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The final authenticated version is available online at:

<https://doi.org/10.1007/s10457-019-00428-x>

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Ethnobotany, rattan agroforestry, and conservation of ecosystem services in Central Kalimantan, Indonesia

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Received: 19 October 2018 / Accepted: 13 July 2019
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Abstract Rattan agroforestry is an important land use system in Central Kalimantan, Indonesia, providing a wide range of products for subsistence communities. The ethnobotanical importance of rattan includes heritage values reflecting traditional ecological knowledge. This traditional forestry practice is consistent with necessary conservation of biodiversity and ecosystem services currently threatened by expansion of oil palm plantations. We examined species composition and morphology (including life

stages) of vegetation associated with rattan agroforests in the Katingan district, Central Kalimantan. An examination of harvested rattan plots revealed 101 species of vegetation of which 90% are considered to be useful (food, construction materials, medicines) and most (97%) were native species, typical of lowland tropical forest vegetation. Vegetation in the rattan agroforests was dominated by trees (in terms of species richness). There were 80 species of trees, representing 79% of the plants surveyed. *Vitex pubescens* (kaluan) had the highest importance value as it occupied more space, was represented by more individuals and was most frequently found in rattan gardens. These trees in general have a relatively open canopy with strong branches; properties considered ideal to support rattan. Canopy forming species are actively managed to provide for growth of useful understory vegetation (including rattan) important in the livelihoods of village communities. Rattan agroforests also provide cultural services reflecting traditional use (e.g. a sense of belonging and ancestral linkages for local forest-dependent communities). The importance of ethnobotanical approaches to rattan cultivation includes the socio-economic evaluation of land use and the promotion of sustainable land use policies in Indonesia. This is important in the context of oil palm expansion which has a demonstrably adverse impact on ecosystem services.

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s10457-019-00428-x>) contains supplementary material, which is available to authorized users.

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Keywords Ethnobotany · Biodiversity · Rattan
agroforest · Indonesia · Ecosystem services ·
Community development

Introduction

Ethnobotany links ecology to the social sciences: expanding on the role of plants in human society (Phillips et al. 2002; Shad et al. 2013). In the developing world, many communities depend on products (e.g. fruit, vegetables, medicines, building materials) from local agroforestry (Nair 1993; Albrecht and Kandji 2003). The preservation of embedded cultural and traditional ecological knowledge among forest-dependent communities can provide conservation benefits to natural resource management (Fifanou et al. 2011; Galluzzi et al. 2010; Lindenmayer and Possingham 1996; Schroth and McNeely 2011) as we show here for rattan agroforestry in Indonesia.

Rattan agroforestry is one of the oldest farming systems in Indonesia (Belcher et al. 2004; Siebert 2012; Bizard 2013). Rattan cultivation in Indonesia has been developed as part of small-scale traditional swidden agriculture systems which involve cutting and burning areas of forest to prepare the land for temporary cultivation of crops. ‘Rattan’ is the common name for approximately 600 species of plants occurring within 13 genera (Dransfield 2001; Meijaard et al. 2014). They are characterised by their use of spines, formed from modified leaf tips or inflorescences, to anchor the plant to trees which they ‘climb’ to access sunlight (Watanabe and Suzuki 2007). The presence of mature and growing trees (the latter often referred to as poles and saplings) in rattan agroforests are essential to the sustainable cultivation of rattan (Siebert 2012; Widayati et al. 2010). Rattan is cultivated and harvested for its canes which are solid (unlike bamboo), durable, lightweight, flexible and strong (Dransfield 2001; Meijaard et al. 2014; Sastry 2001).

Most farmers in Kalimantan cultivate one or two species of rattan, both with clustering growth forms: rattan sigi (*Calamus caesioides*) and rattan irit (*Calamus trachycoleus*) (Arifin 2006). Sustainable harvesting practices recommend that some stems from each harvested cluster remain uncut, nevertheless a single

cluster of rattan can yield about 20–50 kg of rattan stems. The amount of rattan harvested is usually limited by the capacity of the harvester to carry rattan from the forest to the village (Haury and Saragih 1996).

More generally, agroforestry has obvious economic benefits with a wide range of commercially valuable products (Huai and Hamilton 2009; Alam 2012; van der Wal and Bongers 2013). Ecological benefits arising from agroforestry include the provision of habitat for a number of animal species (Acharya 2006; McNeely and Schroth 2006; Bardhan et al. 2012). Social and cultural values encompass spiritual and heritage values (Afentina et al. 2017). Yet rattan agroforestry in Indonesia is threatened by extensive expansion of oil palm plantations (Broich et al. 2011; Miettinen et al. 2012; Sumarga et al. 2015) with associated loss of biodiversity, and increased carbon emissions (Albrecht and Kandji 2003; Hairiah et al. 2004). In contrast, retention of natural forests in rattan agroforestry provides habitat for important species and allows carbon sequestration (Krankina and Harmon 1994; Smith et al. 1993; Winjum et al. 1992).

Research relating to the ecology of rattan agroforests in Indonesia includes studies on the diversity of rattan (Siebert 2012; Sumarhani and Kalima 2015) and tree species (Adiwibowo et al. 2016). The impact of rattan harvesting on the structure and composition and the carrying capacity of the forest was also studied by Siebert (2001) and Widayati et al. (2010). Most of these studies note differences in the diversity of rattan agroforestry located within secondary (lower diversity) or primary (higher diversity) forests.

Traditional ecological knowledge has been recognized as playing an important role in ecosystem conservation and sustainable development (Acharya 2006; McNeely and Schroth 2006; Mulyoutami et al. 2009; Vallejo-Ramos et al. 2016). Berkes et al. (2000) defined traditional ecological knowledge as ‘a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.’ It arises from close and long relationships with nature (Berkes et al. 2000) and exhibits knowledge and awareness related to local physical and ecological conditions (Vallejo-Ramos et al. 2016). Ecological knowledge transferred across generations may include appropriate methods

for the selection and cultivation of beneficial plants (Antons 2010; Jerneck and Olsson 2013; Barreau et al. 2016; Vallejo-Ramos et al. 2016). Thus, traditional ecological knowledge embracing ethnobotanical practices offers an opportunity to develop a strategy for local livelihoods, sustainable use of natural resources and sustainable development in a broader context. In the present study, we examine the biodiversity and the relationship of other vegetation (trees, vines, understorey plants) with rattan production in Central Kalimantan and, associated with this, the ethnobotanical knowledge displayed by farmers and local community members (Fig. 1). Our findings can be used to develop realistic and functional conservation strategies which can accommodate local sustainable development and biodiversity conservation.

Materials and methods

Study area

The research took place at Tumbang Runen village, in the Katingan District, Central Kalimantan Province, Indonesia from 25 May to 10 September 2015 (Fig. 2). This village occupies 62.5 Ha, and utilises mostly

lowland riparian areas that support rattan agroforestry and shifting cultivation (altitude 13–50 m above sea level). At the time of the study, the village had 349 inhabitants (167 female), distributed among 92 households, (mean 3.8 inhabitants per household). Tumbang Runen village is situated adjacent to Sebangau National Park (east side) and a commercial oil palm plantation (west side).

The Katingan River is the main river that flows from Muller–Schwaner in the north to the Java sea in the south.

More than 60% of people in the Katingan district rely on rubber plantations and rattan as their main sources of income (Eriksen 2016).

Data collection

Plant species present in locations used for the cultivation of rattan were identified and quantified at six locations across rattan agroforests managed by the Tumbang Runen community. The locations were selected so that sampling was undertaken across a range of agroforest types. One 40 m × 100 m biodiversity survey plot (Soerianegara and Indrawan 2002), was established at each of the locations (Fig. 3). Since vegetation type and morphology influence rattan

Fig. 1 Traditional ecological knowledge influences management, biodiversity and ecosystem services provided by agroforestry

Fig. 2 Map of the study area

cultivation, each survey plot was divided into several nested subplots in order to assess several structural classes (and morphology) of vegetation, namely: mature trees (trees with a diameter at breast height (DBH) > 20 cm); poles (trees with DBH between 10 and 20 cm); saplings (trees with DBH < 10 cm); understorey vegetation (vegetation that covers soil surface including shrub, grass, fern and seedlings (trees with height < 1.5 m) and vines (climbing woody vegetation)).

Five sub-plots (20 × 20 m) were used to identify and quantify mature trees. Smaller sub-plots were nested within each of the 20 × 20 m sub-plots to

assess other vegetation classes. 10 × 10 m sub-plots were established to quantify poles; 5 × 5 m sub-plots were used to quantify saplings; and 2 × 2 m sub-plots were established to quantify seedlings and understorey vegetation (Fig. 3).

Identification and measurement of rattan and lianas (vines) was conducted within the 20 × 20 m subplots used for mature tree counts, as this type of vegetation is associated with mature trees. In each subplot, the plant species belonging to each of the categories defined above were identified and counted, the number of individuals of each species recorded, and the DBH

Fig. 3 A line and square plot method (Soerianegara and Indrawan 2002) was used in this study to assess plant biodiversity by life form

of each individual plant (for mature trees, poles and saplings) was measured (to the nearest mm).

The common name of each plant species was obtained from local experts and the scientific names were sourced from previous studies in the same area including Hamard (2008), Harrison et al. (2012), Rotinsulu et al. (2013) and P2RK (2015). The vegetation analyses comprised the calculation of:

- Density (number of stems/ha of mature trees, poles, saplings and understorey vegetation)
- Relative density (Density of one species compared with density of all species, $RD = \frac{D_i}{D}$, where RD = relative density, D_i = density of species i , D = Density of all species).
- Frequency (number of plots in which particular species were found)
- Relative Frequency (Frequency of one species compared with frequency of all species, $RF = \frac{F_i}{F}$, where RF = Frequency relative, F_i = frequency of species i , F = frequency of all species).
- Dominance (number of individuals of a particular species (i) as a proportion of the basal area of individuals of all species, $D = \frac{N_i}{N}$, where N_i = basal area of species i , N = basal area of all species).
- Relative Dominance (Dominance of one species compared with dominance of all species, $RD = \frac{D_i}{D}$, where RD = Relative Dominance, D_i = dominance of species i , D = Dominance of all species)

- Shannon Diversity Index (H') (calculated as $H' = \sum_{i=1}^n p_i \ln p_i$, where: p_i = number of individuals of species i divided by the number of individuals of all species; and n is the number of different species).

- Species Richness Index (R) (calculated as $R = \frac{S}{\ln N}$, where S = total number of species, N = number of individuals of all species).

- Evenness Index (E) (a measure of the distribution of species in all observation plots, calculated as $E = R = \frac{H'}{\ln S}$, where H' = Shannon diversity index and S = total number of species) Importance Value (IV) (calculated by summing the relative density, relative frequency and relative dominance).

Ethnobotanical information regarding species identified in rattan agroforestry, and an associated evaluation of traditional ecological knowledge, was obtained through in-depth interviews with local community members and in situ observations of the uses of vegetation found in rattan agroforests. This qualitative approach aimed to identify ethnobotanical approaches consistent with the maintenance of ecosystem services, including cultural services (Creswell 2007; Carlsen and Glenton 2011). The first stage in selecting key informants involved consultations with the village leaders. Leaders were considered to be well placed to recommend potential participants based on the selection criteria. Direct contact was then made with potential informants to gain consent from them with regard to their participation in the study. In-depth face

to face interviews were conducted in the local language (*Dayak Ngaju*). Such respondents were able to identify and explain the use of various plant species in situ. There were ten in-depth interviews in total: three interviews with customary leaders (*Ketua Adat*), four interviews with village elders, and three interviews with rattan farmers and practitioners of traditional medicine (Table 1). A customary leader typically holds knowledge about customs, rituals and culture in the village. The usage of plant species was determined during interviews with participants in the rattan agroforests; further information about usage was acquired while seeking the local names of plants during in situ observation of rattan agroforestry. Plant species described as useful by members of the local community were classified into 12 categories: food, medicine, fuelwood, traditional ceremonies, handcraft, fishing tools, animal fodder, latex, cosmetics, food preparation, construction (of boats) and construction (of houses, bridges and other infrastructure).

Results

A total of 101 species of plants was identified in the six rattan gardens surveyed. Thirty-four plant families were represented, with *Anacardiaceae* the most common. Most (97%) were native species, typical of lowland tropical forest vegetation. Only four exotic species were found within rattan gardens. The number of vegetation species recorded in rattan agroforest was 75% of the number of plant species recorded in the adjacent National Park (Nugroho 2011).

Vegetation in the rattan agroforests was dominated by trees (in terms of species richness). There were 80

species of trees, representing 79% of the plants documented. Other growth forms included shrubs, lianas, palms and ferns. Compared with other vegetation classes, plants comprising the understorey vegetation showed the highest density (53,000 individuals/ha). Densities of other classes were: saplings (1000 individuals/ha), poles (316 individuals/ha) and trees (178 individuals/ha).

Tree species were relatively diverse (relatively high Shannon Diversity Index) compared with poles, saplings and seedlings (Table 2). However, trees were less evenly distributed compared to poles as revealed by the Evenness Index (E) (Table 2). Understorey vegetation had the highest species richness compared with other growth forms (Table 2) but seedlings were not dispersed evenly across the rattan garden (Table 2).

From an ecological perspective, *Vitex pubescens* (kaluan) was the most important mature tree species in the rattan gardens surveyed (Table 3). This species had the highest Importance Value (IV) as it occupied more space, was represented by more individuals and was most frequently found in rattan gardens. *Vitex pubescens* trees in general have a relatively open canopy with strong branches; properties considered ideal to support rattan. *Havea brazillensis* (karet) had the highest IV score for both pole and sapling criteria, indicating that farmers maintain this species in rattan gardens. *Havea brazillensis* is valued for its latex. *Syzygium havilandii* (tatumbu) dominated the seedling criteria with an IV score 13.4% (Table 3).

Interviews with community members revealed that most villagers utilise natural resources, many of which are found in rattan agroforests. About 90% (91 plant

Table 1 Profile of key informants

No.	Age	Gender	Role in the community/occupation
1	52	Male	Customary leader
2	67	Male	Customary leader
3	73	Male	Customary leader
4	68	Female	Village elder
5	75	Male	Village elder
6	80	Female	Village elder
7	75	Male	Village elder
8	68	Female	Practitioner of traditional medicine/rattan farmer
9	66	Male	Practitioner traditional medicine/rattan farmer
10	55	Male	Practitioner traditional medicine/rattan farmer

Table 2 Diversity, species richness and evenness index of various forms of vegetation in rattan agroforests Tumbang Runen village sampled during June–August 2015

Parameter	Mature tree	Pole	Sapling	Understorey vegetation
Shannon diversity index (H')	3.46	3.29	2.94	3.43
Species richness index (R)	8.92	7.69	6.02	9.77
Evenness index (E)	0.89	0.92	0.89	0.82

Table 3 Importance Values for plant species of various life forms found in rattan agroforests in Tumbang Runen village Katingan District

Growth stage	Relative density (%)	Relative dominance (%)	Relative frequency (%)	Importance value (%)
Mature tree				
<i>Vitex pubescens</i>	11.06	10.51	9.43	31.00
<i>Havea brazillensis</i>	8.76	8.49	5.03	22.28
<i>Diospyros</i> sp.	5.53	7.71	4.40	17.64
<i>Artocarpus</i> sp.	4.61	4.81	6.29	15.71
<i>Gluta velutina</i>	4.15	6.26	3.77	14.18
Pole				
<i>Havea brazillensis</i>	10.53	10.32	7.23	28.08
<i>Syzygium havilandii</i>	8.42	5.87	7.23	21.52
<i>Pternadra</i> sp.	6.32	7.25	7.23	20.79
<i>Polyalthia hypoleuca</i>	7.37	8.57	4.82	20.76
<i>Dillenia excelsa</i>	6.23	6.03	6.02	18.38
Sapling				
<i>Havea brazillensis</i>	14.67	13.21	11.29	39.17
<i>Planchonella maingayi</i>	9.33	9.61	9.68	28.62
<i>Pternadra</i> sp.	8.00	9.18	9.68	26.86
<i>Elaeocarpus mastersii</i>	12.00	9.84	3.22	25.06
<i>Syzygium havilandii</i>	6.67	8.04	8.06	22.77
Understorey vegetation				
<i>Syzygium havilandii</i>	8.06		5.33	13.39
<i>Euthemis leucarpa</i>	8.69		4.37	13.06
<i>Dillenia excelsa</i>	5.85		6.79	12.64
<i>Elaeocarpus acmocarpus</i>	6.48		5.34	11.82
<i>Pilodendron mamei</i>	8.69		2.43	11.12

species) of the total number of plant species sampled in rattan agroforests were reported to be utilised.

Members of the local community typically consume the fruits or the young part of many plants found in rattan agroforests. Such food items complement rice and fish, which form the main diet of villagers. Fruit is harvested across the dry (April–September) and rainy seasons (November–March); and is usually eaten fresh

or stored only for a day or two. Juveniles of *Calamus caesi* (rattan sigi) and *Stenochlaena palustris* (kelakai) plants are sold as vegetables to villagers at the local market or to workers at the palm oil company near the village.

Trees found within rattan agroforests and used for construction materials included *Koompassia malaccensis* (bengaris), *Shorea albida* (meranti) and *Vitex*

pubescens (kaluan). Wood is the main source of energy for cooking in Tumbang Runen village and the trunks and branches of many tree species are utilised as fuel wood. Fuelwood is usually collected from surrounding forests and only occasionally taken from rattan agroforest. Trees utilised for construction and fuel wood are taken whole, i.e. they are destroyed. Local people used fruit, leaves, bark and roots of vegetation found in rattan agroforest for traditional medicine. In total, 18 species were identified as useful for medicine.

Vegetation in rattan agroforests also contributes to the cultural wellbeing of village residents. Interviews with key informants revealed that nine species are used in traditional ceremonies. For example, *Ficus benyamina* (lunuk) is considered a sacred tree, home to powerful spirits. Offerings are often placed at the base of these trees. In terms of morphology, the local community perceived *Ficus* trees as charismatic, with big, strong trunks and dense canopies. Another example of the cultural use of vegetation is the use of leaves and flowers of *Cinnamomum sintok* (kajunjung), *Leea indica* (mamali) and *Baccaurea bracteata* (hampuak) in wedding ceremonies. Rattan also plays an important part in traditional ceremonies. For example, rattan is used to bind animals for sacred offerings.

Rattan is used as material for handicraft and for the construction of useful articles. Local people, particularly women, use rattan to make baskets, mats, and ornaments. Rattan is also used as a construction material, for example temporary buildings in gardens, or in the construction of fishing traps.

Other minor usages of vegetation from rattan agroforest include fodder for animals, fishing tools, cosmetics and food preparation. Only 2 or 3 vegetation species were identified as useful for these purposes (Table 4 of Electronic Supplementary Material, Fig. 4).

Rattan farmers use knowledge passed down from their ancestors to manage and utilise plants in their rattan gardens, stewardship of which is also passed down from older to younger generations. This ethnobotanical knowledge includes how to select and manage trees in their rattan garden. As a climbing palm, rattan needs trees on which to climb to compete for and access sunlight in the forest canopy. Thus trees, and their morphology, are important in rattan cultivation. Rattan farmers prefer trees with strong

trunks and branches, since these make good climbing frames for rattan, but also those which form an open canopy to allow sunlight to penetrate to the forest floor. This morphological preference was reflected in the dominant mature tree species found in our plots. Thus, interviews with key informants revealed a preference to cultivate the following trees: *Vitex pubescens* (kaluan), *Elaeocarpus mastersii* (bangkianang bangamat), *Croton laevifolius* (belanti), *Licania splendens* (bintan) and *Ilex cymosa* (kamasira). Younger trees with a diameter greater than 50 cm are usually removed from rattan agroforests to maintain an open canopy so that light can reach growing rattan. Farmers consider several factors in relating to the utility of the tree. Farmers keep sacred trees e.g. *Ficus* sp. (lunuk) with diameters greater than 80 cm. Farmers also preserve trees or shrubs that can be utilized as food, medicine, construction materials or other provisioning services.

Farmers typically ring-bark (girdle) unwanted trees in order to remove them. This method results in the death of the tree but this has limited impact on surrounding vegetation compared with a direct felling method, since the tree remains standing for many years. Accordingly, collateral damage to other vegetation especially seedling and understory vegetation is reduced by traditional approaches to agroforestry.

Discussion

Rattan agroforestry in Tumbang Runen village supports a wide range of plant species. The biodiversity of vegetation in rattan agroforest was considerably higher (101 species), compared with that reported in studies of other agroforestry systems in Kalimantan. For example, Ihalainen (2007) reported 73 species in rubber agroforests in west Kalimantan; and Sumarhani and Kalima (2015) reported 22 species in Tembawang agroforest, a mixed forest in West Kalimantan.

A study by P2RK (rattan farmer association) in rattan agroforests in three villages (including Tumbang Runen) in the Katingan regency found 62 bird species from 29 families and 20 mammal species from 12 families (P2RK 2015). Some animals found in rattan agroforests include vulnerable species, for example, Horsfield's tarsier (*Tarsius bancanus borneanus*), sun bear (*Helarctos malayanus*), Sunda clouded leopard (*Neofelis diardi*), and bearded pig

Fig. 4 Number of plant species in each category of utilization

(*Sus barbatus*). Endangered species inhabiting rattan agroforests include orangutan (*Pongo pygmaeus wurmbii*), ungo or Bornean white-bearded gibbon (*Hylobates albibarbis*), and bekantan or proboscis monkey (*Nasalis larvatus*) (P2RK 2015).

The demonstrated capability of rattan agroforests to support plant biodiversity and to provide habitat for animals is consistent with biodiversity conservation and associated ecosystem services. The role of agroforestry in conservation and sustainability development has been widely recognized as it is an integrated approach to achieve sustainable land use due to its environmental value and production benefits (Jose 2009; Fifanou et al. 2011; Schroth and McNeely 2011; Sharma and Vetaas 2015; Kuyah et al. 2016). By supporting the need for food, timber, fibre, fodder, and other important products, agroforests provide an alternative to deforestation and to forest degradation (van Noordwijk et al. 2008; Jose 2009; El Tahir and Vishwanath 2015; Sinare and Gordon 2015). Biodiversity and other ecosystem services present in rattan agroforests are in stark contrast to the loss of ecosystem services evident for oil palm forests (Fischer et al. 2008; Koh and Wilcove 2008; Phalan et al. 2011; Kremen 2015; Azhar et al. 2017).

The key to the high plant biodiversity in rattan agroforests is the management system based on

traditional wisdom and the ethnobotanical value of rattan which promotes the growth of a wide range of vegetation types and morphologies. Plant species present in rattan gardens are traditionally used for wide variety of purposes ranging from direct benefits such as food, construction material and medicine to more intangible benefits such as spiritual and cultural uses. As Tumbang Runen village is remote from major cities in the Katingan Regency, traditional medicine plays an important role in addressing health issues. The farmers value almost every plant in the rattan garden. Even though some species are not used directly, farmers recognise additional benefits. For example, *Lepisanthes amoena* is not used by farmers but this plant is important as a source of food for birds. *Diospyros pseudomala* is used as food by orangutans (*Pongo pigmaeus*). Local communities encourage orangutans to live in rattan agroforest because they know that orangutans are an endangered species and protected by law.

The high diversity of vegetation in rattan agroforests reflects relatively benign human intervention. The low management intensity practised in rattan gardens allows natural succession processes to occur. In their assessment on benzoin and rattan agroforestry in Indonesia, García-Fernández and Casado (2005) concluded that the vegetation composition and

structure in agroforest systems are driven mainly by natural succession processes. Weeding, pruning and felling activities occur infrequently, about once or twice a year, and are only conducted around the rattan cluster.

Maintenance of certain vegetation species inside the rattan agroforests is mostly utilitarian. The main product of rattan agroforest is the stem of the rattan palm. In particular, stems from *Calamus caesius* and *Calamus trachycoleus* have a high economic value. In the 1990s, these two species attracted a price of IDR 200,000 (US\$ 20 per 100 kg). More recently, improved prices offered to Central Kalimantan farmers certified by FSC demonstrate both economic and ecological benefits of NGO-led campaigns against unsustainable forestry (Miteva et al. 2015; WWF 2017). The farmers utilise the vegetation in their farms as a source of food (leaves, fruits, sprouts), medicines, fuelwood, construction material and fodder. However, forest-dependent communities also value forest biodiversity for its cultural significance, and aesthetics (Vallejo-Ramos et al. 2016).

Palm oil plantations are expanding rapidly in the study area, replacing natural forests and areas of traditional land use. In response to this issue, the promotion of rattan agroforestry as a conservation tool is critical. Inclusion of traditional ecological knowledge and customary management practices into conservation strategies can create realistic and functional conservation programs. Rattan agroforestry demonstrates that biodiversity conservation does not necessarily sacrifice economic development in rural areas in the tropics particularly as consumers increasingly choose products on the basis of certified social and ecological benefits (Miteva et al. 2015). Various products generated from rattan agroforests fulfil the local people's basic needs for nutrition, material and energy. Rattan agroforests represent a self-sufficient system that is particularly important in a rapidly changing physical, social and economic environment.

Acknowledgements This study is part of PhD research supported by Australia Award Scholarship. We thank the people in Tumbang Runen village who willingly helped and participated in this research. Two anonymous reviewers contributed useful suggestions which we have incorporated.

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