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"Filling gaps and removing traps for sustainable resource management"

Enhancing Livelihoods through Integrated Soil Fertility Management in the Highlands of Ethiopia

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Abstract

Many studies have shown that land degradation and declining productivity are serious problems in the Ethiopian Highlands, the major cause being a decline in soil fertility resulting from topsoil erosion, soil nutrient and organic matter depletion and often increased soil acidity. At the same time Ethiopia is being adversely affected by climate change weather patterns.

Integrated soil fertility management (ISFM) aims to improve soil fertility and productivity of small-scale farmers by promoting locally adopted combinations of various ISFM technologies. These include the use of improved seed, organic fertiliser (improved compost, manure, vermi-composting) in combination with inorganic fertiliser, legumes with rhizobia, line seeding, and lime application on acidic soils.

Crop cuts show that ISFM technologies increase crop yields substantially, but farmers are also interested to know if their investment is also financially viable. Therefore, a participatory cost benefit analysis was undertaken to evaluate the financial effect of ISFM under small scale farm conditions. These were based on farmer-led demonstrations undertaken during the 2016 cropping season, comparing ISFM and farmer practice for four major crops - maize, faba bean, teff and wheat in Amhara, Oromia and Tigray regions. Gross margins, returns to labour and benefit-cost ratios were calculated to compare the benefits with an increase of costs of purchased inputs (seed, fertiliser and lime) and an increase in labour (compost production, line seeding and applying inputs). Results show that benefits considerably exceed costs and that it can be financially attractive for small scale farmers to invest in soil fertility enhancing technologies. At the same time, many of the components of ISFM can also be described as "Climate Smart", meaning a win-win situation for both the environment and improving livelihoods. Nevertheless, the availability of inputs, finance and labour, as well as knowledge about ISFM, remain critical to scaling up and long-term sustainability.

Keywords: Climate smart agriculture, cost benefit analyses, integrated soil fertility management (ISFM) livelihood security

Introduction

The Ethiopian Government has prioritized agriculture as the sector to lead national development and to support greater industrialization in the country. However, despite ongoing interventions to improve soil fertility, Ethiopia's soils have not yet reached their full health and fertility potential for sustainable increases in agricultural production (MoANR, 2013). Cumulative experience (GIZ, 2015; IFPRI, 2010) over a number of years led Government to commit towards developing a country-wide Sustainable Land Management Programme, which has been implemented by the Ministry of Agriculture and its agencies with funding from a number of donors.

One, the BMZ Special Initiative "One World – No Hunger", funds GIZ's "Integrated Soil Fertility Management (ISFM+)" project, whose objective is to improve soil fertility and the productivity of small-scale farmers in the Highland areas of Amhara, Oromia and Tigray regions. The project introduced ISFM in 72 watersheds across 18 Woredas, where physical soil rehabilitation measures, such as stone walls, banks, ditches and trees had previously been promoted. Various combinations of ISFM include the use of improved seed, organic fertilisers in combination with inorganic ones, legumes with rhizobia, line seeding and, on the acidic soils found in Amhara and Oromia, lime application. The introduction of ISFM practices was undertaken in association with complementary agronomic practices including, rotation and crop sequencing, as well as soil and moisture conservation. These were combined with knowledge of how to adapt the practices to local conditions, aiming to optimise the efficiency of the nutrients and improve crop productivity over time (Vanlauwe et al, 2015).

The project uses a participatory learning approach (PLA) based on either strengthening existing farmer groups or establishing new ones, called farmer research and extension groups (FREGs). Discussions were facilitated on agricultural challenges and opportunities, as well as agreeing and implementing ISFM demonstrations by each FREG. These were undertaken by individuals selected by each group with monitoring and evaluation undertaken during training sessions and field days, facilitated by development agents and FREG leaders. At the same time farmer-to-farmer extension has been encouraged through FREG champions and ISFM ambassadors, promoting technologies among marginalized members of the community. This included women, who have at times taken a leading role, as well as less well-off farmers in other community based organisations. This involved capacity building of both extension agents and farmers through the use of innovative extension material and backstopping by extension specialists as part of the PLA.

Over 800 ISFM demonstrations were undertaken in 2016 using the important cereal and legume crops grown in each region. In addition, 2,500 lime application demonstrations were undertaken on the acidic soils found in Amhara and Oromia regions. The paper reports the benefits, costs and viability of the 2016 ISFM demonstrations.

Material and Methods

Demonstration plots were established from June onwards shortly after onset of the rainy season, each of which included improved seed varieties, lime where required, organic and blended inorganic fertiliser, line seeding and good agronomic practices. With Faba bean also rhizobia was included. Each was compared with similarly sized plots utilising normal farmer practices (FP). Interestingly, in many cases farmers had already decided to adopt components of ISFM and these were necessarily included as FP.

The study is based on $20m^2$ crop cuts from over 700 farmer-led demonstrations comparing ISFM and FP for four major crops; faba bean, maize, teff and wheat grown across the three regions. Each demonstration included a $600m^2$ plot using ISFM recommended inputs, compared with a similarly sized FP plot based on farmer accepted practices. Grain and crop residue yields measured from each plot were analysed using Residual Maximum Likelihood or REML (Patterson and Thompson, 1971). REML is typically used as a method for fitting linear mixed models to produce unbiased estimates of variance and co-variance parameters. Standard errors of differences are used in comparing ISFM and FP values.

Further analysis was undertaken comparing the use of lime on the acidic soils in Amhara, where larger quantities are generally required due to higher acidity, in Oromia, where less lime is required and in Tigray, where no lime is required. In this analysis, gross margins ha^{-1}, returns to labour day^{-1} and a benefit-cost ratio were calculated based on yields, average amounts of reported inputs, local prices for inputs, labour and outputs as well as work duration standards for operations obtained from farmers, literature and expert opinion. This involved a participatory analysis with farmers allowing them to evaluate the economic effect of ISFM technologies under their conditions.

Results and Discussion

Yield analysis from the demonstrations showed a significant increase in both grain and crop residue yields using ISFM, when compared with FP, 66% and 42% respectively. These were greatest in Oromia, 82% and 45% respectively and least in Amhara, 56% and 46% respectively (Table 1).

Table 1: Mean crop yields for ISFM and FP practices across Regions

All crops	Practice	No of demonstrations	Predicted Mean Yields (kg ha^{-1})		s.e.d		Significance	% increase	
			Grain	Crop residues	Grain	Crop residues		Grain	Crop residues
All Regions	ISFM	706	3817	8338	84.76	159.4	P<0.001	66%	42%
	FP		2301	5908					
Amhara[1]	ISFM	220	4186	9348	116.2	219	P<0.001	56%	46%
	FP		2688	6384					
Oromia[1]	ISFM	204	3082	4717	181.2	341	P<0.001	82%	45%
	FP		1698	3259					
Tigray	ISFM	282	4368	11722	102.9	194	P<0.001	64%	38%
	FP		2682	8600					

[1]Incudes both limed and non-limed demonstrations, where soil analysis showed no lime was required

Comparative gross margin analysis of the acidic soils of Amhara and Oromia with the non-acidic soil of Tigray showed a substantial increase in gross margins, with a wide variation between both crops and regions, with increases varying from 54% to over 300%. In general, the greatest percentage increases occurred in Tigray and the lowest in Amhara, reflecting the increased quantities and cost of lime required (Figure 1).

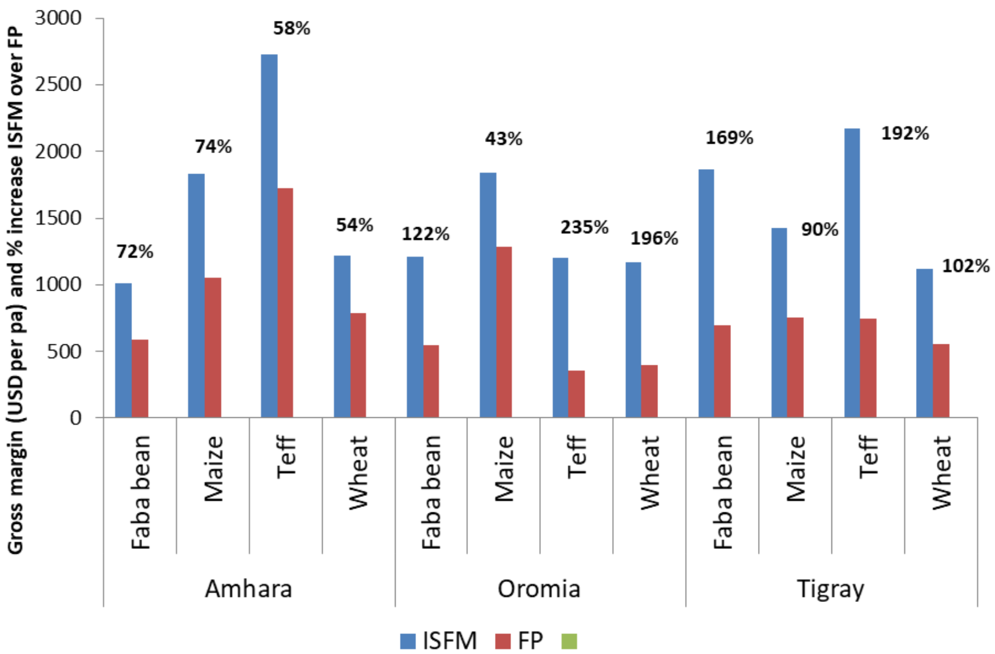

Figure 1: Gross margins for individual crops across Regions comparing ISFM and FP (USD per ha), showing percentage increases

Returns to labour day^{-1} increased substantially using ISFM practices across all crops and regions. At the same time increases in benefit to cost ratios were positive in all cases except for maize in Amhara and in Oromia (Figure 2). This reflects the cost of lime and labour required in these two districts. These are likely to be positive in subsequent crops.

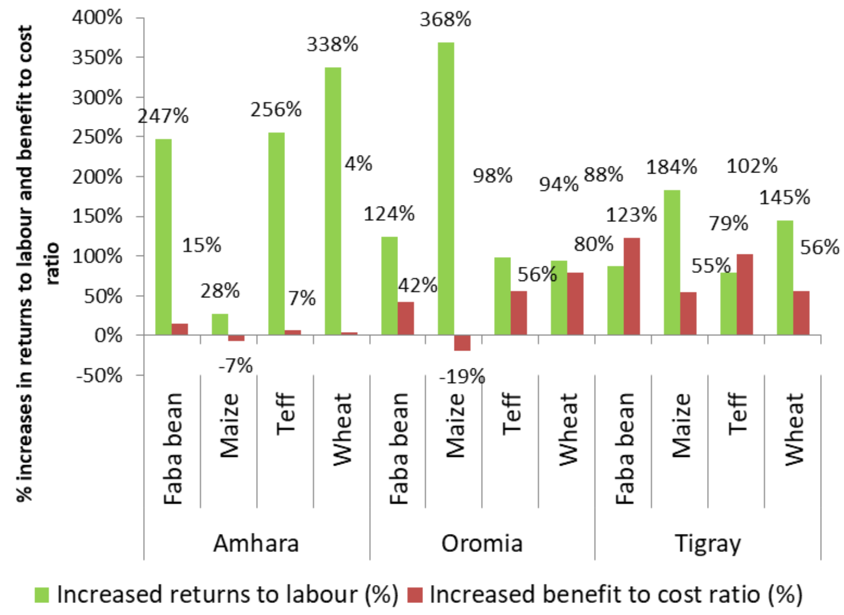

Figure 2: Change of ISFM compared to FP in percentage for labour returns (USD per day) and Benefit: Cost ratios

It should be noted that the costs of lime have been spread over a five-year period as successive crops will benefit over this time period. If the cost of lime is written off a single year, increased gross margins and increased returns to labour are maintained, but increases in benefit-cost ratios are reduced.

In the absence of credit arrangements to pay for the increased cost of inputs especially lime, a government subsidy to reduce the cost of lime can be considered. This is already being provided in some areas, but demand now exceeds demand. The alternatives are to lime small areas each year as well as mitigating the effects of the acid soils by ensuring as much organic matter as possible is incorporated into the soil.

Conclusions and Outlook

Results show that benefits considerably exceed costs and that it can be financially attractive for small scale farmers to invest in soil fertility enhancing technologies. At the same time, many of the components of ISFM can also be described as “Climate Smart”, meaning a win-win situation for both the environment and improving livelihoods. Nevertheless, the availability of inputs, finance and labour, as well as knowledge about ISFM, remain critical to long-term sustainability.

Consequently, scaling up best practices in soil and water conservation and soil fertility management on micro-watersheds has now become a priority for Regional governments seeking to improve food and nutritional security in Highland areas.

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