Enhancing farmers knowledge on soil and crop nutrient management for vegetable production in Bukidnon, Mindanao, Philippines

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Abstract
A field experiment was conducted in major vegetable growing areas in Bukidnon, Mindanao, Philippines. The study was conducted to: 1) optimize nutrient inputs to vegetable production; 2) examine the effect of fertilizer inputs on improving the productivity of vegetables; and 3) improve the fertility and productivity of vegetable soils in the area. Results revealed that treatment 3 (69-18-60 N, P_2O_5 and K_2O/ha) consistently gave the highest agronomic and yield parameters compared to the existing farmers practice. The cost and return analysis showed that the same treatment also gave the highest gross marginal benefit (GMB) of PHP 820,120 compared to the farmer's practice of PHP 785,385. However, in terms of nutrient sustainability, farmer's practice provides better nutrient supply based on the partial nutrient budget.

Key Words
Fertilizer cost, soil fertility, productivity, profitability.

Introduction
Vegetable production is a lucrative venture in Bukidnon, Mindanao, Philippines with favorable climatic conditions and provides an additional source of income to small-holder farmers. Common problems encountered by the vegetable farmers are the inherent poor soil fertility and productivity, lack of appropriate technologies, improper water and soil conservation management and other production factors such as fertilizers and limited capital. The inadequate knowledge of soil and crop nutrient management of vegetable farmers leads to improper allocation of limited financial resources that could result in financial risk, poor soil fertility management and low productivity. This practice makes the soil less productive through time depending on the amount of fertilizer applied per cropping season. However, Cassman (1999) pointed out that productivity can be improved through increased yield per unit of land and intensified production, while meeting acceptable standards of environmental quality. To understand better the nutrient need of the crop and its proper nutrient management, there's a need to intensify the development and awareness of crop and soil management technologies to ensure sustainable and profitable vegetable farming. To understand the importance of proper fertilizer and soil management practices in improving productivity and profitability, a field experiment was conducted through the funding support from the Australian Center for International Agricultural Research (ACIAR) to compare the alternative fertilizer management technologies to the usual farmers practice.

Objectives
The objective of the this study were to: 1) optimize nutrient inputs to vegetable production; 2) examine the effect of fertilizer inputs on improving the productivity of vegetables; and 3) improve the fertility and productivity of vegetable soils in the area.

Methodology
Site Description
The experimental was conducted in Kibangay, Lantapan, Bukidnon, Mindanao, Philippines in the southern foot of Mt Kitanglad range with GPS coordinates of 8°3'6.4"N, and 124°54'5.2"E and an elevation of 1,263m asl. The soils is mapped as adtuyon clay in the order of Ultisols and covers about 1,381,547 ha in the region (Badayos, 1994) Brasicas and tomato have been planted for more than 5 years on gently sloping terrain. The rate of fertilizer application ranges to 200-199-230 kg/ha N, P_2O_5 and K_2O based on the plant performance.

Treatment

The treatments were formulated based on the soil analysis and the nutrient requirements of broccoli. Nutrient concentration of the inorganic and organic sources were computed and are presented in Table 1.

Table 1. Treatments and nutrient concentration of fertiliser inputs (N:P:K) including organic amendments (Chicken Manure) and cost.

Treatment	Fertiliser	Formulation ($N:P_2O_5:K_2O$)	Rate (bags/ha)	Weigh (kg/bag)	Cost (PhP/bag)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	Cost (PhP/ha)
T1 (FP)									
	Chicken dung	(1.68-1.85-3.22)	120	40	90	71.4	142.8	163.8	10800
	Ammophos	(16:20:0)	15	50	920	120	150	0	13800
	Urea	(46-0-0)	3	50	980	69	0	0	2940
	Muriate of Potash	(0-0-60)	1.5	50	1250	0	0	45	1875
					Total	260.4	292.8	208.8	29415
T2	Urea	(46-0-0)	3	50	980	69	0	0	2940
					Total	69	0	0	2940
T3	Urea	(46-0-0)	3	50	980	69	0	0	2940
	Solophos	(0-18-0)	2	50	720		18	0	1440
	Potash	(0-0-60)	2	50	1250	0	0	60	2500
					Total	69	18	60	6880
T4	Urea	(46-0-0)	6	50	980	138		0	5880
	Solophos	(0-18-0)	2	50	720	0	18	0	1440
	Potash	(0-0-60)	2	50	1250	0	0	60	2500
					Total	138	18	60	9820

The cost was based on the month of May, 2009. At the time of writing 1 AUD = 43 PHP

Trial description

The trial was implemented in the wet cropping season of 2009 with broccoli (Marathon variety) as test crop, planted on May 25, 2009 and harvested on August 7-8, 2009 using the different fertilizer treatments. Data gathered include pre and post soil analysis, plant height (cm) at 30, 60 and at harvest, dry matter, yield and gross marginal benefit to measure the profitability of the study. Initial and post harvest soil samples including the organic material used were also analyzed using the standard methods. Tissue samples were also collected at 30DAP and at harvest using the standard method of analysis.

Results and discussion

Soil test results

The chemical properties of the soils used in the experiment gave the idea about the fertility of the soil (Table 2). Initial soil pH of 5.67 was favorable for nutrient availability. The pH of the soil has no significant changes after harvest. Generally, the chemical properties of the soils are favorable for crop growth. With the exception of total N, the concentrations of all soil parameters measured decreased between pre-planting and harvest (Table 2).

Table 2. Pre-plant and post-harvest soil chemical properties from field experiment at Kibangay, Lantapan, Bukidnon, (May- August, 2009).

Soil parameter (units)	Pre-plant	Post-harvest			
		T1 (FP)	(T2)	(T3)	(T4)
pH	5.67	5.55	5.55	5.72	5.42
Total Org. C (%)	3.42				
Total N (%)	0.28	0.29	0.29	0.29	0.28
Extractable P (Bray P-2) (mg/kg)	48.64	39.19	36.48	38.52	34.09
Exchangeable K (cmol(+)/kg)	0.96	0.69	0.67	0.88	0.69
Exchangeable Ca (cmol(+)/kg)	4.46	4.22	4.08	3.87	4.06
Exchangeable Mg (cmol(+)/kg)	0.54	0.45	0.44	0.49	0.46
Exchangeable Na (cmol(+)/kg)	0.25	0.03	0.03	0.03	0.03
Cation Exchange Capacity (cmol(+)/kg)	6.34				

Partial nutrient balance suggests that applying more fertilizer in treatment 1 (FP) gave more nutrients in the soil after harvest compared to treatments 2, 3, and 4 (Table 3). Negative balance of P_2O_5 and K_2O were pronounced in treatment with no application of phosphorus and potassium followed in treatments with minimal application of phosphorus and potassium.

Table 3. Partial nutrient budget from field experiment with broccoli at Kibangay, Lantapan, Bukidnon (May-August, 2009).

Treatment	Nutrient loading			Nutrient Uptake			Nutrient removal			Nutrient balance		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	(kg/ha)			(kg/ha)			(kg/ha)			(kg/ha)		
T1 (FP)	260	293	209	5.6	9.66	2.19	68	118	27	192	175	182
T2	69	0	0	5.9	8.91	2.18	60	91	22	9	(91)	(22)
T3	69	18	60	5.1	9.86	2.22	61	118	27	8	(100)	33
T4	138	18	60	5.7	11.4	2.22	67	134	26	71	(116)	34

Agronomic and Yield Parameters

The yield of broccoli was significantly affected by the different treatments (Table 5). Highest significant yield was obtained in Treatment 1 (Farmers Practice) with high amounts of nutrients (260-293-209 N, P_2O_5, K_2O/ha) followed by no significant difference between Treatments 3 and 4. This shows that the high application of fertilizers by the farmers gave comparable yield to treatments with less fertilizer applied. Application of fertilizer based on the crops needs through soil analysis gave a better understanding of the farmers for effective and efficient allocation of capital for farm inputs. The result provide basic information on the usefulness of the different analytical tool in measuring the amount of nutrients present in the soil system and how to allocate the very limited financial resources for most economic benefit. Roberts (2007) suggested applying fertilizers in the amounts needed and, timed and placed to meet crop demand provide the best benefit to the farmers.

Table 4. Agronomic and yield performance of broccoli as affected by the different treatments in Kibangay, Lantapan, Bukidnon (May-August, 2009).

Treatment	Height at 30 DAP (cm)	Height at 60DAP (cm)	At Harvest (cm)	Dry Matter (t/ha)	Marketable yield (t/ha)	Non-Marketable yield (t/ha)	Total Yield (t/ha)
T1 (FP)	20.76	60.80a	62.48a	12.22b	40.75	4.52	45.27a
T2	20.14	49.17b	55.42c	10.22a	31.74	3.52	35.26b
T3	21.88	56.28a	58.92b	11.94b	41.35	4.59	45.94a
T4	22.12	57.89a	59.60b	11.69b	38.98	4.33	43.31a

Farm price at harvest was 20 PHP/kg. At the time of writing 1 AUD = 43 PHP

Gross Marginal Benefit (GMB)

Reducing the cost of fertilizer by reducing the amount of fertilizer applied without sacrificing the yield which was comparable to the high gross marginal benefit of PHP 820,120 in treatment 3 compared to treatment 1, Farmer's Practice (FP) (Table 5). This means that reducing the cost from PHP 29,415 to PHP 6,880 or about 76.61% still gave 4.4% higher gross marginal benefit. Optimizing the rate of fertilizer gave a higher gross marginal benefit compared to high rate of fertilizer application.

Table 5. Partial cost/benefit analysis of treatments used in the field experiment at Kibangay, Lantapan, Bukidnon (May-August, 2009).

Treatment	Fertiliser Cost	Value of Marketable Yield	Partial GMB
(Kg N, P_2O_5, K_2O/ha)	(PHP/ha)	(PHP/ha)	(PHP/ha)
T1 (260-293-209)FP	29,415.00	814,800.00	785,385.00
T2 (69-0-0)	2,940.00	634,600.00	631,660.00
T3 (69-18-60)	6,880.00	827,120	820,120.00
T4 (138-18-60)	9,820.00	779,600.00	769,780.00

Farm price at harvest was 20 PHP/kg. At the time of writing 1 AUD = 43 PHP

Conclusion and recommendation

Optimum rate of fertilizer application for vegetables (broccoli) provide better agronomic and economic benefits to vegetable growers. The optimum rate can be calculated based on soil analyses and the nutrient needs of the crop. Soil analysis provide a better understanding of what and how much to allocate for fertilizer inputs considering the high cost of fertilizer and the limited financial resources of vegetable farmers. Fertilizer management is dependent on the local soil and climatic conditions, crop, management conditions and other site-specific factors. Thus, to understand further the interacting factors in nutrient management and rates of fertilizers for vegetable production there is a need to conduct a study on the different rates of P and K to optimize profitable and sustainable rates and explore the use of indigenous sources of nutrients (organic sources) to improve productivity, profitability and sustainability without affecting environmental quality.

References

Badayos RB (1994) Soil related constraints to agriculture in the Philippines. Seminar Proceedings.

Cassman GK (1999) Proceeding National Academy of Science. USA 96:5952-5959.

Roberts TI (2007) Right product, right rate, right time and right place the foundation of best anagement practices for fertilizer. In 'Fertilizer best management practices: General principles, strategy for their adoption, and voluntary initiatives versus regulations'. IFA International workshop on fertilizer best management practices.March 7-9, 2007. pp 29-32. (Brussels, Belgium).