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Productivity of Nutmeg (*Myristica* spp.) in Agroforestry System (*Dusung*) in Ambon Island

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Abstract

Nutmeg is an icon of Maluku which has historic value in the world history of spice. However, the research on nutmeg in Maluku is still lacking. The objective of this study was to get the potency of nutmeg in farmers' plantation, cultivation and utilization of nutmeg by farmers, and kind of pests and diseases of nutmeg in Ambon Island. The research was conducted in three districts which are the center of nutmeg production in Ambon Island. Survey method with purposive sampling was used to determine village and farmer samples. Data was collected through direct observation in the field as well as by interviewing farmers. The result showed that nutmeg is cultivated in agroforestry system (*dusung*). The climate in research location is suitable for nutmeg growing and production. Productivity of nutmeg in Ambon Island is consider low which were 0.58, 0.77 and 0.39 t/ha in Leihitu, Leihitu Barat and Salahutu districts, respectively. Pests and diseases found in nutmeg plantation were stem borer, dry fruit rot, wet fruit rot, stem cancer, curly top, die top and thread blight.

Keywords: agroforestry, diseases, pests, potential, spice

Introduction

Agriculture sector has an important role in Indonesia, not only as labor market for 42% people but also as source of income especially for estate crop such as clove, nutmeg and cacao.

Nutmeg (*Myristica* spp.) is a spice that serves as source of farmer income, country foreign exchange and supporting industrial. Nutmeg plant that has economic value is its fruit which is consist of flesh (77.8%), mace (4%), kernel (5.1%) and seed (13.1%), and the most valuable parts are mace and seed that can be used to produce nutmeg oil.

Nutmeg is growing well in the tropical area of Asia, America and Africa. Nutmeg is classified into family of Myristicaceae that consist of 15 genera and 250 species in which 5 genera found in the tropical area of America, 6 genera in Africa and 4 genera in the tropical area of Asia (RISMUNANDAR 1990). There are six species of nutmeg in Maluku, i.e., *Myristica fragrans*, *M. argentea*, *M. fatua*, *M. specioga*, *M. sucedona* and *M. malabarica*, with the most economic value is *M. fragrans* (HADAD *et al*. 2006).

Based on historical review and fact in the field, *M. fragrans* is originally from the Maluku Archipelago (the Banda Islands). Therefore, Maluku has an important role in the world economy as a producer of high quality of nutmeg. However, the production of nutmeg in this area is not optimal yet, because there are many problems faced by the farmer ranging from cultivation technology to post-harvest processing problems.

Nutmeg is planted by almost all communities in Maluku. According to BPS (2013), the majority of population that most heavily cultivated nutmeg crop is resident of Central Maluku as many as 9,580 households, followed by 6,542 of East Seram, 4,800 of West Seram, 1,557 of South Buru, while the other districts of less than 1,000 households.

Nutmeg farm in Maluku Province is mostly smallholder plantations and it tends to increase from time to time (BPS 2013). The production and productivity (production/area of productive tree) of nutmeg is also increasing over the past three years (0.34–0.54 t/ha; Table 1) but they are considered to be still low. Low production and productivity of nutmeg are caused by unsuitable seed used for cultivation, unused of fertilizer and uncontrolled pest and disease (HADAD *et al*. 2006).

Ambon Island is one of the areas that produce nutmeg in Maluku Province. In this area, nutmeg is cultivated traditionally by using a system called *dusung*. *Dusung* is traditional knowledge practiced in Central Maluku including Ambon Island in which nutmeg is planted together with other crops (agroforestry) (MATINAHORU 2014).

Pests and diseases in nutmeg plants highly influence the production; decline in production due to pests and diseases can reach 10–25% (SEMANGUN 2008).

As mention above, productivity of nutmeg is still low because the problems faced by farmer range from cultivation system to post-harvest processing. Therefore, solution is needed to improve the system in order to improve income of the nutmeg farmers.

The objective of this research was to get data on potential of nutmeg, to study the cultivation system and utilization pattern of nutmeg by farmer as well as to get data of pest and disease of nutmeg plant in Ambon Island.

Methods

This research was conducted on July to November 2014 in three districts namely Leihitu, West Leihitu and Salahutu of Central Maluku Regency in Ambon Island. Three villages of each district were purposively chosen as sampling areas because they are main producer of nutmeg in Ambon Island.

Direct observations were done in the field as well as interviewing key respondents. The number of key respondents for each village is 10% of the nutmeg farmers. Data collected were field resources, variety of plant, cultivation techniques, indigenous knowledge, climate conditions, plant pests and diseases, production and post-harvest handling. Secondary data

Table 1. Area and production of nutmeg in Maluku during 2010 to 2012.

Year	Area (ha)			Production (t)	Productivity* (t/ha)
	Young tree	Productive tree	Old tree		
2010	11,949	6,635	3,741	2,391	0.36
2011	13,232	7,943	3,886	2,700	0.34
2012	16,688	8,568	3,608	4,622	0.54

*productivity = production (t)/area of productive tree (ha)

collected from related institution were statistics and agroclimate data as well as other information relevant to the study.

Agroclimate data was analysed using formulas proposed by OLDEMAN (1977) for raining probability, SCHMIDT and FERGUSON (1951) for climate clasification and OLDEMAN (1975) for type of climate. Pest and disease were indentified in Plant Pest Laboratory and Plant Disease Laboratory, Faculty of Agriculture, Pattimura University.

Results and Discussion

Climate aspect in nutmeg cultivation

Water is necessary by plants for photosynthesis, transpiration of mineral and product of photosynthesis, growth and transpiration. For estate crops, major water resource is rainy water.

In nutmeg cultivation area in Maluku (the Banda Islands), average of rainfall is 3,116 mm/year with 215 rainy days. According to RIDLEY (1912), rainfall needed by nutmeg crop is 2,175 to 3,550 mm/year without any period of real drought. The more rainfall the higher production per plant per month. In contrary, dry season causes decrease in production as well as the quality of the seed. According to HADAD *et al*. (2006), nutmeg seed harvest in dry season has lower germination rate compare to that in rainy season. Based on climate suitability, RUHNAYAT and MARTINI (2015) stated that nutmeg crop is suitable to cultivate in area with average rainfall of 2,000–4,500 mm/year. According to FLACH (1966), nutmeg crop cultivated in flat land with low water holding capacity has potential in puddle which will inhibit the growth of plants and susceptible to root rot disease if there is too much rainfall. Rainfall in the research area is 1,692–4,231 mm/year with 153 to more than 223 rainy days, and type of climate B (SCHMIDT and FERGUSON 1951) therefore the research area meets the criteria of climatic suitability for the development of nutmeg.

Varieties of vegetation have been naturally selected to grow in different latitude and altitude. At various latitudes and altitudes above sea level, there are different temperature and rainfall that would affect the lives of the various types of plants.

Relative humidity is related to the amount of water vapor in the air and it depends on air

temperature as well as air pressure. Therefore, temperature is linearly correlated to relative humidity. In general, air temperature and relative humidity is directly related to plant growth, as well as to development of plant pests and diseases. In the research area (Ambon Island) average temperature annually is 26.5°C, according to HADAD *et al*. (2006), optimal temperature for nutmeg growth is 25–30°C.

In Moluccas, nutmeg and clove crops distribution are found on 0–700 m above sea level. Nutmeg cultivated in more than 700 m above sea level will have low production due to high relative humidity that good for plant pathogen (fungus) to grow. Therefore, nutmeg is suitable to be cultivated on area less than 700 m above sea level (LEE 1957). In Banda Island, nutmeg is grown from the coastal to area of 458 m above sea level.

Wind has a role in moving heat, water vapor and CO_2 between the surrounding air and the plant, especially the leaves. In relation to nutmeg cultivation, wind speed and direction should be taking into account since strong wind can cause damage to crops, flowers and/or fruit fall. In area with strong wind, the speed could be reduced using compact wind barrier or other plant. For example, in most of nutmeg plantation in Banda Island, walnut (canary) tree are being used as wind breaker that protects nutmeg tree from the sea wind. Wind direction is also important in spreading of fungus spore and migration of certain plant pests.

Cultivation system of nutmeg in Ambon Island

Farmers in the districts of Leihitu, West Leihitu and Salahutu cultivate nutmeg on their own land by using the system called *dusung* mixed with other crops. Nutmegs were planted from flatland up to the hill with the gradient > 45% and canopy of 80% in the area of 0.5 to 4.0 ha. Nutmegs are harvested 3 times a year in March–April, July–August and November–December with the peak on March to April. Description on the number of plant, production and productivity of nutmeg in three districts are presented in Table 2.

It can be seen in Table 2 that productivity (production [t]/area of productive tree [ha]) of nutmeg is low due to limited cultivation system. Land used for nutmeg cultivation is also planted with other vegetation in order to protect nutmeg plants. Those plants are durian, albizia, walnuts (canary), *gayam*, mangosteen, mango, *lenggua*, teak and resin (upper stratum), clove, langsat, jackfruit, guava, coconut, betel nut, palm, cocoa, avocado (mid stratum) and banana, papaya, cassava, yam, pineapple, soursop (lower stratum).

In nutmeg cultivation, farmers has not used fertilizer and pesticide and the tools that been used only hoe, knife and crowbar. Sanitation of the plantation has not been done properly, and only been done once every 6 months, therefore there were some plant pests and diseases. Very limited and simple cultivation techniques caused low productivity of plant.

In addition, low productivity was also caused by lack of knowledge of the farmers to differentiate between female and male plants. The best ratio for male and female is 1:8, but fact in the field shows that farmer cultivated more male than female plants.

Based on field observation, it is found that there are three species in the study area in

which two are cultivated, i.e., *Myristica fragrans and M. argentea* and the other is wild nutmeg, *M. fatua* (Fig. 2).

Mature nutmeg fruits (6–7 months old) are harvested by using long stick. The most valuable parts of the fruit are seed and mace while most of the fruit flesh are discarded and just a little are kept to produce nutmeg syrup such as observed in Morela Village. Sun-drying of seeds usually takes 3–5 days while for mace just one day (Fig. 3). In the rainy season, seed and mace are smoked.

Table 2. Number of tree, production and productivity of nutmeg in Leihitu, West Leihitu and Salahutu districts in Central Maluku Regency.

District	Village	Number of tree*			Total	Production (t)	Productivity**
		YT	PT	OT/DOT			
Leihitu	Morella	8,869	7,127	2,340	18,336	28	0.61
	Mamala	5,627	5,760	1,960	13,347	23	0.62
	Hila	5,151	4,827	1,763	11,741	14	0.45
	Mean	6,549	5,905	2,021	14,475	22	0.58
West Leihitu	Alang	21,800	29,291	3,409	54,500	167	0.89
	Lilibooy	4,545	9,810	789	14,144	43	0.68
	Hatu	5,654	20,390	2,500	28,544	97	0.74
	Mean	10,666	19,830	2,233	32,396	102	0.77
Salahutu	Liang	2,620	20,149	1,989	24,758	49	0.38
	Tengah Tengah	5,669	26,235	3,457	35.361	70	0.42
	Tial	4,060	17,110	1,740	22,910	41	0.37
	Mean	4,116	21,165	2,395	15,901	53	0.39

*: YT=young tree, PT= productive tree, OT=old tree and DOT=damaged old tree.
**: It is assumed that there are 156 trees in 1 ha based on tree spacing.

Fig. 2. *Myristica fragrans* (A), *M. argantea* (B) and *M. fatua* (C).


Fig. 3. Harvesting and post-harvesting handling of nutmeg.

In relation to harvesting, there is a traditional community based management in Ambon Island called *sasi*. *Sasi* system refers to temporal prohibition on particular resources, e.g., nutmeg and when it is applied (*tutup sasi* closed season), no usage whatsoever is permitted until the *sasi* is lifted (*buka sasi* opened season). Violation of the *sasi* system will cause punishment or fine for the violators. *Sasi* system for nutmeg is still practiced in the villages of Mamala, Morela (Leihitu District) and Allang (West Lihitu District). Through *sasi*, we can get the best quality of nutmeg fruit because it is harvested in condition of physiologically mature.

Pests and diseases

Many pests and diseases were found during the study in all study areas (Table 3). As mentioned earlier, very limited cultivation techniques were used by farmers. Pest and disease control was not done intensively due to lack of knowledge of the farmers. Sanitation was not been done properly, it was only done twice a year usually before harvesting. The trees that had been damaged by pests and diseases were left in the field so they become the source of

Table 3. Diseases and pests found in the study area.

District	Disease	Pest
Leihitu	Stem cancer (*Phytophthora palmivora*)	Stem borer (*Batocera* sp.)
	Curly top	Termites
	Dry fuit rot (*Stigmina myristicae*)	
	Thread blight (*Marasmius* sp.)	
	Wet fruit rot (*Colletotrichum gloeosporioides*)	
	Plant parasite	
	Upasia salmonico	
West Leihitu	Curly top	Stem borer (*Batocera* sp.)
	Stem cancer (*Phytophthora palmivora*)	Termites
	Thread blight (*Marasmius* sp.)	
	Die top	
	Red Algae	
	Dry fuit rot (*Stigmina myristicae*)	
	Wet fruit rot (*Colletotrichum gloeosporioides*)	
	Leave Spot	
	Cracking of young fruit	
Salahutu	Thread Blight (*Marasmius* sp.)	Stem borer (*Batocera* sp.)
	Stem cancer (*Phytophthora palmivora*)	Termites
	Curly top	
	Dry fuit rot (*Stigmina myristicae*)	
	Wet fruit rot (*Colletotrichum gloeosporioides*)	
	Plant parasite	
	Die top	

inoculum to healthy trees. In most of plantations, the upper stratum trees (durian, albizia, canary, mangosteen etc.) occupied the upper canopy and covered the nutmeg and other mid stratum trees. Therefore, they can hinder the sunlight to go through and can cause high humidity in the field which in turn can support the development of the diseases.

Conclusion

Based on the study, it can be concluded that: 1) nutmeg in Ambon Island has a great potential to be developed because climate and physical condition support its growing and production, 2) productivity of nutmeg is low (0.37–0.89 t/ha) due to the non-optimal cultivation system, 3) the unsuitable ratio of male and female trees in the field can cause low productivity and 4) pests and diseases that found are similar among the study areas.

Therefore, improvement of cultivation system including sanitation of plantation, pest and disease control as well as the settings of male and female trees ratio by providing female trees need to be done in order to improve productivity of nutmeg in the area.

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