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Ethnobotanical Study of Cultivated Plants in Home Gardens of Traditional Villages in Bali (Indonesia)

Wawan Sujarwo[1,2] · **Giulia Caneva**[2]

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Introduction

Tropical home gardens are important sites for high levels of plant species diversity (Smith 1996; Coomes and Ban 2004). In general, home gardens are characterized by different vegetation strata composed of trees, shrubs and herbs in association with annual and perennial cultivated plants (Fernandes and Nair 1986; Wezel and Bender 2003). The study of home gardens as distinct ecological and cultural entities in agriculture was initiated in the tropics of Southeast Asia in the 1950s, and has continued over the years (Terra 1954; Stoler 1978; Fernandes and Nair 1986; Soemarwoto 1987; Jensen 1993; Vlkova *et al*. 2011). Much ethnobotanical research on home gardens has been carried out among the indigenous people of the tropical developing world (Kumar and Nair 2004; Vlkova *et al*. 2011). These investigations have led to interesting results and new insights into the composition of gardens and plant species richness (Kumar *et al*. 1994; Coomes and Ban 2004; Vogl *et al*. 2004).

The production of fruit and vegetables in home gardens has a long tradition on Bali (Astuti *et al*. 2000). The island continues to be rich in traditional ethnobotanical knowledge (TEK), as confirmed by the general inventory on traditional plant usage (Astuti *et al*. 2000), by detailed investigations on medicinal, aromatic, and cosmetic plants (Leurs 2010), and studies on wild and semi-wild edible plants (Sujarwo *et al*. 2015). Despite this bio-cultural diversity (Agung 2005), we have observed an increasing erosion of TEK over recent years (Sujarwo *et al*. 2014). Although there are ethnobotanical surveys from Bali, to the best of our knowledge there are no ethnobotanical studies of cultivated plants in Balinese home gardens.

We here document indigenous ethnobotanical knowledge of cultivated plants in Bali, Indonesia, and evaluate diversity of home garden plants. The study focuses primarily on the following questions: (1) Which cultivated plants are related to Bali's TEK, found in Balinese home gardens, and how are they used? (2) Which are the most popular cultivated plants and where do they come from? (3) How do structure, species richness, and patterns of similarity compare among the villages in our study?

Methods

Location of the Study Area

The study was conducted on the island of Bali, located at S 07°54′–08°50′ and E 114°26′–115°43′. The study area is between 242 and 1187 m.a.s.l. Most sites in the study area are found in the higher altitudes of the island. The average annual rainfall is between 1182 and 3696 mm. The dry season is from May to October with temperatures sometimes exceeding 32 °C. In the rainy season (November to April) the temperature drops to about 20 to 25 °C. The soil is alluvial and dominated by latosol, regosol, and andosol (Badan Pusat Statistik 2014).

A total of 13 traditional villages were included in the survey, all inhabited by families who have lived in Bali for many generations and therefore posses representative TEK (Astuti *et al*. 2000; Sujarwo *et al*. 2015): Cempaga, Pedawa, Sembiran, Sepang, Sidetapa, Tigawasa (Buleleng regency),

✉ Wawan Sujarwo
wawan.sujarwo@lipi.go.id

[1] Bali Botanical Gardens, Indonesian Institute of Sciences (LIPI), Candikuning Baturiti, Tabanan, Bali 82191, Indonesia

[2] Department of Science, University Roma Tre, Viale G. Marconi 446, Rome 00146, Italy

Jatiluwih, Wongaya Gede (Tabanan regency), Bayung Gede, Penglipuran, Songan, Trunyan (Bangli regency), and Tenganan (Karangasem regency) (Fig. 1). The villagers generally lead a traditional lifestyle and have access to forests or natural areas (Fig. 2) (Badan Pusat Statistik 2014; Sujarwo *et al*. 2015). The size of home gardens in these villages varies between 10×10 and 20×20 m (Fig. 3), and in this form they date back to between 20 and 25 years ago (Astuti *et al*. 2000; Badan Pusat Statistik 2014).

Bali's vegetation is characterized by 1595 species of Spermatophyta, 173 species of Pteridophyta, and 169 species of Bryophyta (Girmansyah *et al*. 2013). About 18.2 % of its surface area is occupied by forests, of which 7.8, 10.1, and 0.3 % are, respectively, primary, secondary, and plantation forest (Badan Pusat Statistik 2014).

Sampling Techniques and Data Collection

Data were collected between May and July 2013 in the survey villages. Following Vogl *et al*. (2004) we conducted both key informant interviews and semi-structured interviews. The respondents (5 females, 45 males) were aged from 14 to 76 years old. Interviews were conducted in Balinese and Indonesian. The interviewees were asked questions related to their ethnobotanical knowledge of plants cultivated in home gardens in their villages (what is the plant called? What parts are used? How are they used?) (Vlkova *et al*. 2011). Respondents were made aware of the aims of this study and Prior Informed Consent was requested verbally. Interviews were conducted following the ethical recommendations presented in Rosenthal (2006).

Plant specimens were identified in the field by the first author. Unidentified specimens were collected, pressed and dried in the field (Martin 2003), and identified at the Herbarium Hortus Botanicus Baliense in Bali's Botanical Gardens, where the collected specimens were deposited. The scientific nomenclature used in this study was derived from existing databases (The Plantlist 2015), and floristic regions were obtained and applied to the data (Takhtajan 1986).

All detailed information on the usage of cultivated plants was first recorded as freely given by informants and then divided into the following five use categories: (1) vegetables, (2) medicines, (3) edible fruits, (4) spices, and (5) edible seeds (Cook 1995). The same plant could fall into more than one use category.

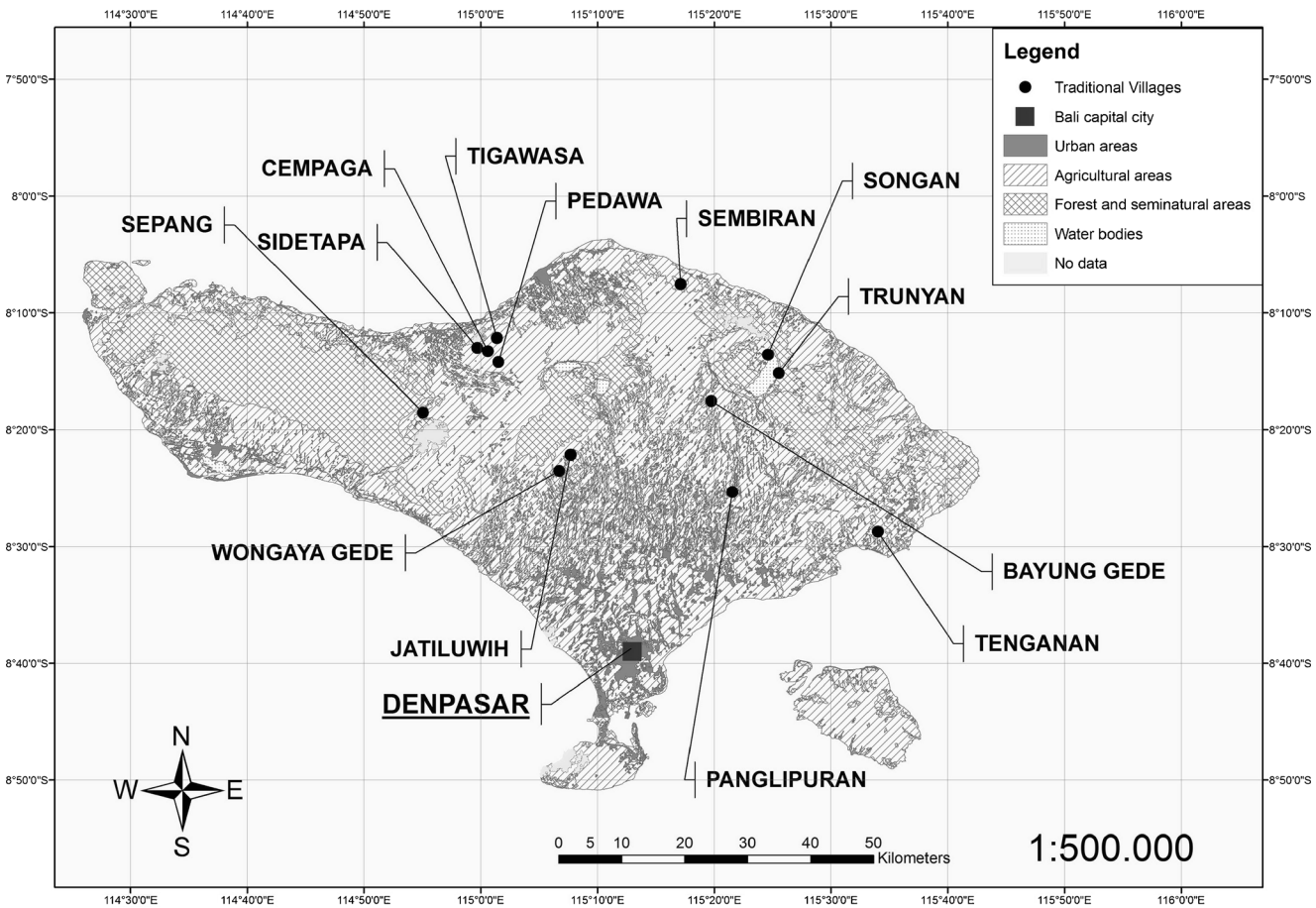

Fig. 1 The island of Bali and the location of the 13 villages in the study

Fig. 2 The village of Tenganan, a village which has a traditional lifestyle and has access to forests or natural areas

Data Analysis

Standard statistical methods were used to calculate data using MS Office Excel. Species richness was estimated using the Margalef index (D_{Mg}) (Magurran 1988, 2003).

$$D_{Mg} = \frac{(S-1)}{\ln(n)}$$

where S was the number of taxa, and n was the total number of all taxa.

Species diversity was calculated using the Shannon-Wiener index (H) (Magurran 1988, 2003).

$$H = -\sum \frac{n_i}{n} \ln\left(\frac{n_i}{n}\right)$$

where n_i was number of taxon i, and n was the total number of all taxa.

Fig. 3 An illustration of a sample home garden's size. Located at the village of Penglipuran [dominated by the banana plant]

Species evenness was calculated using the Pielou index (J) (Magurran 1988, 2003).

$$J = H \Big/ \ln S$$

where H was Shannon-Wiener index and S was the number of taxa.

To compare similarity between the thirteen traditional villages, Sørensen's index of similarity in percentage (Ss) (Müller-Dombois and Ellenberg 1974; Mohan *et al*. 2007) was calculated.

Sørensen's similarities was calculated as $Ss = \frac{2 \times NumberOfCommonSpecies}{Sa+Sb} \times 100$ where Sa was the number of taxa in village A, and Sb was the number of taxa in village B.

Finally, to assess the biological degree of similarity between villages, a cluster analysis on a presence/absence matrix of species was run. This analysis based on the Bray-Curtis similarity algorithm (Bray and Curtis 1957) is used to group objects (in this case, villages) belonging to a given set (the amount of villages) to define subsets (clusters in the final graphical output of the analysis) as homogeneous as possible. Statistical analyses were performed with PAST package ver. 1.94b.

Results and Discussion

Home Garden Composition and Cultivated Plant Uses

The 36 recorded species belong to 20 families and 29 genera (Table 1). The most common families are Zingiberaceae (6 species), followed by Poaceae (5 species), Fabaceae (4 species), Anacardiaceae, Cucurbitaceae, Asteraceae, and Euphorbiaceae (2 species each). The most frequently used parts are leaves, fruits, tuberous roots, young leaves, and young shoots. Most plants are collected throughout the year. In a few cases a single plant part has multiple uses, e.g., the juice or the uncooked ripe fruit of *Cyphomandra betacea* (Cav.) Miers. is used by locals to treat aphthous stomatitis and hypertension.

The results also show that local home gardens are important reservoirs of plant species cultivated for vegetables (46 %), medicines (23 %), edible fruits (20 %), spices (9 %), and edible seeds (2 %). However, 22.22 % of all recorded plants have more than one use category. These multiple uses demonstrate the importance of these plants for subsistence and as a part of local cultural heritage (Addis *et al*. 2005; Shrestha and Dhillion 2006; Ju *et al*. 2013; Sujarwo *et al*. 2015).

Even though almost 2000 species of plants occur in the island of Bali, we only obtained 36 cultivated plants. These plants are known as crops production, but their uses are very traditional, and only exist in a particular area. Our study emphasises the relationship between cultivated plants and

Table 1 List of cultivated plants in home gardens of Bali

Plant families & species	Vernacular names	Life form	Floristic region	Parts used, uses	Traditional Villages
Anacardiaceae					
Mangifera caesia Jack	Wani	Tree	Malesian	Ripe fruit eaten fresh	Jt, Pg, Sg, Tg, Wg
Mangifera odorata Griff.	Poh pakel	Tree	Malesian	Ripe fruit eaten fresh	Sm, Tg, Tw
Arecaceae					
Salacca zalacca (Gaertn.) Voss	Salak	Shrub	Malesian	Ripe fruit eaten fresh	Pg, Sp, Wg
Asteraceae					
Blumea balsamifera (L.) DC.	Daun sembung	Shrub	Malesian	Leaf decoction used for diarrhea, fever, heartburn, constipation	Bg, Cm, Pd, Pg, Sd, Sm, Sg, Sp, Tg, Tr, Tw, Wg
Gynura procumbens (Lour.) Merr.	Sembung dewa	Climber	Malesian, Indochinese	Cooked leaves added to vegetable soups	Pd, Sd, Tg
Caricaceae					
Carica papaya L.	Gedang	Tree	Caribbean	Cooked fruit and young leaves added to vegetable soups	Bg, Cm, Jt, Pg, Sp, Sd, Tg, Tr, Tw, Wg
Clusiaceae					
Garcinia mangostana L.	Manggis	Tree	Malesian	Ripe fruit eaten fresh	Pd, Pg, Sp, Tg
Convolvulaceae					
Ipomoea batatas (L.) Poir.	Ketela rambat	Climber	Caribbean, the Guyana highlands, Amazonian, Brazilian, Andean	Cooked leaves added to vegetable soups	Bg, Cm, Jt, Pd, Pg, Sd, Sg, Sm, Tg, Tr, Wg
Cucurbitaceae					
Luffa acutangula (L.) Roxb.	Pare	Climber	Eastern Asiatic, Malesian	Cooked leaves added to vegetable soups; Edible boiled seeds	Bg, Pd, Sp, Tr, Wg
Sechium edule (Jacq.) Sw.	Labu siam	Climber	Caribbean	Cooked fruit and leaves added to vegetable soups	Bg, Cm, Jt, Pd, Sm, Sp, Tr, Tw, Wg
Euphorbiaceae					
Jatropha curcas L.	Jarak	Shrub	Andean	Leaf decoction used for diarrhea, diuretic; Sap paste used for aphthous stomatitis	Pd, Pg, Sg, Sp, Tg
Manihot esculenta Crantz	Singkong	Shrub	Brazilian	Cooked young leaves added to vegetable soups	Bg, Cm, Pd, Pg, Jt, Sd, Sg, Sm, Sp, Tg, Tr, Tw, Wg
Fabaceae					
Erythrina subumbrans (Hassk.) Merr.	Dadap	Tree	Malesian, Indian	Cooked leaves added to vegetable soups	Bg, Sm, Tr
Phaseolus lunatus L.	Buncis	Climber	Andean	Cooked leaves and seeds added to vegetable soups	Sg
Phaseolus vulgaris L.	Kacang lilit	Climber	Andean	Cooked leaves and seeds added to vegetable soups	Sd
Psophocarpus tetragonolobus (L.) DC.	Kecipir	Climber	Malesian, Indochinese, Indian	Cooked young fruit added to vegetable soups	Pd, Sg, Tr
Lauraceae					
Persea americana Mill.	Apokat	Tree	Caribbean	Cooked young fruit added to vegetable soups	Pd, Pg
Lythraceae					

Table 1 (continued)

Plant families & species	Vernacular names	Life form	Floristic region	Parts used, uses	Traditional Villages
Punica granatum L.	Delima	Shrub	Sudano-Zambezian	Ripe fruit eaten fresh; Roots, fruit, and leaf sap used in dysentery	Sg, Sm
Moraceae					
Morus australis Poir.	Don besar	Shrub	Malesian	Cooked leaves added to vegetable soups; Ripe fruit eaten fresh	Pd, Tr
Musaceae					
Musa paradisiaca L.	Pisang	Herb	Malesian, Indochinese, Indian	Cooked core stems added to vegetable soups	Bg, Cm, Jt, Pd, Pg, Sd, Sg, Sm, Sp, Tg, Tr, Tw
Pandanaceae					
Pandanus amaryllifolius Roxb.	Pandan wangi	Shrub	Malesian	Leaf decoction used for rheumatism and to relax the nerves	Tr
Poaceae					
Dendrocalamus asper (Schult.) Backer	Petung	Tree	Malesian	Cooked young shoots added to vegetable soups	Bg, Cm, Jt, Sd, Sp, Tg
Gigantochloa apus (Schult.) Kurz	Bambu tali	Tree	Malesian, Indochinese, Indian	Cooked young shoots added to vegetable soups	Jt, Sd, Tr
Gigantochloa nigrociliata (Buse) Kurz	Bambu tabah	Tree	Malesian, Indochinese, Indian	Cooked young shoots added to vegetable soups	Cm, Jt, Sd, Sp, Tg, Wg
Saccharum officinarum L.	Tebu	Shrub	Malesian, Indochinese, Indian	Stem sap used for cough	Bg
Schizostachyum lima (Blanco) Merr.	Buluh	Tree	Malesian	Cooked young shoots added to vegetable soups	Cm, Tg
Rutaceae					
Citrus aurantiifolia (Christm.) Swingle	Jeruk nipis	Shrub	Indian	Fruit juice used for cough	Bg
Sapindaceae					
Nephelium lappaceum L.	Rambutan	Tree	Malesian	Ripe fruit eaten fresh	Pg
Sapotaceae					
Manilkara zapota (L.) P.Royen	Sawo	Tree	Caribbean	Ripe fruit eaten fresh	Cm, Sd, Sm, Tg, Tw
Solanaceae					
Cyphomandra betacea (Cav.) Miers.	Terong belanda	Shrub	Andean	Ripe fruit eaten fresh; Fruit juice used for aphthous stomatitis, hypertension	Bg
Zingiberaceae					
Curcuma domestica Valeton	Kunyit	Herb	Indian	Cooked young leaves added to vegetable soups; Tuberous roots used as spices	Bg, Pg, Sg, Tr
Curcuma xanthorrhiza Roxb.	Temu agung	Herb	Malesian	Tuberous root sap used for heartburn	Bg
Kaempferia galanga L.	Cekuh	Herb	Malesian, Indochinese, Indian	Cooked tuberous roots and young leaves added to vegetable soups; Tuberous roots used as spices	Pg, Sg, Wg
Kaempferia rotunda L.	Kunci	Herb	Indian	Cooked tuberous roots and young leaves added to vegetable soups; Leaf decoction used for rheumatism, and to raise body heat	Pg

Table 1 (continued)

Plant families & species	Vernacular names	Life form	Floristic region	Parts used, uses	Traditional Villages
Languas galanga (L.) Stuntz	Lengkuas	Herb	Malesian, Indian	Tuberous roots used as spices	Bg, Pg, Sp, Tr
Zingiber officinale Roscoe	Jahe	Herb	Indian	Tuberous roots used as spices; Tuberous root sap used for cough, rheumatism, headache, and to raise body heat	Sg, Tr

Abbreviations. Villages: *Bg* Bayung Gede, *Cm* Cempaga, *Jt* Jatiluwih, *Pd* Pedawa, *Pg* Penglipuran; *Sd* Sidatapa, *Sg* Songan, *Sm* Sembiran, *Sp* Sepang, *Tw* Tigawasa, *Tg* Tenganan, *Tr* Trunyan, *Wg* Wongaya Gede

traditional uses, for example everyone should know Banana (*Musa paradisiaca*), but the local knowledge, cooked core stems of Banana can be added to vegetable soups, only exists in Bali.

Plant Preferences and Their Floristic Region

The home gardens in the surveyed villages are located close to the houses, and composed mainly of fruit plants. The gardens provide quick and easy access to foodstuffs, such as *Mangifera caesia* Jack, *M. odorata* Griff., *Garcinia mangostana* L., *Persea americana* Mill., *Punica granatum* L., and *Morus australis* Poir. for household consumption.

The top-five cultivated plants cited were *Manihot esculenta*, followed by *Musa parasidiaca*, *Blumea balsamifera* (L.) DC., *Ipomoea batatas*, and *Carica papaya*. These species, with the exception of *Blumea balsamifera*, which is used to treat diarrhea, fever, heartburn, and constipation, are the main food species consumed. The leaf of *Manihot esculenta*, which is the most commonly used of all plant species, and is known by all age groups of the community (Sujarwo *et al*. 2014), is particularly appreciated because it is easy to grow and can be used in a wide variety of dishes. One of Bali's most famous traditional foods is *jukut ares* soups made from the core of the stems of the banana plant (*Musa parasidiaca*) (Sujarwo *et al*. 2015).

Among the cultivated plants recorded and categorized as local food crops, *Salacca zalacca* (Gaertn.) Voss, *Carica papaya*, *Luffa acutangula*, *Phaseolus lunatus* L., *P. vulgaris* L., *Psophocarpus tetragonolobus* (L.) DC, and *Nephelium lappaceum* L. were identified as the most important market-oriented crops. *Ipomoea batatas* and *Manihot esculenta* are both used as food crops and are very valuable cash crops.

In addition to food uses, ten species are used as medicines to treat constipation, cough, diarrhea, dysentery, fever, headache, heartburn, hypertension, rheumatism, aphthous stomatitis, to relax the nerves, as a diuretic, and to raise body temperature. For example, the decoction of leaves of *Pandanus amaryllifolius* Roxb. is used for rheumatism and to relax the nerves. All 36 cultivated plants were cited a total of 479 times by our respondents. The most cited multipurpose species was *Luffa acutangula*, whose cooked leaves are added to vegetable soups, and whose seeds are boiled and eaten. We also documented certain neglected plant species, which were reported by fewer than three informants as grown in their home gardens: *Phaseolus lunatus*, *P. vulgaris* (whose cooked leaves and seeds are used in vegetable soups to treat heartburn), *Saccharum officinarum* L., (used to treat coughs) *Schizostachyum lima* (Blanco) Merr., *Nephelium lappaceum*, *Cyphomandra betacea*, and *Curcuma zanthorrhiza* Roxb. (known in Balinese as *Temu agung*, whose root juice is also used to treat heartburn).

Many plants found in Balinese home gardens are typical of home gardens throughout the Tropics, e.g., bananas, mango, avocado, papaya, *Citrus* spp., cassava, sweet potatoes, *Phaseolus* spp., gourd and sugar cane (Figueiredo *et al.* 1993; Jensen 1993; De Clerck and Negreros-Castillo 2000; Wezel and Bender 2003; Sunwar *et al.* 2006; Mohan *et al.* 2007; Vlkova *et al.* 2011). *Salacca zalacca*, on the other hand, is a species of palm tree native to Java (Indonesia), and has been reported in Balinese home gardens. One of the more popular cultivars throughout the region is *Salak Bali* from Bali (Govaerts and Dransfield 2005).

The floristic regions of the 36 cultivated plants include Malesian (37.50 %), Indian (21.43 %), Indochina (12.50 %), the Caribbean (8.93 %), and the Andes (8.93 %). The first reports of the introduction into Indonesia of plants native to Malesian, Indian, and Indochina appear in an eighth century Javanese charter. This coincides with the introduction of Indian religious and cultural influences during the same period (Terra 1954; Soemarwoto 1987). The presence in Indonesia of plants native to Central and South America is first recorded in the sixteenth century (Simmonds 1976). Home gardens probably originated 10,000 years ago or more, when hunter gatherers discarded domestic refuse containing seeds and other plant matter in the vicinity of their camps and then tended and protected the plants that appeared (Hutterer 1984; Soemarwoto 1987; Casas *et al.* 1996).

Structure, Species Richness, and Patterns of Similarity in Home Gardens

The vertical structure of home gardens in Bali is due to the presence of a large number of trees (33.33 % of all recorded plant species), especially fruit trees (Fig. 4). This finding was also reported by Gajaseni and Gajaseni (1999) and Vlkova *et al.* (2011) in their studies of home gardens in Thailand, Indonesia, and Vietnam. Trees also serve as a support for climbing plants (19.44 % of recorded species) such as *Luffa acutangula*, *Sechium edule* (Jacq.) Sw., *Phaseolus lunatus*, *P. vulgaris*, and *Psophocarpus tetragonolobus*. Other home garden plants are shrubs (27.78 %), perennial herbs (19.44 %), and climbers (19.44 %).

The villages with the highest diversity of cultivated plants (Penglipuran and Trunyan) contained 15 species, whereas those with the lowest had nine species. In terms of number of species per 100 m^2 and per village, Penglipuran and Trunyan were again the most diverse, with a mean of 15 species/100 m^2.

The mean Margalef index, providing an understanding of cultivated plant richness in the study villages, varies from 0.85 to 1.87 (Table 2). Vlkova *et al.*'s (2011) results from their study of home gardens in Vietnam show similar values (0.99–1.51). Mohan *et al.* (2007) report higher Margalef richness in their study of home gardens in India, showing values of 5.43 to 6.42. Their results were attributed to a higher number of recorded plant species.

The Shannon-Wiener index of cultivated plant diversity gives a wide variety of results in tropical home gardens. Bali has a middle mean diversity ranging from 0.92 to 1.13 (Table 2). Similar Shannon indices are reported for South Andaman, with 1.3 (Pandey *et al.* 2007), and Kerala State, India (Mohan *et al.* 2007), with 1.15–1.42. A higher Shannon index is reported by Wezel and Bender (2003), who documented a total of 101 crop species with a mean Shannon index of 1.63–1.79 per village in Cuba, whereas studies carried out in Thailand (Gajaseni and Gajaseni 1999) and Nepal (Sunwar *et al.* 2006) produced Shannon-Wiener indices of 1.9–2.7 and 4.03–4.42,

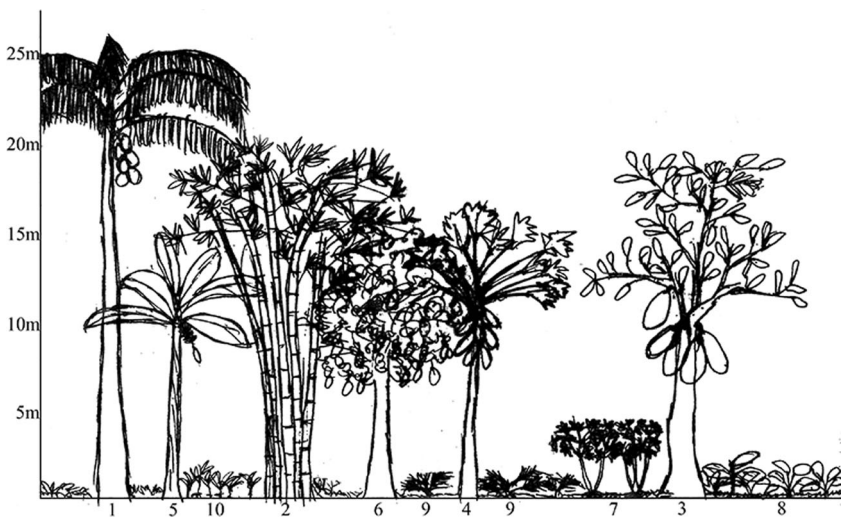

Fig. 4 Typical structure of a home garden in Bali [1=Coconut; 2=Bamboo; 3=Jackfruit; 4=Papaya; 5=Banana; 6=Mango; 7=Cassava; 8=Taro; 9=Vegetable fern; 10=Ginger]

Table 2 Species richness and diversity indices of home gardens in thirteen traditional villages of Bali Indonesia

Traditional villages	Number of species	Margalef index			Shannon-Wiener index	Pielou index
		Average	Min	Max		
Buleleng regency						
Cempaga	10	1.30	0	2.05	0.97	0.97
Pedawa	12	1.54	0	4.31	1.01	0.94
Sembiran	9	1.40	0	2.10	0.93	0.98
Sepang	14	0.85	0	1.99	1.12	0.98
Sidetapa	11	0.91	0	1.43	1.01	0.97
Tigawasa	9	1.01	0	1.51	0.92	0.97
Tabanan regency						
Jatiluwih	9	1.64	0	2.01	0.94	0.99
Wongaya Gede	10	1.67	0	3.21	0.97	0.97
Bangli regency						
Bayung Gede	14	1.40	0	4.16	1.12	0.98
Penglipuran	15	1.76	0	5.04	1.10	0.94
Songan	10	1.87	0	3.12	0.96	0.96
Trunyan	15	1.37	0	4.12	1.13	0.96
Karangasem regency						
Tenganan	12	1.24	0	1.94	1.05	0.98

respectively. A lower Shannon index is reported for Vietnam with mean indices ranging from 0.54 to 0.78 (Vlkova *et al*. 2011).

The Pielou index of evenness is similar across all villages (Table 2). This result indicates that some plant species tend to be concentrated in almost all of the villages (high equitability), although similarities of species richness between villages obtained with Sørensen's index are inconsistent. This means that there is a high degree of variation among villages, with the highest species similarity observed between the villages of Cempaga and Tigawasa (84.21 %) (Table 3).

As for the cluster analysis, villages can be grouped into two different subsets: the first including the villages of Bayung Gede (Bg), Pedawa (Pd), Penglipuran (Pg), Sepang (Sp), Trunyan (Tr) and Wongaya Gede (Wg) (subset 1), while the second included Cempaga (Cm), Jatiluwih (Jt), Sidatapa (Sd), Sembiran (Sm), Tenganan (Tg) and Tigawasa (Tw) (subset 2). The exception was represented by the village of Songan (Sg) which resulted as out-group of the whole set (Fig. 5).

Table 3 Sørensen's index of similarities (in %) of species richness among surveyed traditional villages in Bali Indonesia

	Cempaga	Pedawa	Sembiran	Sepang	Sidetapa	Tigawasa	Jatiluwih	Wongaya Gede	Bayung Gede	Penglipuran	Songan	Trunyan	Tenganan
Cempaga	x	45.45	63.16	58.33	76.19	84.21	73.68	60.00	58.33	40.00	40.00	48.00	63.64
Pedawa	x	x	47.62	53.85	43.48	38.10	38.10	45.45	46.15	51.85	54.55	59.26	58.33
Sembiran	x	x	x	34.78	50.00	66.67	44.44	42.11	52.17	33.33	52.63	50.00	57.14
Sepang	x	x	x	x	48.00	51.17	60.87	66.67	57.14	55.17	33.33	48.28	61.54
Sidetapa	x	x	x	x	x	60.00	70.00	47.62	48.00	38.46	38.10	38.46	69.57
Tigawasa	x	x	x	x	x	x	55.56	52.63	43.48	33.33	31.58	41.67	57.14
Jatiluwih	x	x	x	x	x	x	x	63.16	52.17	41.67	31.58	50.00	50.74
Wongaya Gede	x	x	x	x	x	x	x	x	50.00	56.00	40.00	48.00	45.45
Bayung Gede	x	x	x	x	x	x	x	x	x	40.00	41.67	68.97	46.15
Penglipuran	x	x	x	x	x	x	x	x	x	x	56.00	40.00	59.26
Songan	x	x	x	x	x	x	x	x	x	x	x	56.00	45.45
Trunyan	x	x	x	x	x	x	x	x	x	x	x	x	37.04
Tenganan	x	x	x	x	x	x	x	x	x	x	x	x	x

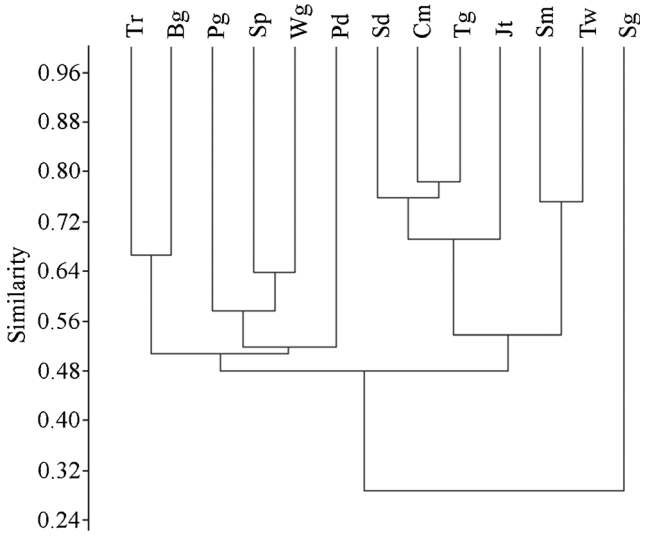

Fig. 5 Cluster tree of Balinese home gardens based on Bray-Curtis's method with villages as measure of similarity

These findings indicate that local knowledge on some cultivated plants only exists in particular villages. For example, the knowledge of preparing vegetables soups from leaves and seeds of butter bean (*Phaseolus lunatus*) can be only found in Songan village. Geographic barrier could be a factor to distinguish local knowledge on cultivated plants among villages. This can be seen that three villages (Bayung Gede, Penglipuran, and Wongaya Gede) from Bangli regency belong to subset 1, and other villages, such as Cempaga, Sidatapa, Sembiran, and Tigawasa, from Buleleng regency belong to subset 2. Interestingly, the village of Pedawa has relatively low similarity values, and different subset, with its three neighbors (the village of Cempaga, Sidetapa, and Tigawasa), this is due to different plant composition in its home garden, local people in Pedawa village prefer to grow clove [*Syzygium aromaticum* (L.) Merr. & L.M.Perry] as dominant plant rather than other cultivated plants.

Conclusion

This study documents cultivated plant diversity in the home gardens of traditional Balinese villages and the respective traditional ethnobotanical knowledge of their inhabitants. In all, 36 cultivated plants were documented of which eight species have more than one use category. The villagers rely on a huge range of both local and conventional crops as food sources. Our results indicate that they maintain the sustainability of their environment by planting many species of plants with various uses in their home gardens.

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