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Farmers and tumpang sari: Case study in Palintang Hamlet, Cipanjalu Village, Bandung, Indonesia

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Abstract. *Iskandar BS, Iskandar J, Wibawa HA, Partasasmita R. 2017. Farmers and tumpang sari: Case study in Palintang Hamlet, Cipanjalu Village, Bandung, Indonesia. Biodiversitas 18: 1135-1149.* People of Palintang hamlet are recognized as one of the local communities reside in the high land of surrounding forest of Manglayang Mountain of West Java, Indonesia. Based on ecological or environmental history, they initially practiced the swidden farming in the natural forest of Manglayang, West Java. Moreover, some of them involved as labor in various activities of the culture systems during the Dutch colonial. After Indonesian independent, they have participated as laborer in the *tumpang sari* program of the Forest Service (*Dinas Kehutanan*) and the State Forestry Corporation (*Perhutani*). Nowadays,farmers of Palintang have intensively cultivated the pine forest for planting cash crops, including cabbage and potatoes. As a result, the farming practice in the forest has caused dilemma between providing cash income for local people and endangering the stability of environment for the near future. This paper presents the findings of research on the development of agro-ecosystems of a the Palintang people, in relation to social-ecological-changes, particularly the forest ecosystem changes. The method used in the study was combination of qualitative and quantitative. The result of study shows that the farmers of Palintang have continuously cultivated the forest for *tumpang sari* since the Dutch colonial period until now. Today, they have farmed the agro-ecosystems of the homegarden and mixed garden in their village land, and have intensively farmed vegetable garden in the forest of the *Perhutani*. Based on the inventory of crops in the mixed-garden (*kebun* or *kebun campuran*) and home garden, it was recoded 47 species and 42 species, respectively. The vegetables and fruits were predominantly found in both the mixed-garden and homegarden. The practice of the commercial vegetable crops as *tumpang sari* in the forests of the *Perhutani* has provided some benefits, including fulfilling cash income for farmer households, but some negative impacts on environment, such as pollution of pesticides have also occurred.

Keywords: Environment destruction, forest, farmers, tumpang sari, vegetable crops

INTRODUCTION

Based on ecological or environmental history, initially rural people of the high land of West Java or Preanger (name in the past) practiced the swidden farming (*huma*) system instead of the wet-rice farming (*sawah*) system. They planted the dry land rice (*padi gogo*) in the forest by cutting and burning forest. Due to in the past the rural population of the highland Preanger was low and the land were still covered by large forest area (Breman 2014). The first report of irrigated wet rice farming (*sawah*) penetration from Central Java into the high land came as late as 1750 from the Sumedang and Tasikmalaya areas approximately half century later from the somewhat larger and higher plateau basin of Bandung and Bogor to the West (Terra 1958; Geertz 1963; Christanty 1989).

Rural people of the high land of Preanger cultivated the dry land rice in the forest by rotation system. The plot of mature forest was selected. Moreover, it was cut and all vegetation biomasses were burned during the dry season. Before the rainy season, the land was planted by local dry land rice varieties and various annual non-rice crops, including various beans, cucumber, and cassava. After harvesting rice, the swidden field was fallowed between 5 and 10 years due to soil fertility decreased and it was regrown by succession of immature and lately become mature forest. The swiddeners moved to other forest areas and cultivated the dry land rice in the same procedure as mentioned earlier. After soil fertility of the fallowed land had been recovery by reason of top soil get matter of litters. Moreover, the fallowed mature secondary forest was recultivated by the dry land rice. The rural people practiced the swidden farming system was based on the local knowledge, identically named as the local ecological knowledge or traditional ecological knowledge system, and cosmos or belief system(cf. Toledo 2002; Berkes 2008; Iskandar and Iskandar 2016a). In terms of the local ecological system, for example, the farmers owned knowledge on various flora, fauna, soil types, soil fertilities, climate, and pests. In addition, almost in every stage of the swidden farming activities, such as cutting shrubs, planting and harvesting was performed by

traditional ritual due to farmers' belief in the rice goddess which is locally named as *Nyi Pohaci* in the Sundanese or *Dewi Sri* in the Javanese (cf. Iskandar and Iskandar 2017). Since the swidden farming system was practiced based on the local ecological knowledge and cosmos, population still low, and economic subsistence, the destruction of environment was avoided. Indeed, the swidden system was traditionally practiced in sustainable system (cf. Conklin 1957; Dove 1985; Padoh 1986).

The swidden farming system of the high land of Preanger was seriously changed due to the Dutch Colonial Government policy that the swidden faming system was legally prohibited due to cut and burn forest and considered as disturbing forest and soil fertility (cf. Kools 1935). Ironically, at the same time, the forest areas of high land of Preanger was enormously cut and dramatically converted to commercial garden through the culture system (*cultuur stelsel* or *tanam paksa*) which was practiced in the 1830-1870 (Gertz 1963). Based on the culture system program, the forest areas were predominantly planted by various crops, including tobacco, pepper, coffee, and cinchona that were considered as commercial commodities and highly demanded in Europe. Consequently, huge area of forest in high land of Preanger was inevitably opened (Boomgaard 1997). Indeed, biodiversity of flora and fauna extremely decreased due to converted by commercial crops.The end of the culture system, it was introduced the Agrarian Law in 1870. Based on the Agrarian Law, the forest land was leased to land lords for approximately seventy five years. As a result, some commercial private plantations of tobacco, coffee, tea, and cinchona were established in some areas of Preanger high land (Kunto 1986). After Indonesian independent, the former Dutch plantation was taken over by the Indonesian Government. While the production forest was managed by the Forest Service (*Dinas Kehutanan*) of West Java, thereafter it was managed by the State Forestry Corporation (*Perhutan*i). Since the Dutch Colonial, the rural people of West Java were involved in various jobs of forest management as laborers. For example, they involved in the *tumpang sari* program activities (cf. Peluso 1992). The *tumpang sari* was initially intended to plant forest trees that are combined with annual crops. In addition, this term has popularly used as planting crop with mixed-cropping between annual and perennial. Indeed, some studies on ecological history of the forest in relation to the government policy, and involvement of rural people in the *tumpang sari* program over time in Java have been studied by some scholars (Geertz 1963; Peluso 1992; Boomgaard 1997; Nawiyanto 2009).

Because the demand of agricultural land has increased, the forest areas of the high land are extensively cultivated by rural people, particularly for planting commercial vegetables. As a consequence, some areas of the high land of West Java, such as Lembang, Ciwidey and Garut have been popularly known as center of vegetable production (cf. Hardjono 1991). The vegetable farming has provided income for rural people who reside in the surrounding forest. However, the vegetable farming practiced in the steep terrain of highland forest of West Java without making terracing land has also caused of environmental destructions, such as soil erosion and land degradation (cf. Hardjono1991; Brookfield 1997). The Palintang people of Cipanjalu village recognized as one of the upland village communities of West Java who have continuously involved with farming in the forest ecosystem. In the past they traditionally engaged in the swidden farming system to cultivate upland rice in the forest. Today, the Palintang people are different from the Baduy of South Banten, Kasepuhan of South Sukabumi, Kemang of Cianjur, and Karangwangi of Cianjur in that they have not persistently engaged in the swidden farming (Iskandar 2007; Adimihardja 1989; Kosuko et al. 2013; Iskandar et al. 2016). Indeed, the Palintang people have not cultivated the irrigation rice field (*sawah*) system. However, until now they have generally acquired the household income, particularly food supply. The Palintang people have been maintaining the sustainability of their livelihoods because they have been able to develop some social-ecological resiliencies, including the development of the *kebun campuran* (mixed garden) system and the *pekarangan* (homegarden) system in their land village, and continuously engaged in the farming of the forest (the *tumpang sari*), namely cultivated the commercial vegetables. In other words, the Palintang people have developed adaptation capacity to various social-ecological changes, particularly the forest ecosystems to maintain their livelihoods (cf. Barkes and Ross 2013). According to Barkes and Ross (2013), the community strength that assist the development of resiliency obviously vary from community to community, and the most import ants of these namely people-place connection, values and beliefs, knowledge, skill and learning, social networks, engaged government (involving collaborate system), a diverse and innovative economy, community infrastructure, leadership; and a positive outlook, including readiness to accept change.

The paper elucidates the development of agro-ecosystem of a highland West Javanese hamlet in relation to social-ecological-changes, particularly the forest ecosystem changes over time. The Palintang area was chosen as location for case study due to some reasoning, including the people of Palintang people have practiced the *tumpang sari* for a long time, since the Dutch colonial until today; and they did not have irrigated rice field (*sawah*) but getting income from the *tumpangsari* in the mixed-garden, the homegarden, and the vegetable garden in the forest. In addition, the practicing of the *tumpang sari* system of the Palintang has dramatically changed recently due to various factors, such as population increase and intensive market economic penetration. As a consequence, although the commercialization of the *tumpang sari* system of both in the mixed-garden and the vegetable garden of the forest of the *Perhutani*, it has caused dilemma between providing income for rural people and causing of environmental destruction for the near future.

Four aspects will be elucidated in this paper namely: (i) historical change of natural forest of the Palintang since the Dutch colonial until today; (ii) establishment of settlement and homegarden, and development of mixed-garden of the Palintang people; (iii) the vegetable trading of Palintang

high land people; and (iv) the intensive the vegetable farming of the *tumpang sari* of the Perhutani forest, and dilemma between providing income for the rural people and environmental destructions.

MATERIALS AND METHODS

Study area

This research was carried out in the Palintang hamlet, Cipanjalu village, Cilengkrang sub-district, Bandung district, West Java, Indonesia (Figure 1). Geographically, the Palintang hamlets is located at approximately latitude 107^0 43' 30"-$107^0$44'00" North and longitude $6^0$45'15"-$6^0$51'30" East. The Palintang is a high land that lies of north of Bandung city, West Java. It is located in approximately latitude 800-1,400 m above sea level, with has air temperature between 18^0 and 20^0 Celsius. The Palintang hamlet is surrounded by pine forest and cinchona plantation of Bukit Unggul of PTPN VIII, Lembang, the pine forest of Manglayang Barat to the East, the pine forest of Gunung Pulosari, and the pine forest of Manglayang Barat to the South. The location of Palintang hamlet is approximately 7 km from the capital of Ujung Berung sub-district, Bandung municipality to the south, and approximately 23 km from the Lembang of Bandung district to the north. To reach this area by vehicle requires a travel time of less than 30 minutes from the direction of Ujung Berung to Lembang area crossing the asphalt road.

Initially in 1830s, the hamlet of Palintang, Cipanjalu village consisted of several houses. Furthermore, since the population had increased, the number of houses also increased. Indeed, after Indonesian Independent, the population of Palintang has rapidly increased. For example, population of Palintang hamlet in 1999, 2004, 2008, 2010, and 2015 was recorded 420 individuals, 840 individuals, 1,345 individuals, 1,945 individuals, and 2,545 individuals, respectively (Cipanjalu statistical data, 2015). About 75 per cent of people of Palintang have main occupation as farmer and farmer laborer. They have predominantly practiced the *tumpang sari* in their own land for cultivating the mixed-garden and the homegarden in the village and the cultivating commercial vegetables *tumpang sari* in the forest of the State Forestry Corporation (*Perhutani*).

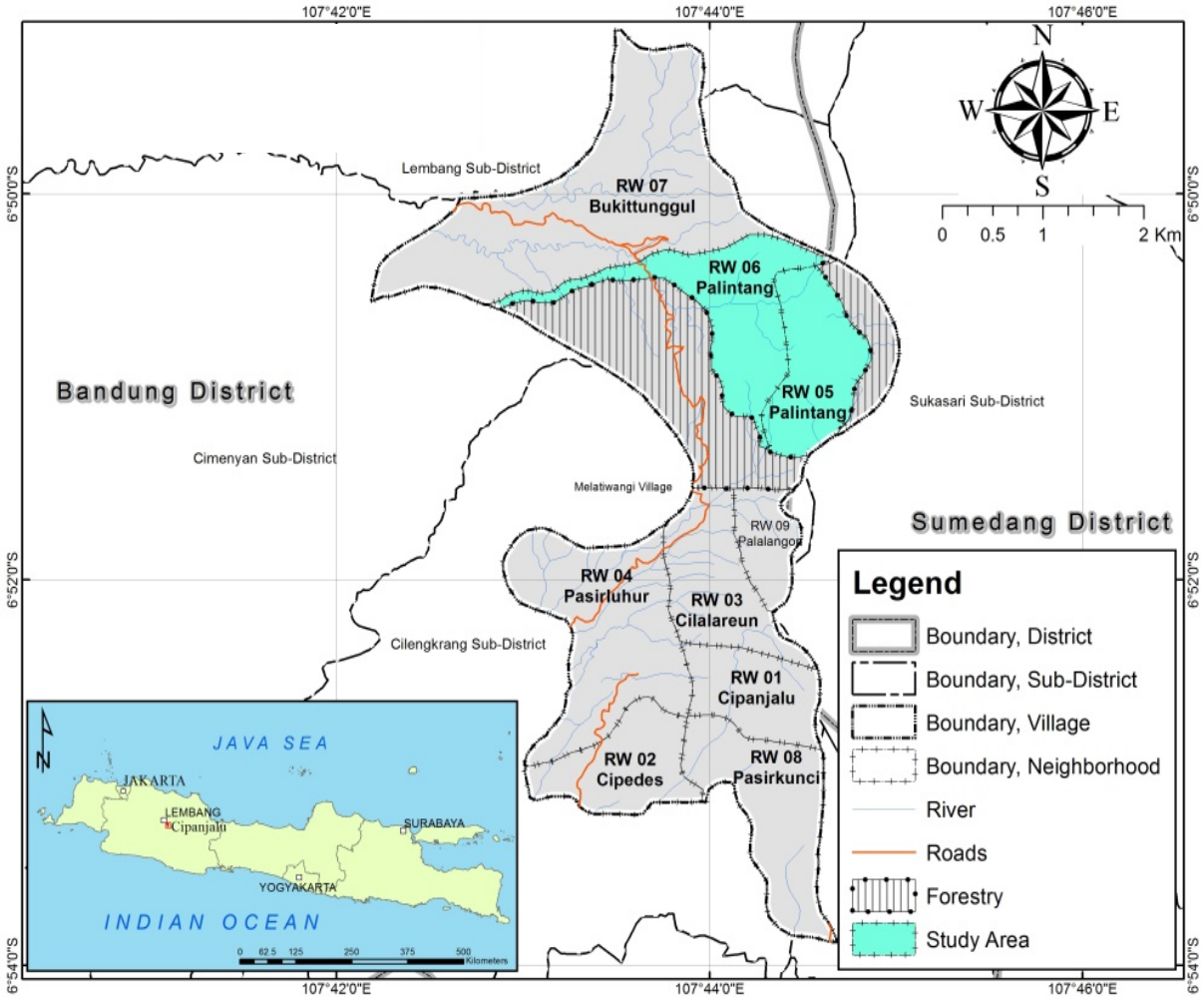

Figure 1. Study site Palintang hamlet, Cipanjalu village, Cilengkrang sub-district, Bandung district, West Java, Indonesia

Procedure

Method used in this study was mixed method, dominant qualitative and less dominant of quantitative (Cresswell 1994). Some techniques namely observation and interview were applied to collect field data (Cresswell 1994, Newing et al 2011). In addition, the survey of plants was undertaken. The observation was applied to observe the condition of the human resettlement, the homegarden, the mixed-garden and the forest. The deep interview was undertaken to competent informants, such as informal leaders, formal leaders, old male and ffemale famers, middlemen, and the State Forestry Corporation (*Perhutani*) staff that were purposively carried out. While inventory of plants , it was undertaken based on 46 samples of home garden and 26 samples of mixed-gardens that was based on randomly selected from the total population.

Data analysis

The qualitative data was analyzed by cross-checking, summarizing and synthesizing from various sources, namely observation, semi-structure or deep interview, and secondary data; moreover, it was descriptively narrated (Newing et al 2011). Various plants of the homegarden and garden were identified in the taxonomy and herbarium laboratory of the Department of Biology, Padjadjaran University. While to analyze data of relative population of plant community was used SDR (Summed Dominant Ratio) index of Numata 1974 (Iskandar and Iskandar 2016), namely:

$$SDR = \frac{Fr + Dr}{2}$$

Where:
SDR = Summed Dominant Ratio,
F = Frequency,
Fr = Relative Frequency,
D = Dominance,
Dr = Relative Dominance

$$F = \frac{\text{Number of homegarden or garden samples is found a species}}{\text{Total number of homegarden or garden samples}}$$

$$Fr = \frac{\text{Frequency of a species}}{\text{Sum frequency of all species}} \times 100$$

$$D = \frac{\text{Number of individual of species a}}{\text{Total number of individual of all species}}$$

$$Dr = \frac{\text{Dominance of a species}}{\text{Dominance of all species}}$$

Plant species which high SDR index can be inferred such species is predominantly found and high individual number in the homegarden or mixed-garden.

RESULTS AND DISCUSSION

Historical change of forest

Based on ecological or environmental history of West Java, the high land forest ecosystem of West Java, including the high land of Palintang area, Cipanjalu village, northern Bandung, has changed over time (cf. Geertz 1963; Elson 1994; Boomgaard 1997; Julaeha 2010; Breman 2014). The ecological forest changed of Palintang area can be divided into 3 main periods, namely the Dutch colonial (1830-1942), the Japan colonial (1942), and post-colonial period (1945-present time).

The Dutch colonial period (1830-1942)

On the basis ecological history, in the past Palintang area was covered by the natural forest (*leuweung geledegan*). It was traditionally used for practicing of swidden farming (*huma* or *ladang*) of the village people. The farmer cut and burned forest, and planted by various upland local rice varieties mixed with other annual crops. After harvesting rice, the land was fallowed between 5 years and 10 years, and it was allowed to change to the immature and secondary forest by the forest succession process (cf. Iskandar 1998; Iskandar et al. 2016). The farmers moved to another forest area and opened the plot of forest to crop upland rice. They will come back and recultivated the secondary fallowed land, after soil fertility was recovered.

The forest of Palintang dramatically changed due to introduction of the culture system (*cultuurstelsel*) that was introduced by van den Bosch who was the Governor General in Java between 1830 and 1833. Van den Bosch as Governor General wanted to get export production moving as quickly as possible from Java to pay interest owed in the motherland to reduce outstanding capital loans (Elson 1994). The cultivation system obliged peasants, instead of paying rent and taxes, to plant cash crops on one-fifth of their land, or alternatively to work 66 days a year on government owned estates or projects (Geertz 1963; Elson 1994; Iskandar 1998). Various annual cash crops, such as sugar cane, indigo, and tobacco were grown on sawah in rotation with rice, while perennial crops, such as coffee, tea, pepper, cinchona, and tobacco were grown in the uplands for sale on the world market (cf. Geertz 1963; Elson 1994; Julaeha 2010). In relation to the culture system program in the Palintang and adjacent areas, the Bukit Unggul Mountain was planted by kina/cinchona (*Cinchonacalisaya* (Rubi.). Based on the Ethnobotany study, originally this plant came from Peru, Latin America. Its bark has been traditionally used by Inca ethnic group as anti-malaria disease. The cinchona was introduced to Java by the Dutch colonial in 1854 from mountain slope of Andes, South America (Whitten et al. 1999). Initially cinchona was planted in Cibodas and was moved to

Malabar, Pangalengan South Bandung and also predominantly planted in some areas of high land of North Bandung, including Bukit Unggul Mountain as direct border area of Palintang forest (Kunto 1986). As a result, the cinchona plantation of high land West Java produced and supplied 97 per cent of the world cinchona production in 1930s (Balix and Cox 1997).

Since the culture system program was needed some laborers, such as for land preparation, planting crops, taking care of crops, and harvesting crops, the local labors from different villages, such as Bandung, Sumedang, Subang and Garut were involved. For example, some laborers could be involved in cutting wood trees, hoeing the land, and planting cinchona seedlings. They daily worked from 8.00 am to 2.00 pm and were paid in every 15 days (Retnowati 1999). In addition, they were also entailed in the program activities of farming tobacco (*Nicotiana tabaccum* L) in the forest. The *tumpang sari* system was applied in tobacco crop farming. This crop was planted mixed with wood tresses, such as puspa (*Schiwa walachii* (DC) Korth) and akasia (*Akasia* sp). At the same time, some rural people was continuously practiced the swidden farming. Furthermore, they established the settlement by cutting trees and constructed houses (Retnowati 1999; Wibawa 2011).

In 1870 the culture system program terminated and the Dutch colonial introduced the agrarian law. The agrarian law was declared by the colony ministry, *Engelbertus de Waal* on 9 April 1870 and announced in a decree (*staatsblad*) No. 55/1870. According to the agrarian law, the private businessmen or land lords could rent land with own right *erfah* for a long time approximately 75 years (Julaeha 2010). As a result, some eminent private plantations developed in some areas of West Java, including Bogor, Sukabumi, Garut, Bandung, Lembang, and Sumedang (cf. Kunto 1986; Julaeha 2010)

The Japanese Colonial (1942-1945)

During the Japanese colonial occupation, some forests areas of Manglayang and Palintang was converted to plantation of *kaliki* (*Ricinus communis* L), *haramay* (*Boehmeria nivea* (L) Gaudich), and *teureup* (*Artocarpus elastica* Reinw ex Blume). The *kaliki* was planted in the plantation due to the Javanese colonial demanded it for source of botanical oil production that is needed as gun and machine lubricant for war purpose While, the *haramay* and *teureup* were demanded for raw materials of making clothes, bullet proof clothing, material roof, and so on. In addition, the local people traditionally used *haramay* fiber for material woven clothes, and cloth to hold baby. Although the cloth that was made of *harmay* fiber hard and rough, the clothing was still used due to lack of the cloth and the food at that time. During the Japan colonial, the plantation of *haramay* was established not only in Manglayang and Palintang but also in other areas of West Java, including Lembang, Garut and Ciamis. However, the plantation of *kaliki* and *haramay* could not sustain due to these plantations were converted to agriculture land and settlement of the village people.

The post-colonial period (1945-present time)

After Indonesian independence, the cinchona of norther Palintang, Manglayang was taken over by the Plantation Service state (*Dinas Perkebunan*), and later on was managed by PTPN VIII Perkebunan Kina. Furthermore, the other forest area of Palintang, Western Manglayang was converted to the forest production of pine (*Pinus merkusii* Jungh and De Vriese) trees. The rehabilitation of the forest of pine trees was planted by tobacco crops (*Nicotiana tabaccum* L) mixed cropping (*tumpang sari*) with some wood tresses, such pine (*Pinus mercusii* Jungh), maesopsis (*Maesopsis eminii* Engl) and lamtoro gung (*Leucaena leucocephala* (Lam) de Wit), and the edge part of plot was planted by suren (*Toona sureni* (Blume) Merr) trees. The pine saplings were planted in a row with distance among saplings approximately 60 x 80 cm, and was intercropped with tobacco crops with planting distance of 60 x 80 cm. Local people of Palintang involved as laborer of the management of the pine forest production activities of the *tumpang sari* program of the the the Forest Service (*Dinas Kehutanan*). They were engaged in preparing land, seedling tobacco, planting young tobacco trees, weeding, and harvesting tobacco leafs. At the period of 1942-1962, because the houses of the Palintang people were burned by DI/TII, the people of Palintang evacuated to Ujung Berung area. Consequently, the tobacco plantation was abandoned and converted to the immature forest (*leuweung ngora*). In 1962 people of Palintang came back to their former hamlet were escorted the Indonesian national army (TNI) due to hordes of DII/TTI have been successfully crushed by TNI. In addition, people of Palintang gave a variety of subsidies by the government, including rice, hoe, and plant seeds.

In 1972 the Forest Service (*Dinas Kehutanan*) was changed to the State Forestry Corporation (*Perhutani*). The program of *tumpang sari* of cropping tobacco mixed with pine trees, however, has not significantly changed. Since the land slide disaster occurred, the practice of *tumpang sari* in the forest of Palintang was prohibited since 1972until 1980.In 1980, the *tumpang sari* activity was allowed due many requests by people. At that time, the tobacco crop was replaced by vegetables, such as kol (*Brassica oleracea* var *cavitata*), kentang (*Solanum tuberosum* L), tomat (*Lycopersicon lycopersicum* (L) Karsten), and so on due tobacco crop farming considered not good for soil fertility. In addition, the tobacco considered as has long harvesting time approximately 10 months. In 1983, the *tumpang sari* program was prohibited again due to the flooding in Citarum watershed. However, some people moved to cultivated vegetables in the forest of Sumedang instead of stop planting vegetables (Retnowati 1999). In 998 the national monetary crisis (*krismon*) occurred and predominantly negative affected to socio-economic rural people. Therefore, the *tumpang sari* program was allowed again to improve social-economic rural people. Nowadays, the *tumpang sari* program has still intensively applied and to achieve the sustainability of forest function and to optimize its benefit, the State Forestry Corporation (*Perhutani*) has promoted the introduction program that is named the community-based forest management (*Pengelolaan Hutan Bersama*

Masyarakat-PHBM) (cf. Bahruzin et al. 2014). Based on this program, the people who engaged in the *tumpangsari* program in addition to plant vegetable must plant banana (*Musa paradisiaca* L) and coffee trees (*Coffea arabica* L).

Establishment of settlement

As mentioned earlier, the forest of West Palintang area was initially covered by the natural forest (*leuweung geledegan*) and traditionally used to practice the swidden cultivation (*huma* or *ladang*) (cf. Geert 1963; Abdoellah et al 1997; Iskandar and Iskandar 2011). Furthermore, during the Dutch colonial at the beginning 1830s, the forest of Palintang, Mangalayang, Bandung was planted by commercial crops such as tobacco (*Nicotiana tabacum* L) in mixed cropping (the *tumpang sari*) system. At that time, the local people were involved as laborer of the *tumpangsari* program of tobacco and cinchona plantation in the forest. Moreover, some of the laborers established houses (*ngababakan*) in the former swidden fallowed secondary forest. The sloping ground was made plate to buildstilt houses that are made of wood, bamboo and alang-alang (*Imperata cylindrica* C.E. Hubb) leaf. Therefore, based on the environmental history, it is widely accepted that the Palintang settlement or hamlet was originally developed from the forest (Figure 2). While the Palintang name is initially derived from the world 'land was flattened' (*dipalintangkeun*). Since the settlement was established by preparing the land of secondary forest was flattened and followed by construction of houses (Retnowati 1999; Wibawa 2011). Today, the forests have been planted by pine trees and farmed by the commercial vegetable crops (Photo 1 and Figure 4).

The homegarden system

The homegarden or *pekarangan* is a land surrounding house that is planted by various annual and perennial crops. The homegarden of Palintang has distinctive structure. Some of the homegardens have stables of cattle, particularly sheep stables, and fish pond (**Figure 5**). The homegarden has not intensively cultivated. However, some annual and perennial crops are found in the homegarden. Since the plant structure of the homegarden is similar to that of the forest and providing the forest functions, and also provide socio-economic function, this agroecosystem can categorized as the traditional agroforestry (Soemarwoto and Soemarwoto 1984; Iskandar and Iskandar 2016).

On the basis of the plant survey conducted to 46 homegardens of Palintang hamlet, it was recorded 42 plant species. These plants can be categorized into 7 main functions, namely additional staple food/carbohydrate source, fruit, vegetable, ornamental, spice, industry/ commercial, and wood (Table 1). Based on Table 1 it was revealed that 3 categories of plant function, namely additional staple food/carbohydrate source 13 species (30.95 %), fruits 12 species (28.57 %), and vegetables 7 species (16.66 %) were predominantly found in the homegardens of Palintang hamlet.

Table 1. Plant diversity of homegarden of Palintang hamlet, Cipanjalu village, West Java, Indonesia

Main function	Species number	Percentage of the total (%)
Additional staple food/ carbohydrate source	13	30.95
Fruits	12	28.57
Vegetables	7	16.66
Ornamentals	5	11.90
Spices	3	7.14
Industry and commercial/coffee	1	2.38
Wood	1	2.38
Total	42	100.00

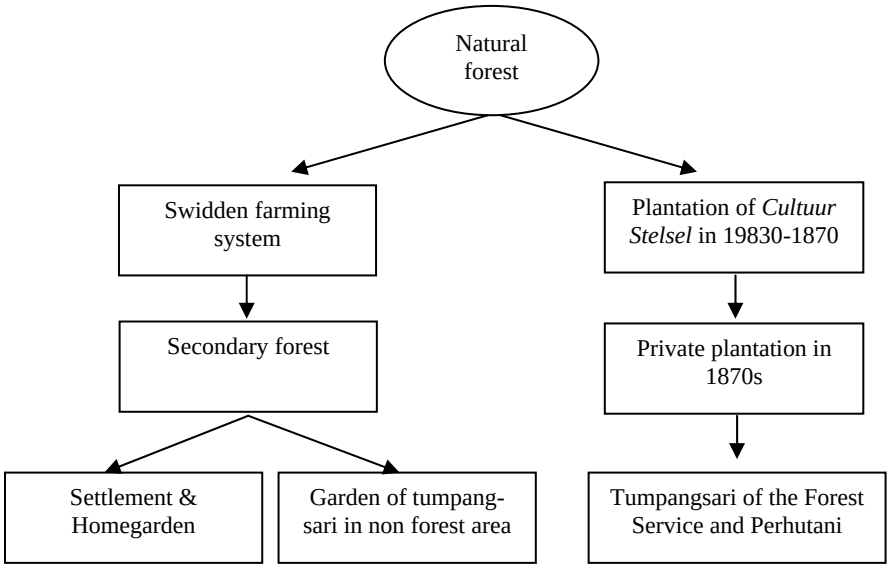

Figure 2. Evolution of the settlement derived from the forest in Palintang hamlet, Cipanjalu village, Bandung, West Java

Figure 3. Pine forest of Palintang hamlet, Cipanjalu village, West Java, Indonesia

Figure 4. The *tumpang sari* system in forest of Palintang hamlet, Cipanjalu village, West Java, Indonesia, vegetable crops are mixed with pine trees

Because the wet-rice irrigated to produce rice as staple was not found in the Palintang hamlet, the number species of staple food/carbohydrate sources were predominantly found in the home garden of this area. Some species of additional food, including singkong (*Manihot esculenta* Crantz), ubi jalar (*Ipomoea batatas* L), talas (*Colocasia esculenta* (L) Schott), ubi manis (*Dioscorea alata* L), and sagu (*Maranta arundinacea* L) were found in the homgardens. Indeed, since the Palintang hamlet is located in the high land with owns low temperature, the species number of vegetables were also predominantly found in the homegardens (cf. Karyono 1990).

Figure 5. Structure of homegarden of Palintang hamlet, Cipanjalu village, West Java, Indonesia, house, sheep stubble, fish pond, and various annual and perennial plants

Based on the analysis of SDR index, it was recoded some plant species including sampeu kadopo (*Manihot escultenta* Crantz, SDR=13.37), pisang ambon lumut (*Musa paradisiaca* L, SDR=13.30), ganyong (*Canna edulis*Ker, SDR=4.94; Cau ambon jepang (*Musa paradisiaca*L, SDR=4,94); brungkol (*Brassicaoleracea* var *botrytis*, SDR=4,83), and talas bogor (*Collocasia esculenta* (L) Schott, SDR=4.08) that have high SDR index. Based on this data, it can be inferred that those species have been an important role for the people of Palintang hamlet and also appropriate growing in the local environment of this area.For example, banana fruit with some cultivars can almost be monthly harvested and its production is traditionally used for home consumption and some surpluses can be sold to village middlemen (*bandar desa* or *pengepul*). In addition, some additional staple food species, such as gangyong and talas bogor have been an important as source of the carbohydrate. They are predominantly cooked for making various traditional cakes made and predominantly consumed with drink a glass of tea or coffee in the morning or afternoon (*ngaleueut teh* or *ngopi*)(cf. Igarashi 1985). While brungkol, it is predominantly sold to the village middlemen to obtain cash income of the households.

The mixed-garden system

The mixed-garden (*kebon* or *kebun* or *kebun campuran*) is a land located outside the homegarden. It is placed in hilly areas neighboring of the pine forest of the State Forestry Corporation (*Perhutani*). The mixed-garden of Palintang is predominantly planted by annual and perennial crops with mixed cropping (*tumpang sari* or *campuran*) system. The annual crops, however, are predominantly planted by vegetable due to appropriate with the local climate that has cold air temperature and have good price for trading (Figure 6).

Unlike the homegarden system, the mixed-garden system has intensively managed. The practice of mixed-garden cultivation of Palintang people is similar to that of *tumpang sari* in the forest. The *tumpang sari* system in the forest can be considered as modification of the traditional swidden cultivation. The people of Palintang cultivate the forest plot by cutting shrubs, burning shrub biomasses, and panting annual crops, particularly vegetable crops. After harvesting the annual crops, the land can be fallowed and change to secondary forest. The people move to other forest areas to cut and burn shrubs, and planting vegetable crops. The practice of garden system of Palintang is similar to that of the forest. But they practice of the mixed-garden in their land instead of the *Perhutani* forest. In addition, after harvesting the annual crops, the mixed-garden land is predominantly recultivated and rarely fallowed to become secondary forest by the forest succession process. Nowadays, however, due to lack of the mixed-garden land, some people of Palintang have cultivated the *Perhutani* forest by involving the *tumpang sari* program. They have cultivated the vegetable crops and must also planted coffee and banana trees to provide income for the local people and conservation of the forest (Figure 7).

There are 4 main stages of farming mixed-garden, namely land preparation (*penyiapan lahan*); planting crops (*tanam*); managing or looking after the garden (*ngarawat kebon*) including weeding and providing fertilizer; and harvesting crops (*panentanaman*) (Figure 8).

Land preparation

Land preparation of mixed-garden consists of some activities, mainly cut shrubs (*ngababad semak-semak*), dry shrub of biomass cut (*ngagaringkeun*),hoe the grasses and tree roots(*ngalenangkeun),* loosen soil (*nggemburkeun*), hole soil (*ngaliangan*),fertilize soil (*ngagemuk*) and re-dry soil (*moyankeun mindo*). Firstly, cutting shrubs is undertaken by using sickle (*arit*), big knife (*bedog*), and hoe (*pacul*). Secondly, all shrubs grown under trees are totally cut and freely grown shrubs. Thirdly, the shrub biomasses are dried by the sun shine (*ngagaringkeun*) to easily burn. Forth, the root of trees and grasses are hoed (*ngalenangkeun*). All vegetation biomasses are collected to be some piles and burned it (*ngaduruk*). While the wet biomasses are dumped by soil (*ngaruang*) to be rotten and produce compostas organic fertilizer. These works of land preparation are usually carried out on June, before rainy season. The next month, on July soil loosed (*digemburkeun*) and reversed of 30 cm deep by hoe. The hoed soil are fallowed and dried by the sun shine (*moyankeun*) of about between 3 and 4 weeks. Then, on August, the loosen soil is re-hoed to remove grasses that have growing during the dry soil time (*moyankeun*). Afterward, the soil surface is holed (*ngaliangan*) to put crop seeds with distance among individual crops between 1 and 2 meters. Each hole is put fertilizer (*ngagemuk*). Then, the land is re-dried of the sun shine (*moyankeun mindo*) and fallowed to wait the beginning of the rainy season. Lastly, on the beginning of rainy season, normally between October and November, seed of crop in put (*melak*) in each ground soil hole that has been made.

The land preparation for cultivating crops in the mixed-garden is annually undertaken three times. Due to the land is predominantly planted by annual crops of harvesting time between three and four months. As a result, after the first harvesting of the annual crops and land is recultivated. Firstly, the biomass of the harvested crops and grasses are cut out (*ngalenangkeun*) without land dry first (*moyankeun*).

Figure 6. Garden of Palintang is predominantly planted vegetable crops in the mixed-garden in Palintang hamlet, Cipanjalu village, West Java, Indonesia

Figure 7. The pine forest is predominantly planted with the coffee and banana tress of the tumpang sari program of the *Perhutani* in Palintang hamlet, Cipanjalu village, West Java, Indonesia

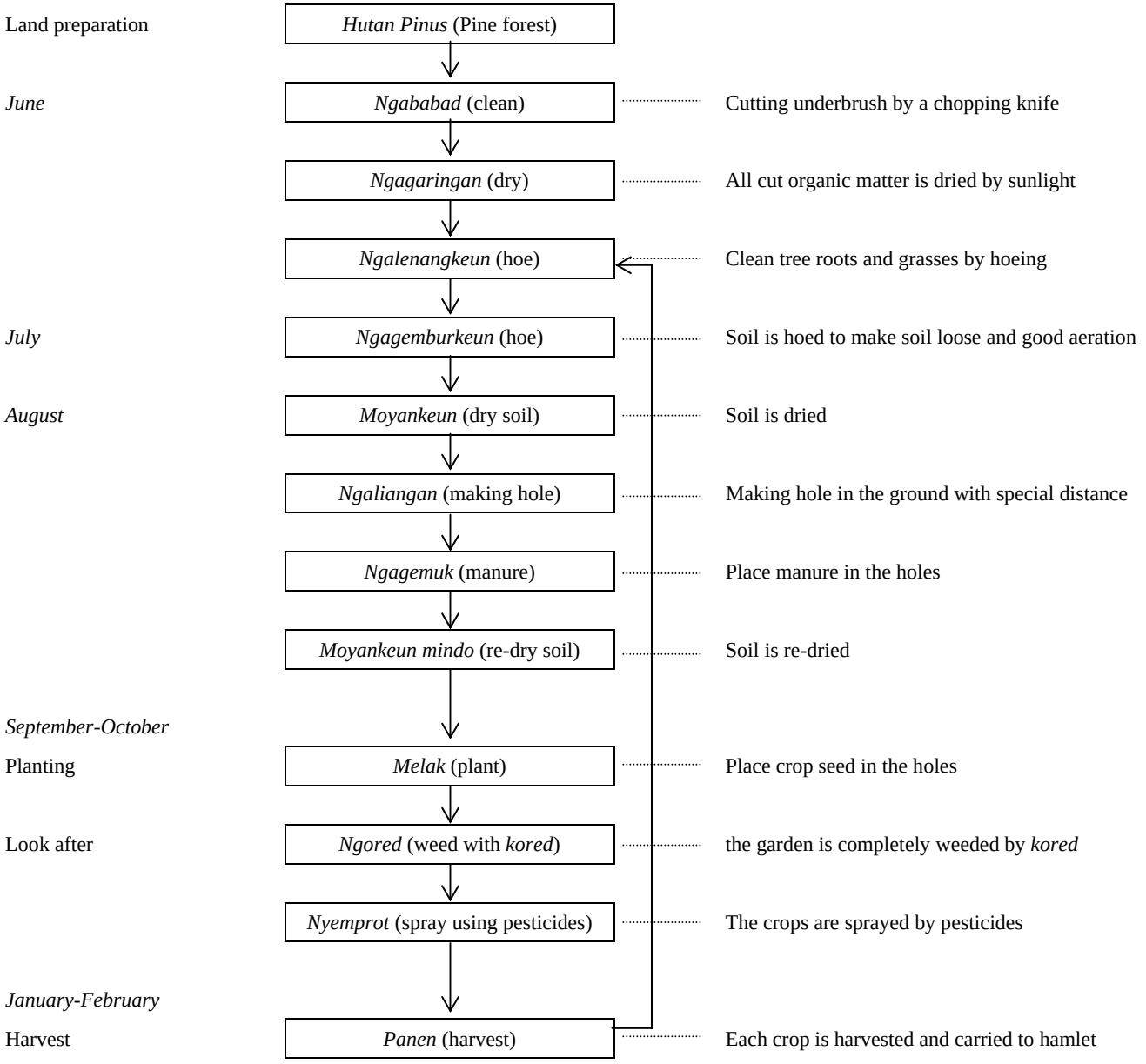

Figure 8. Various activities are carried out in crop cultivation in the mixed-garden of Palintang hamlet, Cipanjalu village, West Java, Indonesia

The planting crops

On the mixed-garden, the banana (*Musa paradisiaca* L) trees are initially planted. If the garden is aimed to plant the banana trees only, distance between individual banana trees is decided about between 2 and 3 meters. However, if the mixed-garden is aimed to plant banana trees and other annual crops, the distance among the individual banana trees are planted with has distance between 5 and 10 meters. It is intended if the banana trees have on high grown, its canopy cannot shading other crops that are planted mixed with other annual crops. Based on the local ecological knowledge of Palintang people (*emic view*), at the beginning rainy season, normally October, various crops that demand a lot of water, including brungkol (*Brassica oleracea* var *botrutis*), brokoli (*Brassicaoleracea italic*), kubis daun/kol (*Brassica oleracea* var *capita*), kunir/koneng (*Curcuma domestica* Val), cabe rawit/cengek (*Capsicum frutescens* L), jagung (*Zea mays* L) and tomat (*Lycopersicon lycopersicum* (L) Karsten) are commonly planted.Similarly, based on agronomic point of view (*etic view*), these crops generally demand a lot of water and suitable to plant in the rainy season due to much water availability (William et al. 1996). In general those crops can be readily harvested about between three and four months after planting, except cabe rawit and kunir can be continually harvested more than 4 months.

Table 3. Diversity crop of the mixed-garden of Palintang hamlet, Cipanjalu village, West Java, Indonesia

Main function	Species number	Percentage of the total (%)
Vegetables	15	31.91
Fruits	13	27.65
Additional staple food/ Carbohydrate source	10	21.27
Wood	4	8.51
Spices	2	4.25
Ornamentals	2	4.25
Industry/Coffee	1	2.12
Total	47	100.00

After harvesting some crops, brungkol, kubis, brokoli, jagung and tomat, afterward, the mixed-garden is reculivated by other annul crops, such as pak choy (*Brassica chinensis*), petsay/pecay (*Brassica chinnsis* var. *parachinensis*) and sawi hijau (*Brassica rapa* var *parachinensis*) that demand both a lot of water and appropriate sun shine intensity to avoid easily to be rotten crops.

On the beginning of the dry season, the mixed-garden is predominantly grown by various crops that less demand water, including labu siam (*Sechium edule* (Jacq) Swartz), talas (*Colocasia esculenta*(L) Schott), kacang tanah (*Arachis hypogaea* L), *kacang merah* (*Phaseolus vulgaris* L), kacang endul (*Phaseolus* sp), kacang buncis (*Phaeolus vulgaris* L), kentang (*Solanum tuberosum* L) and singkong (*Manihotesculenta* Crantz). While the farmers who have not appropriate capital, after first harvesting, the garden is only planted by singkong (*Manihot esculenta* Crantz*).*

Crop diversity

Based on plant survey on 28 mixed-garden of Palintang people, it has been recorded 47 species that can be categorized to 7 main functions. The number of species is predominantly categorized by vegetables 15 species (31 %), fruit 13 species (27.65 %), and additional food/carbohydrate source 10 species (21.27 %) (Table 3). While the crops were recorded as a high value of Summed Dominant Ratio index such as pisang (*Musa paradisiaca* L, SDR=10.21), kol (Brassica oleracea var *capitata*, SDR=8.04), kacang merah (*Phaseolus vulgaris*, SDR=4.80), and alpuket (*Persea americana* Mill, SDR=4.51). Since the Palintang has cold climate and soil fertile, the vegetable crops are predominantly cultivated in the mixed-garden. In addition, because the demand of vegetable has increased in the Bandung town and other big towns of West Java, the price of vegetable production are higher. As a result, the high land of Palintang, Lembang, Ciwidey and Garut has been known as center of the vegetable production of West Java (cf. Hardjono 1991; Sugino et al. 2008).

Look after

After panting, the next important task necessary ensures a successful crop harvest is weeding. About one month after planting, the mixed-garden is already covered in weeds. As a consequence, it is common that during the month of November, the mixed-garden is undertaken weeded by as mall hoe (*kored*) in order to minimize soil nutrient competition between crops and weeds. The weeding is usually repeated in each week or two weeks, before the crop productions are harvested. Moreover, in order the crops properly grow, such plants are provided the inorganic fertilizers, namely NPK and TSZA that are bought from shops of agriculture in the urban area. In addition, some organic fertilizers, such as dung of cattle, sheep, and chicken are provided to plants in the mixed-garden. The proportional dose of organic and inorganic fertilizer is commonly applied inorganic 3: 1. For example, for the garden of 1,400 m^2 (1 *tumbak*), the farmer predominant apply the organic fertilizer of dung animals 150 kilograms and inorganic fertilizer 50 kilograms. However, some people the inorganic fertilizer are higher with the proportional 2: 1, meaning provide organic fertilizer 250 kilograms and inorganic fertilizer 125 kilograms.

To avoid pests, the mixed-garden is sprayed (*disemprot)* the chemical pesticides. The spraying pesticides arepredominantly carried out in each two weeks when the plants have grown between two and four months after planting. Indeed, some farmers have intensively sprayed the chemical pesticides to crops, particularly for kentang/potato crop (*Solanum tubersum* L), predominantly undertaken between 3 and 12 times. In general in each spraying pesticides is used 250 milli liters (0.25 liters) liquid pesticides are mixed with 1 kilogram of pesticide powder to spray of garden that has size about 7,000 m^2(500 *tumbak*). Although the intensification of use chemical fertilizer has some benefits to kill pest, it has some negative impacts to environment, such as kill various pest enemies and beneficial insects, such as bees, and soil and causing of water pollution (cf. Damalas and Eleftherohorinos 2011; Winarto 2016).

Some diseases are predominantly found to attack potato crop of the garden of Palintang people, including '*jaram*' disease. The some visual diagnostics that potato crop is attacked by this disease, mainly potato leafs have blackish color and dry at the tuber growing time. Based on the Western knowledge, this disease is caused by some viruses that are distributed by a kind of bug leafs (Septiadi and Fikri 1993).

Harvesting

The harvesting of various crops of the mixed-garden is undertaken at different times. For example, some crops including brungkoli (*Brassica* sp) , engkol (*Brassica oleracea* var *cavitat*a), and jagong (*Zea mays* L) are usually harvested about between three and four months after planting. They are predominantly planted in October and harvested in January. While other crops, such as paksoy (*Brasica rapa subsp chinensis*), pecay (*Brasica chinensis* (L) C.Zern) and sosin (*Brasica chinensis* (L) C.Zern) can be harvested in approximately 3 months after planting. They are traditionally planted in December and harvested in February. The cassava or singkong (*Manihot esculenta* Crantz) can be predominantly harvested one year after planting. Unlike other crops, the banana/pisang crop (*Musa*

paradisiaca L)can be continuously harvested in each month due to continuous regeneration of young trees (Table 4)

The vegetable trading of Palintang people

The marketing of various crop productions of the mixed-garden of Palintang, particularly vegetable productions harvested from both the mixed-gardens of the village area and the vegetable gardens of *Perhutani* forest can be categorized into two systems. Firstly, the vegetable productions have predominantly sold to the village middlemen (*pengepul desa*). Secondly, they have directly sold by farmers to carry to traditional markets, such as Ujung Berung market and other markets in Bandung urban areas (Figure 9).

Based on the farmer perception of Palintang people, they have preferred to sell vegetable production to village middlemen. Because although the price of selling the vegetable has been lower than that of selling directly to sold to middlemen in the traditional market, but selling vegetable crop production to village middlemen has been more easily and more practice. In addition, they have not needed the transportation cost to carry vegetable production to market place. For selling the vegetable production, many village middlemen have usually come to farmers and buying the vegetable production by cash after harvesting. Indeed, in some cases the village middlemen

Table 4. Various plants of the mixed-garden are predominantly cultivated by the Palintang people, Cipanjalu village, West Java, Indonesia

Local name	Scientific name	Main function	Cropping time (months)
Brungkol	Brassica oleracea var botrytis	Vegetable	October-January
Brungkoli	Brassica sp	Vegetable	October-January
Buncis	Phaseolus vulgaris L	Vegetable	April-August
Engkol	Brassica oleracea var cavitata	Vegetable	October-January
Jagong	Zea mays L	Carbohydrate Source/ Additional Staple Food	October-January
Kacang beureum	Phaseolus vulgaris L	Vegetable	June-December
Kacang endul	Phaseolus vulgaris L	Vegetable	June-September
Kentang	Solanum tuberosum L	Vegetable	July-November
Paksoy	Brasica rapa subsp chinensis	Vegetable	December-February
Pecay	Brasica chinensis L	Vegetable	December-Februar
Sawi	Brasica juncea (L) Czern	Vegetable	December-Januar
Sosin	Brasica juncea (L) Czern	Vegetable	October-December
Suuk	Arachys hypogaea L	Spice	June-September
Taleus biasa	Collocasia esculenta (L) Schott	Carbohydrate Source/Additional Staple Food	July-June
Taleus bogor	Collocalia esculenta (L) Schott	Carbohydrate Source/Additional Staple Food	July-June
Tomat	Solonamun lycopesicum L	Vegetable	October-January
Waluh	Cucurbita moschata (Duch) Poir	Vegetable	April-harvesting throughout the year
Cau ambengan	Musa paradisiaca L	Fruit	April-harvesting throughout the year
Cau Ambon Jepang	Musa paradisiaca L	Fruit	April-harvesting throughout the year
Cau ambon lumut	Musa paradisiaca L	Fruit	April-harvesting throughout the year
Cau raja cere	Musa paradisiaca L	Fruit	April-harvesting throughout the year
Cengek	Capsicum frutescen L	Spice	October-April
Koneng	Curcuma domestica Val.	Spice	September-April
Sampeu Jepang	Manihot esculenta Crantz	Carbohydrate Source/Additional Staple Food	April-March
Sampeu kadopo	Manihot esculenta Crantz	Carbohydrate Source/Additional Staple Food	April-March
Sampeu paris	Manihot esculenta Crantz	Carbohydrate Source/Additional Food	April-March
Sampeu bogor	Manihot esculenta Crantz	Carbohydrate Source/Additional Staple Food	April-March
Sampeu asmid	Manihot esculenta Crantz	Carbohydrate Source/Additional Staple Food	April-March
Strawberry	Pottentia x annanara	Fruit	May-August
Kopi*)	Coffea arabica L	Industry	Perennial crop, not rotation
Alpuket	Persea Americana Mill	Fruit	Perennial crop, not rotation
Jambu batu	Psidium guajava L	Fruit	Perennial crop, not rotation
Mangga	Mangifera indica L	Fruit	Perennial crop, not rotation
Awi/bambu	Gigantochloa apus (Bl. Ex Schult) Kurz	Building material	Perennial crop, not rotation
Akasia/Moris	Akasia sp	Building material	Perennial crop, not rotation

Note: *) plant has been introduced in Tumpang Sari program. Source: adapted fromWibawa (2011)

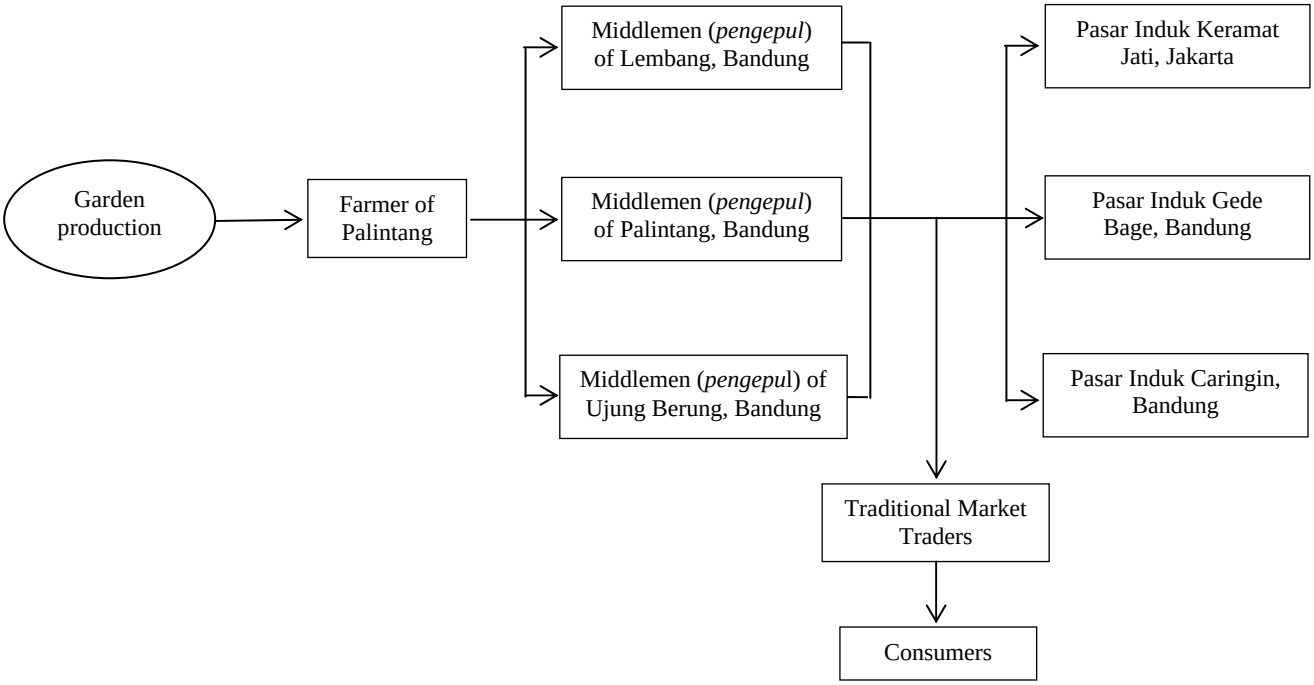

Figure 9. Marketing channel for vegetables from farmers in Palintang hamlet, Cipanjalu village, West Java, Indonesia

have paid the production of vegetable crops before the crops are harvested by the farmers. The village middlemen have been recognized as local people of Palintang hamlet, Cipanjalu village and come from other villages, such as Lembang area. The vegetable production purchased from the farmers has been collected in the home of middleman. Moreover, if the amount of the vegetable production that has been bought from farmers was not much, less than one track or less than one ton, the vegetables have been transported by truck to be sold to middlemen of the traditional markets of Bandung city, including traditional market of Ujung Berung, Gede Bage, Caringin and Kosambi. However, if the vegetable production that have been paid from farmers considered much more than one truck, the vegetable have been transported by truck to be sold to other middlemen of outside of Bandung city, such as middlemen of Pasar Induk Keramat Jati Jakarta. Due to the selling price of vegetable outside Bndung cities, such as in the central market of Jakarta had a high price compared to that of the selling in the traditional markets of Bandung city. Indeed, some vegetable middlemen of Lembang who mainly collected the vegetable production from Palintang and Lembang have sold the vegetable production to outside Java, such as Sumatra or even have been exported to Singapore, particularly if the supply of vegetation production has been considered very much (cf. Marowani and Agustiani 2008).

Providing income of local people versus environment destruction

Unlike the frontier village farmers who engaged the swidden farming system in the past, including Baduy people of South Banten, Kasepuhan people of South Sukabumi, Kemang people of Cianjur, and Karangwangi people of Cianjur (Iskandar 2007; Adimihardja 1989; Kusoke et al. 2013; Iskandar et al. 2016), the Palintang people have not have not persistently engaged in the swidden farming. Indeed, they have not engaged the irrigation rice field farming system. Until recently, the Baduy have still involved and successfully maintained the swidden farming system. Because they have successfully developed some-ecological resiliencies, including the swidden cultivation system that has been farmed by mixed annual and perennial crops instead of mono culture system of upland rice. Moreover, it has developed the traditional agroforestry systems, including swidden farming (*huma*), the fallowed secondary forest (*reuma*), and hamlet forest (*dukuh lembur*) grown by various mixed-crops to produce various products to fulfill home consumptions and some surpluses were sold to adapt to various socio-economic and ecological changes. In addition, they have developed a high diversity of economic activities, such as making the tradition palm sugar (*gula kawung*), traditional woven (*kain tenun*), and involving in trading of non-rice crop productions, and the introduction of Albasiah trees to the swidden farming (Iskandar 2007). Like the Baduy, the Kasepuhan people have also continually maintained the swidden farming. Since the swidden farming system of Kasepuhan has been supported by the irrigation rice field farming system and traditional agroforestry mixed-garden (*talun*) (Adimihardja 1989). Similarly, the swidden farming system of Kemang, Cianjur has been traditionally maintained the swidden farming by the farmers. Because it has supported by the irrigated rice field system, the traditional agroforestry systems of *talun*, various non-agricultural sector activities, and the Perhutani programs of

tumpang sari (Kusoke et al. 2013). In addition, the Karangwangi people have still practiced the swidden farming in non-forest areas. As it has been supported by the irrigation rice field farming system, the traditional agroforestry of the homegarden and mixed-garden, and job diversifications, the Karangwangi swidden farming has continuously bee (Iskandar et al. 2016).

Unlike, the Baduy, Kasepuhan, Kemang, and Karangwangi people, the Palintang have not persistently the swidden farming. Indeed, the Palintang people are different from the Kasepuhan, Kemang and Karangwangi in that they have never involved in the irrigation rice field farming system. The Palintang people have self-sufficient of their income due to develop the social-ecological resilience systems, including the farming of the homegarden, mixed-garden, and farming the commercial vegetable in the forest of the *Perhutani*. In general, more than half of the household income of the Palintang has been supported by the vegetable production of the *Perhutani* forest. Consequently, the sustainability of the livelihoods of the Palintang people have been essentially by the existing the *Perhutani* forests. In other words, the forest destructions and the change of the *Perhutani* policy on the forest may essentially affected the sustainability of the vegetable farming as well as the livelihoods of the Palintang people.

On the basis the environmental or ecological history, the practice of vegetable farming in the forest area of Palintang has provided some benefits of cash incomefor the household of Palintang people. These farming activities in the forests, however, have also caused some negative impacts to environment. For example, the farming the vegetable crops have predominantly practiced in the forests without considering natural conservation efforts, such as making terracing system may cause some environmental problems, such as land degradation, soil erosion, and flooding (cf. Hardjono 1991). The detailed study of the environmental problems, such as soil erosion in the Palintang as one of the sub-watershed of Citarum has not yet undertaken. However, based on the study in the other areas of the upper Citarum watershed, the destruction of forest caused of intensive commercial vegetable garden has seriously caused soil erosion. For example, a large surface of the subwatershed Ciwidey, in the Upper Citarum Watershed is degraded 8830 ha or 39,8 percent of the surface are classified as very badly eroded, such as it has been caused of the intensive the vegetable farming (cf. Andonie 2011). In addition, based on the soil erosion study, it has been the predicted that the soil loss of the forest at the Saguling catchment area is 0,13 ton ha^{-1} year^{-1}, while in the intercropping of annual crops with trees predicted 8,40 0,13 ton ha^{-1} year^{-1}, and the annual upland crops predicted increase 22.02 ton ha^{-1} year^{-1} (Agus and Manikmas 2003). While intensive used of chemical pesticides in the vegetable farming in the forest may cause negative impacts to the environment, such as killing the pest predators and beneficial insects, such as bees. Indeed, the intensive use of chemical pesticides in the vegetable farming may cause the soil and water pollution that may contaminate to wild animal, livestock, and human. As a result, the human health has been very vulnerable to pesticide contamination (cf. Raini 2007; Damalas and Eleftherohorinos 2011; Winarto 2016). Based on studies in other areas, including Jati village, Magelang; Kudunguter village, Berebes; Sumber Rejo Village, Magelang; and Dramaga Bogor and Lembang the application of pesticides have substantially affected to human health and beneficial bee insects (Yuantari 2009; Mahmudah et al. 2012; Kahono and Erniwati 2014; Ipmawati et al. 2016).

The Palintang people has undoubtedly obtained the food and household income by supporting the homegarden, mixed-garden and planting the commercial vegetable crops of the *tumpang sari* program and the the community-based forest management (*Pengelolaan Hutan Bersama Masyarakat*). The community-based forest management of *Perhutani* that has been introduced in in some areas of both Bandung since 2000, it has actually provided benefit for the local people and conservation of the forest environment. For example, the local people have been permitted to cultivated coffee trees (*Coffe*a *arabica* L), grass/*rumput gajah* (*Pennisetum polystachion* (L) Schult) as fodder of cow and sheep, banana (*Musa paradisiaca* L) and so on can provide income for the local people and conservation of forest against erosion and improvement of soil fertility (cf. Bahruzin*et* et al. 2014; Fardhani 2016). As a result, this program must be developed with more active participation of the local people.

To sum up, based on the ecological or environmental history of the forest in Palintang, it can be inferred that Palintang people of Cipanjalu village, Bandung, West Java have involved in the *tumpang sari* of the forest for a longtime since the Dutch period until present time. Unlike the lowland people of West Java, the high land people of Palintang have never cultivated the wet rice (*sawah*) farming; they have practiced the mixed-garden of the *tumpang sari* system both in their land and the forest of *Perhutan*i. The vegetable farming has provided the income of the Palintang people but has side effect to environment, such as pesticide pollution, and soil erosion. In terms of changes of the plants species diversity, the plant species diversity of the forests have decreased, but new species, particularly vegetable and other non-vegetables, such as *palawija*, have increased due to introduction into the commercial vegetable garden farming system by the farmers. The implication of the commercial vegetable farming with the excessive use of external inputs, such as seed, fertilizer, and pesticide has a low stability of fluctuation of price outputs and inputs and cause of negative impacts on environment. Therefore, to obtain sustainable agro-ecosystem in the high land of Palintang, the agroforestry systems that can integrate mixed-cropping annual and perennial crops, and rearing various livestock, including sheep and cow must promoted for a future.

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REFERENCES

Abdoellah OS, Parikesit, Gunawan B, Djuangsih N, Erawan TS. 1997. Biodiversity Condition and Its Maintenance in the Upper Citarum River Basin. In Dove MR, Sajise PE (eds). The conditions of Biodiversity Maintenance in Asia: The Policy Linkages Between Environmental Conservation and Sustainable Development. East-West Center, Hawaii.

Adimiharjda K. 1989. Sundanese people and their environment: the study of socio-culture and ecology of the Kasepuhan community, Sirnarasa village, West Java, Indonesia. [Ph.D Dissertation]. University of Kebangsaan, Malaysia.

Agus F, Manikmas MOA. 2003. Paper presented in Roles of Agriculture in Development Symposium at the 25th Conference of the International Association of Agricultural Economists, in Durban, South Africa, August 17-22.

Albuquerque UP, da LVFC, de Lucena RFP. 2014. Methods and Techniques in Ethnobiology. Springer Science-Business Media, New York.

Andonie M. 2011. Soil and Water Conservation and Rural Livelihoods in the Upper Citarum Watershed in West Java, Indonesia. [Thesis]. Center for Development and Environment, University of Bern, Bern.

Bahruzin, Hidayat A, Putri EIK. 2014. Analysis of The Effectiveness of community-based forest management Institution.(CBFM) in KPH North Bandung, West Java. Journal of Agriculture, Resour Environ Econ 1: 1-11. [Indonesian].

Balick M, Cox PA. 1997. Plants, People, and Culture: The Science of Ethnobotany. Scientific American Library, New York.

Berkes F, Ross H. 2013. Community resilience: toward and integrated approach. Soc Nat Resour 26: 5-20.

Berkes F. 2008. Sacred Ecology. Routledge, New York.

Boomgaard P. 1997. Introducing environmental histories of Indonesia. In Boomgaard P, Colombijin F, Henley D (eds), Paper landscapes: explorations in the environmental history of Indonesia. KITLV Press Leiden.

Breman J. 2014. Cultivation System for Colonial Benefit: Priangan System from the Coffee Cultivation System in Java 1720-1870. Yayasan Pustaka Obor Indonsia, Jakarta [Indonesian].

Brookfield H. 1997. Landscape history Land degradation in the Indonesian region. In Boomgaard P, Colombijin F, Henley D (eds), Paper landscapes: explorations in the environmental history of Indonesia. KITLV Press, Leiden.

Carlson TJS, Maffi K. 2004. Introduction: Ethnobotany and Conservation of Biocultural Diversity. In Carlson, T.J.S, Maffi, L. (eds), Ethnobiology and Conservation of Biocultural Diversity. New York Botanical Garden, New York.

Christanty L. 1989. Analysis of the Sustainability and Management of the Talun-Kebun System of West Java, Indonesia. [Dissertation]. University of British Columbia, Canada.

Conklin HC. 1957. Hanunoo Agriculture, a Report on an Integral System of Shifting Cultivation in the Philippines (Forestry Development Paper 12). Food and Agricultural Organization of the United Nations, Rome.

Creswell JW. 1994. Research Design: Qualitative&Quantitative Approaches. Sage Publications, London.

Damalas CA, Eleftherohorinos IG.2011. Pesticide Exposure, Safety Issues, and Risk Assessment Indicators. Intl J Environ Res Pub Health 8: 1402-1419.

Dove MR. 1985a. Government Perception of Traditional, Social Forestry in Indonesia: History, Causes and Implications of the State Policy on Swidden Agriculture. In Community Forestry: Social Economic Aspect. Regional Office For Asia and Pacific (RAPA), FAO, of the United Nations, Bangkok.

Elson RE. 1994. Village Java under cultivation system 1830-1870. Allen and Unwin, Sydney.

Fardhani I. 2016. Orchids species diversity and its management strategies in a protected forest at Mount Sanggara,West Java, Indonesia. [Thesis]. Padjadjadjaran University, Sumedang' [Indonesian]

Geertz C. 1963. Agricultural Involution: The Process of Ecological Change in Indonesia. University of California Press, Berkeley, USA.

Hardjono J. 1991. Environment or Employment: vegetable cultivation in West Java. In: Hardjono J (ed). Indonesia: Resources, Ecology and Environment. Oxford University Press, Oxford.

Igarashi T.1985. Some Notes on the Subsistence in a Sundanese village. In Suzuki S, Soemarwoto O, Igarashi T (eds). Human Ecological Survey in Rural West Java in 1978 to 1982. Nissan Science Foundation,Tokyo.

Ipmawati PA, Setiani O, Darundiati YH. 2016. Analysis of Risk Factors that Cause Pesticide Intoxication Level to Farmers in Jati Village, Sawangan Sub-district, Magelang District, Central Java. University of Dipenogoro, Semarang.

Iskandar J, Iskandar BS. 2016a. Ethnoastronomy-The Baduy agricultural calendar and prediction of environmental perturbations. Biodiversitas 17 (2): 694-703.

Iskandar J, Iskandar BS. 2016b. Plant Architecture: Structure of rural homegarden and urban greenspace. Teknosain, Yogyakarta [Indonesian].

Iskandar J, Iskandar BS. 2017. Various plants of traditional rituals: Ethnobotanical research among Baduy Community. Biosaintifika 9 (1): 114-125.

Iskandar J, Iskandar BS. 211. Agroecosystem of Sundanese People. Kiblat Buku Utama, Bandung [Indonesian].

Iskandar J. 2007. Responses to Environmental Stress in the Baduy Swidden System, South Banten, Java. In Ellen R (ed), Modern Crises and Traditional Strategies: Local Ecological Knowledge in Island Southeast Asia. Berghahn Books, New York.

Iskandar, J., B.S. Iskandar, R. Partasasmita, 2016. Responses to environmental and socio-economic changes in the Karangwangi traditional agroforestry, South Cianjur, West Java. Biodiversitas 17 (1): 332-341.

Julaeha S.2010. Tea plantation in Netherlands India Case Study: Malabar tea plantation in Pangalengan-Bandung 1930-1934. [Hon. Thesis]. Program of History, Faculty of Cultural Science,University of Indonesia, Depok. [Indonesian]

Kahono S, Erniwati. 2014. Diversity and Abundance of Social Bees (Apidae) in the Pesticide Applied Seasonal Crops in West Java. Berita Biologi 13 (3): 231-238. [Indonesian]

Karyono.1990. Homegarden in Java: their structure and function. In Launder L, Brazil (eds). Tropical Homegarden. The United Nation University, Tokyo.

Kools JF. 1935. Swidden, Swidden Block and Forest Reservation in Banten Residency. [Dissertation]. H Veenman & Zonen, Wageningen [Dutch].

Kunto H. 1986. Fragrant of flower in Bandung Metropolitan. Penerbit PT Granesia, Bandung. [Indonesian]

Kusoke M, Mugniesyah SS, Herianto AS, Hiroshi T. 2013. *Talun-Huma*, Swidden Agriculture, and Rural Economy in West Java, Indonesia. Southeast Asian Studies 2 (2): 351-381

Mahmudah M, Wahyuningsih NE, Setyani O. 2012. Factors related to the incidence of pesticides poisoning on farmers wife in Kedunguter Village, Berebes Regency. Majalah Kesehatan Masyarakat Indonesia 11 (1): 65-70. [Indonesian]

Marwoni H, Agustiani A. 2008. Analysis of Vegetable Distribution and Marketing in Highland Areas (Case Study in Lembang, West Java). In Sugino T (ed), Sustainable and Diversified Vegetable-based Farming Systems in Highland Regions of West Java. ESCAP, United Nations, New York.

Nawiyanto. 2009. Transforming the Frontier: Environmental Change in a region of Java, Besuki 1870-1970. Lembah Manah, Yogyakarta. [Indonesian]

Newing H, Eagle CM, Puri, Watson CW. 2011. Conducting research in conservation: social science methods and practice. Routledge, London and New York.

Nuwata M. 1974. Ecological Problems in Weed Research. In: Soeryani M (ed), Tropical Weeds, Some Problems, Biology and Control. Biotrop Bull 2: 215. Proc.First Indonesian Weed Science Conf., Bogor.

Padoch C. 1986. Agricultural Site Selection Among Permanent Field Farmers: An Example from East Kalimantan, Indonesia. J Ethnobiol 6 (2): 279-288.

Peluso NL. 1992. Rich Forests. Poor People: Resource Control and Resistance in Java. University of California Press, Berkeley, USA.

Retnowati. 1999.Woman participant in intercropping (tumpang sari) system: case study in Palintang hamlet, Cipanjalu, Cilengkrang sub-district, Bandung district.[Hon. Thesis]. Program of Anthropology, Faculty of Social and Political Science, Padjadjaran University, Sumedang. [Indonesian]

Soemarwoto O, Soemarwoto I. 1984. The Javanese Rural Ecosystem. In: Rambo AT, Sajise PE (eds.). An Introduction to Human Ecology Research on Agricultural Systems in Southeast Asia. East-West Environment and Policy Institute, Hawaii.

Sugino T, Mayrowani H, Subarna T, Maryati T. 2008. The Farmers' Perception and Economic Feasibility of crop rotation reduce Club root Damage in the Highlands of West Java. In Sugino T (ed), Sustainable and Diversified Vegetable-based Farming Systems in Highland Regions of West Java. ESCAP, United Nations, New York.

Terra GJA. 1958. Farm Systems in South-East Asia. Netherlands J Agric Sci, 6: 157-181.

Toledo VM. 2002. Ethnoecology: A Conceptual Framework for the Study of IndigenousKnowledge of Nature. In SteppJR., WyndhamFS., Zarger RK (eds), Ethnobiology and Biocultural. International Society of Ethnobiology, Georgia.

Whitten T, Soeriaatmadja RE, Afiff SA. 1999. The Ecology of Java and Bali. Prenhallindo, Jakarta [Indonesian].

Wibawa HA. 2011. Using of garden and homegarden by people of Palintang hamlet, Cipanjalu village, Cilengkrang sub-district, Cilengkrang district. [Hon. Thesis]. Department of Biology, Faculty of Mathematics and Natural Sciences, Padjadjaran University, Sumedang. [Indonesian]

Williams CN, Ujo JO, Peregrine. WTH. 1996. Vegetable Production in Tropical Area. Gadjahmada University Press, Yogyakarta. [Indonesian]

Winarto YT. 2016. Food Crisis and Miss-Thinking: Why is it Still Continued?. Yayasan Pustaka Obor Indonesia, Jakarta. [Indonesian]

Yuantari MC.2009. Environmental Economic Study of Pesticide Using and Its Effect on the Health of Farmers in the Area Horticulture Agriculture Sumber Rejo Village, Ngablak Subdistrict, Magelang District, Central Java. [Thesis] The Environmental Health, University of Diponegoro, Semarang.[Indonesian]