NUTRIENT BALANCE AND POTENTIAL OF ORGANIC WASTE AS A SOURCE OF ORGANIC FERTILIZER IN INDONESIA

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1. Introduction

"Green Revolution" has dramatically increased food crops productivity by large usage of chemical fertilizers in South East Asian Countries from 1960's to 1980's. However, unbalanced usage of chemical fertilizers has caused declining of organic matter in soil and micro-nutrients deficiency[1]. Since 2008, Indonesian government has encouraged farmers to use organic fertilizer and reduce the amount of chemical fertilizers. Typically, the organic fertilizer is derived from organic waste such as livestock manure, agricultural waste and biodegradable solid waste in Indonesia. However, there is little information about potential of nutrient supply from organic fertilizer. The aim of this study is to estimate potential amount of organic fertilizer from various waste sources and nutrients (nitrogen, phosphate and potassium) balance.

2. Research Method

2.1. Study Area

The location of this study is Sukabumi District in West Java Province, Indonesia. The contribution of agriculture to total Gross Domestic Regional Product of this area in 2007 is 33.2%[2].

2.2. Estimation of Current Nutrients Usage

Statistical sources and literature references were used in this study and average data during five years (2005-2009) were used. In Indonesia, the supply of chemical fertilizers to farmers are controlled by the Indonesian Government. The government subsidizes the production and distribution costs of the chemical fertilizers. The chemical fertilizers consumption in Sukabumi District and the nutrient contents are shown in Table 1. The nutrient contents in the fertilizers were obtained from the supply companies and nutrient content standard of chemical fertilizer according to Indonesian National Standard. The amount of required nutrients for farmlands was estimated based on the guideline for seven food crops and ten vegetables. The current usage of potassium chloride (KCl) and organic fertilizers in the area was estimated from the survey by interviewing to 100 farmers.

Table 1. The average consumption of chemical fertilizers in Sukabumi District (2005-2009)[3] and nutrient contents

Type of Fertilizer	Average Consumption (t/year)	Nutrient content (%)		
		N	P_2O_5	K_2O
Urea	49,766	46	0	0
ZA	2,054	21	0	0
SP-36	5,887	0	36	0
SP-18	2,262	0	18	0
NPK Phonska	6,221	15	15	15
NPK Kujang	359	30	6	8
NPK Bintang Kuda Laut	157	15	7	8
NPK Elang Biru	155	20	8	6
NPK Raja	155	18	7	7
KCl	1,802	0	0	60

2.3. Estimation of Potential Amount of Nutrients from Organic Waste

The potential amount of nutrients from organic waste was estimated from three types of organic waste such as livestock manure, agricultural waste and municipal solid waste because those are usually used as the sources of organic fertilizer in Sukabumi District. Table 2 shows the number of livestock in Sukabumi, manure generation rate and nutrient content in manure. Table 3 shows the agricultural waste generation and nutrient contents. The amount of agricultural waste generation was calculated by waste generation rates. In this study, five major crops were considered because of limited available data. The amount of organic municipal solid waste (MSW) was estimated by MSW generation amount. The average of waste generation was 365,822 m^3/year (2005-2009) in Sukabumi[2]. In this study, it was assumed that 1.0 m^3 of solid waste equal to 0.25 ton, and 70% of municipal solid waste is organic material[8]. The nutrient content in organic MSW was used by a reference[9] (2.25% N, 1.15% P_2O_5 and 2.43% K_2O). During the composting process, nutrient loss was considered and the ratios were 31.2% for N, 4.4% for P_2O_5 and 11.4% for K_2O in raw organic waste[10].

Table 2. The number of livestock in Sukabumi (2005-2009), manure generation rate and nutrient contents

Type of livestock	The number of livestock (head)[2]	Manure generation (dry-kg $head^{-1}$ day^{-1})[4]	Nutrient content in manure (wet-%)[5]		
			N	P_2O_5	K_2O
Beef cattle	14,815	4.40	0.60	0.15	0.45
Dairy cattle	4,415	4.40	0.60	0.15	0.45
Buffalo	12,203	5.80	0.60	0.30	0.34
Goat	60,898	0.30	0.95	0.35	1.00
Sheep	430,211	0.30	0.75	0.50	0.45
Chicken	9,099,474	0.05	1.00	0.80	0.40
Duck	99,407	0.06	1.00	0.80	0.40

Table 3. Agricultural waste generation (2005-2009) and nutrient contents

Type of Crop	The average production (t/year)[2]	Residue	Waste generation rates[6]	Nutrient content (dry-%)[7]		
				N	P_2O_5	K_2O
Rice	738,537	Husk	0.267	0.64	0.05	2.00
		Straw	1.757	0.48	0.11	0.26
Maize	26,218	Stalk	2.000	0.81	0.37	1.61
		Cob	0.273	0.33	0.11	0.62
Groundnut	11,866	Husk	0.477	1.73	0.37	1.27
		Straw	2.300	1.30	0.37	1.31
Soybean	1,516	Straw	2.500	1.28	0.14	1.63
Coconut	13,295	Husk	0.419	0.95	0.14	1.32

Result and Discussion

Figure 1 shows an amount of nitrogen applied to the farmlands in Sukabumi and a potential amount of nitrogen derived from organic fertilizers. Currently, 26,774 ton of nitrogen has been applied to farmlands a year and 91% of it is supplied by the chemical fertilizer. The amount of potential nitrogen derived from the organic fertilizers was estimated as 9,524 ton/year. This result suggests that 49% of the chemical fertilizer could be replaced by the organic fertilizer, however still 51% of nitrogen should be applied by the chemical fertilizers.

Figure 2 shows the current applied amount of P_2O_5 and its potential amount derived from organic fertilizers. It is found that around 1,600 ton of P_2O_5 applied by chemical and organic fertilizers was insufficient compared to the requirement amount. When all potential amount of organic waste is used for organic fertilizer, 95% of P_2O_5 derived from the chemical fertilizers could be reduced.

In case of potassium (Figure 3), only 50% of potassium is applied to farmlands compared to the required amount. However, there is a large potential amount of potassium in the organic waste and the amount is enough to replace all of potassium derived from the chemical fertilizers.

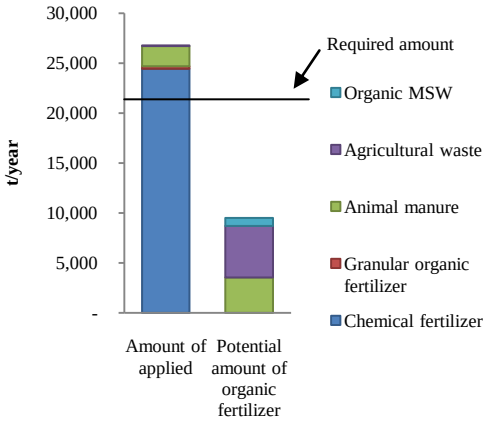

Figure 1. Nitrogen balance

Conclusion

The current amount of nitrogen applied to farmlands is sufficient compared to the required amount, however phosphate and potassium are insufficient. When all of organic waste is used to organic fertilizer, it is expected that 9,524 ton of N (49%), 3,357 ton of P_2O_5 (95%), and 2,076 ton of K_2O (100%) derived from the chemical fertilizers could be reduced. However, a part of organic waste has been already utilized as other resources such as feed for livestock. Therefore, in the future research, the available amount of organic waste should be estimated. This result can be beneficial to design the fertilizer distribution system and to improve agricultural productivity in Indonesia.

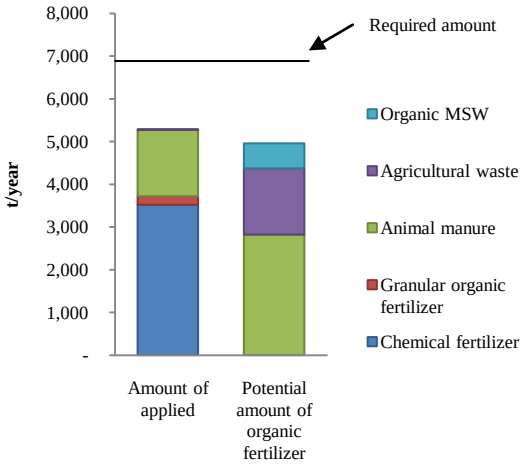

Figure 2. Phosphate balance

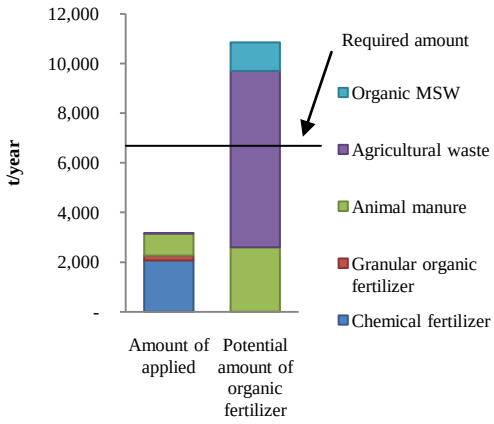

Figure 3. Potassium balance

References

1) Rochayati, S. and Husnain. 2010. Fertilizer management for improving lowland sawah productivity in Indonesia: Integrated plant nutrient management system. Paper presented on International Conference of "Balance Nutrient Management for Tropical Agriculture", 12-16th April 2010, Malaysia.
2) Centre Statistic Bureau of Sukabumi District. Statistical Yearbook of Sukabumi District from 2006 to 2010 (in Indonesian).
3) Agricultural Office of Sukabumi District. Annual Report from 2006 to 2010 (in Indonesian).
4) Devendra, C. 1993. Sustainable animal production from small farm systems in South-East Asia. FAO Animal Production and Health Paper 106. Rome.
5) Sutejo, M.M. 1987. Fertilizer and Fertilizing. Penerbit Rineka Cipta. Jakarta. 177p. (in Indonesian)
6) Koopmans, A. and J. Koppejan. 1997. Agricultural and forest residues generation, utilization and availability. Paper presented at the Regional Consultation on Modern Applications of Biomass Energy, 6-10 January 1997 in Kualalumpur, Malaysia.
7) Hsieh, S.C. and C.F. Hsieh. 1990. The use of organic matter in crop production. 315:1-19. Taiwan, ROC: Thaicung District Agricultural Improvement Station.
8) Mangkudihardjo, S. *et al.* 2007. Priority improvement of solid waste management practice in Java. Journal of Applied Sciences in Environmental Sanitation, 2 (1): 29-34.
9) Budirahardjo, M.A. 2006. Study about the potenty of municipal waste composting as one of alternative waste management at the landfill by using EM4 (Effective Microorganism) as the activator. Jurnal Presipitasi, 1(1):25-30 (in Indonesian).
10) Eghball, B. *et al.* 1997. Nutrient, carbon, and mass loss during composting of beef cattle feedlot manure. J. Environ. Qual. 26:189-193.