Islands of Hope

Indigenous Resource Management
in a Changing Pacific

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**Edited by Paul D'Arcy and
Daya Dakasi Da-Wei Kuan**

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Traditional Pacific Agrosystems and Sustainability into the Future: Vanuatu as a case study

Vincent Lebot and Stuart Bedford

> This is a plea to policy-makers not to ignore the traditional economy of Melanesia and other parts of the Pacific when considering options for future development. We must shift our thinking to considering the traditional economy not as a problem to be solved, but rather as an enormous asset to be utilised. (Regenvanu 2009: 33)

Introduction

Across the Pacific region, there are increasing concerns about the sustainability and resilience of island economies, rapidly growing populations, public health and the impacts of climate change (SPC 2011; WHO 2010; World Bank 2014b). Associated with all these factors is future food security, which without doubt represents a major challenge. There is a general trend of increasing reliance on imported food and a general decline in traditional knowledge relating to gardening practices (Feeny 2014; Taylor et al. 2016). Pacific Island governments and their representatives often favour encouraging and supporting commercial crops that are not connected to traditional agrosystems and, in many respects, work against them. This is partly related to the influences of the cropping and economic structures introduced during the colonial period but is also sometimes seen as a solution to the increasing importation of foods such as rice. The planting of rice was instigated and encouraged well before, and has continued since, Vanuatu's independence in 1980, and it has repeatedly failed (Weightman 1989: 252–54; for a discussion of the wider Pacific, see Sharma 2007). In 2016 and 2017, the Vanuatu Department of Agriculture promoted sending thousands of cattle to various islands in a largely unmonitored program. In 2017, it instigated a program to encourage farmers to plant potatoes as a commercially viable crop. Farmers on Tanna were wary as a previous departmental program encouraging them to plant ginger was unsuccessful as there was no readily accessible market.

Many Pacific Island societies are grappling with these issues but the debates both inside and outside the respective countries are often devoid of historical depth or deeper understanding of traditional agrosystems (Regenvanu 2009: 32). Pacific Island populations before European contact were far larger than they are today (Kirch and Rallu 2007) and were almost wholly sustained through different gardening techniques and cropping systems. The island of Aneityum was once described as the 'Easter Island of Melanesian agriculture' (Groube 1975) due to the extensive and spectacular remains of irrigated terracing and channels associated with taro gardens found there. The island was thought to have had a pre-contact population of between 3,500 and 4,000 people, losing 90 per cent of that number by 1900 (Spriggs 2007). In 2009, it had a population of 915 (VNSO 2009). Marine resources were also a major component of some diets and animal husbandry played an important role not so much in daily diets but related to ceremonial activities. Such traditions included not only accommodating the population's required daily consumption needs, but also providing significant surpluses that were integral to ceremonies and trade and exchange networks. These extensive and often intensive gardening systems have been highlighted particularly in the remnant irrigation systems of Solomon Islands, New Caledonia and Vanuatu and the dryland systems of Hawai`i (Bayliss-Smith and Hviding 2012; Bedford et al. 2018; Kirch 2002; Ladefoged et al. 2011; Sand 2012; Spriggs 1981). The irrigation systems of these regions are considered some of the most productive gardening systems on record anywhere (Spriggs 1981; Weightman 1989). We argue here along the lines of the epigraph above—that a focus on traditional Pacific agrosystems is most likely to provide more secure and sustainable food security into the future. While there have been increasing calls recently for such a realignment in Vanuatu (Regenvanu 2009; Wood 2016), which is the focus of this chapter, it remains to be seen whether the historical trend since independence of increasing food imports and expanding commercial crops can be reversed.

The globalisation of the food trade contributes directly to the production of greenhouse gases. Cereals produced with very high levels of inputs and in large quantities by a few major exporting countries are transformed and transported using fossil fuels to consumers located far from production areas (Shiferaw et al. 2013). Vanuatu represents a textbook case, since the per capita consumption of imported cereals (white rice and wheat flour) is constantly increasing while these products cannot be produced locally. With its increased dependence on imported foods, Vanuatu's contribution to the production of greenhouse gases is also growing (van Groeningen et al. 2012; Neue 1993; Pandey and Agrawal 2014). This form of consumption also weakens the country's position in international discussions on climate change. Often considered a vulnerable victim of climate change, Vanuatu could rapidly emerge as an active contributor because of new diets that encourage the massive importation of food products with high carbon footprints. These new diets also produce dramatic effects on the health of Vanuatu's population. As vividly emphasised by Joel Simo, an organiser of the recent Slow Food Festival on the island of Tanna, in contrast to traditional foods, '[f]ast food is quick and easy, but fast food also leads to a fast death' (Wood 2016).

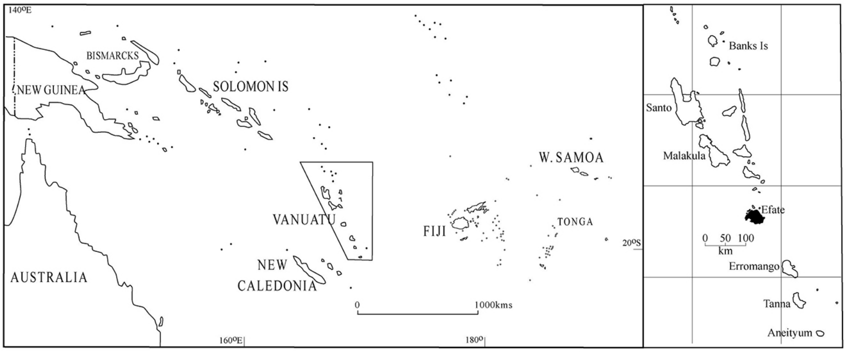
Traditional agrosystems have been changing rapidly during the past few decades. Some village communities are now neglecting local food crops in favour of cash cropping and the establishment of perennial commercial plantations (such as coconuts, cocoa, coffee) or pasture to generate the necessary incomes to purchase imported foods (Siméoni and Lebot 2012). Changes in diets, high demographic pressures and land saturation are increasing the competition between the two types of agrosystems: food crops and cash crops. Questions about agrobiodiversity management and the protection of genetic resources are challenging in current conditions. As communities are focusing on coconuts for copra, cocoa, coffee and kava, they neglect their species-diverse traditional food gardens.

The aim of this chapter is to explain how the redevelopment of local food-cropping systems in Vanuatu will not only improve food security but also increase the country's ability to sequester carbon and thus enhance its credibility in international climate debates. We will attempt to describe the traditional Melanesian cropping system that was developed over 2,800 years before European contact to manage environmental risks and to strengthen food security during an era when generous Western aid was unknown to local populations. We will also discuss how traditional techniques could be used to strengthen smallholders' capacity to adapt to climatic change.

Vanuatu's food-crop systems

Vanuatu comprises 80 islands stretching about 900 kilometres in a north-westerly to south-easterly direction (Map 4.1). The archipelago covers a total area of about 12,280 square kilometres, consisting entirely of islands of volcanic origin, most of which rise more than 700 metres above sea level. Geologically, these islands are between 10 and 20 million years of age and, as the archipelago is at a crossroads between species-rich continental islands (Solomon Islands, Fiji and New Caledonia), its flora were introduced from these source countries on ocean currents, the wind, floating rafts and by bats and birds. Because there were no major herbivores, plants could diversify and evolve through natural adaptation to diverse natural habitats without other constraints. Successive botanical expeditions conducted since the first European visits to these islands have collected and identified approximately 1,200 Indigenous plant species. Among these, many are edible fruit and nut trees, palms and ferns, which represented a major resource facilitating the settlement of the first colonisers and first predators (humans and pigs) approximately 3,000 years ago (Lebot and Sam 2019).

The South-West Pacific is a geographic zone under the influence of regional climatic instability (the so-called El Niño and La Niña phenomena and frequent cyclones) and is subject to high rates of seismic activity (producing acid rain and volcanic ash) (for Vanuatu, see Siméoni 2009). Numerous environmental risks have led local populations to develop resilient and sustainable traditional agrosystems. Several important food crops domesticated further north in New Guinea and Solomon Islands were introduced as vegetative propagules carried in canoes. This was the case for the greater yam (*Dioscorea alata*) and taro (*Colocasia esculenta*), which were traditionally the main crops, along with a leafy vegetable, aibika, also called 'island cabbage' (*Abelmoschus manihot*) and bananas (*Musa spp.*) (Walter and Lebot 2007). All species are asexually propagated and vegeculture characterises these systems. Vegetatively propagated plant species do not develop tap roots and are therefore highly vulnerable to strong winds and drought. The discontinuous extent of food gardens in the forest affords some protection from wind, soil erosion and the spread of crop pests and diseases. However, cyclones frequently sweep through the archipelago, with the resulting destruction of or damage to crops.



Map 4.1: Map of Vanuatu and the region.

Source: Map by Stuart Bedford.

The slash-and-burn rainfed gardening that was developed in the pre-European era (Barrau 1958) is still practised, however, with less intensity. Such gardens are most often associated with yams on the drier areas and taro in the more humid zones, but many other foods are also intercropped, including bananas and plantains, sweet potato (*Ipomoea batatas*), sugar cane (*Saccharum spp*.), kava (*Piper methysticum*), aibika, leafy vegetables and other minor species. Once a plot is cleared, it will be cultivated for about three years and then abandoned for a longer period due to weed infestation or, rarely, because of a significant decline in soil fertility. Most root crops are very efficient converters of solar energy into carbohydrates and their harvest does not extract important amounts of minerals from the soil. Depending where the cropping system is established, on the leeward or windward side of the island, taro or yams are planted first, generally in September–November, and harvested 10 months or so later. In the hole left by the harvest of their underground organs are planted sweet potato cuttings, as the species does well during the cool season. American species introduced after first contact, such as cassava (*Manihot esculenta*) or cocoyam (*Xanthosoma sagittifolium*) are established in the second and third years and the plants will be kept between one and three years, acting as food banks along with bananas. So, the plot is abandoned progressively and a fully fallow period does not begin at a precise time.

This shifting cultivation system needs to be associated with arboriculture of local fruit and nut species (see Table 4.1), resulting in a resilient agroforestry system aimed at risk management. When production needs to be increased for social purposes (weddings, custom ceremonies), it is done by opening new plots rather than enlarging the existing ones, which would increase their vulnerability to damaging strong winds or lengthy drought. The small size of the plots surrounded by useful tree species is seen as protection against adverse environmental changes. Small, irrigated taro terraces established along perennial streams are also surrounded by protective trees. There are several variations in the organisation of the hydraulic system to suit the topography of the area and the cultivation practices. These irrigated plots may be used continuously for 20 years or so before being abandoned for a similar period and restored (Plates 4.1 and 4.2).

In the 1800s, the introduction of new food-crop species had a positive impact on agro-ecosystems. Cassava, African yam (*D. cayenensis* and *D. rotundata*) and cocoyam have been widely adopted on all islands. Their agronomic performances are such that these species are often replacing traditional ones because of their ease of cultivation. The most striking characteristic of these food production systems is that they are based on vegetatively propagated plant species. True botanical seeds are produced by the cultivated plants but are unknown to farmers, and these staple food crops (roots, tubers, bananas and plantains) are always propagated using vegetative propagules: stems, tubers, corms or cormels, and suckers or runners. This is also true for breadfruit varieties (*Artocarpus altilis*) propagated by root cuttings and for aibika, kava and sugar cane propagated by stem cuttings.

These multi-strata systems host numerous species with different varieties, planted simultaneously and successively, and with various dynamics of production to ensure a continuous supply from the garden over time. The plots are rainfed, with annual precipitation ranging from 1,800 millimetres in the south of the archipelago to more than 3,000 millimetres in the north. Plots are generally kept clean and weeded by hand until the harvesting of the taros and yams seven to nine months after planting. Cultivation operates on very small plots. All useful trees species—and there are many—are preserved to be used as living yam stakes or windbreaks. For most useful trees, volunteer plants can be transplanted from the forest into cultivated plots or their surroundings. Within these, various annual species are established simultaneously: yams, aibika, bananas and giant taro (*Alocasia macrorrhiza*). This system works with minimum input, plants are established one by one and weeding, planting and harvesting are done simultaneously so the working day's outputs are optimised. Agrobiodiversity is often about translating a balance of interactions between asexual propagation and species association.

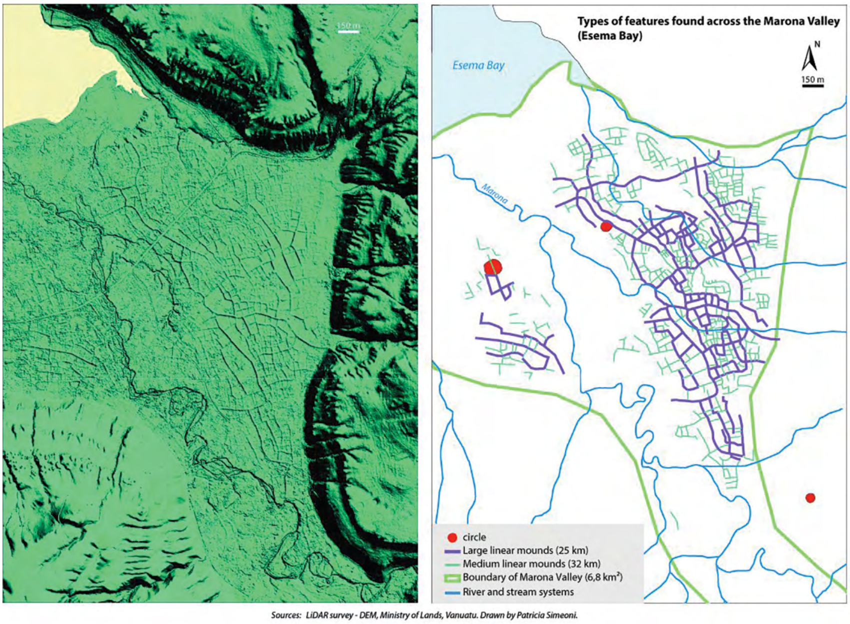
Plate 4.1: Irrigated taro plots, Maewo Island, Vanuatu.
Photo: Stuart Bedford.

Plate 4.2: Abandoned irrigated taro terraces, Col des Roussettes, Bourail, New Caledonia.
Photo: Stuart Bedford.

Epigenetic factors are playing a role more important than that for sexually propagated crops as there are clonal successions. Vegetative propagation has permitted the accumulation of clonal somatic mutations that characterise a great number of traditional varieties but also capture volunteer plants found growing spontaneously within plots when weeding or returning from fallow cycles (VandenBroucke et al. 2015a). In fact, the agrobiodiversity found within these systems is truly remarkable at the specific and intraspecific levels (Walter and Lebot 2007). At the functional level, this is translated into better stability to cope with climatic, parasite and economic changes occurring in the wet tropics. In these agrosystems, producers use intraspecific diversity to optimise the performance of the system (susceptible varieties interplanted with resistant ones to act as filters against pathogens, early and maturing varieties mixed together, and so on). Furthermore, and because of limited means, producers cannot open large areas and the increase of the cultivated area presents some risks (because crops become more distant from the forest curtain).

The issue is, however, quite complex and the genetics of asexually propagated species necessitates a peculiar approach: varieties presenting very different morphotypes can in fact belong clonally to the same genotype (that is, a gene controlling anthocyanins pigmentation is activated or not) and vice versa; some varieties can be polyclonal and are therefore hosting different genotypes although they present the same morphotype. It is consequently necessary to use molecular markers to characterise this genetic diversity (VandenBroucke et al. 2015b). If sexually propagated species have attracted numerous contributions, studies regarding asexually reproduced plant species are unfortunately quite scarce, to say the least.

In food gardens, the main staple crops are grown on land periodically cleared of its natural cover, to which it returns for several years of fallow after three years of cultivation. These food gardens provide most of the population with a high degree of food security (Map 4.2). Families frequently have several gardens and the dispersion of garden sites reduces the risk of the entire food supply being lost to a cyclone or a severe drought due to El Niño.



Map 4.2: Remnant agricultural systems, Marona Valley, Efate Island, Vanuatu.

Source: Map by Patricia Siméoni.

How was the food cropping system developed?

Clonally propagated plant species (roots and tubers, bananas, sugar cane, island cabbage) were introduced with the first settlers for their outstandingly high-yielding performance well known by the Lapita people. All were domesticated in northern Melanesia. However, because they do not develop taproots, they need tree curtains for protection. The rationale was therefore to intercrop these fragile clones under multipurpose local trees, many of which were naturally edible and non-toxic. Agroforestry was therefore common sense, especially as logging represented a serious investment in the absence of adequate tools. The development of these systems was therefore the most rational approach to favour fast and sustainable adaptation of recently arrived communities. The propagation rate of the crops after arrival was also critical. Introduced clones producing carbohydrates had to be associated with protective trees because their vegetative propagation ratios (the number of propagules available per plant for replanting) were very low and settlers could not afford to lose them. Most yam species produce only one or two tubers per plant. Taro are better propagated with their 'headsets' (base of petioles) and there is only one per plant. It is consequently easy to assume that carbohydrate supplies (from taros and yams) were irregular before planting materials were sufficiently bulked and that, for a few years after arrival, communities were mostly foraging the abundant and diverse flora for edible fruits, nuts or palm hearts. In so doing, they learnt which trees to protect and replant, especially as many of these species were similar to the ones known further north in Solomon Islands.

Agroforestry systems exploited by Indigenous populations are now threatened by rapid change. Several significant changes have occurred over the past 100 years or so. American root-crop species have been adopted: cassava, tannia and sweet potato. They are now important foods and are virtually free of pests and diseases in Vanuatu. A few high-yielding yam species and cultivars have also been introduced, including the African *D. cayenensis* and *D. rotundata* and several superior cultivars of *D. alata* originating from other islands or countries. Cocoyam is far less labour intensive than yams. A second planting of yams would require holing, mounding and staking whereas cocoyam is simply planted in the depressions that remain after the first harvest of yams. New World species could be regarded as having been added to the yam system in a way that has produced minimum disturbance while increasing garden yields, especially in the second and third years of production. However, we can observe a significant trend in some villages where local food production is not considered a priority and these American species are now planted as early as the first year, replacing yams.

It is difficult to predict accurately what the ongoing and rapid climatic changes will impose on producers. The traditional Vanuatu multispecies food garden, involving small plots surrounded by forest, is fairly drought resistant, can conserve moisture and is protected from desiccating dominant winds and from diseases through intercropping. These traditional systems are sustainable and this can be explained by the discontinuous nature of cultivation that, so far, has benefited from the length of the fallow. The limited population relative to the amount of arable land, the small size of these gardens and the minimum tillage practices that prevent soil erosion, even on slopes, are also possible explanations for their sustainability.

Possible means of improvement

The productivity of these gardens is impressive considering the low inputs. Traditionally, producers visit their plots between three and five times a week and, during a two–three-hour session, they weed, plant and harvest to optimise their visit, as the time spent to reach the plot on foot can be up to three hours depending on location. At present the bulk of production is grown for household self-sufficiency. The produce is also consumed as part as traditional exchange arrangements. It is estimated that food gardens supply 70–85 per cent of villages' calorific needs, depending on location. However, with growing urbanisation, trade in traditional food staples is developing and these gardens therefore have potential for commercial exploitation.

To support smallholders to adapt to ongoing changes while improving, or maintaining, the productivity of these traditional systems, it is necessary to attempt to answer several important questions:

1. At the country scale: How is agrobiodiversity influenced by demographic factors? What are the spatial and temporal consequences of the ongoing and rapid changes?
   - It is hypothesised that accurate mapping of the soils' agronomic potential, combined with population and rainfall distribution, should allow a first assessment of different zones—those of high and low human pressure and maybe of rich and poor agrobiodiversity. Recent studies have shown that populations are already established on good soils. In the absence of roads and transport, farmers now must walk for several hours to reach fertile land as most plots close to their villages have been exploited for decades without sufficient fallow periods to restore fertility.
2. At the local level: How is agrobiodiversity influenced by land use and management? Is the area occupied by perennial cash crops a constraint on the development of local food crops? Are they the focus of farmers' attention and are the local food crops losing their position in daily diets and consequently in agrosystems? What is the incidence of perennial-crop incomes on these diets (that is, why should farmers cultivate root crops if they can instead purchase rice and bread)?
   - Mapping the local land use of village communities should improve the assessment of local constraints. Current observations indicate that most villages are now surrounded by coconut or cocoa plantations or

pasture (or pasture under coconuts) and food production cannot be associated with these areas because: 1) many food-crop species are not shade-tolerant, 2) the soil under coconuts is compacted by their root systems and intercropping is difficult, and 3) it is difficult to protect food crops from cattle. Consequently, food production must be established in areas far from villages.

3. At the plot level: What are the direct impacts of farmers' strategies at their plots' level? How are plant species intercropped? What are the cropping cycles?
   – We formulate the hypothesis that by measuring agrobiodiversity with different indexes, taking into consideration more variables than the interspecific richness but also integrating intraspecific genetic diversity and the area constraint (number of species, varieties and/or individuals per unit of area), these new indexes should improve the quantification and therefore the comparison of different levels of agrobiodiversity in different locations. We present in Table 4.1 a list of species frequently found in food gardens. Most are established as vegetative propagules, but many are replanted from neighbouring forest, and some grow spontaneously and are protected.
4. At the cultivated species level: How is the genetic diversity of asexually propagated plant species (those for which the human factor has the most significant impact) threatened? What is the impact of farmers' strategies on the genetic diversity of asexually propagated plant species and what happens when some varieties are not propagated?
   – We hypothesise that if we accurately measure genetic diversity with reliable co-dominant molecular markers, we can assess the extent of allelic diversity present in the plots, which is sometimes quite different than what is observed at the morphological level. It has been observed that, for a given species, the extent of allelic diversity present within one island is quite narrow and needs to be broadened to strengthen smallholders' capacity to adapt to climatic changes (Lebot 2013).

Conclusions

In the Pacific, the major food crops are roots and tubers (yams, cassava, sweet potato, taro), all of which produce high yields of carbohydrates per individual plant (from 2 to 4 kilograms). These compounds exist in the form of sugars, starch and fibre. People who have a diet high in carbohydrates are less likely to accumulate body fat than those who have a diet low in carbohydrates and high in fat. The energy density of diets rich in carbohydrates is lower because they contain per unit of weight fewer calories than fat. In addition, fibre-rich foods are bulky, thus nourishing, and quickly cause a feeling of satiety. People who have a diet high in carbohydrates are less likely to overeat. These food crops in the Pacific were traditional but are currently neglected. Their development will have three direct impacts: 1) improving diets and health, 2) contributing to food security, and 3) increasing carbon sequestration in the producing countries, reinforcing their arguments about the need for climate change action internationally.

These plants, unlike cereals, do not need to exhaust important resources in the soil (or to absorb those released by fertilisers) to produce high yields per plant. Grown with very low input, they are remarkable converters of solar energy into carbohydrates stored in their underground organs (corms, roots or tubers). This performance is due to their architecture; unlike cereals, such plants do not need to mobilise resources to build the stems necessary to support their heavy aerial storage organs: ears or panicles of grain. They have large leaf surfaces that transfer through photosynthesis sugars to a sink where they are easily stored underground without physiological constraint. The carbon footprint of their cultivation is therefore very low. With increasing levels of carbon dioxide in the atmosphere, these plants are assets for carbon sequestration in Pacific countries when cultivated within traditional agroforestry systems.

The production of food and agricultural products needed by Vanuatu's rapidly growing population represents a major challenge. In some islands of the archipelago, this challenge could be met by cultivating new land that is under forest. However, on most islands, there is limited scope for increasing the area under cultivation. There are numerous reasons for that, including the land tenure system, the absence of roads and/or the topography of the land available. In most cases, increased production will have to come mainly from the intensification of the existing agricultural land. In Vanuatu, the intensification of food gardens also faces several limitations imposed by weeds and the exhaustion of soil fertility. As most farmers do not use fertilisers and/or herbicides, the use of improved cultivation techniques combined with improved rotation, cover crops and intercropping is a necessity. However, while there are indeed challenging obstacles, there is also ample evidence from the past, in the form of remnant agricultural landscapes, that Vanuatu's highly perfected traditional gardening systems once sustained a much larger population even than that of today (Map 4.2).

Table 4.1: List of plants found in agroforestry systems of Vanuatu, their frequency and importance

Scientific name	Bislama name	Type of plant	Species diversity[1]	Frequency in food gardens[2]	Species propagation (planted, protected, spontaneous)[3]	Average no. cultivars per plot[4]	Rank[5]
Adenanthera pavonina	Fumbisu	LIGN	2	1	1	1	
Albelmoschus manihot	Aelan kabish	HERB	5	2	3	3.5	3
Alcalypha grandis		LIGN	2	1	1	1	
Allium cepa	Anion, shalot	HERB	4	1	3	2	4
Alocasia macrorrhiza	Navia	TUB	4	1	3	1	4
Annanas comosus	Paenapol	HERB	5	2	3	1	4
Annona muriata	Corossol	LIGN	3	1	2	1	4
Antiaris toxicaria	Melek tree	LIGN	3	2	1	1	
Arachis hypogea	Peanut	HERB	4	1	3	1	4
Artocarpus atilis	Bred frut	LIGN	6	3	3	4	3
Artocarpus heterophylla		LIGN	2	1	1	1	
Baringtonia procera	Navele	LIGN	5	3	2	1	4
Brassica rapa	Waet bun	HERB	4	1	3	2	4
Burckella obovata	Naduledule	LIGN	3	1	2	1	4
Canarium indicum	Nangai	LIGN	4	2	2	1	4
Canmaruga dorata	Nadigor	LIGN	3	2	1	1	
Capsicum annum	Kapsicam	HERB	5	2	3	1	4
Capsicum frutescens	Pima	HERB	5	3	2	1	4

Scientific name	Bislama name	Type of plant	Species diversity[1]	Frequency in food gardens[2]	Species propagation (planted, protected, spontaneous)[3]	Average no. cultivars per plot[4]	Rank[5]
Carica papaya	Popo	LIGN	4	3	1	3	3
Citrus grandis	Pamplimous	LIGN	4	2	2	2	4
Citrus limon	Lemon	LIGN	3	1	2	2	4
Citrus reticula	Mandarin	LIGN	4	2	2	1	4
Citrus sinensis	Aranis	LIGN	4	2	2	2	4
Cleidion piciflorum		LIGN	2	1	1	1	
Coconus nucifera	Kokonus	LIGN	6	3	3	1	3
Codiaeum variegatum		LIGN	2	1	1	1	
Colocasia esculenta	Wota taro	TUB	4	1	3	2	4
Cordyline fruticosa	Nangaria	LIGN	3	1	2	1	
Cucumis sativus	Kukumber	LIAN	4	1	3	1	
Cucurbita maxima	Pampkin	LIAN	4	2	2	1	3
Cucurbita moschata	Courge	LIAN	4	1	3	2	
Cycas rumphii	Namele	LIGN	2	1	1	1	
Dendrocnide latifolia	Nangalat	LIGN	4	3	1	1	
Dendrocalamus giganteus	Bambu	HERB	3	1	2	1	3
Desmodium umbellatum		LIGN	2	1	1	1	
Dioscorea alata	Soft yam	TUB	6	3	3	6.3	1
Dioscorea bulbifera	Buebue yam	TUB	5	3	2	2.3	3

Scientific name	Bislama name	Type of plant	Species diversity[1]	Frequency in food gardens[2]	Species propagation (planted, protected, spontaneous)[3]	Average no. cultivars per plot[4]	Rank[5]
Dioscorea nummularia	Strong yam	TUB	6	3	3	6.1	1
Dioscorea rotundata	Martinik yam	TUB	4	1	3	1.1	3
Dioscorea transversa	Maru yam	TUB	5	2	3	2	1
Dioscorea trifida	Afrika yam	TUB	4	1	3	1.3	3
Dracotomelon vitiense	Nakatambol	LIGN	5	3	2	1	4
Dysoxylum arborescens		LIGN	2	1	1	1	
Dysoxylum gaudichaudianum	Stingwood	LIGN	2	1	1	1	
Endospermum medullosum	Waet wud	LIGN	2	1	1	1	
Erythrina variegata	Narara	LIGN	3	1	2	1	
Ficus septica	Nabalango	LIGN	4	3	1	1	
Ficus wassa		LIGN	2	1	1	1	
Fluggea flexiosa	Namamao	LIGN	5	3	2	1	
Garuga floribunda	Namalaos	LIGN	2	1	1	1	
Glaodichro sp.		LIGN	2	1	1	1	
Gliricidia sp.	Gliricidia	LIGN	4	1	3	1	
Gyrocarpus americanus	Waet wud	LIGN	2	1	1	1	
Heliconia indica	Liflaplap	HERB	5	3	2	1	
Hibiscus floribundus	Nalalao	LIGN	2	1	1	1	
Hibiscus tiliaceus	Burao	LIGN	5	3	2	1	

Scientific name	Bislama name	Type of plant	Species diversity[1]	Frequency in food gardens[2]	Species propagation (planted, protected, spontaneous)[3]	Average no. cultivars per plot[4]	Rank[5]
Inocarpus fagifer	Namambe	LIGN	5	3	2	1	4
Ipomoea batatas	Kumala	TUB	4	1	3	3	2
Kleinhovia hospita	Namatal	LIGN	4	3	1	1	
Lactuca sativa	Laituce	HERB	4	1	3	1	4
Licuana grandis	Lif umbrella	LIGN	2	1	1	1	
Lycopersion	Tomato	HERB	4	1	3	1	4
Macaranga sp.	Navenue	LIGN	5	3	2	1	
Mangifera indica	Mango	LIGN	5	3	2	2	4
Manihot esculenta	Maniok	TUB	6	3	3	2.9	2
Metroxylon	Natangora	LIGN	5	3	2	1	4
Micromelum minutum		LIGN	2	1	1	1	
Morinda citrifolia	Noni tree	LIGN	4	1	3	1	4
Musa spp.	Banana	HERB	5	3	2	7.5	1
Myristica fatua	Red wud	LIGN	2	1	1	1	
Pandanus tectorius	Pandanus	LIGN	4	1	3	1	4
Persea americana	Avokado	LIGN	3	1	2	1	4
Phaseolus sp.	Bin	LIAN	4	1	3	1	
Piper methysticum	Kava	TUB	5	2	3	2	3
Piper nigrum	Pepa	HERB	4	1	3	1	4

Scientific name	Bislama name	Type of plant	Species diversity[1]	Frequency in food gardens[2]	Species propagation (planted, protected, spontaneous)[3]	Average no. cultivars per plot[4]	Rank[5]
Pipturus argenteus		LIGN	2	1	1	1	
Pometia pinnata	Nandao	LIGN	5	3	2	1	4
Pongamia pinnata		LIGN	2	1	1	1	
Psychotria anaityensis		LIGN	2	1	1	1	
Psychotria trichotoma		LIGN	2	1	1	1	
Pterocarpus indicus	Blu wota	LIGN	2	1	1	1	
Saccharum edule	Naviso	HERB	4	1	3	1	3
Saccharum officinarum	Sugaken	HERB	4	1	3	2	3
Saccharum sp.	Waelken	HERB	4	2	2	1	4
Sechium edule	Chouchoute	LIAN	4	1	3	1	4
Semeocarpus	Naholas	LIGN	2	1	1	1	
Solanum variegatum	Pico	LIGN	2	1	1	1	
Spondias cythera	Naos	LIGN	5	2	3	1	4
Sterculia fijiensis	Open frut	LIGN	3	1	2	1	4
Syzygium maccense	Nakavika	LIGN	5	2	3	1	4
Terminalia catappa	Natapoa	LIGN	2	1	1	1	4
Theoroma cacao	Kakao	LIGN	6	3	3	1	4
Trema orientalis		LIGN	2	1	1	1	
Trichosanthes cucumeria	Snake bin	LIAN	4	1	3	1	4

Scientific name	Bislama name	Type of plant	Species diversity[1]	Frequency in food gardens[2]	Species propagation (planted, protected, spontaneous)[3]	Average no. cultivars per plot[4]	Rank[5]
Vanilla planifolia	Vanila	LIAN	4	1	3	1	4
Veitchia spp.	Palm tree	LIGN	2	1	1	1	
Xanthosoma sagittifolium	Fiji taro	TUB	6	3	3	2.6	1
Zea mays	Korn	HERB	4	1	3	1	4
Zingiber officinale	Ginga	HERB	3	1	2	1	4

HERB = herbaceous

LIAN = climbing or creeping vine

LIGN = woody and lignified

TUB = tuberous

[1] Species diversification in Vanuatu (1 = very low, 6 = very high).

[2] Occurrence of the species in plots (1 = low, 3 = high).

[3] Type of establishment in food gardens.

[4] Average number of cultivars found within species in food gardens.

[5] Sociocultural importance of the species for smallholders.

Source: Adapted from Walter and Lebot (2007).

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