**BIODIVERSITAS**
Volume 18, Number 1, January 2017
Pages: 295-303

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d180139

# Introduction of *Paraserianthes falcataria* in the traditional agroforestry 'huma' in Karangwangi Village, Cianjur, West Java, Indonesia

**JOHAN ISKANDAR[1,3], BUDIAWATI S. ISKANDAR[2], RUHYAT PARTASASMITA[1,3,♥]**

[1,3]Department of Biology, Faculty of Mathematics and Natural Sciences, Padjadjaran University. Jl. Raya Bandung-Sumedang Km 21 Jatinangor, Sumedang 45363, West Java, Indonesia. Tel.: +62-22-7796412 line. 104, Fax.: +62-22-7794545, ♥email: ruhyat.partasasmita@unpad.ac.id
[2]Department of Anthropology, Faculty of Social and Political Sciences, Padjadjaran University. Jl. Raya Bandung-Sumedang Km 21 Jatinangor, Sumedang 45363, West Java, Indonesia
[3]Institute of Ecology (PPSDAL), Padjadjaran University. Jl. Sekeloa, Coblong, Bandung City 40134, West Java, Indonesia

Manuscript received: 26 August 2016. Revision accepted: 16 January 2017.

**Abstract.** *Iskandar J, Iskandar BS, Partasasmita R. 2017. Introduction of Paraserianthes falcataria in the traditional agroforestry 'huma' in Karangwangi Village, Cianjur, West Java, Indonesia. Biodiversitas 18: 295-303.* This paper discusses the result of study on introduction of '*jengjen'* (Sundanese name) (*Paraserianthes falcataria* (L.) Nielsen in development of traditional agroforestry, '*huma'* in Village of Karangwangi, Sub-district of Cidaun, District of Cianjur, Province of West Java, Indonesia. Method used in this study was qualitative with ethnoecological and biological approach. Observation and deep interview with informants were used to collect data. The result of study shows that although the population of Karangwangi Village has increased, the forest decreased, and intensively penetrated market economy, the *huma* system has continually practiced by village people. Unlike in the past, nowadays, the *huma* has been practiced in the non-forest instead of the forest. The *huma* system has been modified by people to be more permanent of traditional agroforestry system, such as bamboo garden (*kebon awi*), mixed of wood trees (*kebon kai*), and mixed fruit and wood trees (*talun*). In addition, due to more intensive in cultivation of agricultural land, Karangwangi people have adopted and cultivated *jengjen* plant in the *huma* farming system that had initially introduced by the Forestry Office (*Dinas Kehutanan*) through the regreening program. Moreover, the *jengjen* plant has been adopted and cultivated by the village people, such as integrated in the development of traditional agroforestry *huma*. It is caused this plant has provided some benefits, such as to improve soil fertility and to provide economic benefits, and does not eliminate the swidden farming (*huma*) system tradition of the people.

**Keywords**: Ethnoecology, introduction, *jeungjing*, Karangwangi, traditional agroforestry

## INTRODUCTION

On the basis of ecological or environmental story, until the earlier nineteenth century most rural people of West Java and Banten had main livelihood as swidden cultivation (Kools 1935; Haan 1912; Terra 1953; Terra 1959; Iskandar 1998; Iskandar and Iskandar 2011; Iskandar et al. 2016). It is caused at that time, the forest areas had been found still extensive and low population. Nowadays, however, due to intense demographic pressure, rapid socio-economic and land use change, swidden cultivation ('*huma'* in Sundanese) remains only in South Cianjur, South Sukabumi and South Banten (Iskandar 1998; Kosuke et al, 2013; Iskandar et al. 2016; Iskandar and Iskandar 2016a). In south Sukabumi it is mainly practiced by the Kasepuhan community, while in south Banten it is practiced by the Baduy who reside in village of Kanekes, Lebak district, South Banten (Iskandar 1989). In addition, the swidden cultivation has been practiced by rural people of Karangwangi Village, South Sukabumi and modified into several traditional agroforestry systems, including *kebon awi* (bamboo garden), *kebon kai* (mixed perennial woods), and *talun* (mixed perennial fruits) (Iskandar and Iskandar 2016a; Iskandar et al. 2016).

Generally, as population increase and intensive penetration of market economy into Karangwangi Village, progressively more intensive system systems of land use are adopted, combined with consequential change in method of cultivation and choice of tools, in order to offset any tendency for food output per capita to decline, due to diminishing returns (Boserup 1965). As a result, the swidden cultivation system has developed. For example, in response to further development growth and increase in the agricultural labor supply, bush fallow is successively followed by short fallow with fallow period of 1-2 years only, and even developed into more permanent traditional agroforestry systems of *kebon awi*, *kebun kai*, and *talun*. Moreover, the commercial trees of *sengon* or *jengjen* (*Paraserianthes falcataria* (L.) Nielsen) has been introduced by many people of Karangwangi Village. Because it is fast growing, nitrogen-fixing, easily cultivated, and yielding a cash income (Soerianegara and Lemmens 1994; Iskandar and Ellen 2000; Kosuke et al. 2013; Iskandar and Iskandar 2016a). Therefore, by introducing new crops, most obviously *jengjen*, Karangwangi people have been able to practice traditional agroforestry *huma*, despite population growth and the loss of forest around them. This paper discusses the result of study on introduction of *jengjen* in development of traditional agroforestry, *huma* in Village of Karangwangi, Sub-district of Cidaun, District of Cianjur, Province of West Java, Indonesia based on ethnoecological approach.

Ethnoecology as mentioned by Fowler (2000), as an approach to human ecology, was first proposed in mid-

1950s and early 1960s in a series of through-simulating papers by Conklin (1954, 1957) and Frake (1962). Moreover, the ethnoecology has been developed as study of how people interact with all aspects of the natural environment, including plants and animals, land forms, forest types, soil at cetera (Martin 1995; Ahimsa Putra 1997; Fowler 2000). Recently, various studies on ethnoecology have been intensively integrated into study on the Traditional Ecological Knowledge (TEK) due to the technical result of these studies can be used to support various development programs, including agriculture, forestry, traditional medicines, and conservation (Warren et al. 1995).

## MATERIALS AND METHODS

### Study area

Study was undertaken in Village of Karangwangi, Sub-district of Cidaun, District of Cianjur, West Java Province, Indonesia. On the basis of geography this area is located at approximately latitude7°25'-7°30' S and longitude 107°25'-107°30' E (Figure 1). Village of Karangwangi area comprised 2,300.17 ha, the elevation ranges between 200 and 275 m above sea level. The location of Karangwangi 120 km from the city of Bandung, the capital city of West Java Province, Indonesia, and approximately 70 km from the town of Cianjur, with a travel time of 5-6 hours from the city of Bandung and approximately 3-4 hours from the town of Cianjur. Until the middle 1985s, to reach this area was not easy due to bad village road. However, since 1985 the village road was upgraded and in 2014 was asphalted, as a result, it has provided much easier access for vehicles to the isolated Karangwangi.

There are six basic land use types in Karangwangi Village area: *pekarangan* (homegarden), *ladang/huma* (swidden field), *tegalan* (dry land), *kebun bambu*/*kebon awi* (bamboo garden), *kebun campuran tanaman kayu*/ *kebon kai* (wood garden), and *sawah* (rice field). The Karangwangi area is directly bordered by nature reserve of Bojonglarang that has total approximately 700 ha (Table 1). Demographically, in 2013 total population of Karangwangi was recorded 5,587 people and increased by 5,672 people in 2014. In general the total population of Karangwangi has increased over time, however, sometimes it has decreased due to many people went to Middle East as female (*TKW=Tenaga Kerja Wanita*; Indonesian Women Labor) and the male laborers. For example, 181 people consist of 14 males and 167 females were recorded in 2014 as laborers (*TKI=Tenaga Kerja Indonesia*) in the Middle East countries (Karangwangi Village 2014).In terms of village economic development, the market economic system has rapidly increased. For example, in 2012 it was recorded 97 shops and increased to 103 shops in 2014, while in 2015 was totally recoded 200 shops (*warung/toko*). Therefore, the total population has increased over time and market economic system developed in Karangwangi Village.

The main livelihood of Karangwangi people recorded as farmer and labor farmer. The *sawah*, *huma*, *kebun* and *kebun campuran* farming are the main source Karangwangi subsistence. However, some people of Karangwangi are also involved in various off-farm jobs, such as carpenter, laborers, and village traders. Today, although the main cultivation of people is emphasized on *sawah*, the *huma* is farmed by ninety present of the Karangwangi Village people that practiced in-non forests.

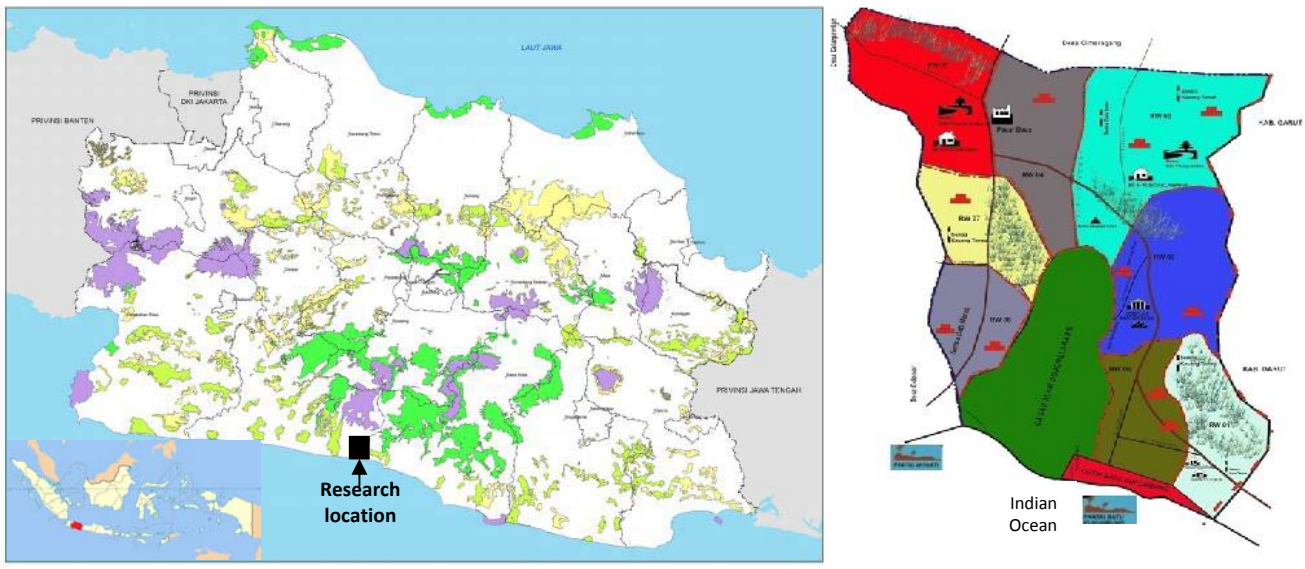


**Figure 1.** Research location, Karangwangi Village, Cidaun sub-district, Cianjur district, West Java province, Indonesia

**Table 1.** The land use system of Karangwangi Village, Cidaun district, West Java, Indonesia (Karangwangi Village Statistic 2015)

| Land use systems | Acreage (ha) | Percentage of the sub-total of village area (%) |
|---|---|---|
| Homegarden (*Pekarangan*) | 1.8 | 0.12 |
| Swidden field (*Ladang/Huma*) | 450.0 | 30.5 |
| Mixed perennial garden (*Kebun campuran kayu-kayuan/kebon kai*) | 5.0 | 0.3 |
| Dry land (*Tegalan*) | 47.0 | 3.2 |
| Plantation (*Perkebunan,* such as *Sawit*) | 5.0 | 0.3 |
| Rice field (*Sawah*) | | |
| - Irrigated rice field (*Sawah irigasi*) | 195.0 | 13.2 |
| - Rainfed rice field (*Sawah tadah hujan/non-irigasi*) | 772.0 | 52.3 |
| Sub-total of village area | 1475.8 | 100.0 |
| Forest of Nature reserve (*Hutan Cagar Alam Bojong Larang-Jayanti*) | 700.0 | 32.9 |
| Total of village area and forest area | 2123.8 | 100.0 |

**Procedure**

The method used in this study is a qualitative, which is based on study ethnoecological and ethnobiological approach (Martin 1995; Alexiades and Sheldon 1996; Newing et al, 2011; Albuquerque et al. 2014). On the basis of ethnoecology, researchers were focused on dimensions of mining and local knowledge of people on environment. The researchers sough perception of village people of Karangwangi on their environment in this research in the context of people activities on introduction of *jengjen* in the *huma* farming system (Johnson 1974; Milton 1996; Ahimsa-Putra 1997). Some techniques of collecting data were applied, namely observation and deep interview (Martin 1995; Newing et al. 2011; Iskandar 2012; Albuquerque et al. 2014). Additionally, we observed structure vegetation of *huma*, *kebun kai*, *talun*, and *jengjen* farming. Meanwhile, in-depth interview with informants purposively selected via snowball sampling, with attention to a diversity of informants was undertaken. Informants include village leader (*kepala desa*/*kades*) and his staff, informal leaders, old farmers, labor famers, carpenters, and construction labors.

**Data analysis**

The data were analyzed by means of cross checking, summarizing, synthesizing of various data obtained from observations and interviews, and narrated by descriptive analysis (Newing et al. 2011).

## RESULTS AND DISCUSSION

**Development of *huma***

In the past the people of Karangwangi Village of South Cianjur were predominantly practiced the swidden cultivation due to still low population and forest area was plentiful (Iskandar et al. 2016). Initially, the management of swidden cultivation was culturally based on the Traditional Ecological Knowledge (TEK) and cosmos or belief (Toledo 2002). As a result, various stages in the swidden cycles, such as cutting underbrush, planting rice and harvesting rice were culturally performed by traditional rituals, to respect to the rice goddess, *Nyi Pohaci* (in Japanese *Dewi Sri*) and to ensure successful farming (cf. Iskandar 1998; Iskandar and Iskandar 206c). In addition, in managing of the swidden system, it was strongly based on the TEK. For example, the Karangwangi traditionally used the star constellation and flowering and fruiting times of certain perennial plants to determine main time of swidden faming activities (Table 2).

There were seven main stages in the Karangwangi swidden cycle: site selection, land preparation, planting rice, weeding and managing pests, harvesting rice, storing rice, and fallowing land. To practice swidden farming, a piece of land between 0.5 and 1 ha was cleared completely of vegetation in dry season. In the beginning of dry season, the swidden field was planted by rice and other annual crops. Two main local rice verities were predominantly cropped *pare sintung* (red hulled rice) and *pare jampang* (white hulled rice). Meanwhile, various non-rice were predominantly cropped namely *suuk/kacang tanah* (*Arachis hypogaea* L), *sampeu/singkong* (*Manihot esculenta* Cratz), *wijen* (*Sesamum indicum* L), *trurubus* (*Saccharum edule* Hassk), *hanjeli* (*Coix lacryma*-jobi L), *jagong/jagung* (*Zea mays* L), *bonteng/mentimun* (*Cucumissativus* L), *kacang panjang* (*Vigna sinensis* L), *hiris* (*Cajanus cajan* Huth), *kacang kedele* (*Glycine max* (L) Merill), kacang hejo (*Phaseolus radiatus* L), waluh/labu (*Cucurbita moschata* Duchesne), *roay* (*Dolichos lablab* L), *cikur* (*Kaempferia galanga* L), and *jahe* (*Zingiber officinale* Roscoe).

About five months after sowing, rice mature and was ready to be harvested. Reaping was undertaken using a finger knife which consists of a thin iron blade, set into a small piece of bamboo, which is sometimes carves. About four fistfuls are tied together with bamboo, to form a *sapocong*. Moreover, the rice bundles were carried to settlements. Unlike the harvesting rice, harvesting other cultigens was undertaken at different times. For example, *kacang panjang*, *mentimun*, *kacang tanah*, and *wijen* were harvested about one month, one month and ten days, 3 months and ten days, and 4 months after planting, respectively.

**Table 2.** Traditional ecological knowledge of Karangwangi people on climate changes used as indicator to cultivate the *huma* system

| **Informant perception (*emic* view)** | **It can be translated as:** |
|---|---|
| **Indicators of climate changes from dry to wet season** | |
| • *Bentang kidang katingali di ufuk timur/wetan waktu fajar, tanda halodo waktuna pikeun nyacar leuweung* | • When *kidang* (the belt of Orion) appears on the horizon just before down, indicated as the dry season and appropriate time for cutting shrubs in the forest for beginning of *huma* cultivation. |
| • *Bentang kidang katingali manceran,hampir ngagilek ka kulon, tanda ngamimitian hujan, ngaseuk di huma.* | • When *kidang* (the belt of Orion) appears overhead or sideways to the west, beginning the wet season and appropriate time to plant rice in *huma*. |
| • *Tangkal randu buahna garing bareulah kaluar kapuk bade hujan.* | • When fruits of *randu* (*Ceiba petandra* (L.) are mature and kapok out of the fruits, indicated it begins the rainy season. |
| • *Tangkal beuris karembangan, baruahan, jeung buahna pada ragragan, tanda usum hujan* | • *Beuris* (*Aporosa prutescens* Bl.) plants are planting and fruiting, and fruits fall down, indicated the wet season. |
| • *Tangkal dangdeur buahna maruka saperti buah kapuk,tanda musim hujan.* | • *Dangdeur* (*Pseudobombax septenatum* (Jacq.) Dugand) plants are mature similar to that of kapok, indicated the wet season. |
| • *Boborosan sarirungan tanda musim hujan* | • Various shoot of banana and *Nicolaia* spp. begin sprout, indicated the wet season. |
| **Indicator of climate change from the dry to wet season** | |
| • *Tangkal randu dauna ngarangrangan, tanda usum halodo* | • When leafs *randu* tree (*Ceiba petandra* (L.) Gaertn have been dry and fell dawn, indicated the dry season. |
| • *Pohon beurih dauna ngarangrang, tanda usum halodo.* | • When leafs of *beuris* tree (*Aporosa frutescens* Bl) have been dry, indicated the dry season. |
| • *Pohon dangdeur ngarangrangan tanda musim halodo* | • When leafs of *dangdeur* (*Pseudobombax septenatum* (Jacq.) Dugand) have been dry, indicated the dry season. |

After harvesting rice and other annual crops, the land was fallowed and transformed into secondary forest (*reuma*). People will shift to another piece of mature *reuma* for planting and follow the same procedure: cutting and pruning, burning, weeding, harvesting and fallowing. Finally, after harvesting rice, the swidden field is fallowed for several years and can be re-cultivated.

However, due to population increase, forest decrease, and government policy to prohibit to practice swidden in the forest, the fallowed lands have been converted to annual garden (*kebon*), bamboo garden (*kebon bambu*), mixed-wood garden (*kebon kai*), mixed-fruits and wood (*talun*), rice fields (*sawah*), and a hamlet (*lembur* or *kampung*) and home garden system (Iskandar et al. 2016; Iskandar and Iskandar 2016a).

Recently, the land right status of *huma* and *reuma* have also been changed from traditional common land tenure or *lahan garapan* (Soepomo 1982) to individual land right (*hak milik*) by obtaining land certificate (*sertifikat tanah*). For example, on the fallow land of 710 ha in Karangwangi Village, 360 ha have been certified through the village program was undertaken in 2013. On the basis this program, some people have successfully obtained land certificate. For instance, based on information of five informants, revealed that they obtained land certificate through the village program, namely Pak Wahyu (80 are or 8,000 $m^2$), Pak Uyun (2,500 $m^2$), Pak Agus (1 ha), Pak Rosman (5,500 $m^2$), and Pak Itang (1 ha dan 1.500 $m^2$). Meanwhile, the rest of non-certificate lands have been called by local village people as 'the grazing land' (*taneuh pangangonan*). Since it used to grazing land of buffalo in the past (Iskandar et al. 2016).

Both the certificate and non-certificate land have been cultivated for swidden (*huma*) and other agroecosystem

types, *kebon awi, kebon kai, talun* and *pekarangan*. These agroecosystems have been predominantly planted with mixed perennial crops and can be categorized as the traditional agroforestry system (Soemarwoto and Soemarwoto 1984). These traditional agroforestry systems have structure vegetation similar to that of forest and own various ecological functions, such as soil erosion protection, hydrology, micro-climate effects, oxygen production, wild animal habitat, carbon stock, genetic conservation, and socio-economic functions for village people (Soemarwoto and Soemarwoto 1984; Aryal and Chaudhury 2015; Colfer et al. 2015; Raintree and Warner 2015; Iskandar and Iskandar 2016b).

Recently, the swidden system (*huma*) of Karangwangi has dramatically changed. For example, unlike Baduy community (Iskandar and Iskandar 2016c), the traditional agricultural calendar that is based on the star constellation and flowering and fruiting times of certain perennial plants has rarely applied. The planting time is mainly determined by the rain season time. Meanwhile, various local rice varieties have not been cultivated any longer due to replace by modern new rice verities that have fast harvesting between 3 and 4 months, and intensively provided by chemical fertilizers. In addition, the *jengjen* trees have been introduced and predominantly planted in the *huma* and other traditional agroforestry systems.

**Introduction of *jengjen***

On the basis of ecological history, *jengjen* (*Paraserianthes falcataria* (L.) Nielsen) and *jabon* (*Anthocephalus* sp.) have been firstly introduced in Karangwangi Village by the Forestry Office in 2000s by proving free seeds (Rohidin A 2015, pers. com.). Main objective of the introduction of these plants was to replanting the dry land area through the regreening program (*program penghijauan*). In the development of these plants, it has been well accepted by local people of Karangwangi, especially *jengjen*. Because *jengjen* has rapidly growth compares to that of *jabon* and provided economic benefit. According to local people of Karangwangi, this species can be divided into two variations, namely '*jengjen beureum'* (*jengjen merah*-red *jengjen*) and '*jengjen bodas'* (*jengjen putih*-white *jengjen*). The *jengjen beureum* has main characteristics, such as bark (*daging kayu*) has red color, while *jengjen bodas* has white color bark. In addition, wood fiber of *jengjen beureum* is considered to be strong compare to that of *jengjen bodas*. Scientifically, *jengjen* has been recognized as *Paraserianthes falcataria* (L.) Nielsen, family Fabacae, sub-family Mimosaideae. In addition, various scientific names: *Falcataria moluccana* (Miq.) Barneby & J.W Grimes are synonymously given to this species (Soerianegara and Lemmens 1993). Originally *jengjen* had grown in natural habitat in surrounding area of Maluku islands. In 1871, *jengjen* has been brought to Botanical Garden of Bogor, West Java. Moreover, this plant has widely spread to many areas of Indonesia, such as Java, South Sulawesi, Maluku (Islands of Taliabu, Mangolle, Sasan, Obi, Bacan, Halmahera, Seram and Buru) and Papua (Sorong, Manokwari, Kebar, Biak, Serui, Nabire, and Wamena) (Martawijaya et al. 1989).

**Cultural practices in the planting *jengjen***

*Jengjen* trees have been traditionally farmed by local people of Karangwangi Village in various agroecosystem types, such as *huma*, *tegal*, *kebon* and *kebon kai* that is strongly embed by Traditional Ecological Knowledge and hybridized with Western scientific knowledge (Iskandar and Ellen 2007). Traditionally, there are five stages: making nursery, planting, maintaining, harvesting, and utilizing in the *jengjen* farming system that are commonly practiced by Karangwangi Village.

**Making nursery**

Initially, the nursery of *jengjen* has predominantly carried out by local people of Karangwangi Village without buying seeds from seed sellers. Before sowing seeds (*ngipuk*), various materials including seeds of *jengjen*, soil, fertilizer, and growing media in the polybag form are prepared. The *jengjen* seeds are obtained by collecting it from fallowed land covered in mature *jengjen* trees between 7 and 15 year old. *Jengjen* seed preparation has been undertaken in several stages. Firstly, seeds are soaked in hot water until water has been cooled. Secondly, seeds are wrapped by cloth and allowed to stand two days until the seeds germinate. Thirdly, *jengjen* sprouts are placed in the polybag that has been filled with soil as a medium plant. Fourthly, seedlings are watered and fertilized of NPK and left a few months. Afterward, the seedlings that have a height about 50 cm are transplanted to the swiddens.

Because the demand of *jengjen* seeds have increased, many people of Karangwangi in addition to setting up their own seed also bought ready seeds from shops of Cidaun and Rancabuaya as well as bought seeds from seed sellers who regularly visit village in the beginning of rainy season. The price of *jengjen* seedlings in the beginning of introduction in 200s were purchased at 150 rupiahs per tree. But as recently as 2015, seedlings were purchased at 1,000 rupiah per tree from both seedling peddlers and shop supplier in district capital, Cidaun.

**Planting and maintaining**

Before the seedlings are planted, land preparation has been undertaken in November. There are several stages in land preparation. Firstly, underbrush grown in fallowed (*reuma*) land or dry land (*tegalan*) is cut by machete (*parang*). Secondly, the land that has been cleared is hoed and a hole dug of between 10 cm and 15 cm according to high seedling in the polybag. The thirdly, when the rainy season has begun, a seedling is placed in the hole and buried with soil as protection against termite damage. Planting distance between trees approximately 3 m x 3 m or 2 m x 3 m depending on land area to be planted. Traditionally, *jengjen* seedlings are planted in *huma* or *tegalan* by Karangwangi people together with various other crops, such as kacang tanah (*Arachis hypogaea* L), kapol or kapulaga (*Amomum compactum* Soland ex Maton), pisang (*Musa paradisiaca* L), jahe-jahean (Zingiberceae), mahoni (*Swietenia macrophylla* King) and *jabon* (*Anthocephalus*

sp.). The planting *jengjen* trees with other crops have provided ecological and socio-economic benefits, such as help improve soil fertility, avoid the risk of pest, and providing various product for subsistence and cash income (Reijntjes et al. 1992; Elias and Wisatara 2009; Iskandar and Ellen 2000; Sudomo and Hadayani 2013; Diniyati et al. 2013; Kosuke et al. 2013; Aryal and Choudhury 2015).

In addition, by planting *jengjen* mixed with other annual has benefit in term of less intensive care. This caused a farmer is caring for annual crops, such as weeding and fertilizing, indirectly the *jengjen* trees are also served. As a result, the *jengjen* trees are normally given fertilizer of NPK and animal dungs when these trees age after one year. The maintenance of *jengjen* trees are also undertaken by farmers, if there are tees die and replaced by new seedlings with have age more than one months. During fertilizing small branches and some leaves of *jengjen* are pruned, particularly if the tree has too many twigs. This technique is an important role due to all biomass so yielded is recycle as compost may help improve soil fertility (Iskandar and Ellen 2000). In addition, by pruning small branches and some lives of *jengjen* trees is important that plants get enough sunlight. As a result, the *jengjen* trees may grow tall, straight, and yield of good quality of wood. Positively, on the basis of the photosynthetic rate measurement, the *jengjen* plant can be categorized as a high rate, but it has a good adaptation with shade of other plant canopies (Christanty et al. 1978). Moreover, after more than one year, the swidden is usually covered by a close canopy of *jengjen* and is not given fertilizer anymore. But the weeding is only sometimes undertaken to avoid nutrient competition with terrestrial weeds. In addition, special pest control is minimally undertaken by Karangwangi people, particularly if the *jengjen* trees have been attacked by various pests, such as caterpillar (*uter-uter*) and kind of termite (*sireum delu*) (Krisnawati et al. 2011; Varis 2011; Pieter et al. 2013). Therefore, generally it can be seen that the introduction of *jengjen* in to the swidden farming providing some benefits because it does not require a lot of labor and costs.

**Harvesting and utilizing**

After more than four years the trunk of *jengjen* trees are large enough to be cut as timber for sale and home use, while the branches can be used for firewood and the leaves and twigs recycled as compost. The harvesting time, however, can be variably done depending on the need of farmers. For example, if the farmer needs money urgently or there is demanded by a timber merchant, harvest of *jengjen* trees can be accelerated between 3 and 5 years. Generally, it has been recognized as three systems of harvesting and selling *jengjen* tree in Karangwangi Village, namely selling of 'whole sale' (*jual borongan*), 'in cubic of logging' (*jual palet*), and 'in timber processed' (*jual dijadikan bahan*) system. The *jual borongan* system is that all *jengjen* trees of the garden are paid by a timber merchant before the trees are harvested by the owner. Generally a timber merchant come to *jengjen* owner before harvesting time and estimates the price of timber. If the two sides have agreed with the price, then timber is paid by a timber merchant. Therefore, when the timber harvest arrives, a timber merchant cut all *jengjen* trees and logs are carried by truck.

The *jual palet* system is that the *jengjen* trees are sold to a timber merchant in form of the trees that have been cut with length between 130 and 160 cm. Unlike *jual borongan*, the price of timber has fixed price based on cubic meters of timber. *Jengjen* tree that has diameter of more than 25 cm was sold to a timber merchant for approximately 890,000 rupiah per cubic in 2015. Meanwhile, the tree that has diameter of less than 25 cm was sold for approximately 670,000 rupiah per cubic. According to informants, the selling timber with the *jual palet* system is considered as more transparency. However, the *jengjen* owner must hire logger services or is popularly called as *jasa nyenso* (initially from word 'chainsaw') to cut trees by chainsaw. Particularly, for the *jengjen* owner who does not have the chainsaw for harvesting trees. The logger was normally paid for approximately between 35,000 and 50,000 rupiah per cubic in 2015. The *jual bahan jadi* system is that the *jengjen* trees are cut by the owner. Moreover, the timber is processed into beam or board form that readily to use for building material and furniture. This harvesting system has high economic value compare to that of the *jual borongan* and *jual palet* system. Due to timber has been processed to be ready material for building material or furniture. Therefore, the *jengjen* timber can be sold for approximately between 1.5 and 2 million rupiah per cubic. This harvesting system is usually undertaken by rich farmers due to need some equipment and adequate capital. Consequently, the harvesting *jengjen* trees in the Karangwangi Village have predominantly undertaken by the harvesting system of *jual borongan* and *jual palet* instead of *jual dijadikan bahan.*

Traditionally, utilization of *jengjen* trees can be divided into two categories, namely for subsistence purpose to fulfill the household needs and for trading. The first category, the *jengjen* timber production is used to accomplish the household needs. Maturing *jengjen* approximately 4-5 years old is cut by pickaxe, saw, or chainsaw. Moreover, the logging is sawed to be variety of building materials, such as board (*papan*), frame house (*kosen*), pole building (*tiang bangunan*); and furniture materials, such as table, chair, and cupboard.This carpentry is usually undertaken by himself, particularly for an individual who has the equipment himself. Meanwhile, for an individual who does not have any equipment himself, he must hire other people as carpenter. The second category, as mentioned earlier, the *jengjen* production is sold to a timber merchant by harvesting system of *borongan*, *palet*, and *dijadikan bahan*. Moreover, the timber production is carried by truck and sent to neighboring district or urban area.

**Impact of *jengjen* introduction**

On the basis ecological or environmental history, swidden system in village of Karangwangi has developed into several types of traditional agroforestry system, namely *kebon awi* (bamboo garden), *kebun kai* (mixed perennial wood garden) and *talun* (mixed fruit and woods)

**Table 3.** Various leguminous plants (Leguminosae, Fabaceae, Papilionaceae) have commonly planted in the *huma* system by Karangwangi people

| Scientific name | Family | Sundanese name | Habitat and uses |
|---|---|---|---|
| *Acacia auriculiformis* Benth. | Fabaceae | *Akasia* | Perennial plant that is commonly in the homegarden, *kebon kai*, and *huma*, traditionally used as wood and firewood |
| *Albizia chinensis* (Osbeck) Merr. | Fabaceae | *Jeunjing* | Perennial plant that is commonly in the homegarden, *kebon kai*, and *huma*, traditionally used as wood and firewood |
| *Albizia procera* (Roxb.) Benth | Fabaceae | *Kihiang* | Perennial plant that is commonly in the homegarden, *kebon kai*, and *huma*, traditionally used as wood and firewood. |
| *Arachis hypogaea* L | Fabaceae | *Kacang suuk* | Annual crop that is commonly cropped in *huma* and garden, traditionally used as spices and sold. |
| *Cajanus cajan* (L.) Millsp. | Fabaceae | *Kacang hiris* | Annual crop that is commonly in *huma* and garden, traditionally used as vegetable. |
| *Calliandra calothyrsus* Meisn. | Fabaceae | *Kaliandra* | Perennial plant that is commonly cropped in *huma* and *kebon kai*, traditionally used as firewood |
| *Dolichos lablab* L | Fabaceae | *Kacang roay* | Annual crop that is commonly cropped in *huma*, traditionally used as vegetable |
| *Glycine max* (L) Merill) | Fabaceae | *Kacang kadele* | Annual crop that is cropped in *huma*, traditionally used as vegetable. |
| *Leucaena leucocephala* (Lam.) de Wit | Fabaceae | *Peuteuy selong* | Perennial plant that is planted in homegarden and *kebon kai*, traditionally used as vegetable and fodder |
| *Paraserianthes falcataria* (L.) Nielsen*) | Fabaceae | *Jengjen* | Perennial plant is commonly planted in homegarden, *huma*, *kebon kai*, traditionally used as building materials and firewood, and sold. |
| *Parkia speciosa* Hassk. | Fabaceae | *Peuteuy* | Perennial plant that is commonly planted homegarden, *huma, kebon kai*, traditionally used as vegetable and sold. |
| *Pithecelobium jiringa* (Jack) Prain | Fabaceae | *Jengkol* | Perennial plant that is commonly planted in *huma*, *kebon kai*, *pekarangan*, traditionally used as vegetable and sold. |
| *Samanea saman* (Jacq.) Merr. | Fabaceae | *Ki hujan* | Perennial plant that is commonly in the homegarden, *kebon kai*, and *huma*, traditionally used as wood and firewood. |
| *Senna alata* (L.) Roxb. | Fabaceae | *Haringin* | Perennial pant is commonly planted in *kebon kai*, traditionally used as wood |
| *Vigna sinensis* L | Fabaceae | *Kacang panjang* | Annual crop that is commonly cropped in homegarden and *huma*, traditionally used as vegetable |
| *Gliricidia sepium* (Jacq) Walp | Papilionaceae | *Gamal* | Perennial plant that is commonly planted in homegarden, kebon kai, traditionally used as firewood and living fences; |
| *Vigna radiata* (L.) R.Wiczek | Papilionaceae | *Kacang hejo* | Annual crop that is commonly cropped in *huma* and garden, traditionally used as vegetable. |

Note: *) Introduced by the Forestry Office (*Dinas Kehutanan*) through the regreening program

(Iskandar et al. 2016; Iskandar and Iskandar 2016a). Traditionally, people of Karangwangi Village have cultivated various crops, including leguminous crops (Leguminosae, Fabaceae, Papilionaceae), such as *kacang hiris* (*Cajanus cajan* (L.) Millsp), *kacang tanah* (*Arachis hyogaea* L), *kacang roay* (*Dolichoslablab* L), and perennial plants, including *peuteuy* (*Parkia speciosa* Hassk), *kihiang* (*Albizia procera* (Roxb) Benth, and *jeungjing* (*Albizia chinensis* (Osbeck) Merr) that can help maintain soil fertility in the swidden system (Table 3).

Moreover, due to more intensive cultivation of swidden, introduction of *jengjen* has been introduced in 2000s. This fast growing plant has popularly cultivated by local people of Karangwangi Village due to provide various ecological and socio-economic benefits. Economic benefits namely can maintain soil fertility in the various traditional agroforestry systems, namely *huma, kebon awi* and *kebon kai* because it is fast growing, nitrogen-fixing, easily cultivated, provides household needs, and yielding a cash income. This plant maintains soil fertility due to able to fixe nitrogen through bacteria of *Rhizobium* that grows in root of *jengjen* (Reijntjes et al. 1992; Iskandar and Ellen 2000). Meanwhile the socio-economic benefits namely almost all product of *jengjen* can be used by people. For example, various products can be used building materials and furniture, while small branches are collected for firewood. Indeed, *jengjen* tree that has been damaged by pest can still use for firewood. In addition, product of *jengjen* timber can be sold both in local or sent to other areas, such as Rancabuaya, Garut, Tasikmalaya, Bandung,

and other areas Central Java and East Java. Both logging and timber product of *jual palet* have predominantly sent to factories in Kertajati and Ciawi, West Java to be used of building materials and furniture. In other words, development of *jengjen* farming in village of Karangwangi since 2000s has created various new economic activities for village people. Before developing the *jengjen* farming, most people of Karangwangi Village has intensively engaged in economic subsistence of swidden farming. Afterward, by development of *jengjen* farming, they have developed and adapted to market economy. It must be considered, however, introduction of *jengjen* tree will not to dramatically changes traditional agroforestry systems of *kebon awi, kebon kai* and *talun* to be commercial monoculture of *jengjen* garden. Due to these agroforestry traditional systems have been traditionally created based on the Traditional Ecological Knowledge for a long time over generation. There are some distinctive characteristic of the traditional agroforestry, namely recognized as low inputs and maintaining crop diversity. Traditionally, various external inputs, such as chemical fertilizer and pesticides have minimally applied in the traditional agroforestry system. In addition, the traditional agroforestry systems have been plentifully cropped by species and verities (land races) both annual and perennial crops. For example, it has been revealed that at least 13, 4, and 13 local species and land races of banana (*Musa paradisiaca* L), coconut (*Cocos nucifera* L), and bamboo (Family Poaceae, Sub-family Bambusoideae), respectively, that are planted at the traditional agroforestry systems of Karangwangi Village. As a result, these traditional agroforestry systems have various products for both subsistence and economic commercial. In addition, it has adapted to environmental changes, including climate anomaly (drought and flood), pest resistant, and has a high resilience with market fluctuations (Christanty et al. 1986; Iskandar 2007; Aryal and Choudhury 2015). Therefore, if these traditional agroforestry system have been dramatically changed to commercial monoculture of *jengjen*, although it has provided high economic value, some negative impact may occurs, such as loss of local plant species and varieties, vulnerable to pests and diseases, and low resilience on market fluctuations (Reijntjes et al. 1992).

On the basis of this study, it can be concluded that although the population of Karangwangi has increased and forest decreased, and market economy intensively penetrated to village, the swidden system has continuously practiced by people of Karangwangi Village. Unlike in the past, recently swidden cultivation (*huma*) has been practiced in non-forest instead of natural forest. The *huma* has been modified by farmers into various more permanent traditional agroforestry systems, such as *kebon awi, kebon kai,* and *talun* (Iskandar et al. 2016). In addition, due to more intensive cultivation of the *huma*, the introduction of *jengjen* has been undertaken by farmers that initially introduced by the Forestry Office (*Dinas Kehutanan*) through the regreening program. Moreover, the *jengjen* has well adopted and integrated with the development of the swidden farming (*huma*) due to this species provide various ecological and socio-economic benefits, and does not eliminate the *huma* system tradition of the local people.

## ACKNOWLEDGEMENTS

This study is one of the topics of the program of Academic Leadership Grant of Prof. Johan Iskandar, funded by DIPA Padjadjaran University. Therefore, in this occasion we would like to thank Prof. Tri Hanggono Achmad, rector of Universitas Padjadjaran, who has provided Academic Leadership Grant. In addition, we would like to thank the field assistant, Riky Novalia Suhendi, who has assisted collect field data. In this opportunity, we also conveyed gratitude to the village head of Karangwangi Village and his staff, along with the informants who have kindly helped used to provide information.

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