

## Assessing factors influencing types, rate of application and timing of fertilizer use among small-scale farmers of western Kenya

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### Abstract

Many soil fertility amelioration technologies exist in western Kenya, but the factors that influence the adoption, and the economic returns of these technologies needs to be assessed. In this study, the value cost ratios (VCR) of five different fertilizers (Diammonium phosphate; Nitrogen Phosphorus and Potassium; agricultural lime; Minjingu phosphate rock; and Organic manure largely farmyard manure) were computed using data obtained from surveying 267 households and 30 fertilizer traders. The value cost ratios (VCR) values ranged from 1.4 - 3.6. Apart from that of organic fertilizers of 1.4, the VCRs are adequate to induce fertilizers' adoption by farmers. It is imperative that individual farmers' economic optimal rate of fertilizer application be established to maximize economic gains.

Key words: Economic returns, fertilizer type, value cost ratios, western Kenya

### Résumé

Beaucoup de technologies d'amélioration de fertilité du sol existent au Kenya occidental, mais les facteurs qui influencent l'adoption et les retombées économiques de ces technologies doivent être évalués. Dans cette étude, les valeurs du coût de cinq engrais différents (phosphate de diammonium; azote phosphore et potassium ; engrais calcique ; Phosphate naturel de Minjingu ; et l'engrais organique en grande partie l'engrais de basse-cour) ont été calculées en utilisant des données obtenues en interrogeant 267 ménages et 30 vendeurs d'engrais. Les valeurs du coût se sont étendues de 1.4 - 3.6. Indépendamment de celui des engrais organiques de 1.4, ces coûts sont satisfaisants pour induire l'adoption des engrais par des fermiers. Il est impératif que le taux optimal économique de différents fermiers pour l'application d'engrais soit établi pour maximiser des gains économiques.

Mots clés: Retombées économiques, type d'engrais, valeur du coût, Kenya occidental

## Background

The recent increases in fertilizer prices in Kenya have caused agronomists, suppliers, and farmers to closely examine the amount of inorganic fertilizer they apply to their maize crop and seek cheaper sources of crop nutrients. Many technologies to restore soil fertility exist in Kenya, but the effective and affordable ones need demonstration across many farmers. The present study aimed at demonstrating the alternative sources of crop nutrients to many farmers and to identify and promote the “best” technologies. The strategy adopted by the project to pass information on the technologies was field trials under farmer conditions with farmers invited during the field operations. Later, traders of the fertilizers involved in marketing of the different types of fertilizers (Diammonium phosphate (DAP); NPK; agricultural lime bought at Koru, Kisumu, Kenya; Minjingu (Tanzania) phosphate rock (MPR); and Organic manure will be engaged. As part of the study, an economic evaluation was undertaken to assess the potential of the technologies to be adopted by the farmers and their economic contribution to the household income. It was hoped that diffusion effects of knowledge from farmers attending field days to those who do not would occur and ensure a large-scale adoption of the technologies.

## Literature Summary

Empirical studies on diffusion of innovations and knowledge in agriculture show that diffusion is a complex process, which depends on multidimensional, interrelated factors (Palis *et al.*, 2002; Rogers, 2003). The field trials act as farmer field schools (FFS) that is an effective tool to extend knowledge to farmers (Pontius *et al.*, 2002). When FFS and field trials are used as a learning platform for farmers, the interpersonal networks are the predominant method by which farmers acquire knowledge (Tripp *et al.*, 2005). It is thus important to assess the intrinsic characteristics of the technologies and that of the farmers which may influence the decision by households to adopt a technology. Indeed, family relations and farm neighbourhood compose social clusters, which offer good conditions for spontaneous diffusion of farming information (Palis *et al.*, 2002).

## Study Description

Primary data were collected through administration of structured questionnaires to randomly selected households and fertilizer traders in three districts of western Kenya, namely, Trans-Nzoia, Siaya and Busia. Information collected from households included organic and inorganic fertilizer type and application rates, maize output quantities and selling prices and factors influencing decision to use a particular fertilizer type. Information on the

average fertilizer prices and stocks available per trader were obtained from input traders. A total of 267 households and 30 input sellers were surveyed between November 2009 and February 2010.

Although technology adoption studies have long relied on logit and probit models, the approach is restricted to technologies whose adoption can simply be measured in discrete terms, i.e., a farmer has adopted/not adopted and the methods are quite limited in their ability to control farmer heterogeneity. For instance, in western Kenya, it is difficult to categorize farmers as adopters or non-adopters of fertilizer types because farmers use fertilizers erratically and fertilizer use in households fluctuate over season depending on myriad factors including the household economic conditions, input and output prices. Indeed, there is evidence that farmers can rely on output price/input price in their decisions on use of fertilizers (Kelly *et al.*, 1996).

In the present study, the Value Cost ratio (VCR) of using the different types of fertilizers based on the 2009 output and input prices was computed. This method was used as an indicator to predict decrease or increase in fertilizer use due to changes in input and output prices. VCR is the ratio of the product unit price to fertilizer unit price multiplied by the fertilizer response rate. Thus:

$VCR = FRR * (\text{Product price}/\text{input prices})$  where:  $FRR = \text{fertilizer response rate} = \text{output (kgs)}/\text{fertilizer (Kgs)}$ .

For a fertilizer type to be attractive enough to induce adoption, it has been estimated that the VCR must be greater than two (Pouzet and Harris, 1992) but preferably more than 4 in order to accommodate price and climate risks (Tessio, 1996).

**Recommended organic fertilizer rate.** The recommended rate of manure range from 5-10 t/ha depending on the quality and source (e.g., AFRENA, 1996; Odendo *et al.*, 2003). Farmers who applied >5ton/ha or organic manure were considered to be applying manure at the recommended rate. The main source of organic manure was farm yard manure largely from animal wastes.

## Research Application

The main factors that influence the choice of fertilizer use was the physical appearance of the maize plants during the vegetative growth stage. Eighty per cent of the farmers acknowledged

that decisions on fertilizer types were made during this growth stage when farmers could admire the maize with good growth vigour and obtain recommendation for fertilizer use. This underscores the importance of demonstrations such as those in FFS technology transfer. Wholesalers played a major role in creating demand for fertilizers as opposed to information on yield response and environmental impacts. Most farmers (76%) learnt about new technologies or fertilizers from fellow farmers. This meant that only 24% of the farmers obtained information from the primary source. Farmer-farmer interactions were a fast means of causing technology adoption for technologies with high economic and visually identifiable returns.

Using organic manure at the recommended rates led to the highest increase in maize yield of 29.4%. This demonstrates the potential of increasing maize yield with little change in farming cost. However, there was a high variation in farmers' yields from using organic manure. This perhaps indicated that organic manure available in households differed in quality. The response of maize yield to fertilizer use by farming households was influenced by the amount of available nutrients that was already in the soil as demonstrated by the influence on the yield of the control. The best rate of fertilizer to apply is the economic optimum rate because the last unit of fertilizer added just pays for itself with additional yield. This rate maximizes the dollar return per hectare to the farmer.

The economic optimal level depends on the price and the initial fertility level. When the optimum fertilizer requirements of maize was considered, using 2009 fertilizer and crop prices to compute the value cost ratios (VCRs) results in Table 1 were obtained. VCR should be higher than two for all the nutrient sources

**Table 1. Influence of fertilizer type on yield and profitability of maize production.**

Fertilizer type	% increase in maize yield*	% change in farming cost/ha	90 kg Bags/ha	Fertilizer total cost(Kshs.)	VCR
Control	0	0	2.1	0	1.5
DAP	26.4	25	4.2	16800	2.1
NPK	22.1	20	3.1	8680	2.3
MPR	14.2	8.7	2.8	5040	3.4
Lime	18.1	7.4	2.1	3570	3.6
Organic fertilizers	29.4	6.7	3.8	1900	1.4

\* Calculations obtained from farmers using up to 80% of the recommended rates. 1 US\$ = 80 KSh.

considered, to secure a profitable and palpable return to the farmer.

### **Recommendation**

There is a need to assess the quality of the manure at farming households in order to develop and recommend ways to improve the manure productivity. Although the agronomic attractiveness of fertilizers may influence farmers' decisions to use a fertilizer type, in order for farmers to maximize profits, there is need to compute individual farmers' economic optimal rate of fertilizer application.

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### **References**

- AFRENA. 1996. Maseno Project rapport. Report no. 110. ICRAF/KEFRI/KARI Maseno, Kenya.
- Kelly, V.B., Diagana, T., Reardon, M., Gaye and Crawford, E. 1996. Cash crop and food grain productivity in Senegal: Historical view, new survey evidence, and policy implications. Michigan State University Department of Agricultural Economics, International Development Paper No. 20.
- Odendo, M., Ojiem, J. and Okwosa, E. 2003. Potential for adoption of legume green manure on smallholder farms in Western Kenya. In: Bationo, André (Ed.). Managing nutrient cycles to sustain soil fertility in sub-Saharan Africa. Academy Science Publishers (ASP); Centro Internacional de Agricultura Tropical (CIAT). Nairobi, Kenya. pp. 557-570.
- Palis, F.G., Morin, S. and Hossain, M. 2002. Social capital and diffusion of integrated pest management technology: A case study in Central Luzon, Philippines. Paper presented at the Social Research Conference, CIAT, Cali, Columbia, September 11-14, 2002. pp.1-14.
- Pontius, J., Dilts, R. and Bartlett, A. (Eds.). 2002. Ten years of IPM training in Asia - From farmer field school to community IPM - Bangkok, FAO. pp.1-110.
- Pouzet, D. and Harris, G. 1992. Economic analysis of on-farm fertilizer use options at the village level in three West African agroecologies (III) The village of Naki-Est (Guinea Savanna Zone) in Dapaong Region of Togo. IFDC. Soil Fertility Restoration Project.
- Rogers, E.M. 2003. Diffusion of Innovations. 5<sup>th</sup> Edition. - New York, The Free Press, 2003.

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- Tesso, E.M. 1996. Regional variation of efficiency of fertilizer use: The case of food crops produced in Togo. Paper presented at the economics of Agro-chemicals Symposium. IAAE, The Wageningen University, The Netherlands.
- Tripp, R., Wijeratne, M. and Piyadasa, V.H. 2005. What should we expect from farmer field schools? A Sri Lanka case study. *World Development* 33(10):1705-1720.