Output 3
Partnerships and tools developed and capacity enhanced of all stakeholders for improving the health and fertility of soils

Output 3: Partnerships and tools developed and capacity enhanced of all stakeholders for improving the health and fertility of soils

Rationale

Managing soil fertility for improved livelihoods requires an approach that integrates technical, social, economic, and policy issues at multiple scales. To overcome this complexity, research and extension staff needs the capacity to generate and share information that will be relevant to other stakeholders working at different scales (i.e., policy-makers, farmers). Thus the activities of Output 3 are founded on building the human and social capital of all TSBF-CIAT stakeholders for research and management on the sustainable use of tropical soils.

The challenge of building the social capital encompasses both the new and existing networks of scientists and other stakeholders (e.g.: AfNet, MIS, CSM-BGBD project). Within these networks, as within the individual project activities where TSBF-CIAT works in partnership with others (NARES, ARI's, NGO's), building social capital means ensuring that communication and co-learning support effective institutional collaboration and build confidence in the collaborative advantage afforded by partnerships. Networks run best with diligent coordination that responds to internal and external challenges. However, partnerships become truly empowering when stakeholders themselves recognize and exploit research and development opportunities. The activities prescribed here envisage tapping the potential of South-South collaboration and establishing strategic partnerships that can build learning strategies that to institutionalize ISFM approaches.

The second challenge, of building human capacity, is particularly acute in sub-Saharan Africa and Central America, where the lack of strong tertiary education systems and the chronic under-funding of NARES hamper the professional development of many of our partners. Since ISFM approaches are inherently holistic, effective training demands interdisciplinary cooperation to instill both a specialized knowledge and a competent understanding of the context(s) in which to apply it (the so-called "T-shaped" skill set). Again, working through new and existing networks and partnerships, TSBF-CIAT will continue to support training that offers cutting-edge biophysical science, laboratory techniques, and also embraces holistic understanding of social, cultural, economic, and policy issues related to soil fertility management.

Building human capacity also applies to the relationship land users have with the products of research. At present, many ISFM technologies remain little used by farmers. This is commonly conceived of as a failure to disseminate the results of research, but can also be seen as indicating a fundamental failure of research toecognize, value, and address farmers' conditions and knowledge. Greater involvement of farmers in the technology design process (to adapt solutions to actual conditions) will not only generate more relevant and adoptable ISFM technologies but is also expected to facilitate the potential dissemination and up-scaling of these technologies through the better interaction and integration of indigenous and formal knowledge systems.

Finally, the lack of an enabling policy environment is made manifest by the often-contradictory policies relating to farm, village, or regional-level conditions. The poor functioning of local input and output markets distorts the incentives for resource conservation. Coherent policy options are needed to address the low added value of farmers' products, the general lack of marketing opportunities on the one hand, and the lack of appropriate infrastructure and mechanisms for input delivery on the other.

Key research questions

1. What are the mechanisms and information required for institutionalization of ISFM approaches with partners for scaling-up and increased impact?

2. Who are the key stakeholders and partners for SLM?
3. What are the relevant learning processes and approaches to improve stakeholders' skills to make improved decisions?
4. How can South-South integration facilitate the development of global products?

Highlights

∉ In Migori district, western Kenya, different R&D approaches were tested. In the first group farmers were invited to collaborate with researchers in the design and conduct of agronomic soybean experiments. In the second group, farmers' representatives were trained in experimentation and then sent to their zones to motivate farmers to experiment for themselves with soybean. During the first season of the research, large differences in behavior and response could be noticed between the two groups. While the initial motivation of the first group was higher, this motivation changed into a demanding attitude and tensions between the farmers and researchers. The second group reacted more positively. Although wondering why the project had not put experiment fields in their zones, the farmers were very interested to evaluate their own experiments. As farmers felt total ownership over the experiments they were not asking for extra compensation. The only requests of farmers were about advice on how to improve their experiments.

∉ The formation of a Strategic Alliance of partners with complementary contributions to make in soybean promotion among smallholder farmers in the farming systems of Kenya has been yielding great fruits including increases in land area devoted to soybean, increases in soybean yield, farm level profitability ranging from 18, 000 to 42, 000 Kenya Shillings (US$265 to US$ 618) per hectare and net returns increase of four to 14 times from value-addition.

∉ The promotion of soybeans in Kenya through the formation of a Strategic Alliance of partners and stakeholders with complementary contributions is enhancing the use of soybeans especially among smallholder farmers in the farming systems of Kenya at all levels including increases in land area devoted to soybean, increases in soybean yield, farm level profitability and net returns increase of four to 14 times through value-addition

∉ In Mozambique, results show that there are no significant differences between group members in terms of investments into social capital, the extent of private goods that are generated by the group are not equally distributed amongst group members. Social capital is more easily accumulated by educated, younger male group members which reflects access to education and cultural social status. Gender has been identified as a key variable to determine a members ability to generate supportive relations and benefit from social capital.

∉ Field study in Burkina Faso on **NERICA (NE**w **RIC**e for **A**frica) varietal differences in the effectiveness of use of nitrogen found three NERICAs (NERICA L 19, NERICA L 20 and especially NERICA L 41) to be more "efficient" varieties with respect to the use of nitrogen as evident from the increasing production with increase in the rate of N application.

∉ The effects of previous cowpea (*Vigna unguiculata*) and annual fallow on N recoveries, succeeding sorghum yields and soil properties were studied using a 5-years old field experiment at the agronomic research station of Kouaré in Burkina Faso. Sorghum produced less than 500 kg ha^{-1} of grain in monocropping. But sorghum produced highest grain yields when fallow or cowpea was used in the cropping system (fallow-sorghum or cowpea-sorghum rotation). The succeeding sorghum grain yields increased from 75 to 100% when it was rotated with fallow and cowpea respectively. The effects of rotations seamed to increase over time and cowpea became most effective on sorghum yield increase during the last three years.

- AfNet research activities continued to be implemented in several sites in Kenya during the year 2006. AfNet supported the trial on nutrient and water management in Emali, Eastern Kenya under the Desert Margins Programme (DMP). AfNet participated in the farmers' field day held on 8th June 2006 at Emali Primary School to demonstrate to the farmers the technologies that can be used in the arid and semi-arid areas (ASALs) for improved agricultural production and environmental conservation. During the field day, participants visited the experimental site. The technologies being experimented were water harvesting (tie ridging), manure application, inorganic fertilizer application, crop rotation, and different maize and cowpea cropping systems. The cropping systems comprised the rotation of maize with cowpea, intercropping both crops and planting them as monocrops. The combined effects of all these factors on crop performance were also demonstrated.

- As part of the WFCP (Water & Food Challenge Program) project "Payment for Environmental Services (PES) to promote rural development in upper watersheds of the Andes" to enhance local capacities required to measure and quantify environmental externalities, several capacity building events (involving 2 training courses, 8 technicians, 1 MS student) have been carried out that were focused on the use of hydrological models for quantification of hydrological services and on the valuation of those services.

- The annual planning meeting with CIAT-MIS collaborators participating in the N fertilization trials for corn in Honduras and Nicaragua, held in 2006 at Siguatepeque - Honduras, was expanded into a joint 3-day workshop with NGO participants in the FAO project for subsistence farmers in Honduras.

Output target 2007

ü *Strategy for building capacity for SLM is developed with partners*

Completed work

I. AfNet - Research progress report from West Africa

The African Network for Soil Biology and Fertility (AfNet) continues its work through the support of research activities in several sites scattered all over the East, West, Central and Southern Africa. In 2006 several trials were continued and these continue to provide vital information on the performance of the various soil and water management technologies being developed and tried out by researchers and farmers. In its effort to build capacity of researchers in the region, AfNet organized two training workshops: Gender mainstreaming and participatory research, monitoring and evaluation which were attended by several AfNet members. These training courses have improved the 'T-shaped' skills of the scientists making them able to address the complex issues affecting resource allocation and natural resource management at farm level. AfNet supported the organization of the Soil Science Society of East Africa (SSSEA) conference and also sponsored several members to attend workshops/conferences where they resented their research findings. Afnet continues to support student training at both MSc and PhD levels. During 2006, 22 students were supported and/or supervised in their studies. Several papers were also published by AfNet staff in refereed journals. The year 2006 saw the publication by Nutrient Cycling in Agroecosystems Journal of the AfNet Symposium Special Issue titled: *Advances in integrated soil fertility management in sub-Saharan Africa: Challenges and Opportunities*. The Special issue contains 19 papers out of the 104 papers presented at the AfNet Yaoundé Symposium. Through AfNet, *The Comminutor*, Newsletter of the TSBF Institute of CIAT Vol. 10: 1 June 2006 was published. The report presents the major research highlights and activities of AfNet during the year 2006.

Since 2001, network experiments in West Africa using commonly developed research protocols. In Niger at Sadore, some long-term on-station trials continue to be run with the objective of identifying sustainability indicators. Four sites including Sadore (Gaya, Banizoumbou, Karabedji and Sadore) are also used to carry out on-farm researchers and farmers' evaluations of soil fertility technologies. The fertilizer equivalencies of organic amendments are one of these trials where manure is collected in the different sites and crop residues were analyzed for N, P, and K. Its values are very high in the semi-arid zones indicating that the critical value for immobilization and mineralization is site-specific. Other technologies are tested such as optimum combination of PR and inorganic fertilizers, small placement of fertilizer (microdose). Research activities in West Africa are under a memorandum of understanding between TSBF institute of CIAT and ICRISAT.

<u>Network research sites in Niger 2006</u>

In Niger (West Africa), several sites have been established since 2001 and being continued in 2006. Table 29 shows a list of Network collaborative trials in Niger, 2006 giving the type of trial and sites located.

Table 29. Network collaborative trials in Niger (West Africa), 2006.

Type of Trials	Site
Long-term operational scale research	Sadore
Long-term cropping system	Sadore
Long-term crop residue management	Sadore
On-farm evaluation of cropping systems technologies	Sadore Karabedji Gaya
On-farm evaluation of soil fertility restoration technologies	Karabedji Gaya
Comparative effect of mineral fertilizers on degraded and non degraded soils	Karabedji
Fertilizer equivalency and optimum combination of low quality organic and inorganic plant nutrients	1. Banizoumbou 2. Karabedji 3. Gaya
Optimum combination of phosphate rock and inorganic plant nutrients	Banizoumbou, Gaya Karabedji, Sadore
Corral experiment (demonstration)	Sadore

1. Long-term soil fertility management trials

a) Long-term management of phosphorus, nitrogen, crop residue, soil tillage and crop rotation in the Sahel

This experiment started in 1986 by ICRISAT Sahelian Center is a long-term soil fertility management trial that studies the sustainability of pearl millet based cropping systems in relation to management of N, P, and crop residue, rotation of cereal with cowpea and soil tillage. Table 30 gives the main treatments in this trial. It's a split-split-plot design where split-split plots consist of crop residue application or no crop residue (CR) application and the sub-sub plot has with or without nitrogen application. The amount of CR applied is half of the total production of the previous year.

Results from the trial indicated that traditional farmers' practices yielded 156 kg/ha of pearl millet grain whereas application of 13 kg P ha^{-1}, 30 kg N ha^{-1} and crop residue in pearl millet following cowpea yielded 925 kg ha^{-1} of pearl millet grain and 977 kg ha^{-1} when ridging was associated (Table 31). These results clearly indicate the high potential to increase pearl millet yields in the very poor Sahelian soils.

Table 30. Main treatments used in the operational scale research trials at Sadore.

Treatments
1= Traditional practices
2= Animal traction (AT) +no rotation +Intercropping + P
3= Animal traction (AT) + rotation +Intercropping + P
4= Hand Cultivation (HC) +no rotation +Intercropping + P
5= Hand Cultivation (HC) + rotation +Intercropping + P
6= Animal traction (AT) +no rotation +Pure millet + P
7= Animal traction (AT) + rotation + Pure millet + P
8= Hand Cultivation (HC) +no rotation + Pure millet + P
9= Hand Cultivation (HC) + rotation + Pure millet + P

Table 31. Effect of fertilizers, soil tillage, crop residue, cropping system on pearl millet grain yield; Sadore 2006 cropping season.

Treatments	Pure millet grain yield (kg ha^{-1})							
	- Rotation				+ Rotation			
	- Crop residue		+ Crop residue		- Crop residue		+ Crop residue	
	-N	+N	-N	+N	-N	+N	-N	+N
Traditional	156	146	225	234				
Phosphorus + HC	448	651	566	853	741	902	652	925
Phosphorus + AT	329	404	481	638	654	882	1043	977

HC: hand cultivation, planting on flat; AT: Animal traction, planting on ridges

b) Long-term management of manure, crop residues and fertilizers in different cropping systems

This factorial experiment started in 1993 is located at the research station of ICRISAT Sahelian Center at Sadore, Niger. The first factor is three levels of fertilizers (0, 4.4 kg P + 15 kg N ha^{-1}, 13kg P + 45 kg N ha^{-1}), the second factor is crop residue applied at (300, 900 and 2700 kg ha^{-1}) and the third factor is manure applied at (300, 900 and 2700 kg ha^{-1}). The cropping systems are continuous pearl millet, pearl millet in rotation with cowpea and pearl millet in association with cowpea. The analysis of variance data indicate that fertilizer, crop residue and manure application resulted in a highly significant effect of both pearl millet grain and total dry matter yields. Fertilizer alone accounted for 18% in the total variation of the grain, the cropping system accounted for 19% whereas manure account for only 5% of the total grain variation due to some long periods of drought that reduce significantly its mineralization. Although some interactions were significant, they account for 3% in the total variation. In this particular year, the cropping system seemed more significant than fertilizer due to the rainfall repartition.

For pearl millet dry matter, the application fertilizer, manure, crop residue and cropping systems together account for 56% of the total variation. The data in Figure 45 illustrates the response of pearl millet grain to the crop rotation and to the different input of organic and inorganic fertilizers. The farmer's practices yielded 109 kg ha^{-1} of millet grain; the application of 13 kg P and 45 kg N ha^{-1} yielded 670 kg ha^{-1} but when these mineral fertilizers were combined with 2.7 t ha^{-1} of manure or crop residue in rotation with cowpea, yield of 900 kg ha^{-1} was achieved.

In another crop residue (CR) trial established since 1982, sole application of CR increased the millet grain yield from 142 kg ha^{-1} in the absolute control to 297 kg ha^{-1}. The yield was 586 kg ha^{-1} with fertilizer (F) application and to 683 kg ha^{-1} when both CR and fertilizer were applied (CR+F). The millet total dry matter yield increased from 840 to 1960 kg ha^{-1} with CR application (Table 32). This could be as a result the large cumulative effect of CR and fertilizers on the soil (organic carbon, protection against erosion…) over these years.

2. Banizoumbou, Sadore and Gaya

In 2005 and 2006, farmers conducted network experiments at 4 benchmark locations across Niger country to investigate the best combination of mineral fertilizer and PR that are available for direct use. The data in Table 33 give the rainfall and chemical characteristics at study sites in the Sahel. These soils are acidic and inherently low in nutrients with ECEC of less than 1 c mol kg^{-1} for all the sites except Gaya where the organic carbon is slightly higher and an ECEC of 1.3 c mol kg^{-1}.

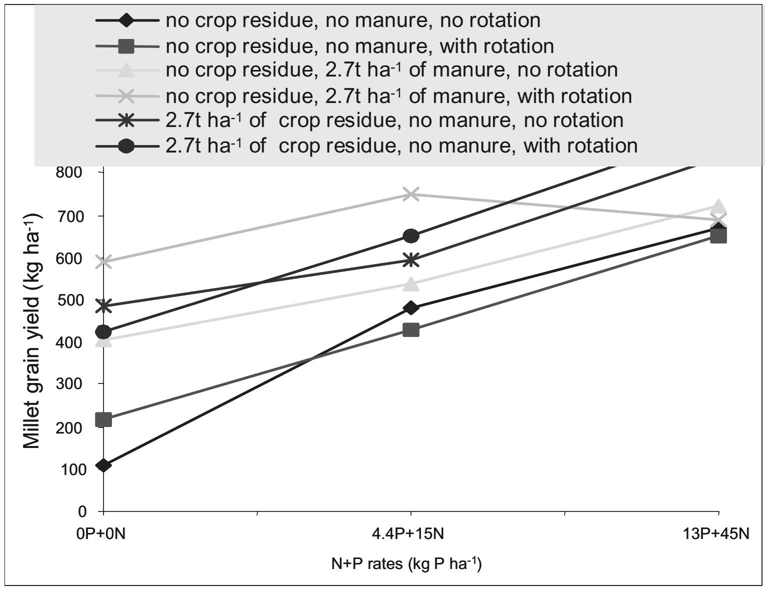


Figure 45. Effect of different N and P rates on pearl millet grain yield, Sadore, Niger, 2006 rainy season.

Table 32. Effect of fertilizer and crop residue on pearl millet and cowpea at Sadore, 2006 rainy season.

Treatment	Grain yield (kg ha^{-1})		TDM (kg ha^{-1})	
	Millet	Cowpea	Millet	Cowpea
1=Control	142	25	840	375
2=crop residue (CR)	297	16	1960	328
3=Fertilizer (F)	586	21	2908	415
4=CR+F	683	25	3693	578
SE	76	14	308	83
CV (%)	36	126	26	39

Table 33. Annual precipitation (2006) and soil characteristics for selected villages.

Sites	Rainfall (mm)	pH KCl	C.org (%)	P-Bray1 (mg kg^{-1})	Ca^{2+} (Cmol kg^{-1})	ECEC (Cmol kg^{-1})	N_{min} (mg kg^{-1})
Sadore	558.6	4.3	0.12	2.0	0.3	1	3
Banizoumbou	?	4.4	0.12	1.5	0.4	0.8	5
Karabedji	493.7	4.2	0.16	1.9	0.2	0.8	4
Gaya	998.7	4.2	0.33	2.5	0.4	1.3	9

The data in Tables 34, 35 and 36 indicate the comparative advantage to combine PR and inorganic plant nutrients for the low suffering soils in the Sahel. Although the experiment started last year, the use of only inorganic P sources yielded 927 kg ha^{-1} of millet grain whereas the same rate as PR farm gave 970 kg ha^{-1} at Sadore. The cowpea fodder yielded in the inorganic P application at Gaya give 2375 kg ha^{-1} and 1650 kg ha^{-1} with the PR.

Table 34. Optimum combination of plant nutrients for cowpea fodder (kg ha^{-1}) at Karabedji, Niger, 2006 cropping season.

Treatments	Karabedji
1 Absolute Control	2253
2 30 kg N ha^{-1}	3358
3 12 kg P ha^{-1}	2796
4 8 tons manure + 30 kg N ha^{-1}	3172
5 6 t manure + 3kg P + 30 kg N	2813
6 4 t manure + 6 kg P + 30 kg N	3340
7 2 t manure + 8 kg P + 30 kg N	3810
8 12 kg P + 30 kg N	2893
SE	413
CV	27%

Table 35. Optimum combination of plant nutrients for millet grain and TDM (kg ha^{-1}) at Karabedji, Niger, 2006 cropping season.

Treatments	Grain	TDM
1. Absolute Control	375	2155
2. 30 kg N ha^{-1}	568	2829
3. 12 kg P ha^{-1}	740	3447
4. 8 tons manure + 30 kg N ha^{-1}	953	4114
5. 6 t manure + 3kg P + 30 kg N	1151	4815
6. 4 t manure + 6 kg P + 30 kg N	1318	5140
7. 2 t manure + 8 kg P + 30 kg N	1677	5853
8. 12 kg P + 30 kg N	1005	4355
SE	37	129
CV (%)	8	6

Table 36. Optimum combination of plant nutrients for millet grain and cowpea fodder (kg ha^{-1}) at Banizoumbou, Niger, 2006 cropping season.

Treatments	Millet grain yield	Cowpea fodder
1. Absolute Control	344	1065
2. 30 kg N ha^{-1}	323	1385
3. 12 kg P ha^{-1}	495	1530
4. 8 tons manure + 30 kg N ha^{-1}	547	1515
5. 6 t manure + 3kg P + 30 kg N	771	1975
6. 4 t manure + 6 kg P + 30 kg N	599	1895
7. 2 t manure + 8 kg P + 30 kg N	797	2205
8. 12 kg P + 30 kg N	708	1570
SE	106	211
CV (%)	37	26

3. Placement of phosphorus and PUE (Karabedji)

An experiment was conducted in Karabedji to assess the phosphorus use efficiency from hill placed (HP) and/or broadcast (bc) Tihoua PR (TPR). Pearl millet grain P use efficiency for broadcasting SSP at 13 kg P ha^{-1} was 42 kg kg^{-1} P but hill placement of SSP at 4 kg P ha^{-1} gave a PUE of 147 kg kg^{-1} P and 169 kg kg^{-1} P with NPK hill placement (Table 37). Whereas the PUE of TPR broadcast was only 14 kg grain kg^{-1} P, the value increased to 47 kg kg^{-1} P when additional NPK was applied as hill placed at 4 kg P ha^{-1}. These data clearly indicate that P placement can drastically increase P use efficiency and the placement of small quantities of water-soluble P fertilizers can also improve the effectiveness of phosphate rock. For cowpea fodder PUE for SSP broadcast was similar to the hill placement of 4 kg P ha^{-1} gave a PUE (respectively 13 and 14 kg kg^{-1} P).

4. Farmer's evaluation of soil fertility restoration technologies (Karabedji and Gaya)

Past research results indicated a very attractive technology consisting of hill placement of small quantities of P fertilizers. With DAP containing 46% P_2O_5 and a compound NPK fertilizer (15-15-15) containing only 15% P_2O_5, fields trials were carried out by farmers on 46 plot per treatment at Karabedji to compare the economic advantage of the two sources of P for millet production. As hill placement can result in soil P mining another treatment was added consisting of application of phosphate rock at 13 kg P ha^{-1} plus hill placement of 4 kg P ha^{-1} as NPK compound fertilizers.

The data in Tables 38 and 39 clearly shows that there was no difference between hill placement of DAP and 15-15-15 indicating that with the low cost per unit of P associated with DAP, this source of fertilizer should be recommended to farmers. The basal application of Tahoua Phosphate rock gave about additional 300 kg ha^{-1} of pearl millet grain. The combination of hill placement of water-soluble P fertilizer with phosphate rock seems a very attractive option for the resource poor farmers in this region. The data

Table 37. Effect of P sources and placement on pearl millet and cowpea yield and P use efficiency (PUE) at Karabedji, Niger, 2006 cropping season.

Treatments	**Millet**		**Cowpea**	
P sources and methods of placement	**Grain yield (kg kg^{-1} P)**	**PUE (kg kg^{-1} P)**	**Fodder (kg ha^{-1})**	**PUE (kg kg^{-1} P)**
1. Control	411		1842	
2. SSP (bc)	962	42	2378	13
3. SSP (bc) + SSP (HP)	1464	62	5685	62
4. SSP (HP)	997	147	3965	14
5. 15-15-15 (bc)	1048	49	4713	59
6. 15-15-15 (bc) + 15-15-15 (HP)	1821	83	8184	76
7. 15-15-15 (HP)	1087	169	5560	22
8. TPR (bc)	587	14	2709	64
9. TPR (bc) + SSP (HP)	1133	42	3502	39
10. TPR (bc) + 15-15-15 (HP)	1202	47	4297	53
11. PRK (BC)	571	12	2612	62
12. PRK (BC) + SSP (HP)	1048	38	3214	37
13. PRK (BC) + 15-15-15 (HP)	1156	44	4078	51
SE	36		288	
CV (%)	7		14	

SSP: Single Superphosphate, 15-15-15: N_2 P2O5 K_2O compound fertilizer; TPR: Tilemsi Phosphate Rock, PRK: Kodjari phosphate rock; BC: Broadcast at 13 kg P ha^{-1}, HP: hill placed at 4 kg P ha^{-1}; PUE: P use efficiency kg yield kg^{-1} P applied.

Table 38. Farmers managed trials at Karabedji, 2006 rainy season.

Treatments	Millet grain yield (kg ha^{-1})	Millet TDM yield (kg ha^{-1})
1=Farmers' practices	244	1180
2=NPK HP	832	2260
3=DAP HP	835	2209
4=PRT+NPK HP	1111	2925
SE	9	15
CV (%)	8	5

NPK: 15-15-15 compound fertilizers; DAP: Diammonium phosphate; HP: hill placement at 4 kg P ha^{-1}; PRT: Tahona Phosphate rock broadcast at 13 kg P ha^{-1}.

Table 39. Farmers managed trials at Gaya, 2006 rainy season.

Treatments	Millet grain yield (kg ha^{-1})	Millet TDM yield (kg ha^{-1})
1=farmers' practices	982	3752
2=NPK HP	1683	5404
3=DAP HP	2075	6447
4=PRT+NPK HP	2547	7404
SE	37	68
CV (%)	14	8

NPK: 15-15-15 compound fertilizers; DAP: Diammonium phosphate; HP: hill placement at 4 kg P ha^{-1}; PRT: Tahoua Phosphate rock broadcast at 13 kg P ha^{-1}.

in Figures 46 and 47 shows the variation of yield of each plot in farmers' fields compared to the farmer's practices and clearly shows that the application of Tahoua PR with hill placement of water soluble P outperformed the other treatments in most instances. At Gaya, with 46 plots per treatment the same effect can be observed and DAP seem better than NPK and confirm the choice on this source (Table 39).

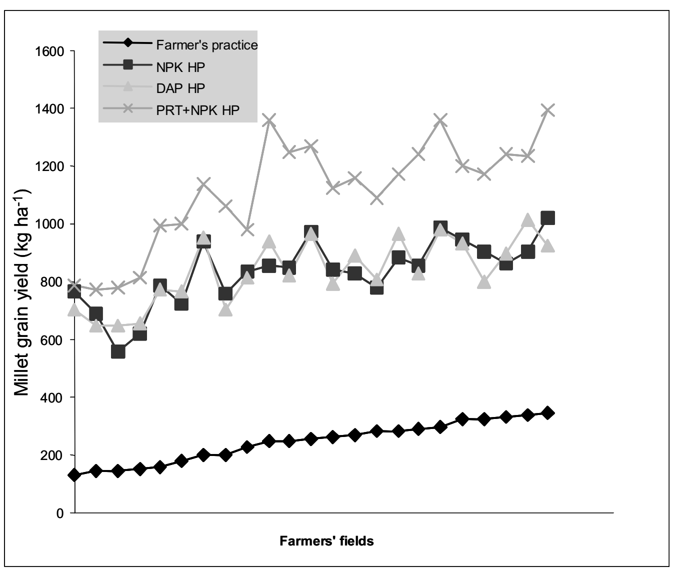


Figure 46. Millet grain yield response to different management practices, Karabedji, Niger, 2006 rainy season.

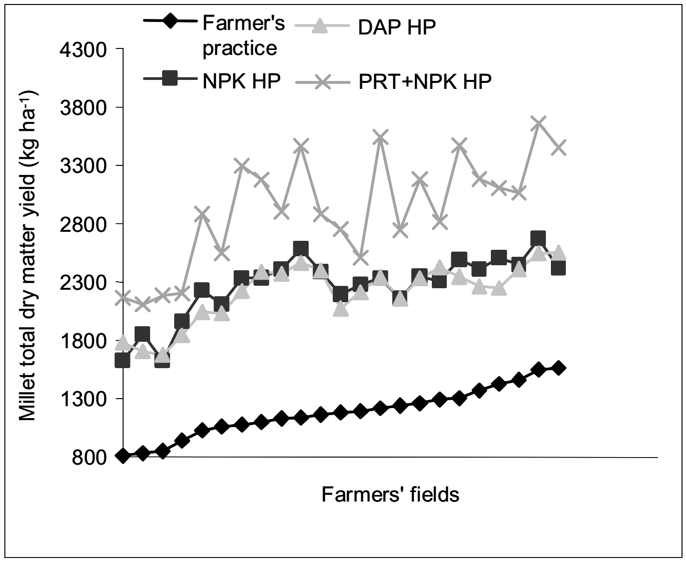


Figure 47. Millet total dry matter yield response to different management practices, Karabedji, Niger, 2006 rainy season.

5. Cropping systems and mineral fertilizers evaluation (Sadore, Karabedji and Gaya)

Farmers' practices were compared to a three cropping systems consistency on pure millet crop with planting density at recommended level to be rotated next year with a pure cowpea, a fourth plot with millet and cowpea intercropped but not as farmer's practice. Here four lines of cowpea were rotated with two lines of millet. Tahoua Phosphate rock at 13 kg P ha^{-1} and NPK hill placed at 4 kg P ha^{-1} were applied for each plot except farmer's practice.

The data in Tables 40, 41 and 42 indicates that millet grain yield can be increased two to three fold with this system and higher biomass can be got especially for cowpea introducing crop-livestock integration. The same trial was implemented at Karabedji and gave a similar effect as Sadore. The data in these tables shows how the yield of the technologies evaluated fluctuated as compared to the farmers' practices with the high density and rotation systems dominating the other systems in most instances.

6. Comparative effect of mineral fertilizer on degraded and non-degraded soils (Karabedji)

This trial started in 1999 and still on going and can also be considered as long-term soil fertility managed one. Mineral fertilizers were applied on two major types of soils: Farms close to the village where household waste, human excreta and farm yard manure are commonly used and farms far from the village degraded and without any organic material added. The results show a high significant effect of the application of Phosphorus on pearl millet grain and total dry matter yields. P alone account for 43% of the total variation of millet grain yield whereas system (degraded and non-degraded) account for 25% meaning that organic fertilizers are important. Nitrogen was also significant as nitrogen and account for 20% of total variability. The significance of N is linked to the availability of P or organic fertilizer in the soil. The data in Figures 48 and 49 show that the application of P increased significantly both millet grain and total dry matter yields and was more important in fertile soils meaning when P is combined with organic fertilizer. Application of N alone was not significant but differences were clear when combined with P.

Table 40. Farmers managed trials at Sadore, 2006 rainy season.

Treatment	Millet grain yield (kg ha^{-1})	Millet TDM (kg ha^{-1})
1=Control	204	1164
2=NPK HP + PRT intercrop	449	2188
3=NPK HP + PRT pure crop	645	2742
SE	120	140
CV (%)	39	10

NPK: 15-15-15 compound fertilizers; HP: hill placement at 4 kg P ha^{-1}; PRT: Tahona Phosphate rock broadcast at 13 kg P ha^{-1}.

Table 41. Farmers managed trials at Gaya, 2006 rainy season.

Treatment	Millet grain yield (kg ha^{-1})	Millet TDM (kg ha^{-1})
1=Control	221 (162)	2905 (435)
2=NPK HP + PRT intercrop	430 (322)	3988 (966)
3=NPK HP + PRT pure crop	1263 (1073)	6197 (3064)
SE	91 (17)	145 (55)
CV (%)	20 (5)	5 (5)

NPK: 15-15-15 compound fertilizers; HP: hill placement at 4 kg P ha^{-1}; PRT: Tahona Phosphate rock broadcast at 13 kg P ha^{-1}; NB: Number in bracket are yields for groundnut.

Table 42. Farmers managed trials at Karabedji, 2006 rainy season

Treatment	Millet grain yield (kg ha^{-1})	Millet TDM (kg ha^{-1})
1=Control	172	3606
2=NPK HP + PRT intercrop	361	4384
3=NPK HP + PRT pure crop	680	5111
SE	61	101
CV (%)	26	4

NPK: 15-15-15 compound fertilizers; HP: hill placement at 4 kg P ha^{-1}; PRT: Tahona Phosphate rock broadcast at 13 kg P ha^{-1}.

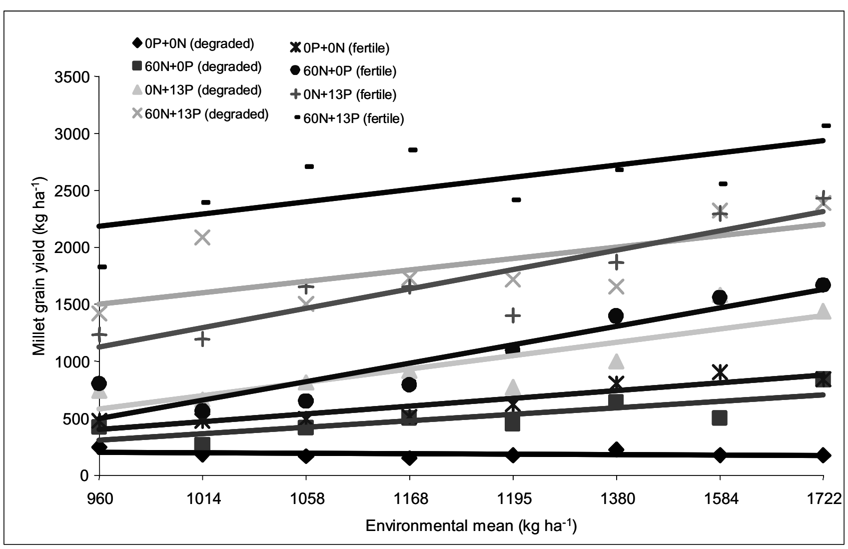


Figure 48. Effect of environmental mean on pearl millet grain yield, Karabedji, Niger, degraded and non degraded land, 1999-2006.

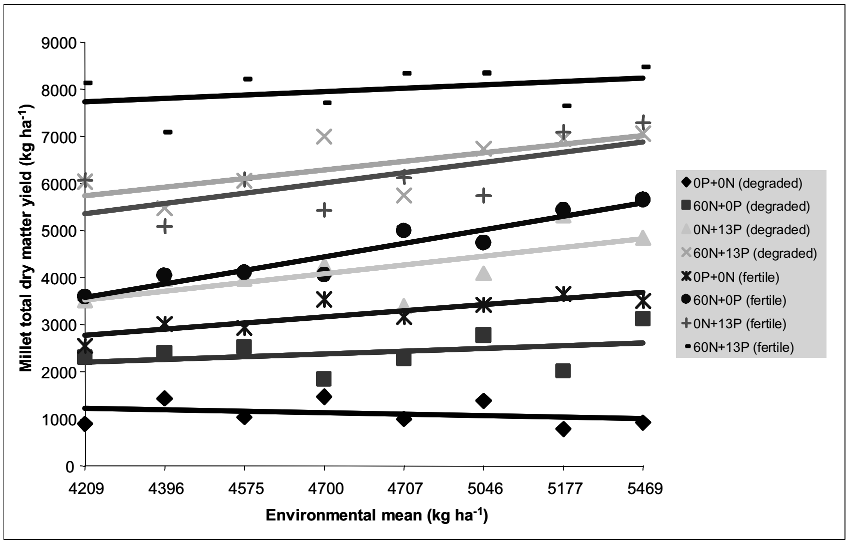


Figure 49. Effect of environmental mean on pearl millet total dry matter, Karabedji, Niger, degraded and non degraded land, 1999-2006.

Research progress from Burkina Faso

Research was conducted in Burkina Faso to study the effects of the mineral manure, organics and organomineral on the performance of irrigated rice yield. The experimental design was a split study and involved two rice varieties FKR 19 and FKR 14. The performance of the paddy rice was evaluated under six modes of management of the mineral and organic manure as indicated in Table 43.

The two rice varieties indicated similar responses to organic and inorganic nutrient management. Similar paddy rice yields were recorded from the recommended inorganic fertilizer (T2) as well as when the recommended inorganic fertilizers were combined with organic fertilizers (T4) indicating that soils under paddy sequesters carbon thus diminishing the effects or organics on crop yields. This observation explains the low yields in the treatments receving 6 and 12 t ha^{-1} of manure (Figure 50).

NERICA (NEw RICe for Africa) varietal differences in the effectiveness of use of nitrogen
In another study in Burkina Faso, a trial was conducted to evaluate the varietal differences of NERICA in the effectiveness of use of nitrogen. Three NERICAs (NERICA L 19, NERICA L 20 and especially NERICA L 41) were found to be more "efficient" varieties with respect to the use of nitrogen as evident from the increasing production with increase in the rate of N application, because producing outputs raised on the various levels of N applied (Figure 51).

Table 43. Treatment structure of the paddy rice tria in Burkina faso.

Treatment	Description
T1	Absolute control
T2	Recommended mineral fertilizer (200 kg NPK and 200 kg ha^{-1} Urea)
T3	Recommended organic fertilizer (6 t ha^{-1})
T4	Recommended mineral fertilizer + Recommended organic fertilizer (6 t ha^{-1})
T5	Organic amendments (12 t ha^{-1})
T6	Recommended mineral fertilizer + Organic amendments (12 t ha^{-1})

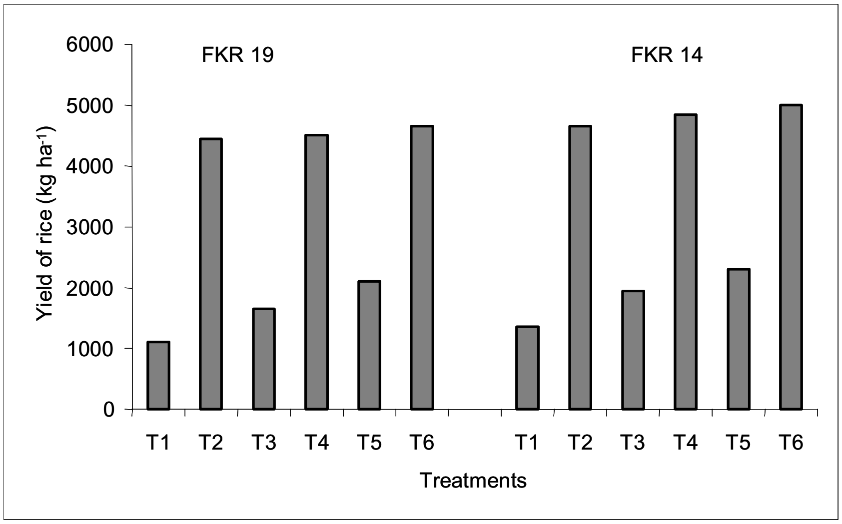


Figure 50. Two paddy rice varieties (FKR 19 & FKR 14) response to organic and inorganic inputs, Bagre Burkina Faso

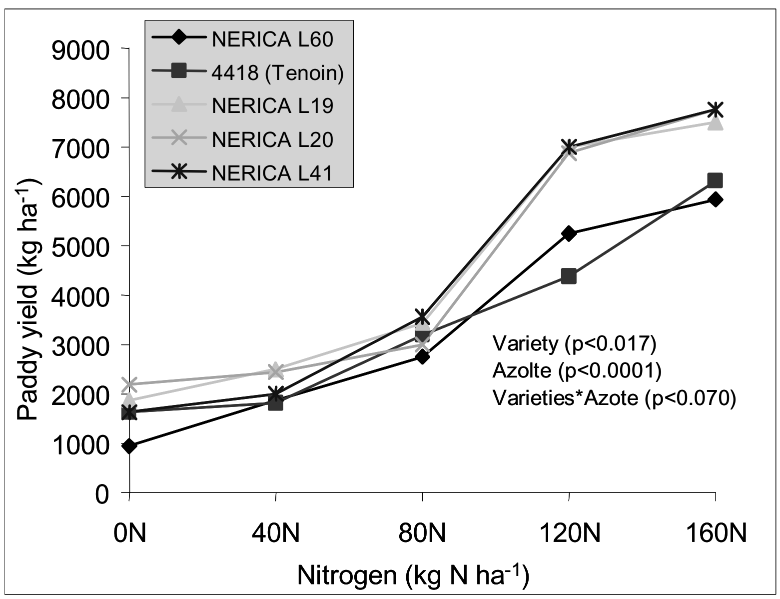


Figure 51. Effect of the nitrogen amounts applied to paddy output for the popularized variety (4418 or FKR 14) and NERICA varieties in Burkina Faso.

The effects of previous cowpea (*Vigna unguiculata*) and annual fallow on N recoveries, succeeding sorghum yields and soil properties were studied using a 5-years old field experiment at the agronomic research station of Kouaré in Burkina Faso. A factorial 3×4 design in a split plot arrangement was used. Three rotations (cowpea-sorghum, fallow-sorghum and sorghum-sorghum) were used as first factor and 4 fertilizer treatments (chemical NPK fertilizer, NPK+Dolomite, P+Manure, and Control without any fertilizer) were used as second factor. Sorghum produced less than 500 kg ha^{-1} of grain in mono cropping. But sorghum produced highest grain yields when fallow or cowpea was used in the cropping system (fallow-sorghum or cowpea-sorghum rotation). The succeeding sorghum grain yields increased from 75 to 100% when it was rotated with fallow and cowpea respectively. However, significant differences were not observed between the effects of cowpea and fallow on sorghum grain yields during the first two years. The effects of rotations seamed to increase over time and cowpea became most effective on sorghum yield increase during the last three years (Figure 52).

A general trend of sorghum yield increases was observed over the first three years of cultivation in all fertilizer and rotation treatments (Figure 52). However, sorghum yields of the control (without fertilizer) and control rotation (sorghum-sorghum) only increased during the second season and remind constant during the last three years. Yield increases over years with fertilizer applications can be explained by the effects of fertilizers on soil fertility replenishment over time. The slight yield increase in control plots only during the second year is probably a seasonal effect.

Total N uptake by succeeding sorghum increased from 26 kg N ha^{-1} in mono cropping of sorghum to 31 and 48 kg N ha^{-1} when sorghum was rotated with fallow or cowpea respectively. Nitrogen derived from fertilizer (FNUE) increased from 10% in mono cropping of sorghum to 22 and 26% when sorghum was rotated with fallow or cowpea respectively (Table 44).

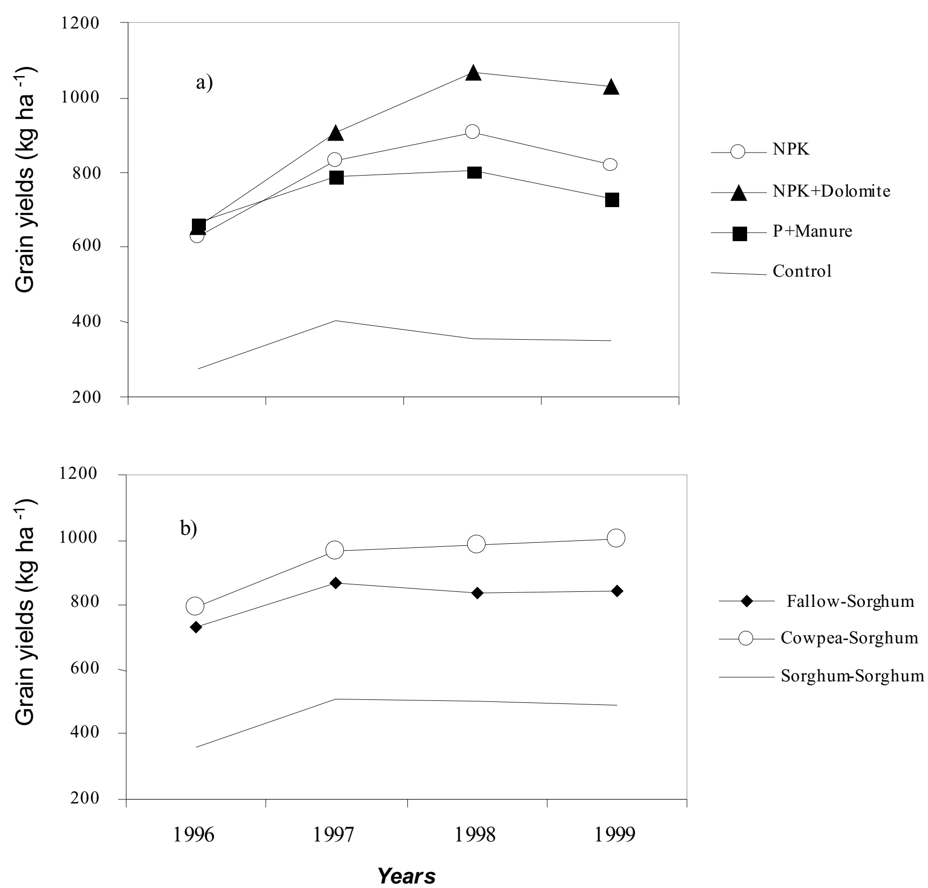


Figure 52. Effects of (a) fertilizer applications and (b) crop rotations on succeeding sorghum grain yields during four years.

Table 44. Effects of cowpea and fallow on total N uptake by succeeding sorghum, fertilizer N use efficiencies (FNUE) and N derived from soil (Ndfs) and fertilizer (Ndfs) in 1999 after 5 years of cultivation.

Cropping systems	Total N uptake ($kg\ N\ ha^{-1}$)	FNUE (%)	Ndff ($kg\ ha^{-1}$)	Ndfs ($kg\ ha^{-1}$)
Fallow-Sorghum	31b	26a	10 a	21b
Cowpea-Sorghum	48a	22ab	8ab	40a
Sorghum-Sorghum	26c	17c	6bc	20bc

Soils of cowpea-sorghum rotation doubled the quantity of N derived from soil (Ndfs) while fallow-sorghum rotation did not increase N derived from soil. Compared to mono cropping, sorghum grain yields increased from 75 and 100% when sorghum was rotated with fallow or cowpea respectively. Highest quantity of organic C was observed in soils of fallow-sorghum rotation and lowest quantities were observed in mono cropping of sorghum and cowpea-sorghum rotation. Compared to original soil, all treatments decreased soil organic C and total N. Dolomite increased sol pH and maintained soil bases (Ca^{++} and Mg^{++}), ECEC and Al^{3+} saturation at the same levels as the original soil. The combined application of P and manure increased soil pH, bases saturation and decreased Al^{3+} saturation. It was concluded that cowpea-sorghum rotation was most effective than fallow-sorghum rotation and five management options were suggested to improve traditional system productivity.

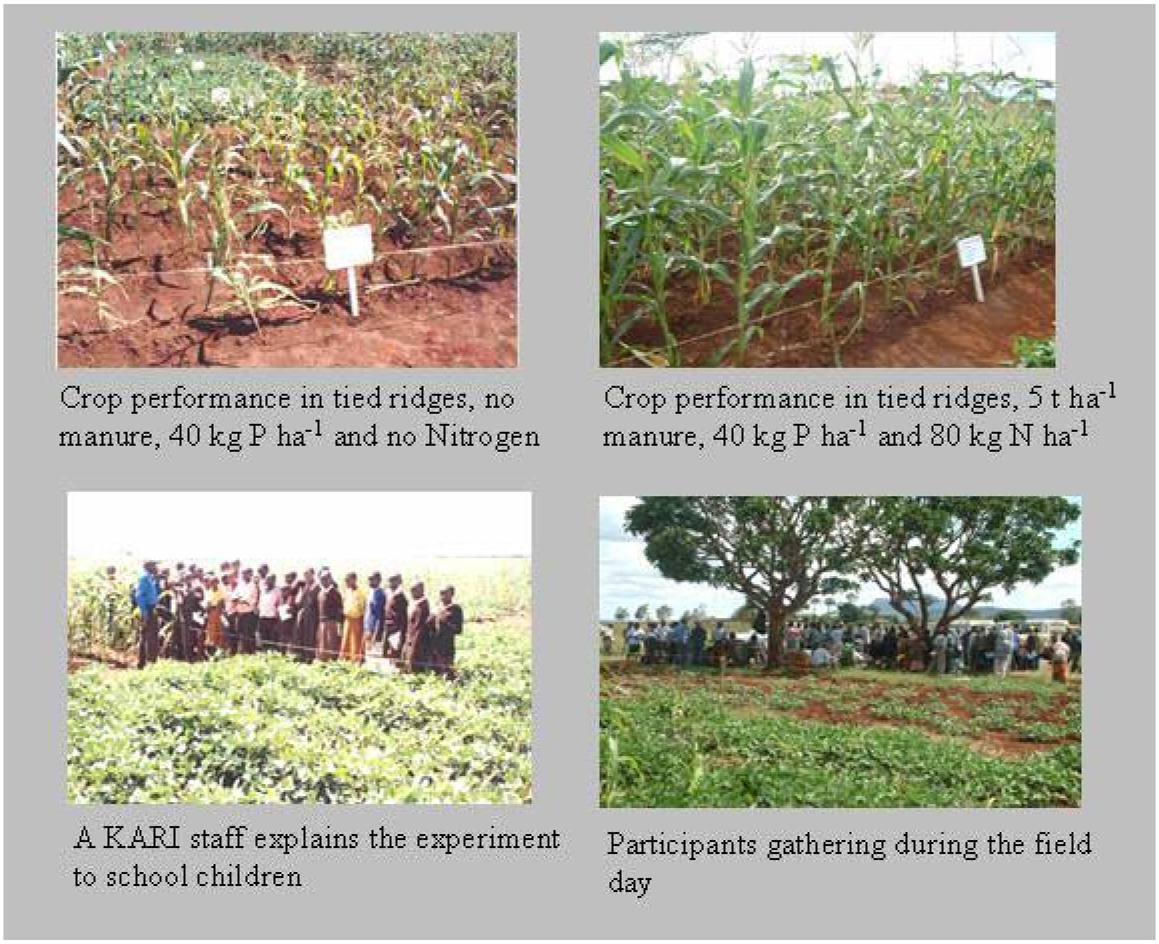
II. AfNet - Research progress report from East Africa

a. Water and nutrient management research in the dry lands of Eastern Kenya

AfNet research activities continued to be implemented in several sites in Kenya during the year 2006. AfNet supported the trial on nutrient and water management in Emali, Eastern Kenya under the Desert Margins Programme (DMP). AfNet participated in the farmers' field day held on 8th June 2006 at Emali Primary School to demonstrate to the farmers the technologies that can be used in the arid and semi-arid areas (ASALs) for improved agricultural production and environmental conservation. These trials are being implemented by DMP, Kenya and Tropical Soil Biology and Fertility Institute (TSBF). The field day was organized in collaboration with Kenya Forestry Research Institute (KEFRI), KARI-Kiboko Centre, Ministry of Agriculture, TSBF, ICRISAT, Non-governmental organizations (NGOs), farmers and other stakeholders from private sector.

About 102 farmers from Kambu, Oloitokitok, Matiliku, Katie and Mbitini locations in Makueni and Kajiado districts attended the field day. Another 50 participants came from KARI-Katumani Centre, KARI-Kiboko Centre, ICRISAT, TSBF, DMP secretariat from KARI HQ, MoA and Mang'elete FM (a local radio station). About 200 students from Emali primary school also participated in the function.

During the field day, participants were taken round the experimental site by KARI and MoA extension officers. The technologies being experimented were water harvesting (tie ridging), manure application, inorganic fertilizer application, crop rotation, and different maize and cowpea cropping systems (Figure 53). The cropping systems comprised the rotation of maize with cowpea, intercropping both crops and planting them as monocrops. The combined effects of all these factors on crop performance were also shown.



Crop performance in tied ridges, no manure, 40 kg P ha^{-1} and no Nitrogen

Crop performance in tied ridges, 5 t ha^{-1} manure, 40 kg P ha^{-1} and 80 kg N ha^{-1}

A KARI staff explains the experiment to school children

Participants gathering during the field day

Figure 53. Scenes from the farmer field day at Emali, Eastern Kenya.

Other available dry land farming technologies for improved environmental conservation and crop production were also demonstrated to the participants by different stakeholders. These demonstrations and exhibitions were:

- Different types of fertilizers, soil erosion control and fertility management
- Agro-chemical products from Osho Chemical Industries Ltd
- Seeds and seedlings of different fruit trees and other trees of economic importance by KEFRI-Kibwezi Station
- Different types of forage grasses and how they are grown by KARI-Kiboko staff
- Hay making using simple home made technologies by a farmer already practicing the technology
- Cereal and legume seeds for the dry lands by KARI-Katumani and ICRISAT

Farmers had an opportunity to interact with the scientists through open discussions. Farmers expressed their appreciation for the information given to them on various technologies through pamphlets, posters and demonstrations.

Conservation Agriculture research in Western Kenya
A study was carried out in Teso district Western Kenya to assess the effects of conservation tillage, crop residues and cropping systems on the dynamics of soil organic matter and overall maize - legume production. Table 45 below gives the treatments evaluated. For each cropping system, plots were sub-divided into 4 subplots to cater for different rates of N and P application as well as the N response curve.

Table 45. Conservation tillage experimental treatments as applied at study sites in Teso District –Western Kenya, 2005/2006

Treatment No.	Tillage method	Crop residue management	Cropping system (CR)
1	CNT-Conservation	+Crop residue	Legume-Cereal ROTATION (CS1+CR)
2	CNT	+ Crop residue	Legume-Cereal INTRCP (CS2+CR)
3	CNT	+ Crop residue	CONTINUOUS CEREAL (CS3+CR)
4	CNT	-Crop residue	Legume-Cereal ROTATION (CS1-CR)
5	CNT	-Crop residue	Legume-Cereal INTERCROP (CS2-CR)
6	CNT	-Crop residue	CONTINUOUS CEREAL (CS3-CR)
7	CT-conventional	+Crop residue	Legume-Cereal ROTATION (CS1+CR)
8	CT	+Crop residue	Legume-Cereal INTRCP (CS2+CR)
9	CT	+Crop residue	CONTINUOUS CEREAL (CS3+CR)
10	CT	-Crop residue	Legume-Cereal ROTATION (CS1-CR)
11	CT	-Crop residue	Legume-Cereal INTERCP (CS2-CR)
12	CT	-Crop residue	CONTINUOUS CEREAL (CS3-CR)

CNT= Conservation tillage; CT= Conventional tillage

Initial soil characterization
Initial soil test values for Teso soils showed low organic carbon and total N content (Table 46). This is because the soils are sandy hence less carbon is protected within the particles. Soil aggregate dynamics strongly influence carbon sequestration and cycling.

Significant increase in soil carbon contents was observed in plots receiving residue compared to plots without residue (Figure 54). The use of organic amendments provided a more stable source of N and increased the SOC content of the top 0-10cm depth of soil.

In the 2005 LR, grain yields varied in conservation tillage plots with and without residue (Table 47). Higher yields were observed in plots with residue application, also yields increased with increasing rates of fertilizer application with plots receiving 60 kg P $h^{-1}a$ and 60 kg N ha^{-1} giving higher yields. Higher response of maize was observed with combination of N and P compared to when the N and P were applied singly.

Table 46. Soil characterization (0-15cm) before treatment application at Asinge site Teso, 2005.

Parameter	
Soil pH (H_2O)	5.49
% Organic Carbon	0.83
Olsen P mg kg^{-1} soil	6.04
Total N (%)	0.08
% Silt	7.45
% Sand	84.7
% Clay	7.85
Textural Class	Loamy Sand

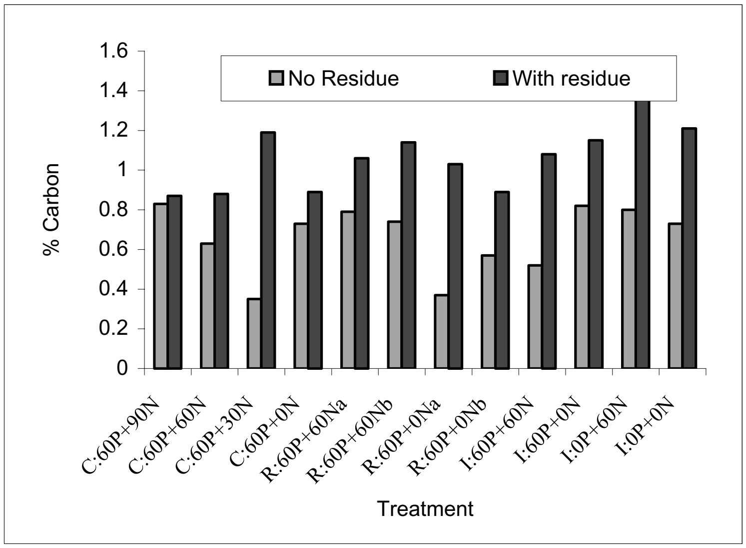


Figure 54. Total carbon content soils (0-20cm) of 2005 (SR) of residue and no-residue plots.

Table 47. Maize yield (t ha^{-1}) as affected by nutrient and crop residue management in conservation trial in Teso, Western Kenya.

Treatment	**Maize yields in residue plots**	**Maize yields in no-residue plots**
	-- **t ha^{-1}**	--
R:60P+0N	4.86	4.52
R:60P+60N	8.14	4.82
I:60P+60N	5.22	5.22
I:60P+0N	2.66	2.55
I:0P+60N	3.47	2.89
I:0P+0N	1.79	1.88
C:60P+90N	6.92	6.51
C:60P+60N	8.13	7.48
C:60P+30N	6.28	4.28
C:60P+0N	2.47	2.47

Technical capacities enhanced for quantification and valuation of water-related ecosystem services in the Andes

R.D. Estrada [1], A. Moreno[2], M.Quintero[3], E. Giron[3], X. Pernett[3] and N. Uribe[3]

[1] *CIAT-CONDESAN,* [2] *GTZ/Andean Watersheds Project,* [3] *TSBF-CIAT*

There is a capacity building strategy as part of the WFCP project "Payment for Environmental Services (PES) to promote rural development in upper watersheds of the Andes" to enhance local capacities required to measure and quantify environmental externalities. For this reason, several capacity building events have been carried out that were focused on the use of hydrological models for quantification of hydrological services and on the valuation of those services. The following training activities were carried out during 2006:

- The course on "SWAT (Soil Water Assessment Tool), a hydrological model as a tool to generate and analyze geospatial information required for the design of PES (Payment for Environmental Services) schemes" was held on June 12-17 of 2006 in Cajamarca, Peru. Sixteen technicians from local institutions of Jequetepeque and Piura watersheds attended the course. This course was supported by the WFCP, the GTZ and WWF-CARE (Peru).
- Four technicians from Altomayo (Peru) were trained in the use of SWAT – Soil & Water Assessment Tool, at CIAT. The training was held in CIAT during January 2006. Subsequently, the research team provided adequate advise to these technicians during the application of the tool for the Altomayo watershed analysis.
- Four technicians from the CAM (Environmental Corporation of the High Magdalena Region of Colombia) were trained in the use of SWAT and ECOSAUT – a model for ex ante evaluation of land use alternatives and the valuation of environmental externalities. These two training activities were held at CIAT during February and June of 2006.
- About 30 professionals working in the Andes attended the course "Manejo Integrado de Cuencas" [Integrated Watershed Management] organized by the GTZ. Various contents were developed by the research team that included SWAT modeling and ex-ante evaluation of land uses in watersheds. The course was academically managed by the Universidad de La Molina in Lima, Peru, who issued the course certificates.
- One professional from CORMAGDALENA (Autonomous Region of the Magdalena River Watershed) was trained in the use of SWAT model. After this, CIAT has been giving support to this organization to apply the model appropriately based on the available biophysical information.

Adoption of the Nutrient Management Support System (NuMaSS) Software throughout Latin America

J. Smyth[1], M. Ayarza[2] and M. Trejo[2]
[1]NCSU, Raleigh, USA; [2]TSBF-CIAT

Completion of a network of N fertilization trials in Honduras and Nicaragua provided soil and crop N coefficients for the six most common maize varieties grown in the region. Along with the interim release of the Data Base Editor Module for NuMaSS, these coefficients enable users to customize the software's database and make site- and varietal-specific fertilizer N recommendations within their regional domains. Six NGOs working with FAO in subsistence farming communities of Honduras were trained in NuMaSS and are using the customized database to develop N recommendations for their demonstration trials with farmers.

Work in Progress

Test and Compare NuMaSS Predictions on Nutrient Diagnosis and Recommendations with Existing Soil Nutrient Management

J. Smyth[1], M. Ayarza[2] and M. Trejo[2]
[1]NCSU, Raleigh, USA; [2]TSBF-CIAT

Field trials to develop varietal and soil coefficients used by NuMaSS for N recommendations on corn were continued in the 2005/06 season at La Ceiba, Yorito, Catacamas and Candelaria in Honduras, and at San Rafael and San Dionisio in Nicaragua. The crop at La Ceiba was severely damaged by hurricane Wilma and there was no response to fertilizer N for the second consecutive crop at Catacamas. The two years of collective data have enabled the development of robust estimates for key crop and soil coefficients used by NuMaSS to provide fertilizer N recommendations for the corn varieties, which are used extensively throughout the two countries.

Coefficient values for each variety are summarized in Table 48 along with the default values used by NuMaSS whenever such information is not locally available. The importance of developing crop and soil coefficients for local varieties and soils is illustrated in Table 48 via comparisons of N recommendations by NuMaSS for a 4.5 t ha^{-1} grain yield using the either the software's default coefficients or the varietal and soil coefficients for each location; differences from the software's default recommendations range from 0 to 197 kg N ha^{-1}. The value of site-specific N recommendations versus regionally-constant "recipes" is also evident when comparing fertilizer N rates to achieve optimum yields among field trial sites. Required fertilizer N ranged from 0 to 125 kg ha^{-1}. A new database editor module allows users to customize the NuMaSS software by adding these varietal and soil coefficients for their specific regions

Table 48. NuMaSS default and site/varietal-specific crop and soil coefficients, and associated software fertilizer N recommendations in Honduras and Nicaragua.

Variable	NuMaSS Default	Location					
		Candelaria	Catacamas	Talgua	Yorito	San Dionisio	San Rafael
Variety	--	*DICTA Guayape*	*HS 15*	*DK 53*	*HB 104*	*NB 6*	*N. blanco*
Yield w/o N, kg ha^{-1}	2468	1700	5600	5200	1400	3000	2450
Opt. yield, kg ha^{-1}	3320	4100	5600	7400	3100	4100	6600
N for opt. yield, kg ha^{-1}	--	50	0	105	95	60	125
Grain:stover ratio	0.84	0.69	0.77	1.34	0.77	0.76	1.17
% N grain	1.24	[a]	1.47	1.44	1.40	1.68	1.43
% N stover	0.57	0.61	1.15	0.65	0.71	0.70	0.51
Soil N supply, kg ha^{-1}	97	[a]	154	75	36	66	46
% fert. N recovery	44	[a]	[c]	49	30	32	74
N Recom.[b] , kg ha^{-1}	0	[a]	0	4	197	124	38

[a] Determination pending completion of plant tissue N analysis

[b] NuMaSS fertilizer N recommendations using either the software's default values or the site- and variety-specific values; for purposes of comparison, a target grain yield of 4500 kg ha^{-1} was used for all recommendations.

[c] Unable to be determined due to lack of yield response to fertilizer N.

Identify and Refine the NuMaSS Components that aid Its Adoption and Usefulness

J. Smyth[1], M. Ayarza[2] and M. Trejo[2]
[1]NCSU, Raleigh, USA; [2]TSBF-CIAT

Field Testing the NuMaSS Data Base Editor Module: During visits to collaborator sites this past year, we have tested the Data Base Editor Module by adding to NuMaSS soils data for their trials sites, and soil and crop N coefficients which their trials have produced for locally-used crop varieties. In some cases we have also added new commercial fertilizer formulations and nutrient analysis for locally available chicken litter and animal manures.

User reactions to this ability to customize the software's data base with their local information has been very good. It minimizes their need to store region-specific information in separate documents, as well as the repetitive task of data input each time they run the software. Data customization and confidence in the software's recommendations for Diagnosis and Prediction has enable users to make better use of the powerful Economics module; users are beginning to appreciate the importance of selecting appropriate mixtures or blends of fertilizers available in their local markets, as well as considerations of various "what if" scenarios in terms of constraints on available cash to purchase fertilizers or available sources of commercial and organic nutrients.

Based on user feedback, we have added additional soil and crop variables to the Data Base Editor Module and perfected steps to be taken for deletion of an undesirable data record. Several user-selectable options for software retrieval of data table values were added to ensure that software performance by users with crop variety-specific information did not compromise NuMaSS use by novice users who depend entirely on the default values originally present in the data tables.

Adapt NuMaSS Database and Structure to Users and Regions

J. Smyth[1], M. Ayarza[2] and M. Trejo[2]
[1]NCSU, Raleigh, USA; [2]TSBF-CIAT

Field Tests of NuMaSS Fertilizer Recommendations by NGOs in Honduras: Five of seven corn field trials comparing NuMaSS recommendations to local farmer practices were followed to completion this year. This outreach program involved the CIAT-MIS consortia providing technical assistance to seven different NGOs involved in an FAO-sponsored seed production project for subsistence agriculture. Each trial site was located in a different farm community throughout Honduras. NuMaSS recommendations were based on a preliminary soil analysis for each site and, when available, information from NGO collaborators on cropping history and targeted corn yield.

For the harvested sites, yields with NuMaSS recommendations were similar or superior to those with local farmer practices (Table 49). Results also show that fertilization, even among subsistence farmers, is a common practice. The two most frequently used fertilizers are 12-24-12 and 18-46-0; however, native soil K levels were adequate for all sites and NuMaSS recommendations for several of the sites indicate adequate P availability.

NGO and FAO collaborators were pleased with the NuMaSS sensitivity to site-specific soil conditions and farmer's targeted yields. Consequently, they have decided to expand the field trials next year to a greater number of farming communities, with NGOs and farmers cost-sharing the initial soil test analyses of all sites.

Table 49. Targeted and achieved corn yields with NuMaSS N and P recommendations and local farmer practices in NGO trials throughout Honduras in 2005.

NGO	Site	Department	Target Yield	NuMaSS N	NuMaSS P	NuMaSS Yield	Local Practice N	Local Practice P	Local Practice Yield
			kg ha^{-1}						
CISP	Tocoa	Colon	6490	220	13	[a]	97	7	[a]
V. Mund.	Cuchilla	S. Barbara	3894	56	15	1362	0	0	951
CCD	Flores	S. Barbara	4543	145	21	[b]	?	?	[b]
G. Guia	Guinope	El Paraíso	4543	136	4	577	0	0	495
MOVIMUNDO	Alauca	El Paraíso	3245	107	0	[b]	8	7	[b]
ICADE	Limones	El Paraíso	3894	113	0	4540	82	26	4824
MOVIMUNDO	Canciras	Ocotepeque	4543	175	0	3959	82	26	4543

[a] Damaged by Hurricane Wilma
[b] No crop harvest

Output target 2007

ü ***At least three capacity building courses on ISFM held by AfNet and MIS***

1) Participatory Research and Gender Analysis Workshop, Harare, Zimbabwe 2nd - 13th October, 2006

This training workshop was organized under the AfNet-ERI-IDRC Project titled: Up-Scaling NRM Innovations in Sub-Saharan Africa The project is funded by IDRC and aims at strengthening partnerships and the capacity of AfNet scientists, NGOs, CBOs, farmers' organizations and groups, to carry out research for development through the application of innovative participatory research approaches and cutting-edge NRM research and development to enhance agricultural productivity and promote rural innovation processes. The project has four specific objectives; building interdisciplinary R&D teams, empowering farmers' organizations and CBOs to participate in the research process, conduct participatory adaptive research to test, adapt and promote innovative NRM and to develop a systematic process for PM&E.

The project is being implemented in six countries: Kenya and Uganda in East Africa, Malawi and Zimbabwe in Southern Africa, Ghana and Burkina Faso in West Africa.

Key objectives of the workshop

- To strengthen skills of country teams in applying participatory approaches in Natural Resource Management
- To strengthen skills of country teams in integrating gender in Natural Resource Management
- To develop across site and across country research agenda for the project including research questions, and data collection protocols
- To develop a participatory monitoring and evaluation system for tracking livelihood and NRM impacts of the project

The workshop was attended by multi-disciplinary teams consisting of soil scientists, agricultural economists and other social scientists including sociologists and extension specialists from the six participating countries. Figure 55 illustrates the diversity in disciplines of the team. This is crucial to the success of the project because to achieve the large scale impacts requires teams with diverse expertise. Participants came from different institutions covering the entire research-extension continuum and included universities (37.5%), research departments (37.5%), extension departments (16.6%) and NGOs (8.4%). The teams included both male (71%) and female (29%) participants (Table 50).

The following components were covered during the training workshop (Figure 56):

- An introduction to Participatory Approaches
- Concepts of Gender and Gender Analysis
- Participatory Diagnosis and community visioning
- Participatory Approach to Community Agro-enterprise Development
- Farmer Participatory Research
- Participatory Monitoring and Evaluation

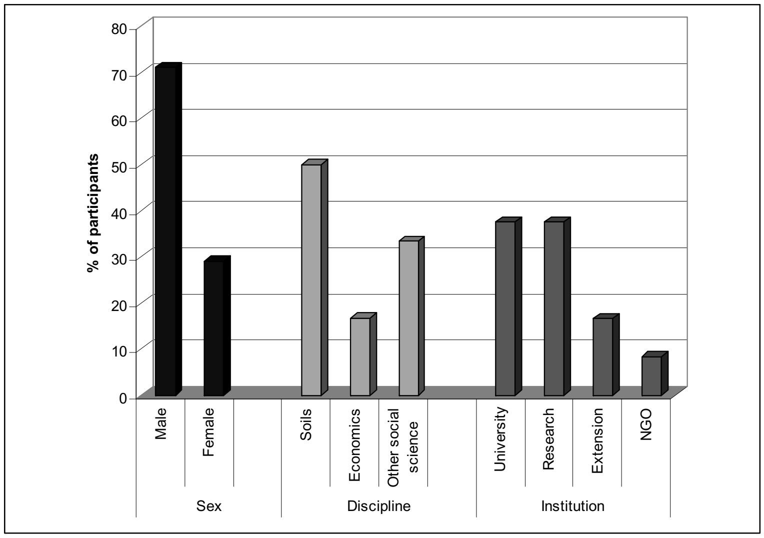


Figure 55: Composition of the participants to the training workshop.

Figure 56. Pictures from the training workshop.

Table 50. Workshop participants and facilitators.

Upscaling NRM Innovations in SSA: Participatory Approaches and Gender Analysis Workshop St. Lucia Park, Harare Zimbabwe 2nd to 13th October, 2006		
FULL NAME	**ORGANIZATION**	**COUNTRY**
Participants		
Isaiah Nyagumbo	University of Zimbabwe, Dept of Soil science and Agric Eng. P.O. Box MP167, Mount Pleasant	Zimbabwe
Shamie Zingore	TSBF CIAT P.O. Box MP228, Mount Pleasant, Harare	Zimbabwe
Malvern Mupandawana	University of Zimbabwe, Dept of Agric Economics P.O. Box MP167, Mount Pleasant	Zimbabwe
Jeremiah Mosioma Okeyo	TSBF - CIAT P.O. Box 30677 (00100) Nairobi	Kenya
Erick Cheruiyot	Egerton University Dept of CHS, P.O. Box 536 NJORO, Kenya	Kenya
Jayne Mugwe	Kenya Forestry Research Institute (KEFRI) P.O. Box 20412 - 00200 NAIROBI	Kenya
Monica Mucheru-Muna	Department of Env. Sciences Kenyatta University P.O. Box 43844 NAIROBI	Kenya
Regina G M Karega	Kenyatta University Dept. of Sociology P.O. Box 43844 NAIROBI	Kenya
Ezra Mbendera	Ministry of Agriculture Salima P. Bag 1, Salima	Malawi
Kenneth Chawa	Ministry of Agriculture Mhchinga P. Bag 3, Liloonde	Malawi
Tennyson Magombo	CIAT Malawi Chitedze Research Station P.O. Box 158, LILONGWE	Malawi
Dalitso Dembo Kang'ombe	Department of Agriculture Extension P.O. Box 30145 LILONGWE	Malawi
Keston Njira	Bunda College of Agriculture P.O. Box 219 LILONGWE	Malawi
Hilda Janet Kabuli	Department of Agriculture Research P.O. Box 158 LILONGWE	Malawi
Christine Iceduna	Pallisa local Government, P.O. Box 14 PALLISA	Uganda
Ali Mawanda	Africa 2000 Network -UGF P.O. Box 21990, KAMPALA	Uganda
Kayuki C Kaizzi	National Agricultural Research Organization KARI/NARO P.O. Box 7065, KAMPALA	Uganda
Elizabeth Balirwa	Makerere University Faculty of Agriculture P.O.Box7062, KAMPALA	Uganda
Edidah Ambaire Lubega	CIAT	Uganda
Solomon Konlan Bariyam	OICI Ghana P.O. Box TL 1183, Tamale, Northern Region, Ghana	Ghana
Benjamin D.K. Ahiabor	CSIR-Savanna Agricultural Research Institute P.O. Box 52, Tamale	Ghana
Francis K Obeng	University for Development Studies P.O.Box1882, Tamale	Ghana
Joyce Afua Bediako	University for Development studies, P.O. Box TL1882, Tamale	Ghana
Paul W Savadogo	INERA GRN-SP 01BP 476 0uaga 01	Burkina Faso
Barry Silamana	INERA /Kamboinse 01BP 476 Ougalogou	Burkina Faso
Gaspard Vognan	INERA /Programme Coton 01 BP 208 Bobo Dioulasso	Burkina Faso
Zacharie Segda	INERA 04 BP 8645 Ouagadougou 04	Burkina Faso

Table 50 (Cont).

FULL NAME	ORGANIZATION	COUNTRY
Facilitators		
Andre Bationo	CIAT - TSBF P.O. Box 30677, NAIROBI	Kenya
Susan Kaaria	International Centre for Tropical Agriculture CIAT, P.O. Box 6247, KAMPALA	Uganda
Jemimah Njuki	International Centre for Tropical Agriculture CIAT Chitedze Research Station, P.O. Box 158, LILONGWE	Malawi
Jonas Chianu	CIAT - TSBF P.O. Box 30677, NAIROBI	Kenya
Pascal Sanginga	International Centre for Tropical Agriculture CIAT, P.O. Box 6247, KAMPALA	Uganda
Robert Delve	TSBF CIAT P.0.Box MP228, Mount Pleasant, Harare	Zimbabwe
Coletah Chitsike	ICRA, P.O. Box 8783, PRETORIA, 001, South Africa	South africa

2) Mainstreaming Gender in Research and Development (Gender Training workshop) Nazareth Ethiopia

This workshop was co-hosted by the African Network for Soil Biology and Fertility (AfNet) and the International Institute for Rural Reconstruction (IIRR) Africa. The general objective of the workshop were to enhance the knowledge, skills and awareness of agricultural research and extension program leaders, so that they can engage in community driven research by including a gender 'lens' to their work and use of participatory approaches in planning, monitoring and evaluation of research and extension work. The training workshop was held in Nazareth Ethiopia between 20th and 31st March 2006. The workshop was attended by 10 participants (8 women and 8 men) drawn from 7 countries- Ethiopia, Kenya, Nigeria, Tanzania, Uganda, and Zambia and was sponsored by the CTA.

Support to Conferences and Workshops

AfNet has continued to support the organization of workshops and conferences to share information on agricultural research and development. In 2006, AfNet was one of the sponsors to the Soil Science Society of East Africa (SSSEA) Conference which was held in Hotel Brovard, Masaka, Uganda. AfNet was also invited to give a key note paper during this conference. AfNet also supported several scientists and students to attend the SSSEA and the African Crop Science Conference (ACSC) and the World Congress of Soil Science, July 9-15, 2006, Philadelphia, Pennsylvania, USA.

NuMaSS Workshop in Honduras/Nicaragua

J. Smyth[1], M. Ayarza[2] and M. Trejo[2]
[1]NCSU, Raleigh, USA; [2]TSBF-CIAT

The annual planning meeting with CIAT-MIS collaborators participating in the N fertilization trials for corn in Honduras and Nicaragua, held this year at Siguatepeque - Honduras, was expanded into a joint 3-day workshop with NGO participants in the FAO project for subsistence farmers in Honduras. One full day was devoted to hands-on training with the NuMaSS software, wherein participants used soil tests, yields and economics data from field trials at each of their locations. A total of 23 participants - 13 from the CIAT-MIS N trial network, 9 from NGOs and 1 representative from the region's major fertilizer distribution company (FENORSA) - attended the workshop. The importance of repeated training events on NuMaSS, to overcome changes in collaborating personnel, can be illustrated by the fact that only one of the 20 CIAT-MIS participants trained in the initial workshop of 2002 attended this second workshop.

The CIAT-MIS collaborators tested the outcomes of NuMaSS predictions and recommendations after entering their soil and maize varietal N coefficients to the software database via and interim version with the Data Base Editor Module. The NGO collaborators benefited from exposure to the field trials generating varietal N coefficients, because they use the same varieties in their work with the subsistence farmer communities.

Considerable discussion focused on the Economic evaluations of the fertilizer N and P recommendations. Several situations were encountered where fertilizers with K were being used on soils with ample native K or P fertilizers on soils with adequate P. Even under conditions where both N and P are needed, the use of locally-available N-P-K mixtures often led to excess applications of fertilizer P when trying to meet the crops N requirements; in such cases, collaborators were enthused to learn that the NuMaSS Economics module adjusted recommendations to avoid excess P when fertilizers with only N were added to the pool of available nutrient sources.

Output target 2007

ü ***Books, web content and papers produced by partners in BGBD project both north and south in seven tropical countries***

Books and bulletins published

Books

Brazil published the Book on Soil biodiversity in Amazonian and other Brazilian ecosystems, Wallingford: CAB International, 2006, 280 p ISBN-10: 1-84593-032-0; ISBN-13: 978-1-84593-032-5 by Moreira, F.M.S.; Siqueira, J.O.; Brussaard, L. (Ed)

Chapters in the book included:

1- **Soil organisms in tropical ecosystems: a key role for Brazil in the global quest for the conservation and sustainable use of biodiversity.** Fatima M.S. Moreira (UFLA), José Oswaldo Siqueira (UFLA) and Lijbert Brussaard (WU) .

2- **Soil and land use in Brazilian Amazon.** M.L. Mendonça-Santos, H.G. dos Santos, M.R. Coelho, A.C.C. Bernardi, P.L.O.A. Machado; C.V. Manzatto and E.C.C. Fidalgo (EMBRAPA-SOLOS).

3- **Soil macrofauna communities in Brazilian Amazonia.** Barros E.(INPA), Mathieu, J.(IRD), Tapia-Coral S.(INPA), Nascimento A.R.L.(INPA), Lavelle P.(IRD-France)

4- **Earthworm ecology and diversity in Brazil.** James, S.W.(NHM) & Brown, G.G.(Embrapa-Soja)

5- **Termite diversity (Insecta:Isoptera).**R. Constantino (UNB), A.N.S.Acioli (INPA).

6- **Patterns of diversity and responses to forest disturbance of ground-dwelling ants in Amazonia.** H. L. Vasconcelos.(UFU)

7- **Soil mesofauna in Central Amazon.** E.Franklin & J.W. Moraes (INPA).

8- **Nematode communities at different land-use systems in Brazilian Amazon and Savannah vegetations.** S.P. Huang & J.E. Cares (UNB).

9- **Diversity of microfungi tropical soil**. L. Pfenning & L.M.Abreu (UFLA).

10- **Diversity of Arbuscular Mycorrhizal Fungi in Brazilian Ecosystems.** Sidney Luiz Stürmer (FURB)& José Oswaldo Siqueira (UFLA).

11- **Nitrogen-fixing *Leguminosae* nodulating bacteria**. F.M.S. Moreira.

Indonesia also published the book titled 'The Future Use of Legume Nodulating Bacteria (LNB) in Indonesia: Technical and Economic Perspectives (2005). Editors: Bustanul Arifin, Hanung Ismono and Muhajir Utomo. 149 p, ISBN: 979-8287-75-4 Copyright Universitas Lampung.

Another Handbook by Indonesia published was titled "Method for Assessment of Below-Ground Biodiversity in Indonesia (2005). Editors: F.X. Susilo and Agus Karyanto. 58 p. ISNB: 979-8287-76-2. Copyright Universitas Lampung.

Bulletins

Coelho, M.R.; Fidalgo, E.C.C; Araújo, F.O; Santos, H.G. dos, Mendonça Santos, M.L.; Pérez, D.V., Moreira, F.M.S., 2005a. Solos das áreas-piloto do Projeto BiosBrasil (Conservation and Sustainable Management of below-ground biodiversity: Phase I), Município de Benjamin Constant, Estado do Amazonas. [Soil of pilot areas of Conservation And Sustainable Management of below-ground biodiversity: Phase I, Benjamin Constant County, Amazonas State.]Rio de Janeiro:Embrapa Solos. **Boletim de Pesquisa e Desenvolvimento**, 67. 159 p.(available on line www.biosbrasil.ufla.br, or http://www.cnps.embrapa.br/solosbr/publicações/levantamentodesolos).

Coelho, M.R.; Fidalgo, E.C.C; Araújo, F.O; Santos, H.G. dos, Mendonça Santos, M.L.; Pérez, D.V., Moreira, F.M.S., 2005b. Levantamento pedológico de uma área-piloto relacionada ao Projeto BiosBrasil

(Conservation And Sustainable Management of below-ground biodiversity: Phase I), Município de Benjamin Constant (AM): Janela 6 [Soil survey of a pilot area related to conservation and sustainable management of below-ground biodiversity project: phase 1, Benjamin Constant County, Amazonas State: window 6].Rio de Janeiro: Embrapa Solos. **Boletim de Pesquisa e Desenvolvimento**, 68. 94 p. (available on line www.biosbrasil.ufla.br or
http://www.cnps.embrapa.br/solosbr/publicações/levantamentodesolos)
Fidalgo, E.C.C; Coelho, M.R.; Araújo, F.O.; Moreira, F.M.S; Santos, H.G.; Mendonça- Santos, M.L.; Huising, J., 2005. Levantamento do uso e cobertura da terra de seis áreas amostrais relacionadas ao projeto BiosBrasil (Conservation and sustainable management of below-ground biodiversity: Phase 1), Município de Benjamin Constant, (AM).[Land use and cover survey in benchmark area of CSM-BGBD/BiosBrasil project:phase 1, Benjamin Constant (AM)] Rio de Janeiro:Embrapa Solos: **Boletim de Pesquisa e Desenvolvimento da Embrapa Solos** 71, 54 p. .(available on line www.biosbrasil.ufla.br or http://www.cnps.embrapa.br/solosbr/publicações/usodosolo).

Theses defended and published

Doctoral Theses

Rafaela Simão Abrahão Nóbrega: Efeito de sistemas de uso da terra na Amazônia sobre atributos do solo, ocorrência, eficiência e diversidade de bactérias que nodulam caupi [*Vigna unguiculata* (L.) Walp] [Effects of Amazonian land use systems on soil attributes, occurrence, efficiency and diversity of bacteria nodulating cowpea *Vigna unguiculata* (L.) Walp]Doctoral Thesis Graduate Programme Soil Science and Plant Nutrition – Soil Science Department/UFLA, MG. 188 p. April 2006. Supervisor Fatima M S Moreira.

Vanessa Andaló: Estudos taxonômicos e armazenamento de nematóides entomopatogênicos (Rhabditida: Steinernematidae, Heterorhabditidae). Taxonomic studies and storage of entomopathogenic nematodes (Rhabditida: Steinernematidae, Heterorhabditidae) 184 p. Tese (Doctoral Thesis Graduate Programme Agricultural Entomology) – Universidade Federal de Lavras, Lavras, MG, December, 2006. Supervisor Alcides Moino Jr.

Adriana Silva Lima: Densidade, eficiência e diversidade de bactérias que nodulam siratro de solos sob diferentes usos na Amazônia Oriental. (Density, efficiency and diversity of bacteria nodulating siratro from soils under different uses in eastern Amazon region) Doctoral Thesis Graduate Programme Soil Science and Plant Nutrition –Soil Science Department/UFLA, MG. 188 p. Supervisor Fatima M S Moreira.

MSc Thesis and graduated students

Ederson da Conceição Jesus.Diversidade de bactérias que nodulam leguminosas, isoladas de três sistemas de uso da terra, na região do Alto Solimões-AM.[Diversity of Leguminosae nodulating Bacteria isolated from different land use systems placed in the Alto Solimões region-]AM, Brazil. MSc Thesis, Graduate programme in Agricultural Microbiology, Universidade Federal de Lavras, MG, 114 p. Supervisor: Fátima M.S.Moreira March 2004.

Paulo Henrique da Silva: Estrutura de comunidade de Scarabaeidae (Insecta: Coleoptera) em diferentes sistemas de uso da terra na Amazônia [Structure of the Scarabaeidae (Insecta: Coleoptera) communities in soils under different land uses in the Amazônia]. MSc Thesis Graduate Programme on Agronomy/Entomology/UFLA, MG. 42 p. Supervisor: Dr. Julio Louzada.February 2005.

Frederico Vasconcelos Ribeiro: "Biodiversidade e distribuição geográfica de *Anastrepha* spp. (Diptera: Tephritidae) no alto e médio rio Solimões, Amazonas". [Biodiversity and distribution of *Anastrepha* spp. (Diptera: Tephritidae) in Upper Solimões River, Amazonas]. MSc Thesis Graduate Programme in

Agriculture and Sustainability In Amazônia, FCA/UFAM, AM, 92 p..Supervisor: Dr. Neliton Marques, June 2005.

Patricia Lopes Leal: Fungos micorrízicos arbusculares isolados em culturas armadilhas de solos sob diferentes sistemas de uso na Amazônia [Arbuscular mycorrhizal fungo isolated by trap cultures from soils under different land uses in Amazonia].. MSc Thesis Graduate Programme Soil Science and Plant Nutrition –Soil Science Department/UFLA. 69 p. Supervisor Dr. José Oswaldo Siqueira. Co-supervisor: Dr. Sidney Sturmer, July 2005.

Gláucia Alves e Silva: Infectividade e eficiência de comunidades de fungos micorrízicos isoladas de solos sob diferentes sistemas de uso na região amazônica [Infectivity and effectiveness of arbuscular mycorrhizal fungi isolated from soils under different land uses in Amazonia].. MSc Thesis Graduate Programme Soil Science and Plant Nutrition –Soil Science Department/UFLA. 62 p. Supervisor Dr. José Oswaldo Siqueira. Co-supervisor: Dr. Sidney Sturmer, July 2005.

Krisle da Silva: Densidade e caracterização de bactérias diazotróficas associativas oriundas de diferentes sistemas de uso da terra na região amazônica.[Density and characterization of diazotrophic associative bactéria in soils under diverse land use systems in Amazonia] MSc Thesis Graduate Programme Soil Science and Plant Nutrition –Soil Science Department/UFLA. 73 p. Supervisor Fatima M S Moreira, February 2006.

Antonio Edson de Souza Soares: Nutrientes e Carbono no Solo em Áreas com diferentes Sistemas de Uso na Região do Alto Solimões-AM. [Soil nutrients and carbon in areas with different land use systems in Alto Solimões region-AM]Dissertação de Mestrado em Agricultura no Trópico Úmido, Inpa/Ufam, 56p.Supervisor: Sonia Senna Alfaia, December 2006.

Giselle Gomes Monteiro – Dissertação em Microbiologia Agrícola. 1/2/2007-Supervisor Ludwig Pfenning.

Yolanda Chalchi Martínez-Ingeniero Agrónomo Facultad de Ciencias Agrícolas Universidad Veracruzana 2005.

Luz María Camarena-Licenciatura en Biología Facultad de Ciencias. Universidad Nacional Autónoma de México. 2006.

Bibiana López-Cano-Licenciatura en Biología Facultad de Ciencias. Universidad Nacional Autónoma de México. 2006.

Carlo Ríos Martínez Soto-Licenciatura en Biología Facultad de Ciencias. Universidad Nacional Autónoma de México. 2006.

Lidia Nelly Morales León-Químico Bacteriólogo Parasicólogo Instituto Politécnico Nacional. 2006.

Presentations at Scientific meetings and other fora

Lecture presented by Stürmer S.L.at **57º Congresso Nacional De Botanica**, 2006. Diversidade de fungos micorrízicos arbusculares em ecossistemas brasileiros. Simpósio – Diversidade Fúngica na América Tropical e Temperada. Anais...57 Congresso Nacional de Botânica. Gramado, RS, Brasil. Pp. 216-219.

Lecture presented by Stürmer, S.L. 2006 at **FERTBIO2006.** Diversidade de fungos micorrízicos arbusculares em ecossistemas naturais e agrícolas brasileiros. Seminário – Ecologia microbiana e estratégias de manejo sustentáveis. Anais...FERTBIO2006. Bonito, MS, Brasil. CD ROM.

COP08, Curitiba-20-24/3/2006
Fátima M S Moreira: Launch of Brazilian book and talk: "The huge and hidden biodiversity below our feet".

XV congresso de pós-graduandos da Universidade Federal de Lavras, MG-20- 24/11/2006
Fátima M S Moreira: Biodiversidade de ecossistemas naturais: Projeto Conservação e Manejo Sustentável da Biodiversidade do Solo- BiosBrasil (http://www.biosbrasil.ufla.br/).

Papers and posters presented at Workshops

Barois I, S. Negrete-Yankelevich , J. Alvarez, G. Castillo, C. Fragoso, F. Franco, J. A. García, T. Fuentes, S. Cram, E. Martinez, M. Moron, P. Rodríguez, P. Rojas, V. Sosa, D. Trejo, L. Varela, J. A. Vasquez, et al., M. de Los Santos, 2005. **Conservación y Manejo Sostenible de la Biodiversidad Bajo el Suelo (Conservation and Sustainable Management of Below Ground Biodiversity, BGBD.), Proyecto GF/2715-02-4517- GF/1030-02-05.** Poster presented in the "Primer Congreso Internacional de casos exitosos de Desarrollo Sostenible del Trópico", organizado por la Universidad Veracruzana a través del Centro de Investigaciones Tropicales (CITRO) en conjunto con la Universidad de California-Riverside, a través de su Centro de Conservación Biológica, Mayo 2005, Boca del Río, Veracruz, México.

Barois I, J.A. García, J. Álvarez, G. Castillo, S. Cram, C. Fragoso, F. Franco, T. Fuentes, B. López-Cano, E. Martínez, E. Meza, M. A. Morón, S. Negrete, P. Rodríguez, P. Rojas, V. Sosa, D. Trejo, y L. Varela. **Resultados del Proyecto Biodiversidad Bajo del Suelo Los Tuxtlas, Ver. 2005** Poster presented in the workshop "Presentación de Resultados del proyecto: Conservation and Sustainable Management of Below-Ground Biodiversity (CSM-BGBD) en la Región de Los Tuxtlas III", celebrated in November in Catemaco, Ver.

Barois I, José A. García, Martín de los Santos, 2005. **Resultados del proyecto Biodiversidad Bajo del Suelo, Ejido Adolfo López Mateos, 2005.** Poster presented to the workshop "Presentación de Resultados del proyecto: Conservation and Sustainable Management of Below-Ground Biodiversity (CSM-BGBD) en la Región de Los Tuxtlas III", celebrated in November in Catemaco, Ver.

Barois I, José A. García, Martín de los Santos, 2005. **Resultados del proyecto Biodiversidad Bajo del Suelo, Ejido Venustiano Carranza, 2005.** Poster presented in the workshop "Presentación de Resultados del proyecto: Conservation and Sustainable Management of Below-Ground Biodiversity (CSM-BGBD) en la Región de Los Tuxtlas III", celebrated in November in Catemaco, Ver.

Barois I, José A. García, Martín de los Santos, 2005. **Resultados del proyecto Biodiversidad Bajo del Suelo, Ejido San Fernando, 2005.** Poster presented in the workshop "Presentación de Resultados del proyecto: Conservation and Sustainable Management of Below-Ground Biodiversity (CSM-BGBD) en la Región de Los Tuxtlas III", celebrated in November in Catemaco, Ver.

Franco-Navarro, F., Godinez-Vidal, D., Barois, I., de los Santos M., y J.A. García,. 2005. **Nemátodos de "Los Tuxtlas" Veracruz México**. Poster presented in the workshop "Presentación de Resultados del proyecto: Conservation and Sustainable Management of Below-Ground Biodiversity (CSM-BGBD) en la Región de Los Tuxtlas III", celebrated in November in Catemaco, Ver.

Trejo, D. 2005. **¿Qué es una Micorriza?** Poster presented in the workshop "Presentación de Resultados del proyecto: Conservation and Sustainable Management of Below-Ground Biodiversity (CSM-BGBD) en la Región de Los Tuxtlas III", celebrated in November in Catemaco, Ver.

María del Pilar Rodríguez-Guzmán, Raúl Rodríguez-Guerra, Grisel Negrete-Fernández, Martha Robledo-Esqueda, Erika Robledo-Esqueda y Bertha Sánchez-García. **2005. Hongos Patógenos de las raíces en Los Tuxtlas, Veracruz**. Poster presented in the workshop "Presentación de Resultados del proyecto: Conservation and Sustainable Management of Below-Ground Biodiversity (CSM-BGBD) en la Región de Los Tuxtlas III", celebrated in November in Catemaco, Ver.

Simoneta Negrete, Isabelle Barois, José A. García, Martín de los Santos, Javier Álvarez-Sanchez, Gonzalo Castillo, Silke Cram, Carlos Fragoso, Francisco Franco, Tajín Fuentes, Esperanza Martínez, Miguel A. Morón, Pilar Rodríguez, Patricia Rojas, Vinicio Sosa, Dora Trejo, y Lucia Varela, 2005. **Below-Ground BioDiversity in Tropical Landscapes: Mexican case study.** Poster presented in the "First Diversitas open Science Conference": OSC1-Integrating Biodiversity Science for Human Well-being Oaxaca, México 9-12 Noviembre 2005.

Pilar Rodríguez-Guzmán. 2005. **Diversity of Root Pathogenic Fungi in the Los Tuxtlas Biosphere Reserve, Veracruz, México.** Poster presented in the "First Diversitas open Science Conference": OSC1-Integrating Biodiversity Science for Human Well-being Oaxaca, México 9-12 Noviembre 2005.

Esperanza Martínez. 2006. **Cuantificación de los microorganismos que participan en los ciclos del nitrógeno y del azufre en suelos de "Los Tuxtlas", Veracruz.** Presented in the XXXV Congrego Nacional de Microbiología. 4-7Abril de 2006 Oaxtepec, Morelos.

Franco-Navarro, F & D. Godinez-Vidal 2006. **Soil nematode community under four land use intensities in the Mexican tropic**. XXXVIII Annual Meeting ONTA (Organización de Nemátologos de los Trópicos Americanos) 26th-30th June San José Costa Rica.

Franco-Navarro, F; J. Miranda-Damián & D. Godinez-Vidal 2006. **New isolates of the nematophaguos fungs, *Pochonia chlamidosporia*, from Mexico**. XXXVIII Annual Meeting ONTA (Organización de Nemátologos de los Trópicos Americanos) 26th-30th June San José Costa Rica

Franco-Navarro, F. & D. Godinez Vidal. 2006. **Occurrence of Pasteuria on soil nematodes in a Biosphere reserve in Mexico.** XXXVIII Annual Meeting ONTA (Organización de Nemátologos de los Trópicos Americanos) 26th-30th June San José Costa Rica.

Varela, L., F.J. Álvarez-Sánchez, I. Sánchez-Gallén, P. Guadarrama, D. Trejo, I, Barois, E. Amora-Lazcano, L. Lara, D. Olivera, W. Sangabriel, R. Zulueta. 2006. **Land Use and Diversity of Arbuscular Mycorrhizal Fungi in Mexican tropical rain forest.** 5th International Conference on Mycorrhiza (ICOM5) 23th-27th, July 2006 Granada, Spain.

Dora Trejo, Wendy Sangabriel, Liliana Lara, Ramon Zulueta, Lucia Varela, Juan Ruiz y Isabelle Barois. 2006. **Disturbance and land use effect on functional diversity of the mycorrhizal fungi.** Poster presented in the 5th International Conference on Mycorrhiza (ICOM5). 23th-27th, July 2006 Granada, Spain.

P. Rojas, A. Angeles, J. Amador and L. Hernández. 2006. **Diversity of Soil Ants in Los Tuxtlas, Ver. Mexico: land use effects mediated by the amount of forested area.** Poster presented in the XV International Congress of the International Union for the Study of Social Insects. 30th July–4th August, 2006 Washington, D.C., USA.

C. Fragoso, L. Camarena, L, Coria & A. Ángeles. 2006. **Earthworm Communities from Los Tuxtlas Reserve: Influence on land use systems and landscape changes.** Poster presented in The 8th International Symposium on Earthworm Ecology, I.S.E.E. 4th-9th September 2006 Krakow-Poland. Will be hosted by the Jagiellonian University, at the University New Campus, 30-387 Krakow, ul. Gronostajowa 7. Poland.

Varela, L; Álvarez-Sánchez, F.J; Sánchez-Gallén, I; Guadarrama, P; Olivera, D; Trejo, D; Lara, L; Sangabriel, W; Zulueta, R; Barois, I & E. Amora-Lazcano. 2006. **Análisis de la riqueza y diversidad de Hongos Micorrizógenos Arbusculares en función del uso del suelo en una selva alta perennifolia.** Congreso Mexicano de Ecología 2006. Morelia Michoacán, México. 26th-30th November 2006. Sociedad Científica Mexicana de Ecología, A. C.

Workshops held

Presentación y discusión final de los inventarios y planeación de la segunda fase. Xalapa, Veracruz 26th-27th September 2005.

Presentación de los inventarios y planeación de la segunda fase. Catemaco, Veracruz 4th-5th November 2005.

Taller de programación de actividades para la segunda etapa del proyecto BGBD. Ejido Adolfo López Mateos, Catemaco, Veracruz. 1st-2nd December 2005.

Taller de planeación para la implementación de parcelas demostrativas y experimentales de azucena y maíz. Pajapan, Veracruz 3rd-4th April 2006.

Output targets 2008

ü ***Farmer-to farmer knowledge sharing and extension through organized field trips and research activities result practices in at least two sites***

Published work

Vanlauwe[1], B. and Giller[2], K. (2006) Popular myths around soil fertility management in sub-Saharan Africa. Agriculture, Ecosystems and Environment 2006, 116: 34–46.

[1]TSBF-CIAT, Kenya; [2]WUR, the Netherlands

Abstract: The aim of this paper is to demystify some of the popular myths related to tropical soil fertility management that have gained hold in the development community and are often being promulgated by NGO's and development agencies in the tropics. Negative nutrient balances at farm scale or at larger scales are very often presented as proof that soil fertility is at stake in SSA. However, nutrient balances at plot and farm section scale are not always negative. In areas with large nutrient stocks, short-term nutrient mining is fully acceptable. Fertilizer use continues to face considerable controversy in SSA. In this paper, we demonstrate that fertilizers rarely damage the soil; that fertilizers are being used in SSA, often with favorable value-to-cost ratios; and that fertilizers do not cause eutrophication in SSA. Rock phosphates are abundantly present in SSA but most are poorly soluble. Adding these phosphates to compost heaps does not enhance the short-term availability of their P. Although organic inputs are essential soil amendments besides fertilizer, organic inputs alone cannot sustain crop production due to limitations in their quality and availability. Organic resources can also potentially stimulate harmful pests and diseases. Legumes are often advocated as important sources of organic matter but not all legumes fix nitrogen, require inoculation, or are a source of free nitrogen, as even green manures require land and labour. Certain grain legumes with high N harvest indices do not improve soil fertility, but remove net amounts of N from the soil. These myths need correction if we are to harness the role of science in the overall goal of assisting farmers to address the acute problems of poor soil fertility for smallholder farmers in SSA.

Completed work

Investing in and benefiting from social capital: some insights into farmer groups and engendered imbalances in rural Mozambique

Gotschi, E.[1], Freyer, B[1], Delve, R.J[2]. and Sanginga, P[3].

[1]University of Natural Resources and Applied Life Sciences, Austria; [2]TSBF-CIAT, Zimbabwe; [3]CIAT, Uganda

Abstract: Farmer groups are a popular strategy for rural development projects to work with farmers in an organized way in sub-Saharan Africa. Group processes strengthen farmers' capacities to articulate their needs, access information, technologies and markets that are often out of their reach. This study investigated who is investing into the group and how benefits of social capital are distributed amongst members and the broader community. Empirical results from analysis of farmers groups in rural Mozambique showed that farmer groups provide three types of goods: public goods, club goods, and private goods. Being in a group leads to a diversification of social relations, increased likelihood of accessing external resources, as well as mobilizing internal resources for collective action. Not all of these goods are equally distributed as there are significant differences based on gender, position within groups and educational levels. Though results suggested that group position is not significant in determining the ability of members to invest in and benefit from social capital, disaggregating this further by gender and position reveals that men are still more likely to obtain credit independent of position and that women leaders are more likely to obtain help and access information when they are leaders than

members of the group. This demonstrates that women in leadership positions can overcome some gender barriers that they experience as members only.

The ability to create social relations that benefit individuals is likely to be concentrated in the hands of younger, male individuals who are more likely to be educated and in leadership positions. Group benefits need prior investments of individuals who are allocating time and efforts into participating in group activities. Imbalances between investments and benefits from social capital will also be discussed. Even though the results show that there are no significant differences between group members in terms of investments into social capital, the extent of private goods that are generated by the group are not equally distributed amongst group members. Social capital is more easily accumulated by educated, younger male group members which reflect access to education and cultural social status. Gender has been identified as a key variable to determine a members ability to generate supportive relations and benefit from social capital.

Work in progress

Comparing Two Research &Development Approaches: Collaborative Experiment Design And Farmer Experimentation

I. Vandeplas[1], S. Deckers[2], J. Mukalam[2] and B. Vanlauwe[2]
[1]KULeuven, Belgium; [2]TSBF-CIAT, Kenya

The aim of the research in Migori/Rongo District is to improve the impact of the soybean introduction by further collaboration with the farmers involved, thereby enhancing their capacity in experimentation, marketing, and processing and finally transferring them the project.

The work was conducted in seven “zones”, being areas where the soybeans had spread naturally in absence of TSBF during 2005. The zones are organized into a Soybean cooperative, called Uriri Soya Farmer Cooperative. This approach was discussed in detail in a posted presented on the Highland Conference in September 2006 in Ethiopia.

Choice of zones: The seven zones were divided into two groups in which different R&D approaches were tested. In the first group of 4 zones farmers were invited to collaborate with researchers in the design and conduct of agronomic soybean experiments. This approach is further called Collaborative Experiments (CE). In the second group of 3 zones, farmers’ representatives were trained in experimentation and then sent to their zones to motivate farmers to experiment for themselves with soybean. This approach is further called Farmer Experimentation (FE). The seven zones were divided over the two groups in such a way that both would include zones lying close to the main road, zones having political influence of a previous chancellor, and very remote zones. This division allows observing how these different categories of zones react to the different R&D approaches.

CE: In this approach, the farmers were involved as equal partners in the whole process of experimentation, from problem identification to conduct and data analysis. The major problems identified by the farmers for soybean production were labour and input cost. Seasonal calendars indicated planting and weeding time as the busiest moments. For those two factors, the different treatments to be tested were chosen together. Farmers chose to experiment on 4 to 5 fields per zone, spread as far as possible from each other to allow more farmers to learn. Farmers agreed to provide land and labour, while researchers provided seeds and inputs. Throughout the season every activity was performed together and the farmer’s preferences were assessed during several field days to compare the agronomic output with the farmer’s conditions.

FE: In this approach everything was left to the farmers. Farmers did not receive any seed or input. They were provided booklets with guidelines and monitoring documents. Researchers only visited the fields as outsiders and advisors. Farmers were assisted at harvest and crop samples were taken for analysis.

During the first season of the research, large differences in behavior and response could be noticed between the two groups, CE and FE. While the initial motivation of the Collaborative Experiments was higher, this motivation fast changed into a demanding attitude and tensions between the farmers and researchers. During each meeting farmers involved tried to ask for payments for labour. In contrary, the Farmer Experimentation group reacted more positively. Although wondering why the project had not put experiment fields in their zones, the farmers were very interested about their own experiments. As farmers felt total ownership over the experiments they were not demanding. The only requests of farmers were about advice on how to improve their experiments.

After one season it is too early to conclude on this issue, but it allows to reflect on the relation between farmers and researchers. Both approaches try to break down the top-bottom approach often used by research. Nevertheless, they are mainly useful for the transfer of technologies which have already been tested on station for their agronomic capacities.

Sustainable promotion and development of soybeans in the farming systems of Kenya: The working of strategic alliances

J. Chianu[1], B. Vanlauwe[1], O. Ohiokpehai[1], N. Sanginga[1], and A. Adesina[2]
[1]TSBF-CIAT, Kenya; [2]Rockefeller Foundation, Kenya

Soybean was introduced in the farming systems of Kenya many decades ago. However, the crop has remained a minor crop despite its great potentials for improving household food and nutrition security (through quality food supply), household cash income (through the sales of soybean and soybean products), household health (through the provision of high quality protein-rich food), and soil fertility improvement (through its atmospheric nitrogen-fixing ability). Literature indicates that low yield, lack of knowledge on its utilization, and lack of market are among the key factors that have contributed to lack of widespread adoption of soybeans in the farming systems of Kenya. A recent effort based on improved dual-purpose promiscuous soybeans varieties sourced from IITA, Ibadan, Nigeria has been commenced by TSBF-CIAT and aims at solving the different problems that forestalled the take-off of this crop in the past by engendering strategic alliances of all the stakeholders that can contribute in one way or another in sustainable promotion and development of soybean in the farming systems of Kenya.

The objectives of this study are: (1) to understand the missing links that prevented widespread adoption and production of soybean in the farming systems of Kenya despite great efforts to promote the crop in the past, (2) to search for, contact, discuss with, and prioritize among different stakeholders or partners that can contribute towards alleviating missing links that have prevented widespread adoption and production of soybean in the farming systems of Kenya, (3) to develop the strategies for all the partners in the strategic alliance to work on defined and complementary roles in the new initiative for the promotion and development of soybean in Kenya, and (4) make recommendations on plausible strategic alliances for future development and promotion of a crop or livestock sub-sector in Kenya.

This study is being carried out in Nairobi. Literature review and interactions with various stakeholders (individual soybean farmers; producer groups; food processing industries; livestock feed industries; supermarket operators; farm input suppliers; staff of the Ministries of Agriculture, Trade and Industry, Finance, and Planning and Economic Development; staff of the National Agricultural Research Systems including research institutes and the Universities; Key informants, etc.) were used to identify the missing links that prevented widespread adoption and production of soybean in the farming systems of Kenya despite great efforts to promote the crop in the past.

Following this, some brainstorming sessions were organized and are used to list the potential partners that could be approached for their cooperation in the new initiative for sustainable development and promotion of soybeans in the farming systems of Kenya. Appointments to discuss the strategy were made with each of the listed partners and decisions taken were documented in minutes of related meetings shared with all in attendance at the meetings.

For the different functions, the following partners (Table 51) have agreed to work with TSBF-CIAT (discussions are still going on with other partners) in the strategic alliance for the development and promotion of soybean in the farming systems.

Table 51. Partners to TSBF-CIAT in the strategic alliance for the development and promotion of soybeans in the farming systems of Kenya

Function	Partners	Type of Organization
Research to develop technologies	Kenya Agricultural Research Institute, Kenyatta University, Jomo Kenyetta University of Agriculture	Research institutes and Universities
Producer groups	*Ebubala* Self-Help Group, *Tushiauriane* Self Help Group, *Nabongo Panga* Self-Help Group, *Jitolee* Women Group, *Itako* Women Group, *Bushe* Women Group, *Shishebu* Women Group, *Masaa* Men and Women Group, *Eluche Mwangaza* Community Development Organization, etc.	Farmer organization
Inorganic fertilizer supply	FIPS-Africa [FIPS means Farm Inputs Promotion Services]	Private business organization
Micro-credit supply	K-Rep Development Agency	Micro-credit institution
Seed supply	Western Seed Company, Kenya Seed Company	Private and Public Companies
Seed/grains bank development	SACRED-Africa	NGO
Food processing industries for the marketing of output	Bidco, NUTRO EPZ	Private companies
Information development and dissemination	*AfriAfya*	NGO
Scaling out and scaling up	Ministry of Agriculture, Ministry of Trade and Industry; Ministry of Finance; Ministry of Planning and Economic Development	Public institutions
Produce haulage and transportation	Farmers' Own Trading Company and KACE (Kenya Agricultural Commodity Exchange)	NGO
Research funding	The Rockefeller Foundation	Donor organization

Output targets 2008

ü ***Web content in the BGBD website enhanced to contain data and information on BGBD taxonomy and species identification***

Currently four countries participating in the BGBD project namely Brazil, Indonesia, Kenya and Mexico have developed their individual websites to complement the global BGBD website http://www.bgbd.net/. Content of the sites to be enriched by 2008 once the identities of the different soil biota have been confirmed and verified by the individual scientists and the technical advisors. The BGBD project aims at having a global synthesis of its results in May 2007 where all the data collected in the project will be put together analyzed and global output produced. Portions of the individual country outputs have been highlighted in output 1 of this report. The results need to be published according to the project policy before it is uploaded on the project website to avoid uploading misleading or unvaried information.

Output targets 2009

ü ***Profitable land use innovations scaled out beyond pilot learning sites through strategic alliances and partnerships, and application of alternative dissemination approaches***

Progress towards this output target will be reported next year.

Output targets 2009

ü ***At least three capacity building courses on ISFM held by AfNet and MIS***

Output targets 2009

ü ***Strategies for institutionalization of participatory NRM approaches and methodologies established***

Progress towards this output target will be reported next year.

Progress towards achieving output level outcome

∉ *Strengthened and expanded partnerships for ISFM facilitate south-south exchange of knowledge and technologies*

Strengthening partnerships is at the core of TSBF-CIAT strategy to promote ISFM and SLM in the tropics. Last year, we have restructured AFNET to include regional multidisciplinary teams in Eastern, Southern, and West and Central Africa to better coordinate and interact with the growing membership. The BGBD project completed its first phase with a successful conference in Manaus where 71 southern scientists were able, for the first time, to share results of pioneering inventory work on belowground biodiversity. We have also consolidated the MIS and CONDESAN Consortia in Latin America and have started a new partnership initially in Colombia aimed at restoring degraded pastureland.

AFNET remains the most dynamic and widespread network for linking scientists working on ISFM in Africa. The more than 350 members now benefit from participation in networked long-term experimental trials, degree-related training and capacity building activities, as well as more general information dissemination (such as on training opportunities and scholarships for young scientists, as well as scientific findings and progress in ISFM). South-south exchange of expertise and findings within the network has been visible in the prominent involvement of many AFNET members in the preparation of successful proposals for the sub-Saharan African Challenge Program.

The 3rd annual symposium of the BGBD project, held in Manaus Brazil, provided a forum for the exchange of preliminary data on (i) Benchmark area description and socio-economic characterization, (ii) Results of the inventory of macro-fauna, (iii) Inventory of nematodes and mesofauna, (iv) Inventory of legume nodulating bacteria and arbuscular mycorrhizal fungi (AMF) (v) Inventory of pathogenic and antagonistic fungi and insect pests and (vi) Standard methods for the inventory of BGBD. The innovative pan-tropical research activities of this project were evaluated by a team of external reviewers in 2005, which has translated into a successful restructuring of the project for the launch of a second phase in 2006.

The MIS consortium is very active in advancing the research agenda for the agriculture in Honduras and Nicaragua. The most important achievement has been the strong commitment from partners in Nicaragua to disseminate the Quesungual System into the Country. This is generating very positive synergies between the NARS, the academia, regional and national authorities and of course farmers. Partners of MIS were involved in regional workshops and many students have benefited from training that is associated with MIS activities.

The CONDESAN Consortia continues to be a strong partner in the Andes and will be a major vehicle to transfer research outputs, particularly related to implementation of schemes for payment of environmental services. A new partnership with the regional environmental agency in the Caribbean savannas of Colombia, (CVS), the National Research Institution (CORPOICA) and regional Universities (U. Cordoba and U. Sucre) as well as organizations of indigenous communities, has made significant progress in the rehabilitation of degraded pastureland in the region. Pasture degradation is perceived as a major problem in the region. This partnership with funding from the Colombian Ministry of Agriculture and Rural Development will greatly strengthen the capacity of partners to focus on land rehabilitation and will also include a large number of students from the region at different project phases.

Progress towards achieving output level impact

- ∉ *Improved institutional capacity in aspects related to ISFM and SLM in the tropics contribute to agricultural and environmental sustainability*

By involving the principles of ISFM and SLM in the implementation of the activities of the partnerships, we are advancing in reinforcing local and regional capacity to use and disseminate such strategies. Large involvement of students from different disciplines will warrant the continuation of these efforts beyond those of the current partnerships.

In particular, AFNET has been highly effective in placing young scientists and building the capacity of mid-career scientists in advancing ISFM and SLM within African NARES. In preparation for the upcoming 2007 Symposium, a study will be conducted of the disciplinary and career impacts of AFNET members since the network's inception in the early 1990s. The impact of the network is already visible in the regular successes of AFNET members in securing funding for ISFM and SLM work from major donors and initiatives, such as the sub-Saharan African Challenge Program. The networking of leading scientists in various, African agro-ecoregions has already led to significant advances in understanding the dynamics of combining organic and inorganic resources, the interaction of water and nutrients in dryland conditions, and in conservation agriculture.