

Table 3. Cost and benefits (USD/ha) of fertilizer use by sole maize and maize-bean intercrop.

Crop system	Maize benefit	Bean benefit	Costs that vary	Net benefit
Sole maize	55	0	31	24
Maize + bean	48	45	42	51

ensure the legumes benefit from fertilizer targeted to maize. Intercrops can result in increased grain output over maize alone, both with and without fertilizers (Snapp and Silim, 2002). Although maize yields when intercropped with beans were lower than for sole maize, the overall economic benefits of fertilizer use were greater for the intercrop than a maize monocrop due to the added benefits of the bean yield. An economic analysis of a maize-bean intercropping system showed that both fertilized and unfertilized intercrops had greater economic returns than corresponding sole maize crops, and that the economic viability of intercrops was substantially increased by fertilizer application (**Table 3**).

A meta-analysis of fertilizer response under agroforestry in smallholder farming systems showed that fertilizers give the better maize yield response than legume trees and green manures (Sileshi et al., 2008). However, maize yield response to fertilizer application in the tree legumes systems was significantly higher than in green manures, natural fallows, and unfertilized maize. Based on the analysis, amending the post-fallow plots with 50% of the recommended fertilizer rate increased yields by more than 25% over similar plots that were not fallowed. Adding 100% of the recommended fertilizer to the post-fallow plots did not significantly increase yields over the yield obtained with 50% of the fertilizer treatments, as this resulted in oversupply of N. Tree legumes can play an important role in increasing fertilizer use efficiency, especially when fertilizer availability or amounts are limited.

Strategically targeting fertilizer use to variable soil fertility conditions, combined with recycling crop residues, manure application, and various legume-based technologies is necessary for viable fertilizer use in smallholder farming systems in SSA (Giller et al., 2006). Recognition of the spatial heterogeneity within smallholder farms will help to design more effective recommendations that target different soil fertility niches (i.e.,

poorly-responsive fertile fields, responsive fields, and poorly-responsive poor fields).

However, it is also necessary to develop communication/extension frameworks to build capacity among extension and industry field staff and smallholder farmers for the practical identification of such variability and its effect on fertilizer use and other management interventions. This will allow farmers to fine-tune their decision-making for the allocation of their scarce (labor, cash, and nutrient) resources. **DC**

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