A framework for prioritising nutrient management research in vegetable production in the southern Philippines

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Abstract
This paper describes an approach which has been used to identify and prioritise nutrient management research activities in a project currently being undertaken in the southern Philippines. It has highlighted the potential to improve the productivity and profitability of these systems by reallocating limited capital (fertiliser) resources from phosphorus and potassium to nitrogen based on an application of soil test information and the principles of nutrient budgeting. This approach also has applications for developing broader agricultural research programs in that it can be used as a tool for identifying and prioritising the activities which are likely to be the most successful and establish likely timeframes for impact.

Key Words
Research planning, decision making, capacity building.

Introduction
Providing higher economic returns per unit area and developing new export markets for high value crops in the Philippines has been identified as a priority by the Philippine Government and the Australian Centre for International Agricultural Research (ACIAR) as a means of increasing economic growth and improving the standard of living of people living in rural areas. Regions 8 (Leyte), 10 (Northern Mindanao/ Cagayan de Oro) and 11 (Southern Mindanao/ Davao) have been indentified as having significant potential for expanding vegetable production. However, a number of barriers exist to achieving these objectives including diminishing areas of arable land, declining soil fertility, high fertiliser costs and a lack of capital for purchasing fertiliser inputs. Consequently, growers are looking to alternative fertiliser inputs such as composts and animal manures but lack training on how to integrate organic and inorganic fertilisers into their production systems. Consequently, ACIAR has funded a research project in the southern Philippines aimed at defining current soil fertility status and management practices, developing more productive nutrient management systems for vegetables, encouraging adoption of best management practices and building scientific research capacity of collaborating staff in Philippines and Australia. Given the multiple objectives of the project, there are numerous issues which could be investigated and infinite possibilities for undertaking research activities. Therefore, a structured approach is required to work through the issues and develop an integrated research program for optimising the probability of success and maximising the impact of the project. The objectives of this paper are to i) describe an approach which has been used to identify and prioritise nutrient management research activities in the project and ii) discuss the potential application of this process for undertaking broader agricultural research in developing and developed countries.

Methods
Participatory assessments were conducted in September and October 2008 and examined: the fertility status of vegetable soils in Mindanao (Malaybalay, Lanpatan and Kapatagan) and Leyte (Isabel and Cabintan); and soil and nutrient management practices and availability and costs of inorganic (e.g. traditional NPK) and organic (e.g. poultry litter, carabao manure) fertiliser inputs. The participatory assessments involved conducting one on one interviews with vegetable farmers to gather detailed information about soil and nutrient management practices and typical vegetable production systems, as well as facilitated group workshops to identify the key soil fertility and crop nutrient management issues for these growers. Soil surveys were also conducted in conjunction with the participatory assessments and these are described in a

companion paper by Tulin *et al*. (2010). A research planning workshop was held with project team members at the Department of Agriculture, (Regional Field Unit 10) Northern Mindanao Agricultural Research Center (NOMIARC), the Philippines in March 2009 to analyse and interpret the output from the participatory and soil assessments. Only the results arising from the assessments conducted at Claveria are presented in this paper to illustrate the approach used and outputs arising from the workshop. The workshop was broken into the following components:

Key issues from participatory assessments: The participatory assessments were designed as facilitated workshops to identify the key issues for farmers relating to soil fertility and plant nutrition and describe the areas where they would like research to be undertaken. At the end of the participatory assessment, workshops summary tables of the key nutrient management needs for farmers and potential strategies for addressing these needs were developed.

Availability and costs of nutrient inputs: The costs and nutrient content of existing and potential nutrient inputs available to the farmer were evaluated to determine if more cost-effective forms of essential nutrients were available. This was achieved by deriving a value per unit of nutrient for each product based on current retail prices.

Current nutrient management practices: During the participatory assessments farmers were asked to describe current nutrient management practices including types and rates of fertilisers used and when they are typically applied.

Partial mass balance: Based on the information provided by the farmers, partial mass balances were developed by calculating the quantities of nutrients typically applied during each crop. Rates of nutrient removal were calculated by multiplying the yields reported by farmers (t/ha) by data described by AVRDC (1992) on typical rates of nutrient removal (kg nutrient/t product) for the crops grown. These did not account for nutrient losses by downward leaching, surface transport or losses to the atmosphere.

Soil nutrient status: The results from the soil survey described by Tulin *et al*. (2010) were used to develop summary tables of nutrient status of vegetable soils to determine which soil chemical properties were limiting to the production system described by the farmer.

Perceived vs. actual needs: The next step was to determine whether the key issues described by farmers were consistent with the results of the semi-quantitative analysis of the production system (partial mass balances and soil survey). Potential interventions for addressing the key needs identified were then listed.

Likely impact vs. probability of success: As a group exercise, participants were then asked to draw upon their personal experience and knowledge to discuss each potential intervention which was listed and assign a score out of 10 (1 = lowest, 10 = highest) regarding the: i) Probability of success – i.e. what is the likelihood of the research theme being successful in advancing knowledge/ understanding?; and ii) Likely level of impact – i.e. what level of impact would a breakthrough in this area have with respect to addressing the key needs of farmers? The scores were then plotted graphically as a way of prioritising the interventions listed.

Establishing experimental objectives: The groups were then asked to develop experimental objectives for the interventions with the greatest likelihood of impact and probability of success and describe how the objectives would address the key needs identified.

Results and Discussion

Key issues from participatory assessments: High costs of fertilisers, poor fertiliser management and declining soil fertility were identified by growers as the key issues in relation to soil fertility and nutrient management. They expressed interest in looking at organic sources of fertilisers, making compost, integrating the use of organic and inorganic fertilisers, changing timing of application and crop rotations as strategies for overcoming these constraints. They also indicated a desire to be trained in soil sampling, analysis and interpretation.

Availability and costs of nutrient inputs: A variety of fertilisers are available to farmers, including chicken manure (1.7:3.4:3.9), ammophos (16:20:0), “Complete” (14:14:14), urea (46:0:0), muriate of potash (0: 0:

60) and single superphosphate (0:18:0) (% $N:P_2O_5:K_2O$). Prices range from 40-157, 74-157 and 57-157 PHP per kilogram of N, P_2O_5 and K_2O, respectively. The cheapest form of nitrogen, phosphorus and potassium were urea, chicken manure and muriate of potash, respectively, whilst "Complete" was the most expensive form of fertiliser on an individual element basis at 157 PHP/kg nutrient.

Current nutrient management practices and partial mass balance: Tomatoes are the main vegetable crop grown in Claveria and a summary of the forms and rates of fertilisers which farmers apply to the crop is presented in Table 1. The total loading of N, P_2O_5 and K_2O applied to a typical tomato crop is in the order of 215, 166 and 226 kg/ha, respectively (Table 1). Based on a yield of 20 t/ha, the quantities of nutrients removed in harvestable yield are only 55, 15 and 75 kg/ha, suggesting a net accumulation of up to 160, 15, 75 kg/ha N, P_2O_5 and K_2O, respectively (Table 1).

Table 1. Summary of current nutrient management practices of vegetable farmers in Claveria, Misamis Oriental, the Philippines.

Time of application (Days after planting)	Fertiliser	Rate (bags/ha)	Weight (kg/bag)	Cost (PHP/bag)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	Cost (PHP/ha)
0	Lime	100	40	40				4000
	Chicken dung	68	40	100	46	93	106	6800
7	Ammophos	4.6	50	920	37	46	0	4232
14-18	Complete	1.3	50	1100	9	9	9	1430
	Urea	1.5	50	920	35	0	0	1380
	Potash	1.04	50	1700	0	0	31	1768
21-30	Complete	1.3	50	1100	9	9	9	1430
	Urea	1.5	50	920	35	0	0	1380
	Potash	1.04	50	1700	0	0	31	1768
35-40	Complete	1.3	50	1100	9	9	9	1430
	Urea	1.5	50	920	35	0	0	1380
	Potash	1.04	50	1700	0	0	31	1768
Total					215	166	226	24,766
Nutrients removed in 20 t/ha tomatoes*					55	15	75	
Balance					160	151	151	

*Based on data from AVRDC (1992)

Soil nutrient status

The results from the soil survey indicated that the vegetable soils in Claveria were typically high in available P and exchangeable K, but low in total N (Tulin *et al*. 2010). The results for P and K were were consistent with the results from the partial mass balance in that they suggest P and K is accumulating in these systems based on excessive applications of these nutrients. However, despite the apparent excessive application of nitrogen (160 kg/ha), soil Total N concentrations remain low (Tulin *et al*. 2010), suggesting significant quantities are lost from the system through leaching, soil erosion or volatilisation.

Perceived vs. actual needs

High fertiliser prices and a lack of capital to buy fertilisers were the key soil fertility and plant nutrition issues identified by growers during the participatory assessments. However, they are spending up to 25,000 PHP/ha (~ $595 AUD/ha) on fertiliser inputs with phosphorus and potassium apparently being applied in excess of crop and soil requirements, but nitrogen remaining limiting. Therefore, the issue does not appear to be one of lack of capital, but rather a need for more effective allocation of limited capital (fertiliser) resources. This could be achieved by reducing rates of P and K fertilisers, as well as purchasing more cost-effective forms of each nutrient, particularly urea, instead of expensive fertilisers like "Complete" (14:14:14).

Likely impact vs probability of success

The outcomes from this activity suggested that the priority for interventions should be in the order of: Training in nutrient management best management practices > Reallocating investments from P & K to N > Reduce the rate of N> Change timing of N application (Figure 1). Whilst growers expressed interest in making and using N-rich compost, this is likely to have a lower probability of success given these materials typically have variable characteristics and agronomic performance (Chan *et al.* 2007).

Establishing experimental objectives
Based on the outputs from the workshop a field experiment was designed with the objectives of: i) Increasing N-use efficiency in vegetable production systems in Claveria; ii) Examining different rates of N application and iii) Evaluating different sources of N fertilisers. This will address the issues identified in the workshop by reducing N losses, reducing N fertiliser inputs and identify more cost-effective sources of N for vegetable production systems in Claveria. Activities are also planned for training farmers in techniques for undertaking and interpreting soil tests and making better informed fertiliser management decisions based on soil and crop requirements.

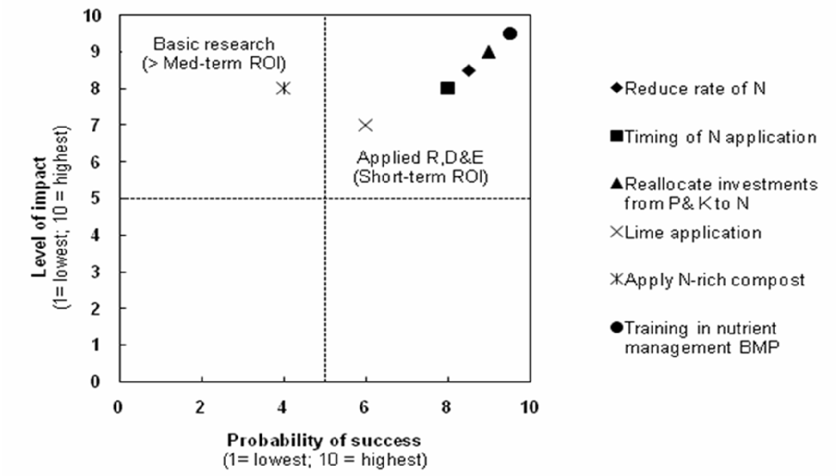

Figure 1. Representation of the likely level of impact and probability of success of interventions proposed to improve soil and fertiliser nutrient management in vegetable production in Claveria, Misamis Oriental, the Philippines.

Conclusions
This paper has presented a structured framework for identifying and prioritising research aimed at improving nutrient management in vegetable production systems in the southern Philippines. It has highlighted the potential to improve the productivity and profitability of these systems by reallocating limited capital (fertiliser) resources from phosphorus and potassium to nitrogen based on an application of soil test information and the principles of nutrient budgeting. The resulting research program will aim to test this hypothesis and in the process help refine the assumptions made particularly in light of rates of nutrient uptake and removal and critical limits for soil fertility. Whilst the focus has been on soil fertility and nutrient management, this approach has applications for developing broader agricultural research programs in that it can be used as a tool for processing background information and identifying and prioritising the activities which are likely to be the most successful. It can also assist in determining whether the timeframe for impact and return on investment (ROI) is likely to be short (applied research), medium or longer term (basic or fundamental research).

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