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Introducing Paddy *(Oriza sativa)* in the PlantationForest Management to Support Food Safety

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Abstract

There are plantation forest areas in Indonesia with large of 21.6 million ha, and 11.4 million ha other things are gone out to social forestry managementin the form of agroforestry system. The aim of this research was to create the value added and to know excellence of agroforestry system using paddy (Oriza sativa) mixed albisia (Albizia falcataria). Research was located at the plantation forest management in Balangan District, South Kalimantan. There are two plots for experiment, i.e. agroforestry plot and monocultur of albisia plot, where each plot was comprised 15 sub plots sized 10 m x 10 m (100 m^2). Collecting data of albisia and paddy were conducted at the fisrt and second year. Research result show that, agroforestry system has excellence at the diameter growth of albizia at the second year caused by added organic manure that come from decomposed waste and straw of paddy on the land. It also produce rice namely 3.4 ton ha^{-1} at the first year and 3.1 ton ha^{-1} at the second year. This research result is hoped useful as a reference to support food safety in the form of agroforestry system on plantation forest management.

Keywords: albisia, agroforestry, food safety, paddy.

1. INTRODUCTION

1.1 Background

Indonesia is agricultural country with fourth population in the world, whereas large of land for agriculture is 14.26 million ha only with productivity namely 70.61 million ton $years^{-1}$(dry rice) [1], [2]. However, to support food safety, Indonesia often buy (import) rice from Thailand, Vietnam or India. In order to support food safety, Ministry of Environment and Forestry RI launched the social forestry programme on the RPJMN (Middle Plan of National Development) period of 2015-2019 with target area of 12.7 million ha or 10% of state forest area[3]. It show that the government has the big political commitment to provide management space to the local community, especially those who live in nearby forest area. However, challenges at implementation level for this program are no less burdensome and complex. Whatsoever, opportunities widely open to various parties, either to district or provincial government, CSO and private sector to support and participate to succeed the program.

Social forestry activity is suitable conducted on the plantation forest area, because there are much space between annual plants that could to be used to agroforestry[4].Pursuant to decision of Ministry of Forestry No.10.1/Kpts-II/2000 and Law of Goverment No.34/2002, that development of plantation forests have been addressed at plantation forest areas in the form of shrubs (bushes and underbrush), grassland and critical land or in the form of logged over forest with low potential. There areplantation forest areas with large of 21.6 million ha, and 11.4 million ha other thingsare gone out to social forestry management that already set in Indicative Map of Social Forestry Area of Ministry of Environment and Forestry [4]. These areas area spreaded at the islands of Sumatera, Kalimantan, Sulawesi, Jawa, etc. and potentially to developing the social forestry using agroforestry system. Introducing *Oriza sativa*plant, as source of staple food,in the plantation forest management is believed could to raise the rice production to support foot safety in Indonesia. Social forestry also relates to poverty allevation of 6.8 million peoples living in and surrounding forest, relates to effort to reduce carbon emission and adaptation to climate change[4].

1.2 Aim of Research

The aim of this research was to create the value added and to know the excellence of agroforestry sistem, i.e.paddy (*Oriza sativa)* mixed albisia (*Albizia falcataria)* at the plantation forest management in Balangan District, South Kalimantan, in order to support food safety in Indonesia.

2 METHOD

This research was conducted on Industrial Timber Estate of PT.GM with albisia (*Albizia falcataria)* as staple plants, located in Buntu Karau Village, Balangan district, South Kalimantan Province, Indonesia. Type of climate is A [5] with precipitation namely2.382 mm year^{-1}. Initially vegetation was bushes, underbrush and grassland (*Imperata cylindrica*) with composition of vegetation was *Melastoma, Vitex pubescens*, kirinyu, evatorium etc. The land is included in the degradation forest land (PP No.34/2002). Type of soilis podsolik red-yellow (ultisol) and soil tekstur is clay sand. Research data was collected at 2015 to 2017.

2.1 Research Procedure

Chronological of research is showed at the Table 1, whereas research procedures of this research as foloow:

1. Preparing land using land clearing was done by disc plow, tonner and harroweach a time gap was 3 days
2. To raise pH of soil, land was given dolomit chalk ($MgSO_4$) 150 kg ha^{-1} at 5 days before plant staple plants of albisia (*Albizia falcataria)*
3. Fertilizing used organic manure from feces of cows with dosis 500 kg ha^{-1} was conducted at 3 days before plant staple plants of albisia at first years.

Table 1. Chronological of research

No	Date	Research activity
1	Nov 10-20 2015	Land clearing
2	Nov 21 2015	Sow of dolomit
3	Nov 23 2015	First fertilization
4	Nov 25 2015	Planting albisia
5	Dec 03 2015	First record of albisia data
6	Dec 06 2015	First planting of paddy
7	March 07 2016	First replanting of death albisia& tending
8	April 15 2016	First harvesting of paddy & record of its yield
9	July 05 2016	Second replanting of death albisia
10	Nov 23 2016	Second fertilization
11	Nov 25 2016	Second planting of paddy
12	Dec 03 2016	Second record of albisia data (1 year old)
13	March 06 2017	Tending
14	April 15 2017	Second harvesting of paddy & record of its yield
15	Dec 03 2017	Third record of albisia data (2 years old)

4. Seedling planted with distance of 2 m x 2 m at November 2015, when rainy season. All seedling of albisia come from same nursery.
5. Making sampling plots, they were placed in such a manner so that represent soil type and micro climate, which placed in a random manner. Plot 1 was the mixing of albisia and mount-paddy, called agroforestry plot; and plot 2 was pure albizia plantation, called as monoculture plot. Each plot composed of 15 sub plots as replication whereas size of each sub plot was 100 m^2 (Figure 1).

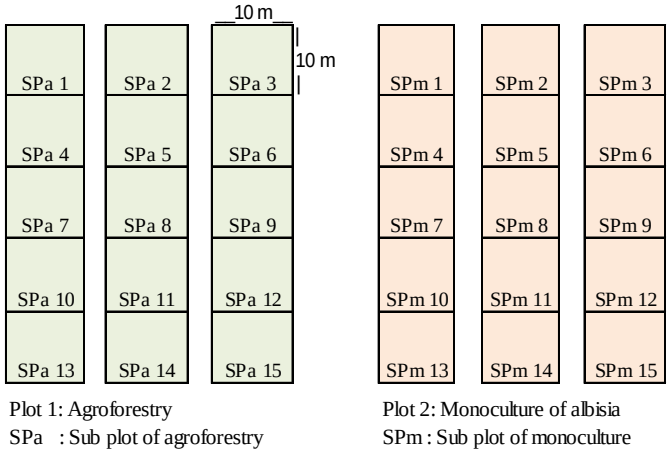

Figure 1. Layout of plot 1 and plot 2 with their sub plots

6. First record of albisia were done on 7-9 days after plantation of albisia.
7. At 10-12 days after planted albisia, mount-paddy *(Oriza sativa)* was planted at the plot 1 with dibble (that is wooden tool with a sharp end for making holes in the ground). Holes distance namely 25 cm x 25 cm and each hole filled by 2-4 seeds of mount-paddy and then closed by top soil
8. Replanting (replacement of the dead seedling with a new one) each on 3 month and 7 month after planted albisia. At this moment, conducted tending, either albisia and paddy.
9. Harvested mount-paddy was done at 4.5 months of age. Result of paddy yields were recorded.
10. The second manuring using organic manure from feces of cows with dosis 500 kg ha^{-1} conducted at the plot 1 and plot 2. After that, the second planted of paddy using seed of mount-paddy were conducted at 25 November 2016, when rainy season next year.
11. Recording diameter and height of albisia were done after 12 and 24 months after planting (at the moment of 12 and 24 years old).

2.2 Data Analyse

The data, either diameter and height of albisia at the first and second year were analyzed using homogeneity test and analyse of varians (anova) to know the signification of the treatments.

3 RESULT AND DISCUSSION

3.1 Result

Growth of diameter and height of albisia at the agroforestry plot(plot 1) at the moment of 1 year old (2015) and at the moment of 2 years old (2016) areshowed at Table 2. The data show that average diameter and height of albisia at 1 year old namely 3.31 cm and 292 cm respectively, and at 2 years old namely 5.22 cm and 460 cm respectively. Meanwhile, growth of diameter and height of albisia at the monoculture of albisia plot (plot 2) at the moment of 1 year old (2015) and at the moment of 2 years old (2016) are showed at Table 2. Table 3 show that average diameter and height of albisia at 1 year old namely 3.11 cm and 301 cm respectively, and at 2 years old namely 4.95 cm and 473 cm respectively.

Table 2. Growth of diameter and height of albisia at the agroforestry plot

PLOT 1	Age: 1 year (2015)		Age: 2 years (2016)	
	Dbh (cm)	Height (cm)	Dbh (cm)	Height (cm)
SP 1	3.5	315	5.5	450
SP 2	2.8	245	5.8	430
SP 3	3.2	265	5.1	460
SP 4	3.7	320	5.2	450
SP 5	3.6	315	5.5	500
SP 6	3.1	265	5.2	450
SP 7	3.1	275	5.2	480
SP 8	3.4	285	4.8	430
SP 9	3.5	350	5.1	480
SP 10	3.2	285	4.8	470
Average	3.31	292	5.22	460

Explanation: Dbh: diameter breast height, SP : sub plot

Table 3. Growth of diameter and height of albisia at the monoculture of albisia plot

PLOT 2	Age: 1 year (2015)		Age: 2 years (2016)	
	Dbh (cm)	Height (cm)	Dbh (cm)	Height (cm)
SP 1	3.1	320	4.8	480
SP 2	2.9	310	5.1	480
SP 3	3.3	320	4.5	500
SP 4	3.5	305	4.9	475
SP 5	3.1	350	5.2	470
SP 6	2.9	290	4.9	480
SP 7	3.1	315	5.1	500
SP 8	2.8	230	5.1	450
SP 9	2.9	230	4.8	400
SP 10	3.5	340	5.1	490
Average	3.11	301	4.95	473

Explanation: Dbh: diameter breast height, SP : sub plot

Basedon the homogeneity test, the data of diameter and height at agroforestry and monoculture of albisia, either at 2015 and 2016, have the significance value start from least value of 0.43 to greatest value of 0.66, and all of them bigger than 0.05, that indicated the data are homogeneous.

Based on the analyse of varians(Table 4)showed that significance value (:0.108) > 0.05, indicated that there are not significant different between diameter growth of agroforestry system versus monoculture systems at the first year (2015).Meanwhile, based on the analyse of varians (Table 5) showed that significance value (:0.036) < 0.05, indicated that there are significant different between diameter growth of agroforestry system versus monoculture systems at the second year (2016).

Table 4. Analyse of varians of albisia diameter at agroforesry and monoculture system at the first year

Varian	Sum of squares	df	Mean Square	F	Sig.
Between groups (combinet)	0.2	1	0.2	2.862	0.108
Within groups	1.258	18	0.2	2.862	0.108
Total	1.458	19	0.07		

Table 5. Analyse of varians of albisia diameter at agroforesry and monoculture system at the second year

Varian	Sum of squares	df	Mean Square	F	Sig.
Between groups (combinet)	0.364	1	0.364	5.122	0.036*
Within groups	1.281	18	0.364	5.122	0.036*
Total	1.645	19	0.071		

Table 6 and Table 7 showed the analyse of varians for height of albisiaat the agroforestry system versus monoculture systems, either 2015 at the first year and 2016 at the second years. At the first year, the significance value (:0.591) > 0.05, indicated that there are not significant different between height growth of albisia at the agroforestry system versus monoculture systems. Meanwhile, at the second year, the significance value (:0.008) < 0.05, indicated that there are significant different between height growth of agroforestry system versus monoculture systems.

Table 6. Analyse of varians of albisia height at agroforesry and monoculture system at the first year

Varian	Sum of squares	df	Mean Square	F	Sig.
Between groups (combinet)	405	1	405	0.299	0.591
Within groups	24,400	18	1,355.	0.99	0.591
Total	24,805	19			

Table 7. Analyse of varians of albisia height at agroforesry and monoculture system at the second year

Varian	Sum of squares	df	Mean Square	F	Sig.
Between groups (combinet)	781.3	1	781	1.138	0.3
Within groups	12,362	18	686	1.138	0.3
Total	13,143	19			

3.2 Discussion

Growth of albisia

At the first year, growth of diameter and height of albisia at the agroforestry system are as good as at the monoculture system.Meanwhile, at the second year, average diameter of albisia at agroforestry system namely 5.22 cm is better than monoculture system namely 4.95 cm. However inversely for average height of albisia. At the second year, average height of albisia at agroforestry system namely 460 is as good as at monoculture system namely 473cm.To the 2 years time, the mean annual increment of albisia diameter at the agroforestry and monoculture systems are 2.61 cm year^{-1} and 2.47 cm year^{-1}. Agroforestry system with paddy as supplement crop give added organic manure in the soil, so it cause the growth of albisia diameter better than monoculture system at the second year. At the first year, organic matter from straw (dried rice stalks) were not yet decayed, therefore could not to be used as absorbate. Organic manure from plants play importand role to improving soil structure, soil quality and soil fertility in growth of plants[6]-[8]. Organic materials are potential important sources of micro and macro nutrients in agricultural soils environment [7].

Nothing of the kind at the growht of height of albisia. Notwithstanding at the first year growth of albisia height at the agroforestry system as good as at the monoculture system, and at the second year, growth of albizia diameter at agroforestry system is better than monoculture system, but at the second year also, the growht of albisia height at agroforestry system is as good as at monoculture system. Therefore, superiority of agroforestry system is could to increase diameter growth of albisia plants.

The trees growth quality was represented by function of density which could be arranged through the plants distance[9], [10]. The good wood quality was yielded from well-balanced and good tree growth since early [11], [12]. Plants distance of2 m x 2 m at albisia plantation could give good influence at stems architectof albisia because it hasbeen happened well-balanced of effect fototropisme [13], [14].

Albisiais the fast growing species which needing many availability the sunlight and nutrient to balance of their growth speed [10], [15]-[17]. Initially,research landis categorised the degradation land with some limiting factors (PP No.34/2002) [16]. According to PT GM [18], the type of soil at the Balangan District, South Kalimantan, is ultisol and characteristic of acidity (pH) is start from 4.3 to 6.2. According to Mc Kinnon et al [19], the ultisol soil is tend to form of acid soil and includedthe marginal soil. With the result, this soil is categorised as soil with low fertility. This soil more contain of iron (Fe) and aluminium (Al)elements [20], [21], it cause Phospor (P) element at the soilin the form of bound state of Fe and Al, therefore the soil is poor of P element. Phospor at the soil couldn't absorbed by plants well. That is the cause, from the beginning, the research soil was given and sowed dolomit chalk ($MgSO_4$) 150 kg ha^{-1} at 5 days before plant staple plants of albisia (*Albizia falcataria)* to raise soil acidity. To raise fertility of soil,management used organic manure from feces of cows with dosis 500 kg ha^{-1}.

Land preparation at the site using plows, basic manure of dolomit and organic manure. Growth of plant is influenced by farm processing, site and species factor[6]. It also, land processing with three time of plows could positive affect to mix the mineral soil at the above and underground[22], [23]. Waste and other organik substance as source of soil nutrient is importand for grow well of plants[6]. According to Noor [24], the marginal land isnot suitable for agricultural cultivation but with the technological adjusment in the form of apply the correct processing system and raising fertility of soil using fertilization, itcould tobecome productive land for agriculture. Utilizing the basic manure (dolomit) and organic manure isrecommended to rapidly growth of plants at marginal land[9], [10], [16], [24], [25].

This research was conducted at the marginal land of ultisol. In the mean time, applying land processing of plows, using basic manure and add the organic manure at the research lands make the albisia grow well.In the first year, mean annual increment (MAI) value of albisiaat the agroforestry system is3.31 cmyear^{-1}for diameter and 292 m year^{-1}for height, it is as good as monocultural system, namely 3.11 cmyear^{-1} for diameter and 301 m year^{-1}for height. After 1 year, waste and straw of paddy was decomposed, then add the organic manure on the land. At this condition, diameter growth of albisia at the agroforestry system namely5.22 cm at 2 years old, this is better than diameter growth of albisia at the monoculture system namely 4.95 cm at 2 years old (Table 5). The excellence of agroforestry system is added organic manure come from waste and straws of paddy that was decomposed as long as 1 year. Meanwhile, height of

albisia at the agroforestry system is 460 cm at 2 years old, it is as good as monocultural system, namely 473 cm at 2 years old (Table 6). Based on literature study, MAI of diameter and height of albisia plants namely 4.4 cm $year^{-1}$ and 483 cm $year^{-1}$ respectively [25]. In Semaras, MAI of diameter and height of albisia plants namely 1.14 to 2.3 cm $year^{-1}$ and 152 to 236 m $year^{-1}$[26]. In PT ITCI (East Kalimantan) MAI of diameter and height of albisia plants namely 2.53 to 3.5 cm $year^{-1}$ and 215 to 373 m $year^{-1}$[27].The data show that albisia at this research grow normally, and finally, agroforestry system is better than monoculture system, either in the growth of albisia and product of rice.

Yield of rice

Agroforestry plot be sides make plants of albisia grow well, also produce the rice after 4 months plantation. At the first years, agroforestry system produce rice namely 0.51 ton $plot^{-1}$or equivalently with 3.4 ton ha^{-1}, meanwhile at the second year, its system produce rice namely 0.46 ton $plot^{-1}$ or equivalently with 3.1 ton ha^{-1}. Compared with the other data, product of rice in the research plots are good categories. According to Noor [24], agricultural project of mount-paddy at the marginal land in Kalimantan produce rice start from 1.3 to 3.6 ton ha^{-1}, in Sumatra namely2.0 to 3.5 ton ha^{-1}, and in Sulawesi namely2.3 to 4.4 $tonha^{-1}$. At the second year, product of rice decrease than at the first year, caused by raised competition of albisia and paddy plant [9] in the form of nutrient quantity and water absorption [28], [29]. The albisia plantsgrow and enlarge canopy, more big progressively. It cause decreasing of light intensity and its distributed on the forest floor [9] so that could lessen photosynthesis quality and quantity of paddy, so that decreasing productivity of paddy [14], [30].Nevertheless,albisiais grouped of *Leguminocea*, its root capable to catch the free nitrogene from the air through the rhizobium bacteria on the root nodule [6], it had contributed to carry through high productivity of paddy yield.

Picture 1. Albisia and paddy at the first year

Pursuant to this research result, the growth of albisia on the agroforestry system better than monocultur system. Based on evaluation of social aspect, economics and culture, the agroforestry system was the best method if compared by monocultural system because the local peoples can be participated on this project, to raise local people income, accept more amount labour, creating the cooperation among local peoples and corporate so that created the care of and own to sustained natural resources [14]. Agroforestry system also could improve the positive perception of local peoples to develop forest plantation in the forest region [1].Mean size of the farm land on the agroforestry system is 1.2 ha per household, so that the agroforestry system could to add income from production of paddy namely3.72 to 4.08 ton or equivalent with3 - 4 million IDR.

The other use of the agroforestry system isto security especially to prevent forest fire. Manyexperiences show that most caused of forest fire is human factor [31]-[33]. The local peoples at the surrounding forest region apply the traditional agriculture that using combustion [32], it often cause the negative effect i.e. forest fire [34]. Thereby, agroforestry system could decrease the number of forest fire that proceed fromlocal peoples, maybe as agent of combustion, would be take care of the plants and environment.

Social forestry program that be launched by Ministry of Environment and Forestry, Republic of Indonesia on the Middle Plan of National Development with target area of 12.7 million ha can be applied in the form of agroforestry system to support food safety. This research result is hoped useful as a reference to support agroforestry system.

4. CONCLUSION

Agroforestry system is better than monoculture system, either to staple plant of albisia and paddy. The excellence of agroforestry is at the diameter growth of albizia at the second year caused by added organic manure that come from decomposed waste and straw of paddy on the land. At plot of agroforestry is also produce rice namely 3.4 ton ha^{-1} at the first year and 3.1 ton ha^{-1} at the second year. This research result is hoped useful as a reference to conduct agroforestry system on plantation forest management to support food safety.

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