (Tarepe 1982), pineapple (Watson 2005), purple passionfruit (Nitsche 1971), rockmelon (Antonio 1986) and strawberry (Tarepe 1979).

There is much ethnobotanical material on village production from many locations in PNG. The following is an example of a description from Nissan Island in Bougainville Province:

> People depend on garden food, various fruits and nuts and a little imported rice … Among the fruit, mango and golden apple (*kalok*) are very common. Other fruits include *bukabuk*, watery rose apple, orange, mandarin, pawpaw, pineapple, *ton*, pomelo, guava and *lovilovi*. Nut trees are very common and include *pao*, *galip*, Polynesian chestnut, sea almond and minor amounts of *tulip* seed. Both the flesh and seed of breadfruit are commonly eaten … People preserve the flesh of breadfruit by roasting it to form a biscuit. This is said to remain unspoilt for several years. People also preserve the kernels of *galip*, *pao* and sea almond nuts by smoking. Fruit of golden apple from Nissan is popular in Rabaul and Buka markets (Bourke and Betitis 2003:65).

[2] The intake of *karuka* nut is insignificant compared with sweet potato which was up to 1.1–1.7 kg per person per day for different age brackets of men and women. However, the intake of *karuka* nut varies greatly over time, so data from a survey conducted over a short period has little meaning. It is known that many villagers, especially those living at over 2000 m altitude, consume a lot of nuts of both the planted and wild *karuka* nut species when they are fruiting.

No attempt is made to survey ethnobotanical literature here. A useful recent review of some of this kind of literature is given by Kennedy and Clarke (2004). From the MASP project, references cited in each provincial Working Paper are a useful entry point for ethnobotanical literature (for example, see Bourke, Allen et al. (2002) for East New Britain Province and Bourke, Hide et al. (2002) for West New Britain Province).

Increasingly, papers and monographs can be accessed from the World Wide Web, sometimes in unexpected locations. Bruce French's (1986) book, for example, has been placed on a web site for Indonesian Papua (http://www.papuaweb.org/dlib/bk/french/). Other papers cited here that can be located on the web include those in ACIAR Proceedings Numbers 69 and 99; the Mapping Agricultural Systems of PNG working papers and other papers produced by the Land Management Group at The Australian National University (for example, Bourke and Betitis 2003; Bourke and Vlassak 2004) and RMAP working papers (RSPAS, ANU). Typing the title of the paper or volume and the author's name into a search engine will usually find the item.

There are a number of hard copy bibliographies on fruit and nuts in PNG as well as electronic literature databases that can be searched for particular species, locations or aspects. The most accessible of the published bibliographies is that by Walter et al. (1996) on the South Pacific indigenous nuts. Electronic bibliographies are being developed by the National Agricultural Research Institute; by the Land Management Group, ANU (the PNG Agriculture Literature Database), by Dr Robin Hide in Canberra and by Professor Terry Hays in Rhode Island, USA. The ANU database is available as a CD and is being continually updated.

Acknowledgements

The MASP database was generated in association with Bryant Allen, Robin Hide and other colleagues in the Land Management Group at The Australian National University. Bryant Allen extracted the data from that database for Tables 3 and 6 and Figures 1 to 4. Tracy Harwood of the LMG did a fine job in editing my five papers in this volume.

References

Aburu, K. (1982). Notes on some fruit and nut trees in the Keravat area of East New Britain. In R.M. Bourke and V. Kesavan (eds). *Proceedings of the Second Papua New Guinea Food Crops Conference*. Department of Primary Industry, Port Moresby. pp. 101–122.

Akus, W.L. (1996). The Canarium nut: research and development at the Lowlands Agricultural Experiment Station, Keravat, Papua New Guinea. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 110–112.

Allen, B.J., Bourke, R.M. and Hanson, L. (2001). Dimensions of PNG village agriculture. In R.M. Bourke, M.G. Allen and J.G. Salisbury (eds). *Food Security for Papua New Guinea. Proceedings of the Papua New Guinea Food and Nutrition 2000 Conference*. ACIAR Proceedings No. 99. Australian Centre for International Agricultural Research, Canberra. pp. 529–553.

Allen, M. (1991). Cashews in Papua New Guinea. In A.A. Bala (ed). *Proceedings of the Papua New Guinea First International Fruit Conference*. Department of Agriculture and Livestock, Port Moresby. pp. 169–180.

Antonio, W.C. (1986). Rock melons as a cash crop in the Markham Valley. *Harvest* 12(1):5–9.

Ase, D. (1996). Production and market development of okari nuts (*Terminalia kaernbachii*) on the Managalas Plateau in Papua New Guinea. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 92–93.

Bourke, R.M. (1988). *Taim hangre*: variation in subsistence food supply in the Papua New Guinea highlands. Unpublished PhD thesis. The Australian National University, Canberra.

Bourke, R.M. (1989). Altitudinal limits of 230 economic crop species in Papua New Guinea. Unpublished paper. Department of Human Geography, Research School of Pacific and Asian Studies, The Australian National University, Canberra.

Bourke, R.M. (1996). Edible indigenous nuts in Papua New Guinea. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 45–55.

Bourke, R.M., Allen, B.J., Hobsbawn, P. and Conway, J. (1998). *Papua New Guinea: Text Summaries*. Agricultural Systems of Papua New Guinea Working Paper No 1. Two volumes. Department of Human Geography, The Australian National University, Canberra.

Bourke, R.M., Allen, B.J., Hide, R.L., Fritsch, D., Geob, T., Grau, R., Heai, S., Hobsbawn, P., Ling, G., Lyon, S. and Poienou, M. (2002). *East New Britain Province: Text Summaries, Maps, Code Lists and Village Identification*. Agricultural Systems of Papua New Guinea Working Paper No. 14. Revised

edition. Department of Human Geography, The Australian National University, Canberra.

Bourke, R.M. and Betitis, T. (2003). *Sustainability of Agriculture in Bougainville Province, Papua New Guinea*. Land Management Group, The Australian National University, Canberra.

Bourke, R.M., Camarotto, C., D'Souza, E.J., Nema, K., Tarepe, T.N. and Woodhouse, S. (2004). *Production Patterns of 180 Economic Crops in Papua New Guinea*. Coombs Academic Publishing, The Australian National University, Canberra.

Bourke, R.M., Hide, R.L., Allen, B.J., Fritsch, D., Grau, R., Hobsbawn, P., Levett, M., Lyon, S., Nama, L. and Nen, T. (2002). *West New Britain Province: Text Summaries, Maps, Code Lists and Village Identification*. Agricultural Systems of Papua New Guinea Working Paper No. 13. Revised edition. Department of Human Geography, The Australian National University, Canberra.

Bourke, R.M. and Tarepe, T.N. (1982). Locations for commercial citrus production in Papua New Guinea. *Harvest* 8(4):147–155.

Bourke, R.M. and Vlassak, V. (2004). *Estimates of Food Crop Production in Papua New Guinea*. Land Management Group, The Australian National University, Canberra.

Brough, E.J. (1982). Observations of citrus insects in the Port Moresby environs. In R.M. Bourke and V. Kesavan (eds). *Proceedings of the Second Papua New Guinea Food Crops Conference*. Department of Primary Industry, Port Moresby. pp. 492–495.

Cull, B. W. and Trochoulias, T. (1982). Macadamias – environmental range for commercial production. In D. Noel (ed). *Tree Crops: The Third Component*. Proceedings of the first Australasian conference on tree and nut crops. Cornucopia Press, Perth. pp. 54–61.

Elevitch, C.R. (ed.) (2005). *Species Profiles for Pacific Island Agroforestry*. Permanent Agriculture Resources (PAR), Hōlualoa, Hawai'i. <http://www.traditionaltree.org>.

Evans, B.R. (1994). Marketing galip nut (*Canarium* spp.) in Kandrian and Gloucester districts, West New Britain, Papua New Guinea. Project Design and Management Pty Ltd, Canberra.

Evans, B.R. (1996a). Overview of resource potential for indigenous nut production in the South Pacific. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 10–35.

Evans, B.R. (1996b). What we don't know about indigenous nuts in Melanesia. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 67–73.

Fooks, L.D. (1991). The potential for development of a banana industry in Papua New Guinea. In A.A. Bala (ed). *Proceedings of the Papua New Guinea First*

International Fruit Conference. Department of Agriculture and Livestock, Port Moresby. pp. 145–151.

French, B.R. (1986). *Food Plants of Papua New Guinea: A Compendium*. Published privately, Sheffield, Tasmania.

Gunther, M. and Wiles, G.C. (2003). *Proceedings of the Highlands Horticulture Workshop. NARI Proceedings No. 3*. National Agricultural Research Institute, Lae.

Harvey, P.W.J. and Heywood, P.F. (1983). *The Research Report of the Simbu Land Use Project. Volume IV: Nutrition and Growth in Simbu*. Institute of Applied Social and Economic Research, Port Moresby.

Henderson, M. (1996). The role of galip nut (*Canarium indicum*) in forest conservation in East New Britain, Papua New Guinea. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 80–83.

Henty, E.E. (1982). Some nut-bearing plants in Papua New Guinea. In R.M. Bourke and V. Kesavan (eds). *Proceedings of the Second Papua New Guinea Food Crops Conference*. Department of Primary Industry, Port Moresby. pp. 78–85.

Houghton, K. (1996). Domestic market development of okari nuts (*Terminalia kaernbachii*) in Papua New Guinea. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. p. 100.

Kennedy, J. and Clarke, W. (2004). Cultivated landscapes of the southwest Pacific. *RMAP Working Paper No. 50*. Resource Management in Asia-Pacific Program, RSPAS, The Australian National University, Canberra.

Kumar, R. (2001). *Insect Pests of Agriculture in Papua New Guinea. Part 1. Principles and Practice. Pests of Tree Crops and Stored Products*. Science in New Guinea, Port Moresby.

Long Wah, C. (1996). Marketing indigenous nuts in Vanuatu – a private enterprise perspective. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. p. 79.

Maima, M. (1996). Processing of galip (*Canarium indicum*) in Papua New Guinea. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 118–121.

Masamdu, R. (1991). Pests of fruit and nuts and their control in Papua New Guinea. In A.A. Bala (ed). *Proceedings of the Papua New Guinea First International Fruit Conference*. Department of Agriculture and Livestock, Port Moresby. pp. 66–73.

Naki, G. (1991). Enga fruit and nut project. In A.A. Bala (ed). *Proceedings of the Papua New Guinea First International Fruit Conference*. Department of Agriculture and Livestock, Port Moresby. pp. 36–42.

Nitsche, J.J. (1971). The growing of passion-fruit. *Harvest* 1(2):56–60.

Ngere, O. (2002). Durian. *NARI Information Bulletin No. 2*. National Agricultural Research Institute, Lae.

Odani, S. (2002). Subsistence ecology of the slash and mulch cultivating method: empirical study in the Great Papuan Plateau of Papua New Guinea. *People and Culture in Oceania* 18:45–63.

Olsson M. (1996). Okari Ecoenterprises: a snapshot of participatory rural development. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 94–99.

Pearson, M.N. (1982). A review of virus and mycoplasma diseases of food crops in Papua New Guinea. In R.M. Bourke and V. Kesavan (eds). *Proceedings of the Second Papua New Guinea Food Crops Conference*. Department of Primary Industry, Port Moresby. pp. 448–457.

Peekel, P.G. (1984). *Flora of the Bismarck Archipelago for Naturalists*. E.E. Henty (translator). Office of Forests, Lae.

Philemon, E.C. and Muthappa, B.N. (1991). Diseases of fruit and nuts in Papua New Guinea – a review. In A.A. Bala (ed). *Proceedings of the Papua New Guinea First International Fruit Conference*. Department of Agriculture and Livestock, Port Moresby. pp. 74–82.

Powell, J.M. (1976). Ethnobotany. In K. Paijmans (ed). *New Guinea Vegetation*. Australian National University Press, Canberra. pp. 106–183.

Rogers, A.F. (1992). The Papua New Guinea avocado industry. In M.P. Levett, J. Earland and P. Heywood (eds). *Proceedings of the First Papua New Guinea Food and Nutrition Conference*. University of Papua New Guinea Press and Department of Agriculture and Livestock, Port Moresby. pp. 154–160.

Rogers, A.F. and Movis, A. (1991). Recent developments in the Papua New Guinea highlands citrus industry. In A.A. Bala (ed). *Proceedings of the Papua New Guinea First International Fruit Conference*. Department of Agriculture and Livestock, Port Moresby. pp. 152–160.

Rose, C.J. (1982). Preliminary observations on the pandanus nut (*Pandanus julianettii* Martelli). In R.M. Bourke and V. Kesavan (eds). *Proceedings of the Second Papua New Guinea Food Crops Conference*. Department of Primary Industry, Port Moresby. pp. 160–167.

Shaw, D.E. (1984). Microorganisms in Papua New Guinea. *Research Bulletin No. 33*. Department of Primary Industry, Port Moresby.

Sillitoe, P. (1983). Natural resources exploited by the Wola in the manufacture of artifacts. *Science in New Guinea* 10(2):111–132.

Simpson, J.A. and Arentz, F. (1982). Notes on tree fruits cultivated in the Bulolo and Wau valleys with particular reference to diseases and pests. In R.M. Bourke and V. Kesavan (eds). *Proceedings of the Second Papua New Guinea Food Crops Conference*. Department of Primary Industry, Port Moresby. pp. 458–466.

Sinnett, P.F. (1975). *The People of Murapin*. Institute of Medical Research Monograph Series No. 4. E.W. Classey Ltd, Faringdon, Oxon.

Smith, E.S.C. and Thistleton, B.M. (1982). Some common pests of vegetables and fruit in Papua New Guinea and their control. In R.M. Bourke and V. Kesavan (eds). *Proceedings of the Second Papua New Guinea Food Crops Conference*. Department of Primary Industry, Port Moresby. pp. 476–482.

Tarepe, T.N. (1979). Growing strawberries. *Technical Bulletin No. 9*. Highlands Agricultural Experiment Station, Aiyura.

Tarepe, T.N. (1982). Naranjilla: a new fruit for the highlands. Harvest 8(4):183–185.

Tarepe, T.N. (1991). Potential for mango production in Papua New Guinea. In A.A. Bala (ed). *Proceedings of the Papua New Guinea First International Fruit Conference*. Department of Agriculture and Livestock, Port Moresby. pp. 188–193.

Tarepe, T. and Bourke, R.M. (1982). Fruit crops in the Papua New Guinea highlands. In R.M. Bourke and V. Kesavan (eds). *Proceedings of the Second Papua New Guinea Food Crops Conference*. Department of Primary Industry, Port Moresby. pp. 86–100.

Walter, A., Evans, B., Bourke, R.M. and Hobsbawn, P. (1996). Bibliography of South Pacific indigenous nuts. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 162–172.

Walter, A. and Sam, C. (2002). *Fruits of Oceania*. ACIAR Monograph No. 85. Australian Centre for International Agricultural Research, Canberra.

Watson, B. (2005). Growing pineapples in Papua New Guinea. *Information Bulletin No. 10*. National Agricultural Research Institute, Lae.

Watson, B.J., Weminga, J., Pandi, J. and Ulai, S. (2001). Avocado in the highlands of PNG: 'the silent provider'. In R.M. Bourke, M.G. Allen and J.G. Salisbury (eds). *Food Security for Papua New Guinea. Proceedings of the Papua New Guinea Food and Nutrition 2000 Conference*. ACIAR Proceedings No. 99. Australian Centre for International Agricultural Research, Canberra. pp. 839–845.

Willson, K.C. (1982). Apples in the highlands: results, culture and potential for high altitude gardens. In R.M. Bourke and V. Kesavan (eds). *Proceedings of the Second Papua New Guinea Food Crops Conference*. Department of Primary Industry, Port Moresby. pp. 353–358.

Wissink, D. (1996). Galip (*Canarium indicum*) as a cash crop in West New Britain, Papua New Guinea: experiences of the Kandrian Gloucester Integrated Development Project. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 84–91.

Woodhouse, S. (1991). Asian fruit in Papua New Guinea. In A.A. Bala (ed). *Proceedings of the Papua New Guinea First International Fruit Conference*. Department of Agriculture and Livestock, Port Moresby. pp. 161–168.

Yen, D.E. (1996). Melanesian arboriculture: historical perspectives with emphasis on the genus *Canarium*. In M.L. Stevens, R.M. Bourke and B.R. Evans (eds). *South Pacific Indigenous Nuts*. ACIAR Proceedings No. 69. Australian Centre for International Agricultural Research, Canberra. pp. 36–44.

Captions for figures

Figure 1. Distribution of mango (*Mangifera indica*) in PNG
Source: MASP database.

Figure 2. Distribution of *marita* pandanus (*Pandanus conoideus*) in PNG
Source: MASP database.

Figure 3. Distribution of *galip* nut (*Canarium* spp.) in PNG
Source: MASP database.

Figure 4. Distribution of *karuka* nut (*Pandanus julianettii*) in PNG
Source: MASP database.

Table 1. Review papers that cover fruit and nuts in PNG

Main focus	Approximate number of species		Author
	Fruit	Nuts	
Ethnobotany in PNG	-	-	Powell 1976
Fruit and nuts, Keravat area	40	10	Aburu 1982
Fruit and nuts, Bulolo and Wau	29	9	Simpson and Arentz 1982
Food crops of PNG	102	43	French 1986
Fruit and nuts in Oceania	24	26	Walter and Sam 2002
Horticulture in the highlands	16	2	Gunther and Wiles 2003
Arboriculture in SW Pacific	15	13	Kennedy and Clarke 2004
Crop production patterns	75	25	Bourke et al. 2004
Pacific Island agroforestry	15	7	Elevitch 2005
Fruit in the highlands	50	-	Tarepe and Bourke 1982
Fruit in Enga Province	14	-	Naki 1991
Asian fruit in the lowlands	7	-	Woodhouse 1991
Edible nuts in PNG	-	14	Henty 1982
Indigenous nuts in PNG	-	44	Bourke 1996
Indigenous nuts in Melanesia	-	25	Evans 1996a
Canarium in Melanesia	-	7	Yen 1996

Table 2. Villagers' ranking of the relative importance of fruit and nut trees on New Britain (excluding the Gazelle Peninsula)[1]

Common name	Scientific name	Number of mentions	Score
Breadfruit	*Artocarpus altilis*	16	114
Mango	*Mangifera indica/M. minor*	16	99
Galip	*Canarium indicum*	15	84
Malay apple	*Syzygium malaccense*	14	84
Polynesian chestnut (*aila*)	*Inocarpus fagifer*	9	39
Parartocarpus	*Parartocarpus venenosa*	7	27
Ton	*Pometia pinnata*	7	24
Sis/*Solomon*	*Pangium edule*	6	21
Sea almond (*talis*)	*Terminalia catappa*	4	16
Pao	*Barringtonia* spp.	3	9
Golden apple	*Spondias cytherea*	2	6
Guava	*Psidium guajava*	1	4
Bukabuk	*Burckella obovata*	1	3
Ficus	*Ficus copiosa*	1	2

1. This is based on a survey conducted by R.M. Bourke in 16 villages on New Britain in June–July 1995 during the fieldwork for the Mapping Agricultural Systems of PNG project (Bourke, Allen et al. 2002; Bourke, Hide et al. 2002). This survey was suggested by Will Akus of LAES Keravat. Surveyed villagers were located on the south coast, north coast and interior of New Britain (but not the Gazelle Peninsula) and on Unea Island north of New Britain. Groups of village men and women were asked in Tok Pidgin to rank the relative importance of fruit and nut trees in their diet. The number of species mentioned ranged from four to eight per village. A score of 8 was allocated to the first-mentioned species in each village, a score of 7 to the second species etc. The maximum score is 128 (16 villages × 8) and the minimum is 1 (mentioned eighth in one village only). Thus the scores reflect both the number of times that a species was mentioned and the ranking assigned to it by the villagers.

Table 3. Proportion of rural population who grow certain edible nuts in PNG

Common name	Scientific name	Proportion[1] (%)	Provinces where nuts are most commonly grown[2,3]
Breadfruit	*Artocarpus altilis*	57	ESP, Mor, Mad, MBP, ENB, Boug
Karuka, planted	*Pandanus julianettii*	47	SHP, WHP, EHP, Enga, Simbu
Galip	*Canarium indicum*	32	Mad, ESP, ENB, Boug, Sandaun, Mor
Karuka, wild	*Pandanus brosimos*	32	WHP, SHP, Simbu, Enga, EHP
Polynesian chestnut (*aila*)	*Inocarpus fagifer*	15	MBP, ENB, WNB, NIP
Sea almond (*talis*)	*Terminalia catappa*	14	MBP, ENB, NIP, WNB
Pao	*Barringtonia procera*	13	ENB, Boug, NIP, WNB, Manus
Okari	*Terminalia kaernbachii*	13	Central, Oro, Gulf, Western
Okari	*Terminalia impediens*	8	ESP, Mad, Sandaun
Sis/*Solomon*	*Pangium edule*	8	MBP, WNB, Mad, SHP
Castanopsis	*Castanopsis acuminatissima*	7	SHP
Dausia	*Terminalia megalocarpa*	2	MBP
Tulip	*Gnetum gnemon*	2	MBP

1. The data are based on a nationwide survey of village agriculture (Mapping Agricultural Systems of PNG project), with most fieldwork conducted between 1990 and 1995 (Bourke et al. 1998). Figures are the proportion of rural villagers living in agricultural systems where each nut species was classed as common or important. The relative importance of 17 nut species was assessed as part of that survey. Because the number of plants per household is not great and the plants are spatially dispersed, relative importance is not easy to assess in the field and the figures are subject to large errors. Nevertheless, ranking of the relative importance of the species is likely to be fairly accurate.

2. The ranking of provinces is based on the number of people growing each nut species, not on the proportion of people who grow a species in each province. Thus, the more populous provinces are more likely to appear here.

3. Abbreviations for provinces are: Boug Bougainville; EHP Eastern Highlands; ENB East New Britain; ESP East Sepik; Mad Madang; MBP Milne Bay; Mor Morobe; NIP New Ireland; SHP Southern Highlands; WNB West New Britain; WHP Western Highlands.

Table 4. The altitudinal range of fruit species in Papua New Guinea[1]

Scientific name	Common name	Mean usual altitudinal range (m)	Extreme altitudinal range (m)	Number of observations/ standard deviation (m)	
				Usual min.	Usual max.
Ananas comosus	Pineapple[2]	0–1800	0–2380	–	25/110
Annona cherimolia	Cherimoya	?–?	750–2200	–	–
Annona muricata	Soursop	0–1000	0–1460	–	7/100
Annona reticulata	Bullock's heart	0–?	0–1210	–	–
Annona squamosa	Sweetsop (custard apple)	0–?	0–1210	–	–
Artocarpus heterophyllus	Jackfruit	0–?	0–1230	–	–
Averrhoa bilimbi	Tree cucumber	0–?	0–750	–	–
Averrhoa carambola	Carambola (five corner)	0–1300	0–1430	–	4/120
Burckella obovata	*Bukabuk*	0–?	0–390	–	–
Carica candamarcensis	Mountain pawpaw	?–?	1750–2760	–	–
Carica papaya	Pawpaw	0–1700	0–1950	–	30/100
Citrullus lanatus	Watermelon[3]	0–1700	0–1980	–	6/180
Citrus aurantifolia	Lime	0–1800	0–2260	–	5/80
Citrus limon	Lemon[4]	0–2150	0–2240	–	6/90
Citrus maxima	Pomelo	0–1300	0–1640	–	4/70
Citrus paradisi	Grapefruit	0–1800	0–1980	–	6/100
Citrus paradisi × *C. reticulata?*	*Ugli*	0–1800	0–1830	–	3/50
Citrus reticulata	Mandarin	0–1800	0–2260	–	9/50
Citrus sinensis	Orange	0–1800	0–2280	–	12/80
Cucumis melo	Rockmelon (cantaloupe)	0–?	0–2180	–	–
Cyphomandra betacea	Tamarillo (tree tomato)	1050–2300	0–2600	8/160	7/170
Durio zibethinus	Durian[5]	0–?	0–?	–	–
Eriobotrya japonica	Loquat	850–1800	0–2410	3/170	6/70
Eugenia uniflora	Brazil cherry	0–1750	0–1880	–	3/140
Fortunella sp.	Cumquat[6]	0–?	0–1160	–	–
Fragaria sp.	Strawberry	800–2450	660–2800	7/100	5/240
Fragaria vesca	Alpine strawberry	?–?	1740–3580	–	–
Garcinia mangostana	Mangosteen[7]	0–?	0–?	–	–
Hibiscus sabdariffa	Rosella	0–1700	0–2220	–	8/160
Malus sp.	Apple	?–?	600–2670	–	–
Mangifera indica	Mango[8]	0–1600	0–1820	–	13/110
Mangifera minor	Traditional mango	0–1750	0–1900	–	6/100
Monstera deliciosa	Ceriman	?–2200	0–2330	–	3/180
Morus nigra	Mulberry	800–2200	0–2760	6/100	8/150
Musa cvs	Triploid banana	0–2150	0–2580	–	30/130
Nephelium lappaceum	Rambutan	0–?	0–750	–	–
Pandanus conoideus	Marita[9]	0–1700	0–1980	–	37/90
Passiflora edulis f. *edulis*	Purple passionfruit	800–2300	700–2520	7/90	13/90
Passiflora edulis f. *flavicarpa*	Lowland yellow passionfruit	0–850	0–960	–	5/80
Passiflora ligularis	*Suga prut* (Highland yellow passionfruit)	1350–2350	1300–2460	3/80	4/140
Passiflora mollissima	Banana passionfruit[10]	1850–2800	1640–2920	7/110	5/100
Passiflora quadrangularis	Granadilla	0–1000	0–1520	–	10/300
Persea americana	Avocado	0–2050	0–2430	–	16/160
Physalis peruviana	Cape gooseberry	950–2800	750–2870	5/190	6/60
Pometia pinnata	Ton[11]	0–800	0–1120	–	7/160

Prunus sp.	Plum	?–?	1590–2600	–	–
Psidium cattleianum	Cherry guava	0–1850	0–1900	–	3/90
Psidium guajava	Guava	0–1850	0–2020	–	19/110
Punica granatum	Pomegranate	0–?	0–1620	–	–
Rubus lasiocarpus	Black raspberry	950–2250	760–2830	5/150	11/180
Rubus moluccanus	Red raspberry	0–2150	0–2250	–	3/120
Rubus rosifolius	Red raspberry[12]	950–2800	700–2900	8/180	5/60
Sambucus canadensis	Elderberry[13]	450–1900	0–2150	3/110	11/140
Spondias cytherea	Golden apple	0–950	0–1070	–	4/110
Syzygium aqueum	Watery rose apple	0–1600	0–1640	–	3/50
Syzygium malaccense	Malay apple	0–850	0–1580	–	5/80

1. The source is an unpublished paper by Bourke (1989).
2. Both smooth leaf and rough leaf pineapple have the same usual upper altitudinal limit (1800 m). The rough leaf is less common above about 1500 m and produces the best quality fruit between about 400 and 1200 m.
3. Watermelon is not common above about 1200 m, but is grown up to a mean usual upper limit of 1700 m.
4. Lemon grows better above about 400 m. For a fuller discussion on the optimum altitudinal range for citrus species in PNG, see Bourke and Tarepe (1982).
5. Durian has failed to establish at Bulolo (750 m) (Simpson and Arentz 1982), suggesting that its upper limit may be below 750 m.
6. Cumquat would almost certainly bear at higher altitudes in Papua New Guinea as it is cold tolerant, but it has not been recorded above 1160 m.
7. Mangosteen failed to bear fruit at 550 m on the Managalas Plateau in Oro Province, suggesting that its upper limit may be below this.
8. Mango fruit quality is poor above about 1200 m and bearing is irregular above 1600 m.
9. *Marita* pandanus is not usually planted near the ocean, but it is grown in inland areas at altitudes below 100 m, for example, near Kiunga, Popondetta, Gogol Valley and Aitape. It is more commonly planted above about 500 m.
10. Banana passionfruit plants grow as high as 3580 m but the highest that I recorded fruit was at 2920 m (Chimbu Valley) and 2850 m (Sirunki Plateau). Self-sown plants are not common below about 2000 m, although planted vines bear as low as 1640 m (Aiyura).
11. *Pometia pinnata* bears edible fruit up to a mean upper limit of 800 m, but the tree grows at higher altitudes. It has been recorded at about 1700 m in the Nipa area by Sillitoe (1983:115).
12. Peekel (1984:202) implies that *Rubus rosifolius* has been recorded as low as 300 m in New Ireland and New Britain. The Forest Research Institute has one identification from 200 m (Tufi), but all other specimens were collected at over 1000 m.
13. Elderberry grows up to about 2650 m, but does not usually bear fruit above 1900 m.

Table 5. The altitudinal range of edible nut species in Papua New Guinea[1]

Scientific name	Common name	Mean usual altitudinal range (m)	Extreme altitudinal range (m)	Number of observations/ standard deviation (m)	
				Usual min.	Usual max.
Aleurites moluccana	Candle nut	0–1800	0–2160	–	9/140
Anacardium occidentale	Cashew	0–?	0–1400	–	–
Arachis hypogaea	Peanut	0–1850	0–1940	–	21/70
Artocarpus altilis	Breadfruit	0–1250	0–1450	–	23/130
Barringtonia procera	*Pao*	0–500	0–620	–	4/90
Canarium indicum	*Galip*	0–700	0–930	–	5/160
Carya illinoensis	Pecan	?–?	1390–1640	–	–
Castanopsis acuminatissima	Castanopsis[2]	700–2350	570–2440	6/80	8/110
Cocos nucifera	Coconut[3]	0–950	0–1310	–	20/190
Finschia chloroxantha	Finschia[4]	0–1850	0–2000	–	4/110
Gnetum gnemon	*Tulip*	0–1100	0–1330	–	10/150
Inocarpus fagifer	Polynesian chestnut (*aila*)	0–400	0–870	–	4/90
Macadamia integrifolia/ *M. tetraphylla*	Macadamia[5]	0–1750	0–1810	–	3/60
Pandanus antaresensis	Wild *karuka*	1000–2350	850–2460	4/110	9/90
Pandanus brosimos	Wild *karuka*	2400–3100	1800–3300	20/150	6/60
Pandanus julianettii	*Karuka*	1800–2600	1450–2800	50/110	18/100
Pangium edule	*Sis*/*Solomon*	0–1050	0–1380	–	11/120
Terminalia catappa	Sea almond (*talis*)	0–300	0–460	–	4/100
Terminalia impediens	*Okari*	0–1000	0–1100	–	3/110
Terminalia kaernbachii	*Okari*	0–1100	0–1260	–	11/90

1. The source is an unpublished paper by Bourke (1989).

2. Self-sown castanopsis is more common above about 1100 m, although the usual mean lower limit is 700 m.

3. Coconut palms grow as high as 1760 m, but the highest palms that bore nuts in the period 1979–1984 were at Yonki, EHP (1310 m) and the Baiyer Valley, WHP (1220 m). By 1999, coconuts were bearing as high as 1370 m (Benabena Valley), 1420 m (Korofeigu, EHP) and 1450 m (Wahgi Valley).

4. The highest recording for *Finschia* (2000 m) is a Forest Research Institute record from Aseki in Morobe Province.

5. In its natural range in Australia, *Macadamia tetraphylla* occurs in a slightly cooler climate than *M. integrifolia* (Cull and Trochoulias 1982; Stephenson, this volume). The limited numbers of observations from Papua New Guinea do not indicate a separate range for the two species. Both species bear from sea level up to 1700–1800 m.

Table 6. Proportion of rural population who grow certain fruit in PNG

Common name	Scientific name	Proportion[1] (%)	Provinces where fruit are most commonly grown[2,3]
Banana[4]	*Musa* cvs	98	Mor, ENB, Central, Mad, ESP
Pawpaw	*Carica papaya*	64	WHP, Mad, ESP, Mor, MBP
Marita	*Pandanus conoideus*	59	EHP, Mor, WHP, SHP, ESP, Simbu, Mad
Pineapple	*Ananas comosus*	53	ESP, Mor, WHP, Mad
Mango	*Mangifera indica*	44	ESP, Mad, Mor, ENB, MBP, Bougain
Watermelon	*Citrullus lanatus*	28	MBP, Bougain, Central, ENB, Oro
Ton	*Pometia pinnata*	23	ESP, ENB, Mad, Sandaun, NIP
Malay apple	*Syzygium malaccense*	22	NIP, Bougain, MBP, Central, WNB
Guava	*Psidium guajava*	18	Bougain, ENB, Mor, Mad, WNB
Orange	*Citrus sinensis*	13	Mor, Oro, Gulf, Central
Passionfruit	*Passiflora* spp.	11	Enga, SHP, Mor
Avocado	*Persea americana*	6	Central, Simbu, Mor, EHP
Bukabuk	*Burckella obovata*	6	MBP, New Ireland, Bougain
Mon	*Dracontomelon dao*	6	Madang
Golden apple	*Spondias cytherea*	4	MBP, Manus, NIP, Bougain
Mandarin	*Citrus reticulata*	4	Central, Mor, Bougain
Parartocarpus	*Parartocarpus venenosa*	4	WNB, ENB
Rukam	*Flacourtia rukam*	2	MBP
Pomelo	*Citrus maxima*	2	WNB, NIP
Tamarillo	*Cyphomandra betacea*	2	Mor, Central
Coastal pandanus	*Pandanus tectorius*	2	Manus
Pouteria	*Pouteria maclayana*	2	Madang

1. The data are based on a nationwide survey of village agriculture (Mapping Agricultural Systems of PNG project), with most fieldwork conducted between 1990 and 1995 (Bourke et al. 1998). Figures are the proportion of rural villagers living in agricultural systems where each fruit was classed as common or important. The relative importance of 35 fruit species was assessed as part of that survey. Because the number of plants per household is not great and the plants are spatially dispersed, relative importance is not easy to assess in the field and the figures are subject to large errors. Nevertheless, ranking of the relative importance of the species is likely to be fairly accurate.

2. The ranking of provinces is based on the number of people growing each fruit species, not on the proportion of people who grow a species in each province. Thus, the more populous provinces are more likely to appear here.

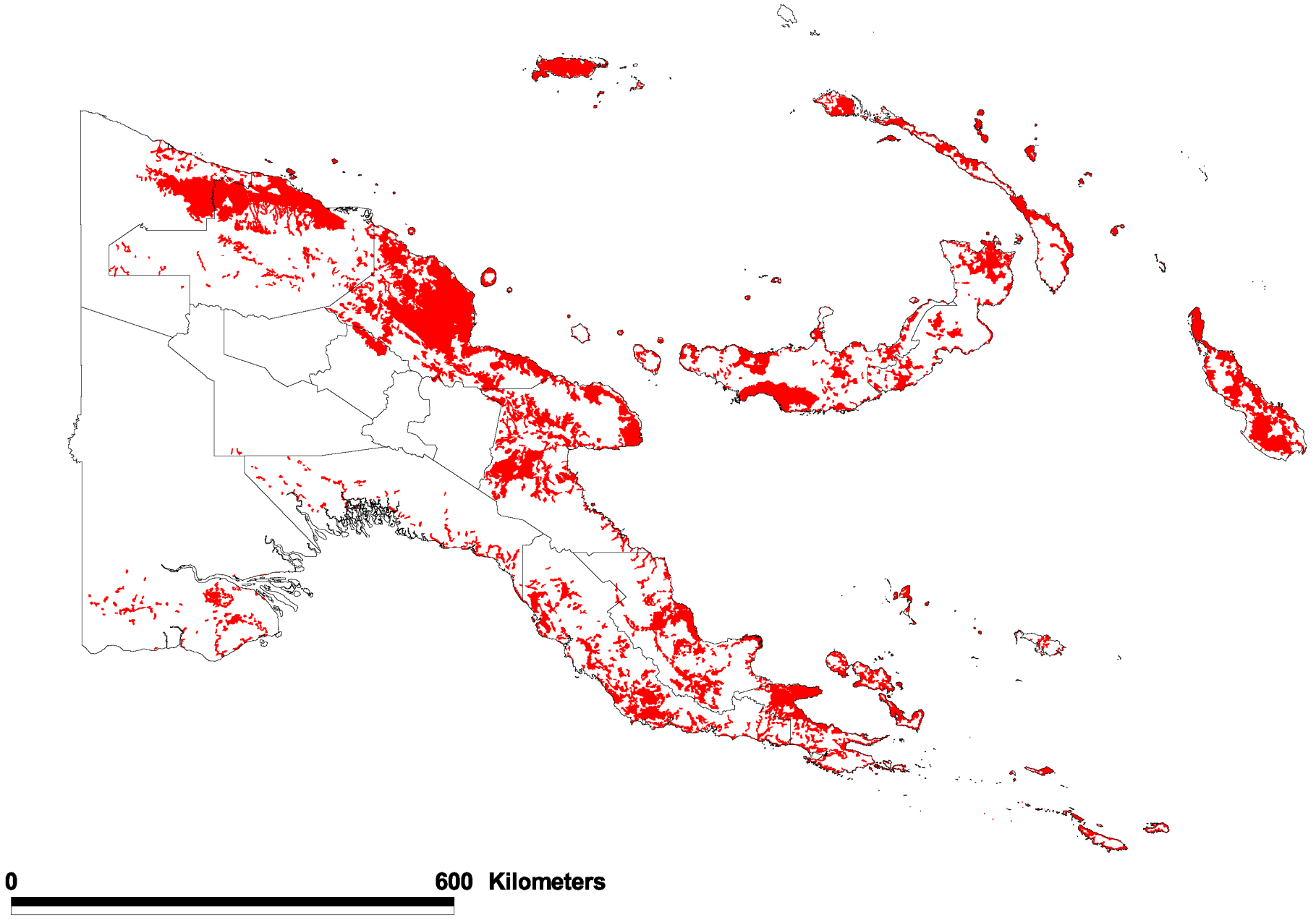
3. Abbreviations for provinces are: Bougain Bougainville; EHP Eastern Highlands; ENB East New Britain; ESP East Sepik; Mad Madang; MBP Milne Bay; Mor Morobe; NIP New Ireland; SHP Southern Highlands; WNB West New Britain; WHP Western Highlands.

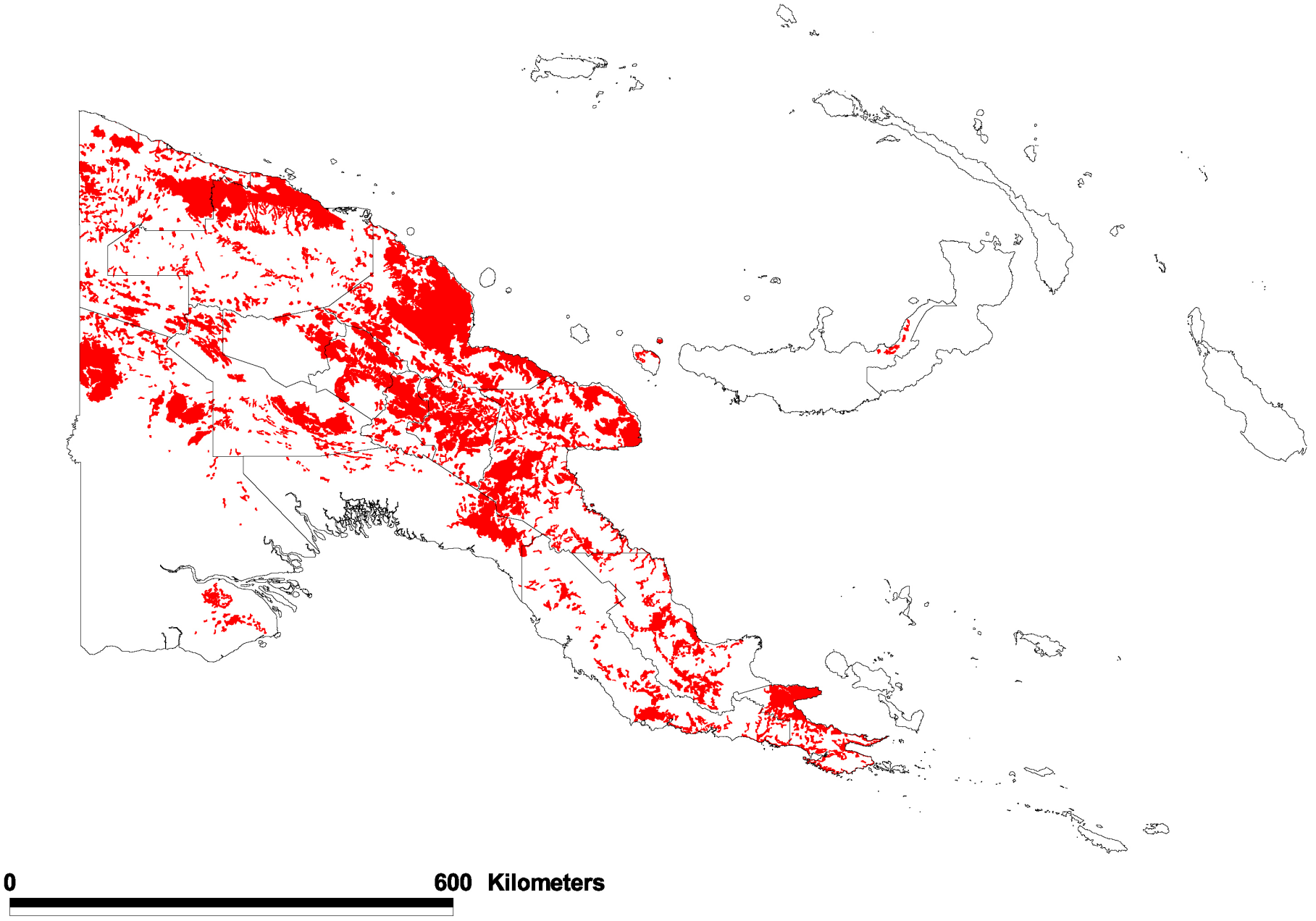
4. Banana is grown by most households in PNG, up to 2600 m altitude. These data include banana used for cooking and for fresh fruit.

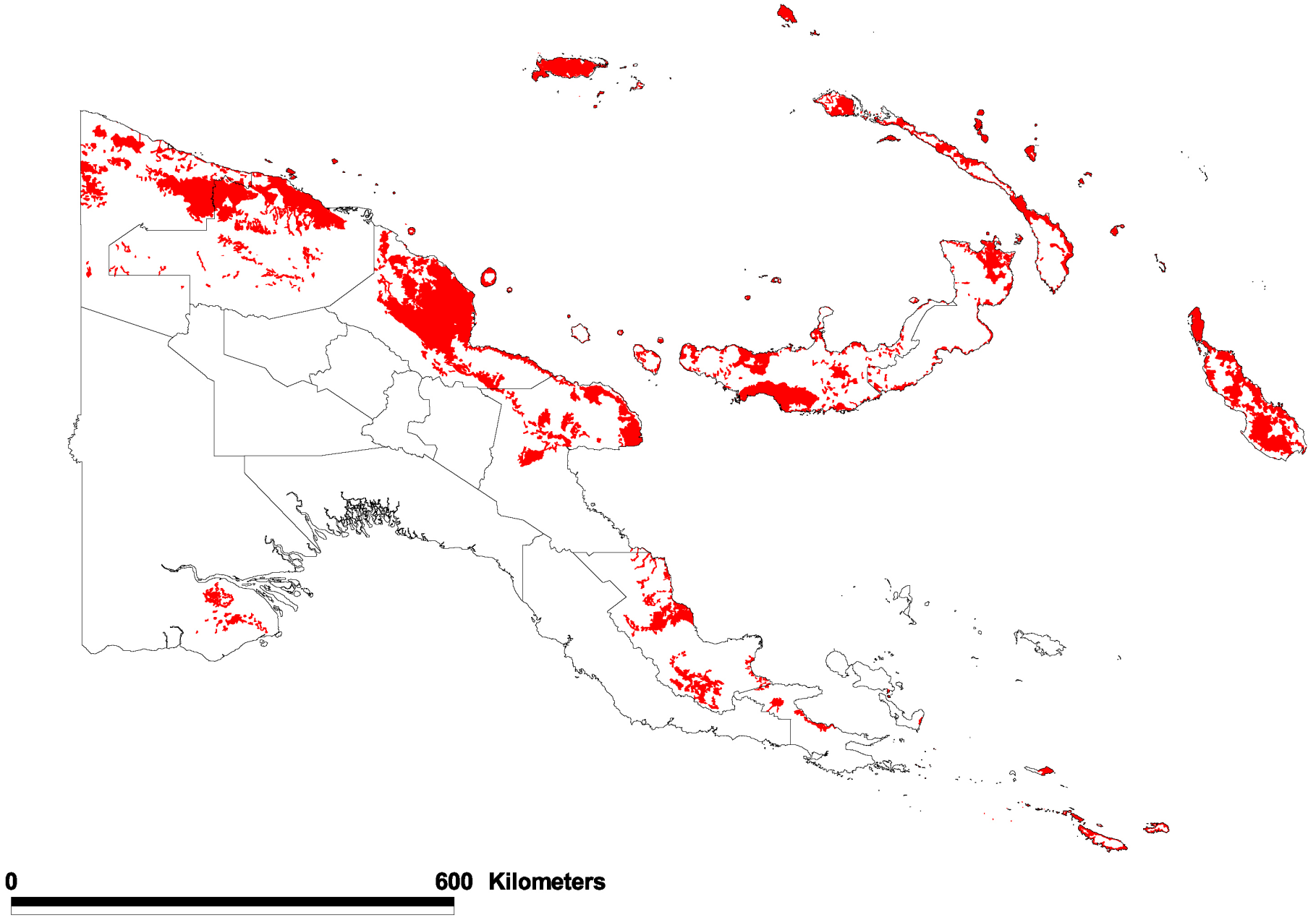
Table 7. Number of planted economic tree crops per household in Asiranka village, Eastern Highlands, and Upa village, Southern Highlands[1,2]

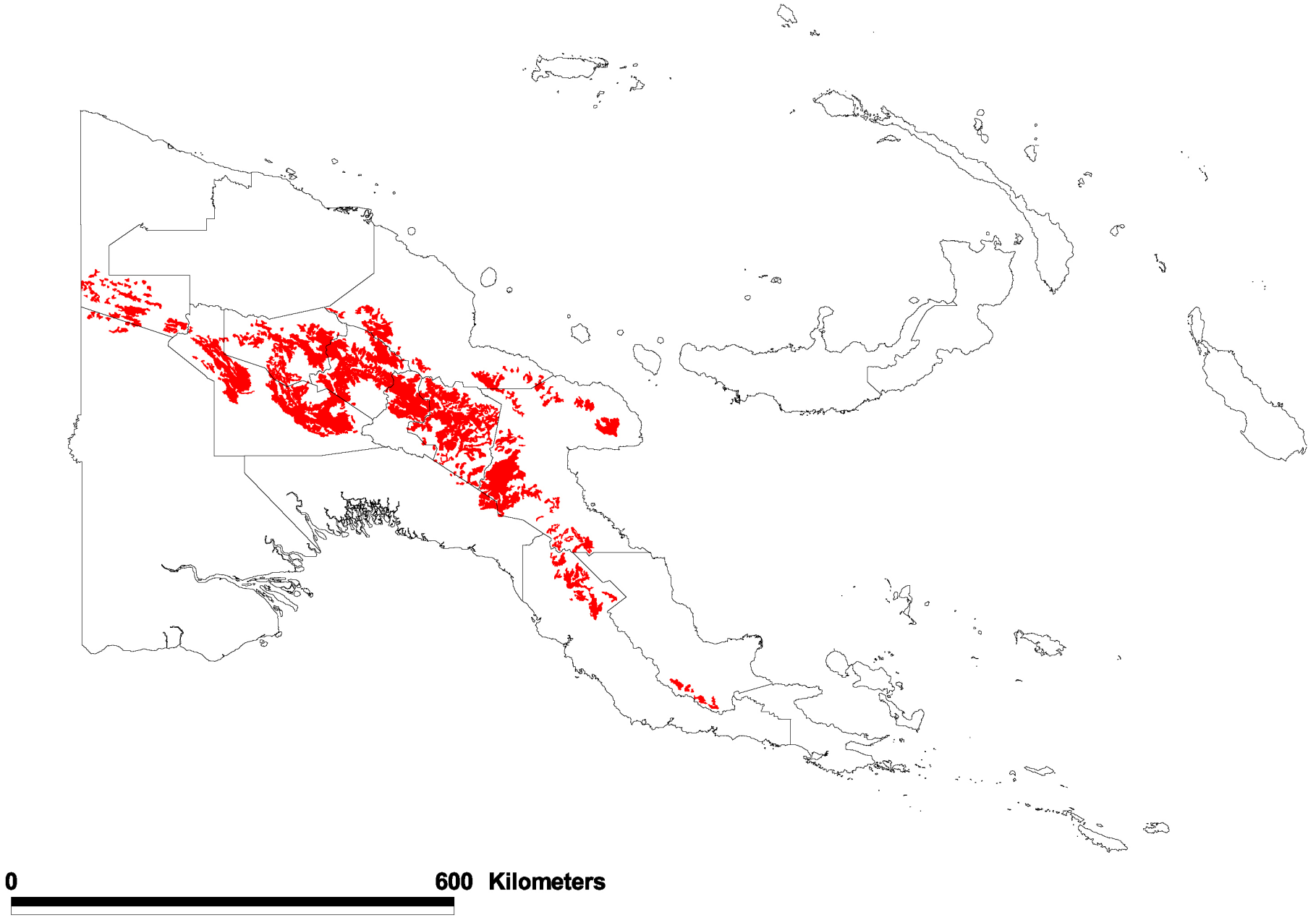
Tree crop	Asiranka village		Upa village	
	Number	% mature	Number	% mature
Coffee (*Coffea arabica*)[3]	464	95	478	95
Karuka nut pandanus (*P. julianettii*)[4]	176	28	12	60
Highland betel nut (*Areca macrocalyx*)	137	23	0	–
Marita pandanus (*P. conoideus*)[5]	19	32	29	82
Ficus copiosa[6]	–	–	8	86
Avocado (*Persea americana*)	5	35	1	0

1. The source is field counts of trees in 10 male-headed households in each community in September–November, 1984 (Bourke 1988). Asiranka village is in the Aiyura Basin, Kainantu District, Eastern Highlands Province, while Upa village is located on the Nembi Plateau, Nipa District, Southern Highlands Province. Household size in Upa (14.5 persons) is much larger than in Asiranka (3.9 persons), hence the number of trees per person is generally greater in Asiranka.
2. *Casuarina oligodon* is an important planted species in both villages, but trees of this species were not counted.
3. Coffee numbers at Upa exclude the large holdings of a single household head. There are 11.8 persons per household for coffee holdings at Upa.
4. The number of *karuka* trees was probably under-enumerated in Asiranka, as the people spoke of trees that I did not see.
5. *Marita* pandanus trees were not counted in the Wage Valley, and the figure for Upa is an underestimate.
6. *Ficus* trees were not recorded at Asiranka, but there are only a few trees.


0
600 Kilometers


0
600 Kilometers


0
600 Kilometers


0
600 Kilometers