EFFECTS OF BOKASHI PLUS FERTILIZER ON THE GROWTH AND YIELD OF PEANUT (*ARACHIS HYPOGAEA L.*) IN INTERCROPPED MAIZE AND PEANUT UNDER SUSTAINABLE CREATIVE AGROFORESTRY SYSTEM

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ABSTRACT

The nutrient shortages are the main soil problems faced by the farmers in the study regions. The use of bokashi plus fertilizer was newly adapted to improve soil conditions including at the early stages of teak tree plantation. Teak tree plantation based agroforestry system has been applied in the farmers land of Napabalano district for two years and teak trees with 6 m x 6 m crop spaces were well grown while intercropped maize and peanut was planted between the rows of 1-2 years of teak tree plantation. The main purpose of this paper was to evaluate the application effects of bokashi plus fertilizer in sustainable creative agroforestry system on the growth and yields of peanut under intercropped maize and peanut pattern in agroforestry system of Pentiro village, Napabalano district, Muna regency. The research was arranged in randomized block design (RBD) with one factor of the application of bokashi plus fertilizer with four level of treatments namely without bokashi plus fertilizer (P0), bokashi fertilizer plus 3 t ha-1 (P1), bokashi fertilizer plus 6 t ha-1 (P2) and bokashi fertilizer plus 9 t ha-1 (P3). Each treatment was repeated four times so that there were 16 experimental units. Peanut growth and yield components recorded were plant height, number of leaves, number of branches, total pod number, total pod content, weight of 100 seeds, number of nodules, number of seeds per plant, total dry weight of plant, yield per ha. and LER. All variables were analyzed using analyses of variances (ANOVA), and if significant, followed by Honestly Significant Difference (HSD) with 95 percent confidence level. The results of research showed that the application of various doses of bokashi plus fertilizer gave a significant influence on peanut growth and yield components under intercropped maize and peanut planted between the rows of 1-2 years of teak tree plantation. The best effects of peanut growth and yield were obtained at the doses of 9 t ha-1 (P3), indicating a promising strategy of intensive and effective use of space between the rows of teak trees without interfering them in sustainable creative agroforestry and improve soil fertlity to produce sufficient quantity of peanut cultivated with maize in intercropping system. The integration with the cultivation of maize and peanut in intercropping system proved to maintain soil condition, biodiversity and crop production sustainably.

Key words: agroforestry, bokashi plus fertilizer, intercropping, maize, peanut, teak tree

INTRODUCTION

Agroforestry system is the management and integration of trees, crops and/or livestock on the same plot of land and can be an integral component of productive agriculture. This agricultural system has been practiced by local community of Muna region for hundreds of years, in order to gain various staple crops production and to maintain good environmental stability (Karimuna, *et al*., 2019). It may include existing native forests and forests established by landholders. It is a flexible concept, involving both small and large-sized land holdings. Agroforestry has a lot in common with intercropping (the practice of planting two or more crops on the same plot) with both practices placing an emphasis on interaction between different plant species (Garity, 2004). Moreover,

Karimuna, *et al*., (2018) reported that agroforestry system is a sort of future integration of various plant species derived from annual and perennial crops which play a significant ecosystem function in sustaining biological diversity and improvement of agriculture production for the smallholding farmers of the region.

Most of the farmers practiced agroforestry system under sub optimal soil conditions. The nutrient shortages are the main soil problems faced by the farmers in the study regions. This lead to low agricultural productivity and low revenues gained. Many approaches have been introduced to overcome soil deficiency and low productivity of agricultural crops, like the use of chemical fertilizer, new variety of agricultural crops, conventional pest and diseases control, and common crop maintenance and local poor seed quality as reported by Suwarjono (2004). However, the outputs of these approaches have not yet been achieved, since the demand of peanut production increased (Central Statistical Beaureu, 2018). Production of peanut in 2018 and 2019 was continued to decline with 550,032,000 ton and 517,950,000 ton, respectiverly and estimated to decline in 2020 to 2022, while the total consumption was 657,750,000 ton and increased 0,88% per year due to growth population (Outlook Ministery of Agriculture, 2017). The decreasing production of peanut was caused partly by frequent planting system and the decreasing of soil nutrient. The use of bokashi plus fertilizer was newly adapted to improve soil conditions in agricultural landscapes, including at the early stages of teak tree plantation for the first year 2019. Teak tree plantation based agroforestry system in the form of social forestry has been applied in the farmers land of Napabalano district wih various stages of development aged from one to 25 years . Intercropping maize and peanut between the rows of two years teak trees with 6 m x 6 m crop spaces were well grown so far and the performances of agricultural crops for the first year had been reported by Karimuna, *et al*., 2019.

Application of bokashi plus fertilizer that contains sufficient nutrients in marginal soil is necessary to improve soil fertility and to maintain better growth development in order to overcome the shortage of nutrient contents may affect metabolisme of plant tissues. However, during the early stages of development, the nutrient amount of soil should be high enough to sustain the plant life cycle (Wilson *et al*. 2001), and can be periodically increased with doses of organic fertilizers and chemical fertilizers-NPK (Beaulah *et al*. 2001). Factors required for better crop yield are adequate soil fertilization and proper feld management with organic amendments of plant or animal origin. According to Stofella *et al*. (1997), compost and other organic fertilizers have been reported to improve soil nutrient levels, as fertilizers provide a ready source of carbon and nitrogen for soil microorganisms, improve soil structure, reduce erosion, lower soil temperatures, facilitate seed germination and increase soil water retention capacity. Fertilizers stabilize soil pH, increase soil organic matter, and ultimately improve the growth and yields of plants (Roe *et al*. 1997).

During the first year of research in 2019, the application of bokashi plus fertilizer on the growth and yields of intercropped maize and peanut or soybean proved to significantly result in higher overall yields (Karimuna, *et al*., 2019). Similar study had been conducted by Haverkort *et al*. (1992) suggested that bokashi fertilizer functions as a nutrient storage which would slowly be released into the soil solution and could be utilized by plants, organic materials in or above the soil surface would also protect and help regulate the temperature and soil moisture. Over the past two decades, a number of studies have been carried out analysing the viability of agroforestry. The combined research has highlighted that agroforestry can reap substantial benefits both economically and environmentally, producing more output and proving to be more sustainable than forestry or agricultural monocultures. Technology applied in improved technology was used in agroforestry system through the use of selected and high adapted crops such as maize, peanut, soybean for annual crops and teak, mahogany and cashew nut for plantation crops but how various doses of bokashi plus fertilizer affect the peanut growth and yields of intercropped maize and peanut has been unkown. The main purpose of this paper was to analyze the effects of bokashi plus fertilizer in sustainable creative agroforestry system on the growth and yields of peanut under intercropped maize and peanut pattern in Lambiku and Pentiro villages, Napabalano district, Muna regency.

MATERIALS AND METHODOLOGY

Place and Time

This research was carried out in two farmers land of Lambiku dan Pentiro villages, Napabalanao district, Muna regency. Soil samples and bokashi plus fertilizer were carefully collected and analyzed for nutrient contents in the analytical laboratory of the Faculty of Agriculture, University of Halu Oleo, Kendari, Southeast Sulawesi Province, Indonesia. This research was held from January 2020 to May 2020 during rainy season. This land was previously used as the demonstration plot of planting maize and peanut or soybean in intercropping system applied by bokashi plus fertilizer under financial support of the Government of Indonesia, Ministry of Research, Technology and Higher Education, Republic of Indonesia for three years from 2019 to 2021.

Materials and Equipment

Materials used in this research were local maize and local peanut ecotype, bokashi plus fertilizer, pouches of plastic and newsprint, while equipment used in this research were soil processing tool, sieve the soil, analytic scales, meter, water pump, watering tools, ropes, plastic pouches, scissors, digital camera, stationery writing, waring net, electric oven, leaf area meter, measurement of moisture content and tools for laboratory analysis of soil and bokashi plus fertilizer applied for residual effects of bokashi plus.
Other materials used in the agroforestry experimental field for annual crops were biomass of secondary vegetation dominated by *Chromolaena odorata* L., chicken manure, EM4, water, sugar, rice bran, label, poles and rope. The equipment used in the field test were chopper machine, hoe, knife, balance, sprayer, oven, camera, measurement, and soil thermometer. In addition, hand tractor was used for land preparation in two farmers areas of Lambiku dan Pentiro villages.

Methods

All growing herbs and shrubs in the demonstration plots were cleared, while young teak trees of one and two years of age were maintained and recorded the vegetative growth development. *Chromolaena odorata* L. as a source of organic materials used in this research was collected to be mixed with chicken manure, rice bran, palm sugar, EM4 and water to make bokashi plus fertilizer. Agricultural farmers land with the area of 40 m x 100 m was ploughed twice using hand tractor and demonstration plot of 10 m x 10 m was swathed. Planting maize and peanut in intercropping system between the rows of teak trees was carried out according to the experiment designed. The demonstration plot was set up in the same plot used in 2019.

Provision of bokashi plus fertilizer was made using komba-komba (*Chromolaena odorata* L.), chichen manure, EM4 and inoculated with mycorrhiza. Application of bokashi plus was done a week before planting depends on the appropriate treatment dose. Before planting, the seeds were soaked into the water to accelerate the process of seed germination. Planting was done manually using wood stick, and each hole planted two seeds. During maintenance of growth, when there was no rain for six days, then watering was applied evenly in accordance with cropping condition. Two weeks after planting, abnormal plants are cut so that there is only one plant per hole and maintained until the time of harvest. Pest and disease that attacks were controlled with insecticides, pesticides or fungicides. Plant maintenance included the activity of making fence, watering, weeding and controlling pest and disease.

The research was arranged in randomized block design (RBD) with one factor of the application of bokashi plus fertilizer with four level of treatments namely without bokashi plus fertilizer (P0), bokashi fertilizer plus 3 t ha^{-1} (P1), bokashi fertilizer plus 6 t ha^{-1} (P2) and bokashi fertilizer plus 9 t ha^{-1} (P3). Each treatment was repeated four times so that there were 16 experimental units. Peanut growth and yield components recorded were plant height, number of leaves, number of branches, number of nodules formed, total pod number, total pod filled, weight of 100 seeds, number of nodules, number of seeds per plant, total dry weight of plant, yield per ha. and LER. All variables were analyzed using analyses of variances (ANOVA), and if significant, followed by Honestly Significant Difference (HSD) with 95 percent confidence level.

RESULTS AND DISCUSSION

Components of Peanut Growth

Plant Height

Based on the results of data collected on averages of peanut plant height (cm) at 2, 4, 6 and 8 weeks after planting (WAP) in Lambiku and Pentiro villages, it showed that the higher the bokashi plus fetilizer applied the higher the penut plant height obtained. Data on the averaes of peanut plant height (cm) at 2, 4, 6 and 8 WAP in Lambiku and Pentiro villages was figured out in Table 1.

Table 1. Averages plant height (cm) of peanut in intercropped maize and peanut treated by bokashi plus fertilizer under two years teak trees at 2, 4, 6 and 8 WAP in Lambiku and Pentiro villages.

Bokashi plus fertilizer	Lambiku				Pentiro			
	2 WAP	4 WAP	6 WAP	8 WAP	2 WAP	4 WAP	6 WAP	8 WAP
0 t ha^{-1} (B0)	11,53c	18,24c	28,15b	32,77b	12,43	19,29c	29,43b	33,28c
3 t ha^{-1} (B1)	12,42bc	18,65bc	28,24ab	36,64bc	12,26	19,87bc	30,12ab	37,47bc
6 t ha^{-1} (B2)	13,12ab	19,73ab	29,53ab	41,55ab	13,14	20,05ab	31,48ab	42,96ab
9 t ha^{-1} (B3)	13,61a	20,28a	31,45a	44,16a	13,22	21,86a	32,02a	46,54a
HSD 0,05	1,21	1,30	2,24	8,20	ns	1,33	2,41	8,56

Notes : Values followed by different letter were significant different in Honestly Significant Difference (HSD) at 95% confidence level. Ns = not significant different.

Table 1 showed that the higher the doses of bokashi plus fertilizer applied, the higher the average plant height gained in Lambiku and Pentiro village, similar trend of increasing plant height was performed by increasing age of peanut plant. Moreover, rapid increase was shown in the application of 9 t ha^{-1} compared to lower doses of bokashi plus fertilizer. At 2 WAP for Lambiku village, the highest average of plant height was 13,61 cm obtained in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant different compared with 6 t ha^{-1} (B2), whilst for Pentiro village, the highest average of plant height was 13,22 cm gained in the treatment 9 t ha^{-1} (B3) but not significant compared with other treatments. At 4 WAP in Lambiku village, the highest average of plant height was 20,28 cm achieved in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not signficant different compared with 6 t ha^{-1} (B2), whilst for Pentiro village, the highest average of plant height was 21,86 cm gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2). At 6 WAP in Lambiku village, the highest average of plant height was 31,45 cm achieved in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0), but not significant different compared with 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2), whilst for Pentiro village, the highest average of plant height was 32,02 cm gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) but not significant compared with 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2). At 8 WAP in Lambiku village, the highest average of plant height was 44,16 cm achieved in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) but not signficant compared to 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2), whilst for Pentiro village, the highest average of plant height was 46,54 cm gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2).

Number of leaves

The result of research on the number of peanut leaves intercropped with maize collected in Lambiku and Pentiro villages was shown in Table 2. Table 2 showed that the significant rapid increase of the number of leaves lined with the increase of peanut plant age.

Table 2. Averages number of leaves (strands) of peanut in intercropped maize and peanut treated by bokashi plus fertilizer under two years teak trees at 2, 4, 6 and 8 WAP in Lambiku and Pentiro villages.

Bokashi plus fertilizer	Lambiku				Pentiro			
	2 WAP	4 WAP	6 WAP	8 WAP	2 WAP	4 WAP	6 WAP	8 WAP
0 t ha^{-1} (B0)	12,48	46,57c	92,47c	136,54c	12,32	46,95c	90,26c	137,12c
3 t ha^{-1} (B1)	12,13	48,15bc	94,21bc	148,75bc	12,10	48,03bc	94,03bc	145,12bc
6 t ha^{-1} (B2)	12,76	49,03ab	110,56a	167,18a	12,88	48,47ab	103,94a	154,57ab
9 t ha^{-1} (B3)	12,69	49,54a	108,45ab	162,15ab	14,09	49,38a	101,21ab	155,53a
HSD 0,05	**ns**	**2,44**	**8,71**	**18,33**	**ns**	**1,27**	**7,73**	**12,41**

Notes : Values followed by different letter were significant different in Honestly Significant Difference (HSD) at 95% confidence level. Ns = not significant different.

Table 2 showed that the higher the doses of bokashi plus fertilizer applied, the higher the average number of plant leaves gained in Lambiku and Pentiro village. At 2 WAP in Lambiku village, the highest average number of plant leaves was 12,76 strands achieved in the treatment of 6 t ha^{-1} (B2) but not significant compared with other treatments, whilst in Pentiro village, the highest average number of plant leaves was 14,09 strands achieved in the treatment of 9 t ha^{-1} (B3) but not significant compared with other treatments. At 4 WAP for Lambiku village, the highest average number of plant leaves was 49,54 strands achieved in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2), whilst in Pentiro village, the highest average number of plant leaves was 49,38 strands gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2). At 6 WAP in Lambiku village, the highest average number of plant leaves was 108,45 strands gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2), whilst in Pentiro village, the highest average number of plant leaves was 103,94 strands gained in the treatment 6 t ha^{-1} (B2) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 9 t ha^{-1} (B3). At 8 WAP for Lambiku village, the highest average number of plant leaves was 167,18 strands gained in the treatment 6 t ha^{-1} (B2) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 9 t ha^{-1} (B3), whilst in Pentiro village, the highest average number of plant leaves was 155,53 strands gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2).

Leaf Area

The result of research on peanut leaf area (cm^2) intercropped with maize collected in Lambiku and Pentiro villages was shown in Table 3. Table 3 showed that the significant rapid increase of the leaf area lined with the increase of peanut plant age.

Table 3. Averages leaves area of peanut (cm^2) in intercropped maize and peanut treated by bokashi plus fertilizer under two years teak trees at 2, 4, 6 and 8 WAP in Lambiku and Pentiro villages.

Bokashi plus fertilizer	Lambiku				Pentiro			
	2 WAP	4 WAP	6 WAP	8 WAP	2 WAP	4 WAP	6 WAP	8 WAP
0 t ha^{-1} (B0)	29,89	122,01c	274,49d	403,42c	30,73	124,54c	278,82d	415,42c
3 t ha^{-1} (B1)	30,16	127,82bc	296,00c	426,74bc	31,44	129,74bc	299,43c	432,88bc
6 t ha^{-1} (B2)	33,70	134,75ab	311,54b	452,71ab	32,65	135,52ab	318,91b	456,43ab
9 t ha^{-1} (B3)	34,86	136,02a	338,77a	465,25a	32,62	137,81a	340,24a	472,08a
HSD 0,05	ns	9,11	23,32	35,75	ns	9,42	21,56	38,72

Notes : Values followed by different letter were significant different in Honestly Significant Difference (HSD) at 95% confidence level. Ns = not significant different.

Table 3 showed that the higher the doses of bokashi plus fertilizer applied in intercropping maize and peanut, the higher the average plant leaves area gained in Lambiku and Pentiro village. At 2 WAP in Lambiku village, the highest average of plant leaves area was 34,86 cm^2 achieved in the treatment of 9 t ha^{-1} (B3) but not significant compared with other treatments, whilst in Pentiro village, the highest average of plant leaves area was 32,65 cm^2 achieved in the treatment of 6 t ha^{-1} (B3) but not significant compared with other treatments. At 4 WAP for Lambiku village, the highest average of plant leaves area was 136,02 cm^2 achieved in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2), whilst in Pentiro village, the highest average of plant leaves area was 137,81 cm^2 gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2). At 6 WAP in Lambiku village, the highest average of plant leaves area was 338,77 cm^2 gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0), 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2), whilst in Pentiro village, the highest average of plant leaves area was 340,24 cm^2 gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0), 3 t ha^{-1} (B1) and 9 t ha^{-1} (B3). At 8 WAP for Lambiku village, the highest average of plant leaves area was 465,25 cm^2 gained in the treatment

9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2), whilst in Pentiro village, the highest average of plant leaves area was 472,08 cm^2 gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2).

Stem Diameter of peanut

The result of research on peanut stem diameter (cm) intercropped with maize collected in Lambiku and Pentiro villages was shown in Table 4. Table 4 showed that the significant slight increase of peanut stem diameter lined with the increase of plant age.

Table 4. Averages stem diameter (cm) of peanut in intercropped maize treated by bokashi plus fertilizer under two years teak trees at 2, 4, 6 and 8 WAP in Lambiku and Pentiro villages.

Bokashi plus fertilizer	Lambiku				Pentiro			
	2 WAP	4 WAP	6 WAP	8 WAP	2 WAP	4 WAP	6 WAP	8 WAP
0 t ha^{-1} (B0)	0,20	0,26c	0,35c	0,38b	0,24	0,27c	0,34c	0,36b
3 t ha^{-1} (B1)	0,25	0,33bc	0,47bc	0,47ab	0,27	0,38bc	0,48bc	0,49ab
6 t ha^{-1} (B2)	0,31	0,36b	0,48b	0,49ab	0,32	0,39b	0,50b	0,51ab
9 t ha^{-1} (B3)	0,36	0,41a	0,52a	0,55a	0,38	0,42a	0,54a	0,58a
HSD 0,05	ns	0,13	0,14	0,16	ns	0,12	0,19	0,21

Notes : Values followed by different letter were significant different in Honestly Significant Difference (HSD) at 95% confidence level. Ns = not significant different.

Table 4 showed that the higher the doses of bokashi plus fertilizer applied in intercropping maize and peanut, the higher the average stem diameter area gained in Lambiku and Pentiro village. At 2 WAP in Lambiku village, the highest average stem diameter was 0,36 cm achieved in the treatment of 9 t ha^{-1} (B3) but not significant compared with other treatments, whilst in Pentiro village, the highest average of stem diameter was 0,38 cm achieved in the treatment of 9 t ha^{-1} (B3) but not significant compared with other treatments. At 4 WAP for Lambiku village, the highest average stem diameter was 0,41 cm achieved in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2), whilst in Pentiro village, the highest average stem diameter was 0,42 cm gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared with 6 t ha^{-1} (B2). At 6 WAP in Lambiku village, the highest average stem diameter was 0,52 cm gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1) but nt significant compared with 6 t ha^{-1} (B2), whilst in Pentiro village, the highest average stem diameter was 0,54 cm gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1) but nt significant compared with 6 t ha^{-1} (B2). At 8 WAP for Lambiku village, the highest average stem diameter was 0,55 cm gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0), 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2), whilst in Pentiro village, the highest average stem diameter was 0,58 cm gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0), but not significant different compared with 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2).

Number of nodules formed and Productive Branches

The result of research on the number of peanut nodules formed (nodule) and productive branches (stalks) intercropped with maize collected in Lambiku and Pentiro villages was shown in Table 5. Table 5 showed that the significant increase of the number of nodules formed and productive branches lined with the increase doses of bokashi plus fertilizer applied.

Table 5. The effects of bokashi plus fertilizer on the number of peanut nodules formed (nodule) and productive branches (stalks) at 8 WAP in Lambiku and Pentiro villages.

Bokashi Plus Fertilizer	Lambiku		Pentiro	
	Number nodules formed	Number of productive branches	Number nodules formed	Number of productive branches
0 t ha^{-1} (B0)	19,54c	6,95c	20,16c	7,60c
3 t ha^{-1} (B1)	32,63b	7,95bc	34,18b	8,10bc
6 t ha^{-1} (B2)	34,37ab	8,10ab	35,91ab	8,75b
9 t ha^{-1} (B3)	45,42a	9,00a	42,85a	9,95a
HSD 0,05	10,42	1,29	12,69	1,00

Notes : Values followed by different letter were significant different in Honestly Significant Difference (HSD) at 95% confidence level.

Table 5 showed that the higher the doses of bokashi plus fertilizer applied in intercropping maize and peanut, the higher the average number of peanut nodules formed and number of productive branches in sustainable creative agroforestry system of Lambiku and Pentiro village. In Lambiku village, the highest average number of peanut nodules formed was 45,42 nodules gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared to 6 t

ha^{-1} (B2), whilst in Pentiro village, the highest average number of peanut nodules formed was 42,85 nodules gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant different compared with 6 t ha^{-1} (B2). In Lambiku village, the highest average number of productive branches formed was 9 branches gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant compared to 6 t ha^{-1} (B2), whilst in Pentiro village, the highest average number of productive branches formed was 9,95 branches gained in the treatment 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1), but not significant different compared with 6 t ha^{-1} (B2).

Components of Peanut Yields

The yields of peanut applied by bokashi plus fertilizer in intercropped maize and peanut in two villages of Lambiku and Pentiro, Napabalano district, Muna regency. The application of organic fertilizer derived from bokashi plus and other sources of organic matter was very important to increase soil fertility significantly. During the early growth of 1-2 years teak plantation, agriculture crops could be planted between the rows of teak and other forestry trees. The increasing age of teak tree might increase stem diameter, plant height, leaf number, number of branches and leaf area. When teak trees have been reached 3-4 years of age, huge number of leaves lead to the limitation of sunlight to reach the leaves of underground annual crops, and then the growth was inhabited as explained by [1]. Yields components of peanut crops observed in this agroforestry research were limited to flowering time, 100 seeds dry weight, total dry biomass and yield of annual crops.
The results of research on the peanut yields performances in intercropped maize and peanut in sustainable creative agroforestry system for flowering time, 100 seeds dry weight, total biomass dry weight of annual crops and yield (t ha^{-1}) between the rows of 1 and 2 years teak trees in Lambiku and Pentiro villages, Napabalano district was shown in Table 6.

Table 6. The averages peanut yields on flowering time (day), total pod number, filled pod number and seed number per plant in intercropped local maize and peanut in sustainable creative agroforestry system in Lambiku and Pentiro villages

Bokashi plus fertilizer	Lambiku				Pentiro			
	Flowering Time	Total pod number	Filled pod number	Seed number / plant	Flowering Time	Total pod number	Filled pod number	Seed number/ plant
0 t ha^{-1} (B0)	33,23a	21,53c	18.76c	24,58c	32,89a	24,61b	19.72c	26,52c
3 t ha^{-1} (B1)	32,48ab	30,82b	28.06b	38,74bc	31,42ab	31,51ab	28.14bc	39,22bc
6 t ha^{-1} (B2)	31,64ab	35,54ab	33.21ab	52,73ab	31,26ab	34,85ab	32.65ab	51,43ab
9 t ha^{-1} (B3)	31,25b	39,02a	37.14a	61,72a	30,86b	38,44a	36.63a	60,66a
HSD 0,05	1,98	7,83	9.15	22,61	1,84	8,12	8.46	21,09

Notes : Values followed by different letter were significant different in Honestly Significant Difference (HSD) at 95% confidence level.

Table 6 interestingly showed that the higher the doses of bokashi plus fertilizer applied, the higher the average total pod number, filled pod number and seed number per plant except for flowering time in Lambiku and Pentiro villages. In Lambiku and Pentiro villages, the longest flowering time of peanut was 33,23 days and 32,89 days, respectively, occurred in the treatment of without fertilizer (B0) significant different compared with 9 t ha^{-1} (B3) but not significant compared to 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2). In Lambiku village, the highest average total pod number was 39,02 pods gained in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1) but not significant compared to 6 t ha^{-1} (B2), whilst in Pentiro illage, the highest average total pod number was 38,44 pods gained in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) but not significant compared to 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2). In Lambiku village, the highest average filled pod number was 37,14 pods gained in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1) but not significant compared to 6 t ha^{-1} (B2), whilst in Pentiro illage, the highest average filled pod number was 36,63 pods gained in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1) but not significant compared to 6 t ha^{-1} (B2). In Lambiku village, the highest average seed number per plant was 61,72 seed gained in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1) but not significant compared to 6 t ha^{-1} (B2), whilst in Pentiro illage, the highest average seed number per plant was 60,66 seed gained in the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0) and 3 t ha^{-1} (B1) but not significant compared to 6 t ha^{-1} (B2).

Table 7. The averages peanut yields on biomass dry weight (t ha-1), yield (t ha-1) and LER in intercropped maize and peanut in sustainable creative agroforestry system in Lambiku and Pentiro villages

Bokashi plus fertilizer	Lambiku				Pentiro			
	!00 seed dry weight (g)	Biomass dry weight (t ha^{-1})	Yield (t ha^{-1})	LER	!00 seed dry weight (g)	Biomass dry weight (t ha^{-1})	Yield (t ha^{-1})	LER
0 t ha^{-1} (B0)	29.45b	3.25b	2.14b	1,24b	30.01b	3.16b	2.23b	1,23
3 t ha^{-1} (B1)	31.29ab	3.61ab	2.31ab	1,28ab	33.44ab	3.43ab	2.42ab	1,26
6 t ha^{-1} (B2)	33.81ab	3.88ab	2.37ab	1,32ab	36.72ab	3.76ab	2.54a	1,33
9 t ha^{-1} (B3)	35.05a	4.17a	2.62a	1,37a	38.48a	4.05a	2.56a	1,36
HSD 0,05	5.02	0.79	0.21	0,11	4.65	0.81	0.22	ns

Notes : Values followed by different letter were significant different in Honestly Significant Difference (HSD) at 95% confidence level.

Table 7 showed that the highest averages of 100 seeds dry weight (g) for Lambiku and Pentiro villages was 35,05 g and 38,48 g, respectively, obtained at the treatment 9 t ha^{-1} of bokashi plus fertilizer giving significant different compared to without fertilizer (B0) but not significant different compared with 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2). The highest average s of total biomass dry weight (t ha^{-1}) of peanut in Lambiku and Pentiro was 4,17 t ha^{-1} and 4,05 t ha^{-1}, respectively, obtained at the treatment 9 t ha^{-1} of bokashi plus fertilizer giving significant different compared to without fertilizer (B0), but not significant different compared with 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2). Table 7 also showed that the highest averages of penut yield for Lambiku and Pentiro was 2,62 t ha^{-1} and 2,56 t ha^{-1}, respectively, obtained at the treatment 9 t ha^{-1} of bokashi plus fertilizer giving significant different compared to without fertilizer (B0) but not significant different compared with 3 t ha^{-1} (B1) and 6 t ha^{-1} (B2). In term of land equivalent ratio (LER), the highest ratio in Lambiku and Pentiro villages was 1,37 and 1,36, respectively, achieved at the treatment of 9 t ha^{-1} (B3) significant different compared without fertilizer (B0), but not significant compared to other treatments.

Discussion

The results of research revealed that the application of bokashi plus fertilizer gave significant and better effects on the growth and yields of peanut in interropping maize and peanut conducted in two villages of Lambiku and Pentiro that might have significant impact on the increasing farmer's income. The response of bokashi plus fertilizer on the growth components on plant height, number of leaves, leaves area and stem diameter of peanut were significant and lined with the increase of peanut yields components as figured out in Table 1, 2, 3, 4, 5, 6 and Table 7. It was shown that the farmers in the two villages were intensively participated in the research work to adapt the sustainable creative agroforestry system since it provides sufficient yield of maize and peanut, has the role and function to increase peanut growth crops cultivated under early teak growth of one to two years of age and to increase other agricultural productivity as illustrated in Table 1, 2, 3 and Table 4. This was relevant to the previous finding as reported by Silitonga, *et al*., (2018); Karimuna, *et al*., 2018 and Ma'sumah (2002), even though these results were mostly higher compared to growth and yields components of peanut in interropping system stated by Pasaribu, *et al*., (2014). During the growth and yields of peanut, the weeds grow a lot around the plant and are controlled manually, so as not to disrupt the growth of peanut crops. Peanuts grown during the study showed normal growth. By the time the plant is 4 WAP, about 80% of the peanut plant population begins to bloom. The number and size of the canopy affect the weight of the plant stalk, the more leaves and the higher the plant, the fresh weight of the shoot will be greater. The fresh weight of the shoot is also influenced by water harvesting by plants. Peanut plant growth looks normal, according to descriptions of varieties, peanut seed height between 34.23-51.00 cm, leaf number 163.8-363,20 strands, branch number 4.60-8.40 branches, greenish leaves 128.2- 291.51, leaf area 32.75-40.80 cm2 and number of root nodule 3.60 – 64.0, where some agronomic character of a plant is influenced by environment especially phenotypical character, but the expression of genes carrying certain characters can not be affected by the environment (Asnawi and Dwiwarni, 2000). The leaf area ranges from 32.75 cm^2 to 40.8 cm^2 with an average of 36.91 cm^2, while the number of leaves ranges from 163.8 to 363.2. The leaf area of a plant depends on the number of leaves, there was a tendency if the number of leaves the more the greater the leaf area. According Ma'sumah (2002) and Silitonga, *et al*. (2018), reported that leaves play a very important role for productivity a plant. The number and size of leaves was influenced by genotypes and environmental factors, such as soil, water, light and nutrients. Based on the vegetative characteristics of peanut properties in particular of stem and leaves was taller, rather slim stem diameter and wider leaves in intercropping system, eventhough they were less compact and tough especially in the demonstration plot of two years of age teak trees.

According to the results of research showed that mostly the higher the doses of bokashi plus fertilizer applied, the higher the generative peanut components intercropped maize and peanut under sustainable creative agroforestry system (Table 5, 6 and Table 7). Table 5 showed an interesting result on the total nodules formed and number of productive branches. The integration of bokashi plus fertilizer that contains not only sufficient quantity of nutrients for macro elements such as nitrogen, potasium, phosphorus, calsium, magnesium, sulphur and other microelements as determined to the results of soil analyses, but also the presence of mycorrhiza added might affect the extensive capability of root tissues to absorb high quantity of nutrients from the soils. This will result in high photosinthetic activity of green leaves occurred as photosyntate and it is then transported to the whole parts of crops. This phenomenon was in lined with findings reported by Basuki (2000) that the provision of organic materials in providing nitrogen, potassium, calcium and the availability of phosphorus element that is easily soluble in the soil is needed peanut plants for the development of pods. In addition, other findings were relevant, proclaimed by Pasaribu, *et al*., (2014); Andila, *et al*., (2016); Rahayu, *et al*., (2006) and Karimuna, *et al*., (2018), as described that the proper intercropping system of maize and peanut under early growth of teak plantation might maintain the stable production of annual crops and to keep the diversity of plant growth and yields of crops.

Looking at the generative components of peanut, predominantly the higher the doses of bokashi plus fertilizer applied, the higher the generative properties gained, except for flowering time. The highest total pod number, filled pod number, seed number per plant, 100 seed dry weight, total dry biomass, yield and LER found in Lambiku and Pentiro villages was 39,02 pods, 37,14 pods, 61,72 g, 38,44 pods, 36,63 pods, 60,66 g, 35,05 g, 4,17 t ha-1, 2,62 t ha^{-1}, 1,37, 38,48 t ha^{-1}, 4,05 t ha^{-1}, 2,56 t ha^{-1} and 1,36, respectively, gained in the treatment of 9 t ha^{-1} as shown in Table 6 and Table 7, indicating the significant effect and better response of higher doses of bokashi plus fertilizer applied that contained sufficient nutrient to the yields of peanut components. Adequate nutrients of bokashi plus fertilizer applied to the soil brought into the increase nutrients availability that contribute to form yield components of peanut, covering total pods formed, biomass dry weight, 100 seed dry weight and seed formed, even though almost all yield components were higher compared to Maesarah (2018) and Silitonga (2018). She revealed that the number of pods per plant is the principal yield component for peanut crops. The number of pods obtained in the range of 21.02 fruit and 54.88 fruit, while the void obtained in the range of 30.92 fruit to 63.84 pieces with an average of 553.52 pieces. The number of pods formed was determined by the amount of gynophores capable of penetrating the soil and capable of forming pods. The weight of pods ranged from 80.34 gram to moderate to 199.10 gram was very large. According to Maesarah (2018) stated that pod weights are categorized into very small pods (35-50 grams), small (51-65 grams), medium (65-105 grams), large (106-155 grams) and very

large (>155 grams). Basuki (2000) that the provision of organic materials in providing nitrogen, potassium, calcium and the availability of phosphorus element that is easily soluble in the soil is needed peanut plants for the development of pods.

Table 6 and Table 7 also interestingly showed that the higher the doses of bokashi plus fertilizer given to the soil under agroforestry condition, the higher the average generative peanut components of intercropped maize and peanut in Lambiku and Pentiro villages, implying high adaptability of peanut crops cultivated between the rows of early growth and teak trees. This trend was a good potential to be cultivated between the rows of early growth of teak trees in the form of agroforestry pattern in study region without interfering the normal growth of teak trees and still give a positive effect on the growth and yields of peanut in intercropping system. It was caused by the availability of sufficient nutrient contents and enough space to grow, so the competition among plants was minimized by the proper space arrangement of maize and peanut between the rows of teak trees and the soil media provide enough quantity of nutrient, water and other elements that might affect to development of well growing generative components as explained by Karimuna, *et al*., (2017) and Pasaribu, *et al*. (2014).

The results of research as shown in Table 1, 2, 3, 4, 5, 6 and Table 7 also proved to the fact that sustainable creative agroforestry as called improved agroforestry system was better response to the growth and yields of peanut in intercropping as long as the application of bokashi plus fertilizer carried out in a proper manner. Two years of teak tress so far might grow well with less interfered by the presence of peanut and maize, and intercropping maize and peanut could produce sufficient yield of crops cultivated, indicating high adaptability of such annual crops as maize and peanut and this trategy of using bokashi plus fertilizer applied to the soil leading to increase soil fertility and contribute to produce good quantity and quality of products. This approach gives better opportunity for smallholding farmers by using local natural resources of the regions to improve their soil fertilities and agricultural crops production. Therefore, the govenment policy to effectively utilize natural resources owned by local community was necessary as formerly reported by Karimuna, *et al*., 2018, revealed that the low production of annual crops such as local maize and local peanut under agroforestry practices due to low soil fertility can be overcome by the application of bokashi plus fertilizer and other organic materials. Some local ecotype of maize and peanut that have been released to the community did not yet have the level of adaptation to local conditions and is susceptible to various types of plant disease. The prominent effort has been conducted, as propounded by the American colony, but the result has not been satisfactory. This is caused by the dry climatic conditions which include a shortage of nutrient elements, sensitive to erosion and very little organic material content (Karimuna, 2000; Karimuna, *et al*., 2009; Kasno, *et al.*, 2006; Nursyamsi, 2004, Pasolon, 1998, Sopandie, 2006).

It was interested that under teak trees plantation, intercropping of maize and peanut was more beneficial compared with monocropping, indicated by the higher value of land equivalent ratio more than one (LER=1,37 in Lambiku village), as shown in Table 7. The results of research also revealed that agroforestry system which is simply practiced by the combination of crops cultivated for more than one plants in one place, has the function and importance of maintaning biological diversity and protection of soil degradation since all plants canopy might close soil surfaces that lead to stability of ecosystem landscape. It was seen that most of plants canopies in two demonstration plots were covered and soil surface was closed by all plants parts that results in the supress of weed development. This finding was similar to the previous report by Karimuna, *et al*., (2018) that agroforestry trees provide important ecosystem services including: soil, spring, stream and watershed protection; animal and plant biodiversity conservation; and carbon sequestration and storage, all of which ultimately affect food and nutritional security (Garity, 2004 and Roshetko, *et al*., 2007). This research proved to the importance of sustainable creative agroforestry system applied in the agricultural landscapes through the use of bokashi plus fertilizer integrated with the cultivation of maize and peanut in intercropping pattern between the rows of young teak trees. This approach could also be applied to other crops stands like cashew nut, palm trees, palm oil and coconut trees as along as the minimum requirement of plant growth and yields was sufficient.

Conclusion

Based on the results and discussion of research described above, it could be concluded that (1) The higher the doses of bokashi plus fertilizer applied, the higher the growth and yields of peanut cultivated in intercropped maize and peanut under one and two years of teak trees plantation. (2) the application of various doses of bokashi plus fertilizer in the village of Lambiku and Pentiro under sustainable agroforestry system had significant different and better effects on the growth and yields components of peanut in intercropping maize and peanut planted, and (3) the highest averages growth and yields peanut components treated by various doses of bokashi plus fertilizer might achieve to 2,62 t ha^{-1} and 2.54 t ha^{-1}, respectively with the optimal doses of bokashi plus fertilizer amounted to 9 t ha^{-1} with LER value 1,37, indicating beneficial effect of intercropping pattern rather than monocropping on yield crops.

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