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Productivity of dwarf elephant grass (*Penisetum purpureum* cv. Mott) and coconut (*Cocos nucifera*) in Coconut-Beef Cattle Integrated Farming System (Coco-Beef IFS) in South Minahasa, Indonesia

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***Abstract*—** *This study as a phase I research was carried out on farm (in situ) in the farmer's coconut (Cocos nucifera) land with different designs every year. In this study, the treatments are dwarf elephant grass (Penisetum purpureum cv. Mott) planting and the use of organic fertilizer processed from cattle manure and coconut waste. The variables that become the parameters of technical productivity were measured in first year of three years of research, namely the amount of fresh forage production of dwarf elephant grass, the amount of nuts per coconut bunch, and the stocking rate of forage forages in coconut fields in the Coconut and Beef Cattle Integrated Farming System (Coco-Beef IFS). The results of the study as follows: (1) Productivity of Pennisetum purpureum cv. Mott in coconut field that has been fertilized with cattle manure based compost, produces the yield of fresh forage per year can reach 661,947.64 kg per hectare per year, then the stocking rate of grass* Pennisetum purpureum *cv. Mott per hectare of land under coconut trees can be given to around 45.34 heads of adult cattle a year; and (2) Production of coconut (Cocos nucifera) around 7.88±2.44 nuts or in average about 8 nuts per bunch in land planted with Pennisetum purpureum cv. Mott and fertilized with cattle manure-based compost. Coconut productivity is seen in two parameters (around the bunches and number of coconuts) in the first year of study is still low. The results of the influence of cattle manure-based compost fertilizer on several parameters of coconut productivity are expected to increase in the second or third year of research to be conducted later.*

***Keywords*— cattle, compost, forage, manure, nut.**

I. INTRODUCTION

Nowadays farmers' heavy dependence of cattle on natural pasture for grazing has resulted in the emergence of a range of grazing systems and ecosystem challenges (Lawal-Adebowale et al. 2018). Farmers generally only rely on local forage from vegetation of natural pastures, both grasses and legumes which according to Paat and Taulu (2012) and Osak et al. (2018) that the farmers generally only cultivate forage crops in the lands, fields and on the edge of the irrigation canal lands.

Prawiradiputra and Priyanti (2009) stated that in almost all cattle production areas in Indonesia, smallholder farmers have problems providing and supplying forage sources that are effective and available throughout the year, especially the limited area of forage crops. Whereas in the areas of coconut production centers there are lands that are generally only monocultures of coconut plants that can be intercropped with forage crops.

Coconut plant is one of plantation plants that are able to adapt to the environment, growing in tropics and can be found both in lowlands and highlands (Salendu et al. 2018). Paat and Taulu (2012) explained that in coconut fields if planted with superior grass such as dwarf elephant grass (Pennisetum purpureum cv Mott) and intensively applied fertilizer will be able to increase carrying capacity forage up to more than 30 head per ha.

The land under coconut trees is only overgrown with vegetation for wild pastures both grass and local legume that grows wild, although the yield and quality of these types of forages are low and some of them are low edible for cattle, but due to lack of forages then the farmers are forced to feed or provide feed for local species. Land under a coconut tree if used by planting quality grass, the

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income earned by the farmer household will be higher (Salendu and Elly 2012).

However, the introduction of forage fodder grasses on coconut plantations can lead to competition in the absorption of soil nutrients between forage and coconut plants, so it is necessary to intensify the use of fertilizers to meet the needs of both types of plants. Mantiquilla et al. (1994) suggested that fertilizer used in coconut fields could be chemical fertilizers (in organic fertilizer), organic fertilizers or a combination of both.

The use of inorganic fertilizers continuously and tends to be excessive can cause a lot of agricultural land in Indonesia to be in sick condition. Based on this condition, manure as an organic fertilizer has been glimpsed to substitute inorganic fertilizers, where organic fertilizer based on livestock manure and crop waste can improve soil physical properties. The recycling of precious organic manure wastes might have been responsible for conserving ecosystem and thus increasing the fertility of soil and keeping the environment free from pollution hazards (Ramrao, et al. 2006)

Forage planting on coconut fields and the use of compost based on livestock manure on coconut and forage crops can save fertilizer costs, by eliminating chemical fertilizers so as to increase forage and coconut products that are more productive. Integration of pasture and cattle in coconut plantation is expected to increase the value of the land productivity (Anis et al. 2014). Likewise the integration of plants and livestock in the coconut area can increase coconut production almost twice as much, through the use of livestock manure as organic fertilizer (Polakitan 2012). And according to Ramrao et al. (2006) that the farmyard manure available from the animal was used for fertilizing of crops and 30-35% savings in fertilizer use could be affected in mixed farming system.

Today's mixed farming system is known as Integrated Farming System (IFS), where according to FAO (2001) consist of components such as crops and livestock that coexist independently from each other. The integration system of cattle and plantation is often considered as a step forward in farming practices that are environmentally friendly and sustainably, and as an alternative approach to diversifying sustainable agricultural production that profitable mutually and simultaneously (Osak et al. 2015 and Osak et al. 2016). For this reason, the need for research on the productivity of forage especially dwarf elephant grass (*Penisetum purpureum* cv. Mott) and coconut (*Cocos nucifera*) for Coconut - Beef Cattle Integrated Farming System (Coco-Beef IFS) in South Minahasa, Indonesia.

II. MATERIALS AND METHODS

The study was carried out in a coconut plantation land owned by farmers (in situ) in South Minahasa Regency, Indonesia. Materials and tools used in this study are: coconut land covering 0.5 hectares, dwarf elephant grass seeds, cattle manure, coconut waste (coconut water, dry leaves, and coconut husks), scales and other auxiliary equipment.

This research was conducted in May – August 2018, as a Phase I study in the first year of the three years plan, which was carried out on the farmer's coconut land (*in situ*) with different designs and applications each year. In the Phase I study, the application of dwarf elephant grass (*Penisetum purpureum* cv. Mott) and the use of organic fertilizer processed from cattle manure and coconut waste. The variables that become the parameters of technical productivity were measured in year I, namely the amount of fresh forage production of dwarf elephant grass, the amount of nuts per coconut bunch, and the level of stocking rate for forage in coconut fields in the integration system of coconut – beef cattle and (coco-beef IFS).

The data collected was analyzed descriptively, where according to Lawal-Adebowale et al. (2018) that the descriptive tools such as frequency counts and standard deviation in tables form the basis for summarizing the data collected in relation to the research goals. The descriptive methods of data analysis can be used to identify a new and smaller assembly of non-correlated variables (Gabor, 2012).

III. RESULTS

Based on the results of interviews with cattle farmers in the research location (*in situ*) information was obtained that the management of cattle feeding was still simple with the type and composition as it was in accordance with the availability on their land. Characteristics of farmers showed that the average amount of forage grass fed for a cattle is only about ±17-20 kg/day, while the feeding of rice or corn bran will be given to cattle if available.

Farmers are only able to raise cattle as much as 1-4 heads or <10 heads only, and forage feeding is not yet in accordance with the needs of the existing cattle, because of the low availability of forage livestock owned by farmers. While coconut production is still around 4-15 nuts per bunch or an average of about 8 nuts per bunch, with around the stem of the coconut bunches only about 12 cm, even though the larger it is around the bunches, the production of coconut per bunch is higher.

Training and demonstration activities have been carried out for farmers for the com

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posting process. Cattle manure is used for the processing of manure-based organic fertilizer, which is used as fertilizer for grass forages planted in coconut fields. Farmers are trained in compost processing by utilizing cattle manure from the feedlot, which has been done in compost hut. Processing procedure: initially a box made of beams and bamboo measuring 2x1x1 m in compost hut. Then the plant waste is stacked in the box as high as 15 cm and then put cow dung that has been dried while trampled to make it solid. Then watered or sprinkled with a mixture of coconut water with sugar. So the stages are repeated until the box becomes full and solid. After the box is full, the wall of the box is opened / released, and then the compost material is covered with tarpaulin and tied. A week later the compost was reversed and this was repeated over four weeks. Furthermore, the composting box is opened and aerated by field cooperators. A good compost fertilizer is one that has experienced enough weathering and is characterized by a color that is different from the color of the constituent material, odorless, low moisture content and room temperature.

The land is carried out perfect tillage and then planted with *Pennisetum purpureum* CV. Mott with a planting distance of 100x50 cm, the number of potential clumps are 20,000 clumps per hectare, while cattle manure-based compost is used as much as 10 tons of wet. Coconut land used is 0.5 hectares, so that the number of seeds used are 10,000 cuttings and 5 tons of wet cattle manure-based compost.

Table.1: Productivity of Pennisetum purpureum cv. Mott on coconut land and fertilized cattle manure-based compost in Phase I of coco-beef IFS research

Parameters	Productivity		
	Amount		Std. Dev.
1. Plant height (cm)	201.68	±	34.33
2. Number of tillers per clump (buds)	16.31	±	0.79
3. Stem production per clump (kg)	2.72	±	0.19
4. Leaf production per clump (kg)	2.26	±	0.11
5. Fresh forage production per clump (kg)	4,98	±	0.27

The results of the production of *Pennisetum purpureum* cv. Mott in coconut field fertilized with cattle manure-based compost can be seen in Table 1. Plant height reached 201.68±34.33 cm each 45 days after crop (d.a.c) or days after first harvest, with number of tillers per clump amounting to 16.31±0.79 buds each 45 days after crop (d.a.c), production of stems per clump weighing 2.72±0.19 kg each 45 days after crop (d.a.c) and production of leaves per clump weighing 2.26 ± 0.11 kg each 45 days after crop (d.a.c), so the fresh forage of stems and leaves per clump weighing 4.98 ± 0.27 kg each 45 days after crop (d.a.c). Then several parameters such as neutral detergent fiber (NDF), acid detergent fiber (ADF), feed convertion ratio (FCR) and carrying capacity of *Pennisetum purpureum* cv. Mott and other forages will be observed in the following research phases in the second and third years.

Tabel.2: Two parameters of coconut productivity (Cocos nucifera) on land planted with Pennisetum purpureum cv. Mott and fertilized cattle manure-based compost in Phase I coco-beef IFS research

Parameter	Productivity		
	Amount		Std.Dev.
1. Circle stem of bunches on 11 coconut trees (cm)			
- bunch 1 (bottom bunch)	11.70	±	1.73
- bunch 2 (second bunch after bottom)	10.89	±	1.27
- bunch 3 (third bunch after bottom)	11.11	±	1.65
Average around the bunches in 11 trees	*11.23*	±	*1.18*
2. Coconut production per bunch in 11 coconut trees (nuts)			
- bunch 1 (bottom bunch)	7.18	±	2.27
- bunch 2 (second bunch after bottom)	8.09	±	3.42
- bunch 3 (third bunch after bottom)	8.36	±	3.93
Average number of nuts per bunch in 11 trees	*7.88*	±	*2.44*

In this phase I study, coco-beef was only observed in two coconut (*Cocos nucifera*) productivity parameters in the land planted with *Pennisetum purpureum* cv. Mott and fertilized cattle manure-based compost, which are around the bunches and the number of coconut production per bunch in 11 sample coconut trees, as can be seen in Table 2, while other parameters will be observed in the next phase of research in the second and third years.

The results of the influence of cattle manure-based compost fertilizer on several parameters (such as nuts per bunch, total weight per nut, nut meat weight, and copra weight, protein content, reducing sugar content, fat content, galactomannan content and phospholipid content of fruit meat) of coconut productivity are expected to increase in the second or third year of research to be conducted later.

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IV. DISCUSSION

The above forage production data is still the first data in the Phase I study for three years of research. Closer data to be used in stocking rate calculation is data based on the second harvest in 45 days after crop (d.a.c) or 120 d.a.p., and so on every 45 days after crop (d.a.c) interval. Therefore, phase II research and so on in the following years, must still be carried out to obtain more accurate and systematic production data by rotating forage crops for both grasses and legumes according to the needs of the number of cattle raised. In the next year research will be observed based on ten feeder cattle that will be farmed, where in the second year and third rotational forage harvest based on the needs of the ten feeder cattle.

Based on the results of the Phase I study, the second crop or cut of forage after plant age 45 d.a.c (days after crop) or 120 d.a.p (day after planting) of *Pennisetum purpureum* cv. Mott, produced stem weight per clump every 45 days after crop (d.a.c) is 2.72±0.19 kg and leaf weight per clump is 2.26±0.11 kg so that the total feed for fresh forage is 4.98 ± 0.27 kg per clump in 45 d.a.c or 120 d.a.p., with a spacing of 100 x 50 cm or 20,000 clumps of plants per ha, minus 20 percent of ineffective land overgrown with forages in coconut land, then the number of forages is only 16,000 clumps of plants per ha, so the potential for fresh forage at the first harvest is 79,752.73 kg per harvest.

After harvesting at the first devoliation at 75 d.a.p (day after planting) with a devoliation distance of 45 days, there are 8.3 harvests in a year, so the annual forage yield is 661,947.64 kg per hectare per year. The amount of consumption per adult cattle per day is 40 kg fresh forage, then the stocking rate or availability level of *Pennisetum purpureum* cv Mott per ha of land under coconut tree can be given to a total of 45.34 animal unit (AU) cattle a year.

Coconut (*Cocos nucifera*) production on land planted with *Pennisetum purpureum* cv. Mott and fertilized cattle manure-based compost showed that the total production of coconut fruit is 7.88±2.44 or about 8 nuts. Coconut productivity in the first year is still low, or still like the initial data from interviews with farmers around 4-15 nuts per bunch or about 8 nuts per bunch on average. These results are due to the coconut fruit being only based on natural soil fertility, where the results of cattle manure-based compost fertilizer are expected to increase coconut productivity in the second or third year during future research.

Organic fertilization based on cattle manure is indeed a versatile component in the integration system of cattle and coconut-based agriculture. This organic fertilization not only affects the soil, forage crops, cattle and coconut plants, but also for farmers as an important element in the system in a practical, efficient and effective.

There are still challenges that make organic fertilizer less acceptable, especially bulkiness, relatively low nutritional content, need more labor, stinging odors, and indirect effects on plants. However, intensive research and development efforts will be able to make organic farming more attractive to farmers, and benefit technically, economically and ecologically (environmentally friendly). In addition to forage and coconut productivity, also the production of cattle product that are more relevant will be conducted in the second or third year of the following research will be conducted later. It is expected that there will be continuous efforts that can provide other options acceptable to farmers, in producing high yields and high-quality agricultural products as a result of sustainable integration farming system management.

V. CONCLUSION

1. Productivity of *Pennisetum purpureum* cv. Mott in land under coconut (*Cocos nucifera*) trees was fertilized with cattle manure-based compost in phase I of coco-beef IFS study, the potential yield of *Pennisetum purpureum* cv. Mott fresh forage per year can reach 661,947.64 kg per hectare per year, then the stocking rate of per ha of land under coconut trees can meet the need for cattle feed of about 45.34 heads mixed-age cattles for a year.
2. Coconut (*Cocos nucifera*) production in phase I of coco-beef IFS research on land planted with *Pennisetum purpureum* cv. Mott and fertilized cattle manure-based compost produce around 7.88 ± 2.44 or about 8 nuts per bunch. Coconut productivity in the first year is still low, where the results of fertilization with cattle manure-based compost are expected to increase coconut productivity in the second or third year of following research will be conducted later. In addition those productivity, also the production of cattle product that are more relevant will be conducted in the second and third year of the following research will be conducted later.

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