Early Farmer Evaluation of Integrated Nutrient Management Technologies in Eastern Uganda

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Abstract

There has been widespread recognition of the need to rejuvenate the fertility of soils for sustainable agricultural productivity, food security, household income, and poverty alleviation in sub-Saharan Africa. Since 1999 different Integrated Nutrient Management (INM), technologies have been under on-farm adaptive/ dissemination trials in Tororo district, eastern Uganda. The area is well known for its highly unproductive sandy ferralsols. Options promoted included the use of leguminous trees/shrubs and cover crops such as, Mucuna, Canavalia, Tephrosia, and Crotalaria species. Also promoted were Tithonia biomass transfer and Rhizobia inoculation. For the P deficient soils, various P fertilizers were evaluated including Busumbu Phosphate Rock from nearby deposits, TSP and Minjingu Phosphate rock from Tanzania. Initial assessments by farmers indicate wide-scale testing in the pilot areas and farmer adaptation and innovation of the options promoted. Eighty eight percent (88%) of the farmers who tested the options indicated willingness to expand 56% of these to more than one acre of land. To scale up these efforts to the entire district and to address constraints like seed availability, awareness creation and training, a consortium of R&D partners through a project called Integrated Soil Productivity Initiative through Research and Education (INSPIRE) steered by the District administration has been initiated. Farmer to farmer extension, participatory crop management training, fertiliser use, green manure crop/ shrub husbandry frame the way forward of the project.

Key words: Integrated Nutrient Management, Green manure legume cover crops, Participatory evaluation, Dissemination.

Introduction

Soil fertility depletion in smallholder farms is recognised as a major biophysical root cause of the declining per-capita food production in most of sub-Saharan Africa (Sanchez *et al.*, 1997). Soil fertility rejuvenation for increased productivity, food security and income has been recognised by the Government of Uganda as a strategy towards poverty alleviation (Soil Fertility Initiative –SFI, 1999). The widespread belief by many, including politicians that Ugandan soils are fertile has also been corrected to a recognition that there has been a lot of soil degradation of all forms leading to poorer soils (PMA, 2000).

The government has set up a strategy to combat soil degradation under the Plan for modernisation of agriculture through the Soil Fertility Initiative (SFI).

The SFI in Uganda aim at correcting the negative nutrient balance in smallholder farming. Households needs to move beyond the two extremes of high external input agriculture and the low external input agriculture to integrated forms of agriculture such as integrated nutrient management. The advantage of the integrated approaches to agriculture is the synergism between locally known practices and introduced or research inputs and practices that are developed either through a participatory technology development (PTD) process or participatory learning and action research (PLAR) process. These processes are part of development thinking for poverty alleviation that promotes empowerment of the beneficiaries through partnerships and pluralism (RoU, 1997; Ashley & Carney, 1999).

In Tororo District since 1997, various efforts by the National Agricultural Research Systems (NARS) and an international NGO, (Africa 2000 Network), have been in place to fight poverty of farm households by increasing food security through the promotion of integrated nutrient management technologies. This has been through a consortium involving civil society, NGOs, national agricultural research systems, international agricultural research systems and government, called the Integrated Soil Productivity Initiative through Research and Education (INSPIRE) project. The efforts of the consortia have been directed to Tororo District, because of its dense population of over 280 persons per square kilometre, poorly endowed natural resources, acidic and sandy soils, and a reversion to mainly annual crop system. About 82 % of the district land is farmed making this area a high incidence poverty area (RoU, 1991; Zake *et al.*, 1998; World Bank, 1993).

The INSPIRE Project

The INSPIRE project is a broad based consortium of district based development organisations, the NARS and district local government, formed to address increasing poverty and food insecurity by promoting appropriate soil management technologies for increased agricultural productivity. The partners include: the district government's department of production, Africa 2000 Network (A2N), Sasakawa Global 2000 (SG2000), Tororo District Farmers Association (TODIFA), the Food Security and Marketing organisation (FOSEM) and appropriate Technology (AT) Uganda; a local branch of Enterprise Works Worldwide. Others are Plan International, the International Centre for Research in Agroforestry (ICRAF) of western Kenya and Uganda, Tropical Soil Biology and Fertility (TSBF), The International Centre for Tropical

Agriculture (CIAT), Makerere University, Faculty of Agriculture and the National Agricultural Research Organisation (NARO). The consortium is overseen by a steering committee led by the District Production Officer and the project activities are co-ordinated by Africa 2000 Network.

A five-year activity plan has been made to address the soil needs of the district using an integrated approach. The project goal is the improvement of livelihoods of farmers in eastern Uganda by empowering them to overcome food insecurity and poverty. The project purpose is to improve the soil fertility productivity in Tororo District in a sustainable manner. Four outputs are expected:

1. Establish through baseline studies the current soil fertility levels and farmer management practices, and develop, test and verify with farmers the appropriate and sustainable soil management technologies,
2. Disseminate verified soil management technologies and practices,
3. Improve access to soil fertility enhancing agricultural inputs in the district such as fertilizers, cover crops, seeds, Rhizobia, compost inputs, tree seedlings, and mulching materials and
4. Enhance capacity of the stakeholders to implement sustainable soil fertility management technologies.

To date, the technologies tested on-farm include the use of leguminous trees/shrubs and cover crops such as Mucuna, Canavalia, Tephrosia and Crotalaria species. Also promoted is Tithonia biomass transfer and the use of rhizobium inoculum for legume crops. Since the soils in the district are highly P deficient, P fertilisers including Busumbu Phosphate rock from the nearby Tororo hills have been evaluated in comparison with other sources such as Triple Super Phosphate (TSP) and Minjingu Phosphate rock from Tanzania. The demonstration/ dissemination strategy used several farmers from a farmer research group, who hosted the trials on behalf of the group. Training, field days and farmer evaluation of these trials are conducted throughout the season. Exchange visits between farmer groups were conducted to allow different farmer groups in the District and from outside the District to visit and learn from each other.

This paper that provides an overview of the INSPIRE project, does share results of an early qualitative evaluation of the soil fertility enhancing adaptive trials. The study established the performance of the technological options tested, the initial benefits and constraints, adaptations, relevance of pre-trial training, on farm expansion, continuity and dissemination/diffusion. The future direction of the consortium's planned activities is outlined.

Methodology

The study was conducted in the district of Tororo in Osukuru and Kisoko sub-counties. Tororo district is found in eastern Uganda bordering Kenya. Most of the district is flat, lying at an altitude of 1,097 to 1,219 m above sea level and a temperature range of 15.7° to 30.6° C. The annual rainfall is more than 1,200 mm per year. It has a population density of about 280 persons per sq. km, with over 82% of the land under agriculture. Soil type in the area is sandy loam often acidic and K deficient. Soil erodibility and erosivity is moderate (Wortmann and Eledu, 1999).

There were two stages to the qualitative analysis:

1. Data were collected using a structured interview schedule, developed by the NARS partners of the INSPIRE project. The sample size was 25 out of the 92 farmers who conducted demonstration trials between 1998 and 2000 (Table 38.1). Data were collected in June-July 2000 by the extension workers of A2N who had been trained on the data collection processes.
2. A qualitative group evaluation of the legume cover crops to capture their performance was conducted in February 2001. A pair-wise ranking of the legume cover crop preferences was done with the farmers. Farmers hosting the green manure trials were invited along with those who were interested in trying out the technologies. Sixty farmers were in attendance in the Kisoko meeting and more than 70 from Osukuru. Only data from Kisoko will be presented in this paper.

Table 38.1: Numbers of farmers who hosted the trials

Trial description	No. of farmer trials	Number of evaluated farmers
1. Determining the effectiveness of Busumbu rock phosphate as a source of P using maize as a test crop	20	14
2. Determining the effectiveness of Busumbu rock phosphate as a source of P using groundnuts as a test crop	20	7
3. Determine the contribution of Nitrogen by inoculated groundnuts	16	10
4. Compare the integration of Tithonia biomass with TSP to the sole application of inorganic fertilizer at an equivalent rate of NPK	10	5
5. To determine the effectiveness of using legume cover crops (LCCs) as an organic source of fertilizers on maize	10	6

Results and Discussion

Farmer evaluations of phosphate rock, biomass transfer and rhizobia innoculum

Farmers evaluating the technologies were asked about what they had feared before hand and what had actually been constraints or problems during the trials. They also explained what they had learned from the trials, and how the technologies compared with each other. Nearly half of the farmers (48%) indicated that their main fear prior to testing the different options was related to their experience with inorganic fertilizers (Table 38.2). In particular, Busumbu phosphate rock was unfamiliar to nearly a third of the farmers (32%). In contrast, few farmers were unfamiliar and worried about the use of the organic fertilizers. Worries about lack of funds to buy inorganic inputs or hybrid maize seed were also common (28%). Lack of funds for inputs was not an issue for the use of Tithonia, compost and Rhizobia, because these relied more on labour than capital inputs, the former being cheap.

Table 38.2: Fears held by farmers before the trials were hosted (n=25)

	Impro-ved maize	Busu-mbu blend	Busu-mbu PR	Minji-ngu PR	TSP	Urea	P and K	Titho-nia	Com-post	Rhiz obia
Had never used it before	_	40%	40%	40%	40%	40%	40%	_	_	_
Lack of funds to buy inputs	28%	28%	28%	28%	28%	28%	28%	8%	4%	4%
Not known as a fertilizer	_	32%	32%	_	_	_	_	_	_	_
Source not known or not available	16%	_	_	28%	28%	28%	28%	_	_	_

Amongst the things learned from the trials (Table 38.3), the most indicated was the use of inorganic fertilisers (69%). It is also interesting to note that most of the new knowledge farmers indicated to have learned addressed general techniques of crop management, such as using fertilisers, line planting, thinning, weeding and top dressing, rather than specific organic technologies such as the legume cover crops (12%) or applying tithonia biomass (4%).

Table 38.3: Things farmers learnt from the trials (n=25)

Things farmers learnt	Frequency	Percentage
Use of fertilizers	18	69
Line planting/spacing	11	42
Inoculation with Rhizobia	4	15
Thinning	3	12
Top dressing	3	12
Planting legume cover crops	3	12
Frequent weeding	2	8
Planting tithonia	1	4
Measuring of harvest area	1	4

Table 38.4: Current impressions of the soil fertility enhancing options (n=25)

	Busumbu	Busumbu blend	Minjingu PR only	TSP	Urea	P and K	Tithonia	Compost	Rhizobia
	Percentage (%)								
Gives higher yields	48	48	48	48	48	48	16	_	16
Not well known	28	28	28	28	28	28	_	_	_
Poor performance	4	4	_	_	_	_	_	_	_
Not aware of option	4	4	4	4	4	4	_	_	4
Increased number of groundnut pods	_	_	_	_	_	_	_	_	16

In general, nearly half of the farmers (48%) felt that yields had improved from the use of inorganic fertilisers and only 4% felt that the Busumbu PR or Busumbu blend had performed poorly (Table 38.4). The use of organic materials appeared less compelling – 16% said *Tithonia* had increased yields, while a similar proportion felt that the use of *Rhizobia* had increased yields or the number of groundnut pods. When asked about whether they wanted to expand the areas dedicated to the trials, 83% were prepared to do so. Over half (56%), would increase the area to between one and ten acres, 28% would dedicate at least half an acre , and 8% would allocate a quarter acre.

Farmers' own experiments and dissemination efforts

Farmers learnt how to conduct own experiments following contact with the INSPIRE project activities. The own experiments given as provided by the farmers included planting:

1) maize with compost,
2) maize with FYM manure,
3) groundnuts with compost,

4) groundnuts and spraying with urine to control pests and diseases,
5) pineapples with and without compost and ash,
6) beans with compost,
7) sorghum with compost and
8) maize with and without Di-Ammonium Phosphate (DAP).

Farmers indicated to have had regular discussions about the trials and the newly learned techniques with their neighbours. Over three quarters of the farmers (76%) had discussed the trials specifically, while 92% said they had discussed related topics. These topics included: use of both organic and inorganic fertilisers to increase yields, spacing and line planting of maize and groundnuts, timely planting as well as group formation and working together. In the process, a total of 179 other farmers were talked to (Table 38.5). On average each farmer had talked to 9 farmers. These discussions resulted in neighbouring farmers wanting to participate in the evaluation of some of the technologies, line planting and spacing (48%), planting maize with fertilizers/Tithonia (20%) and use of compost (4%).

Table 38.5: Number of neighbours the farmers told about the technologies

Number of other farmers contacted	Frequency	Total
20	4	80
15	1	15
10	4	40
6	3	18
5	2	10
3	5	15
1	1	1
None	5	
	25	179

Participatory group evaluations of the legume cover crops/ shrubs

Six farmers who hosted the legume cover crops/improved fallow experiments for two seasons were involved in the participatory evaluation of the cover crops. In addition over 60 farmers who included those who had grown the fallows and were about to incorporate the fallows and those who wanted to start the on-farm test trials, were present at the evaluation. A number of issues arose from the evaluation of the technologies and the highlights based on specific criteria/aspects are given in Table 38.6.

Table 38.6: Qualitative evaluations of the legume cover crops/shrubs

	Legume cover crops/shrubs					Legume shrubs/trees		
	Crotalaria grahamiana	Tephrosia	Mucuna	Canavalia	*Crotalaria pancilla*	Sesbania	Calliandra	Leucena
Germination	Took a week to germinate					Took 4 days if seed is soaked in hot water		
Vegetative growth	Good		Very good	Good	Fair			
Pests	Attacked by caterpillar when its moist							
Solutions to pests	Spray with pesticides or use ash							
Drought resistance	Good if planted closely	The Best			Good if planted closely			
Labour require-ments	High for weeding	High for weeding						
Harvesting seed	Seed harvesting need a lot of labour							
Family labour contributor	All participate but the men do more work on the crops							
Seeding		Easily attacked by cater-pillars,	Gives higher seed yields		Easily eaten by cater-pillars			
Seed	Farmers have their own seed stands				Most scarce	Farmers have their own seed stands		
Seed needed		Want more seed			Want More seed			

Initial benefits of the green manure cover crops

The farmers indicated the initial benefits of growing the green manure cover crops. With germination, mucuna was considered the best, followed by canavalia and *Crotalaria grahamiana*. Mucuna was indicated to rapidly produce thick vegetation on the land that smothered weeds.

Maize planted with mucuna grew very fast and looked healthy. It was rated the best in terms of drought resistance, while *C. grahamania*, and *C. pancilla* were good at drought resistance if planted closely. Mucuna also gave the highest seed yields. It was used as a livestock feed, and its boiled seeds were edible to humans.

Tephrosia rejuvenated soil fertility, killed mole rats and was quick maturing. It could also be used for harvesting fish.

Sesbania improved soil fertility and could eradicate the striga weed if planted as a fallow. It also provided firewood and its poles were used to make fences. Canavalia controlled weeds when planted in banana plantations, and its seed were edible after boiling. Tithonia could be used as medicine against cough, and stomach pains. As a measure to ensure seed sufficiency, farmers had established own seed stands for most of the legume cover crops/shrubs except for *C. pancilla*. However, they wanted more seeds for those crops with seeding difficulties (*C. grahamania*, and *C. pancilla*). Apparently men worked more on the green manure crops than women.

Difficulties with the fallows planted

Farmers indicated the difficulties they encountered with the fallow crops. Crotalaria species had small seed and were easier to broadcast than to plant in lines. Weeding crotalaria before it establishes was a laborious exercise and it needed spraying or use of ash when infested by the caterpillars. All legume cover crops and shrubs were indicated to have difficulties in getting seeds. Sesbania had beetles that ate the leaves and young shoots, which tended to kill the plants. Sesbania pods were usually sharp pointed at the end and pierced during transportation. Mucuna which has climbing characteristics increased the labour demands to have it removed from the crops it was intercropped with such as maize. Canavalia pods were hard to split during threshing, while tephrosia was difficult to weed and produced itching dust when threshing. Tithonia was observed to leave a bitter taste in ones hands after working with it. A number of these findings concur with those in Miiro *et al. (in press)* who reported on the integration of green manure cover crops in the farming systems of small scale farmers in Iganga district. They particularly point out labour difficulties associated with mucuna intercrops, and harvesting crotalaria.

Table 38.7 shows the pairwise ranking that was done for six legume crops including mucuna, canavalia, *Crotalaria pancilla, Crotalaria grahamiana*, sesbania, and tephrosia. The criteria for evaluating the crops included their ease to germinate, vegetative production, and ease to manage. Results show that farmers ranked mucuna first followed by sesbania then *Crotalaria pancilla, C. grahamiana*, tephrosia and canavalia. In Iganga district, small holder farmers integrated mucuna more than the other species because of its fast growing nature, and ability to improve soil fertility (Miiro *et al. in press*)

Table 38.7: Pairwise ranking of the five important legume crops/shrubs in Kisoko

Mucuna	Canavalia	*Crotalaria pancilla*	*Crotalaria grahamiana*	Sesbania	Tephrosia	Score	Rank	
	M	M	M	M	M	5	1	Mucuna
		P	G	S	T	0	6	Canavalia
			P	S	P	3	3	*C. pancilla*
				S	G	2	4	*C. grahamiana*
					S	4	2	Sesbania
						1	5	Tephrosia

Conclusions and implications for the INSPIRE project

The testing on-farm of the various inorganic and organic sources of nutrients by farmers in eastern Uganda, seems to yield useful learning experiences to both the farmers and the INSPIRE members. Initial worries about the experiments were hinged around the use of inorganic fertilisers and their being expensive. This however reveals a knowledge gap and need to expose farmers to the various soil fertility options including their crop yield and cost implications. Further sustainable promotion of integrated nutrient management system should take care of this. The choice of fallow species depends very much on the production constraints that the farmer wants to address; whether smothering invasive weeds like couch grass, or introducing a multi-purpose legume for livestock feed or fuelwood not just soil fertility. Not surprisingly, due to financial constraints farmers are more inclined towards technologies that do not require a large capital investment and would rather allocate their time to production and management of legume cover crops and improved fallows.

Farmer to farmer communication was seen as a very successful way of disseminating new technologies to a wider audience. This should be reinforced with farmer exchange visits, field days, and training farmer extensionists or farmer to farmer training. There was willingness among the farmers of Tororo district to test new technologies. Interestingly, after many years of extension services on crop production, one of the main results from the technology testing was the increased knowledge on crop management in terms of planting, thinning and weed management. Understanding of farmer priorities and constraints, decision making and how farmers trade-off production technologies and their time will be increasingly important in targeting interventions/

technologies to smallholder farmers. The INSPIRE project needs to refine these technologies through more participatory technology testing approaches to foster adaptability to farmer conditions and empower farmers with a sustainable green manure husbandry system that includes a strategy to ensure seed sufficiency.

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References

Ashley, C. and Carney, D. (1999) *Sustainable Rural Livelihoods: Lessons from early experience.* Department for International Development (DFID) Russel Press Ltd. Nottingham United Kingdom.

PMA, (2000) *"Plan for the Modernisation of Agriculture: Eradicating Poverty in Uganda" Government Strategy and Operational Framework.* Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and the Ministry of Finance. Planning and Economic Development (MFPED). Government of Uganda.

Miiro, R., A. Esilaba and S. David (in press). Integration and dissemination of green manure cover crops in African small scale farming systems: Successes and constraints in Eastern Uganda. *Paper accepted by the Makerere University Agricultural Research Institute Kabanyolo Bulletin*

Republic of Uganda (1991) *Housing and Population Census.*

Republic of Uganda (1997) *The Local governments Act 1997* and *the Local Governments (Amendments) Act, 1997.*

Sanchez, P., Izac, A.M., Buresh, R., Shepherd, K., Soule, M., Mokwunye, U., Palm, C., Woomer, P. and Nderitu, C. (1997) Soil Fertility Replenishment in Africa as an Investment in Natural Resource Capital. In: Buresh, R., Sanchez, P. (eds.), *Replenishing Soil Fertility in Africa.* SSSA Special Publication 51 Madison WI: Soil Science Society of America (SSSA).

SFI (1999) *Uganda. Soil Fertility Initiative.* Concept Paper. Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), National Agricultural Research Organisation (NARO), Food and Agricultural Organisation (FAO) and Investment Centre Division FAO/WORLD BANK Co-operative Programme. The Republic of Uganda.

Zake, J.Y.K., Nkwiine, C., Miiro, R. (1998) A baseline study of the Farming Systems of Client Farmers of Africa 2000 Network in Tororo District, Eastern Uganda.

Wortmann, C.S., Eledu, C.A.. (1999) *Uganda's Agro-ecological Zones: A guide for planners and policy makers.* Kampala Uganda: Centro Internacional de Agricultura Tropical (CIAT).

World Bank (1993) *Uganda Growing out of Poverty.* World Bank Country Report.