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Community forestry adoption based on multipurpose tree species diversity towards to sustainable forest management in ICEF of University of Lampung, Indonesia

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Abstract. *Wulandari C, Bintoro A, Rusita, Santoso T, Duryat, Kaskoyo H, Erwin, Budiono P. 2018. Community forestry adoption based on multipurpose tree species diversity towards to sustainable forest management in ICEF of University of Lampung, Indonesia. Biodiversitas 19: 1102-1109.* Integrated Conservation Education Forest (ICEF) of University of Lampung (Unila) at Wan Abdul Rachman (WAR) Forest Park is a conservation forest which should be free from any kinds of human activities. In fact, more than 75% the area has been managed by community hence there is a need for management strategy through Community Forestry (CF). It is known that there are a lot of Multipurpose Tree Species (MPTS) that can be utilized for the community's daily life. The research's objectives are to analyze the ability of the community to adopt CF scheme, to calculate the diversity index of MPTS and level of Skill Knowledge Attitude (SKA) and to determine the correlation variables to sustainable CF. This study used Shannon-Wiener diversity index, analysis of SKA level and regression analysis for adoption level. The results of this study noted that at the research site has diversity index 0.115 and 74.29% of plants are MPTS. Based on the data analysis, 168 respondents [89%] agree to adopt CF scheme and level of their SKA is moderate therefore needs to increase this level towards to forest sustainability. There are three variables of community forestry adoption toward to sustainable forest management at ICEF: number of trees species, the volume of forest products that would be sold, and roles of extension education.□

Keywords: Adoption, community forestry, multipurpose, skill knowledge, tree species

INTRODUCTION

Three countries in Southeast Asia namely Malaysia, Philippines, and Indonesia are the megadiversity countries. The biodiversity in the region has been severely threatened due to deforestation, forest conversion, climate change, and invasive species. This condition would be the driving force behind the ecological, social and economic changes in a landscape and then become the problems that the world has to face. As the cause of losing biodiversity is blamed on the forest dwellers due to their continuous dependence on the availability of forest resources for the fulfillment of daily needs (Baliton et al. 2017). In Indonesia, biodiversity is lots found in including Forest Park that has the biodiversity value must be maintained its existence, one of which is Wan Abdul Rachman (WAR) Forest Park, Lampung, Indonesia. According to Wulandari et al. (2014), the condition of WAR Forest Park is now changing from the original characteristics because 52.2% land is managed by surrounding communities even though only 49% are classified as agricultural areas. That area of 1,143 ha of the total area 22,249.43 ha of WAR Forest Park is the Integrated Conservation Education Forest (ICEF) mandated to University of Lampung (Unila).

Based on the national policies, i.e. Laws Number 41 the Year 1999 about Forestry and Laws Number 5 the Year 1990 about Biodiversity and Its Ecosystem, it is forbidden to let any area of conservation forest being interrupted. Nonetheless, it turns out that factually over 75% of 1,143 Ha this location has been managed by the community. This situation occurs because 7 villages with a population density surround ICEF is high due to population rate 2.1-2.5% per year (Wulandari et al. 2014). Since the community has managed more than 50% of the forest in ICEF, there is the urgency to prepare a proper strategy hence the forest destruction can be minimized (Wulandari et al. 2014).

Unila who is responsible for the management must also consider the existence of these communities, especially their daily needs to be fulfilled. In general, Multipurpose Tree Species (MPTS) can be found in the field and it can be used to fulfill the local people's daily needs. Wulandari et al. (2014) stated that WAR Forest Park were occupied for daily needs community planted MPTS which have good economic value. In Bangladesh, agrobiodiversity in protection and conservation forests is essential not only for environmental sustainability but it also as supplements the local livelihood (Baul et al. 2015). In Indonesia, although

the surrounding communities need forest products of conservation areas, they are only allowed to consume Non-Timber Forest Products (NTFP). Approached by CF program method means that the community is given the rights to manage the forest, but not including cutting down the timber. During this time, the local community maintains the forest based on their SKA which means that they nurse various kinds of MPTS plants in ICEF forest. Skill, knowledge, and attitudes are formed as a part of individuals or communities perceptions and experiences that can change their values and thoughts and improve their overall welfare including through the management and conservation of forest resources (Farouque et al. 2017). Integrated of those skills, knowledge, and attitude can be called as competence, and assumed to be prerequisite for adequate function in the succeeding of such a program or job (Baartman and de Bruijn 2011).

However, the real condition in the field remains unknown. There is no determine the real motives yet from communities in adopting the CF program, whether it is purely because of their willingness or because of the existing law under Ministry of Environment and Forestry Decree Number P.83/2016 on Social Forestry or others reason. Therefore variables that may affect the CF program in ICEF are also necessary to be discovered to unfold the unanswered questions and towards to sustainable forest management. Based on these reasons, then this research in ICEF is conducted: (i) to determine the diversity of MPTS, (ii) to analyze adoption level of community to joint CF based on their skill, knowledge, and attitude, and (iii) to examine significant variables on CF that implemented in ICEF.

MATERIALS AND METHODS

Study area

The study was conducted in the Utilization Block of Wan Abdul Rachman Forest Park, Gunung Betung, Pesawaran District, Lampung Province, Indonesia (Figure 1.) from November 2015 to February 2016 and August 2017.

Procedures

Tools and Materials. The tools were used in the research is Garmin Global Positioning System (GPS), tally sheet, camera, tape measure, plastic rope, stationery and questionnaires. While the object of the research is the vegetation found in the Education Forest utilization block of Tahura Wan Abdul Rachman.

Data collection. The type of data collection consists of primary data. Primary data is data derived from the original or first source, not in the form of files but through the interviewees that used as a means of obtaining information or data or through direct measurement in the field (Sugiyono 2012). Primary data species diversity has taken through pivot line method. The other primary data are data from the respondents to know the SKA as the basis to analyzes adoption level through questionnaires. Secondary Data. Secondary data is data source which indirectly provides data to the data collector (Sugiyono 2012). Secondary data taken include the general condition of research location, the physical condition of the environment, and socioeconomic condition of the community in general. Sources of the secondary data are from previous research and Badan Pusat Statistik (BPS) of Lampung Province year 2016. Figure 2 described that research framework.

Method of data retrieval

Data to support the CF adoption level analysis

Respondents gathered. Initial step to find out the adoption level is select respondents. To better understand a population's behavior, the Slovin formula was occupied to determine appropriate sample size. The number obtained from the sample in this research was 198HH. This is computed (Wulandari and Inoue 2018) as: n = N / (1+Ne2), where: n = no. of samples, N = total population and e = error tolerance. Based on the calculation of the total number of community living surrounding the education forest then the number of respondents to be taken is 198 peoples. Sample determination in field done by random sampling.

Questionnaires validity. Data processing in this study started with validity test and reliability test of research instrument or the questionnaire used (Sugiyono 2012). Validity test in this research is assisted by data processing program SPSS version 16 for windows using Product Moment Correlation formula (Pearson) and Corrected Item Total Correlation, while the reliability test is using Cronbach's Alpha formula (Tavakol and Dennick 2011). It is known that all questions in the questionnaire have the greater value than the r table value, it means that all questions in the questionnaire are valid to use in this study. This research has the Cronbach's Alpha value (correlation index = r) of 0.693, means that it has a high-reliability value because it lies between 0.600-0.799. Noted that the classification of reliabilities is as follows: 0.800 to 1,000 = very high, 0.600 to 0.799 = high, 0.400 to 0.599 = high enough, 0.200 to 0.399 = low, and 0.000 to 0.199 = very Low (not reliable).

Analysis of adoption and SKA levels. There are five questions to reveal the motives of local people in adopting CF program. For the local people's SKA, the questionnaires consist of 10 items for each S, K, and A. Each item has three options of the answer. Meanwhile, for revealing the local people motive questionnaire, it starts with general inquiries-such as whether they are willing to join CF or not, the background of their decision, and how they can suggest implementing the related policies about CF program. After that, the questions ask more specific issues regarding SKA, such as the level of preference of local people about MPTS plant species, the way they want to nurture the MPTS plants in their surroundings, their knowledge about a suitable place to grow the plants, and production of the MPTS plants.

When the questionnaires are filled, the data were processed. The results of adoption level are obtained by calculating the data descriptively and the results are shown in a percentage format. Then, for the SKA level, the

obtained results are categorized into several groups (Amir 2016): 1-30 as low, 31-60 as medium, and 61-90 as high. The understanding that SKA level can impact to the adopting degree of land or forest management is also used by Ebifa-Othieno et al. (2017) and Nordlund and Westin (2011) when they did a study in Eastern Uganda and Sweden.

Shanon-Weiner diversity index analysis

The direct observation technique to know the species diversity begins with the plotting of rectangles using the method of pivot line (Erwin et al. 2016). The determination of plot starting point is done randomly (random sampling), and the next plot is done systematically. Area of utilization block education forest of WAR Forest Park is 549,76 ha; with standard deviation 27.1 t c/ha, obtained sample area of 21,9904 ha so that the number of sample plot is 19 plots. The distance between lines is 100 meter and the distance between plots is 50 meter. In the square plots, the data taken is the stands at the tree level in the 20x20 m^2 plot, at the pole level in the 10x10 m^2 plot, the sapling in 5x5 m^2 plot and the regeneration or seedling, herb, shrub, liana or epiphytes in the 2 x 2m^2 plot size (Condit 2008). Figure 3. The design of pivot line method used for research.

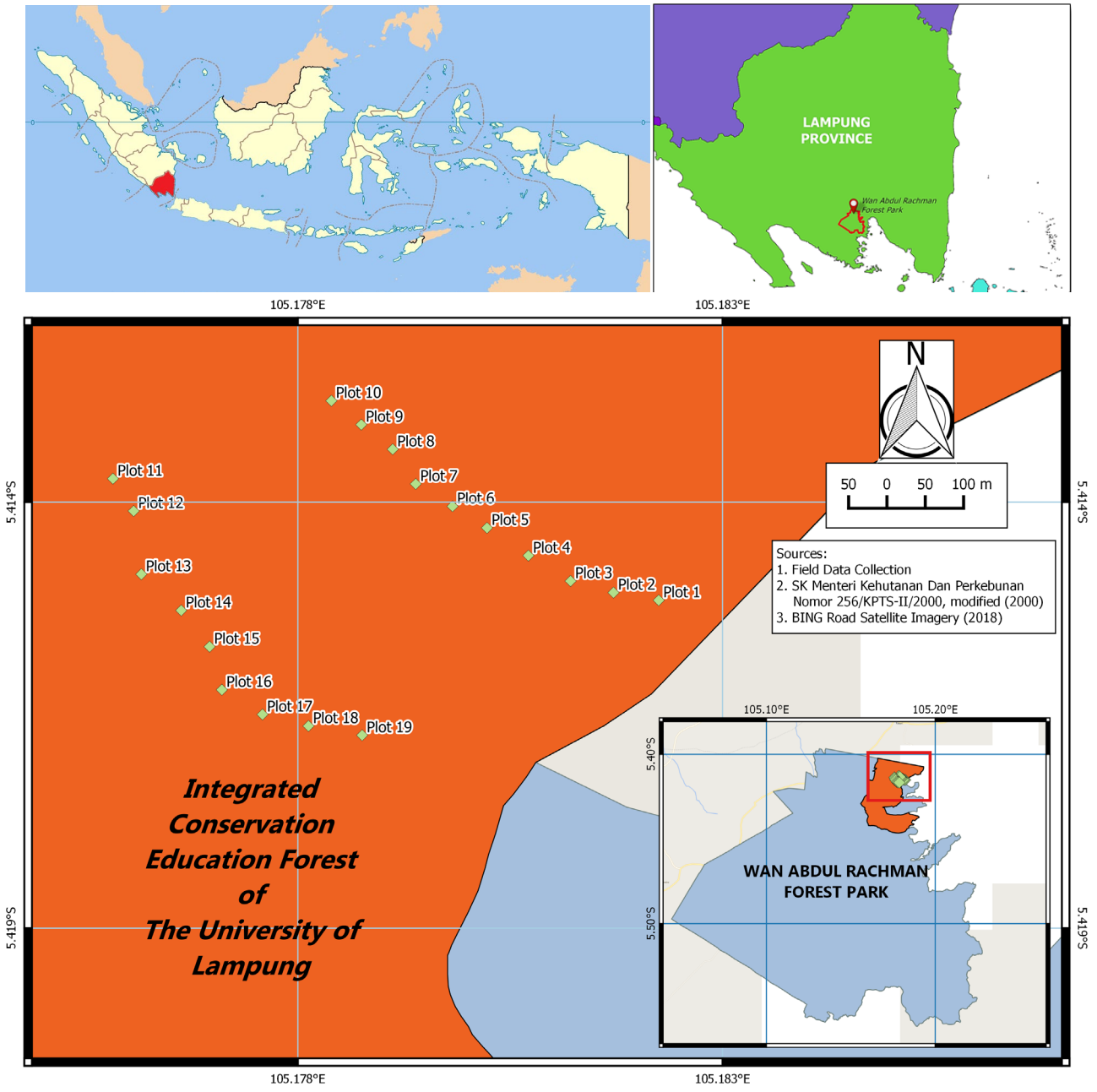

Figure 1. Location of Integrated Conservation Education Forest of the University of Lampung (Unila) of Wan Abdul Rachman Forest Park, Gunung Betung, Pesawaran District, Lampung Province, Indonesia

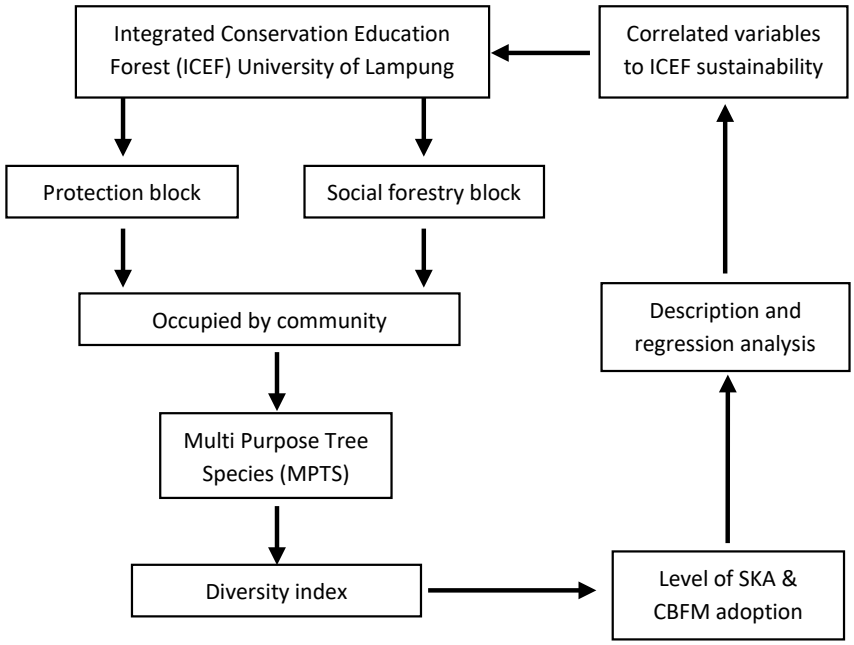

Figure 2. Research framework on CF Adoption and SKA levels in ICEF WAR Forest Park

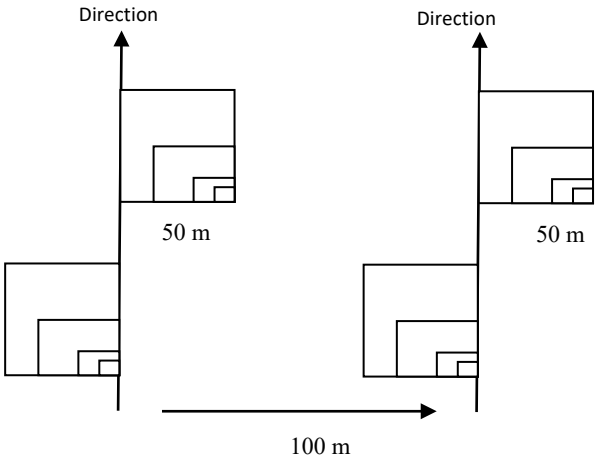

Figure 3. Design of pivot line

Data analysis

Analysis of SKA level

From each question group of S, K, A, 10 comes up with the lowest score, which resulting 30 as the lowest total score (Amir 2016). If all respondents answered the questions with '3' as the score, the total score would be 90. Therefore, 10-30 will be categorized as low, 31-60: moderate and 61-90: high. In this research, the questionnaire results yield 53 as a score for Skill, 45 for Knowledge, and 55 for Attitudes. Thus, it can be calculated that the SKA total score is 153 and the average is 51 (moderate).

Regression analysis of adoption variables

The regression analysis is used to discover which variables that are related to sustainable CF. The equation of this regression analysis, i.e., Y = a +bX where X is the explanatory variable/s and Y is the dependent variable. There are tested variables namely number of trees (X1), the volume of forest products to be sold (X2), providing economic motivations by managers for forest's community (X3), using of courses result (X4), management experiences (X5) and extension role (X6) in creating positive attitudes.

Diversity Index of MPTS

The measures of biodiversity were obtained using the Shannon-Wiener Diversity Index (H) (Kimaro and Lulandala 2013) calculated using formula as follows:

$$H = \sum_{I=1}^{S} -(P_i * \ln P_i)$$

The Pielou's Evenness Index (J) was calculated using formula (Baliton et al. 2017):

$$J = \frac{H}{\ln S}$$

Note: The power to which the base e (e = 2.718281828 ..) must be raised to obtain a number is called the natural logarithm (ln) of the number.

The index was calculated by dividing the number of individuals of each species found in the sample by the total number of all species (represented by P), multiplied by the fraction of its natural log ($P_1 * \ln P_1$). This procedure was repeated for all of the different species. The sum of all the ($P_1 * \ln P_1$) represents the value of H. Physical evidence of

the movement of wildlife in the agroforestry matrix were noted in terms of frequency, duration, and kind of species.

Where:

H : Shannon-Wiener diversity index

J : Pielou's Evenness Index

P_i : Fraction of the entire population made up of species i

S : Total numbers of species encountered

∑ : Sum from species 1 to species S

Diversity index (*H'*) as follows:

H'<1 : Low

1<*H'*≤3 : Moderate

H'>3 : High

RESULTS AND DISCUSSION

Characteristic of respondents

Based on the respondent characteristics throughout the research, it is known that the majority respondents' age ranges from 31-45 years old (58%) and their primary job is farming (96%)(Figure 4). Based on this data, it is logical to think that the local people in the research field have the willingness to adopt the CF program because the majority of their professions are farmers. From most of the respondents who are farmers shows that they need forest sustainability since they depend their lives on the forest products. The similar condition also occurs in Sarawak, Malaysia where the majority of its people lives to depend on the forest product hence their forest remains sustain (Nelson et al. 2015). According to Wiernik et al. (2013), a high percentage of young respondents is predicted to guarantee the existence of SFM more because they have an ideal on environmental values, concern, and awareness, also have positive pro-environmental behaviors.

Diversity index

The diversity of vegetation in the social forestry block of ICEF can be determined by looking at the stands composition that is the species and number of vegetation that built stands in the forest. Based on the results of the research, it is known that there are 35 species consists of understories plants, seedling phase, sapling, poles, and trees. Based on Shanon Diversity Index analysis found that in the social forestry block in ICEF there are 1010 plants consists of 258 trees, 138 poles, 203 sapling, 103 seedlings and 318 understories plants. This result indicates that there are differences in the structure and composition of certain species that are missing or dead and there are also new species appears in the social forestry block area of ICEF. Out of 35 species, majority or 26 species have known as MPTS (Table 1.). Avocado (*Persea americana*), dadap (*Erythrina variegata*), cashew (*Anacardium occidentale*), jengkol (*Archidendron pauciflorum*), kemiri (*Aleurites moluccana*), harp (*Sandoricum koetjape*), walnut (*Junglas regia*), petai (*Parkia speciosa*), and forest rambutan (*Nephelium lappaceum*) are the species that have decreased in number in their growth phase. Those species are not found in the sapling and seedling phase, so it is suspected that these species are lost or exhausted. In contrast, species found in both sapling and seedling phase are thought to grow and form new communities, such as durian (*Durio zibethinus*), cocoa (*Theobroma cacao*), rubber (*Hevea brasiliensis*), and coffee (*Coffea canephora*) species. The occurrence of differences in structure and composition of vegetation in a forest area such as in national park in a certain period are caused by natural factors or human destruction (Kimaro and Lulandala 2013).

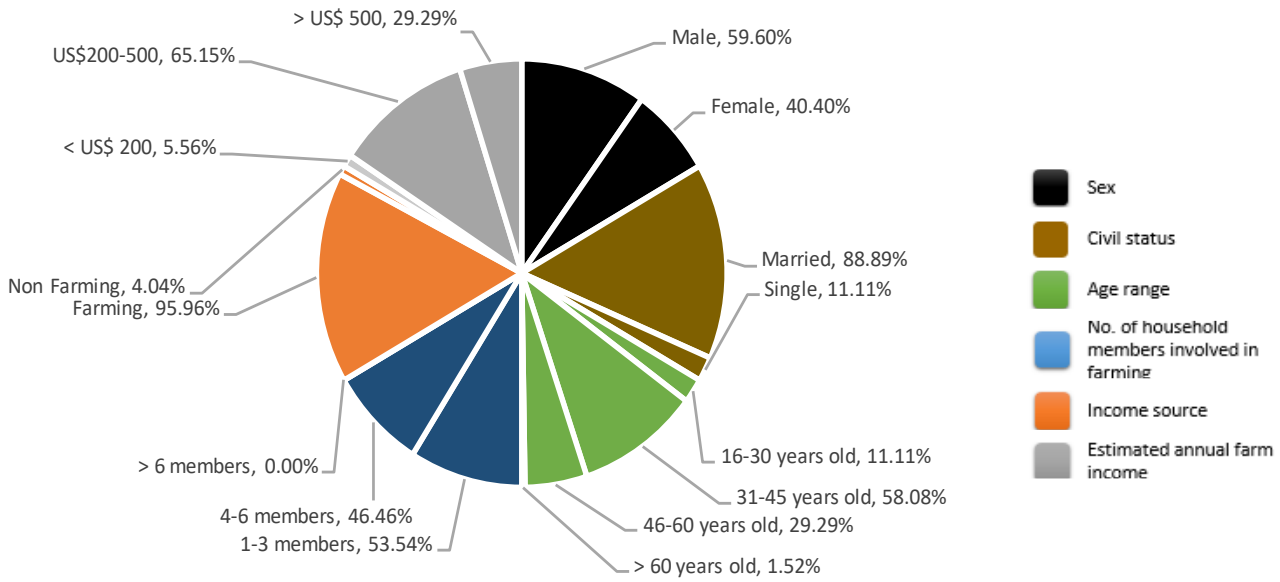

Figure 4. Respondents characteristic for community forestry adoption research

Table 1. Number of plants and its location in research plots

Name	Scientific name	Founded at plot number 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	Amount
Avocado	*Persea americana* Mill.		8
Areca	*Areca catechu* L.		12
Arenga	*Arenga pinnata* (Wurmb) Merr.		29
Banana	*Musa paradisiaca* Linn.		47
Bamboo	*Bambuseae spp.* Kunth ex Dumort.		8
Bratanila	*Brachiaria decumbens* Stapf.		48
Canarium	*Canarium vulgare* Leenh.		7
Candlenut	*Aleurites moluccana* Wild.		4
Kapok	*Ceiba petandra* (L.) Gaertn.		27
Cinnamomum	*Cinnamomum burmanii* Ness.		5
Clove	*Syzygium aromaticum* L. Perry		13
Cocoa	*Theobroma cacao* L.		74
Coffee Robusta	*Coffee canephora* Pierre.		81
Dadap	*Erythrina variegata* L.		43
Durian	*Durio zibethinus* Murr.		56
Gnemon	*Gnetum gnemon* L.		23
Harp	*Sandoricum koetjape* Merr.		26
Indonesia rosewood	*Dalbergia latifolia* Roxb.		11
Jampangan	*Eleusine indica* (L.) Gaertn.		76
Jengkol	*Pithecellobium lobatum* Benth.		13
Mantangan	*Borreria alata* L.		17
Mango	*Mangifera indica* L.		7
Mangosteen	*Garcinia mangostana* L.		27
Michelia	*Michelia champaca* L.		5
Nutmeg	*Myristica fragrans* Houtt.		4
Pakis	*Polypodiopsida spp.* Chris.		49
Pepper	*Piper nigrum* L.		7
Petai	*Parkia speciosa* Hassk.		15
Rambutan hutan	*Nephelium juglandifolium* Bl.		7
Rose apple	*Eugenia aquea* Burm.F		3
Rubber	*Hevea bracilliaencis* Muell Arg.		169
Rumput jagungan	*Cynodon esculenta* L.		58
Taro	*Colocasia esculenta* (L) Schott.		9
Vanilla	*Vanilla planifolia* Andrew.		4
Walnut	*Junglas regia* L.		18
Total			**1010**

Understorey plants species are the most common species in the research sites, because these species are species of wild plants that can live quickly in various conditions of growing place. Besides, it also caused by old trees which fall and die in the social forestry block, so that the canopy is open and allows the sunlight to touch down the bottom layer and turns the depressed seedling to be growing well (Erwin et al. 2017). According to Yang et al. (2014) changes in a plants population always occur due to competition and mastery in the growing place. Any change in the social forestry block will have a process that turns out to a state of equilibrium of plants population. Therefore, it is necessary to involve the community in preserving the forest, which can be done with CF joint program. The CF program allows the community for using the non-timber forest products, and enrichment species by planting the wood trees.

In ICEF, the changes are due to human factor (Wulandari et al. 2014) because the community has been cultivating the land since the year of 1990' as revealed by 74% or 147 respondents such as mentioned by one of the respondents as follows: Our grandmother came from West Java and has been living here since the forest is still quite dense around 70's and many MPTS plants that can be harnessed to fulfill people's daily needs.

According to Yang et al. (2014), changes in vegetation that occur continuously due to the missing or dead of certain species and there are new species appear, and then the old population will be replaced by the new population. Its hoped species diversity of MPTS will not decrease and all community's need will be fulfilled. The calculation result of total vegetation diversity value in Social Forestry block is 0.115. It means that it has a moderate diversity so that the species enrichment still needs to be done.

The SKA level

Based on the observation, noted that 26 species of total 35 species dominated in the social forestry block is MPTS that cultivated by community due to economic value (17 species) and 9 species of them has high demand by market,

i.e., avocado, durian, jengkol, cocoa, petai, rubber, kemiri, cashew and, coffee. This result supports Wulandari et al. (2014) which states that farmers selecting the plants species for agroforestry land they manage based on the economic value of the plant and the commercial capability. □

Rubber is a common and dominant species as MPTS . This is assumed because the area has a reasonable level of conformity to the rubber growing place. The area planted with rubber species is the cultivated land of the community.

Wulandari et al. (2014) stated that the dominant species in ICEF is rubber. This plant is selected by the community because it is considered economically more profitable and suitable to be planted at various altitudes. Therefore, rubber species dominate and become competitors for other species. As Chalmandrier et al. (2015) points out, the dominant species have a higher level of conformity to growing places (adaptability) and better competition power compared to other species in the land. The similarity is in Niger, it can be seen in the field that the majority of existing plants is MPTS and can be utilized by the community to meet their daily needs (Luedeling et al. 2016). Under these conditions then it would be possible to develop CF in Indonesia as it happens in Niger.

Community usually eliminates tree species that has no economic value. Farmers will replace with tree species that have commercial value for non-timber forest products (NTFPs). It is expected that the species diversity will not be decreased, as well as kinds/types of MPTS so that the community needs will always be fulfilled.

The community's knowledge about the economic value of a species usually based on their SKA. According to Firdaus (2017), understanding of economic theory will influence knowledge and skill of community' entrepreneurship. Nordlund and Westin (2011) and Ebifa-Othieno et al. (2017), SKA also affects their mindset about how to nurse and manage a species, including its products and how to sell them in the market. In this research, the result analysis shows a medium level with 153 and 51 as the SKA total score and average consecutively. This result resembles a situation in Jember (East Java), Eastern Uganda and Sweden where the SKA level of the community in managing MPTS based on the plant diversity.

The adoption level and correlated variables of CF

Based on the government regulation of Ministry of Forestry and Environment no. 83/2016 on PS then CF scheme that can be developed in the ICEF is Conservation Partnership program. If the government would implement this scheme, there are 89% of respondents agree, and rest of them (11%) do not have land tillage inside forest, therefore, they said abstain. The respondents also had some suggestions on the implementation of conservation partnerships, of which 72% said they were allowed to make regeneration of coffee and cacao crops, and 63% asked for an explicit benefit sharing, 90% requested an agreement agreed upon by both parties, and as many as 77% decided if in the implementation of conservation partnership also carry out environmental services scheme of water utilization and ecotourism development. The high rate of agreement from the community to adopt CF program in maintaining their forest (89%) makes it feasible to implement this scheme.

A forest community is very essential for the community because it is an area of water system regulatory and soil fertility, life support, germ plasma resources, and as a food provider/contributor. Therefore, in forest management always pay attention to the preservation of its function. This condition is very important in supporting life and welfare of the community. Utilization of forest that has been managed and inhabited by the community must be done by utilizing the land in CF by planting multipurpose trees or MPTS that have economic value (Luedeling et al. 2016)). While the species suggested are rubber which is the most dominant species, and durian, candlenut, cocoa, clove, and coffee.

Based on this condition, then it is required an accurate implementation strategy in ICEF. Accuracy is necessary because there is a tendency that this forest will become homogeneous or monoculture because the diversity at various growth phases is moderate and adoption level to CF is also moderate. After that, the regression analysis was done to variables that affect the strategy-making of developing sustainable forest. According to Dehyouri et al. (2011) and Wulandari and Inoue (2018), it is known that economic motivation, understanding of conservation, training result usage, and experience of forest management and extension roles are related to SFM. This research also has the similar results, where some variables are associated with the condition of a sustainable forest after being analyzed with regression. Result of regression analysis as follows: $Y=101.025 + 89.910X_1 + 93.322\ X_2 + 80.060\ X_3 + 69.347\ X_4 + 83.692\ X_5 + 87.497\ X_6$ (F value = 85.075). Those variables are the number of trees (X_1), the volume of forest products that will be sold (X_2), providing economic motivations by managers for forest's community (X_3), using of courses result (X_4), management experiences (X_5) and extension role in creating positive attitudes (X_6). All variables that obtained from regression analysis show positive. Its meant that X_1 to X_6 variables are all influential and can make the sustainability of forest more guaranteed. According to Dehyouri et al. (2011), all of those positive variables will have the positive impact on the improvement of sustainable forest management. Specifically for this research, the significant variables to SFM that have to be considered properly in CF work plan development are the number of trees species, the volume of forest products that would be sold, and roles of extension education. Based on those three significant variables, there should be, at least 89.910 ~ 90 trees, 93.322 tonnes of forest products can be harvested and 87.497 ~ 87 person of extension education staff to manage WAR forest park toward to guarantee 1 hectare of SFM will be achieved.

Majority plant species are 26 species of 35 total existing species is MPTS and used by the community who can support the implementation of conservation partnership scheme as one of the CF schemes by following the prevailing policies. The success of CF program could be achieved because 89% of respondents agreed to adopted the CF and conserved the forest. They have moderate levels

of MPTS diversity and SKA for managing the MPTS diversity. Those two substances should be considered on managing the ICEF. Based on regression analysis, the attempts to improve the levels can be made based on three correlated variables towards to sustainable forest management, i.e., the number of trees species, the volume of forest products that would be sold and roles of extension education. Sustainable forest management through CF programs will bring positive impacts to ICEF functions to environment and prosperity of the community.

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