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The Agronomic and Economic Benefits of Fertilizer and Mulch Use in Highland Banana Systems in Uganda

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Banana is a major food crop in the East African highlands but actual yields are less than 30 t/ha/yr, while the potential is greater than 70 t/ha/yr (van Asten et al., 2005). The poor yields have been attributed to declining soil fertility, drought, pests, diseases and socio-economic factors (Gold et al., 1999).

Most of the soils in the region are highly weathered tropical soils (Acrisols, Ferralsols) that contain small nutrient stocks (Jaetzold and Schmidt, 1982). Due to increases in population; traditional methods of restoring/improving soil fertility (e.g. shifting cultivation and fallow) are no longer feasible. Use of soil inputs is low or inadequate although studies in the region have shown that traditional soil management practices should be complemented with fertilizer use. Continuous production without use of adequate soil inputs has led to high nutrient depletion (Stoorvogel et al., 1993). Constraints to fertilizer use include high prices of fertilizer and poor availability of fertilizer. Fertilizer use by farmers is also complicated by the high heterogeneity of the production environments and farmers' resource endowments leading to differences in nutrient requirements.

This study was carried out by the International Institute of Tropical Agriculture (IITA) and the USAID funded Agricultural Productivity Enhancement Program, with the aim to evaluate the effects of fertilizer and mulch on East African highland cooking banana varieties, across the major banana producing regions in Uganda. The study was carried out in 179 smallholder plots in Central, South, Southwest and East Uganda in 2006/7. About half of the plots were "demonstration plots" while the other half were neighboring farmer plots that acted as "control plots" depicting farmer management practices. All demonstration plots received mineral fertilizer at 71 N, 8 P and 32 K kg/ha/yr whereas control plots received no mineral fertilizer. Mulch thickness averaged 2 and 1 cm in demonstration and control plots, respectively. We did not distinguish between mulch generated within the plots (e.g. dried banana leaves) and external mulch.

Demonstration plots had higher yields than control plots **(Figure 1)**. These differences could mainly be attributed to differences in fertilizer and mulch applications. In addition, reduced weed densities in demonstration plots when compared with control plots, in the Central and

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Southern regions, could have also contributed to the yield differences between the two plot types. Mulch from crop residues has been reported to increase productivity in bananas (Bananuka et al., 2000) and plantains (Salau et al., 1992) and to suppress weeds in other crops (Ramakrishna et al., 2006). In addition, the improved leaf area production of a healthy banana plant has been reported to reduce weed pressure (Olasantan et al., 1994). There were differences in responses among regions, and these were partially attributed to differences in nutrient deficiencies. These findings are in partial agreement with findings in other studies and indicate that fertilizer use can improve banana production but recommendations should be site-specific and should address existing nutrient deficiencies in farmers' fields.

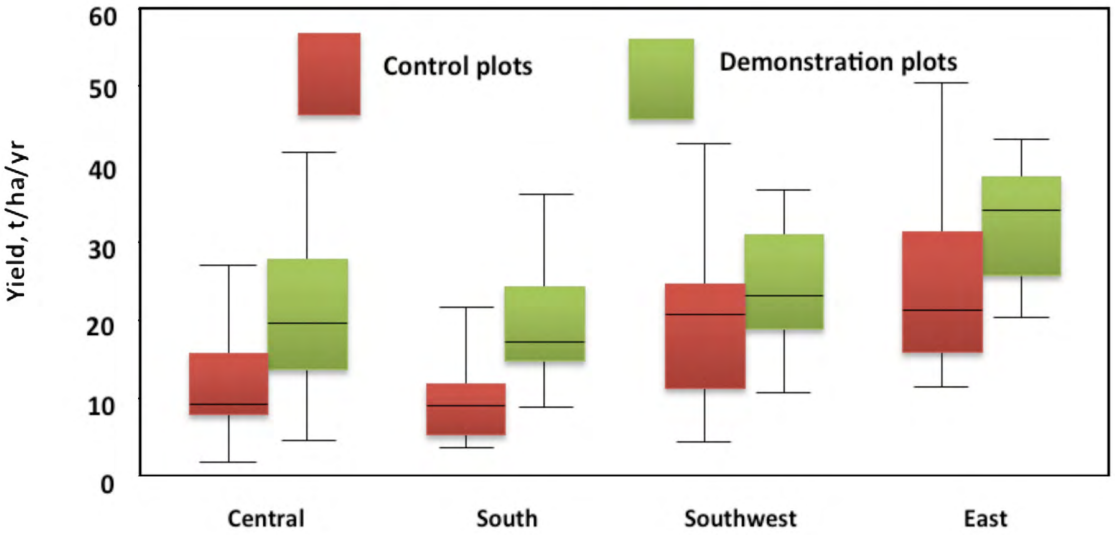

Figure 1: Banana yields in control and demonstration plots in Central, South, Southwest and East regions of Uganda. The boxes represent the inter quartile range (25th-75th percentile), the bars indicate the 5/95% values, and the solid lines across boxes are medians.

The Marginal Rate of Return (MRR) of the demonstrated technology (fertilizer and external mulch) decreased with increasing distance to the capital (a major market for bananas) for Central (17, 43, 46 and 80 km away from the capital for Wakiso, Mukono, Luwero and Mpigi, respectively), South (138 and 216 km for Masaka and Rakai, respectively) and Southwest (290 and 322 km for Mbarara and Bushenyi, respectively). The MRRs were low in the Southwest (<50%) compared with Central, South (except Rakai) and East where MRRs were above 100% **(Table 1)**. The low MRRs in the Southwest were due to low farm gate prices and poor crop response in the region compared with other regions. The study showed that farmers whose main market was within 160 km of the capital were likely to adopt the use of fertilizer (MRR≥100%) in 2006/7.

Based on the fertilizer prices of 2006/7, purchase of external nutrient inputs may not be very profitable in areas that are far from the market. Moreover, the current high banana production in Southwest Uganda, which is far from the capital (Kampala), is unlikely to be sustainable due to massive soil mining. Decline in productivity, particularly in the South and Southwest regions, would cause serious food shortage in the country. These regions produce approximately 61% of the total banana output in the country (Spilsbury et al., 2002).

From the study, we conclude that use of fertilizer and mulch in highland banana systems can be highly profitable, but recommendations should not be generalized into "blanket" treatments that apply for an entire country. Profitability and adoption of fertilizer use can be substantially improved if fertilizer recommendations are tailored to the primary plant nutrient deficiencies currently observed in farmers' fields, and take into consideration the cost of inputs and banana prices. Intensification of production of banana (a perishable and bulky commodity) should occur close to the large urban markets, while storable and dry commodities like coffee can be produced far from the markets. Although our study was based on data collected in Uganda, the findings suggest that there is a need to provide farmers in Uganda and other East African countries (i.e. Tanzania, Kenya, Rwanda, Burundi and the Democratic Republic of Congo), where similar production systems for highland banana are found, with site-specific fertilizer recommendations to improve adoption of fertilizer use and crop productivity.

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Table 1: Summary of partial budget of the benefits and costs of demonstration plots over controls.

Parameter	Central				South		Southwest		East
	Wakiso	Mukono	Luwero	Mpigi	Masaka	Rakai	Mbarara	Bushenyi	Mbale
[a]Difference in net benefits (USD/ha/yr)	1525	941	309	815	822	118	93	27	517
[b]Difference in costs (USD/ha/yr)	264	254	252	344	323	340	259	272	205
[c]MRR (%)	575	370	123	237	254	35	36	10	252

Banana prices (USD/kg) averaged 0.17 (Wakiso, Mukono), 0.16 (Luwero), 0.11 (Mpigi), 0.09 (Masaka), 0.07(Rakai, Mbarara and bushenyi) and 0.10 (Mbale). Fertilizer prices averaged USD 0.56 /kg of fertilizer.

[a]Differences in net benefits were calculated by subtracting cost of fertilizer and mulch from the value of yield.

[b]Calculated by subtracting costs in control plots from costs in demonstration plots. Costs were for purchase, transport, and labor for application of mulch in control plots and fertilizer and mulch in demonstration plots.

[c]Marginal rate of return of investment of demonstration plots compared with control plots calculated by dividing difference in net benefits by difference in costs.

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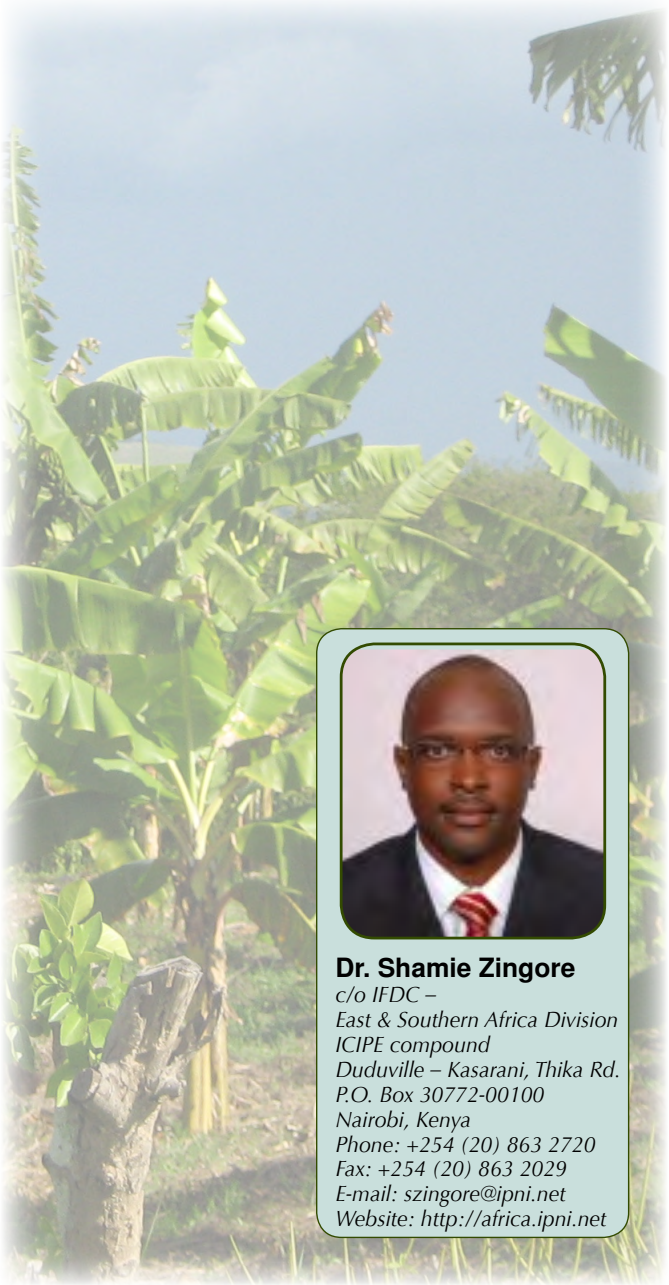

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