Journal of Socioeconomics and Development
Vol 1, No 2, October 2018, 100 – 105
DOI: 10.31328/jsed.v1i2.603

The Economic Feasibility of Sweet Potatos Farming by Using Selected N Fertilization

Dian Adi Anggraeni Elisabeth[1*], Erliana Ginting[1], and Joko Restuono[1]

[1] Indonesian Legumes and Tuber Crops Research Institute

(Received September 24, 2018; accepted October 3, 2018; published December 8, 2018)

ABSTRACT. Sweet potato is normally cultivated in wet land after rice or in dry land during rainy season. N fertilization is commonly applied to increase sweet potato yield. Therefore, the economic feasibility of using selected N fertilizer in sweet potato farming in dry land was studied. Three improved varieties, namely Jago (white-fleshed), Beta 2 (orange-fleshed), and Antin 2 (purple-fleshed) were grown at the Experimental Station of Muneng, East Java and treated with six N fertilization as follows: F1= 0 N fertilization as a check; F2= 50 kg/ha of Urea; F3= 100 kg/ha of Urea; F4= 100 kg/ha of ZA; F5= 200 kg/ha of ZA; and F6= 5,000 kg/ha of manure. The treatment is assumed to be economically viable if the value of Marginal Benefit Cost Ratio (MBCR) is greater than 1. The results showed that the combination of F2 with Beta 2, F3 with Antin 2, and F5 with Beta 2 were viable with the MBCR value of 17.13, 25.85, and 11.61, respectively. Although the data was limited, the study tentatively concludes that profitable N fertilization for sweet potato farming considerably depends on differences in yield, N fertilizer source and dose, as well as selling price of particular variety.

Keywords*: feasibility analysis, sweet potato farming, N fertilizer, improved varieties*

JEL Classification: C93, D24, Q12

INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) as a food crop has been long cultivated in Indonesia. About 89% of sweet potato production is used for foods, particularly traditional foods (snacks) and to a lesser amount for ingredient of sauce industry. In particular, sweet potato is consumed as a staple food in Papua. The harvested area of sweet potato in Indonesia in 2014 was about 156.8 thousand ha with the total production of 2.38 million ton and productivity 15.2 ton/ha (BPS, 2016). This gave Indonesia as the fourth rank of sweet potato producer worldwide. This production is yet possible to be increased as the application of appropriate cultivation technologies, including high-yielding varieties may raise the productivity as high as 20-30 ton/ha (Jusuf & Ginting, 2014). The high sweet potato production would has great impacts in terms of generating farmers' income.

Currently, the development of sweet potato food products with regard to supporting food diversification program is intensively performed. This considerably will require guaranteed supply of fresh sweet potato as an ingredient. The application of appropriate cultivation techniques, particularly the use of recommendation fertilizers and improved varieties therefore is essential to increase sweet potato production. A number of high-yielding improved sweet potato varieties (> 25 ton/ha) with different flesh colors have been released by Indonesian Ministry of Agriculture (Indonesian Legumes and Tuber Crops Research Institute, ILETRI), 2016) and needs to be adopted by farmers and utilized by industries. This includes the white-fleshed variety, namely Sukuh, Shiroyutaka, and Jago (25-30 ton/ha), Beta 1, Beta 2, and Beta 3 (orange-fleshed varieties) that are rich in beta-carotene (34-35 ton/ha) as well as Antin 2 and Antin 3 (purple-fleshed varieties) with high anthocyanin content(130.2 mg and 150,7 mg/100 g fresh weight, respectively) and yield of 30-37 ton/ha. Antin 2 is also drought tolerance and

[*] Corresponding author email: dian.elisabeth21@gmail.com,
ISSN 2615-6075 online; ISSN 2615-6946 print
@UWG Press, 2018
OJS http://publishing-widyagama.ac.id/ejournal-v2/index.php/jsed/

that is suitable for upland farming. In Malang area, East Java province, the price of purple-fleshed sweet potato is double if it is compared to that of white and orange-fleshed sweet potatoes (Ginting, Utomo, & Yulifianti, 2014). Therefore, it is an attractive point for farmers to cultivate these improved varieties with respect to their high yielding capacities and high price in the market.

Sweet potatos is commonly cultivated in upland during the rainy season or in wet land after rice. Sweet potato cultivation in the upland is predominantly done by farmers in Indonesia. Recommended fertilizer application for sweet potato includes 45 kg of N, 30 kg of P_2O_5 and 60 kg of K_2O (Indonesian Legumes and Tuber Crops Research Institute, ILETRI), 2012) and is similar for most of sweet potato cultivars. However, (Villagarcia, 1998) reported the differences in N utilization and N uptake exhibited by sweet potato cultivars and environment. Previous studies showed that NPK fertilization increased the yield and nutrient contents of horticulture, cereals, legumes, tubers as well as oilseed crops (Wang, Li, & Malhi, 2007; Shaaban & Kisetu, 2014). N fertilization significantly increases the tuber yield of sweet potato (Jett & Mulkey, 1996). However, the excessive use of N fertilizer would increase nitrat residue in the fresh tuber and be a contamination source of underground water that is normally used for drinking water (Bundy & Andraski, 2005; Abah, Akan, Uwah, & Ogugbuaja, 2008).

Other previous study revealed that N fertilizer had negative effect on sweet potato yield grown on sandy soil in the humid lowland of Papua New Guinea although in many tropical soils, sweet potato yield might be increased using inorganic fertilizers (Hartemink, Johnston, O'Sullivan, & Poloma, 2000). The use of 300 kg/ha of NPK fertilizer for local cultivars of Irish potato on an ultisol of Morogoro, Tanzania significantly increased the tuber yield as well as net benefit and benefit cost ratio based on the partial budget analysis (Shaaban & Kisetu, 2014). However, the information on appropriate sources and doses of N fertilization to increase sweet potato production in upland as well as the economic feasibility for its application at farm level is yet lacking. Therefore, this study was performed to obtain the effect of the different sources and doses of N fertilization on yields of selected improved sweet potato varieties and to analyze their responding economic feasibility.

RESEARCH METHOD

This study was conducted at the Experimental Station of Muneng, Probolinggo Regency, East Java during the first dry season of 2015. The trial was a split plot design, with three replicates. The main plot was sweet potato varieties, namely Jago (white-fleshed), Beta 2 (orange-fleshed), and Antin 2 (purple-fleshed) and six N fertilization as the split plot as follows: F1= 0 N fertilizer as a check; F2= 50 kg/ha of Urea; F3= 100 kg/ha of Urea; F4= 100 kg/ha of ZA; F5= 200 kg/ha of ZA; and F6= 5,000 kg/ha of manure.

Sweet potatos were planted in a plot sized of 4 m x 5 m (20 m^2) with spacing of 100 cm x 25 cm (4 rows x 20 holes). About100 kg/ha of SP36 + 100 kg/ha of KCl were applied as basic fertilizers that were similar to that control treatment. At harvest time (the age of 4 to 4.5 months), the number of tubers and weight of fresh tubers in each harvest plot (3 rows of mound along 5 m) were calculated. The economic feasibility of sweet potato farming by using selected N fertilization was also observed. The data collected were tuber yield, total variable costs, and the benefit. The revenue or gross benefit was calculated as tuber yield (kg/ha) x field price that farmers receive for the sale of tubers per kg. The total variable cost was calculated as the sum of all production cost issued for the farm. The net benefit or marginal return was calculated by subtracting total variable costs from gross benefit.

The feasibility of sweet potato farming was analyzed by using Marginal Cost Benefit Ratio (MBCR). MBCR is a ratio between net benefit and marginal cost (FAO, 1990). The mathematical equation for calculating MBCR is:

$$MBCR = (Bt1-Bt0)/(ICt1-ICt0),$$

where

Bt1 = the benefit of the new technology (sources and doses of N fertilizers),
Bt0 = the benefit of the previous technology (without N fertilization; used as a control),
ICt1 = the treatment input cost of the new technology,

ICt0 = the treatment input cost of the previous technology

If MBCR value is less than 1, the selected N fertilization is economically not viable to be developed. Otherwise, if it is greater than 1, the selected N fertilization is economically viable to be developed.

RESULT AND DISCUSSION

Based on the analysis of variance, the interaction of varieties and N fertilization had no significant effect on the productivity of sweet potato. Among three varieties, Beta 2 showed the highest productivity, i.e. 53.34 kg/plot, 63.9% and 369.8% higher than those of Jago and Antin 2, respectively. The highest productivity of Beta 2 due to the highest number of tubers per plot and vice versa for Antin 2 (Table 1).

Table 1. The Effect of Improved Varieties on Tuber Yield of Sweet Potato

Improved variety	Number of tubers per plot	Weight of tubers per plot (kg)
Jago	100[b]	31.93 [b]
Antin 2	73 [c]	11.14 [c]
Beta 2	293 [a]	53.34 [a]

Different letter(s) in each column indicate(s) significant difference at p = 0.05

N fertilization sources and doses had no significant effect on the productivity of sweet potatos (Table 2). The result was in line with the study of (Hartemink et al., 2000) where N fertilizer failed to substantially increase the yield of taro and sweet potato. However, the finding of this study was contradictive for some other previous studies Talleyrand & Lugo-Lopez, 1976 *in* (Ankumah, Khan, Mwamba, & Kpomblekou-A, 2003). Harris (1992) reported that due to N is a component of protein, N fertilization is very essential for a growth and development. Zamil, Rahman, Rabbani, & Khatun (2010) reported that the application of N levels significantly affected the number of tubers/hill, weight of tubers/hill, yield of tubers and seed tubers/ha. Even, the study of Abdissa, Dechassa, & Alemayehu (2012) reported that the use of manure and phosporus can increase root diameter, enhance soil micronutrients, and result better root growth and tuber yield.

The declining trends of tuber yield as observed in Table 2 suggest that the application of 50-100 kg/ha of Urea, 100-200 kg/ha of ZA, and 5,000 kg/ha of manure are not quantitively viable. The study of Shaaban & Kisetu (2014) might answer the finding of this study where the check could have higher tuber yield compared to N fertilization treatments. The study of Shaaban & Kisetu (2014) revealed that the tuber yield obtained higher by control treatment than 150 kg of NPK per ha could be influenced by the ability of the crops to adjust themselves to the deficiency of nutrients in the soil. Thus, they take a benefit from the residual nutrients in the soil.

Table 2. The Effect of N fertilization on Tuber Yield of Sweet Potato

Fertilization (kg/ha)	Number of tubers per plot	Total tuber yield (ton/ha)
0 N fertilizer (Check)	159	17.04
50 kg of Urea	156	16.63
100 kg of Urea	150	16.03
100 kg of ZA	154	14.21
200 kg of ZA	170	16.98
5000 kg of manure	146	14.51
Average	155.8	15.9

Different letter(s) in each column indicate(s) significant difference at p = 0.05

Partial budget analysis of sweet potato farming under N fertilization treatment indicated the highest total cost (IDR 25.78 million) was obtained where 5000 kg of manure was applied. On the other hand, the lowest total cost (IDR 23.40 million) was obtained by the application of the check. On the contrary, the gross benefit of the check was the highest (IDR 41.54 million), while the gross benefit if 5000 kg of manure applied was the lowest (IDR 35.37 million) (Table 3). In addition, the highest marginal return (IDR 18.14 million) and the highest benefit cost ratio (0.8) were recorded for the check. From the study, it is suggested that sweet potatos still can be produced profitably in the study area with the minimum fertilization application, without considering to the availability and the high prices of N fertilizers in the market. This finding is also in line with the finding of Shaaban & Kisetu (2014).

All treatments had economic benefit. The benefit cost ratio that was less than 1 indicated that sweet potato farming was not viable to be developed (Table 3). Therefore, to determine the benefit cost ratio, it should be more specified for each improved variety of sweet potato combined with each N fertilization treatment, the marginal benefit cost ratio (MBCR) which calculated ratio between the difference of benefit obtained from the selected N fertilizer application with the check and the difference between input cost paid from the use of selected N fertilizer treatment with the check was used (Table 4).

Table 3. The Partial Budget Analysis of Sweet Potato Farming under N Fertilization Treatment

Description	N fertilization treatment*					
	F1	F2	F3	F4	F5	F6
	.... IDR000/ha					
Production cost:						
– Seed, insecticide, fuel	8500	8500	8500	8500	8500	8500
– Fertilizer	720	870	1020	902	1084	3095
– Labor	14183	14183	14183	14183	14183	14183
Total variable costs	23403	23553	23703	23585	23767	25778
Gross benefit**	41543	40543	39081	34640	41381	35371
Marginal return	18140	16990	15378	11055	17614	9593
Benefit cost ratio	0.8	0.7	0.6	0.5	0.7	0.4

*Six N fertilization treatments: F1= 0 N fertilization as a check; F2= 50 kg/ha of Urea; F3= 100 kg/ha of Urea; F4= 100 kg/ha of ZA; F5= 200 kg/ha of ZA; and F6= 5000 kg/ha of manure

**The average field price of sweet potato was IDR 2438/kg, whereas the price of purple-fleshed sweet potato was IDR 3000/kg and price of white-fleshed and orange-fleshed sweet potato was IDR 1875/kg

Table 4. Yield, Benefit, and MBCR of Sweet Potato Farming under N Fertilization Treatment

Description / Variety	N fertilization treatment					
	0 N fertilizer (Check)			Urea 50 kg/ha		
	Jago	Antin 2	Beta 2	Jago	Antin 2	**Beta 2**
Treatment input cost (IDR000/ha)	720	720	720	870	870	**870**
Yield (kg/ha)	18.45	5.57	27.12	17.00	4.33	**28.57**
Price (IDR/kg)	1875	3000	1875	1875	3000	**1875**
Gross benefit (IDR000/ha)	34394	16695	50841	31875	13001	**53559**
Net benefit on treatment input cost (IDR000/ha)	33874	15975	50121	31005	12131	**52689**
MBCR	-	-	-	-19.13	-25.63	**17.13**

Description / Variety	N fertilization treatment					
	Urea 100 kg/ha			ZA 100 kg/ha		
	Jago	**Antin 2**	Beta 2	Jago	Antin 2	Beta 2
Treatment input cost (IDR000/ha)	1020	**1020**	1020	902	902	902
Yield (kg/ha)	14.80	**8.25**	25.05	14.59	4.98	23.07
Price (IDR/kg)	1875	**3000**	1875	1875	3000	1875
Gross benefit (IDR000/ha)	27750	**24750**	46987	27347	14951	43247
Net benefit on treatment input cost (IDR000/ha)	26730	**23730**	45949	26445	14049	42345
MBCR	-23.81	**25.85**	-13.91	-40.80	-10.58	-42.70

Description / Variety	N fertilization treatment					
	ZA 200 kg/ha			Manure 5,000 kg/ha		
	Jago	Antin 2	**Beta 2**	Jago	Antin 2	Beta 2
Treatment input cost (IDR000/ha)	1084	1084	**1084**	3095	3095	3095
Yield (kg/ha)	16.02	5.35	**29.57**	14.94	4.93	23.67
Price (IDR/kg)	1875	3000	**1875**	1875	3000	1875
Gross benefit (IDR000/ha)	30028	16050	**55434**	28003	14801	44372
Net benefit on treatment input cost (IDR000/ha)	28944	14966	**54350**	24908	11706	41277
MBCR	-13.54	-2.77	**11.61**	-3.78	-1.80	-3.72

(1) Jago = white-fleshed; Antin 2 = purple-fleshed; Beta 2 = orange-fleshed; (2) Price of fertilizer: SP36 IDR 2200/kg; KCl IDR 5000/kg, ZA Rp 1821/kg, Urea IDR 3000/kg, manure IDR 475/kg; (3) Field price of sweet potato in research site per August 2015: purple-fleshed sweet potato IDR 3000/kg, white-fleshed and orange-fleshed sweet potato IDR 1750 – 2000/kg (average of IDR 1875/kg)

From 18 combination treatments, three combination treatments namely Urea 50 kg/ha with Beta 2, Urea 100 kg/ha with Antin 2, and ZA 200 kg/ha with Beta 2 were viable with the MBCR value of 17.13, 25.85, and 11.61, respectively (Table 4). An increase of IDR 1.00 in production cost to replace the check with such N fertilizer applications gave a profit increase of about IDR 17.13; IDR 25.85; and IDR 11.61, respectively. The two combination treatments of Urea 50 kg/ha with Beta 2 and ZA 200 kg/ha with Beta 2 had proved that the combination of improved variety resulted the highest productivity (Table 1). Thus, is suggested that regarding to the doses of N fertilization from ZA source, it needs equal or more than 200 kg/ha and from Urea source, it needs equal or less than 50 kg/ha for achieving optimum tuber yield (Table 2) and they were viable.

For combination treatment of Urea 100 kg/ha with Antin 2, although Antin 2 had the lowest productivity (Table 1) and the application of Urea 100 kg/ha resulted the lower productivity than Urea 50 kg/ha (Table 2), but the field price of Antin 2 (purple-fleshed sweet potato) was relatively much higher than Beta 2 (orange-fleshed sweet potato). That is IDR 3000/kg compared to IDR 1750-2000/kg. The high selling price of Antin 2 influenced high benefit. Therefore, this combination was also viable. This suggested that beside the yield and N fertilizer source and dose, profitable N fertilization for sweet potato farming considerably depends on differences in selling price of particular variety.

The implication of this study is to increase the economically benefit of sweet potato farming, it is not only limited to the application of recommended cultivation technology (includes N fertilization), but also the selection of high-yielding improved sweet potato varieties that have the high selling price in the market.

CONCLUSION

The combination treatments of Urea 50 kg/ha with Beta 2, Urea 100 kg/ha with Antin 2, and ZA 200 kg/ha with Beta 2 were viable with the MBCR value of 17.13, 25.85, and 11.61. It means that the increase of IDR 1.00 in production cost to replace the control (without N fertilization) with such N fertilizer applications give a profit increase of about IDR 17.13; IDR 25.85; and IDR 11.61. Although the data was limited, the study tentatively concludes that profitable N fertilization for sweet potato farming considerably depends on the differences in yield, N fertilizer source and dose, as well as the selling price of particular variety.

REFERENCES

Abah, J., Akan, J., Uwah, E., & Ogugbuaja, V. . (2008). Levels of Some Anions in Tuber Crops Grown in Benue State, Nigeria. Trends in Applied Sciences Research, , (3), 196–202. https://doi.org/10.3923/tasr.2008.196.202

Abdissa, T., Dechassa, N., & Alemayehu, Y. (2012). Sweet Potato Growth Parameters as Affected by Farmyard Manure and Phosphorus Application at Adami Tulu, Central Rift Valley of Ethiopia. Agricultural Science Research Journal, 2(1), 1–12. Retrieved from https://nanopdf.com/downloadFile/agric-sci-res-j-international-research-journals_pdf

Ankumah, R. O., Khan, V., Mwamba, K., & Kpomblekou-A, K. (2003). The influence of source and timing of nitrogen fertilizers on yield and nitrogen use efficiency of four sweet potato cultivars. Agriculture, Ecosystems and Environment, 100(2–3), 201–207. https://doi.org/10.1016/S0167-8809(03)00196-8

BPS. (2016). Statistik Indonesia 2016. (BPS Pusat Jakarta, Ed.), Statistik Indonesia. Jakarta: BPS Pusat Jakarta. Retrieved from https://www.bps.go.id/publication/2016/06/29/7aa1e8f93b4148234a9b4bc3/statistik-indonesia-2016.html

Bundy, L. G., & Andraski, T. W. (2005). Recovery of Fertilizer Nitrogen in Crop Residues and Cover Crops on an Irrigated Sandy Soil. Soil Science Society of America Journal, 69(3), 640. https://doi.org/10.2136/sssaj2004.0216

FAO. (1990). Guidelines for the conduct of a training course in farming systems development. (F. and A. O. of the U. Nations, Ed.). Rome: Food and Agriculture Organization of the United Nations.

Ginting, E., Utomo, J. S., & Yulifianti, R. (2014). Potensi Ubijalar Ungu Sebagai Pangan Fungsional. Iptek Tanaman Pangan, 6(1), 116–138. Retrieved from http://ejurnal.litbang.pertanian.go.id/index.php/ippan/article/download/2601/2240

Harris, P. M. (1992). The potato crop: the scientific basis for improvement. Chapman & Hall. Retrieved from https://books.google.co.id/books?id=u1UjAQAAMAAJ

Hartemink, A. E., Johnston, M., O'Sullivan, J. N., & Poloma, S. (2000). Nitrogen use efficiency of taro and sweet potato in the humid lowlands of Papua New Guinea. Agriculture, Ecosystems and Environment, 79(2–3), 271–280. https://doi.org/10.1016/S0167-8809(00)00138-9

Indonesian Legumes and Tuber Crops Research Institute (ILETRI). (2012). Description of legumes and tuber crops improved varieties. (in Bahasa Indonesia). Malang. Retrieved from http://balitkabi.litbang.pertanian.go.id/wp-content/uploads/2016/09/kedelai.pdf

Indonesian Legumes and Tuber Crops Research Institute (ILETRI). (2016). Deskripsi Varietas Ubi Jalar 1977-2016. Malang. Retrieved from http://balitkabi.litbang.pertanian.go.id/wp-content/uploads/2016/09/ubijalar.pdf

Jett, L., & Mulkey, W. (1996). Nitrogen fertilizer effects on growth and yield sweetpotato. Hort Science. , 31(5), 759. Retrieved from http://hortsci.ashspublications.org/content/31/5/759.5.abstract

Jusuf, M., & Ginting, E. (2014). The prospects and challenges of sweet potato as bio-ethanol source in Indonesia. Energy Procedia, 47, 173–179. https://doi.org/10.1016/j.egypro.2014.01.211

Shaaban, H., & Kisetu, E. (2014). Response of Irish potato to NPK fertilizer application and its economic return when grown on an Ultisol of morogoro, tanzania. Journal of Agricultural and Crop Research, 2(9), 188–196. https://doi.org/10.1016/j.chemosphere.2006.04.081

Villagarcia, M. R. (1998). Nitrate uptake and nitrogen use efficiency of two sweetpotato genotypes during early stages of storage root formation. Journal-of-the-American-Society-for-Horticultural-Science; Sept 1998; 123(5): 814-820, Sept; 123(5), 814–820. Retrieved from http://journal.ashspublications.org/content/123/5/814.full.pdf+html

Wang, Z.-H., Li, S.-X., & Malhi, S. (2007). Effects of fertilization and other agronomic measures on nutritional quality of crops. Journal of the Science of Food and Agriculture, 88(1), 7–23. https://doi.org/10.1002/jsfa.3084

Zamil, M., Rahman, M., Rabbani, M., & Khatun, T. (2010). Combined effect of nitrogen and plant spacing on the growth and yield of potato with economic performance. Bangladesh Res. Public. J. , 3(3), 1062–1070.