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Agro-Economic of *Dusun* Systems in Small Islands: A Case of Ambon City, Maluku Indonesia

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ABSTRACT

Whereas many studies highlight positive environmental and socio-economic effects of agroforestry systems, the agro-economic effect of *Dusun* practices as indigenous agroforestry systems has rarely been studied in detail, particularly in small island-Maluku Indonesia. This article examines the agro-economic of tropical perennial and annual fruit crops in the *Dusun* systems in Ambon city islands. A survey was conducted in three different *Dusuns* to obtain data through in-depth interviews of 88 heads of households. Our findings indicate that most Dusun farmers are uneducated and old age, half of them have small size of land, and 95% of land status belongs to kinship-clan ownership. Then, half of the farmers have an elementary school education, and 71% have a primary job as farmers, while 29% have a secondary job on the farm and non-farm activities. Amongst 26 crops that are found in three Dusun areas, nine crop types can be found in the whole *Dusun,* while the rest are located in one or two Dusun only. These crops are grown together and form multiple cropping structures from high stratum like durian and coconut to medium strata such as clove and nutmeg and low strata such as vegetables and tubers. The structures of the crops have an important role in maintaining biodiversity, minimizing soil erosion, water reservoir, and supporting socio-economic of the households. Annual income from rural household was estimated at around US$6487 or US $3.6/capita/day. Income average value was almost two folds of the World Bank poverty line standard. Nearly 80% of the total income are contributed by four main crops, i.e. clove (*Eugenia aromaticum*), durian (*Durio zibethinus* Mur*)*, nutmeg (*Myristica fragnans*), and duku (*Lansium domesticum*), of which 11% is contributed predominantly by snake fruit (*Salacca zallaca var amboniensis Becc*), mangosteen *(Garcinia mangostana L)* and langsat *(Lansium domesticum).*

Introduction

The current issues of conventional agriculture practice are its dependency on high and expensive external input particularly chemical fertilizer and insecticides, to nurture and increase the production of monoculture crops. This practice will endanger the environment, water pollution, reduce soil fertility and productivity, and become a threat to human health. As an alternative, it needs to search for an ecological agriculture system that is more sustainable and profitable, resistant to climate change impact, reduces soil and water pollution. Important ecological agriculture is known as an agroforestry system that gives a better contribution to ecological services, biodiversity, carbon stock in the land. It provides a better alternative solution to the problem of natural resources degradation, global warming, and climate change impact both at the global and local levels (Ducos, 2014; Schwab *et al*., 2015).

In general, agroforestry is multiple cropping systems that combine both agricultural crops and forestry trees. However, agroforestry shapes identity of its own; therefore, it is not part of agriculture or forestry. Forest trees should be embraced as enthusiastically as agricultural crops (Nair, 1998). Monk *et al*. (1997) defined agroforestry as a 'garden in which few or no annual crops are grown and have a permanent close canopy together with a closed forest structure'. By incorporating into science and technology, traditional agroforestry is modified into modern agroforestry systems such as *alley* farming systems and *taungya* farming system in Nigeria, Liberia, Nepal and the South Pacific regions that combined multipurpose trees, edible fruits and food crops to substitute shifting cultivation and to create a sustainable soil and land, food security and cash-income for rural households (Adegbehin & Igbuanugo, 1990; Fouladbash & Currie, 2015; Vergara & Nair, 1985; Neupane & Thapa, 2001).

Even though modern agroforestry has been promoted in many countries in the last decade, most farmers are unable to adopt because for several reasons (Rasul & Thapa, 2003; Rasul & Thapa, 2004). First, they need short-term production for food security and cash income to fulfill basic needs, including acquiring credit incentives and government subsidies. Second, low competitiveness of ecological agriculture products because most people are uninformed about the danger of chemical fertilizer and insecticides so the price of ecological farm was less-competitive. Third, the environmental costs of the conventional agriculture system are not incorporated into the benefit cost analysis. There is no significant level of financial benefit between conventional and ecological systems. Next, most government policies like agricultural and fishery offices focus on economic and then subsidy, credit support, price distortion, credit, extension service, research, and marketing to conventional rather than ecological farming systems.

Therefore, agriculture and fishery development need to incorporate into Dusun systems as part of small islands' ecological systems.

Besides, most agroforestry studies were in line with soil, water, and crops in continental regions but limited study about agro-economic agroforestry in small islands (Montambault *et al*., 2005). Unlike the continental region, small islands are more vulnerable to natural disasters and the high-level usage of chemical agriculture inputs. Because of limited natural resources, small islands are also sensitive to social conflict and environmental degradation. As an indigenous knowledge and technology agro-forestry, *Dusun* systems have been practiced by farmers from generation to generation and have a crucial role in sustaining the natural and human resources in the islands. However, little is known about the agro-economic aspects of the *Dusun* systems and its possibility to incorporate them into science and technology. Therefore, this study will explore the social economy and ecology of the edible fruit and spices crops of *Dusun* systems in the small island.

Methodology

This research was conducted in three different Dusun areas selected purposively, including *Negeri* Hutumury, *Negeri* Hative Besar, and *Negeri* Soya. The main reason to choose the first two villages was to explore the *Dusun* characteristics in the coastal areas, while the last Dusun was selected to describe the *Dusun* characteristics in the hilly land area. These three villages are part of the small island Ambon city administration area (Figure 1). Unlike the village, *Negeri* is the smallest unit of the local government administration region, but its borders and land ownership refer to the local administrative rules and customary laws.

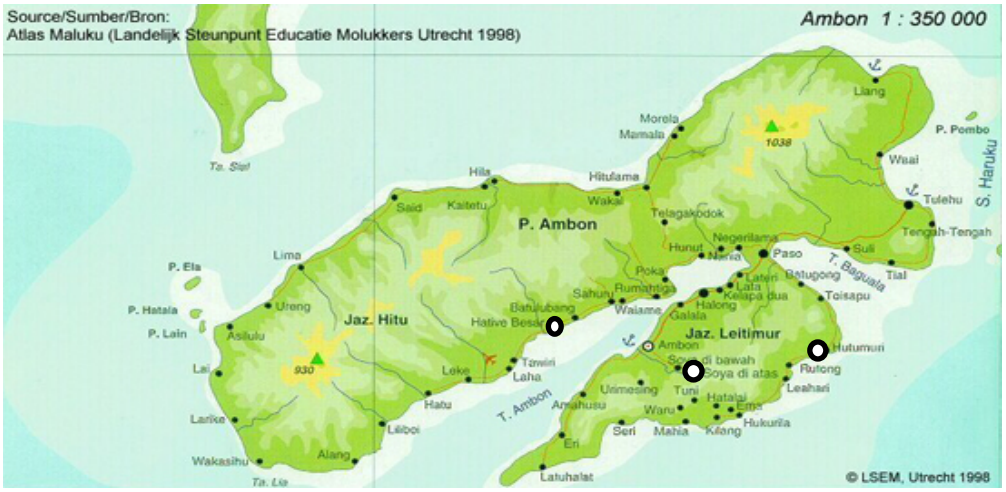


Figure 1. Research sites in Ambon city, Ambon Island, Maluku, Indonesia

The first type of primary data was in line with the history of *Dusun* and the types of crops in the *Dusun*. Data was collected regarding household income and factors that have influenced income from the *Dusun*. Primary data was obtained from 88 households in three Dusun areas selected by researchers and enumerators in 2014/2015. The enumerators were trained to apply in-depth interviews and fill the questionnaire forms before gathering the data in the field. Further investigation was conducted through field observation and interviews with the head of the village and key informants in the Dusun areas. Then data was analyzed using both qualitative and quantitative approaches.

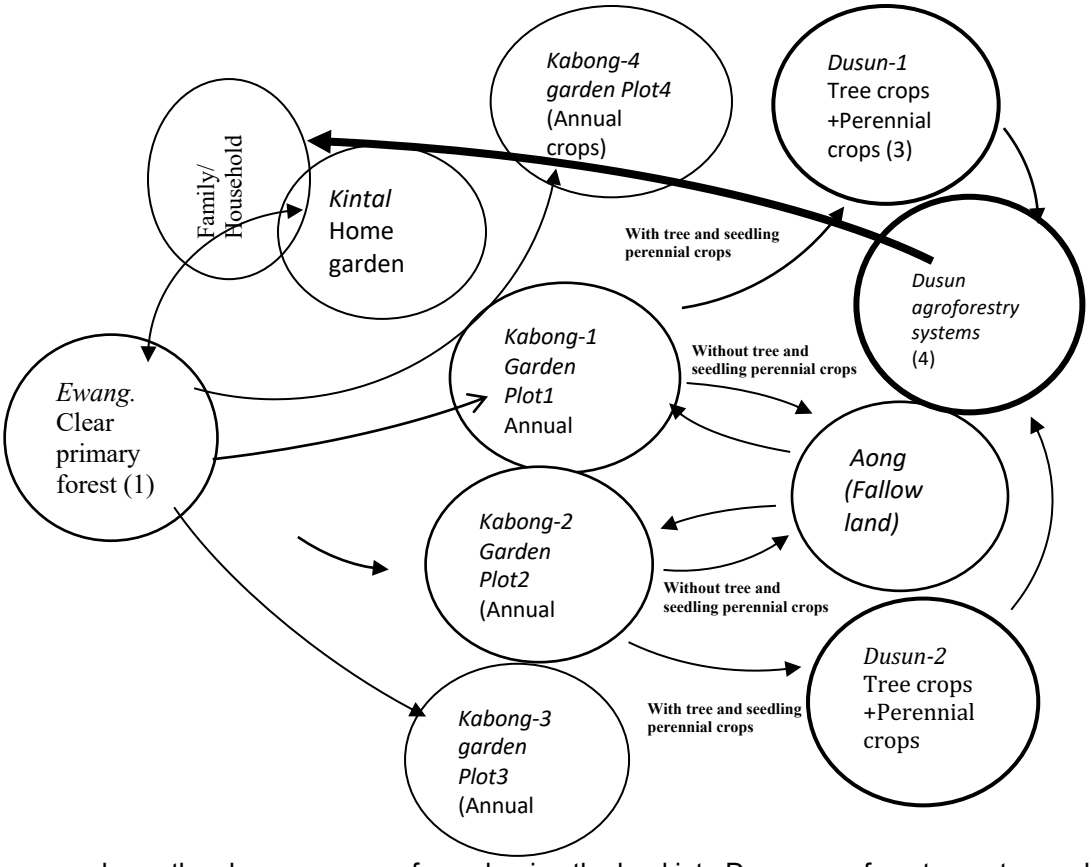
Result and Discussion

The process of *Dusun* development

Based on Figure 2, Dusun development processes can be divided into 4 phases. First, the head of the household opened and cleared the primary forest to cultivate food crops garden (*kabong)*. Farmers let some tree crops grow to shade the land and crops. Second, farmers cultivated the garden/*kabong* land with annual crops and then cultivated edible fruit crops; otherwise, the garden will become *Aong* (fallow land). Third, due to the declining soil fertility after the land was used for several years, farmers moved to other new lands, while edible fruit crops and perennial crops will grow naturally and shade the previous crops. This was the reason why farmers had several plots of garden, *aong,* and *Dusun*. Dusun formation will begin at this phase when birds and mammal from Wallace regions start to come and live in the *Dusun* (Wattimena, 2003). Finally*,* several years later, *Dusun* systems will be formed entirely like primary forest and will return ecological service, food security, energy and fiber, and cash income to household members (Figure 2).

Derived from its historical background, the process of *Dusun* development was similar to *swidden* agriculture, which is defined by Dove (1983) as non-destructive agricultural practices, family land ownership, and market economy-oriented. This explains that deforestation issues of around 1.2% per year in Maluku (Matinahoru, 2014) was not caused by *swidden* agriculture but by private companies that have Forest Concession Right, a large area of plantations, resettlement program, and ambiguous forest borders between villages and state (Silaya & Hatulesila, 2008; Ducos, 2014). In this case, Dusun can be defined as traditional agroforestry as it has not been incorporated with science and technology (Montambault & Alavalapati, 2005), consists of complex coexistence between trees and wild plants (Kumar & Nair, 2004), and is mainly cultivated with spontaneous regeneration of clove, nutmeg and coconut trees (Kaya *et al*., 2001). Unlike

agroforestry in the main islands milieu, agriculture and aquaculture-fisheries are integrated in the small islands because of the small size and short distance of watershed.



Note: Thin arrow shows the change process from clearing the land into Dusun agroforestry systems whilst the thick arrow shows the agro-economic and environmental services to household

Figure 2. The process of *Dusun* development forestry base in Ambon Island Maluku

This means forest and agriculture practices will directly influence coastal areas' environment. As 85% of Maluku Island is categorized as coastal rural areas, both forestry-agriculture and aquaculture-fisheries in these areas are integrated systems. Both agriculture and fisheries are the basis for livelihood strategies to survive or to consolidate and accumulate capital assets, as well as to reduce risks and uncertainties in every season (Girsang, 2011) whether East season (April-September), West season (September-February) and transitional between East and West seasons (February-April). Basically, farmers work in both sectors, agriculture, and fisheries, during the transitional season but will work only on the farm and non-farm activities during the heavy sea wave, whether during the West or East season. Because two-third of their time is allocated to *Dusun* farms and fisheries, it can be argued that the concept of *Dusun* in the coastal and small islands can be extended *beyond* traditional agroforestry, limiting its borders around the forest land only. This conceptual development was fundamentally relevant as

Wattimena (2003) stated that *Dusun* is an intangible indigenous knowledge and technology of local people to modify agriculture and fisheries resources. In this context, *Dusun* systems can be defined as intangible indigenous knowledge and technology to modify and integrate forest-agricultural land and aquaculture/coastal area as an integrated system in small islands so that it will be more ecologically sound, economically viable, and social justice and humane. As a system, there are positive interactions between natural plants and mammals, including socioeconomic and environment such as water, soil, and microclimate.

In terms of socioeconomic perspective, *Dusun* is like a bank for rural residence to invest capital assets such as trees and crops as well as aquaculture-fisheries for food security as well as cash income from marketing the crops and aquaculture products. Besides, *Dusun* can also be used for social justice because the poor have customary law to collect fruits that have fallen from the trees (*usu*). In addition, customary laws also have a group of selected people (*kewang*) to control special natural resource sustainability by creating a period of time to harvest or not to harvest the crops, fish, or animals (*sasi*). As mentioned during the formation of Dusun development, various specific birds and animals came and lived in the *Dusun*. There are at least 26 species of birds and six species of *Kusu* (endemic animal) that live in the Dusun, and they can become the source of meat to the people. Some of these mammals were wild pigs (*Sus crova*), deer (*Cervus timorensis*), *Phalanger orientalis and Spilocuscus maculat* (Wattimena, 2003; Silaya & Hatulesila, 2008). Endemic birds species were known as dove birds (*Gymnophaps* spp.), betet (*Tanygnathus* spp), and uncal (*Macropygia* spp.), particularly in the *Dusun* of Central Maluku regions (Coates & Bishop, 2000, *in* Wattimena, 2003; Flannery, 1995, *in* Wattimena, 2003).

The characteristics of Dusun farmers

Table 1 shows the characteristics of the human capital of farmer households that are pivotal to maintaining and sustaining *Dusun* systems development. Most of the *Dusun* farmers were traditional farmers. Most of them were in their old age, and half of them have a low level of formal education-elementary school and lack access to the new technology and market. Most households have 3 children or more, and around 92% work as farmers. In the past, children were expected to work as the source of agricultural labor, but now the young generation is reluctant to work in agriculture anymore. Amongst all farmers, around 71% work as pure farmers and are entirely dependent on *Dusun*, whereas the rest of the farmers have a secondary job in the fishery (18%) and non-farm such as small industry, trade, and services (11%). This indicates that they are not specialized farmers but those with multiple jobs as farmers who work both in agriculture and fisheries as an integrated part of Dusun systems in the rural coastal area in small islands (Table 1).

The other important Dusun characteristic was land ownership status. *Dusun* land status can be divided into *tanah pusaka (private land), tanah dati (clan-family land), tanah negeri (village land) and tanah sewa (rental land)*. Most of *Dusun* land status belonged to *Tanah dati* because most family members work together for the land. Consequently, all family members have rights and inheritance to the *Dusun* land, which is based on patriarchal systems. This shows that the Dusun's land status was different from agroforestry, which is based on private ownership status. In this matter, *Dusun* system land might be more sustainable as it will be much more challenging to sell the land as it needs agreement from all family members. The last type of Dusun land status, called rental Dusun is not common, but it happens because there are family members without land and ask to rent the Dusun from the owner, who probably does not have enough labor of nurturing the Dusun.

Table 1. Main Characteristics of the farmer's household in the *Dusun* systems in Ambon city islands

Characteristics	*Indicators*	*%*	*Characteristics*	*Indicators*	*%*
1. Age	Older (≥45)	77.0	6. Land ownership status	Dati (Clan)	95.5
	Young (<45)	23.0		Negeri (Village)	3.4
2. Education	Elementary	50.0		Rental	1.1
	High school	44.0	7. Dusun land size	Small (1-2 ha)	53.4
	University	6.0		Medium (3-4)	22.7
3. Number of dependents	Low (≤2)	33.0		Large (>4 ha)	23.9
	Medium (3-4)	40.0	8. Number of Dusun location	One location	69.3
	High (>4)	27.0		2-3 locations	26.1
4. Primary job	Farmer/Fisher	92.0		4-5 locations	4.5
	Non farmers	8.0	9. Sex	Male	95.5
5. Secondary jobs	Farmer only	71.0		Female	4..5
	Farmer + Fisher	18.0	10. Marital status	Married	94.3
	Farmers + Non-farm activities	11.0		Unmarried	5.7

Note: *n* = 88

Table 1 also showed that more than half of households (53.4%) have a small Dusun land (less than one hectare) whereas the other farmers have a larger land size of more than 3 hectares. The difference in land size is not caused by selling land transactions but by the capability of the farmers to expand the Dusun land area in several locations around the village (1-10 km). Based on its ownership, 69.3% of households have *Dusun* land in one location; only the rest have more than 2 Dusun locations. The decline of Dusun land size and locations indicates that the land size tends to decrease gradually due to the labor scarcity to nurture productive Dusun land and

conversion of the land into resettlements, property development, and monoculture vegetable crops. In addition, the unclear land certificate and borders of the Dusun land that is based on trees or rivers need to be clarified; otherwise, it could become the potential source of latent conflict in the future.

Agro-economic of the Dusun Systems

The structure of the plants in the *Dusun systems*

Table 2 depicts the stratum of multiple cropping of at least 26 names and a number of edible and annual crops that have been identified in three different *Dusun* sites. Based on the structure of crops in the Dusun, these crops can be categorized into three strata: (1) the highest stratum of trees and edible fruits such as petai (*Parkia speciosa*), durian *(Durio zibethinus),* langsat/duku (*Lansium domesticum Correa*), coconut (*Cocos nucifera*) and aren (*Arenga pinnata*); (2) middle stratum of spices and fruits such as clove, nutmeg, *mangosteen* and banana; and (3) the lowest stratum crops including vegetables and food crops such as eggplant, chili, cabbage, and tubers. The strata of the crops were crucial to conserve water and avoid soil erosion, maintain variability and diversity of the crops, and balance the complex relationship between crops, water, and soil, stability and multifunction of the Dusun systems to fulfill socioeconomic and environmental services. The first two crops stratum grow naturally in the same land without regular planting distance and external inputs usage. These crops have mutual biophysical interaction with each other to conserve water and soil and protect them from pests and diseases (Wattimena, 2003). Still, they are mostly edible seasonable crops that are only harvested once per year (Table 2).

Because edible crops are seasonable and harvested once per year, only when farmers need cash for daily basic needs. Therefore, farmers start to convert a small part of suitable flat land in the Dusun to vegetable cash crops harvested monthly. To increase production, farmers use a limited dose of external inputs such as chemical fertilizers, pesticides and compost. However, due to the high demand of vegetables from Ambon city market, Dusun land conversion to vegetables in the dusun of Hutumury has been extended and the usage of external inputs increased due to the declining soil fertility. In this case, excessive use of chemical fertilizer should be controlled by the provincial agricultural agency. Otherwise, this practice will endanger crops, soil, water, and aquaculture in the coastal areas and human health.

Table 2. Names and the numbers of perennial and annual crops in Dusun by villages in Ambon islands

No	Name of the crops			No. of crops tree or clump			No. of crops or clump per household		
	Indonesia / English name	Local name	Latin name	Hutumury	Hative Besar	Soya	Hutumury (n=30)	Hative Besar (n=29)	Soya (n=29)
1	*Pete-Petai*	*Petai/ Jengkol*	*Leucanea leucochephala*	5	5	18	0.17	0.17	0.62
2	*Durian*/Durian	*Duriang*	*Durio zibethinus Mur*	1081	298	1179	36.03	10.28	40.66
3	*Langsat*/ Langsat	*Langsa*	*Lansium domesticum*	1129	565	773	37.63	19.48	26.66
4	*Duku*/ Duku	*Duku*	*Lansium domesticum Correa*	1778	437	168	59.27	15.07	5.79
5	*Kelapa*/ Coconut	*Kalapa*	*Cocus nucifera*	662	630	380	22.07	21.72	13.10
6	*Aren*/Sugar palm	Mayang	Arenga pinnata	0	0	50	0.00	0	1.72
7	*Manggis*/ Mangosteen	*Manggis*	*Garcinia mangostana L*	92	43	575	3.07	1.48	19.83
8	*Embacang*	*Bacang*	*Mangifera foetida Lour*	3	3	0	0.10	0.10	0.00
9	*Pala*/ Nutmeg	*Pala*	*Myristica fragnans*	1341	510	532	44.70	17.59	18.34
10	*Cengkeh*/ Clove	*Cengkih*	*Eugenia aromaticum*	861	995	920	28.70	34.31	31.72
11	*Coklat* / Cocoa	*Kakao*	*Theobroma cacao*	530	50	0	17.67	1.72	0.00
12	*Jambu/Guava*	*Jambu*	*Syzigium aqueum*	0	14	0	0.00	0.48	0.00
13	*Alpukat/Avocado*	*Apukat*	*Persea americana*	0	0	5	0.00	0.00	0.17
14	*Rambutan*/ Rambutan	*Rambutan*	*Nephelium lappaceum*	65	57	0	2.17	1.97	0.00
15	*Gandaria*	*Gandaria*	*Borrea macrophylla Griff*	0	308	560	0.00	10.62	19.31
16	*Cempedak*	*Nangka Belanda*	*Artocarpus integra Merr*	97	181	25	3.23	6.24	0.86
17	*Kedongdong*	*Kadongdong*	*Lannea grandis Engl*	0	2	0	0.00	0.07	0.00
18	*Kecapi/ Lute*	*Kecapi*	*Sandoricum koetjpe Merr*	0	0	200	0.00	0.00	6.90
19	*Pisang*/ Banana	*Pisang*	*Musa spp*	0	970	20	0.00	33.45	0.69
20	*Salak*/ Snake fruit	*Salak*	*Salacca zallaca var amboniensis Becc*	0	10	6140	0.00	0.34	211.72
21	*Nenas*/ Pine apple	*Nanas*	*Ananas comasus Merr*	7650	4010	0	255.00	138.28	0.00
22	Pare/	*Pare*	*Momordica charantina*	110	0	0	3.67	0.00	0.00
23	Tomat/ Tomatoe	*Tomat*	*Solanum lycopersicum L*	560	0	0	18.67	0.00	0.00
24	Cabe rawit/ Chili	*Cili*	*Capsicum frutescens*	0	500	0	0.00	17.24	0.00
25	Terong/ egg plant	*Terung*	*Solanum melongena*	200	0	0	6.67	0.00	0.00
26	*Ubi*/ tubers/ cassava/ taro/ sweet potato	*Patatas/Kasbi /Kaladi*	*Manihot esculenta, Ipomea batatas, Colocasia spp*	560	8440	4285	18.67	291.03	147.76

Among these 26 crops, nine kinds of tree crops are generally found in all *Dusuns* but pine apple (*Ananas comasus* Merr.) was only found in Hutumury and Hative Besar Dusun. Chili was only found in Hative Besar, whereas tomato was found in Hutumury Dusun. Next, snake fruit (*Salacca zallaca* var amboniensis Becc*)* and sugar palm (*Arenga pinnata*) were found only in

Soya *Dusun*. Sugar palms (*Arenga pinnata*) have been maintained and incorporated in the Dusun because they have a high content of macronutrients like K and N (Mogea *et al*., 1991), and raw materials for brown sugar and alcohol products. The other important edible crop in the other *Dusun* in Central Maluku was kenari (*Canarium indicum).* Nevenimo *et al*. (2007) state that these crops should be incorporated in the modern agroforestry in the Pacific islands. Pine apple, duku (*Lansium domesticum Correa)* and nutmeg (*Myristica fragnans)* are found as the dominant crops in Hutumury, whereas pineapple, tubers, and clove are found to be dominant crops in Hative Besar Dusun. The higher number of snake fruit, durian (*Durio zibethinus Mur)* and tubers were found in Soya Dusun. Therefore, different from modern agroforestry, Dusun system does not only have the structure and stratum of crops but also it has prime commodity as well as similarities and differences of crops within and between *Dusun*.

The socioeconomic of the *Dusun* systems

Figure 3 shows the shape of annual household income potential from *Dusun* which was estimated at around IDR 84.3 million ($US6487). Amongst all types of crops, almost 80% of household income is obtained from 4 types of edible tree crops, predominantly clove (*Eugenia aromaticum)*, durian (*Durio zibethinus Mur)*, nutmeg and duku (*Lansium domesticum)*. The other three crops, namely snake fruit, *mangosteen,* and *langsat (Lansium domesticum)* contribute 11% to the income. Thus, these seven main crops contribute around 91% to the household income whilst the other 19 crops only around 9% (Figure 3).

These 7 types of crops can be determined as the prime commodities in the Dusun systems because they have significant contributions to both household economy and environmental services in the small islands. In fact, the potential and types of crops and its contribution to household income are different among *Dusuns.* Annual household income in Soya *Dusun* was about $US8312, whereas household income in the Dusun of Hutumury and Hative Besar was $US5769 and $US5380, respectively. This means that household income in Soya was almost 1.5 times higher than that of the household income in the other two villages. Moreover, the contribution of Dusun crops to household income was estimated at around 3.6 US$/capita/day or almost two folds of the World Bank poverty line standard.

Dusun land area, the number of clove, durian, and *mangosteen* trees influenced positively on income. The young farmers have a higher income than the older farmers because young farmers work harder on land and also have higher number of mature edible trees. The higher number of snake fruit will decline the household income because this crop was only found in *Soya*

Dusun. The other variables tested by correlation analysis showed that the number of household dependents and poverty status have a positive relationship with Dusun income. In short, poorer households and a higher number of family members tend to have a lower income level from *Dusun.*

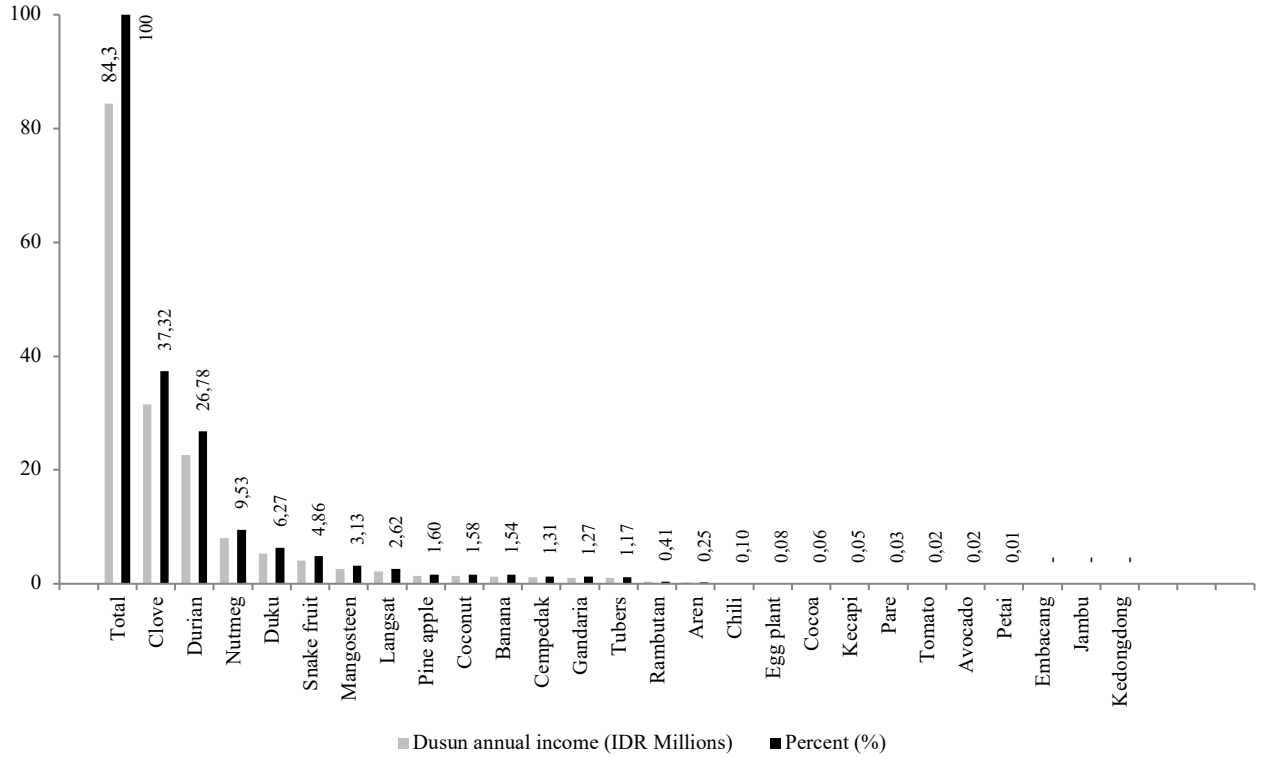


Figure 3. The structure of annual household income from Dusun systems in Ambon islands

Closing remarks

Different from the purpose of monoculture practices which focus on increasing production and profit, the historical background of *Dusun* system is the continuum line process from *swidden* agriculture (Dove, 1983) to settled traditional agroforestry that has purposes not only for production but also to maintain soil, water and crops as well as to sustain the source of regular and stable staple food and household income for the people who live in the dynamic socioeconomic and environmental change of coastal rural areas in the islands (Ducos, 2014). Based on an agro-economic view, findings suggest around 26 varieties of different crops in the Dusun. These are to form the structure that can be categorized into high, medium, and low stratum crops to maintain and sustain a complex relationship of soil, water, and crops and farmer income from the Dusun systems. Annual household income from *Dusun* was estimated at around $ US 7041 or $US 1408/capita/year, or it was almost two folds of the poverty line standard ($US2/day).

Table 3. Distribution of households income from various crops in the Dusun systems in Ambon City Islands

No	Crops	Dusun Hutumury		Dusun Hative Besar		Dusun Soya		Average	
		IDR (000)	%	IDR (000)	%	IDR (000)	%	IDR (000)	%
1	**Clove**	22,456	29.9	33,234	47.5	38,729	35.8	31,473	37.3
2	**Durian**	19,457	25.9	11,134	15.9	37,172	34.4	22,588	26.8
3	**Nutmeg**	8,377	11.2	7,588	10.8	8,141	7.5	8,035	9.5
4	**Duku**	14,299	19.1	931	1.3	638	0.6	5,289	6.3
5	**Snake fruit**	-	-	-	-	12,286	11.4	4,095	4.9
6	**Mangosteen**	1,427	1.9	95	0.1	6,395	5.9	2,639	3.1
7	**Langsat**	3,308	4.4	1,631	2.3	1,697	1.6	2,212	2.6
8	**Pine apple**	1,460	1.9	2,600	3.7	-	-	1,353	1.6
9	**Coconut**	2,128	2.8	1,070	1.5	788	0.7	1,329	1.6
10	**Banana**	-	-	3,874	5.5	34	0.0	1,303	1.5
11	**Cempedak**	1,037	1.4	1,845	2.6	431	0.4	1,104	1.3
12	**Gandaria**	-	-	2,609	3.7	597	0.6	1,068	1.3
13	**Tubers**	12	0.0	2,594	3.7	345	0.3	984	1.2
14	**Rambutan**	560	0.7	470	0.7	-	-	343	0.4
15	**Aren**	-	-	-	-	621	0.6	207	0.2
16	**Chili**	-	-	259	0.4	-	-	86	0.1
17	**Egg plant**	200	0.3	-	-	-	-	67	0.1
18	**Cocoa**	145	0.2	8	0.0	-	-	51	0.1
19	**Kecapi**	-	-	-	-	131	0.1	44	0.1
20	**Pare**	72	0.1	-	-	-	-	24	0.0
21	**Tomato**	53	0.1	-	-	-	-	18	0.0
22	**Avocado**	-	-	-	-	43	0.0	14	0.0
23	**Petai**	-	-	-	-	14	0.0	5	0.0
24	**Embacang**	-	-	-	-	-	-	-	-
25	**Jambu**	-	-	-	-	-	-	-	-
26	**Kedongdong**	-	-	-	-	-	-	-	-
	Total IDR (000)	74,991	100	69,942	100	108,061	100	84,331	100
	Total US $/Year	5,769		5,380		8,312		6,487	
	US $/Capita/day	3.2		2.9		4.6		3.6	

Source: Field work

The land size will determine the number of cash crops, production level, and then household income at a stable market price whilst the number of crops particularly clove, durian and mangosteen trees, significantly influence the household income. Therefore, the larger land size and the higher number of spices crops will stimulate a higher household income. Besides, the percentage of younger farmers was lower, but they had higher income than that of older farmers because they worked harder in the *Dusun* forest, were well-informed about the market prices, and had secondary jobs. The number of snake fruit had a negative impact on income because this crop was endemic and only found in *Soya Dusun*. In addition, lower household income is correlated with the poorer farmers and the number of children.

These research findings implied that *Dusun* system was not only multiple cropping of tree crops but it was also formed by the crop structure to maintain the harmonious relationship between soil, water, crop and socioeconomic of farmers in the small islands. Dusun is part of indigenous knowledge and its borders include crops and fish at the coastal areas as an integrated

part of the watershed systems of the islands. Due to the issues of housing development, division of land inheritance to the children, and land conversion into vegetable and food crops that endanger Dusun's sustainability, it suggests developing Dusun Land Protected Area (DLPA). The subsequent implication is to develop Dusun modernization by incorporating science and technology to manage land use and improve the productivity of primary crops, especially spices, durian, mangosteen and snake fruit, as part of Dusun Agro-tourism Development (DAD). Modernization of Dusun can be learned from the modernization of agroforestry systems that show a better influence on environmental and socioeconomic. Okubo *et al*. (2010) found that modern clove agroforestry base in West Java was more profitable to farmer household whereas wild fruit trees agroforestry in Zimbabwe and modern agroforestry fruit trees in Philippines were more profitable than food crops and livestock (Mithöfe & Waibel, 2003; Snelder *et al*., 2007). Farmers in Asia and the Pacific combined fruit trees with coffee, pine apple and legume shrubs (Craswell *et al*., 1998) to improve income whereas farmers in Canada used prairies shelterbelt for ecological service to reduce erosion, improved water quality, enriched biodiversity and air quality and also emission reduction (Kulshreshtha & Kort, 2009).

To incorporate science and technology to support the agro-economic sustainability of the Dusun systems, a number of complex factors need to be considered, including market price of the products, education and training Dusun systems to lecturers and students, operational costs, technology development, access to credit and contact with extension service (Lu *et al*., 2015; Tremblay *et al*., 2015; Arifin *et al*., 2003; Walker *et al*., 1995). The other important factor is to develop community-based *Dusun* systems management, and increase local people participation, livestock population, membership in organization, positive perception about *Dusun* systems (Neupane *et al*., 2002; Salampessy *et al*., 2010), and the pivotal role of main actor power particularly forest department (Islam *et al*., 2015). Future research needs to explore these complex, diverse, dynamic factors of the Dusun systems that interplay to shape an integrated and sustainable agriculture and aquaculture environments in small islands.

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