International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Contribution of *Dusun* Agroforestry to Household Income on Ambon Island, Indonesia

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Abstract

Dusun agroforestry on Ambon Island plays an essential role ecologically and socioeconomically. This type of agroforestry contributes not only to household income but also to daily necessities for the owners and neighbors or relatives. The aims of the study were (1) to analyze the contribution value of dusun agroforestry to the total income and the fulfillment of the minimum standard of physical needs (KFM) and standard requirement for a decent living (KHL) of the households of dusun owners, and (2) to determine the minimum land size for dusun agroforestry in order to meet the needs for decent living standards. Sampling was conducted purposively in three villages, namely Halong, Amahusu and Soya. Soya is located in a mountainous area while Holong and Amahusu are situated along the Bay of Ambon. Based on the results of the plantation survey and interviews with the owners, there were ten species of dominant plants that contributed to the household income of the dusun owners. Cloves and nutmeg contributed the highest income among the other commodities.

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The contribution of dusun agroforestry in Soya village enabled the households to meet their minimum living standards. However, the dusun agroforestry in the three villages had not been able to meet the requirements for a decent living standard. To reach the level of a decent living, the minimum land areas required were 4.13, 3.62, and 2.17 ha for each household in Halong, Amahusu and Soya villages, respectively. Arenga pinnata had the potential to increase household income in addition to biodiversity conservation purposes.

Keywords: Dusun agroforestry; household income; KFM; KHL; minimum land areas.

1. Introduction

Various forms of agroforestry have long been known in the local land-use systems in Indonesia. Such systems can be found almost all over Indonesia despite their different techniques, plant species, and names. For example, the term *kebon talun* in Java, *tembawang* in Kalimantan, *repong* and *parak* in Sumatra, and *holu* in Sulawesi.

Agroforestry practices in small islands, such as Ambon Island, have been quite important in the development of the island, since the coverage is very large, from coastal to inland areas. One of the agroforestry practices that build islands is called *dusun*. Most *dusuns* are privately-owned. However, the management of the *dusuns* is based on a series of customary practices, administrative procedures, laws and rituals called *sasi* that limit access and use of resources in certain places at certain times. *Sasi* is imposed on by the village head and policed by an elected supervisor of the village *dusun*.

The *dusuns* provide numerous economic benefits to the owners and serve as intermediary for biodiversity conservation, especially in small islands. The *dusuns* have a complex multi-storey structure where different species of crops, such as fruit trees and spice crops, are integrated in an intimate association. Other food crops which are also grown for household consumption include maize, vegetables, and root and tuber crops such as cassava, taro, yam, sweet potato, pulses and other cereals. The major functions of the *dusuns* are subsistence production and income generation. In addition, agroforestry also fulfills many social, cultural, economic, and ecological functions [1, 2, 3, 4].

Agroforestry research on small islands like the island of Ambon is still very limited. A number of researchers have examined the practices of agroforestry in Indonesia with a different focuses, for example, the research of agroforest, and agroforestry homegardens, in West Java [1,2,3]; forest garden in Kalimantan [4]; agroforestry systems and the role of traditional agroforest in Sumatra [5]; the practice of agroforestry system in Sulawesi [6].

The name and location of the research mentioned above indicates that this practice is more widespread in big islands than small islands. In fact, the strengthening and expansion of this practice should be done on small islands in view of the limited carrying capacity, ecological vulnerability and domination of this region in the geographical structure of Indonesia.

Unlike big island regions in Indonesia, studies and publications on agroforestry systems contributing to the household economy, especially ones focusing on studies of the regions of small islands that are very vulnerable to the climate change and the global economy are still lacking. On the contrary, the development of agroforestry

research on small islands in other tropical regions has received researchers' intensive attention, such as in Virginia Island [7,8], in Caribben Island [9,10], The Vanuatu Islands, Pacific [11,12,13] India [14,15].

Not all people on the island of Ambon have an area of *dusun*. *Dusun* agroforestry practices are seen as places to fulfill family food, wood for building construction, medicine sources, sources of a variety of family needs, and the main household income. Therefore, considering the contribution of *dusun* agroforestry systems to the household economy on the island of Ambon as a small island is necessary to be analyzed.

The aims of the study were (a) to analyze the contribution value of *dusun* agroforestry to the total income and the fulfillment of the minimum standard of physical needs (KFM) and standard requirement for a decent living (KHL) of the households of *dusun* owners, and (b) to determine the minimum land size for *dusun* agroforestry in order to meet the needs for decent living standards.

2. Methods

2.1. Study site

The study was conducted in Leitimor Peninsula in Ambon City, Maluku Province, from January 2013 to June 2013. Ambon City is located on the island of Ambon, which is geographically at 3°–4° South Latitude and 128°–129° East Longitude. Ambon City covers an area of 377 km^2, about 95% (359.45 km^2) of which is a land area extending along the coast and surrounding the waters of the inner and outer Ambon bay. Ambon island was selected simply because the island is relatively small. According to Regulation No. 1 of 2014, when an island is physically $\geq$ 2,000 km^2, it is classified as a small island, and Ambon island is just around 761 km^2. In 2011, Ambon City had a population of 340,427 people. The mean of the population growth in the period 2007-2011 was 5.42%, while the population density was 840 people km^{-2}. The annual precipitation is approximately 3,000 mm, with the rainy season from May to October and the dry season from December to March. The topography of Ambon island is dominated by slopes ranging from 30-40%. Types of soil in Ambon island consist of oxisol, ultisol, and inceptisol.

2.2. *Dusun Agroforestry practices*

On the view point of ecology, economy and social agroforestry practices play an important role in the *dusun* on the island of Ambon. *Dusun* formed from a shifting cultivation system which is managed for generations. Not all families have a *dusun* area. In a *dusun* area various types of agricultural crops and forest trees are planted. The fruit trees like durian, *gandaria*, mangosteen and the spices such as clove and nutmag are the main source of cash income for households. They manage the plantations by themselves and sell the products on local markets. The land area managed by *dusun* is generally small, ranging from 1-2 ha although there are also a few families who have more than 5 ha.

2.3. Data collection

The research was conducted in three selected villages such as Halong, Amahusu, and Soya. The villages of

Halong and Amahusu are located along the coast of the island of Ambon, while Soya village is situated at the mountainous area which the *dusun* owners do not rely on marine resources to augment their income as the case with the former villages. Those villages are noted as Negeri Adat (traditional villages) on the island of Ambon. The number of elected owners as the respondent to be observed is 5 for Halong, 13 for Amahusu, and 15 for Soya villages.

The owners of each dusun were interviewed using a structured questionnaire, and at the same time the vegetation survey of dusun was conducted to collect information on the species which had a direct contribution to the income of the households. The questionnaire contained the sources of income of the households and their types of spending. There were two main sources of income: first, from the agricultural sector, namely through the sale of fruits and spices, the raising of cattle or poultry, and the fishing of fish in the sea (especially for Halong and Amahusu); second, from non-agricultural sources like salaries and pensions as a official goverment, services, kiosks, money given by working child / children or sibling. Household spending is also divided into two categories such as food consumption and non-food consumption. The food consumption spending consists of carbohydrates, proteins, fruits and spices. Meanwhile, spending components for non-food consumption are energy, education, health, clothing / housing, sanitation, social / cultural / religious activities, entertainment, transportation and vehicles.

2.4.Data analyzes

Calculation of income from *dusun* agroforestry using the formula:

$$TP = TR - BL \qquad (1)$$

$$TR = \sum_{i=1}^{n} (JP \times HP) \qquad (2)$$

$$BL = \sum_{i=1}^{n} (MJT \times HJT) \qquad (3)$$

Where: TP (1) is the household income of *dusun* owner (Rp), TR (2) is revenue (Rp), BL (3) is spending (Rp), JP is ith the plant species production, HP is the price of ith plant species production, MJT is input from ith plant species, and HJT is the input price (Rp) of ith plant species. The net income of households of dusun owners is calculated by totaling the revenues derived from (agriculture + non-agriculture) minus the spending derived from (food + non-food).

2.4.1. Standard minimum physical need and need for a decent living

According to [16], the threshold value of food (rice) adequacy for levels of household spending in rural areas ranged from 240-320 kg person^{-1}year^{-1}, while for urban levels of household spending ranged from 360-480 kg person^{-1}year^{-1}. Furthermore, calculating the standard of Minimum Physical Need (KFM) and the Standard Need for Descent Living Need (KHL) was performed using the approach proposed by [17], as follows:

1. Minimum Physical Need (KFM) is the need of rice equivalent for a household x 100% x number of family

members x rice price

2. Additional Living Needs (KHT) is educational and social needs + health and recreation + insurance and savings.

- The need for education and social activities = 50% KFM

- The need for health and recreation = 50% KFM

- The need for insurance and savings = 50% KFM

3. Need for a Decent Living (KHL) = KFM + KHT is the need of household rice equivalent x 250% x number of family members x rice price

Then there should be a need analysis of the minimum land size for *dusun* agroforestry (Lmin) in order to meet Decent Living Need (KHL), namely (Lmin) = KHL divided by net income from dusun agroforestry activity.

3. Results and Discussion

3.1. Contribution of dusun agroforestry

The results showed that the income of the non-agricultural sector was greater than that of the agricultural sector (Table 1). In conjunction with the reduction of poverty, some researchers suggested that economic growth in the non-agricultural sector is less important than the growth in the agricultural sector [18,19].

Table 1: Average income source, spending and contribution of *dusun* agroforestry in the villages of Halong, Amahusu and Soya

Source	Village		
	Halong	Amahusu	Soya
	Rupiah. year^{-1}		
Income			
Agriculture	19 499 800	16 983 000	19 333 091
Non-agriculture	32 364 000	27 258 462	37 238 182
spending			
Food	16 744 000	14 332 692	16 145 182
Non-food	21 299 600	20 318 615	30 702 727
*Dusum*Agroferstry (AFD)$^{*)}$	9 684 000	11 033 615	18 397 636
% AFD$^{**)}$	18.67	24.94	32.52

$^{*)}$ AFD = contribution of *dusun* agroforestry business; $^{**)}$= Contribution percentage of *dusun* agroforestry to total income

However, *dusun* Agroforestri which is dominated by fruit and spice plants can contribute to the total revenue (agriculture + non-agriculture) by 18.67%, 24.94% and 32.52%, respectively, in the villages of Halong, Amahusu and Soya. Bamboo-tree garden contributed less than 50% to the total household income in West Java [2]. A higher contribution by *dusun* agroforestry was seen in Soya village indicating that agroforestry activity can still be relied upon to support the household income of the owner of the *dusun*.

Based on an analysis of agroforestry activity on a small island, there should be an integration of terrestrial and marine components. The interview results with the owners of the *dusuns* showed that not everyone who had a *dusun* was eager to supplement their income by carrying out marine and livestock-related business. The villages of Amahusu and Halong, which are geographically located along the Bay of Ambon, had a very small number of people whose pure livelihood was a fisherman. However, there was one respondent in Amahusu who was able to increase his revenue by 73.70% just by using the technology of stretching rod and trolling, 16.73% of the pig business, and only 9.57% of *dusun* agroforestry. In Halong village, no respondents who did not use the technology of stretching rod and trolling, but they work as anglers in a skipjack-fishing boat, and was able to increase its revenue by 55.78% of the total income earned in a year.

Sources of income from the agricultural sector in Halong village was slightly higher than in Soya village due to the contribution of cattle and pig raising businesses. However, Halong village had a smaller contribution in *dusun* agroforestry compared to the villages of Amahusu and Soya. In the meantime, Soya's agricultural income was dominated by the contribution of *dusun* agroforestry.

Expenditure varied across the villages. Spending on non-food needs was higher than the food (Table 1). The non-food spending of Soya was bigger than the other two villages. This was probably caused by the cost of transport from and to Soya village, which is located in the mountainous area. On the whole, the revenue earned could still meet the needs of family life in a year with the average number of family members of five people. An important aspect of the amount of the expenditure is that it was not used an entire income, but there was savings of Rp.13, 819, 400 $year^{-1}$ in Halong village, Rp.9, 590 154 $year^{-1}$ in Amahusu village, and Rp.9,723 364 $year^{-1}$ in Soya village. This means there is a capital potential from the *dusun* owner. The implication of this phenomenon is the increase in *dusun* owner's revenue would have been better in terms of capital accumulation.

Contribution to revenues from the *dusun* agroforestry components will determine the owner's decision to continue to develop *dusun* agroforestry. This development is related to the types of the plants chosen, which is actually related to economic benefits. The interviews with the owners of the villages showed that there were ten kinds of plants that contributed significantly to the economic development of the *dusun* owner households (Table 2). Of the ten species of the plants there were six species of fruit trees, namely: *Durio zibethinus*, *Bouea macrophylla*, *Lansium domesticum*, *Garcinia mangostana*, *Salacca ambonense*, and*Musa* sp.; three species of herbs, namely *Syzygium aromatica*, *Myristica fragrans*, and *Cocos nucifera*; and one wild palm species, that is, *mayang* or sugar palm (*Arenga pinnata).* Mayang product is not only in form of sugary sap from its flower stalks, but the fruit is also edible. *Mayang* sap (*sageru*) is processed to prepare *sopi*, an alcoholic beverage.

The revenue distribution from ten species of plants varied in each village. Soya achieved the highest value of

Rp.24,550, 755, followed by Amahusu Rp.14,972, 009 and the least Halong Rp.10,409,330. The income obtained depends on the amount of production and prices. Cloves still account for the highest income amounted to 44.04% in Halong, 37.23% in Amahusu and 25.57% in Soya.

Tabel 2: Ten main commodities of income sources in the villages of Halong, Amahusu and Soya

Commodity	Income (Rupiah.year^{-1})		
	Halong	Amahusu	Soya
Durio zibethinus	2 100 000	763 461	3 284 545
Bouea macrophylla	750 000	560 000	2 266 660
Lansium domesticum	50 000	112 000	773 863
Garcinia mangostana	275 000	1 360 000	2 232 730
Salacca ambonense	-	208 750	503 000
Musa sp.	-	743 000	2 658 330
Cocos nucifera	420 000	687 500	590 000
Syzygium aromatica	4 584 000	5 573 538	5 786 000
Myristica fragrans	2 230 330	1 697 090	3 043 125
Arenga pinnata	-	3 266 670	3 412 500

Table 2 shows that all species of productive plants are found in Amahusu and Soya, but in Halong three species of plants did not exist or contribute to the formation of household income, namely: *Salacca ambonese, Musa* sp., and *Arenga pinnata*. This does not mean that all the three of these crops were not planted or grown naturally in Halong. It was simply because the respondents chosen in Halong did not rely on them as a revenue improvement.

Contribution of *Arenga pinnata* to the income of the families in the villages of Amahusu and Soya was very reliable. In Amahusu village, the contribution of Mayang was approximately 21.19 %, much higher than the 5.10% from durian and 9.08% from mangosteen. Meanwhile, in Soya village, these plants accounted for 13.90%, relatively the same as durian 13.38% and higher than mangosteen which only accounted for 9.09%. It shows that the fruit and non-fruit products (*Arenga pinnata*) completed one another. It is also interesting to note the contribution of durian, cloves, nutmeg, and mayang. Durian, cloves, and nutmeg do not produce the whole week of the year compared with *tipar mayang* (tapped *Arenga pinnata*). The results of the research conducted by [20] in Batang Toru, South Tapanuli, North Sumatra, showed that *Arenga pinnata* business in form of *tuak* (alcoholic beverage) capable of producing 40-50% of the weekly family income.

Arenga pinnata is not cultivated but grows wild. When asked their motivation to run a business in *tipar mayang* (tapped *Arenga pinnata*), they said that *Arenga pinnata* played an important role in the source of their household

income. In the early 1990s the Indonesian government policy through the Buffer Agency for Clove Marketing (BPPC) brought about very low prices of cloves. This situation had made most clove farmers on the island of Ambon frustrated and many of them cut down their clove trees or left their plantation unattended. At the time, many farmers who relied on business in *tipar mayang* (tapped *Arenga pinnata*) to augment their income. The same motivation was also found with smallholder farmers who adopted an agroforestry system in the Philippines [21] and in Indonesia [22]. For areas that have steep slopes (30-45%), this plant can be considered to be used as a land rehabilitation crop. *Arenga pinnata* roots are fibrous and horizontal so that they potentially invite the growth of other plant species. However, if there are more *Arenga pinnata* left to grow or domesticated on steep slopes or near streams, together with the planting of bamboos, it is then believed to be a potential to prevent erosion. With the dominant topography of Ambon Island being steep slopes, it is necessary to have a policy of utilization mayang plants along with various types of bamboo, such as *Bambusa atra*, *bambusa vulgaris*, *Dendrocalamus asper*, *Gigantochloa apus*, *G. verticillata* as land rehabilitation crops. However, on the island of Ambon, until now both of these plants have not been included or used as a plant in a rehabilitation program. On the other hand, it was reported that bamboo contributed to the family economy, ecologically stable and socio-culturally related, for example, traditional agroforestry practices such as *kebon-talun* (domination of bamboo or bamboo mixed fruit with trees and non-fruit trees) or *kebon-tatangkalan* in West Java [1,2,3].

Biodiversity conservation potential of *Arenga pinnata* is as a provider of food for wildlife [24,25]. So that, the existence of *mayang* plants and various species of fruit trees in the village will greatly assist in the distribution of the seeds that will still maintain biodiversity in the village. This phenomenon indicated that through the practice of *dusun* agroforestry the loss of species diversity and genetic variation could be avoided. Harvesting fruits in turns in a year shows that there was no great emphasis on short-term productivity. The emphasis on short-term productivity can lead to a loss of genetic diversity and genetic variation and the decline in agricultural systems [26,27].

Arenga pinnata produces multi-products that contribute positively to local livelihoods [20,28]. In every *dusun,Arenga pinnata* is sure to be found growing wild. On the island of Ambon, only *sageru* (sap) can be harvested as a source of daily income;*sopi*is (alcoholic beverage) for weekly income. Therefore, if there were no social barriers (such as religion) for alcohol consumption and sufficiently available on the market, the alcohol production might be the best option to meet the farmers' weekly income. The information compiled from various *mayang* farmers, it was found that, through *tipar mayang* (tapped *Arenga pinnata*) buisness, they could build a permanent house and finance the education of their children up to college. This shows that *Arenga pinnata*is quite potential as a source of household income. There is a local market, there is always *sopi* drink consumption, and the price is relatively high (one liter of *sopi* was around Rp30 000-Rp 35 000). In addition, *sopi* was consumed daily and also in traditional ceremonies.

3.2. Minimum physical need and a decent life

The average number of hosusehold and their family members in the three village were five people and the price of rice in 2013 was Rp.10,000 kg^{-1} so that their minimum physical need (KFM) was R.p16,000,000 $household^{-1}year^{-1}$ and the need for a decent life was Rp40,000,000 $household^{-1}$ $year^{-1}$.

Table 1 shows that the revenues derived from agroforestry in the three villages were Rp. 9,684,000, Rp.11,033,615, and Rp18,397,636 year^{-1}, respectively for Halong, Amahusu and Soya. Except for Soya village, the income from *dusun* agroforestry had not met the minimum physical needs (KFM). Nevertheless, the overall revenues from the agricultural sector had reached the standard of minimum physical need KFM (Table 1). Clearly, agroforestry business in the three villages had not reached the needs of decent living (KHL).

Fruit treesproduction is seasonal. Therefore, the *dusun* owners cannot just rely on *dusun* to meet their various needs. This had caused many of them to work in the non-agricultural sector to meet the needs of a decent living. This is evident that the sources of income from the non-agricultural sector were greater than the agricultural sector. Income contributions from the non-agricultural sector were 62.40%, 61.61%, and 65.82%, respectively in the villages of Halong, Amahusu and Soya. This information indicated that the non-agricultural sector accounted for house income twice as high as the agricultural sector in which there are *dusun* agroforestry. Although the contribution of *dusun* agroforestry to the household income was smaller but their presence play an important role in relation to the function of vegetation *dusun* to continue to provide ecological services to residents on the Ambon island.

3.3. Need for minimum land size

The net income from the business of dusun-system agroforestry varied from the three *dusun* samples (Table 1). Based on information on the amount of need of decent living and net income of dusun agroforestry of each village, we can determine the minimum land area to be able to achieve a decent living (KHL), which is respectively 4.13 ha household^{-1} in Halong village, 3.62 ha household^{-1} in Amahusu village, and 2.17 ha household^{-1} in Soya village. The average area of land ownership in the villages of Amahusu and Soya could reach more than 3 ha household^{-1}, and thus the areas for both villages were felt not so problematic. However, in Halong village to achieve a minimum land area of 4.13 ha household^{-1}would be somewhat difficult, simply because many parts of *dusun* area had been sold, changing their land ownership rights. Observations and interviews found that in Halong village there are five to six locations of permanent housing complexes had been built. The government policy of Ambon city, which made Teluk Ambon Baguala sub-district, where Halong village is situated, as a buffer area of Ambon City, has triggered the dusun owners to sell their certified land.

The land area of dusun plays an important role in meeting the needs of the household income. The types of fruit plants were the main source of income. With a minimum land area, which may be different in each village, it is necessary to think about the density of fruit trees in one-hectare *dusun* so that the diversity of fruit trees could be retained. It is closely related to the production time of each species of fruit plants in a year, so there is time allocation and labor management. In addition, there is always food available for species such as *Phalanger orientalis*, *Spilocuscus maculatus*, and big bat (*Pteropus* spp.) which spread seeds in different areas. By paying attention to the choice balance between density and diversity in the area size to a minimum extent, it is expected that there is good continuity in the utilization of natural resources and the environment as well as in the economic fulfillment (for a decent living).

4. Conclusion

1. There were ten species of plants that were relied on to meet household income from dusun agroforestry in Leitimor Peninsula, the island of Ambon. Of the ten species of them there were six species of fruit trees, namely durian, gandaria, mangosteen, tan, bark and banana; three species of plantation crops, namely cloves, nutmeg and coconut; and one species of sapping plant called *mayang* (*Arenga pinnata*)

2. Dusun agroforestry can contribute to the economic income of households amounting to 18.67%, 24.94%, and 32.52%, in Halong, Amahusu and Soya villages, respectively. The potential of *mayang* (*Arenga pinnata*) should be considered as one of strategies to increase household income as well as biodiversity conservation effort.

3. The revenues of dusun agroforestries in Halong and Amahusu, respectively amounted to Rp.9,684,000 and Rp.11,033, 615 ha year^{-1}, had not yet reached the standards of Minimum Physical Need (KFM), while in Soya village it had reached KFM amounting to Rp.18,397, 636 ha year$^{-1.}$

4. Agroforestry exploitation of dusun system in the three villages had not reached the Standards of Decent Living (KHL), that is, Rp.40,000, 000 household^{-1} year^{-1}. To achieve revenue of *dusun* agroforestry activity for a decent living, a large size of *dusun* is required, in this case, at least 4.13 ha household^{-1} in Halong, 3.62 ha household^{-1} Amahusu, and 2.17 ha household^{-1} in Soya villages.

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