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DRY LAND AGROFORESTRY PRACTICES IN MENOREH HILLS, KULON PROGO

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ABSTRACT

Private forest in Java Island is mainly managed by Agroforestry (AF) system. There are three levels in AF systems: early AF, middle AF, and advance AF. The land productivity in AF system by villagers is mostly low because of inappropriate AF practice. The objective of this research is to analyze the land management practice in Menoreh hills, Kulon Progo, Yogyakarta. The study was conducted in Giripurwo Village, Kulon Progo. Stratifed sampling with purposive sampling was used in this study. Total of twelve plots were determined in every AF levels. Studies conducted in every plot includes the species composition and soil fertillity. The results showed that: (1) Tree composition in early and middle AF is dominated by woody tree (Sengon), while in advance AF is dominated by non-timber forest product (clove), (2) Low soil fertility in the study area is caused by high intensity of biomass harvesting and low fertilization dosage applied, (3) The increment of land productivity could be achieved by increasing the biomass input to the soil from organic fertilizer and crop waste.

Keywords: agroforestry; land management practice; land productivity; Menoreh Hill; soil fertility

INTRODUCTION

Tropical natural forest has persistently been degraded and deforested. The estimation of deforestation rate in tropical forest in 1999-2000 was 14.2 million ha year^{-1} in which 1 million ha ha^{-1} became plantation forest (Gascon *et al.*, 2004). Ministry of Forestry (2009) reported that forest degradation in Indonesia in 2004-2005 was 0.96 million ha year^{-1} causing degradation on biodiversity, environmental capability, and socio-economic value. However, the number of trees that grow outside forest area increased, it was indicated by the increasing area of private forest from 32,164,000 ha in 2005 to 248,154,000 ha in 2009 (Ministry of Forestry, 2009).

The development of community forest is mainly promoted by its high economic return and supported by government land restoration program since 1950. Total area of community forest in Indonesia significantly grows from 32,164 ha in 2005 to 248,154 ha in 2009 (Ministry of Forestry, 2009). Community forest plays an important role for substituting the virgin forest that is degraded and deforested. Awang *et al.* (2007) argues that there are two roles of trees in villages: (1) trees can maintain and improve environment to support crops by improving nutrition and energy intake, and (2) trees can improve economic sources for villagers. Community forests in Menoreh Hills are managed by agroforestry (AF) system.

The improvement of private land management may affect the economic condition of farmers in the village. The more intensive management of community forest the more labour needed and it may contribute to broader income generation because there are more actors involved in the community forest supply chain (Darusman and Hardjanto, 2006). The objective of this research was to analyze the land management practice in Menoreh hills, Kulon Progo, Yogyakarta. The results of this study may contribute to relevant parties on private forests e.g. decision makers, researchers, professionals, and farmers to develop better plans and strategies in improving land productivity and land management.

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MATERIALS AND METHODS

This study was conducted in Giripurwo Village, Girimulyo Sub District, Kulon Progo District, Yogyakarta. The study area was located in Menoreh hilly area that was characterized by thin soil layer low soil fertility. Soil type in study area was latosol. The area was mostly steep with average slope of 14ºto more than 40º. The elevation of the study area was 300-600 m asl with the average rainfall of 2,323 mm per year and the average temperature of 24.2º – 25.4˚C (Statistics Agency of Kulon Progo District, 2011).

The climate type in this study area was D according to Schmidt and Ferguson type. Geographically, Giripurwo village is located at 110.184-110.229 East Longitude and 7.789 – 7.821 South Latitude (Figure 1). The study was conducted from March-December 2012.

Material used in this study was questionnaire as guidance for interviewing selected respondents. Tools in this study were: (1) Light meter to measure the light intensity that is important to determine the under storey species, (2) Termo-hygrometer to measure temperature and humidity, (3) length scale to measure tree canopy area, (4) Pita meter and haga meter to measure tree dimension.

Interview and survey were conducted to collect socio-economic data from 12 respondents that apply three AF levels: early AF (A1), middle AF (A2), and advance AF (A3). Suryanto *et al.* (2005) argues that there are three development stages in agroforestry system which is characterized by the proportion of crop planting area: (1) *early agroforestry* (crop planting area 50%), (2) *middle agroforestry* (crop planting area 25-50%), and (3) *advance agroforestry* (crop planting area < 25%). If the dominant trees are multipurpose species then the advance agroforestry may become mixed garden. If the dominant trees are commercial wood species then the advance agroforestry system may become full of trees or private forest.

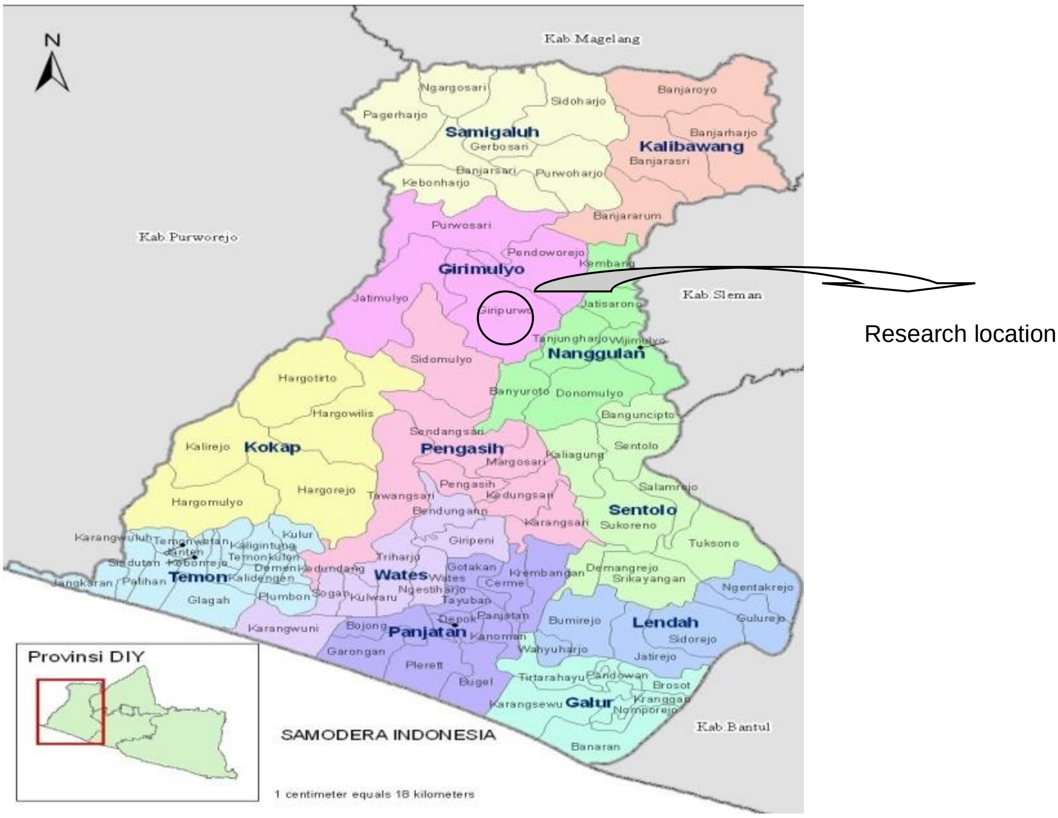

Figure 1. Research location

An interview was conducted to collect data of land management by farmers, while a survey was conducted to find out the vegetation composition in AF system. Four plots were made in each level of AF (total 12 plots). Tree measurement was conducted 100% in each plot following Soerianegara and Indrawan (1978) category: trees (tree which has >20 cm dbh), pole (tree which has 10-20 cm dbh), sapling (tree which has height of >1.5 m and <10 cm dbh), and seedling (tree which has height < 1.5 m). The tree identification was conducted by asking local people on the local name of the certain species and if necessary the specimen was collected and compared with the Heyne (1987) categories.

Soil fertility status data were obtained by taking soil samples in each research plot. The composite of six points of each plot represented the soil sample of each plot. Soil samples were analyzed in the soil laboratory of Jenderal Soedirman University. The analyzed parameters were macro nutrients, organic-C, pH, and soil texture. The laboratory analysis results were compared with the soil fertility criteria from Center for Soil Research (Hardjowigeno, 2003) to categorize soil fertility. The data on land management practices obtained through interviews. There were 12 respondents for dry land management practices applied in the study area.

The questionnaire was developed to determine the level of community interaction with the land, how the land management, what is obtained from the land, and the factors that influence land management. Environmental conditions data i.e. temperature, humidity and light intensity were obtained by direct measurement in the field. Measurement of temperature, humidity and light intensity was at the optimum time to photosynthesis which is at 11:00 AM to 01:00 PM (Nilsen and Orcutt, 1996).

Soil characteristics were analysed in laboratory to examine soil fertility. Then the collected data was compared with the soil fertility quality standard of Agroclimate and Soil Research Center (1994). The soil fertility parameters were macro nutrients content in the soil (NPK). The land management of AF system was analysed with descriptive analysis.

RESULTS AND DISCUSSION

Biophysics Aspect

Soil Physical and Chemical Properties

The analysis on soil fertility was conducted to determine soil fertilizer type and its dosage. The lack of macro nutrient indicated the needs for certain soil fertilizer. The chemical properties of soil in study area are presented in Table 1.

The analysis results show that the soil fertility in the study area, compared to soil fertility quality standard of Center for Soil Research in 1994 (Hardjowigeno, 2003), has very low content of C-organic, N total, P and K. The low content of these macro nutrients (NPK) indicated that the low productivity of plant since these macro nutrients is very important for crop vegetation to grow in its life cycle. The soil pH in the location is from 4.51-5.38. Soils are leached intensively which commonly dominated by kaolinite minerals, ferrioxide and aluminium so that it has low cation exchange capacity (Hairiah *et al.*, 2000).

Table 1.Soil fertility on the observation plots in Giripurwo Village, Girimulyo Sub District, Kulon Progo

No.	Location	C-organic (%)	N total (%)	P_2O_5 available (ppm)	K_2O available (me%)	pH (H_2O)
1	A1.1	0.737	0.032	0.44	0.37	5.21
2	A1.2	1.338	0.13	0.619	2.326	5.2
3	A1.3	1.356	0.123	0.0055	2.113	4.95
4	A1.4	1.114	0.224	3.046	2.12	5.3
5	A2.1	1.454	0.138	0.251	0.917	5.06
6	A2.2	1.639	0.147	0.014	2.009	5.01
7	A2.3	1.784	0.162	0.223	2.578	5.01
8	A2.4	1.142	0.118	0.677	1.472	5.14
9	A2.5	0.911	0.095	0.065	1.249	4.97
10	A3.1	0.909	0.107	0.439	1.775	4.98
11	A3.2	0.418	0.043	0.793	3.032	5.38
12	A3.3	1.84	0.12	0.183	0.711	4.51

The availability of soil nutrients in tropical soils are commonly depends on inputs from organic materials from vegetation that grow on the soils. The dependency of the villagers in the study area on dry land area to fulfil their economic needs is very high. The villagers commonly gather leaves for feeding livestock so that the nutrient supplies from organic materials become very low. Therefore, the soil fertility in the study area is very low.

The villagers commonly apply organic fertilizers for species which has high economic return e.g. clove, sengon and tectona. The frequency of organic soil fertilizer application for these species in average is once a year. The dosage of fertilizer highly depends on livestock property and the existence of paddy field. Villagers who have many livestock may apply more fertilizers than those of less livestock. Villagers who have paddy field will give more priority to apply organic fertilizers to their paddy field than to the agroforestry field.

Some of the villagers do looping (pruning for fertilizing the soil). This activity is conducted by villagers who have no livestock. Nevertheless, villagers who have livestock will harvest leaves for livestock feeding. The organic soil fertilizer is put on the surrounding of the main trees. As a consequence, this technique is inefficient in rainy season since the soil fertilizer will be easily eroded and in dry season fertilizer is easily getting dry so that the nutrient from the fertilizer is hardly absorbed by the roots. Soil conservation technique that may reduce soil erosion in hilly area is grass plantation. Grass not only contributes on the soil stabilization but also contributes on providing livestock food. Therefore, the dependency of villagers who has livestock on leaves from the trees can be minimized by substituting leaves with grass. Dass *et al.* (2011) proves that surface run off on grass is only 8.1-9.8%. This may also increase soil humidity and nutrient loss.

Soil texture is one the factors for species suitability development. Crops species commonly need loose soils with high porosity because its root system is not as strong as trees'. The soil texture analysis result in study area is presented in Table 2.

Soil texture in study area is classified clay. Under this condition, the soil is less crumble and has low porosity, so water infiltration is very low and may cause water stagnant and high soil humidity. Under this soil condition, crops do not optimally grow under the tree stand.

Thus, physical soil improvement is important in the study area by organic fertilizer application and appropriate soil tillage. The application of organic soil fertilizer may improve physical, chemical and biological properties of the soil. Syukur and Harsono (2008) argue that the important roles of C-organic are: improving soil structure and water storage capacity, supplying nitrate, phosphate and organic acid for mineral disintegration, supplying nutrients, increasing cation exchange capacity (CEC) and nutrient absorption, carbon source, mineral and energy for crops and microorganism and slow release.

The soil improvement can be done by planting species that fix nitrogen (legume species) either trees or cover crops. Some studies have shown that nitrogen availability in soils under legume cover crops is high (Schroth *et al.*, 2000).

Table 2. Results of analysis of soil texture in the observation plots

No.	Site Replication	Sand (%)	Clay (%)	Silt (%)	Class
1	A1.1	28.21	52.14	19.65	clay
2	A1.2	7.9	45.54	45.56	clay
3	A1.3	7.34	52.48	40.18	clay
4	A1.4	14.22	50.3	35.48	clay
5	A2.1	8.23	50.54	41.23	clay
6	A2.2	8.29	49.1	42.61	clay
7	A2.3	9.6	50.62	39.78	clay
8	A2.4	16.5	49.58	33.92	clay
9	A2.5	8.44	55.03	36.53	clay
10	A3.1	13.75	50.46	35.79	clay
11	A3.2	14.23	54.81	30.96	clay
12	A3.3	13.54	54.37	32.09	clay

Organic soil fertilizer may improve biological properties of the soil because the organic matters may increase the amount and the type of microbes that is important for crops to grow well (Metting, 1992). The existence of organic matter and soil microbe increases organic acids that function as nutrients fixation in the soils so that the nutrients are not easily eroded by surface run off.

To increase the effectiveness of fertilizer application, the fertilizer can be buried or mixed with the soil so that in the rainy season the nutrients are not easily eroded, and in the dry season the soils are not easily dry (Hardjowigeno, 2003). Because the study area is located in a catchment area, the soil tillage needs special attention. To reduce soil erosion, manual tillage with organic fertilizer mulch is preferred than mechanic tillage (Schroth *et al.*, 1995). Competition on nutrients absorption among trees and crops can be minimized if the nutrient contents in the soil are high. The effect of plant density on agroforestry system growth is lower on the high quality soils with high nutrient contents (Palma *et al.*, 2007).

Micro Climate on Dry Land Agroforestry

The existence of trees can create micro climate that is different from surrounding climate. The measurement of air temperature and humidity in the study area shows that the air temperature under canopy shading is lower and air humidity is higher than those not under the canopy area (Table 3). Under shading level <50% , 50-70% and > 70%, the air temperatures are 5.67%, 2,65%, and 6.24% respectively lower and air humidity are 2.5%, 5.75%, and 7.21% respectively higher than the surrounding area. The optimal air temperature for photosynthesis process is from 26-35ºC (Sutopo, 1985).

The lower air temperature and humidity under agroforestry system than those in open areas may prevent crops from extreme fluctuations of temperature and humidity. In dry season, the micro climate under agroforestry system may reduce the transpiration rate and evaporation from soil surface. Very high air temperature may damage the leaves tissue and increase evapotranspiration (Pamuji and Saleh, 2010). In the contrary, the very low temperature may damage root system.

Dry Land Agroforestry Practice
Species Composition

The identification of agroforestry practice in dry land conducted by villagers may give insight on how to improve the existing practice with new technology. The land utilization in the study area is very intensive; it is indicated by high diversity of species composition, the tree density and the intensity of the villagers to manage the land. Villagers utilize biomass (wood, leaves, branches and fruits) from agroforestry system. Suryanto *et al.* (2012) argues that the land tillage in dry land Menoreh characterized as intensively managed, high diversity of species and product, high resilient rate, application of alley cropping system with low quality of seedlings.

The level of agroforestry development caused differences in the main species composition. Differences in the composition of the species are presented in Table 4.

Table 3. The average temperature and humidity in the observation plots

No.	Location	Open (control)				Under agroforestry system			
		T (°C)	SD	Rh (%)	SD	T (°C)	SD	Rh (%)	SD
1	Early agroforestry (shading<50%)	37.56	1.25	54.37	1.28	35.43	0.76	55.73	2.25
2	Mid agroforestry (shading 50-70%)	36.18	1.76	57.84	3.42	35.22	0.76	61.17	3.95
3	Advance agroforestry (shading>70%)	36.15	0.76	57.72	2.12	33.93	1.82	61.88	5.82

Remarks: T: temperature, Rh : humidity, SD : standard deviation

Table 4.Differences in the composition of the species in the every level agroforestry

No	**Species**	**Early Agroforestry (%)**	**Middle Agroforestry (%)**	**Advance Agroforestry (%)**
1.	Clove (*Zygizium aromaticum* L.)	5	20.17	25.64
2.	Coral tree (*Erythrina variegata* L.)	-	-	1.28
3.	Teak (*Tectona grandis*L.f.)	-	10.92	2.56
4.	Dogfruit (*Pithecellobium jiringa* Prain)	1.25	-	-
5.	Cocoa tree (*Theobroma cacao* L.)	12.5		17.95
6.	Coconut (*Cocos nucifera* L.)	8.75	6.72	6.41
7.	White lead tree (*Leucaenaleucocepala* (Lamk) De Wit)	1.25	-	-
8.	Mahogany (*Swietenia mahagony* L.*)*	8.75	16.81	8.97
9.	Mangosteen (*Garcinia mangostana* L.)	1.25	-	-
10.	Melinjo (*Gnetum gnemon* L)	2.5	1.68	2.56
11.	Jack fruit (*Artocarpus heterophylla* Lam.)	1.25	1.68	8.97
12.	Stink bean (*Parkiaspeciosa* Hassk.)	1,25	2.52	2.56
13.	Rambutan*(Nephelium lappaceum* L.)	-	2.52	-
14.	Red Lucky Seed (*Adenantera pavonine* L.)	7.5	-	-
15.	Indonesian laurel (*Syzigium polianthum*)		0.84	
16.	Sengon (*Falcataria mollucana* L.)	37.5	34.45	19.23
17.	Indian rosewood (*Dalbergialatifolia*)	7.5	-	1.28
18.	Sungkai (*Peronema canescens*)		0.84	1.28
19.	Large leaf rosemallow *Hibiscus macrophylus* Roxb.)	2.5	0.84	1.28

The dominant species in every level of agroforestry are: sengon (37.5%), cacao (12.5%), coconut and mahagony (8.75%) in early agroforestry, sengon (34.45%), clove (20.17%), mahagony (16.81%) in mid-level agroforestry and in advance level of agroforestry are clove (25.64%), sengon (19.23%), cacao (17.95%).

The main products of early agroforestry level is sengon wood. The farmer can plant crops (ginger and cassava) because of the plenty of sunlight get through the soil surface. In the middle agroforestry, the main products are sengon wood and clove. As compared to early agroforestry, sengon composition is lower. But, the shading level is higher than that in early agroforestry as the clove trees also planted. At this advance level of agroforestry, the dominant species are plantation species (clove and cacao) because these species may generate income monthly and annually. The owners of this agroforestry level mainly have non-forest jobs e.g. tempe producer that cannot allocate all of his time to manage the land. The villagers who have several land sites may also plant only clove (monoculture) in their lands.

The productivity of cacao plantation in the study area is very low. In the rainy season, the cacao plantation cannot produce fruits because of the fungus attack. The bad drainage and aeration condition of the soil in the study area is an ideal condition for fungus to grow. The unsuitable conditions for cacao in the study area may cause low productivity of cacao. As reported by Firdausil *et al.* (2008), cacao will be optimal in soil with characteristics: pH 6-7, texture of sandy loam, and under shading trees with spacing 6x6 m or 8x8 m (156-277 trees ha^{-1}). The tree density in early agroforestry system is 488 trees ha^{-1} (including cacao) or 122 trees ha^{-1} (excluding cacao). The shading trees required by cacao are planted irregularly consisting of diverse species. Osei-Bonsu *et al.* (2002) reported that cacao growth is 54-193% better in coconut intercropping that has 9.8 m triangular space as compared to glirisidae intercropping.

Regeneration System

Regeneration in all levels of agroforestry are both natural and artificial regeneration. Artificial regeneration was made in the open area in a parcel of land to produce wood seedlings. Clove, sengon, and tectona seedlings are normally bought from the seedling sellers. The willingness to buy these species is based on the fact that these species are commercial fast growing species. Some of the seedlings are also from government support via forest rehabilitation program. Gregorio *et al.* (2015) sugested that to improve quality planting materials goverment nurseries can supply planting material which cannot be supplied by individual or communal nurseries. In general, villagers plant all of the seedlings from the government on their lands. The origin of seedlings that grow in villagers lands are described in Table 4.

Table 4. Origin of seedlings in AF system in Giripurwo, Girimulyo, Kulon Progo

No	Species	Procurement
1.	Clove,sengon, teak	Buying
2.	Mahagony, coconut, jackfruit	Natural regeneration
3.	Cocoa tree, ginger	Government support
4.	Jackfruit, stink bean,dogfruit, durian	Parent heritage

Plant Maintenance System

The plant maintenance system of the villagers depends on their interaction intensity with their lands. The villagers mostly have livestock that is fed with leaves from agroforestry land such as mahogany, gliricidia, jackfruit, calliandra, and cassava species. Mahogany species is the main producer for livestock feeding because mahogany is less commercial.

Pruning technique in this study area is conducted by cutting the branches and leaving 30-50 cm of tree canopy. Pruning is applied for mahogany, gliricidia, jackfruit, and calliandra. Pruning on tectona is once a year by cutting unwanted branches. Not only for livestock feeding, tree leaves are used for soil fertilizer (looping). Pruning is not applied to sengon species because it is susceptive for drilling bug attack.

Fertilization dosage pretty much depends on the number of livestock the villagers have. The more livestock the villagers have, the more dosage of organic fertilizer applied for the land. However, not all of species are fertilized; only the commercial ones such as clove, cacao, and sengon species are fertilized once or twice a year. Soil tillage is only applied to young tree sengon and tectona (once a year), and ginger (three times a year). Soil tillage is simultaneously done with fertilization.

Thinning is conducted not based on the canopy competition control, but based on commercial consideration.

Harvesting System

Harvesting system in the study area is whenever needed. Trees are sold in wholesale while trees are still standing. The stumpage price is based on the diameter above the head (> 1.3 m) not diameter at breast height (± 1.3 m). This measurement certainly will give more profit to the buyers. The stumpage price is also influenced by the distance from the main road. The stumpage price in the study area is presented in Table 5.

Other commodity such as fruits and tubers are sold to collectors who are usually the local people. The collectors sell the commodity to traditional markets or bigger collectors. Medicinal plants such as cardamom is not harvested regularly but only when the villagers need money. Now, farmers find it more convenient to the system of harvesting and marketing timber in the presence of the issuance of government regulation of the Ministry of Forestry Regulation No. 30/2012 (P.30 / Menhut-II / 2012) because timber document issued at the village level (Maryudi *et al.*, 2015).

Table 5. Stumpage price in the in the Giripurwo village, Girimulyo district, Kulon Progo

Dbh	Species			
	Sengon(IDR/tree)	Mahogany (IDR/tree)	Tectona (IDR/tree)	Sonokeling (IDR/tree)
25-30 cm	200,000	300,000	650,000	200,000
30-50 cm	400,000	500,000	*	(juvenile >13 cm)
>50 cm	800,000-100,0000	900,000 -110,0000	*	

Remarks: *) there is no tectona wood with dbh> 30 cm

Table 6. Identification of management practices in the Giripurwo Village, Girimulyo Sub District, Kulon Progo and technological input effort

Management Variable	Management Practice	Objectives	Impact	Proposed Technology Input
Land status	Own property or tillers	Fulfill economic needs	Certainty and uncertainty of management	Mutual cooperation system
Intensity to land	Very high	Fulfill economic needs	Utilization intensity is high	Working plan
Planting system	Mixed	Many products	High biodiversity, inter species competition	Management on appropriate mixed species by planting pattern
Tillage	Tillage on both trees and crops	Increase yield from preferred species	Improvement on physical soil properties	Improvement on physical properties of soil by application of organic fertilizer More intensification
Space	Irregular	Land optimization	Species competition on light, water and nutrients	Controlling the space to minimize competition
Origin of seedling	Buying, natural regeneration, government support	Easier	Quality is not guaranteed	Developing village nursery from superior seed
Pruning	Often, rare	Livestock feeding, Improvement of wood quality, Producing fire wood	Too often will disturb tree growth, To rare will effect on low quality of timber	Appropriate pruning intensity Appropriate technique of pruning
Biomass gathering	Harvesting	Gain yield	Reducing soil fertility	Returning organic matters by organic fertilizer application
Fertilization	Once a year for commercial species	Increasing productivity	Increasing soil fertility	Improving fertilizer quality by improving the fertilizer producing process Increasing the dosage of fertilizer Land combination with chemical fertilizer
Thinning	If timber is already sold	Gain yield	Reducing the density	Thinning only on low quality trees
Timber harvesting	Wholesale	simplifying the mechanism	Price is determined by buyers	Improving the knowledge on tree measurement Standardized price
Sale of agroforestry products	Raw product	Easy for villagers	Low price	Identification and course on processed products from agroforestry Capital support including equipment and money

The Improvement Effort and Land Management System

The villagers need to adapt new technology regarding the current socio and economic conditions and management practice. Isaac *et al.* (2009) reports that there are some steps for increasing land productivity of agroforestry system developed by villagers: (1) identify the existing land management as the starting point for more flexible management scenarios; (2) group the variables of practice to map the cause and effect of current management practice as a starting point to choose an appropriate technology.

The development of agroforestry also depends on socio-economic condition and local knowledge on management practice. Local knowledge contributes on minimizing negative impact of natural resource management (Mulyoutami *et al.*, 2009). It affects the species on soil quality, interaction among species, and the role of each species on land productivity which are important components to adopt the agroforestry system (Pauli *et al.*, 2012). Isaac and Kimaro (2011) mention some prescriptions for improving agroforestry land productivity: a) to minimize the lack of nutrient if the inputs from villagers are low, is by minimizing understorey competition, low density intercropping of high value species, b) to reduce competition among species, villagers may modify light and water and proper fertilization, c) to increase nutrient absorption, villagers may manipulate environmental condition (water, light, and humidity), d) to increase growth response, villagers may apply intercropping with high facilitation level (nutrient availability by input or resource sharing), e) to support growth and nutrient availability, villagers should maintain the agroforestry system and monitor what element is the limitation factor, f) Social factor also play an important role in new technology adoption. Alene and Manyong (2007) mentioned that some factors influencing technology adoptions by villagers are education level, participatory technology evaluation, seedling supply, assistance and access to market. Therefore, the development of technology is tailor made which can be different from one area to another. The existing management practices proposed new technologies for land management improvement are presented in Table 6.

Adaptation of local knowledge as a response to climatic conditions, economic, social and market can increase the productivity of the land and maintain the environmental functions. Traditional knowledge systems in Asia, as in the rest of the world, have historically been dynamic, responding and adapting to changing environmental, social, economic and political conditions to ensure that forests and associated agricultural lands continue to provide tangible (foods, medicines, wood and other non-timber forest products, water and fertile soils) and intangible (spiritual, social and psychological health) benefits for present and future generations (Parrotta *et al.*, 2009). Rerkasem *et al.* (2009) mentioned that indigenous knowledge and skill are a) not static but continually evolving to in incorporate innovations to deal with new challenges and opportunities and b) transferred among farmers themselves and between communities. Canadas and Novais (2014) mention that privat forest management is very strongly influenced by social factors, therefore forestry development planning needs to be cross-sectoral.

CONCLUSION

From this research it can be concluded that trees composition in early and middle AF is dominated by sengon, while in advance AF is dominated by non-timber forest product (clove). Low soil fertility in the study area is caused by high intensity of biomass harvesting and low input of biomass harvested back to the soil. The increment of land productivity may be achieved by increasing the biomass input to the soil from organic fertilizer and crop wastes.

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