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Learning Experiences of Farmers Field School on Integrated Nutrient Management: Evidence from Wolaita in Southern Ethiopia

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Abstract: This study presents three years of farmer field school learning experiences on integrated soil nutrient management in Kindo-Koisha district of Wolaita, Southern Ethiopia. Emphasis is placed on the findings of determining optimum combination of compost and inorganic fertiliser (DAP-Urea) experiment conducted under the farmer field school platform in two schools. Three years of group observation, recording, presentation and discussions in plenary has boosted the confidence and experiential learning among participants. It has improved farmers capacity to experiment with technologies and implement the same in their own farms. Grain and biomass yields increased with increasing levels of inorganic fertilisers. However, the yields obtained from treatments of organic and inorganic fertilisers combinations were not significantly different in most cases, implying that reliable yield could be obtained as long as comparable proportions of the two sources are used. Farmers preferred treatments with 50:50% inorganic: organic fertilisers combination on account of cost implications of inorganic fertilisers and risk considerations. But cohesion and sustainability of the farmer field school depends on perceived commercial benefit in the short to medium terms.

Key words: Farmer field school, agro-ecosystem analysis, integrated nutrient management, Ethiopia

INTRODUCTION

In the last two decades, per capita food production has been lagging behind the rates of population growth and food shortage and rural poverty have become chronic problems in Ethiopia (Adenew, 2005). Ensuring food security and at the same time slowing or reversing the trend in agricultural land degradation is one of the challenges that the country is currently facing. Cognizant of the seriousness of the soil fertility problems and the necessity of improving agricultural productivity and food security, government and donors have made extensive efforts to promote yield enhancing and soil conserving technologies. Past efforts and programmes to intensify agricultural production through dissemination of fertilisers, improved seeds and adoption of soil conservation structures have in most cases failed and the adoption and dissemination rates are low even by African standards. The average technology adoption rate of modern fertilisers, for example, is estimated at less than 33% of the cultivated lands and the average level of use of modern fertiliser is only 11 kg ha^{-1}, compared to 48 kg ha^{-1} in Kenya and 97 kg ha^{-1} worldwide (Yesuf, 2005).

Past efforts and programmes failed mainly due to excessive emphasis given to superficially perceived causes of land degradation such as over-cultivation, over-grazing, over-population, deforestation, climatic factors, etc. (Bojö and Cassells, 1995). However, there is a growing consensus in recent literature that these factors tend to be physical manifestations of underlying market and institutional failures (Yesuf, 2005). Development and implementation of technologies that can mitigate declining soil fertility and using strategies that fit within farmers' socio-financial settings are believed to offer potentials for increased agricultural productivity and household income. Approaches which empower farming communities to decide what they need in light of their own environment, rather than making blanket recommendations are essential. This is particularly important to develop sustainable methods for integrated nutrient management in highly degraded highlands of Woilaita in Southern Ethiopia.

Integrated Nutrient Management (INM) technologies and approaches that foster the interaction between science-farmer knowledge base, collaboration between different stakeholders; such as farmers, research, development organisations and extension and farmer learning processes are believed plausible in combining

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technology development and social learning processes for increasing agricultural productivity in East Africa. Farmer Field School (FFS) is one of such approaches developed in Asia. FFS approach was initially developed in Indonesia by FAO in the early 90's to address a major threat to food security resulting from dramatic yield losses caused by the brown plant hopper (Pontius *et al*., 2002). The FFS is a learner-centred approach, whereby farmers through understanding, observation, experimentation and evaluation are equipped to address challenges and make appropriate changes in their farm management practices. Farmers are the main actors in this process and outsiders (research, extension, NGOs) take a role as facilitator or resource centers. It is a forum where farmers make regular field observations, relate their observations to the ecosystem and apply their previous experiences and new information to make a crop or livestock management decision with the guidance of a facilitator (Pretty, 2002). Over the years the FFS approach has been extended to other technical issues in agriculture and rural development such as natural resource management, animal husbandry, conservation agriculture, HIV/AIDS, food security and nutrition (CIP/UPWARD, 2003; LEISA Magazine, 2003; Minjauw *et al*., 2002). More recently the FFS is considered to be an appropriate vehicle for general empowerment of rural areas in which life-long learning processes, strengthening of local institutions and networks, stimulating social processes and collective actions may lead to improvement in rural livelihoods (Hounkonnou *et al*., 2004).

This study presents three years (2002-2005) learning experiences of FFS on INM in Kindo-Koisha district of Wolaita, Southern Ethiopia implemented by Integrated Nutrient Management for Sustainable Productivity Increase in East African Farming Systems (INMASP). Emphasis is placed on assessing the efficacy of participatory farmer field school approach in determining optimum combination of compost and inorganic fertiliser in experiments conducted under the FFS platform in two schools.

MATERIALS AND METHODS

Formation of farmer field school: Ground working activities were carried out in the project site to identify constraints and opportunities, identify possible INM technologies and prospects for using FFS as a platform for developing, testing and promotion of INM technologies. The organisation of the school was pursued as a continuation of the existing self-help groups established earlier by SOS-Sahel for soil and water conservation activities in the catchment. The watershed management groups have been functional for over five years conducting joint activities in watershed protection and flood control. They have already gathered lots of experience in soil and water management.

Consultation and familiarization meetings were held with the Zonal Department of Agriculture and the Woreda Office of Agriculture as part of ground work activities by an INMASP team to provide them with information about the programme to get support. A series of community meetings were conducted within the selected catchment to ensure participatory identification and prioritization of soil management problems and their solutions. Moreover, the fora were used to acquaint prospective participants with the basics of FFS procedures and to gain collaborations and to enlist volunteers to the programme as representatives of the community. Through such exercises it was learned that farmers are enthusiastic to participate in a season long course organized on INM. The first Farmers' Field School was set up in Solkua with a group of 20 farmers in March 2002. The second school was launched at Wache in February, 2003. The schools were run based on standard FFS principles and procedures for three seasons at Solkua and two seasons at Wache.

Curriculum development: Curriculum development workshop was held at the project area, where participants identified possible trials and test crops for experimentation through brainstorming. Accordingly, organic-inorganic fertilisers management trial on maize was identified as top priority. Moreover, agreement was made on the number of study plots and replications. To this end, one central learning plot and four replications belonging to a number of participating farmers owning adjacent plots were suggested. In both cases, the farmers who own experimental plots must be members of the same school. The selected trials were presented to farmers for comments. Farmers were particularly impressed with compost-DAP fertiliser trial and enthusiastic to conduct a season long experiential learning on the treatments.

Meanwhile, appraisal of existing constraints and opportunities in farmers' soil fertility management was done through baseline survey. Besides, productivity and sustainability of the farming system was tested using NUTMON diagnostic tool. The results indicate negative farm nutrient balances in kg ha^{-1} for all the major nutrients Nitrogen (N), phosphorus (P) and Potassium (K). This practice was pursued hand in hand with running the schools.

The organic-inorganic fertiliser combination trial included the following treatments:

Treatments	Description
T_1	100% inorganic fertiliser only
T_2	75% inorganic fertiliser with 25% organic (compost)
T_3	50% combination of each
T_4	25% inorganic fertiliser with 75% organic (compost)
T_5	100% organic fertiliser (compost) only
T_6	Control (without compost and inorganic fertilizers)

The indicators identified for observation by the farmers include; day to germination/emergence, plant count, plant leaf color, plant height, weed density, disease incidence, number of ears/cobs, biomass yield, grain yield, soil moisture holding capacity and soil thickness (work ability). The experiment was conducted in one central learning plot and four replicates in the fields of participating farmers.

Farmers contributed land, compost and provided free labor needed for the activities as per the agreement reached at the inception of the project. Seeds, fertiliser, stationery and other supplementary inputs were supplied by Awassa College of Agriculture. A full time field assistant was contracted to facilitate the field school. Moreover, researchers from Awassa College of Agriculture took care of regular monitoring, technical support and oversight of overall project activities.

Agro-ecosystem analysis: Agro-Ecosystem Analysis (AESA) was carried out in sub-groups with each group assigned a treatment in a rotating manner during each learning day. Season-long participatory monitoring and evaluation of the trial was conducted fortnightly in the central learning plot. Data were recorded and the results were summarized using different formats developed for farmers and facilitators. By means of the exercises contained in these sessions, school participants were exposed to observations and record keeping in small groups followed by discussions on plenary sessions, where findings of the groups were shared and recommendations for future made.

RESULTS AND DISCUSSION

Agronomic indicators and farmers evaluation: AESA was found effective in improving decision-making skills, through a field situation analysis by observing, drawing and presenting small group decisions for critique in the larger group. It is encouraging to see farmers make their own observations, record events and discuss the issues in the fields during the FFS sessions. Special topics on INM and other topical issues to farmers were also included in the learning process. Group dynamic activities incorporated in the learning sessions were also helpful to establish a learning climate that is enjoyable and fruitful. This observation corroborates with the findings from the highlands of Central Kenya where the participation of farmers in FFS experimentation and in AESA leads to a majority of them experimenting in their own farms with technologies learned from FFS or using the acquired skills to experiment on new topical issues of interest (Onduru *et al*., 2006).

At the end of each cropping season, farmers were able to summarize overall outcome of the trial and choose the best treatment based on performance indicators chosen by the farmers' themselves. Some results are presented to substantiate the learning experiences. Increased grain and biomass yields of maize were obtained from all treatments as compared to control plots. Application of organic: inorganic fertilisers in 1:3 proportion resulted in highest biomass and grain yield in Solkua. The grain and biomass yield increments of the treatment were about 130 and 72% over control, respectively (Table 1). The differences in grain yields were highly significant as compared to the control and 100% fertiliser application in the form of organic. However, there was no significant difference between the yields obtained from the plots treated with 100, 75 and 50% of the fertiliser as urea. Generally, inclusion of inorganic fertiliser in the treatments significantly increased the grain yields, whereas application of organic fertiliser alone did not increase yield significantly.

While increasing yields was observed with increasing proportion of inorganic fertilisers, farmers preferred the treatment with 50:50 organic: inorganic combination (Table 2). This option minimizes risk and yet gives reasonable yield, which was not significantly different from the highest yield obtained in the experiment.

Other indicators such as pest infestation, plant leaf colour, plant health, soil moisture, weed infestation and

Table 1: Grain and biomass yield of maize at Solkua FFS

			Grain yield increase over control	
Treatments	Grain ($t\ ha^{-1}$)	Biomass ($t\ ha^{-1}$)	($t\ ha^{-1}$)	Percent increase against control
T_1	1.772	6.270	0.928	110.00
T_2	1.944	6.328	1.100	130.33
T_3	1.735	5.469	0.891	105.50
T_4	1.480	4.981	0.636	75.30
T_5	1.080	4.394	0.236	28.00
Control plot	0.844	3.680	-	-

Table 2: Mean scores of farmer's evaluation of indicators-Solkua FFS

Treatments	Pests	Plant leaf color	Plant health	Soil moisture	Weed infestation	Plant height	Yield
T_1	3	9	8	4	4	9	9
T_2	4	9	7	6	5	8	8
T_3	4	8	7	8	7	8	8
T_4	5	6	6	8	6	6	7
T_5	5	5	4	9	9	4	5
Control plot	6	3	3	2	3	3	3

The indicators were ranked from highest (10) to lowest (0) plant height were monitored. Farmers' observation indicated that there was no remarkable variation among treatments regarding insect pest infestation. Dark green leaf colour of plants was observed on treatments that received higher proportion of inorganic fertiliser and the leaf colour changed to light green with decreasing inorganic fertiliser application and yellow in control. The control was also rated as least by farmers in terms of plant health.

On the other hand, soil moisture was the parameter that was greatly associated with the amount of organic fertiliser. As proportion of organic fertiliser increased retention of soil moisture after rain, increased crop establishment and resistance to drought and ease of ploughing after harvest were noticed. Farmers clearly indicated that despite the crop performance the soil fertility improved with successive use of organic fertilisers. Farmers recognized that the highest weed infestation on the organic plots was the result of the organic materials used (Table 2). Incomplete composting process might have not killed persistent weed seeds, which were transported with the compost and invaded the plots. Hence, the farmers learned the importance of using a composting material before seed setting and/or properly killing the weed seeds in composting process.

Maize plants grown on plots with full or relatively higher inorganic fertiliser rate were found to be vigor and taller in height. This might be due to the availability of nutrients from the water soluble inorganic fertilisers, whereas the rate of release of the nutrients from organic material was relatively slow.

Similarly, the grain yield at Wache FFS increased with increasing proportion of inorganic fertiliser application. The increment over the control ranged from 18 to 292% when the proportion of urea in treatment combinations increased from 0 to 100% (Table 3). Similar to the results of Solkua FFS, there was no significant difference between the yields obtained from the treatments where 100, 75 and 50% fertiliser were applied as urea. The results from these three treatments were, however, significantly different from those obtained from lowest level in proportion of inorganic fertiliser and control. There was no difference between fully organic fertilized plot and control. During monitoring, it was realized that the control plot gets nutrients both from leaching and surface run off in either directions. Therefore, it was suggested both by the farmers and back-stoppers to conduct such experiments dealing with nutrient rates on flat or gentle slope fields.

Generally, inclusion of inorganic fertiliser in the treatments has also significantly increased the grain and biomass yields at Wache where as application of organic fertiliser didn't significantly increase yields. The result fairly compares with other findings of compost-inorganic fertilizer trails in sub Saharan Africa. The influence of five rates each of compost, inorganic fertilizer and combination of both fertilizers on maize (*Zea mays* L.) was evaluated in the greenhouse at Ilora and at Ibadan of Nigeria (Adediran *et al*., 2005). They found an agronomic effectiveness of compost and combination on maize relative to inorganic fertilizer to be 88 and 118%, at Ilora and 81 and 97% at Ibadan.

Farmers of Wache FFS have similarly implemented the AESA. They have also found different treatments responding differently to the parameters or indicators used to study the experiment. The farmers' preferences for the three treatments with relatively highest grain and biomass yields were more or less the same (Table 4). Based on informal discussions, however, farmers are in favour of treatments with less inorganic fertiliser combinations. This might be due to the high cost of fertilisers and risks involved therein in seasons of crop failure. On the other hand, increased application of organic fertiliser improves the chemical and physical conditions of the soil, as was evaluated in terms of moisture retention by farmers at both FFS (Table 2 and 4).

Farmers indicated that plants on inorganic fertiliser plots are resistant to pest attack as compared to those grown on higher proportion of organic fertiliser. This might be due to the vigor of the plants and fast early growth, which enabled them to pass the stage of susceptibility to pests and diseases. The problem of weed infestation at Wache FFS was by far higher than that of Solkua fields due to transportation of weed seeds from the upper slopes by run-on, in addition to those coming with compost material to the fields.

Table 3: Grain and Biomass yield of Wache FFS

Treatments	Grain ($t\ ha^{-1}$)	Biomass ($t\ ha^{-1}$)	Grain yield increase over control ($t\ ha^{-1}$)	(%)
T_1	1.185	3.531	0.883	292.40
T_2	1.124	2.963	0.822	272.20
T_3	0.931	3.098	0.629	208.30
T_4	0.543	1.759	0.241	79.80
T_5	0.357	0.907	0.055	2.00
Control plot	0.302	0.754	-	-

Table 4: Mean scores of farmer's evaluation of treatments-Wache FFS

Treatments	Pests	Plant leaf color	Plant health	Soil moisture	Weed infestation	Plant height	Yield
T_1	4	9	8	8	6	9	9
T_2	5	9	7	8	7	9	8
T_3	5	9	7	8	8	8	8
T_4	6	8	6	8	8	7	6
T_5	4	6	4	9	9	4	4
Control plot	6	4	3	6	4	2	3

Financial evaluation of treatments: Finally, referring to the objective of the experiment, the best combination level of the two fertilisers was assessed using financial benefits obtained.

Financial evaluation of treatments was done by considering the cost of production inputs and market value of the produce. Production cost items considered were external inputs, mainly fertiliser and seeds. Labour is a partial external input in cases where a given household could not fulfill labour requirement from family labour. The local market prices were considered for purchased items while Birr 5 per man-day was used as wage rate for labour. But the family labour used in compost making and other management practices was difficult to measure and not included as cost (Table 5).

Gross revenue, total variable cost and net revenues were calculated for each treatment based on the above inputs price and maize grain prices at local market. Then treatments were ranked according to their financial performance. Treatments with 75% followed by 50% inorganic fertilizer had highest net profit. This result conforms to the finding reported from western Oromia region in Ethiopia where integrated use of compost with inorganic fertilizer is economically feasible (Negessa *et al.*, 2001) (Table 6 and 7).

Impact assessment: Impact assessment was conducted at the end of the project in the area. In that event it was learned that farmers are impressed with the FFS process and combined use of compost and inorganic fertilisers.

Table 5: Inputs levels used per hectare and respective prices

Item/External inputs	Recommended rate	Price at local market
Fertiliser (kg ha^{-1})	300	100
DAP Urea (kg ha^{-1})	225	100
Seed (kg ha^{-1})	100	25
Labour (Man day^{-1})	150	5

Table 6: Financial evaluation of grain yield of treatments -Solkua FFS

Treatments	Yield (t ha^{-1})	Gross revenue (in Birr)	Variable cost (in Birr)	Net revenue (in Birr)	Rank
T_1	1.77	1594.80	775.00	819.80	4
T_2	1.99	1794.60	643.75	1151.00	1
T_3	1.74	1561.50	512.50	1049.00	2
T_4	1.48	1332.00	381.25	950.75	3
T_5	1.09	978.30	250.00	728.30	5
Control plot	0.84	759.60	125.00	634.60	6

Table 7: Financial evaluation of grain yield of treatments- Wache FFS

Treatments	Yield (t ha^{-1})	Gross revenue (in Birr)	Variable cost (in Birr)	Net revenue (in Birr)	Rank
T_1	1.19	1066.50	775.00	291.50	3
T_2	1.12	1011.60	643.75	367.85	1
T_3	0.93	837.90	512.50	325.40	2
T_4	0.54	488.70	381.25	107.45	5
T_5	0.36	321.30	250.00	71.30	6
Control plot	0.30	271.80	125.00	146.80	4

More than 50% of the participants are already using compost, soil and water conservation practices in their own farms. But when they were asked if they could continue as a group as the project withdraws, they said they will not continue. This is because cohesion and sustainability depends more on attractive financial benefits in the short to medium term. Farmer field school should encompass several issues other than soil fertility problems to be of interest to farmers. Continuity of farmer field school largely depends on institutionalization of the approach in government structure and formalization of the group as self help organization with strong economic and social benefits.

CONCLUSIONS

Three years of on farm trial was conducted to determine optimum combination of compost and inorganic fertiliser (DAP-Urea) under farmer field school platform in two schools in Kindo-Koisha district of Wolaita Zone.

Grain and biomass yields increased with increasing levels of inorganic fertilisers. However, the yields obtained from treatments of organic and inorganic fertilisers combinations were not significantly different in most cases. Farmers preferred treatments with 50:50% inorganic: organic fertilisers combination on account of cost implications of inorganic fertilisers and risk considerations.

The technical learning and innovation processes in FFS had a positive impact on the level of knowledge, skills and experimentation/innovation processes of the members. Adoption of the tested technologies by the farm households is selective, but relatively high if a positive impact on one or more of the essential indicators has been observed during the learning and experimentation process. However, the role of outsiders such as extension staff, researchers, NGOs, but also neighbours in technology development remain to be essential to trigger the process in the beginning.

The study shows a relatively limited spread of knowledge generated within the FFS beyond the village in which the FFS is located in all research sites in the region. Questions therefore need to be raised in which way FFS of this type can be effectively used in rural extension strategies.

In order to make the FFS approach effective in addressing long-term rural development challenges such as soil fertility decline, successful adaptations in the original IPM-FFS approach were made focusing on facilitating the development of permanent farmer groups with a focus on sustainable learning and innovation processes. Given the leadership problems during the project period it is concluded that during the facilitation more attention needs to be paid to leadership and group management aspects. Cohesion and sustainability of groups appear to be better when they emerge from or are based upon existing groups, compared to newly formed groups.

The potential impacts of Farmers Field Schools go beyond processes of technical innovations and effectively addressing challenges in the farming system. It should be seen as a stepping stone to establish farmers' organisations, linking farm households to markets and empowerment of rural people. Experiences in this project and elsewhere show that various essential development actions leading to improved income and livelihood, are taken up by well-functioning community groups, which otherwise would never have been initiated. Active facilitation of the emergence of bottom-up farmers' organisation should therefore receive high priority by policy makers, education specialists and private sector partners to arrive at sustainable economic and agricultural development in rural areas in Africa, where the degree of organisation has always been very low.

The results of this pilot project give no indication about the cost effectiveness of FFS compared to existing and other alternative rural development approaches. Also the issue of the challenges and conditions for up-scaling the approach to national level cannot be addressed on the basis of this pilot activity.

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