Improvement of Maize and Peanut Production in Intercropping System Through the Application of Organic Fertilizer and Mulch in Ultisol Soil

La Karimuna[1*], Sitti Leomo[2] and Lies Indriyani[1]

[1]*Department of Agrotechnology, Faculty of Agriculture, University of Haluoleo, Kendari, HP. 081342643068*

[2]*Department of Soil Science, Faculty of Agriculture, University of Haluoleo, Kendari, HP. 0811401757*

**Corresponding author. E-mail: lkarimuna@hotmail.com*

ABSTRACT

Ultisol is the soil type that plays an important role for the smallholding farmers in tropical region, characterized by low soil fertility, low soil organic matter, low cationic exchange capacity, shallow top soil and high acidity. These soil limiting factors lead to low agriculture production earned by the farmers. The purposes of this study were to study the interaction effects between mulch and bokashi fertilizer of secondary vegetation and to determine the best response on the growth and yield of maize intercropped with peanut in Abeli district, Southeast Sulawesi, held from February to May 2010. The research was arranged in Randomized Complete Block Design (RCBD) in factorial pattern, consisting of two factors. The first factor was mulch of secondary vegetation (M) with three levels, i.e. without mulch (M0), mulch of 4 t ha^{-1}(M1) and mulch of 8 t ha^{-1}(M2). The second factor was bokashi fertilizer (B), consisting of three levels, i.e. without bokashi fertilizer (B0), bokashi fertilizer of 5 t ha^{-1}(B1) and bokashi fertilizer of 10 t ha^{-1}(B2). The variables measured were plant height (cm) of 28 and 56 days after planting, Leaf Area Index (LAI) of 28 and 56 days after planting, stem diameter (cm), bean dry weight 100 g at 14% moisture content and seed dry weight (t ha^{-1}). The results showed that the interaction between the treatment of mulch and bokashi fertilizer gave a significant effects on the yield of maize and peanut, including diameter of the cob, bean dry weight of 100 g, and pod weight of peanut. The treatment of mulch amounted to 8 t ha^{-1} with bokashi fertilizer of 10 t ha^{-1} had the highest dry weight of 100 g of maize with 22.43 g. Production of seed dry weight of maize achieved was 8.07 t ha^{-1}. For peanut, the highest seed dry weight on mulch treatment of 8 t ha^{-1} with bokashi fertilizer 10 t ha^{-1} was 2.25 t ha^{-1}. The application of bokashi fertilizer and mulch derived from secondary vegetation might double maize and peanut yield compared to control.

Key words: Mulch, Secondary vegetation, Intercropping system, Maize, Peanut

INTRODUCTION

One of the six provinces in Sulawesi island is Southeast Sulawesi province, situated in the eastern part of Indonesia covering the total area of 38.140 km^2 with various soil types found. Ultisol soil is the dominant soil type (about 60.3 percent) of the region that plays an important role for the smallholding farmers to grow various crops, characterized by such limiting factors as low soil fertility, low soil organic matter, low cationic exchange capacity, shallow top soil and high acidity (Pasolon, 1998; Karimuna, 2000), which these limiting factors lead to low agriculture production earned by the farmers (Karimuna, 2003).

Based on the recent data in 2009, the total population of Southeast Sulawesi province was 2,217,667 people and about 80 percent of population in the study region are being engaged in agriculture sector as farmer (SCB, 2010). Growing population and declining soil productivity were the predominant problems faced to be solved. Several strategies like intensification, extensification and diversification have been implemented by the government to improve agriculture production, but maximum yield of crops has not been achieved. On the other hand, sufficient yield of staple crops for human consumption has to be encouraged. Maize plays as the main staple food after rice not only for human being but also for liverstock feed industry. Then, peanut is as nutricious food needed for human, and all other part of plants can be used to improve soil fertility as organic fertilizer. Maize and peanut are the two crops that can be either planted monocropping or intercropping in order to obtain beneficial for increasing production. The productivity of maize and peanut was 0.85 t ha^{-1} and 0.4 t ha^{-1}, respectivelly that is much lower compared to potensial yield for both maize 7-8 t ha^{-1} and peanut 1.2-1.9 t ha^{-1} (Department of Agriculture, 2005).

Research findings reported that the use of organic fertilizer might alleviate the shortages of Ultisol soil through the improvement of soil physical, chemical and biological behaviours (Poerwidodo, 1992; Hardjowigeno, 2003; Karimuna, 2007). Having assumed that biotechnology application could be one the appropriate alternatives to improve soil fertility using organic fertilizer after decomposed by effective microorganism four (EM4) and the application of mulch derived from secondary vegetation dominated by *Chromolaena odorata* L. (Karimuna, 2000), which has been recognized as a plant associated with mycorrhiza (Halim, 2008). The purposes of this study were to study the interaction effects between mulch and bokashi fertilizer of secondary vegetation and to determine the best response of those treatments on the growth and yield of maize intercropped with peanut in Abeli district, Southeast Sulawesi.

MATERIALS AND METHODS

Place and time

This research was carried out at the farmer's land of Abeli village, Kendari city, Southeast Sulawesi at the elevation of about 50 m above sea level, surrounded by dominant shrubs vegetation from the three main species of *Chromolaena odorata* L., *Imperata cylindrica* L. Beauv. and *Colopogonium mucunoides* L. This research was held from from February to May 2010.

Materials and instrument

Materials used in this research were maize seed var. Bisi 2, peanut seed var. Gajah, bokashi fertilizer, mulch of secondary vegetation, EM4, water, sugar, label, and rope. The instrument used were hoe, knife, balance, sprayer, oven, camera, measurement, soil thermometer and scissor.

Experimental design

The research was arranged in Randomized Complete Block Design (RCBD) in factorial pattern, consisting of two factors. The first factor was mulch of secondary vegetation (M) with three levels, i.e. without mulch (M0), mulch of 4 t ha^{-1}(M1) and mulch of 8 t ha^{-1}(M2). The second factor was bokashi fertilizer (B), consisting of three levels, i.e. without bokashi fertilizer (B0), bokashi fertilizer of 5 t ha^{-1}(B1) and bokashi fertilizer of 10 t ha^{-1}(B2). Therefore, there were nine combinations, and evergy combination was repeated three times as block, so, there were 27 experimental units, added with six plots for monocropping maize (three plots) and peanut (three plots), so there were 33 plots in all. The variables measured were plant height (cm) of 28 and 56 days after planting, Leaf Area Index (LAI) of 28 and 56 days after planting, stem diameter (cm), bean dry weight 100 g at 14% moisture content and seed dry weight (t ha^{-1}).

Data collection and analyses

Variables recorded in this research varied for maize and peanut. For maize, the variables measured were plant height (cm) and leaf area index at 28 and 56 DAP, cob length (cm), cob diameter (cm), seed weight of 100 grains (g) and dry grain weight (t ha^{-1}), while for peanut, the variables recorded were plant height (cm) at 28 and 56 DAP, number of nodules (nodule), pod number (pod), pod weight (g), seed weight of 100 grains (g) and dry grain weight (t ha^{-1}). All variables of data recorded were tabulated using excell program and analysed with proper statistical measures of such methods as analyses of variance (ANOVA) and others. For further analyses if the F calculated value is higher than F Table (0.01 and 0.05), to determine the different among treatments, the calculation was continued using Duncan's Multiple Range Test (DMRT) with 95 confidence level.

RESULTS AND DISCUSSION

The growth and yield of maize and peanut in intercropping system was significantly affected by the application of various doses of bokashi fertilizer and mulch derived from secondary vegetation. The recapitulation results of analyses of variance was shown in Table 1. It showed that the interaction between the treatment of mulch and bokashi fertilizer gave significant effects on the yield of maize and peanut, including cob diameter and dry weight of 100 grains of maize, and pod weight of peanut, while other variables were not significant.

Table 1 also revealed that the application bokashi fertilizer and mulch either partially or interaction between them gave difference responses to the growth and yield of intercropped maize and peanut. For maize, plant height at 28 and 56 DAP and leaf area index at 56 DAP gave significant difference on the application of bokashi fertilizer and mulch, while cob diameter and seed weight of 100 grains gave very significant. Cob length of maize, plant height at 28 DAP and seed weight of 100 grains were not signicant different, while others were signficant and very significant difference after the application of bokashi fertilizer and mulch. The application of mulch and bokashi fertilizer proved to give best responses to plant growth and yield of peanut (Table 1) and gave significant difference on the variables of plant height at 56 DAP, number of nodules, pod number, pod weight and dry grain weight, while others were not significant for plant height at 28 DAP and seed weight of 100 grains.

Table 1. Recapitulation results of analyses of variance (ANOVA) on the growth and yield of intercropped maize and peanut treated by bokashi fertilizer and mulch.

Type of crop	Variables recorded	Mulch (M)	Bokashi fertilizer (B)	Interaction (M*B)
Maize	a. Plant height			
	- 28 DAP	*	*	ns
	- 56 DAP	*	*	ns
	b. Leaf area index			
	- 28 DAP	ns	ns	ns
	- 56 DAP	*	*	ns
	c. Cob length	ns	ns	ns
	d. Cob diameter	**	**	*
	e. Seed weight of 100 grains	ns	**	*
	f. Dry grain weight	ns	*	ns
Peanut	a. Plant height			
	- 28 DAP	ns	ns	ns
	- 56 DAP	*	*	ns
	b. Number of nodules	*	**	ns
	c. Pod number	*	**	ns
	d. Pod weight	*	**	**
	e. Seed weight of 100 grains	ns	ns	ns
	f. Dry grain weight	*	**	ns

Note: DAP = days after planting
ns = non significant difference
* = significant difference
** = highly significant difference

Maize

The interaction between various doses of mulch and bokashi fertilizer on the growth and yield of maize was occurred on the variables of cob diameter and seed weight of 100 grains as shown in Table 2 and Table 3, respectively.

Table 2. Effects of interaction between various doses of mulch and bokashi fertilizer on cob diameter of maize (cm).

Mulch (M)	Bokashi fertilizer (B)			$DMRT_{0.05}$
	Without bokashi fertilizer (B0)	5 t ha^{-1} (B1)	10 t ha^{-1} (B2)	
Without mulch (M0)	4.50 c r	4.70 b q	5.20 b p	-
4 t ha^{-1} (M1)	4.90 b r	5.10 a q	5.30 b p	2 = 0.11
8 t ha^{-1} (M2)	5.10 a r	5.20 a q	5.40 a p	3 = 0.12

Note: Values followed by different letter at the same column (a-c) and row (p-r) were significant differences at DMRT of 95 confidence level.

Table 2 showed that the higher, the level of mulch and bokashi fertilizer applied, the more the cob diameter of maize produced. The highest cob diameter was 5.40 cm obtanied at the treatment of 8 t ha^{-1} (M2) combined with 10 t ha^{-1} of bokashi fertilizer (B2). The good performance growth and yield of intercropped maize and peanut as figred out at Table 2 and Table 3. This was caused by the quantity of nutrients and nutrient balance derived from the treatment bokashi fertilizer and provision of microclimate condition due to the availability of mulch on the surface of soil.

Table 3. Effects of interaction between various doses of mulch and bokashi fertilizer on maize seed weight of 100 grains (g).

Mulch (M)	Bokashi fertilizer (B)			$DMRT_{0.05}$
	Without bokashi fertilizer (B0)	5 t ha^{-1} (B1)	10 t ha^{-1} (B2)	
Without mulch (M0)	16.66 a p	17.43 a p	16.86 b p	-
4 t ha^{-1} (M1)	16.76 a q	18.45 a pq	21.08 a p	2 = 2.92
8 t ha^{-1} (M2)	16.93 a p	19.25 a q	22.43 a p	3 = 3.07

Note: Values followed by different letter at the same column (a-c) and row (p-r) were significant differences at DMRT of 95 confidence level.

Table 3 revealed that the higher, the level of mulch and bokashi fertilizer applied, the more the seed weight of 100 gains of maize produced. Table 3 also showed that the treatment of mulch amounted to 8 t ha^{-1} with bokashi fertilizer of 10 t ha^{-1} had the highest dry weight of 100 g of maize with 22.43 g that was significantly different compared to others.

Effects of various doses of bokashi fertilizer and mulch derived from secondary vegetation on the different variables of growth and yield of maize at the intercropped maize and peanut varied as shown in Table 4.

The higher, the level of mulch and bokashi fertilizer applied, the more the vaiables of peanut produced. Table 4 showed that the highest levels of mulch treatment (8 t ha^{-1}) and bokashi fertilizer (10 t ha^{-1}) gave the best response for all variable of maize growth and yield. There were statistically significant differences of maize plant height at 28 and 56 DAP, leaf area index at 56

DAP treated by mulch and bokashi fertilizer in intercropped maize and peanut. The highest plant height of maize at 56 DAP (226.71 m) was obtained at the treatment of 10 t ha^{-1} bokashi fertilizer, significantly different compared to without bokashi fertilizer. This trend was similar to variables of cob diameter and seed weight of 100 grains of maize, while the application of mulch had non significant difference on leaf area index at 28 DAP, cob length and seed grain weight of maize, and the treatment of bokashi fertilizer gave non significant different on leaf area index at 28 DAP, cob length and seed weight of 100 grains of maize (Table 4). Average production of seed dry weight of maize achieved was 8.07 t ha^{-1}, while there was a trend of good yield of maize obtained at the mulch treatment of 8 t ha^{-1} (8.49 t ha^{-1}) and 10 t ha^{-1} of bokashi fertilizer (8.32 t ha^{-1}) that was higher compared to the potensial yield of maize, as illustrated in Table 4.

Table 4. Effects of various doses of mulch and bokashi fertilizer on plant height (cm) at 28 and 56 DAP, leaf area index at 28 and 56 DAP, cob length (cm), cob diameter (cm), seed weight of 100 grains (g) and seed dry weight of maize (t ha^{-1}).

Treatment	Plant height (cm)		Leaf Area Index (cm^2)		Cob length (cm)	Cob diameter (cm)	Seed weight of 100 grains (g)	Seed dry weight (t ha^{-1})
	28 DAP	56 DAP	28 DAP	56 DAP				
Mulch (t ha^{-1})								
0	43.53 b	183.67 b	0.24	1.32 b	17.49	4.80 b	17.36 b	6.27
4	52.90 ab	202.19 a	0.36	1.83 ab	18.86	5.07 ab	19.15 ab	7.08
8	56.47 a	214.23 a	0.48	2.07 a	19.02	5.89 a	21.95 a	8.49
$DMRT_{0.05}$	-	-	-	-	-	-	-	-
- 2 =	9.53	25.36	-	0.65	-	0.75	2.96	-
- 3 =	10.05	27.08	-	0.74	-	0.85	3.02	-
Bokashi fertilizer (t ha^{-1})								
0	45.97 b	198.24 b	0.34	1.52 b	19.03	4.89 b	18.45	6.74 b
5	53.37 a	207.37 ab	0.41	1.96 ab	19.83	5.27 ab	20.49	7.98 ab
10	57.57 a	226.71 a	0.55	2.25 a	20.34	5.78 a	21.56	8.32 a
$DMRT_{0.05}$	-	-	-	-	-	-	-	-
- 2 =	9.66	26.11	-	0.68	-	0.76	-	1.25
- 3 =	10.12	27.42	-	0.75	-	0.89	-	1.37

Note: Values followed by different letter at the same column (a-c) were significant differences at DMRT of 95 confidence level.

Peanut

There was an interaction between the treatment of mulch and bokashi fertilizer on the dry pod weight of peanut as shown in Table 5.

Table 5. Effects of interaction between various doses of mulch and bokashi fertilizer on dry pod weight of peanut (g).

Mulch (M)	Bokashi fertilizer (B)			$DMRT_{0.05}$
	Without bokashi fertilizer (B0)	5 t ha^{-1} (B1)	10 t ha^{-1} (B2)	
Without mulch (M0)	17.73 b q	20.30 b q	28.93 a p	-
4 t ha^{-1} (M1)	21.19 ab q	23.95 b q	31.23 a p	2 = 3.47
8 t ha^{-1} (M2)	21.48 a p	31.81 a p	33.81 a p	3 = 3.64

Note: Values followed by different letter at the same column (a-c) and row (p-r) were significant differences at DMRT of 95 confidence level.

Table 5 revealed that the higher, the level of mulch and bokashi fertilizer applied, the more the dry pod weight of peanut produced. Table 5 also showed that the treatment of mulch amounted to 8 t ha^{-1} with bokashi fertilizer of 10 t ha^{-1} had the highest dry pd weight of peanut produced with 33.81 g that was significantly different compared to others.

Effects of various doses of bokashi fertilizer and mulch derived from secondary vegetation on the different variables of growth and yield of peanut at the intercropped maize and peanut varied as shown in Table 6.

Table 6. Effects of various doses of mulch and bokashi fertilizer on plant height (cm) at 28 and 56 DAP, number of nodules (nodules), pod number (pods), pod weight (g), seed weight of 100 grains (g) and seed dry weight of peanut (t ha^{-1}).

Treatment	Plant height (cm)		Number of nodules	Pod number (pods)	Pod weight (g)	Seed weight of 100 grains (g)	Seed dry weight (t ha^{-1})
	28 DAP	56 DAP					
Mulch (t ha^{-1})							
0	14.33	51.24 b	62.22 b	18.48 b	24.87	26.95	1.84 b
4	15.83	51.51 b	65.57 ab	18.53 b	25.26	27.26	2.12 ab
8	16.40	58.24 a	74.51 a	20.50 a	27.59	30.87	2.31 a
$DMRT_{0.05}$	-	-	-	-	-	-	-
- 2 =	-	4.79	9.81	1.65	-	-	0.288
- 3 =	-	5.02	10.29	1.73	-	-	0.296
Bokashi fertilizer (t ha^{-1})							
0	15.50	50.61 b	54.29 b	16.47 c	22.22	27.68	1.854 b
5	16.27	53.38 ab	69.69 a	18.59 b	26.85	28.94	2.153 ab
10	17.04	57.01 a	78.32 a	22.46 a	30.66	31.74	2.377 a
$DMRT_{0.05}$	-	-	-	-	-	-	-
- 2 =	-	4.79	9.81	1.65	-	-	0.312
- 3 =	-	5.02	10.29	1.73	-	-	0.327

Note: Values followed by different letter at the same column (a-c) were significant differences at DMRT of 95 confidence level.

It was also realized that the higher the level of mulch and bokashi fertilizer applied, the more the variables of peanut growth and yield produced. Table 6 showed that the highest levels of mulch treatment (8 t ha^{-1}) and bokashi fertilizer (10 t ha^{-1}) gave the best response for all variables of peanut growth and yield. There were statistically significant differences of peanut plant height at 56 DAP, number of nodules, pod number and seed dry weight, after treated by mulch and bokashi fertilizer in intercropped maize and peanut. The highest plant height of peanut at 56 DAP (58.24 m) was obtained at the mulch treatment of 8 t ha^{-1} that was significantly different compared to without mulch. However, the application of various doses of mulch and bokashi fertilizer gave non significant difference on plant height at 28 DAP, pod weight and seed weight of 100 grains of peanut (Table 6). Average yield of seed dry weight of peanut achieved was 2.25 t ha^{-1}, while there was a trend of good yield of peanut obtained at the mulch treatment of 8 t ha^{-1} (2.31 t ha^{-1}) and 10 t ha^{-1} of bokashi fertilizer (2.38 t ha^{-1}) that was higher compared to the potensial yield of peanut (only 1.6 t ha^{-1}), as shown in Table 6.

The applications of mulch and bokashi fertilizer have an effect partially or interactively on the growth and yield of maize and peanut in intercropping system. In this research work, there was an interaction effect between mulch and bokashi fertilizer on variables recorded (Table 2, 3 and 5). The higher the level of mulch and bokashi fertilizer applied, the more the cob diameter of maize produced (Table 2), the seed weight of 100 grains of maize (Table 3), and the dry pod weight of peanut (Table 5). This finding revealed that there was a sinergism effect on both factors treated, the limitation from mulch factor could be fulfilled from bokashi fertilizer. Mulch treatment plays an important role to protect a plant from high temperature and create good microclimate to support plant growth (Hakim, 1986), and after mulch decomposed may contribute to increase soil fertility (Histiani, 2005). In addition, bokashi fertilizer provides sufficient organic material that contains macro and micro nutrients to improve soil chemical condition which then be used for plant growth and yield (Rinsema, 1986; Karimuna, 2006a, 2007).

The results of research showed that the treatment of various doses of mulch and bokashi fertilizer derived from secondary vegetation had an effect on the growth and yield of maize (Table 4) and peanut (Table 6) in intercropping system. Interestingly is that for all variables recorded the higher the doses of mulch and bokashi fertilizer applied, the more the production of maize and peanut growth and yield achieved (Table 4 and Table 6). This research proved that mulch might increase soil permeability, develop good soil structure and maintain microclimate condition that could be considerably noted compared with the treatment without mulch (Hakim, 1986; Haverkort, 1992; Karimuna et al., 2009). Moreover, research finding also indicated that higher level of bokashi fertilizer provided sufficient nutrients and reached nutrient balance that promotes photosynthesis running in proper way, and sustain the allocation and distribution of nutrient to all parts of maize and peanut tissues. Then, the effects of much and bokashi fertilizer on plant growth of maize and peanut, and on yield of maize and peanut varied. This finding was similar to the results reported by Setyamidjaja (1986), Hardjowigeno, 2003; Histiani (2005), Karimuna (2006b) and Karimuna et al. (2009). Selection of a crop cultivated in a certain area determines the sustainability of high production either planted monocropping or intercropping. Maize and peanut are two crops of suitable option which can be more advantageous to cultivate in intercropping system, since peanut is a legume crop that may contribute nutrient through Nitrogen fixation to the soil. The arrangement of crop space for maize and peanut properly in intercropping system may increase soil efficiency (Turmudi, 2002). It could be summarized that the application of bokashi fertilizer and mulch derived from secondary vegetation had significant effects and better responses on the improvement of maize and peanut production, and it might doubled improve maize and peanut yield compared to control.

CONCLUSION AND RECOMMENDATIONS

Based on the results and discussions above, it could be concluded and recommended as follows:

1. The interaction between mulch treatment and bokashi fertilizer gave significant effects on the yield of maize and peanut, including cob diameter, 100 seed dry weight, and peanut pod weight.

2. The combination treatment 8 t ha^{-1} of mulch and 10 t ha^{-1} of bokashi fertilizer gave the best response to 100 maize seed dry weight which amounted to 22.43 g. The highest yield of maize in this combination was 8.07 t ha^{-1}, and for peanut, the highest yeild of peanut produced at the combination of 8 t ha^{-1} of mulch and 10 t ha^{-1} was 2.25 t ha^{-1}.

3. In oder to improve agricultural production of maize and peanut in intercropping systems, the combination of 8 t ha^{-1} of mulch and 10 t ha^{-1} of bokashi fertilizer is needed derived from secondary vegetation.

REFERENCES

Department of Agriculture. 2005. Cultivation guidance for rice, beans and vegetables. Society Guiding Control Unit, Jakarta, Indonesia.

Hakim, N. 1986. Introduction to soil science. University of Lampung, Lampung province.

Halim. 2008. Exploration of weed indigenous micorrhyza. Faculty of Agriculture, University of Haluoleo, Kendari.

Hardjowigeno, S. 2003. Soil science. Akademika Pressindo, Jakarta.

Haverkort, B. 1992. Agriculture for the future. Kanisius, Jakarta.

Histiani. 2005. Efficiency test of various bokashi fertilizers and SP-36 doses on the growth and yield of peanut (*Arachis hypogaea* L.) local variety from Muna. B.Sc. Thesis. Faculty of Agriculture, University of Haluoleo, Kendari.

Karimuna, L., 2000. Floristic composition and biomass of fallow vegetation in abandoned agricultural field of Southeast Sulawesi. Georg-August-University Goettingen, Goettingen.

Karimuna, L. 2003. The role of organic farming on the improvement of agriculture production in Southeast Sulawesi, Indonesia. Published in book of abstracts Tropentag 2003. University of Goettingen.

Karimuna, L. 2006a. Increasing high and sustainable agricultural production through appropriate technology implementation in supporting development of agribusiness/agro-industry at Southeast Sulawesi. 19 August 2006.

Karimuna, L. 2006b. Study of secondary vegetation treated as bokashi on the intercropped maize and soybean of smallholding farmers land in Southeast Sulawesi, Indonesia, Tropentag 2006. 11-13 Oct 2006. Bonn, Germany.

Karimuna, L. 2007. Optimization use of organic fertilizer derived from secondary vegetation as bokashi in supporting National Food Security. National Seminar on Natural Resource Management of Southeast Sulawesi Region. 2 April 2005. Kendari.

Karimuna, L., S. Leomo, and L. Indriyani. 2009. Applications of mulch technology and bokashi fertilizers derived from secondary vegetation on the growth and yield of intercropped maize and peanut in Abeli Village. Department of Agrotechnology, Faculty of Agriculture, Science and Art Technology Application Program, Institution of Extension Services, University of Haluoleo, Kendari.

Pasolon, Y.B. 1998. Concepts and strategies for agriculture development in supporting regional food stability. Upland Study Center, Institution of Research, University of Haluoleo, Kendari.

Poerwidodo. 1992. Studies of soil fertility. Angkasa, Bandung.

Rinsema, W.J. 1986. Fertilizer and fertilization methods. Bhrata Aksara, Jakarta.

Setyamidjaja, D. 1986. Fertilizer and Fertilization. Simplex, Jakarta.

Statistic Center Board (SCB). 2010. Plant production survey of rice, beans, vegetables and fruits in Southeast Sulawesi province, Statistic Center Board, Southeast Sulawesi, Kendari.

Turmudi, E. 2002. Studies on the growth and crop development of intercropped maize and four bean cultivars in various crop spacings. Journal of Indonesian Agriculture Sciences 4(2): 89-96.