Narrative country reports

Month 30

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N2Africa

Putting nitrogen fixation to work for smallholder farmers in Africa

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1. DR Congo Country Report on Month 30 of the N2Africa Project

Prepared by Frederick Baijukya (country mentor), Jeanmarie Sanginga (agronomist), Dieudonne Mongane (Farm Liaison Officer) and Prof. Jean Masamba Walangululu (country coordinator, Rhizobiology)

Objective 1. Establish a baseline of the current status of N2-fixation; identify niches for targeting N2-fixing legumes in the impact zones, M&E and impact assessment.

Activity 1.3. Identify new opportunities for targeting legume technologies to increase BNF and enlarge the area under the priority legumes.

Milestone 1.3.2. New opportunities identified prior to each new cropping season. Month 3, years 2, 3&4.

In 2012 long rains growing season, the N2Africa activities in DR Congo have been extended to new action sites namely Rusizi plain (South Kivu) and Goma (North Kivu). This follows additional funding from HGBF that is directly managed by IITA. The old project staff has teamed up with the newly recruited IITA staff to establish, in the new sites, the adaptive trials and demonstrations on soybean germplasm, and on the use of inoculants and P fertilizers. Following this development, three new partners have been recruited namely Women for Women International, CARITAS-Kiringi, and IPLCI (Initiative Paysanne pour Lutter Contre L'ignorance, an initiative working to improve farmers knowledge) were recruited. These organizations are currently working with 1,500 farmers. Apart from disseminating legume technologies, new partners organizations are working with farmers to establish collective markets of beans, soybeans and associated crops including maize and cassava. CARITAI is also in the process to revive its oil crop extraction plant in Rusizi plain. The newly introduced soybean rust tolerant materials from Seed co Zimbabwe and IITA-Malawi are showing good adaptability and yield potential in different agro-ecological zones (AEZ) of DR Congo. In collaboration with breeders from INERA, the varieties are being tested in different environment in order to collect enough information to allow for their release in South Kivu. Another opportunity is a newly formed national policy on free importation of agricultural input including fertilizers. This is expected to improve availability of fertilizers in South Kivu ant its eventual use by smallholder farmers.

Milestone 1.3.3. Complete market analysis for inoculum in representative areas of the three hubs reported on, including cost/benefit analysis at smallholder level; recommendations for private sector engagement made. Month 6, year 2.

Market analysis for inoculums has not been done for DR Congo. Inoculants used in South Kivu are imported by N2Africa from MEA Kenya (MEA Kenya ltd) and from Spain, then supplied free of charge to beneficiaries. No attempt has been made to sell inoculants locally although information on its increased demand by farmers is immense. However, the team in Bukavu has limited capacity to undertake such a study and it will need support from Dr. Paul Woomer in this endeavor.

Activity 1.4. Quantify the current on-farm N2-fixation in the target farming systems and its impact on livelihoods (income, nutrition).

Milestone 1.4.2. A baseline report quantifying the current level of BNF and its contributions to rural livelihoods is available for all impact zones. Month 12, year 1.

Estimates of BNF were done based on data collected from agronomy and Delivery and Dissemination (D&D) trials results of which, are included in Milestone report 1.4.2. Actual estimate of BNF using baseline information will be provided as ^{15}N analyses results become available and analysis of data collected from detailed farm characterization completed. A comprehensive picture will be provided in month 36 report.

Activity 5. Monitor impact of investments and uptake of legume and inoculant technologies in the impact zones.

Milestone 1.5.2. A monitoring and evaluation framework used for evaluating progress and planning subsequent activities during planning. Month 3, years 2, 3 & 4.

Monitoring tools were provided by M&E specialist and required information collected including amount of input supplied to beneficiaries, number of field days conducted, number and type of trainings conducted, number and type of exchange visits as well as media events conducted. Use and impact of N2Africa technologies continue to be monitored using field books. Analysis of information collected is currently been done by Data work stream leader. Lessons from past D&D activities include the need for good planning and supervision of field days because some field days are not well directed, which leads to them being dominated by politicians.

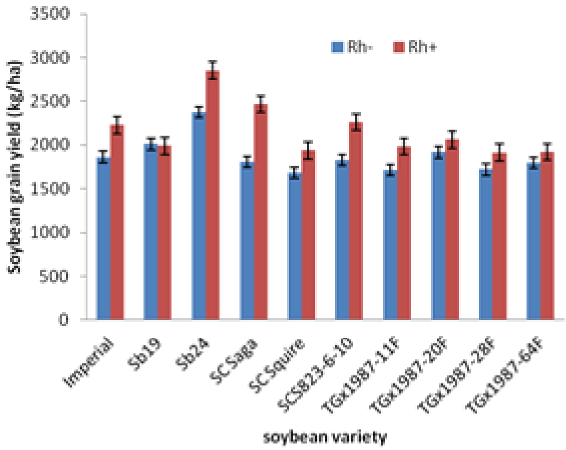


Figure 1.1: Response of selected soybean varieties to rhizobia, inoculation as observed at Mulamba site during 2011short rains growing season.

Milestone 1.5.3*.* An external project review has been conducted, with representatives of the Bill & Melinda Gates Foundation. Month 6, year 3.

The visit by external evaluator Dr. John Lynam to Bukavu has been differed to end June.

Activity 1.6. Evaluate the impact of introduced legume and inoculant technologies on farmer's livelihoods and soil health in the impact zones.

Milestone 1.6.1. A report on the impact of N2-fixation technologies on farmers' livelihoods is produced. Month 12, year 4.

Not yet done for DR Congo.

Objective 2. Select multi-purpose legumes (food, fodder, stakes, and soil fertility management) for enhanced BNF and integrate these into farming systems.

Activity 2.1. Identify and field test best varieties of soybean for high N2-fixation capacity and adaptation to abiotic and biotic stresses.

Milestone 2.1.2. At least 3 new soybean varieties with high BNF potential identified. Month 12, year 2.

Evaluation of soybean germplasm continues with three Seed co materials (Sc Saga, Sc Squire, and Sc 822-10-6), five IITA materials (TGx1740-2F, TGx1987-11F, TGx1987-20F, TGx1987-28F and TGx1987-64F) and one Ugandan material SB 24 (Namsoy), tested against a local variety Imperial. The new materials appear to yield of above 1,500 kg and respond to rhizobial inoculation (Figure 1.1). However, the Ugandan material SB 24 is more promising in term of yield closely followed by Seed co materials are when inoculated. The variety SB 24 is earmarked for release this year, whereas the rest of materials are undergoing multi-locational testing to assess their stability in yield.

Activity 2.4. Explore the N2-fixing potential of multi-purpose tree and forage legumes for intensive meat and milk production and environmental services.

Milestone 2.4.2. Sufficient planting materials are available for at least 2 multipurpose tree legumes and 4 forage legumes with high BNF capacity that have been identified across the impact zones. Month 12, year 2.

Sufficient seeds were obtained for two tree legumes *Callindara callothyrsus* and *Lucaena diversifolia* and three herbaceous legumes *Stylothanses guianensis, Clitoria ternatea and Lablab purpureus.* The obtained seeds were used to established on farm trials with in 25 farmers in Nyangezi, Kamanyola and Tubimbi in the 2011 short rains growing season. However, establishment of herbaceous legumes was poor in most sites due to poor soils and high rainfalls that were received in 2012 long rains season. More seeds of the same legumes have been collected and will be used to replant the old demos as well as establishing new demos in Kamisimbi and Ikoma sites where there is relatively large population of livestock (cattle, small ruminants and cavies).

Activity 2.5. Identify best-fit agronomic practices for maximizing potential benefits of legume and inoculant technologies on increasing and stabilizing productivity.

Milestone 2.5.1. At least 9 adaptive [impact zone-specific] research campaigns focusing on major gain legume (soybean, cowpea, groundnut, beans) implemented in the impact zones. Month 6, year 2.

Testing of best-fit agronomic practices continues with more focus on intercropping patterns of improved varieties of soybean or beans with improved varieties of maize or cassava. Also work on combined effect of inoculants and Phosphorus on soybean yield continues. In the maize/ soybean intercropping trials, total grain yields per ha (maize + soybean) increased with a maximum of 170 kg/ha (an increase of 3%) during 2011 short rains season. In the improved cassava/ soybean or beans intercropping trials there was more room for soybean and or beans (Figure 1.2), which resulted in higher soybean or bean grain yields. However, cassava yields were not affected by the different cropping arrangement but total soybean and cassava yields in two years increased by 300 kg/ha (4%) in the improved system (Table 1.1).

Figure 1.2: Improved intercropping of cassava and beans or soybean give more room for legumes observed in Ikoma Sector, south Kivu, DR Congo.

Table 1.1. Soybean grain and cassava tuber yields (kg/ha) in tradition and improved intercropping system as observed at Murhesa site in DR Congo during 2011short rain growing season

		Not inoculated		Inoculated		
		traditional	improved	traditional	improved	Average
Soybean	PK6	783	836	816	844	820
	SB24	833	933	883	992	910
Mean		808	885	849	918	865
Cassava	Intercropped with PK6	21,320	21,464	21,978	20,583	21,336
	Intercropped with SB24	20,944	22,369	20,839	22,347	21,625
Mean		21,132	21,916	21,408	21,465	21,480

In most sites, we continue to observe consistent positive interaction between inoculants and P application on soybean yield. Assessment continues on 15 adaptive research trials established in March 2012 at 20 sites to ascertain results obtained during 2011 short rains growing season.

Activity 2.6. Evaluate contributions of best fit agronomic practices to system productivity and livelihoods with specific attention to trade-off analysis between competing enterprises.

Milestone 2.6.1. Household benefits from specific BNF interventions quantified for the four major grain legumes in the impact zones. Month 12, year 3.

Compilation data for this milestone has started and the results will be presented in the year 3 report.

Objective 3. Select superior rhizobia strains for enhanced BNF and develop inoculum production capacity in sub-Saharan Africa, including private sector partners.

Activity 3.1. Assess the need-to-inoculate for the target legumes and identify elite strains across the impact zones.

Milestone 3.1.3. At least 2,000 strains screened for effectiveness under greenhouse conditions to select the top 5% for field testing. Month 6, year 3.

Bio-prospecting for rhizobia strains is ongoing in various ecosystems of DR Congo. A total number of 2,130 nodules obtained from both cultivated and wild legume communities that are closely related to soybean and bean have been collected from 213 sites. Table 1.2 provides an extract of sites and legumes species from which the nodules were collected. Isolation of strains is going on with 40 new strains isolated so far (this is different from other 40 strains that were isolated by MIRCEN). Characterisation of strains is expected to begin mid June and evaluation of their effectiveness will follow.

Table 1.2: Extract of nodule sampling sites and host legume in DR Congo.

N°	Sample ID	Location	Host legume	Coordinates	Altitude (m)
1	Luh1	Luhihi	*Bean*	S02°16.780´E028°53.091´	1557
5	Kat7	Katana	*Soybean*	S02°14.615'E028°51.945'	1543
20	Kab1	Kabare	*Peas*	S02°29,616 E028°47,754´	1952
27	Kaw 2	Kawizi	*bean*	S03°17,654´E029°09,630´	810
28	Run1	Runingu	*bean*	S03°06,901´E029°08,402´	981
31	Luv3	Luvungi	*Groundnut*	S02°50,548´E029°01.216´	895
48	Kal31	Kalehe	*Rhynchosia sp.*	S02°09.172'E028°50.376'	1697
79	Inera 1	Inera	*Crotalaria cleomifolia*	S02°19.197'E028°47.239'	1722
83	Kav 1	Kavumu	*Glycine wightii*	S02°43.739'E029°00.232'	753
89	Kag 2	Kagando	*Rhyncosia sublobata*	S03°19.967'E029°09.522'	775
94	Kaw 6	Kawizi	*Vigna vexillata*	S03°15.804'E029°09.684'	836
98	Kil 3	Kiliba	*Indigofera repens*	S03°14.721'E029°11.128'	797
120	Lurh 11	Lurhala	*Indigofera zenkeri*	S02°36.305'E028°45.672'	2003
138	Burh 2	Burhale	*Rhyncozia sp.*	S02°42.665'E028°37.869'	1644
145	Wal 3	Walungu	*Sesbania sesban*	S02°37.640'E028°417301'	1656
146	Kama 1	Kamanyola	*Bunch bean*	S02°43.591'E028°59.988'	1034
152	Luv 3	Luvungi	*Arachis hypogaea*	S02°50.548'E029°01.216'	895
212	Mon 9	Monvu	*Desmodium adsendens*	S02°11.575 E028°59.414'	1496

Milestone 3.1.4. The benefits of inoculation of soybean and beans with at least 2% of the elite strains demonstrated in the impact zones. Month 12, year 3.

Activity 3.3. Formulate improved inoculant products and develop cost-effective production methods, including quality assurance procedures.

This activity has not been achieved as isolation of strains has just commenced. However, it is anticipated that the significant progress will be made before end of year 3.

Milestone 3.3.2. Cost effective inoculant production methods including fermentation technologies, carrier selection, inoculant formulation, enhanced shelf life developed. Month 12, year 2.

The rhizobiology lab at Kalambo has full capacity to do quality control of inoculants. Initial work has begun on identification and characterization of carrier materials where peat samples have been collected at two sites Ciherano and Nyangezi. However, follow up activities on testing of fermentation methods and inoculant formulation will be hindered by the lack of equipment such as the fermentor and an efficient autoclave. For this activity, it would be advisable to develop mechanism for the rhizobiology team in Bukavu to work with the Rwanda team and make use of facilities available at RAB Rubona.

Milestone 3.3.3. Universal logo representing quality assurance standards adopted among cooperating laboratories. Month 6, year 3.

The logo developed by Dr Paul Woomer was presented to the rhizobiology team of DR Congo in May, 2012. The team is currently studying it and it will provide comments to Paul Woomer for consideration.

Activity 3.4. Expand and upgrade inoculant production capacity in sub-Saharan Africa.

Milestone 3.4.3. At least 50,000 inoculant packets produced per year in at least 3 cooperating laboratories. Month 12, year 2, 3 & 4.

This activity is currently not applicable for Dr Congo.

Milestone 3.4.4. Potential private sector inoculant producers invited to planning meeting and interim assessment workshops. Month 6, years 1, 2 & 3.

No private investor has showed interest in producing inoculants in DR Congo. However, inoculants production manager from MEA Kenya was invited and participated in two planning meetings in Bukavu and interacted with input dealers who showed interest to sell inoculants. MEA is currently working out on the modalities to supply inoculants in DR Congo.

Objective 4. Deliver legume and inoculant technologies to farmers throughout sub-Saharan Africa.

Activity 4.1. Create strategic alliances for facilitating dissemination of legume and inoculant technologies in the impact zones.

Milestone 4.1.3. At least 10 additional satellite sites have been identified per impact zone. Month 12, year 3.

Seven satellite sites were identified at the beginning of 2012 long rains growing season. They include; three sites in Rusizi plain (one under the management of IFAD funded project “increasing smallholder farm productivity income and health though wide spread adoption of integrated soil fertility management”, the second managed by CARITAS and the third site managed by IPLCI); one site in Kalehe (Mukwidja sector) and another one in Mwenga (Kasika) all managed by IFAD project and two sites in Karhehe-Ihusi and Walungu under the management of Women for Women International. Farmer in these sites are testing inoculants technologies as well as multiplying seed of improved legume varieties.

Activity 4.2. Produce specific dissemination tools, including inoculant packets, adapted to the needs of farmer groups, agro-dealers, and development partners.

Milestone 4.2.1. At least 1 dissemination tool for each Action Site related to legume and inoculant use is produced per impact zone, resulting in about 24 different tools by the middle of year 3. Month 6, years 2, 3 & 4.

In 2011 short rains growing seasons, 26 demonstrations on intercropping soybeans and maize and 14 demos on soya bean-cassava intercropping were established. In the 2012 long rains season, additional 14 demo plots on new P fertilizer blend Sympal, TSP and inoculants were established (12 within the action sites and 2 away in the satellite sites). In both 2011 short rains and 2012 long rains growing season the demo farmers testing maize-soybean intercropping were provided with 0.6 kg improved maize seed, 1 kg soybean and 2 kg of fertilizer NPK. Farmers testing soybean-cassava intercropping were provided with 1 kg of bean, 2 kg of NPK, 1 packet of inoculants and 80 cuttings of improved seed varieties. Farmers testing effect of inoculants on soybean were provided with 1 packet on inoculants, 1 kg of soybean seed and 1 kg of sympal.

Activity 4.3. Engage with legume seed system, market, and nutrition initiatives operating in the impact zones.

Milestone 4.3.3. At least half of the farming communities engaged in the project are actively linked to legume market outlets. Month 12, year 2.

In DR Congo, N2Africa, in collaboration with IFAD project continues to train farmer on collective marketing especially in areas with high production of soybean. Currently, efforts are put to identify collection centers and warehouses, training of farmers on achieving and maintaining the quality of grains. In this endeavor, participating cooperatives are provided with quality control kits comprised of tarpaulins, moisture meter, aflatoxin test instrument, weighing scales and storage bags. In addition, representatives of participating cooperatives were trained on business plan to sensitize them on production costs and realization of storage cost before selling. Farmer cooperatives are also linked to microfinance institutions including MECREBU, COOPEC FOMILAC, COOCEK KIVU, and COOPEC Nyawera to facilitate them to offset low prices offered at the time of harvest. In each action site a market committee has been formed and it is charged with responsibilities of receiving and disseminating to members the market information collected on weekly basis the provincial marketing office. All participating cooperatives are now linked to GAP-UPACO (an organization of progressive farmers involved in production and commercialization of farm products). Challenges still exist however, on lack of serious large buyers and existence (yet to be quantified) of informal farming contracts with business men from Rwanda.

Milestone 4.3.4. At least half of the farming communities engaged in the project are linked to legume processing initiative. Month 12, year 3.

The main efforts have been directed to train the trainers (ToT) on household and cottage processing of soybean into products such as soymilk, soy beverage and tofu. A total of 48 women farmers from partner organization were trained in December 2011 and these are expected to train about 2,400 farmers by end of July 2012, just after harvesting activities have been completed. The ToT was done jointly by N2Africa and IFAD project making use of training materials developed by CIALCA and Paul Woomer.

Activity 4.4. Conduct collaborative legume and inoculant technology dissemination campaigns and create awareness in rural communities in all impact zones.

Milestone 4.4.1. Dissemination and extension process and Proof of Principle in pilot site testing documented. Month 10, year 1.

A mid-course examination of the dissemination and extension processes and proof of principles in pilot sites appears in the milestone 4.4.1 report. In this report, DR Congo is indicated to have made good progress, but need greater priority in raising the productivity of legumes in degrades soils in order to achieve the project goal. The report also points out the lack of clear understanding of project's contribution to BNF, as there still no good quantification of initial field BNF and that of improved legume managements, the fact which, is attributed to delayed analysis of collected plant samples on ^{15}N. The good news is that results on ^{15}N analysis have started coming permitting the information to be provided in year 3 report.

Milestone 4.4.2. Large-scale demonstration and dissemination campaigns held in each impact zone. Month 6, all years.

In 2011 short rain growing season (October-December), a total of 13 demonstration plots were established in different action sites working with 1,900 households who planted over 3.6 tons of beans, 8.67 tons of soybean, 2.5 seeds of improved maize variety and 85,6898 cuttings of improved cassava variety. In 2012 long rains growing season (March-July), 16 new demonstrations plots have been launched with direct participation of 3,123 households (excluding 1487 in satellite sites), where 685 farmers are testing soybean-maize intercropping; 428 farmers testing soybean-cassava intercropping, 1602 farmers testing bean-maize intercropping, 560 farmers testing beans-cassava intercropping and 699 farmers testing soybean inoculant and Sympal fertilizer use. For this season 3.6

tons of improved maize seeds, 6.45 tons of beans, 13.6 tons of soybean, 96,564 cuttings of improved cassava varieties and 549 packets of soybean inoculants were distributed to beneficiaries.

Milestone 4.4.3. At least 3 extension events (e.g., field days, exchange visits) organized per season per country. Month 9, all years.

Between October 2011 and January 2012, a total of 5 field days were organized by the partner organizations, with the participation of 1,599 farmers (446 men and 1599 women). Four (4) exchange visits were also conducted, where a total of 143 farmers participated (36 men and 107 women).

Milestone 4.4.4. At least 3 mass media events (e.g., radio programs, video documentaries) organized per hub. Month 12, all years.

Twenty four media events were conducted during the reporting period. All media events were in the form of radio shows which were presented by the project staff (Agronomist and a Farm Liaison officer), the partner projects (IFAD and CIALCA) as well as agronomists from partner organizations. The shows are done weekly, through FM Radio Maendeleo. In return to the aired information the project staffs have so far received about 1,032 SMS requesting for details about disseminated technology (improved seeds and inoculants) or seeking for clarification on the use of disseminated technologies.

Activity 4.5. Develop strategies for empowering women to benefit from the project products.

Milestone 4.5.2. A report documenting the involvement of women in at least 50% of all farmer-related activities produced. Month 9, years 2, 3 & 4.

Information on involvement of women in project activities is collected and provided to M&E specialist. In the past 6 months, the project has worked with a total of 6,561 farmers, with 4,584 (70%) being women. Of farmers attending field days, 72% were women and 74% of farmers attending exchange visits were women.

Milestone 4.5.3. At least 2 special events on the role of legumes in household nutrition and value-added processing conducted per country. Month 12, all years.

The field days organized by the partner DIOBASS in Bugorhe and Mushinga sites and partner PAD in Murhesa covered information on processing and on the role of legumes in household nutrition. As indicated before, en-mass events to show the role of legumes in household nutrition will be conducted in July, 2012 soon after harvest has been completed.

Objective 5. Develop and strengthen capacity for BNF research, technology development, and application.

Activity 5.2. Advanced training to MSc and PhD level of an elite young cadre of African scientists focused on topics filling identified knowledge gaps and operationalization of a gender-sensitive participatory monitoring and evaluation framework.

Milestone 5.2.1. At least 14 MSc and 7 PhD candidates selected for training from the impact zones. Month 6, year 1.

Ms. Bintu Ndusha has completed her coursework at University of Nairobi and is actively isolating and characterizing the rhizobia strains at Kalambo laboratory in Bukavu. Three other students nalely Isaac Balume, Fidele Barhebwa and Eric Sika continue with their course work at University of Nairobi and Kenyatta University. In addition, five BSc students (3 men and 2 women) from the faculty of agriculture of Catholic University of Bukavu and the Protestant Universities of Bukavu are attached to N2Africa for their field work.

Activity 5.3. Training-of-trainers workshops on legume and inoculant technologies for agricultural extension workers, NGO staff, and agro-dealers.

Milestone 5.3.2. At least 8 training-of-trainers workshops (1 workshop in each country), attended by at least 40 farm liaison staff, conducted on inoculation technology and legume agronomy. Month 10, years 2 & 3.

A total of 32 master farmers were trained to strengthen activities in the new action sites as well as in the satellite sites. The previously trained 589 Master Farmers continue to serve in the old action sites as the ratio of new farmers to Master Farmers is still well balanced. Additional 50 Master Farmers will be trained in August just at the beginning of 2012 short rains season.

Activity 5.4. Training workshops on legume and inoculant technologies for officers of farmer associations and community-based organizations.

Milestone 5.4.2. At least 2 grass-root training events organized by each of 320 to 640 trainers across all impact zones, with an expected attendance of 50 farmers per event [resulting in 51,000 farmers trained during year 3 and 132,000 during year 4]. Month 12, years 3&4.

At the beginning of both 2011 short rains and 2012 long rain season, refresher training workshops for agronomist and field technicians (from partner organizations) were organized in order to help them to understand the protocols and be able to manage and collect data from demos and field trials. A total of 10 agronomist and 16 field technicians participated in these training workshops.

Milestone 5.4.3. At least 30 agro-dealers in each hub are trained in accessing, managing and distributing information on inoculant use each year [270 trained agro-dealers by year 4]. Month 10, years 2, 3 & 4.

No agrodealers were trained during the reporting period. However, a total of 18 agrodealers have been identified from different action sites and an inventory of training needs continues. The actual training is planned for July 2012.

Activity 5.5. Provide training, educational and extension resource materials to support activities 5.1 – 5.4.

Milestone 5.5.3. Support for undergraduate and postgraduate education will be provided through access to long distance education programs, visiting professorships or adjunct appointments in the area of N2 fixation at 25 African Universities, and the provision of resource materials to assist in course planning and evaluation. Month 12, year 2.

Although not formalized, materials developed by N2Africa including the training The Master farmer Training Manuals, the training manual on advanced skills to Rhizobiology and various other reports developed by N2Africa are becoming valuable resources for students from various universities in Bukavu. These materials are used in labs as well as guides in the field.

Staff / Management Updates

A new assistant field technician was recruited in March, 2012 to strengthen the capacity of project team. The technician will assist to collect data from closely monitored farms as well as processing of soil and plant samples collected from agronomy trials.

Risks:

As development is made to improve land productivity, other production challenges are increasingly becoming pronounced including bad weather (mid-season drought and excessive rains) and insecurity to some of action sites. This might hinder to achieve the expected results.

2. Ghana Country Report on Month 30 of the N2Africa Project

Introduction

This report details the progress made by the N2Africa Ghana in the last six months of year 2. During this period, project MSc students completed their course work, research technicians were employed, project review and national planning meetings held, new partnerships formed, and adaptive research trials and dissemination activities carried out.

Objective 1: Establish a baseline of the current status of N2-fixation, identify niches for targeting N2-fixing legumes in the impact zones, M&E and impact assessment

Activity 1.1.3: Engage project staff and make capital investment in all impact zone

Establish project management structures

Accomplishments: The position of research technician has been advertised, applicants have been interviewed and three candidates have been selected; one to be responsible for the trials in each of the three mandate regions. Mr. Yemyoliya A. Haruna joins the Ghana Project team as research technician for Upper East, with Mr. Jonathan A. Yelevielbavire for Upper West and Mr. Abraham Baalabong for Northern region.

N2Africa partners participating in D and D and/or agronomic trials have been supplied with one rain gauge per mandate community each amounting to a total of 60 rain gauges. In addition partners received 3 digital weighing scales each for field work.

Activity 1.5.2: monitoring and evaluation framework has been used for evaluating progress and planning subsequent activities during planning

The country leader, officers from the various partners and farm liaison officer were all fully engaged in the monitoring and evaluation activities of the project. The requisite data on, Input distribution, Training events, Field days, Field Book, Use survey, Media interactions, Lead Farmer, GPS data Assessment were collected, recorded in the templates and sent to the M and E work stream leader.

Agricultural inputs in the form of legume seeds, fertilizers, inoculums and insecticide were distributed to about 30 villages in six districts. In all inputs were distributed to about 344 lead farmers and 10,800 satellite farmers of which 59.1% were males and 40.9% were females. A total of 27 training events were conducted in the six mandate districts. Three of the trainings were particularly focused on inoculation techniques, Biological Nitrogen Fixation, agronomy of legumes and storage and handling of inoculants. Other trainings were seasonal trainings. These trainings covered the following subjects: Explanation of D and D protocol for 2011 cropping season, How to lay out a Trial Plot, Soil Sampling Techniques, Biological Nitrogen Fixation, Inoculation (handling and proper storage of inoculants), Agronomy of Legumes, and Lessons learnt from last year's cropping season. An over view of the training event is presented in Table 2.1.

Table 2.1: Overview of trainings and participation in Ghana

		Participants				
Action sites	Place of training	Male	Female	Total	% Male	% Female
Nadowli	Daffiama Area Council			137	n/a	n/a
Nadowli	Zambogu			9	n/a	n/a
Nadowli	Moyiri			134	n/a	n/a
Bawku West	Apotabogo	11	2	13	84.6	15.4
Bawku West	Kobore	5	8	13	38.5	61.5

Bawku West	Sapelliga	12	2	14	85.7	14.3
Bawku West	Tanga	11	1	12	91.7	8.3
Bawku West	Tilli	10	14	24	41.7	58.3
Chereponi	Achuma	9	4	13	69.2	30.8
Chereponi	Adari	11	4	15	73.3	26.7
Chereponi	Andonyamanu	5	7	12	41.7	58.3
Chereponi	Ugando	11	4	15	73.3	26.7
Chereponi	Jakpa			0	n/a	n/a
Chereponi	Adari			0	n/a	n/a
Chereponi	Adari			0	n/a	n/a
Kassena Nankana East	Manyoro	16	4	20	80	20
Kassena Nankana East	Naaga	13	3	16	81.3	18.8
Kassena Nankana East	Nyangua	28	3	31	90.3	9.7
Kassena Nankana East	Punyoro	4	5	9	44.4	55.6
Kassena Nankana East	Pung North	14	2	16	87.5	12.5
Kassena Nankana East	Doba /Kandiga Junction	10	2	12	83.3	16.7
Karaga	Pishegu	20	21	41	48.8	51.2
Karaga	Nyong	19	4	23	82.6	17.4
Karaga	Sheillianyili	24	9	33	72.7	27.3
Karaga	Sung	26	0	26	100	0
Karaga	Maglaa / Nyoglo	17	5	22	77.3	22.7
Savelugu	Yong			0	n/a	n/a
Nadowli		6	2	8	75	25
	Total	282	106	388		

Objective 2: Select multi-purpose legumes (food, fodder, stakes, and soil fertility management) for enhanced BNF and integrate these into farming system

Activity 2.1. Identify and field test best varieties of soybean for high N_2-fixation capacity and adaptation to abiotic and biotic stresses

A maximum of seven soybean varieties (Salintuya 1, Jenguma, TGX1855-2E, TGX1855-10E, Anidaso, TGX1448-2E, Quarshie) were identified and used for varietal trials (Table 2.5). In the Northern Region, these trials were sited at Ugando and Adari in the Chereponi district and on-station on SARI's experimental/research field at Nyankpala in the Tolon-Kumbungu district.

Results and Discussion

The results of the parameters measured are indicated in the Tables 2.2-2.22 and Figures 2.1-2.4 below.

Table 2.2: The response of different soybean varieties grown on-station at Nyankpala to *Bradyrhizobium* inoculation in 2011

Treatment	Nodule score (no./plant)	Nodule dry wt. (mg/plant)	Biomass dry wt. (kg/ha)	Haulm dry wt. (kg/ha)
Salintuya + Ino	66cd	2911ab	3372.4b	1811.8d
Salintuya -Ino	112a	1805abc	5692.5a	3098.5abc
Anidaso +Ino	66cd	2915ab	4925.9ab	3056.6abc
Anidaso-Ino	91abc	2915bc	4579.9ab	2346.4bcd
Jenguma + Ino	71bcd	2164abc	5211.2ab	3047.3abc
Jenguma + Ino + Urea	84abc	2949a	5147.4ab	3666.4a
Jenguma - Ino	94abc	1806abc	5382.0ab	2773.0abcd
Quarshie +Ino	47d	1299c	4172.8ab	2522.8abcd
Quarshie -Ino	91abc	1275c	4502.3ab	3146.2abc
TGX 1448 - 2E + Ino	69bcd	2194abc	3798.4ab	3295.abc
TGX 1448 - 2E - Ino	84abc	1981abc	3294.8b	2883.9abcd
TGX1834-5E+ Ino	71bcd	2886ab	3180.9b	2135.1cd
TGX 1834-5E - Ino	102ab	288 abc	3337.9b	1756.2d
CV (%)	39.71	48.0	41.36	34.91

Means followed by the same letter(s) are not significantly different at P≤0.05

Table 2.3: The response of different soybean varieties grown on-station at Nyankpala to *Bradyrhizobium* inoculation in 2011

Treatment	Pod Clearance (cm)	Pod load (no/plant)	Pod air dry wt (kg/ha)	Grain air dry wt (kg/ha)	I000 seed wt (g)
Salintuya + Ino	8.4	72ab	24476.7e	1561.3e	112.00d
Salintuya -Ino	8.3	88ab	4019.3abcd	2560.2bcd	123.50cd
Anidaso +Ino	8.6	58b	3882.6bcd	2558.1bcd	125.0bcd
Anidaso-Ino	6.2	78ab	2694.4de	1601.3e	114.75d
Jenguma + Ino	8.3	82ab	4306.8abc	3329.3ab	149.75a
Jenguma + Ino + Urea	7.3	108a	5395.7a	2772.6abc	125.50bcd
Jenguma - Ino	6.8	109a	4730.7ab	2778.2abc	130.50bcd
Quarshie +Ino	6.0	103ab	4232.8abc	2337.3cde	123.00cd
Quarshie -Ino	7.3	113a	5267.4ab	3470.5a	131.0bc
TGX 1448 - 2E + Ino	6.3	92ab	5290.2a	3160.6ab	140.0ab
TGX 1448 - 2E - Ino	7.4	84ab	4605.6b	2993.3abc	126.50bcd
TGX1834-5E+ Ino	8.7	77ab	3029.7cde	1937.6ed	122.75cd
TGX 1834-5E - Ino	8.4	78ab	24441.e	1715.4d	122.75cd
CV (%)	28.8	37.0	33.7	32.9	10.8

Means followed by the same letter(s) are not significantly different at P≤0.05

Table 2.4: Response of Jenguma grown on-station at Nyankpala to different input applications in 2011

Treatment	Nodule number (/plant)	Nodule weight (mg/plant)	Oven.dry biomass wt (kg/ha)	Pod air dry wt (kg/ha)	Grain air dry wt (kg/ha)
TSP+Manure + Micro + Ino	83ab	818bc	7702.6a	6647.9a	3809.0a
TSP+Manure + Micro - Ino	77ab	3369a	7036.2ab	5488.4a	3036.4a
TSP+Manure +Ino	117a	1502b	6865.8ab	5701.9a	3004.9a
TSP +Manure - Ino	105a	3935a	7293.8a	6464.5a	3340.5a
TSP + Ino	77ab	439c	2917.2de	3297.4b	1678.0bc
TSP - Ino	34cd	221c	4398.3cde	3177.6bc	1745.9bcd
TSP - Ino +N	29cd	421c	5445.8bcd	3555.4b	2160.6b
SSP + Ino	79ab	454c	3075.5de	2766.1bcd	1386.1bcd
SSP - Ino	31cd	828bc	3153.5de	2248.9bcd	1190.5bcd
None + Ino	60 bc	375c	2165.2e	1823.1cd	1091.8cd
None - Ino	14d	188c	2424.4e	1587.9d	813.13d
CV (%)	63.66	117	57.77	55.31	55.86

Means followed by the same letter(s) are not significantly different at P≤0.05

Table 2.5: Response of Jenguma grown on-station at Nyankpala to different input applications in 2011

Treatment	Oven dry haulm wt (kg/ha)	Pod clearance (cm)	Pod load (no./plant)	100 seed wt (g)
TSP+Manure + Micro + Ino	3868.7a	8.4650ab	99.250a	128.00ab
TSP+Manure + Micro - Ino	3190.2ab	7.3250b	93.800a	135.25a
TSP+Manure +Ino	2835.5bc	7.4100b	87.400a	130.00ab
TSP +Manure - Ino	3405.3ab	8.2650ab	85.850a	122.50ab
TSP + Ino	2150.6cde	8.9655ab	39.700b	112.00abc
TSP - Ino	1991.9cde	9.2300ab	46.200b	118.25ab
TSP - Ino +N	2671.9bcd	9.7250ab	45.900b	115.50ab
SSP + Ino	1838.5de	9.6700ab	45.750b	110.25abc
SSP - Ino	1555.9e	7.4350b	34.150b	106.25bc
None + Ino	1447.7e	10.460a	20.250b	103.00bc
None - Ino	1268.1e	9.6800ab	25.950b	84.950c
CV (%)	45.954	23.296	55.31	19.161

Means followed by the same letter(s) are not significantly different at P≤0.05

Table 2.6: Growth and yield performance of different cowpea varieties grown on-station at Nyankpala in 2011

Variety	Nodule number (no./plant)	Nodule dry wt (mg/plant)	Oven dry biomass (kg/plant)	Grain dry wt (kg/plant)
Apagbaala	29ab	923.2ab	2920.3ab	969.63b
Bawutawuta	46a	1255.3ab	3332.3a	1445.7a
IT98K-205-8	10b	493.0b	1414.6d	527.66c
IT 99-573-1-1	21b	1438.3a	3222.0ab	661.28bc
Omondao	20b	449.0b	2413.1bc	812.91bc
Padi-tuya	22ab	478.1b	3155.0ab	634.79 c
Songotura	27ab	961.2ab	1683.8cd	776.81bc
Zayura	24ab	860.0ab	3665.3a	757.45bc
CV (%)	71.14	68.32	35.02	42.42

Means followed by the same letter(s) are not significantly different at P≤0.05

Table 2.7: Growth and yield of different cowpea varieties grown on-station at Nyankpala in 2011

Variety	Pod dry wt (kg/ha)	Husk dry wt (kg/ha)	1000 seed wt (g)	Shelling %
Apagbaala	1699.0b	726.03b	98.00e	57.248b
Bawutawuta	2803.5a	1241.8a	123.00cd	51.594b
IT98K-205-8	1013.6c	482.28b	105.75de	52.726b
IT 99-573-1-1	1283.1bc	603.56b	157.00b	52.181b
Omondao	1157.1bc	472.16b	112.00cde	74.149a
Padi-tuya	1170.6bc	530.92b	163.75b	54.159b
Songotura	1374.4bc	636.23b	126.50c	56.613b
Zayura	1339.9bc	579.52b	174.50a	55.415b
CV (%)	46.43	45.95	22.14	1.80

Means followed by the same letter(s) are not significantly different at P≤0.05

Table 2.8: Response of Songotura to applications of different inputs at Nyankpala in 2011

Treatment	Nodule number (no./plant)	Nodule oven dry wt (mg/plant)	Biomass Oven dry wt (kg/ha)	Pod air dry wt. (kg/ha)	Grain air dry wt. (kg/ha)	1000 seed weight (g)	Shelling percentage (%)
TSP+Manure+Micro	14a	1164.0a	13651a	990.46a	551.02a	125.3ab	56.002a
TSP + Manure	10ab	546.3b	14973a	845.80a	549.89a	133.0a	61.895a
SSP	12a	334.6b	4255b	626.99ab	358.47ab	107.8b	56.827a
TSP	10ab	388.0b	7452b	619.03ab	392.10ab	127.8ab	64.098a
None	7b	220.2b	5250b	378.30b	207.44b	124.0ab	54.780a
CV (%)	79.9	78.9	56.2	49.8	55.4	11.9	35.2

Means followed by the same letter(s) are not significantly different at P≤0.05

Table 2.9: Effect of fertilizer application on growth, yield and yield components of Chinese grown at Nyankpala in 2011

Treatment	Biomass oven dry wt (kg/ha)	Shell dry wt (kg/ha)	Haulm dry wt (kg/ha)	Pod dry wt (kg/ha)	Grain yield (kg/ha)	100 seed wt (g)
TSP+Manure+Micro	5480.7a	230.7a	2621.8a	762.3a	531.6a	531.6a
TSP+Manure	4362.2b	227.6a	2448.3a	729.5a	501.9a	501.9a
TSP	2445.0c	133.1b	1729.9ab	697.7a	307.8b	307.8b
SSP	2726.0c	185.7ab	1688.9ab	593.1a	407.4ab	407.4ab
None	2558.8 c	160.0 b	1267.5b	484.9a	324.9b	324.9b
CV (%)	36.4	26.2	38.6	33.8	29.4	12.5

Means followed by the same letter(s) are not significantly different at P≤0.05

Table 2.10: Growth and yield responses of six varieties of groundnut grown at Nyankpala in 2011

Variety	Biomass oven dry wt (kg/ha)	Shell dry wt (kg/ha)	Haulm dry wt (kg/ha)	Pod dry wt (kg/ha)	Grain yield (kg/ha)	Shelling %	100 seed wt (g)
Chinese	5269.9ab	278.5ab	3217.5ab	926.1ab	647.62ab	69.3a	33.1b
Nkatie-SARI	4202.2b	364.9ab	2925.5ab	1155.1a	790.17a	69.0a	45.65a
Manipinta	5247.4ab	315.9ab	2145.2ab	833.1ab	517.22b	61.5c	37.65ab
Samnut 22	6279.2a	402.0a	3310.8a	1067.6a	665.57ab	61.8c	41.55a
Samnut 23	4450.1ab	338.3ab	2563.8ab	818.1ab	527.44b	63.5bc	39.43ab
Bogla	3927.5b	214.1b	1908.4b	675.7b	461.53b	67.8ab	38.85ab
CV (%)	27.02	34.6	34.44	29.07	28.42	6.92	15.43

Means followed by the same letter(s) are not significantly different at P≤0.05

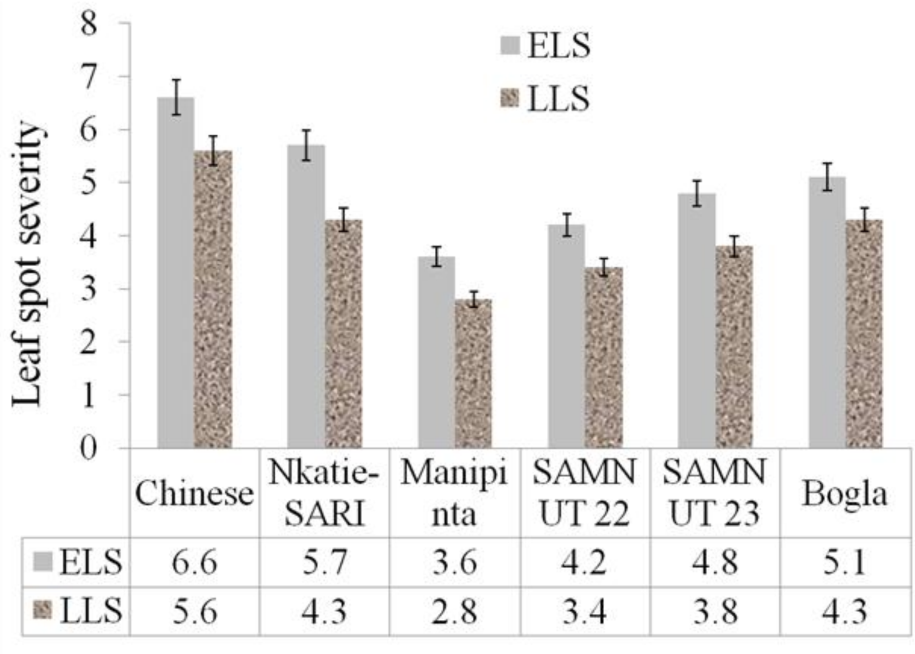


Figure 2.1: Severity of early leaf spot (ELS) and late leaf spot (LLS) in six groundnut varieties grown on- station at Nyankpala in 2011.

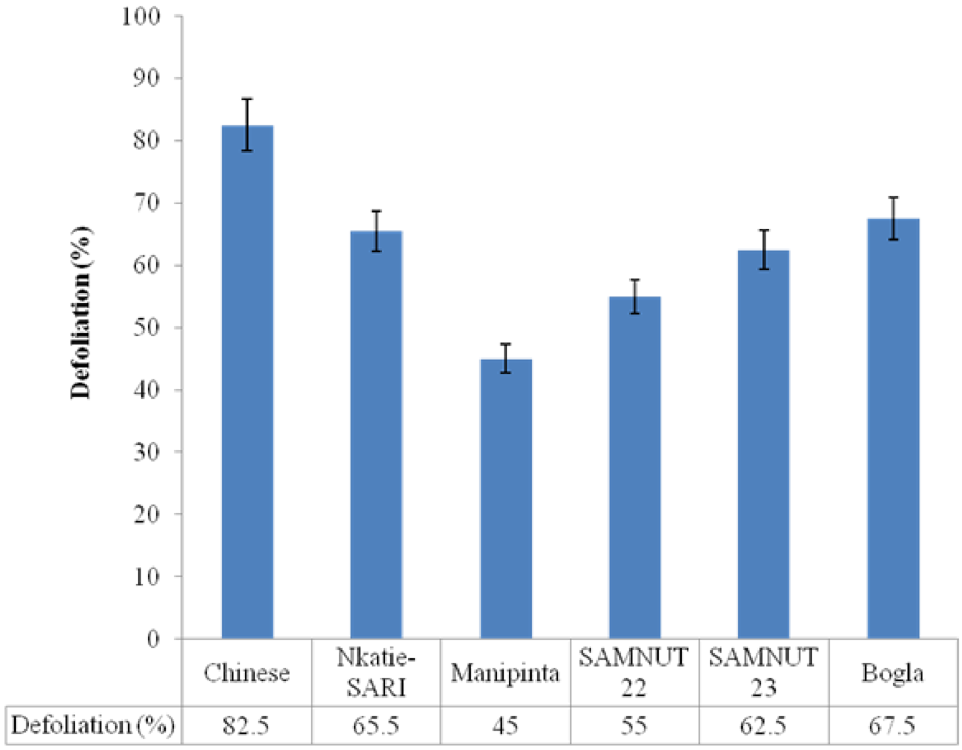


Figure 2.2: Degree of defoliation (%) in six groundnut varieties grown on –station at Nyankpala in 2011

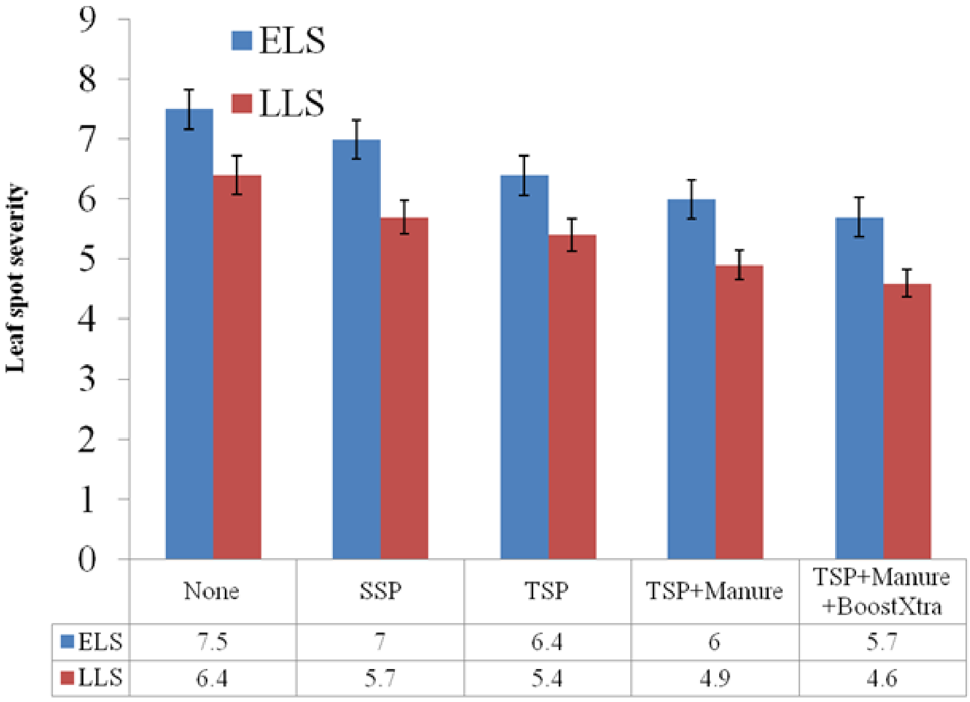


Figure 2.3: Effect of application of different fertilizer types on early spot (ELS) and late spot (LLS) severity in the groundnut variety Chinese grown at Nyankpala in 2011

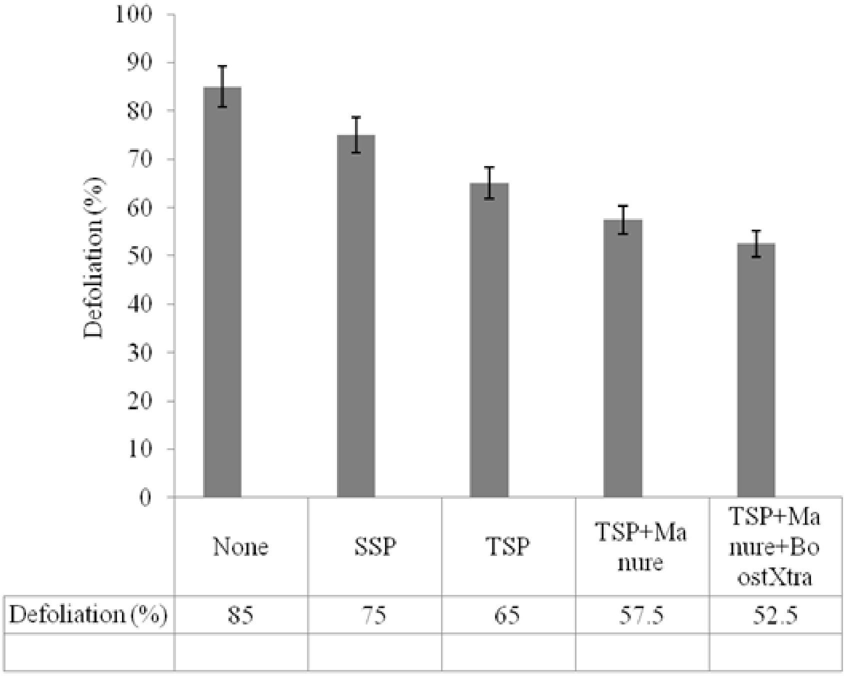


Figure 2.4: Defoliation in the groundnut variety Chinese as affected by application of different fertilizer types

Table 2.11: Soyabean variety trial at Aderi IN 2011 cropping season

Treatment	Oven dry biomass wt (kg/ha)	Pod dry wt (kg/ha)	1000 seed wt (g)	Pod load	Nodules score/plant	Pod clearance (cm)	Grain yield (kg/ha)
Salintuya-Ino	7147.7a	1490.9c	46.267c	30.667d	8.3500ab	6.7533ab	708.44bc
Salintuya+Ino	5676.8a	1679.0abc	69.967a	50.667abc	4.6000b	6.0800ab	879.18abc
Anidaso-Ino	7005.2a	1792.9abc	47.200c	28.000d	4.7333b	6.7267ab	818.78abc
Anidaso+Ino	5537.8a	1799.8abc	49.133c	39.333bcd	6.9333ab	6.8000ab	853.30abc
Jeng-Ino	6413.3a	2413.1ab	58.467abc	42.667bcd	4.4667b	5.4067ab	1185.4bc
Jeng+Ino	3491.9a	2496.8ab	54.833bc	39.333bcd	7.7333ab	5.3600b	1080.3abc
Jeng/Urea+Ino	5243.3a	2548.7a	55.233bc	40.333bcd	6.8000ab	6.9733ab	1344.7a
TGX1 448-Ino	5170.9a	2175.2abc	54.967bc	34.667cd	4.0000b	6.2200ab	981.34abc
TGX1 448+Ino	4164.6a	1633.1bc	57.767abc	29.000d	8.6667ab	6.2133ab	764.17bc
TGX1834-Ino	5262.3a	1795.5abc	64.967abc	34.667cd	6.1333b	6.2067ab	754.35bc
TGX1834+Ino	4619.7a	1697.1abc	54.667bc	34.000d	6.6000ab	7.4800ab	905.61abc
Quarshie-Ino	4487.7a	2126.8abc	51.233bc	52.333ab	6.4333b	5.9733ab	567.73c
Quarshie+Ino	4950.9a	2333.8abc	45.967c	65.000a	13.067a	8.3333a	921.61abc
CV (%)	49.037	36.087	63.350	33.557	58.416	25.123	46.64

Table 2.12: Soyabean input trial at Aderi

Treatment	Oven dry biomass (kg/ha)	Pod dry weight (kg/ha)	Grain Yield (kg/ha)	1000 seeds weight (g)	Oven dry haulm weight (g)	Pod load	Pod clearance (cm)	Nodule score/plant
None-Ino	817.75bc	1109.5b	496.35a	75.667ab	482.08d	40.000ab	8.6067a	4.8000de
None+Ino	368.10c	1254.0ab	555.01a	77.000ab	479.56d	26.667b	8.1333ab	8.6000bcde
SSP-Ino	615.08c	1054.2b	407.04a	69.667b	558.93cd	34.667ab	7.8067ab	3.4667e
SSP+Ino	832.72bc	1244.8ab	491.06a	77.000ab	552.66cd	25.333b	9.5000a	17.067a
TSP-Ino	695.07bc	1061.5b	519.69a	75.000ab	631.10bcd	31.667ab	8.1400ab	7.2667cde
TSP+Ino	819.20bc	1371.8ab	762.82a	73.667ab	627.80bcd	27.333b	8.1800ab	10.933abcd
TSP+Man+Mic-Ino	1898.0a	1682.6ab	709.41a	75.333ab	1018.0ab	53.333a	6.3133b	12.667abc
TSP+Man+Mic+Ino	1253.9abc	2059.4a	761.32a	72.000ab	1193.5a	53.000a	7.7133ab	14.600ab
TSPMa+Ino	1536.7ab	1678.3ab	668.27a	69.333b	1005.2abc	46.000ab	7.4067ab	13.933abc
TSP+Man-Ino	1968.3a	1794.3ab	746.79a	73.333ab	886.89abcd	36.667ab	8.3467ab	17.200a
TSP+N-Ino	469.03c	1747.8ab	726.51a	79.333a	790.59abcd	50.333ab	8.0067ab	8.4000bcde
C.V(%)	69.563	38.489	38.479	7.5346	42.616	45.478	18.718	60.451

Table 2.13: Cowpea variety trial at Aderi

Treatment	Oven dry biomass wt (kg/ha)	Pod air dry wt (kg/ha)	1000 seed wt (g)	Pod load	Oven dry haulm wt (kg/ha)	Nodule score/plant	Nodules wt (mg)	Grain yield (kg/ha)
Bawutawuta	2164.8a	3701.3a	99.000d	8.7613ab	2850.4a	10.455a	138.54a	1476.2a
IT90K-227-2	1622.3ab	3205.1a	154.00bc	10.089a	1466.0b	9.2123a	24.917b	1195.7ab
Omondao	1447.0ab	2334.9a	110.25d	7.8015abc	1650.3b	6.5660a	31.839b	1082.0ab
Zayura	1265.7b	2414.1a	190.75a	6.7862bcd	1459.7b	7.9637a	33.750b	968.29b
Songotura	1196.7b	1851.8a	163.50b	5.6500cd	1294.4b	11.133a	59.512b	975.54b
Padituya	1195.6b	1731.3a	138.50c	4.8510d	1442.2b	6.1757a	64.688b	887.85b
CV (%)	38.4	32.4	24.0	53.3	51.3	47.6	93.2	31.5

Table 2.14: Groundnut variety trial at Aderi

Treatment	Oven dry biomass (kg/ha)	100 seed wt (g)	Oven dry haulms wt (kg/ha)	Nodules score/plant	Nodules wt (mg)/plant	Pod load	Shelling %	Grains yield (kg/ha)
Sumnut23	2137.4a	8.5500b	566.17a	97.550a	143.75a	8.5500b	48.941a	394.24ab
Sumnut22	1522.8ab	14.400a	803.28a	107.40a	155.25a	14.400a	37.011a	336.09ab
Nkatie-SARI	2114.4ab	11.950ab	517.33a	94.825a	119.25a	11.950ab	48.008a	452.83a
Manipinta	2141.0ab	9.1500ab	871.75a	107.67a	131.25a	9.1500ab	68.230a	207.85b
Chinese	1819.4ab	8.1500b	377.98a	71.650a	97.000a	8.1500b	45.480a	230.70b
Bogla	1399.7b	11.450ab	583.61a	109.63a	125.38a	11.450ab	39.915a	377.27ab
CV (%)	28.554	39.073	52.438	37.230	32.298	39.073	68.184	43.870

Table 2.15: Soybean variety trial at Ugando

Treatment	Oven dry biomass wt (kg/ha)	Pod dry wt (kg/ha)	Grain Yield (kg/ha)	Oven dry haulms wt (kg/ha)	Pod load	Pod clearance (cm)	1000 seed wt (g)	Nodules score
Salintuya + Ino	12419a	1243.6b	550.12bc	1553.7ab	30.600ab	6.7550b	54.750ab	5.4500c
Salintuya – Ino	4812.7d	684.21c	228.75e	972.18b	26.300abc	6.6650b	50.750ab	8.3000abc
Anidaso + Ino	11765ab	995.82bc	468.24bcd	1550.7ab	20.200c	7.3100b	57.000a	6.9500bc
Anidaso – Ino	5979.6cd	1034.1bc	259.87de	1183.5ab	21.800ab	7.8250ab	50.250ab	8.5325abc
TGX 1834 + Ino	6843.5bcd	1110.1bc	399.51bcde	1690.9a	26.550abc	10.330b	47.000b	11.450ab
TGX 1834 - Ino	10667abc	1242.2b	426.25bcde	1429.0ab	32.500a	8.5850ab	54.000ba	9.4500abc
Jenguma + Ino	6534.6cd	1180.7bc	457.28bcd	1424.6ab	27.200abc	6.8700b	53.500ab	10.650ab
Jenguma – Ino	9403.3abcd	2006.5a	847.03a	1674.3a	24.500abc	7.2950b	56.000a	8.6500abc
Jenguma/Urea + Ino	7162.1bcd	1369.5b	597.18b	1379.9ab	26.200abc	7.1600b	55.000ab	12.800a
TGX1 448 + Ino	5446.3d	890.08bc	372.15bcde	1096.8ab	25.400abc	10.330a	56.250a	9.5000abc
TGX1 448 – Ino	8315.2abcd	1293.2b	443.74bcde	1209.7ab	24.800abc	7.7750ab	49.750ab	9.4000abc
Quarshie + Ino	5079.0d	1030.8bc	365.40cde	975.73b	31.050ab	6.8000b	53.500a	10.900ab
Quarshie – Ino	6633.8bcd	1187.8b	370.27bcde	1127.4ab	32.900a	6.8950b	49.750ab	11.000ab
CV (%)	52.65	38.97	46.59	36.51	25.48	27.29	15.86	38.18

Table 2.16 Groundnut variety trial at Ugando

Treatment	Oven dry biomass wt (kg/ha)	Grain yield (kg/ha)	Oven dry haulm (kg/ha)	100 seeds wt (g)	Shelling %	Nodule score/plant (no.)	Nodule wt/plant (mg)
Sumnut22	3357.4a	87.761ab	317.48a	28.500b	49.342a	77.850a	108.15a
Chinese	2514.8ab	119.05ab	392.70a	29.500ab	45.461a	104.94a	106.63a
NkatieSARI	2097.0b	148.24a	424.99a	41.000a	36.320a	94.225a	99.000a
Manipinta	2035.5b	58.671b	424.74a	25.250b	37.296a	66.009a	76.500a
Sumnut23	1942.5b	101.07ab	473.98a	29.750ab	39.782a	101.83a	138.75a
Bogla	733.40c	117.91ab	395.86a	33.000ab	36.105a	67.950a	109.75a
CV (%)	46.16	57.15	38.89	30.68	33.43	37.32	47.81

Table 2.17: cowpea variety trial at Ugando

Treatment	Grain yield (kg/ha)	1000 seed wt (g)	Pod load	Oven dry haulms wt (kg/ha)
IT90K - 277- 2	2309.9a	78.000a	7.8000a	3938.8abc
Songotura	1880.9a	47.250b	4.7250b	3455.5bc
Omondao	1625.8ab	54.750ab	5.4750ab	2152.5c
Zayura	1124.1b	50.750ab	5.0750ab	5240.1ab
Bawutawuta	1094.3b	41.500b	4.1500b	5411.0a
Padituya	965.80b	34.000b	3.4000b	4265.2ab
CV (%)	43.404	41.353	41.353	40.061

Table 2.18: Groundnut input trial at Andonyamanu

Treatment	Oven dry biomass wt (kg/h)	Grain yield (kg/ha)	Shelling %
None	989.61a	236.50c	50.403b
SSP	960.67a	228.24bc	59.671a
TSP	718.65a	138.06ab	54.717ab
TSP + manure	1099.6a	329.22a	60.621a
TSP + manure +BoostXtra	990.93a	238.24abc	56.973ab
CV(%)	36.603	62.817	11.203

Table 2.19: Cowpea input trial at Andonyamanu

Treatment	Oven Dry Biomass Wt (Kg/ha)	Oven Dry Haulm Wt (Kg/ha)	Grain Yield (Kg/ha)
None	622.91c	1039.9b	726.64ab
SSP	965.65bc	1102.5b	594.69b
TSP	1222.4abc	1626.9b	859.05ab
TSP + Manure	1687.5ab	2365.4a	1081.6a
TSP + Manure + BoostXtra	2035.2a	1709.0ab	829.71ab
CV (%)	51.414	43.904	36.639

Table 2.20: Soybean input trial at Sheillanyili

Treatment	Oven dry biomass wt (kg/ha)	Pod oven dry wt (kg/ha)	Pod load /plant	Pod clearance (cm)	Oven haulms wt (kg/ha)	Nodule score /plant	Nodule weight (mg)
None - Ino	2058.4ab	433.03ab	47.5a	5.41ab	800.41ab	5.9558c	8.895b
None + Ino	1839.4ab	364.18ab	22.55ab	6.005ab	811.09ab	11.525ab	8.054b
SSP - Ino	1953.9ab	443.83ab	38.2ab	5.845ab	936.88ab	6.114c	10.747b
SSP + Ino	1953.9b	200.77b	22.55ab	6.46a	1008.4ab	12.05a	11.27b
TSP - Ino	1953.9ab	306.87ab	17.665b	5.705ab	736.28b	7.8055bc	9.965b
TSP + Ino	1953.9ab	302.57ab	14.7b	6.18a	767.99b	12.178a	9.465b
TSP + Manure -Ino	1953.9ab	196.19b	18.95ab	6.48a	1069ab	6.2278c	11.268b
TSP +Manure + Ino	1953.9ab	410.6ab	19.25ab	6.66a	947.85ab	13.65a	11.83b
TSP + Manure +Micronutrient -Ino	1953.9ab	401.54ab	23.4ab	5.875ab	827.2ab	5.475c	9.41b
TSP +Manure+ Micronutrient + Ino	1953.9a	570.44a	26.7ab	7.14a	1433.1a	10.531ab	19.273a
TSP+N -Ino	1953.9ab	498.58a	26.65ab	4.2875b	1074.3ab	5.664c	10.56b
CV (%)	38.034	53.614	80.004	21.858	47.382	46.975	43.844

Table 2.21: Cowpea input trial at Sheillanyili

Treatment	Oven biomass wt (kg/ha)	Oven dry haulms wt (kg/ha)	Oven dry haulms wt (kg/ha)	Nodule score /plant	Nodules weight (mg/plant)
None	1577.1b	745.89b	745.89b	3.7875a	19.008b
SSP	2203.4ab	1356.4a	1356.4a	5.0275a	44.032ab
TSP	2103.6ab	1098.2ab	1098.2ab	3.775a	31.082ab
TSP+Manure	2519.5a	1117.5ab	1117.5ab	3.1875a	73.75a
TSP + Manure + BoostXtra	2653.7a	1181.4ab	1181.4ab	3.045a	18.125b
CV (%)	26.754	37.016	37.016	38.36	96.158

Cowpea grains were harvested and bulked by the farmer therefore yield data were not taken.

Table 2.22: Groundnut input trial at Sheillanyili,

Treatment	Pod load/plant	1000 seed wt(g)	Nodule score/plant	Nodule wt (mg)	Shelling (%)	Grain yield (kg/ha)
None	35.402a	297.33ab	51.033b	25c	35.259a	204.9a
SSP	29.94a	347.33a	66.567ab	54.333bc	42.23a	190.55a
TSP	28.007a	280b	51.667b	37c	38.204a	145.15a
TSP+Manure	31.341a	324ab	91.178a	78.037ab	42.949a	203.03a
TSP+Manure +BoostXtra	27.536a	309.67ab	80.367ab	91a	30.21a	121.73a
CV (%)	23.736	10.714	38.656	53.95	21.425	35.07

Table 2.23: Cowpea variety trial at Loggu-Kparisaga

Treatment	Oven dry biomass wt (kg/ha)	Oven dry haulm wt (kg/ha)	Oven dry Pod wt (kg/ha)	Pod load	Pod clearance (cm)	Nodule score /plant	Grain yield (kg/ha)
Marfo-tuya	3489.6a	3465.6a	3366.5ab	50.750ab	20.300a	13.450b	2573.6bc
Apagbaala	3270.8a	2183.5bc	3769.8ab	72.250a	16.425ab	14.775ab	2861.0abc
Songotura	3322.9a	2424.0b	4269.5a	38.750b	12.100bc	26.425a	3392.3a
IT90K-277-2	3302.1a	2518.7b	3971.4a	58.500ab	11.650c	18.925ab	3150.4ab
Padituya	3218.8a	1571.8c	2893.1b	51.500ab	11.550c	14.200b	2156.8c
IT98K-205-8	1072.9b	766.98d	1244.9c	69.750a	8.1250c	23.450ab	983.48d
CV (%)	34.32	46.38	36.88	34.77	39.42	53.14	37.99

The pH of the soils ranges from moderately acidic to acidic. The site soils are generally poor but uniform in the characteristics measured except in total P content where the site on which cowpea trials were located had a comparatively higher total P content than the other two sites. The available P ranged from very low to low. Total N, exchangeable calcium, exchangeable magnesium and cation exchange capacity can all be described as being quite low. All the soybean varieties did not respond to inoculation with respect to nodulation, plant growth and pod and grain yields with clear trends of suppression due to inoculation. Inoculation, however, increased the seed size of Jenguma (Table 2.4).

Rhizobium inoculation significantly enhanced nodule proliferation (Fig. 2.1) but not nodule tissue build-up (Fig. 2.2).

Application of SSP and TSP did not significantly affect nodulation (Figs. 2.1 and 2.2) and growth in Jenguma even when a starter N was applied. The combination of P and inoculation only increased nodule number without affecting nodule biomass production (Table 2.5). Integrated application of organic manure (fertisoil) and TSP with or without inoculation enhanced nodulation in Jenguma (Table 2.5). Foliar spraying Jenguma with BoosXtra did not enhance nodulation in Jenguma with or without inoculation or with manure application (Table 2.5). TSP application increased pod weight in both inoculated and non-inoculated Jenguma but without increasing grain yield (Table 2.5). Inoculation also failed to significantly enhance both pod production and grain yield of Jenguma. However, manure application remarkably increased these two parameters (Table 2.5) but BoostXtra had no remarkable effect on pod and grain production (Table 2.5).

Of all the cowpea varieties tested, Bawutawuta tended to be the most prolific in terms of nodulation, pod and grain yields whilst Zayura produced the highest biomass and the largest seed (Tables 2.6 and 2.7).Even though applications of SSP and TSP did not enhance nodulation, and biomass, pod and grain productions in Songotura, combined application of TSP and manure greatly enhanced biomass, pod and grain yields (Table 2.5).Together with nodulation, these parameters were further boosted when Songotura received foliar sprays of BoostXtra (Table 2.5).

Even though applications of SSP and TSP did not enhance any of the parameters measured on Chinese, the combined application of TSP and manure greatly enhanced haulm, shell and biomass dry weights and grain yield and increased seed size (Table 2.10). With the exception of seed size, these parameters were also increased when Chinese received foliar sprays of BoostXtra (Table 2.10). Generally, Nkatie-SARI and Samnut 22 seemed to be the best of the groundnut varieteis evaluated in terms of grain yield and biomass production but Nkatie-SARI, Chinese and Bogla had the highest shelling per cent (Table 2.9).

Manipinta was the most tolerant/resistant of all the groundnut varieties to both early and late leaf spot diseases followed by Samnut 22 and Samnut 23 (Fig. 2.3). The degree of defoliation also was the least in Manipinta, followed by Samnut 22 and Samnut 23, respectively (Fig. 2.4). Application of nutrient amendments significantly increased the tolerance/resistance of Chinese to Cecospora leaf spot disease which subsequently reduced defoliation (Figs. 2.3 and 2.4).

At Adari in the Chereponi district, rhizobium inoculation had no positive effect on soybean biomass yield irrespective of variety. Application of urea even did not elicit any such response in Jenguma (Table 2.12) even though urea addition to inoculated Jenguma increased its pod and grain yields.

In the Upper East, the two soybean varietal trials were located at Kandiga and Sakom in the Kassena-Nankana and Bawku West districts, respectively. Another one was also established on-station at SARI's Manga out-station in the Bawku Municipality.

Objective 3: Select superior rhizobia strains for enhanced BNF and develop inoculum production capacity in sub-Saharan Africa, including private sector partners

Activity 3.1.2: Conduct 50 MPN counts and need to inoculate trials for soybean across the impact zones.

Accomplishment: A total of 22 soil samples were collected from selected sites across the impact zones in the three northern regions of Ghana for enumeration of indigenous rhizobia population. In the northern region soils were collected from Shelanyili within the Karaga district as well as Andonyamanu and Ugando in the Chereponi district. Areas covered in the Kasena-Nankana East district of the Upper East region include Naaga, Mayoro, and Fungu. In the Bawku West district of the Upper East region soils were taken from Sakom, Tanga, Apodabog and Tilli. A total of 10 core samples were taken from a depth of 0-20 cm from uninoculated plots and bulked together after which subsamples were taken for MPN counts and physicochemical analysis.

Composite soil samples were collected along a transect of 10m and to a depth of 20 cm from uninoculated plots. A 100 g (dry weight) of soil was added to 400 ml of distilled water (diluent) in a wide mouthed flask. The soil and diluent were mixed on a shaker set at a higher agitation level for 25 minutes. Using a wide-mouthed pipette, 5ml of the resulting solution was transferred immediately after shaking into a 100 ml sterile screw top Erlenmeyer flask containing 20 ml of the diluent. Similar dilutions were made till the 5-6 representing the third through to the sixth dilution steps. One millilitre volume of each dilution step was applied directly onto the roots of uniform soybean plants growing in plastic growth pouches (Plate 2.1) in four replicates. The inoculated plants were placed in a growth room and monitored periodically for the formation of nodules. The plants were watered regularly with N- free nutrient solution and were observed after 28 days for the presence of nodules. Rhizobia population estimates were done using MPNES software (Woomer et al., 1990).

Results of MPN counts have been obtained from 13 sites out of the 22 soil samples taken. Counts on the remaining 9 will be due on the 26th of May 2012. Soils from the study sites generally had low rhizobial populations capable of nodulating soybean. Soils from Tanga site 3 had the highest rhizobial population of 142 cells /g of soil while Naaga site 1 had the lowest of 2 cells /g of soil. The results of MPN counts from the 13 sites are shown in Table 2.23.

Plate 2.1: Soybean growing in plastic growth pouches

Table 2.24: Results of rhizobia population counts from 13 sites in the study area.

Sample Location	Rhizobial Count (cells/g of soil)
Bawku West	6
Kasena Nankana East	17
Shelanyilli	10
Andonyamanu	58
Apodabog site 3	3
Apodabog site 1	44
Kandiga Junction	7
Tilli site 3	11
Tilli site 2	16
Naaga site 1	2
Tanga site 3	142
Tanga site 2	22
Manyoro site 2	9

The need to inoculate soybean was assessed by evaluating the N_2 fixation capacity of indigenous rhizobia using soils from the study sites. This was done by growing soybean in pots filled with 2.5kg of soil (plate 2.1) without Nitrogen (–N) and + N treatment as a positive control. The plants were harvested after 35days and the biomass weight of + N treatments compared with that of –N treatments by performing ANOVA on the biomass weight. There were significant ($P< 0.001$) differences between the biomass weight of +N and –N treatments indicating the need for inoculation. Results of the biomass weight of soils from four locations are indicated in Figure 2.5.

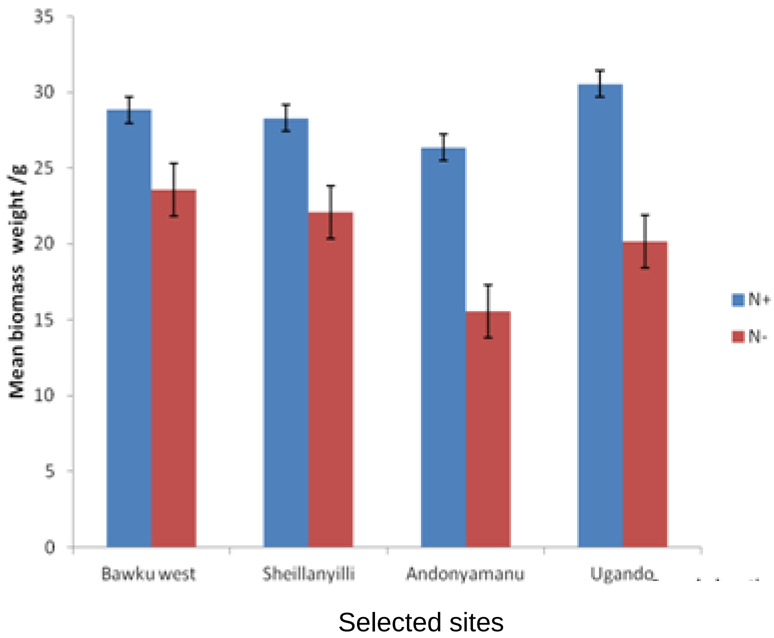


Figure 2.5 Biomass yield of soybean grown in soils from four locations

Activity 3.1.3: Isolate and screen native rhizobia

Accomplishment: Indigenous rhizobia were isolated from nodules of soybean grown in soils from the study sites. Soybean plants were harvested after 6 weeks by cutting the stem about 2cm above the soil surface. The roots were harvested by gently washing the whole volume of soil in a bucket of water. Nodules were severed off the roots by cutting them about 0.5cm from each side of the root. Ten nodules were taken from each plant and were surface sterilized by immersing them in 95% ethanol for 10 seconds. Surface sterilized nodules were crushed in sterile Petri dish with two drops of sterile distilled water using sterile blunt-tipped forceps. One loopful of the nodule suspension was streaked on yeast-mannitol agar plate containing Congo Red. One loopful of the nodule suspension was similarly streaked on yeast-mannitol agar plates containing Bromothymol blue (BTB). The plates were incubated at 26◦C for 10 days. After the incubation period, well isolated single colonies were streaked on agar plates and incubated to obtain a pure culture. Cells from the pure culture were then transferred onto agar slants in glass vials for storage.

A total of 80 isolates have been obtained and have been stored on agar slants in glass vials.

Soil (pH), organic carbon, total nitrogen, available P, potassium, and exchangeable cations were analyzed using standard protocols (Ingram and Anderson, 1993). Particle Size analysis was determined by the pipette method (Gee and Bauder, 1986). A summary of the analytical results on the physical characteristics of the soils is presented in Table 2.25.

Table 2.25: selected physical properties of the soils in the study area

Location	Sand%	Silt%	Clay%	
Bawku West	43.90	46.48	9.62	Loam
Kasena-Nankana East	69.78	26.62	3.60	Sandy loam
Karaga	70.90	21.46	7.64	Sandy loam
Andonyamnu	67.62	26.79	5.59	Sandy loam
Mean	66.94	27.73	5.33	Sandy loam
Range	43.9 - 76.62	19.78 - 46.62	1.62 - 9.62	
STDEV				

Chemical and physical properties of the soils

A summary of the analytical results on the chemical characteristics of the soils is presented in Tables 2.25 and 2.26. The levels measured and/or calculated have been ranked according to classes described by FAO (1984) for soil reaction (degree of acidity): Landen (1991) for Mg (low to high) Arcia et al. (1995) for the other parameters (low to high). The soil pH ranged from moderately acid to neutral (pH 5.3 – 7.1) with majority of the soils being moderately acid to slightly acid. Soil organic carbon content of the soils ranged from 0.32 % to 1.26 % with a mean of 0.77 %. Total nitrogen levels ranged from 0.15 % to 0.23 % which were ranked medium. There was considerable variability in exchangeable basic cations of the soils. Exchangeable calcium (Ca++) ranged from low (4.81 cmol (+)/Kg soil) to high (11.48 cmol (+)/Kg soil). Mean Ca++ levels in the region was ranked medium (6.18 cmol (+)/Kg soil). Exchangeable Mg also ranged from low to high (0.80 to 4.48 cmol (+)/Kg soil). Exchangeable potassium levels were similarly low to high (0.14 to 0.69 cmol (+)/Kg soil). The soils were generally coarse textured. They were dominantly sandy loam with very low clay contents (Table 2.25).

Table 2.26: Selected chemical properties of soils in the study area

Location	pH H_2O	Org. C (%)	Total N (%)	Org. M (%)	Avail P (mg kg^{-1} soil)	Avail. K (mg kg^{-1} soil)
Bawku West	6.4	0.98	0.16	1.69	12.64	312.75
Kasena East	7.1	0.78	0.20	1.34	21.00	65.84
Karaga	5.3	0.64	0.23	1.10	5.55	95.45
Andonyamanu	5.7	0.40	0.15	0.69	10.11	98.74
Mean	6.0	0.77	0.18	1.33	16.19	163.96
Range	5.3 - 7.1	0.40 – 0.98	0.15 - 0.23	0.69 – 1.69	5.55-21.00	65.84-312.75
STDEV	0.61	0.34	0.03	0.59	10.59	109.05

Table 2.27: Analytical results on exchangeable cations on the soils in the study area

Location	Exchageable basic cations (cmol $_{(+)}$ kg-1)				TEB	Al+H	ECEC	Base Sat.
Bawku West	Ca	Mg	K	Na	cmol (+) kg-1)	cmol (+) kg-1)	cmol (+) kg-1)	(%)
Kasena East	11.48	4.41	0.69	0.25	16.83	0.10	16.93	99.4
Karaga	8.54	2.27	0.14	0.14	11.69	0.05	11.74	99.6
Andonyamanu	4.81	0.80	0.26	0.13	6.00	0.15	6.15	97.6
Mean	6.18	1.95	0.36	0.15	8.72	0.10	8.82	98.60
Range	4.81 - 11.48	0.80 - 4.41	0.14 - 0.69	013 – 0.25	6.00 - 16.83	0.05 - 0.15	6.15 - 16.93	97.5 - 99.4
STDEV	2.88	1.34	0.22	0.06	4.27	0.04	4.26	0.88

Objective 4: Deliver legume and inoculant technologies to farmers throughout sub-Saharan Africa.

Activity 4.1: Create strategic alliances for facilitating dissemination of legume and inoculant technologies in the impact zones.

Accomplishments: Two new D and D partners have added to the existing 4. The contract of N2Africa with all the partners in Ghana expired in April 2012. Memoranda of Understanding have been formalized with all partners are contracts ready for signing. The N2Africa partners in Ghana for the 2012 cropping season are as follows, with the new partners in bold:

- Urban Agriculture Network (URBANET)
- Savanna Agricultural Research Institute (SARI),
- Association of Church Development Projects (ACDEP)
- Kwame Nkrumah University of Science and technology (KNUST)
- **Agricultural Development and Value Chain Enhancement (ADVANCE)**
- **Evangelical Presbyterian Development and Relief Agency (EPDRA)**

Activity 4.2.1: Produce specific dissemination tools.

Accomplishment: To facilitate the understanding and diffusion of improved legume technology among farmers, the N2Africa technologies disseminated through demonstration plots were packaged as follows:

- Soybean: Seed, inoculants, TSP, Pre-emergence herbicide, Insecticide, D and D protocol,
- Cowpea: Seed, TSP, Pre-emergence herbicide, Insecticide, D and D protocol,
- Groundnut: Seed, TSP, KCl, Pre-emergence herbicide D and D protocol.

Some components of the original package for cowpea and soybean were modified to speed up the technology transfer. The modifications were as follows:

- New package on cowpea: Apaagbala was replaced with IT90K-277-2 and padi-tuya in some action sites due to the insufficiency of Apaagbala seeds.
- Size of inoculants sachet: Last year the inoculants came in 400 g sachets but this year it was in 100 g sachets and this made it easier and safer handling.

Activity 4.3.2: Communities producing improved legume seed

Accomplishment: Community seed production was initiated in all the impact zones in order to raise a seed stock to supplement quantities that are purchased from the private seed dealers. The acreages cultivated are shown in Table 2.27.

Table 2.28: Acreages of various seeds cultivated in the six districts in 2011.

District	Soyabean	Area	Cowpea	Area	Groundnut	Area
Bawku West	Jenguma	0.5 ha	Marfo-tuya	0.5	Chinese	0.5
K-Nankana East	Jenguma	0.5 ha	Padi-tuya	0.5	Chinese	0.5
Nadowli	-	-	padi-tuya, Apagbaala	0.5 0.5	Chinese	0.5
Wa East	-	-	Marfo-tuya, Songotura	0.5 0.5	Chinese	0.5
Chereponi	Jenguma	0.5 ha	Marfo-tuya	0.5	Chinese	0.5
Karga	Jenguma	0.5 ha	Marfo-tuya	0.5	Chinese	0.5

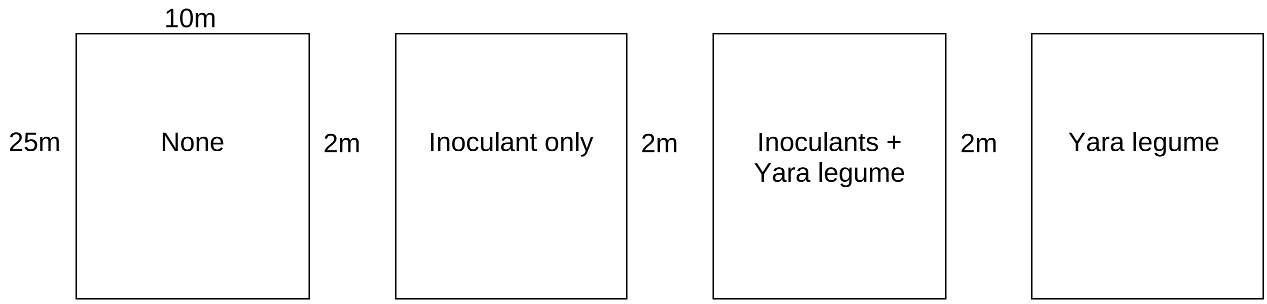
Activity 4.4.3 Conduct three extension events per season

Accomplishment: On March 28, 2012, ACDI/VOCA –Advance, Tamale, in collaboration with N2Africa project and Yara Ghana Limited held farmers field day at Bontanga irrigation dam to demonstrate the effect of inoculants and Yara legume fertilizer on soybean to Agroinputs dealers and some commercial farmers from the three northern regions of Ghana.

The inoculants and the seeds for the trial were given by N2 Africa project, Yara (Ghana) Limited provided the Yara legume fertilizer whilst Advance was responsible for the laying out and management of the Demonstration.

Generally, legumes need phosphate- and potassium-based fertilizers for optimal growth performance. The objective of the field day is to ascertain and demonstrate if Yara legume fertilizer could be to substitute TSP which is currently expensive and also not readily available to the farmers. The Yara legume fertilizer is composed of the following plants nutrients formulation: P_2O_5: 18, K2O: 12%Mg: Zn: Mo: Bo:

Field lay – out



Soybean variety: Jengume (TGX 1448 -2E)

During the event (see plates 2.2 and 2.3) representatives of the major partners were invited to talk on each of the inputs used and also to address some questions that were raised by the participants.

Generally, Participants observed that the plot that received both inoculants and Yara legume fertilizer had more and bigger pods on their plants than the rest of the treatments imposed on the other plot. In addition, their plants looked more robust and had more leave biomass than the rest of treatments. Table 2.29 indicates the organizations which participated in the extension event.

Table 2.29: List of organizations which attended the field day.

Organization	**Numbers**
Commercial farmers	11
Aggregators	3
Agro input dealers	8
ACDI/ VOCA Advance staff	8
Yara (Ghana) Limited	2
N2Africa project	2
Total	34

Plate 2.2: The Soybean Demonstration as affected by Rhizobium inoculants only

Plate 2.3: Participants observing the various soybean demonstrations

Activity 4.5.3: Conduct annual events on human nutrition

Accomplishment: Women in Agricultural Development (WIAD) unit of MoFA trained 254 women and AEAs in the actions sites in the Northern region of Ghana on legume recipes and value-added processing technologies. The training aimed at providing nutritional security for the women and children within the project catchment areas by exposing the women to methods of processing locally available foods and to empower women to harness improved livelihoods sources.

The training focused on:

- The role of legumes in household nutrition
- Malnutrition and its effect on society
- How to prepare soya flour, soymilk and soy khebab
- How to fortify some local dishes with processed legume flour such as soybean & cowpea flour

Handling and proper storage of value-added and processed soybean products

Table 2.30: The number of participants and their gender

District	Men	Women	Total
Chereponi (Chereponi township)	11	65	76
Karaga (Kpataribogu)	5	90	95
Savelugu (Yong)	5	78	83
Grand Total			**254**

The participants with the help of the WIAD team prepared meals such as kosie, tubani, soya kebab, soy porridge, soy milk, soy banku etc. The participants (Plates 2.4-2.6) undertook group exercises to try their hands on the various dishes. Mr. Edwin Akley, FLO of N2Africa explained the objectives of N2Africa to the participants. The women expressed satisfaction in the exercise and some promised to pick it up as a business.

Plate 2.4: Selected products from the training activity

Plate 2.5: Project Team with participants during WIAD Training in Karaga District

Plate 2.6: Project Team members interacting with participants in Savelugu-Nantom District

What went on well:

- Participants really appreciated the training since it would help them to improve upon their cookery/culinary art.
- Generally, participants acknowledged that they had only heard that soybean could be processed into flour/ dough which could be used for preparing various dishes like soymilk and soybean khebabs but they have not seen such soy products before. Therefore the N_2Africa collaboration with MoFA has helped to build their capacities in using soybeans to do this.
  They also appreciated the fact that the training would go a long way to improve their livelihoods since unemployed could easily go into commercial production of soybean milk and khebabs for income to support their families.
- Participants also indicated that they didn't know that soybean flour could be used to fortify their main dishes (*Tuo-zaafi*, *banku*, *fufu*, *koko*, soups etc.). The training therefore enlightened them on this and they believed this would help to reduce malnutrition in their households in that, if they didn't have money to buy fish or meat to put into their soups/sauces they could easily fortify these with soy flour which plays the same role.

What didn't go well:

- In Chereponi District, the soybean dough meant for soy khebabs got fermented as a result of late arrival and organization by the participants. As a result, participants were not taken through the detailed practical lesson / procedure involved in making soybean khebabs.
- Poor communication linkages among all stakeholders involved in the project at Karaga district delayed the training.

Activity 4.4.2: Large-scale demonstration and dissemination campaigns held in each impact zone

Accomplishment: Out of the 360 demonstration farms target set for the 2011 cropping season, a total of 344 demos were established across the six districts in the Northern, Upper West and Upper East Regions of Ghana. As indicated in Table 2.31, these consisted of 191, 68, and 85 demos of soybean, cowpea and groundnut demonstrations, respectively.

Table 2.31: Number of demonstrations of the three legume types.

Region (Mandate area)	District (Impact zone)	No. of Demonstrations			**Total**
		Soybean	Cowpea	Groundnut	
Upper East	Bawku West	36	10	11	**57**
	K/N East	23	10	24	**57**
Upper West	Nadowli	29	14	10	**53**
	Wa East	36	10	14	**60**
Northern Region	Karaga	**31**	**12**	**14**	**57**
	Chereponi	36	12	12	**60**
Total		**191**	**68**	**85**	**344**
Target		**210**	**60**	**90**	**360**

(iv) Types of demonstrations established

The three main types of demonstrations established on-farm in the 2011 growing season and their respective treatment combinations are shown in Table 2.32. For the cowpea plus and minus P fertilizer demonstrations, Songotura was used as variety 1 and Padi-tuya as variety 2 in all the four mandate areas.

Table 2.32 Types of demonstrations and their respective treatment combinations

Type of demonstration	Treatment combinations			
Soybean plus P fertilizer and inoculants	+P-Inoculation	+P + Inoculation	–P-Inoculation	–P+Inoculation
Cowpea plus and minus P fertilizer	Variety 1-P	Variety 1+P	Variety 2-P	Variety 2+P
Groundnut input	Chinese-P-K	Chinese+P+K		
	Samnut 22-P-K	Samnut 22+P+K		
	Samnut 23-P-K	Samnut 23+P+K		

Figure 2.6 shows the effect of P fertilizer application and/or inoculation on the average grain yield of soybean across the six mandate areas. It was evident from the study that application of P fertilizer alone led to higher increase (14%) in the average grain yield of soybean than the sole use of inoculums (7%). In all however, the combined application of inoculum and P fertilizer gave the highest increase (22%) in grain yield.

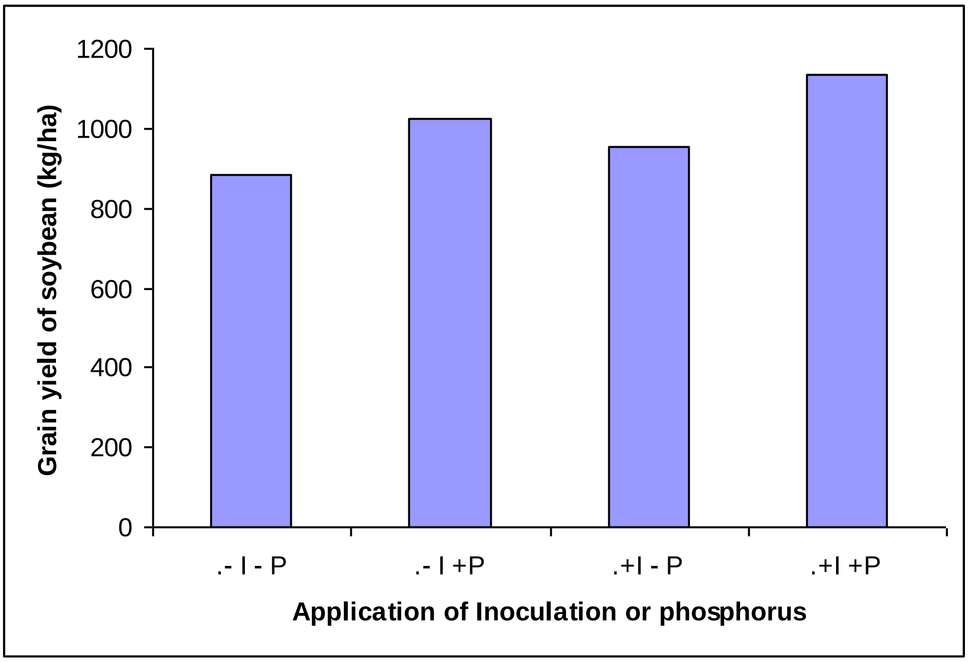


Figure 2.6: Effect of P fertilizer application and inoculation on grain yield

Objective 5: Capacity Building and Training

Activity 5.2: Advanced training to MSc and PhD level of an elite young cadre of African scientists focused on topics filling identified knowledge gaps and identified through competitive calls.

The two MSc students sponsored by N2Africa at the Kwame Nkrumah University of Science and Technology have completed their taught courses and have commenced their research study. In addition, three PhD students are currently conducting field research on legume agronomy or rhizobiology on N2Africa fields.

Activity 5.3: Training-of-trainers workshops on legume and inoculant technologies for agricultural extension workers and NGO staff

The Agricultural Development and Value Chain Enhancement (ADVANCE) in collaboration with N2Africa-Ghana and IFDC organized a three day pre- season workshop under the theme Northern Ghana Pre-season Planning and Networking Forum for all stakeholders in the Agricultural sector at CSIR – SARI conference hall, Nyankpala. The essence of the workshop was to create a platform for all institutions /organizations that are engaged in Agricultural related activities in the country to showcase their products and/or technologies to the public and farmers in particular.

3. Kenya Country Report on Month 30 of the N2Africa Project

Prepared by Dr. Paul L. Woomer, Kenya Country Mentor; Prof. Nancy K. Karanja, Nairobi MIRCEN; and Dr. Freddy Baijukya, Legume Agronomy Specialist

Summary. This report covers N2Africa project activities Kenya up to Month 30 from November 2011 through April 2012. It is structured by project Objectives, Activities and Milestones relevant to this reporting period. In terms of five quantifiable parameters in the project Vision of Success and 26 specific milestone tasks, the project is performing 59% above expectation (Appendix 3.1). Many project achievements (48%) are beyond expectation particularly in the areas of seasonal extension events (767%), agro-dealer training (470%), identifying promising soybean varieties (400%), conducting events on human nutrition (400%), engaging communities for outreach activities (250%) and training MSc candidates (250%). Several milestone tasks (26%) stand exactly as expected. Performance is less than 50% expectation in five areas, however, conducting MPN counts (48%), increasing legume grain yield during a problematic short rains growing season (35%), increasing household income (15%), continued technical training (no progress) and conducting Master Farmer workshops (none held but four are planned). Several outreach goals were compromised by late release of funds by CIAT-TSBF to cooperators. Some highlights of the past season include release of the project's first experimental legume inoculants by the Nairobi MIRCEN and farmer sales of over 217 tons of soybean to Smart Logistics.

Objective 1. Establish a baseline of the current status of N2-fixation, identify niches for targeting N2-fixing legumes in the impact zones, M&E and impact assessment.

Activity 1.3. Identify new opportunities for targeting legume technologies to increase BNF and enlarge the area under the priority legumes.

Milestone 1.3.2. New opportunities identified prior to each new cropping season. Month 3, years 2, 3&4. Three new opportunities were identified prior to the 2011-2012 short rains growing season. Seed Co has provided the project with several new soybean varieties (e.g. Saga and Squire) that appear to have greater yield potential and improved resistance to rust. These varieties are being evaluated by the Legume Agronomy team and in on-farm field demonstrations. Potential exists for improving the Sympal fertilizer blend through the addition of zinc. Preliminary tests from the 2011-2012 short rains (2011 SR) were surprisingly positive (+31% yield increase in soybean) and the +Zn formulation is undergoing more extensive agronomic testing during the 2012 long rains (2012 LR). Finally, the first of the candidate elite rhizobium isolates for soybean and bean resulting from bio-prospecting and greenhouse testing by MIRCEN were prepared into experimental inoculants for comparison to commercially available BIOFIX. These inoculants are under evaluation during the 2012 LR by the Legume Agronomy team.

Milestone 1.3.3. Complete market analysis for inoculum in representative areas of the three hubs reported on, including cost/benefit analysis at smallholder level; recommendations for private sector engagement made. Month 6, year 2.

An analysis of BIOFIX production and marketing in Kenya was conducted and sent to the project M&E Specialist for inclusion into this Milestone Report. BIOFIX inoculant is manufactured by MEA Fertilizers Ltd. at its factory in Nakuru, Kenya. Production began in 2010 after licensing the process and brand from the University of Nairobi MIRCEN. Briefly, broth cultures are raised in five liter flasks containing YMB aerated with filtered pumps.

Liquid cultures are mixed with finely-ground, sterilized "filter mud" obtained from a sugar processing factory and cured at room temperature for two weeks. BIOFIX offers a full range of products for bean, soybean, pea, alfalfa and other economic legumes in packets of 10, 20, 50 and 100 grams, all marketed with the appropriate quantity of powdered gum arabic adhesive. Quality control services are provided by the University of Nairobi as per licensing agreement and the resulting population of

Table 3.1. Breakdown of production costs and profits of inoculant based upon BIOFIX offered to N2Africa for $1.34 per 100 g packet.

Item	$ per 100 g packet
Retailer mark up	1.16
Manufacturer profit	0.62
Labor and quality control	0.22
Marketing and accounting	0.13
Equipment depreciation	0.10
Monthly facilities	0.08
Broth production	0.07
Packaging	0.07
Carrier preparation	0.05
Total	**2.50**

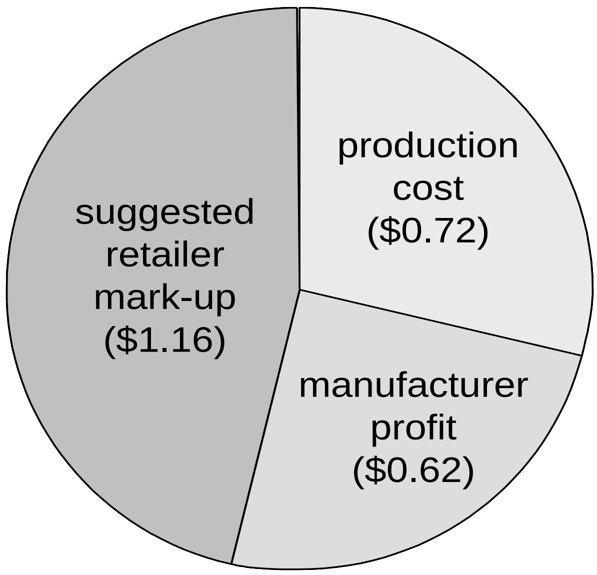


Figure 3.1. Estimated manufacturing costs of BIOFIX inoculant, manufacturer's target profit and suggested retail mark-up in Kenya.

rhizobia averages only 410 million cells per gram (CV = 34%). This population is somewhat below the target of >10^9 cells per gram, presumably because of the silt content of the carrier material. Nonetheless, this corresponds to about 533 million rhizobia per seed when a 100 g packet is applied to 10 kg of soybean seed (about 0.13 g per seed). Approximately 400,000 packets were marketed during 2011.

A breakdown of production costs and profits of BIOFIX, based upon a 100 g packet, is presented in Table 3.1 and Figure 3.1. Total production and marketing costs are estimated to be $0.72. At a sales price of $1.34 per 100 g this allows a manufacturer's profit of $0.62 per unit. The suggested retail price is $2.50 per packet, resulting in a retailer profit of $1.16. When asked for details on production costs and returns, MEA Fertilizer only offered information on their wholesale price and suggested retail price (and did not respond to further queries for more detailed information). Consequently, the production costs of BIOFIX were calculated based upon familiarity with MEA's production process and operations. If we assume that the average size of packets marketed was 50 g, and that profits are proportionate to packet size, then MEA produced about $268,000 of inoculants in 2011. MEA's target production in 2012 is one million packets.

Activity 1.4. Quantify the current on-farm N2-fixation in the target farming systems and its impact on livelihoods (income, nutrition).

Milestone 1.4.2. A baseline report quantifying the current level of BNF and its contributions to rural livelihoods is available for all impact zones. Month 12, year 1.

Table 3.2. Coefficients for calculating BNF based upon on grain legume yield.

coefficient	soybean	bean	cowpea	groundnut
seed N	0.057	0.035	0.037	0.035
NDF	0.75	0.45	0.68	0.65
NHI	0.65	0.70	0.47	0.50

Unfortunately, the baseline report quantifying BNF and its contributions is not yet completed but samples are presently being analyzed for natural abundance of N^{15}. In the meantime, we have adopted an approach to estimate BNF used in many crop models where *BNF = (legume yield x grain nitrogen content x NDF) / NHI.* Legume yield and grain N are measured and nitrogen derived from fixation (NDF) and N Harvest Index (NHI) are obtained from the literature (Duke 1981; Giller 2001) (Table 3.2). In this way, BNF may be estimated from grain yield increase pending completion of the overdue milestone report. These values for soybean and bean were generated based upon available data and compared to original estimates appearing in the project implementation plan, and extrapolated along likely trajectories by project's end (Table 3.3). In conclusion but based upon an incomplete data set, it is likely that soybean will exceed its targets for BNF in smallholder legume cultivation but that bush bean will not. This analysis does not include climbing bean for which BNF coefficients could not be estimated. We note that the analysis of BNF is based upon calculated values and these must soon be compared to measured values as required under long overdue Milestone 1.4.2. Finally, it is possible that BNF increases in a greater than linear trajectory as improved inoculation delivery systems and more effective rhizobia are identified through research findings by the Objective 3 Rhizobiology team. A more complete analysis along these lines appears in the Milestone 4.4.1 report recently submitted to the project Principle Investigator.

Table 3.3. Originally estimated, Year 2 observed and linearly projected BNF of soybean and bush bean.

Biological nitrogen	---- Soybean ----		--- Bean ----	
fixation	Estimated	Observed	Estimated	Observed
	------------- BNF N (kg ha^{-1}) -------------			
Initial	50	63	13	13
Improved management (Y2)	80	97	29	22
Linear trajectory (Y4)	110	131	44	31
Target improvement	60	68	31	18

Activity 5. Monitor impact of investments and uptake of legume and inoculant technologies in the impact zones.

Milestone 1.5.2. A monitoring and evaluation framework used for evaluating progress and planning subsequent activities during planning. Month 3, years 2, 3 & 4.

Compliance with M&E requirements was severely impeded by failure to release funds to Resource Projects Kenya in a timely manner. No funds for country M&E activities were released by CIAT-TSBF during the first 23 weeks of the 26 week reporting interval! Nonetheless, data were collected for five M&E report forms including; field day attendance, field day evaluation, input distribution, Lead Farmer assessment and training events. These data report forms were submitted to the project's M&E Specialist but feedback on them has not yet been received. In terms of local planning, the most useful form is field day evaluation, that allows for strengths and shortcomings of field days to be more readily interpreted (see Milestone 4.4.3). The same data will be collected during the current season with additional information collected on Progressing Farmers (past season's New Farmers provided with incentives to adopt project technologies).

Milestone 1.5.3*.* An external project review has been conducted, with representatives of the Bill & Melinda Gates Foundation. Month 6, year 3.

The External Evaluation was not conducted in Kenya, and we understand this delay results from medical complications of the contracted evaluator. Several materials were forwarded to Dr. Lynam in preparation for this evaluation including the Year 2 Kenya Country Report, the Milestone 1.3.3 Kenyan submission and the draft Milestone 4.4.1 report.

Activity 1.6. Evaluate the impact of introduced legume and inoculant technologies on farmer's livelihoods and soil health in the impact zones.

Milestone 1.6.1. A report on the impact of N2-fixation technologies on farmers' livelihoods is produced. Month 12, year 4.

An economic analysis of grain legume production using technologies developed by the N2Africa Project was performed using results from the 2011 LR and SR. During the long rains we compared four managements involving inoculation and fertilizers with all plots sprayed with fungicide to control soybean rust. Total production costs ranged between $178 to $285 per ha including labor (Table 3.4). Labor costs were estimated by assigning time and wage for different field tasks in consultation with farm association leaders. We assume that land is tilled using oxen and if hand tilled this adds several days of additional field labor (but not necessarily additional labor costs). Soybean yields ranged between 758 and 1680 kg per ha depending on management resulting in net returns of $266 to $699 (Table 3.5).

The best returns were obtained from applying inoculants and Sympal blended fertilizer offering a benefit:cost ratio of 3.45. Note that Table 3.5 also contains information on total days of labor (33 to 39 days per ha), the grain to seed weight ratio (13 to 28 seeds per seed) and the Agronomic Efficiency of fertilizer use (2.1 to 9.2 kg grain per kg fertilizer). The Sympal blend was developed by N2Africa in Kenya, contains P, K, Mg, Ca and S, and was subsequently commercialized by MEA Fertilizers based upon these findings.

Table 3.4. Estimated production costs of soybean in west Kenya during the 2011 long rains growing season.

management	seed & inoculant	fertilizer & fungicide	labor	bagging	total
	------------------------------ $ ha^{-1}	---------------------------			
SB19 spraying only	40	46	87	5	178
SB19 SSP no BIOFIX	40	107	90	6	243
SB19 SSP w/BIOFIX	62	107	91	8	268
SB19 Sympal w/BIOFIX	62	119	93	11	285

Table 3.5. Grain yield and economic returns to soybean production in west Kenya during the 2011 long rains growing season (based on 26 farms).

management	SB19 yield kg ha^{-1}	gross return	net return	benefit: cost ratio	labor days per ha	grain: seed ratio	AE fertilizer ratio
		------ $ ha^{-1}	-----				
SB19 spraying only	758	444	266	2.50	33	13	na
SB19 SSP no BIOFIX	970	568	325	2.34	36	16	2.1
SB19 SSP w/BIOFIX	1310	767	499	2.86	37	22	5.5
SB19 Sympal w/BIOFIX	1680	983	699	3.45	39	28	9.2

An economic analysis of five different soybean managements by smallholders was repeated during the 2011-2012 short rains growing season. Two soybean varieties were compared, SC Samba and SB19, with the former variety more specific in its nodulation requirement and noted for rust resistance; in contrast to promiscuously-nodulated and rust-susceptible SB19. In this case, all managements received Sympal fertilizer but only SB19 was sprayed with fungicide.

One management included zinc oxide in its Sympal blend. These managements resulted in total production costs ranging from $201 to $284 per ha (Table 3.6). Soybean yields ranged

Table 3.6. Estimated production costs of soybean in west Kenya during the 2011-2012 short rains growing season.

Management	seed & inoculant	fertilizer & fungicide	labor	grading & bagging	total cost
	--------------------------- $ ha-1	------------------------------			
SC Samba no BIOFIX	40	73	84	4	201
SC Samba + BIOFIX	62	73	85	7	227
SB19 no BIOFIX	40	119	90	6	255
SB19 + BIOFIX	62	119	91	6	279
SB19 + BIOFIX + Zn	62	121	92	9	284

Table 3.7. Grain yield and economic returns to soybean production in west Kenya during the 2011-2012 short rains growing season (based on 20 farms).

Management	grain yield kg ha^{-1}	gross return	net return	benefit: cost ratio	labor days per ha	grain: seed ratio
		----- $ ha^{-1}	----			
SC Samba no BIOFIX	641	391	189	1.94	35	11
SC Samba + BIOFIX	1071	653	426	2.88	36	18
SB19 no BIOFIX	898	548	293	2.15	36	15
SB19 + BIOFIX	1024	624	346	2.24	37	17
SB19 + BIOFIX + Zn	1345	820	536	2.89	38	22

between 641 and 1345 kg per ha depending on management resulting in net returns of $189 to $536 (Table 3.7). The best returns were obtained from applying inoculants and Sympal plus zinc blended fertilizer offering a benefit:cost ratio of 2.89. Note that Table 3.7 also contains information on total days of labor (35 to 38 days per ha) and the grain to seed weight ratio (11 to 22 seeds per seed). The short rains growing season offered lower yield and reduced economic returns, in large part because of its difficult growing season. Rains started over two weeks earlier than expected, interfering with the harvest from the previous long rains, and ended earlier than expected. These conditions resulted in late planting of the trial and late season drought. Nonetheless, two managements resulted in benefit:cost ratios of greater than 2.8. We also note with interest the yield improvement from adding zinc to the Sympal fertilizer blend that warrants additional research attention in the future.

Knowledge of the best managements and their input requirements, costs, resultant yields and returns allows calculation of benefits to smallholder farmers responding to incentives offered by the N2Africa Project and our private sector partners in Kenya (Table 3.8). Briefly, farmers are encouraged to produce soybean on 1/2 acre (2000 m2) during each growing season (twice a year). This requires 24 kg soybean seed, 40 kg of Sympal fertilizer, 200 g of BIOFIX inoculant and about 16 days of labor. Soybean yields are 624 kg per year and marketed for $0.61 per kg through Smart Logistics for a fee of $0.09 per kg (data not presented). Total production costs throughout the year are $110. Fertilizer is the largest single cost ($40) and inoculant one of the least costs (<5% of total). A household earns $220 per year from the one acre (0.4 ha) enterprise, enjoying a benefit-to-cost ratio of 3:1. But this profit is considerably less than $465 per year targeted in the N2Africa Vision Statement. Keeping in mind that the average area planted in field crops is 0.7 ha per farm with two crops per year, smallholders can conceivably double their commitment to soybean production, resulting in economic benefits nearly equal to the target value. Note from Tables 3.5 and 3.7 that these benefits are not possible without investment in rhizobial inoculants. It costs to invest in soybean production, and its management requires expertise, but the returns to investment are substantial. Future attention should perhaps address tradeoffs in entering soybean production (and growing less of something else) and the residual benefits to crops following soybean.

Table 3.8. Costs and returns from participating in farmer collective soybean marketing on 0.2 ha twice a year in west Kenya

SB 19 seed	$16
BIOFIX inoculant	$5
fertilizer	$40
fungicide	$8
labor	$37
processing	$3
total cost	$110
Gross Return	$330
Net Return	$220
Benefit:cost ratio	3.0

Objective 2. Select multi-purpose legumes (food, fodder, stakes, and soil fertility management) for enhanced BNF and integrate these into farming systems.

Activity 2.1. Identify and field test best varieties of soybean and common bean for high N2-fixation capacity and adaptation to abiotic and biotic stresses.

Initial variety test in Kenya had identified two soybean varieties SB 19 (released) and SB 25 (not released) to be preferred by both farmers and buyers but susceptible to abiotic stress including soybean rust disease. This prompted an introduction and testing of new lines known to be resistant/tolerant to rust disease; namely Saga, Sequel, S8-23-6-16 (from Seed Co), and TGx 1987-62F, TGx 1987-11F (from IITA) as well as evaluating potential benefit of spraying fungicide Amistra Xtra to control the disease. Results from the second season suggests the varieties Saga, S823-6-16 and TGx 1987-67 are less affected by rust (Figure 3.2). In collaboration with Seed Co Kenya, the varieties Saga, S823-6-16, SB 25 and TGx 1987-67 have been submitted to Kenya Plant Health Services (KEPHS) for inclusion in National Performance Trails (NPT), in preparation for official release.

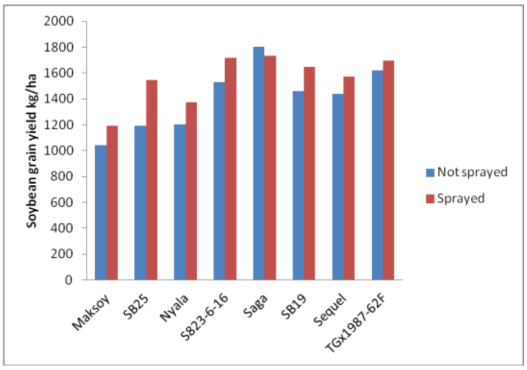


Figure 3.2. Soybean grain yield of different soybean varieties as affected by spaying with fungicide Amista Xtra at Mumias site 2011 long rains growing season.

At the end of Year 2, we identified four bush bean varieties (KAT B1, KAT B9, KATX 59 and Kenya Umoja) for lowlands areas and one climbing bean variety (Kenya Tamu) for midlands and upper midlands areas that are less infested by root rot and root knot nematodes. This limited success has prompted testing of new climbing bean varieties from Rwanda as well as bush bean lines from KARI bean program targeting areas which are highly infested by root rot and root knot nematodes.

Milestone 2.1.2. At least 3 new soybean varieties with high BNF potential identified. Month 12, year 2.

Sixty five (65) best performing soybean materials from KARI and CIAT-TSBF soybean germplasm collections continue to be evaluated for biomass accumulation, yield and BNF potential under different agro-ecoloical zones of West Kenya. Plant samples taken are presently being analyzed for natural abundance of N^{15}. Several lines accumulated higher biomass, but this did not necessarily translates to higher grain yields (Figure 3.3). Evaluation continues for the third season to assess performance of these varieties under different environment. Best soybean varieties with high BNF will be recommended at the end of Year 3.

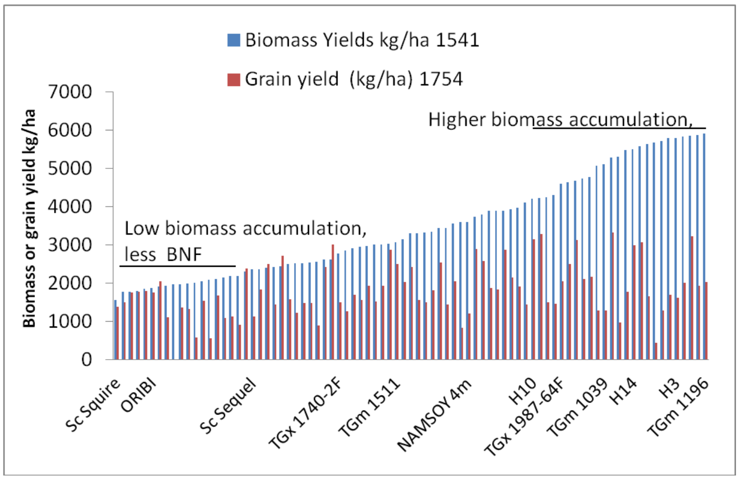


Figure 3.3. Biomass and grain yield of different soybean varieties/lines indicating their potential for BNF as observed at Sidada west Kenya during 2011 short rains season.

Activity 2.4. Explore the N2-fixing potential of multi-purpose tree and forage legumes for intensive meat and milk production and environmental services.

Milestone 2.4.2. Sufficient planting materials are available for at least 2 multipurpose tree legumes and 4 forage legumes with high BNF capacity that have been identified across the impact zones. Month 12, year 2.

The seed bulking exercise at KARI Kakamega has yielded small quantities (in parenthesis) of seeds of established herbaceous forage legumes; *Macroptilium bracteatum* cv. Burgundy bean (0.3 kg), *Desmodium uncinatum* cv. Silverleaf (1.5 kg), *Desmodium intortum* cv. Greenleaf (0.5 kg), *Desmanthus virgatus* (0 kg), *Lupinus angustifolius* (0 kg), *Vicia villosa-dasycarpa* (0.2 kg), *Canavalia brasiliensis* (0 kg), *Lablab purpureus* (3 kg), *Cratylia argentea* (0.1 kg) and, *Clitoria ternatea*, *Brachiaria* sp (0 kg). There is largely because of poor establishment and poor seeding of some legume specifies. The obtained seeds will be established in selected farmer's fields in Butere and Emuhaya. Two (2) kg of *Calliandra collothyrsus* and one kg of *Leucaena diversifolia* were obtained from KEFRI-Muguga seed unit and seeded at the Maseno nursery. The germination for Leucaena was very poor as only 50 seedlings could be raised. On the other hand, *Calliandra collothyrsus* germinated relatively well giving a total of 2,216 seedlings. Of these, 1,600 were distributed to 42 farmers in Butere and Emuhaya districts for on-farm evaluation.

Activity 2.5. Identify best-fit agronomic practices for maximizing potential benefits of legume and inoculant technologies on increasing and stabilizing productivity.

Milestone 2.5.1. At least 9 adaptive [impact zone-specific] research campaigns focusing on major gain legume (soybean, cowpea, groundnut, beans) implemented in the impact zones. Month 6, year 2.

By the end of Year 2, nine different BNF technologies (including rhizobium inoculation, phosphate fertilization, fertilizer blend, rock phosphate addition, intercropping or rotation, staking system, micronutrient, soil liming and disease management of soybean) were tested and results reported. Six of these technologies (rhizobium inoculation, phosphate fertilization, fertilizer blend, rock phosphate addition, intercropping or rotation and soil liming) have been repeated in the 2012 long rains season. Two additional adaptive research campaigns were conceived in 2012 long rains growing season, which include field evaluation of N2Africa Kenya (NAK) inoculants and systematic diagnosis of nutrient deficiencies to determine nutrient-limited yield gaps in soybean production, targeting the non responsive soils in western Kenya. The N2Africa Kenya inoculants contain the candidate elite strains for bean and soybean identified by MIRCEN (see Milestones 3.3 and 3.1.4).

Activity 2.6. Evaluate contributions of best fit agronomic practices to system productivity and livelihoods with specific attention to trade-off analysis between competing enterprises.

Milestone 2.6.1. Household benefits from specific BNF interventions quantified for the four major grain legumes in the impact zones. Month 12, year 3.

Evaluation of contribution of best varieties and best fit agronomic practices to system productivity and livelihood requires development of methods for conducting trade-off analysis to explore the effect of crop substitution, the direct and indirect residual effect of BNF on crop and associated livestock in the farming system and on the soil. The Research Workstream is currently collecting data on 300 farms and initial results will be reported at the end of Year 3.

Objective 3. Select superior rhizobia strains for enhanced BNF and develop inoculum production capacity in sub-Saharan Africa, including private sector partners.

Activity 3.1. Assess the need-to-inoculate for the target legumes and identify elite strains across the impact zones.

Milestone 3.1.3. At least 2,000 strains screened for effectiveness under greenhouse conditions to select the top 5% for field testing. Month 6, year 3.

Bio-prospecting for rhizobia in Kenya continued through Month 30. Exploration included diverse ecosystems ranging from coastal sand dunes to high elevation montane regions (Figure 3.4). Samples were obtained from both cultivated and wild legume communities. Roots were excavated to expose nodules, nodules collected and stored in desiccation vials prior to isolation. A wide variety of cultivated and wild legumes were targeted but with an emphasis on those closely related to soybean and bean. A spreadsheet data base was developed in MS Excel to compile results. A total of 208 strains were collected from 20 legume genera. Of these, 45% were collected from cultivated fields. Most hosts (83%) belonged to the tribe *Phaseoleae* and as many as 26% were isolated from project target legumes. Isolates were described as slow (52%), intermediate (1%) and fast (47%). An extract from the N2Africa Rhizobium Data Base appears in Table 3.9.

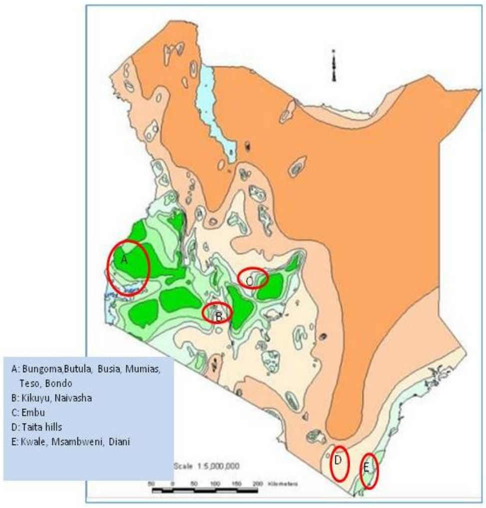


Figure 3.4. Bio-prospecting in Kenya.

Indeed, bio-prospecting rhizobia throughout Kenya has raised the exciting possibility of discovering new elite strains for use in legume inoculants. MIRCEN and N2Africa have developed a effectiveness screening

Table 3.9. An extract from the Kenyan N2Africa Rhizobium Database.

Code				Host		Cultural Characteristics	
Source	Entry	Longitude	Latitude	Genus	Species	Growth rate	BTB YMA
NAK	142	039° 32.934' E	04° 23.119' S	Crotalaria	Crotalaria sp.	S	B
NAK	143	039° 32.714' E	04° 24.508' S	Indigofera	Indigofera sp	S	B
NAK	144	039° 31.608' E	04° 24.002' S	Vigna	Vigna sp	S	B
NAK	169	039° 35.778' E	04° 15.509' S	Vigna	V. membranacea	F	A
NAK	170	039° 26.910' E	04° 29.282' S	Glycine	G. wightii	S	B
NAK	176	039° 27.051' E	04° 29.431' S	Vigna	V. unguiculata	S	B
NAK	177	039° 23.064' E	04° 31.671' S	Eriosema	Eriosema sp.	S	B
NAK	183	039° 32.893' E	04° 23.677' S	Terminalia	Terminalia sp	I	NR

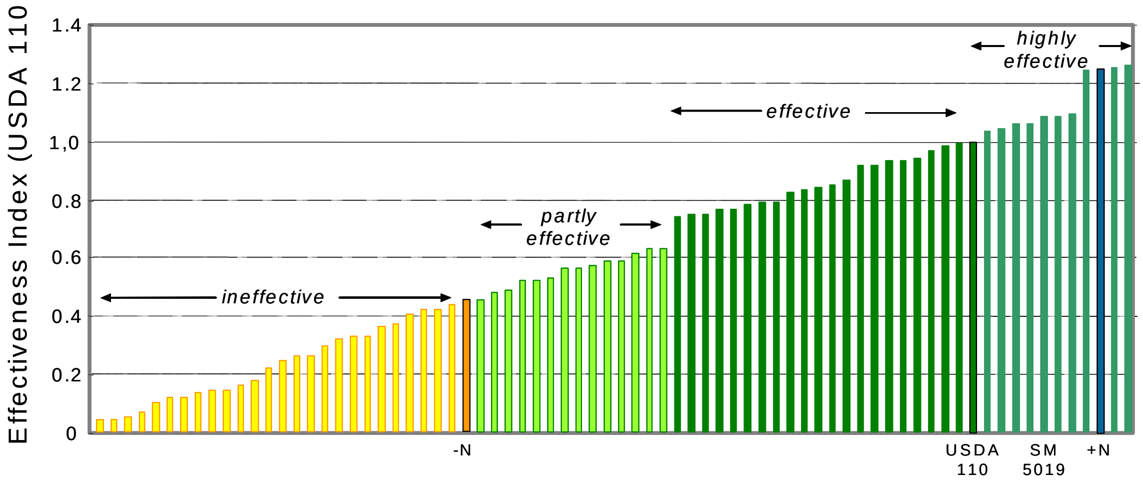


Figure 3.5. Effectiveness testing of isolates from Kenya has identified several candidate elite strains for field testing.

procedure that separates isolates into effectiveness classes and forwards the best ones for field testing. This work is most advanced with soybean. Isolates were obtained from the NAK collection and compared to standard controls using a two-step procedure. The first step involved 400 ml Leonard jars containing sand to authenticate isolates on soybean and the next step examined strain performance in rhizobium-free vermiculite in 3 liter pots to establish strain effectiveness. Pre-germinated seeds were planted and inoculated with 1 ml broth of 70 test isolates after 5 days. Soybeans were harvested after 8 weeks and shoot and nodule mass measured. An effectiveness Index was developed comparing performance to USDA 110. Isolates were then assigned to four classes (Figure 3.5). A majority of isolates were either ineffective or partly effective (68%) but several promising isolates were identified, including those that outperformed strains currently used in commercial inoculants (below). The overall CV was 29%. In all, 9 isolates were classed as Highly Effective on soybean. These isolates were obtained from four different hosts including six from cultivated fields and four from soybean. The best performing isolates were NAK 96, 115, 176 and 179. This technique combines bio-prospecting and greenhouse strain testing in a manner that rapidly identifies candidate elite strains for field testing and, hopefully, improvement of commercial inoculants. A similar procedure is now being explored for bean.

Milestone 3.1.4. The benefits of inoculation of soybean and beans with at least 2% of the elite strains demonstrated in the impact zones. Month 12, year 3.

The process of developing the 2% elite strains has begun as field testing of experimental inoculants developed from eight candidate elite strains from the MIRCEN collection is underway in west Kenya (Butere). These strains included NAK 9, 96, 115 and 128 for soybean and NAK 67, 91, 103 and 104 for bean. Performance will be compared to commercially-available BIOFIX containing USDA 110 (for soybean) and CIAT 899 (for bean), and non-inoculated controls (± fertilizer N). SEMIA 5019 from Brazil was included in the soybean experiment. This study will be reported in full detail in the next Kenya Country report. Clearly, progress is being made in Kenya toward this important milestone and we are now prepared to exchange our candidate elite strains with other project partners.

Activity 3.3. Formulate improved inoculant products and develop cost-effective production methods, including quality assurance procedures.

Milestone 3.3.2. Cost effective inoculant production methods including fermentation technologies, carrier selection, inoculant formulation, enhanced shelf life developed. Month 12, year 2.

Legume inoculants are produced by MEA Fertilizer Ltd. under the trade name BIOFIX. While no industry standards have yet to be established in Kenya, it is nonetheless important that an independent quality assessment be conducted. This service is conducted by the University of Nairobi MIRCEN Laboratory. Product targets are at least 109 rhizobia per gram of inoculant and no more than 107 contaminants. Inoculants are submitted to MIRCEN from the BIOFIX factory in Nakuru and assessed on CR YMA in triplicate using the drop plate method, with the 10-5 to 10-7 dilutions plated.

An extract from the N2Africa Inoculant Quality Assessment Database under development at the UoN MIRCEN.

date day/m/yr	lab code	batch number	host legume	lab rep	sample rep	drop factor	dilution series	dilution factor	rhizobium count	rhizobium x 10^9	contaminant count	contaminant x 10^6
24-3-2012	17	009S	soybean	1	1	50	10^-5	0.0000100	tnc		6	30.00
24-3-2012	17	009S	soybean	1	1	50	10^-6	0.0000010	tnc		tfc	
24-3-2012	17	009S	soybean	1	1	50	10^-7	0.0000001	6.0	3.00	tfc	
24-3-2012	17	009S	soybean	2	1	50	10^-5	0.0000100	tnc		7	35.00
24-3-2012	17	009S	soybean	2	1	50	10^-6	0.0000010	tnc		tfc	
24-3-2012	17	009S	soybean	2	1	50	10^-7	0.0000001	10.0	5.00	tfc	
24-3-2012	17	009S	soybean	3	1	50	10^-5	0.0000100	tnc		12	60.00
24-3-2012	17	009S	soybean	3	1	50	10^-6	0.0000010	tnc		tfc	
24-3-2012	17	009S	soybean	3	1	50	10^-7	0.0000001	7.0	3.50	tfc	
24-3-2012	18	009S	soybean	1	2	50	10^-5	0.0000100	tnc		8	40.00
24-3-2012	18	009S	soybean	1	2	50	10^-6	0.0000010	tnc		tfc	
24-3-2012	18	009S	soybean	1	2	50	10^-7	0.0000001	12.0	6.00	tfc	
24-3-2012	18	009S	soybean	2	2	50	10^-5	0.0000100	tnc		12	60.00
24-3-2012	18	009S	soybean	2	2	50	10^-6	0.0000010	tnc		tfc	
24-3-2012	18	009S	soybean	2	2	50	10^-7	0.0000001	14.0	7.00	tfc	
24-3-2012	18	009S	soybean	3	2	50	10^-5	0.0000100	tnc		16	80.00
24-3-2012	18	009S	soybean	3	2	50	10^-6	0.0000010	tnc		tfc	
24-3-2012	18	009S	soybean	3	2	50	10^-7	0.0000001	16.0	8.00	tfc	

Sample and batch report	
009S	mean
Rhizobium x 10^9	
Sample 1	3.83
Sample 2	7.00
Batch	**5.42**
Contaminants x 10^6	
Sample 1	41.67
Sample 2	60.00
Batch	**50.83**
Entered by: SM	

Results are entered into a spreadsheet utility to calculate the inoculant population, total contaminants and their respective CVs. Results are reported for specific batches with duplicate samples per batch. Results are summarized into a “sample and batch report” (Table 3.10). These results are then relayed to the MIRCEN Director and MEA’s Factory Supervisor. Each batch consists of about 1000 packets of inoculant, resulting in 0.2% quality assurance sub-sampling. The reporting time is currently too late to intercept inferior samples from the manufacturer’s inventory. Contaminants continue to exceed targets. Some inoculants appear to contain mixed cultures (right). These shortcomings are currently being addressed by the factory and MIRCEN laboratory.

Milestone 3.3.3. Universal logo representing quality assurance standards adopted among cooperating laboratories. Month 6, year 3.

A candidate logo and accompanying grading system was designed in MS PowerPoint and distributed to many project members for discussion on 15 March 2012 (Figure 3.6). A way forward was proposed that included develop grade criteria (e.g. B = >10^8 rhizobia, contaminants < 10^7, A = >10^9 rhizobia, contaminants <10^6, AA = >10^9 rhizobia, no contaminants and AAA = >10^{10} rhizobia, no contaminants). We can perhaps establish "side grade" for inclusion of adhesive agent (e.g. +) or (in)sufficient or (in)correct information on packet. This standard requires approval from inoculant producers, importers and recognition from AABNF at a meeting later this year. Unfortunately, no feedback to this development was received.

Activity 3.4. Expand and upgrade inoculant production capacity in sub-Saharan Africa.

Milestone 3.4.3. At least 50,000 inoculant packets produced per year in at least 3 cooperating laboratories. Month 12, year 2, 3 & 4.

We continue to monitor the use of BIOFIX inoculants by project partners and its wider distribution by MEA Fertilizers Ltd. During the current 2012 LR season the project distributed 8000 ten-gram packets to New Farmers, 2000 fifty-gram packets to Progressing Farmers and facilitated consignment delivery of 1000 twenty-gram packets to ten collaborating agro-dealers, resulting in 11,000 packets containing 200 kg of inoculant. Our marketing partner, Smart Logistics, also ordered and distributed 4500 one hundred-gram packets (containing 450 kg). MEA reported that its overall production in 2011 was 400,000 packets. In this way, N2Africa and its partners in Kenya directly account for approximately 8% of this production, assuming two season's per year.

Figure 3.6. Proposed QA label.

Milestone 3.4.4. Potential private sector inculant producers invited to planning meeting and interim assessment workshops. Month 6, years 1, 2 & 3.

As suggested above, we continue to work closely with MEA Fertilizers Ltd., makers of BIOFIX inoculants. Together we are exploring the feasibility of using vermiculite inoculants (a large deposit is being explored on the Kenya-Uganda border). We are exploring refinement in the formulation of Sympal fertilizer. We continue to improve BIOFIX quality assessment procedures performed by MIRCEN. During the past six months we have met thrice with MEA's Product Manager (Daniel Ndegwa) on these issues.

Another private concern, Real IPM of Thika, Kenya, is exploring inoculant production. A liquid formulation inoculant intended for bean and pea (20 ml per kg seed) was recently provided to MIRCEN for evaluation. This pilot product is currently under evaluation and will be reported in greater detail in the next report.

Objective 4. Deliver legume and inoculant technologies to farmers throughout sub-Saharan Africa.

Activity 4.1. Create strategic alliances for facilitating dissemination of legume and inoculant technologies in the impact zones.

Milestone 4.1.3. At least 10 additional satellite sites have been identified per impact zone. Month 12, year 3.

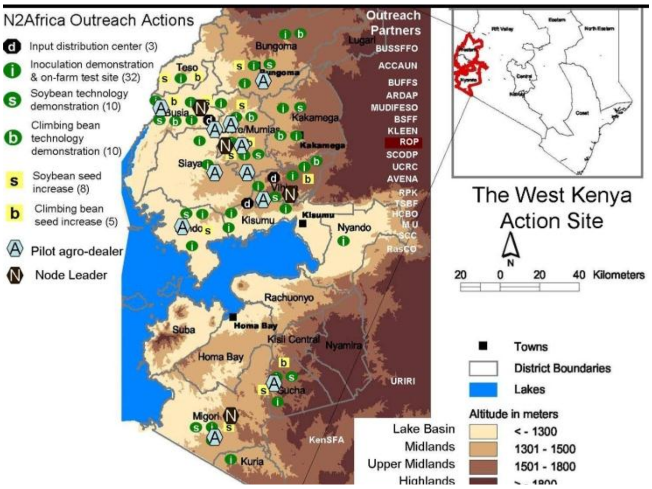


Figure 3.7. Coverage of the West Kenya Action Site by Month 30 of the project.

This milestone is not due until the end of Year 3 but our attempts to initiate Satellite Sites, as defined by new technology development partners not receiving funds from the project, have met with limited success. We sought two new partners, Rural Outreach Project (ROP) and One Acre Fund, and the former joined the project while the latter declined. One difficulty is the comprehensive coverage of cooperators within the Action Site (Figure 3.7). The four node leaders, 25 cooperators and 10 pilot agro-dealers leaves few areas uncovered, and engaging more than one partner in a given location may lead to redundancy. We argue that our largest Satellite cooperator is the commercial alliance of Smart Logistics and Promasidor, and it is through their opportunities opening to Progressing Farmers that the greatest impacts are being achieved. In summary, we currently are engaged with two Satellite partners, Smart Logistics (4500 farms) and ROP (320 farms). It may be that the greater opportunity for Satellite partnership exists away from the Action Site, including in neighboring countries.

Activity 4.2. Produce specific dissemination tools, including inoculant packets, adapted to the needs of farmer groups, agro-dealers, and development partners.

Milestone 4.2.1. At least 1 dissemination tool for each Action Site related to legume and inoculant use is produced per impact zone, resulting in about 24 different tools by the middle of year 3. Month 6, years 2, 3 & 4.

A detailed dissemination tool was developed for the 2012 long-rains in west Kenya introducing eight BNF technologies to farmers that included two new soybean varieties (SC Saga and Squire), effects of inoculating with SC Saga with BIOFIX and inclusion of Zn in the Sympal fertilizer blend. This tool requires only 370 m^2 and established 50 Field Demonstration and Information Centers in seven counties and 16 administrative Districts of Nyanza and Western Provinces and supplied 8000 satellite farmer with "take-away" technology tests (160 tests per field demonstration). The materials contained in the tool appear in Table 3.11. The field design appears in Figure 3.8. Accompanying these materials are 160 two-kg bags of Sympal PKS+ fertilizer. Improved legume seed and BIOFIX inoculant are provided according to cooperator needs as described in the 2012 long rains work plan. The tool also contained a six-step procedure for the on-farm BNF Technology Tests consisting of legume seeds (soybean or climbing bean), 10 g legume inoculant, 2-kg fertilizer (SYMPAL).

1. Prepare an area 200 m^2 according to usual practice (10 m x 20 m).
2. Broadcast 2-kg fertilizer and incorporate with shallow tillage.
3. Plant four 10 m rows of non-inoculated soybean at 45 cm x 5 cm spacing. Mark these rows with a stake.

4. Inoculate the remaining soybean seed using the two-step method.
5. Plant the remaining inoculated seed in 40 rows 45 cm apart at 5 cm spacing.
6. Weed according to usual practice.

Cooperators are expected to return two kg of seed to their node leaders for every one kg they receive from the project. This allows us to bring in additional cooperators next season. All current cooperators

Table 3.11. Materials in the 2012 LR West Kenya Dissemination Tool.

no	item	use
2	2 kg bag of Sympal fertilizer	blanket pre-plant application to demonstration plot
1	575 g Sympal fertilizer +Zn	tests the benefits od adding zinc to Sympal fertilizer
1	One kg bag of urea fertilizer	top-dress application to maize and sorghum plants
1	One kg bag of WS303 maize seed	plant in maize intercropping technologies, kills striga
1	250 g bag of climbing bean seed	plant in adjacent plots as described in protocol
2	1 kg bag of soybean 19 seed	plant in plots as described in protocol
1	1 kg bag of SC Squire seed	plant in plots as described in protocol
1	1 kg bag of SC Saga seed	plant in plots as described in protocol
1	1 kg bag of SC Sila sorghum seed	plant in plots as described in protocol
1	10 g BIOFIX bean inoculant	Inoculate climbing beans, includes adhesive
4	10 g BIOFIX soybean inoculant	Inoculate soybean, includes adhesive
1	B4 labeled white envelope	contains instructions, labels and documents
1	9 page field protocol	instructions for installing field demonstration, includes report forms
1	11 page documentation form	***must be completed and returned ASAP***
12	A4 signs for demonstration	Display during field days ***(some to be delivered later in season)***
160	Soybean production guidelines	Assist in farmer training by Master Farmers

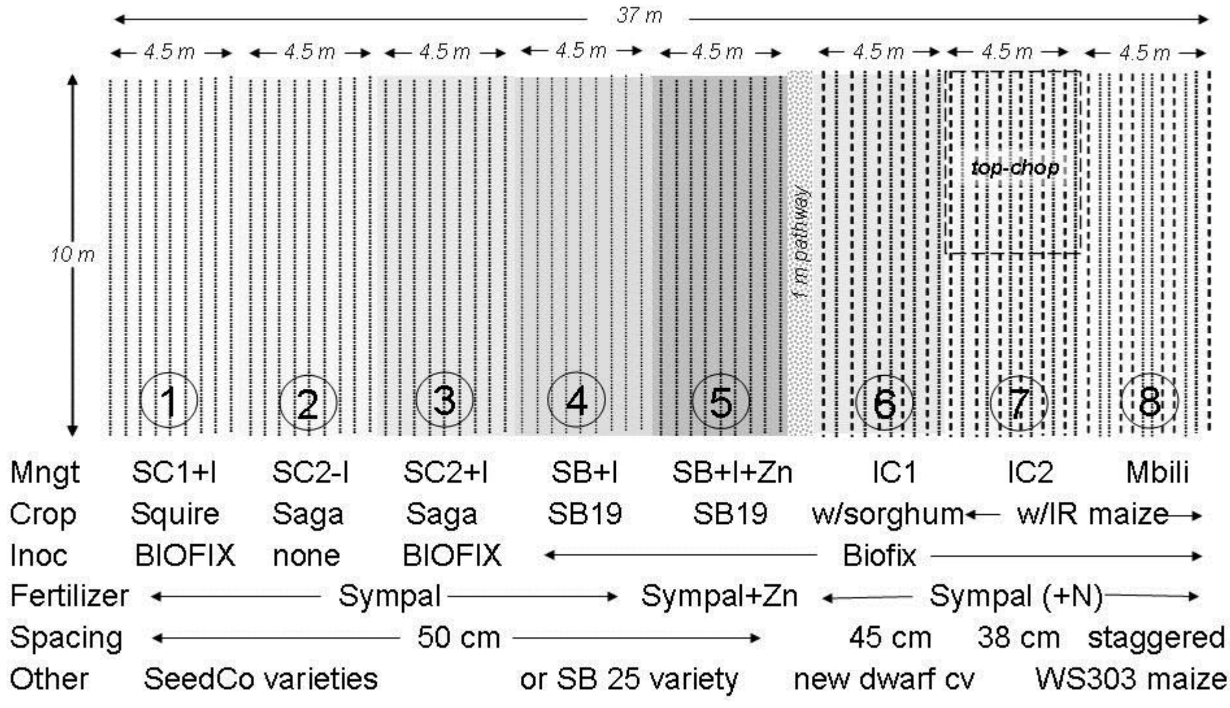


Figure 3.8. Field design of the 2012 LR Dissemination Tool used as the focus of field days later in the season.

are expected to become self sufficient in terms of seed production.

Activity 4.3. Engage with legume seed system, market, and nutrition initiatives operating in the impact zones.

Milestone 4.3.3. At least half of the farming communities engaged in the project are actively linked to legume market outlets. Month 12, year 2.

The project could do little to engage farmers with markets owing to the late disbursement of funds. No funds for market linkage were released to dissemination partners by CIAT-TSBF during the first 23 weeks of the 26 week reporting interval! Nonetheless, momentum from past seasons and our alliance with Smart Logistics resulted in gains. Following the 2011 LR (late 2011), Smart Logistics purchased 45.2 tons of soybean from 691 farmers belonging to 19 partner organizations (79% market linkage). Following the 2011 SR (early 2012), Smart Logistics purchased 217.2 tons of soybean worth about $111,000 from 19 partner organizations (79% market linkage). The project promise to several farmer associations of grain legume processing equipment was not kept owing to delay in funding.

Milestone 4.3.4. At least half of the farming communities engaged in the project are linked to legume processing initiative. Month 12, year 3.

Limited progress was made in the area of legume processing, owing to late disbursement of funds. No funds for country legume processing activities were released by CIAT-TSBF during the first 23 weeks of the 26 week reporting interval! The main focus of legume processing remains soy milk production produced at the grassroots level following a simple five-step procedure using apparatus costing only $55. Briefly, soybeans are washed and soaked, passed through a mincer and mixed with water, pressed between two heavy pots, liquid soymilk and press cake separated, soymilk boiled, packaged and consumed (Table 3.12). This process costs about $.082 for each kg of soybeans, and results in two kg of moist press cake and six liters of soymilk worth a total of $3.77. This slightly diluted soymilk is suitable for making the sweet African tea preferred by many communities and is indistinguishable from that prepared using cow's milk. In West Africa, the same basic procedure is followed except that soaked soybeans are pounded using a large traditional wooden mortar and pestle and "pressed" by wringing the cloth. This procedure is fast, women will typically meet to share the apparatus at a local center and return home after 40 minutes or so carrying soymilk for their families. Alternatively, soymilk may be produced and sold as hot tea alongside other snacks from a kiosk at marketing centers and bus stations.

Table 3.12. A simple five-step procedure for local production of soymilk.

Step	Process	Cost/Value
Step 1: Soak	Wash and soak 1 kg of soybean in 2 l clean water for 4 to 6 hours	- $0.50
Step 2: Mince	Pass 3 kg soaked soybean through mincer, add 5 liters clean water, mix	- $0.24
Step 3: Press	Transfer mince to clean cloth and press between two heavy pots, drain	- $0.08
Step 4: Boil	Filter soymilk, boil for 5 minutes, recover 2 kg press cake for grit or animal feed	+ $0.37
Step 5: Package	Cool and place 6 liters of soymilk in clean container or add tea and sugar and market (consume) as "African sweet tea".	+ $3.40

This soymilk is also lifesaving. For example, ten year-old Jared Andere is one of 15 orphans supervised by a small church in west Kenya. Jared was the most severely malnourished of these children and nearly died until receiving a 10 day treatment including soymilk provided by a N2Africa partner, Josephine Ongoma of Kleen Homes and Gardens. Now, each of these 15 children receive 300 ml of fresh soy milk daily from Josephine's group. Soon thereafter, the children's skin changed from scaly dry to soft and smooth; their hair changed from reddish and brittle to dark, shiny and strong; and their demeanor changed from weak and lethargic to playful, outspoken and energetic. Through the efforts of N2Africa, soymilk literally saved Jared's life and is improving the well-being of many other children.

Activity 4.4. Conduct collaborative legume and inoculant technology dissemination campaigns and create awareness in rural communities in all impact zones.

Milestone 4.4.1. Dissemination and extension process and Proof of Principle in pilot site testing documented. Month 10, year 1.

The Kenya Country Mentor was asked to complete this overdue Milestone Report and did so in March 2011. The report is 22 pages, contains 15 tables and 2 figures and was resubmitted to the Principle Investigator after receiving a detailed review in late April 2012. Milestone 4.4.1 provides a mid-course examination of the dissemination and extension processes and Proof of Principle in pilot site testing. In effect, this requires an evaluation of the project's Vision of Success. This milestone was originally scheduled for Month 10 of Year 1, but this target was later proved unrealistic as only three of eight countries (the ECA Region) had completed their first cropping cycle by then, and three others (the Southern Africa Region) had not yet planted their first season. It was then decided to reschedule the Milestone for the end of Year 2 so that its evidence would be based upon at least one and as many as three cropping cycles per region. This Proof of Principle is first presented within the context of the project Vision of Success, then it is related to the project's original and adjusted dissemination and farmer training approaches and then concludes with a short synthesis and lessons learned. Special attention is paid to the quantitative components of the Vision of Success; legume yield increase, increased BNF, expected improvement of household income and number of target households." Five recommendations appear as follows.

1. Agronomic research must place greater priority in raising the productivity of bean and groundnut so that project targets may be more completely achieved.
2. Measurements of BNF under initial field conditions and improved legume managements remain lacking and this greatly affects our understanding of project impacts. The Legume Agronomy Research team must address this shortcoming immediately and if necessary drop peripheral lines of research in order to do so. Field measurement of BNF should then be correlated with transfer functions and progress in meeting BNF targets recalculated.
3. As households increasingly adopt BNF technologies and grain legume enterprises promoted by the project, it is important that M&E address the new areas falling into cultivation and the economic returns being achieved. This will better allow the project to assess the increased income enjoyed by farmer clients.
4. The project has performed well in meeting most its extension goals but its media events tend to be simplistic and localized. Whenever possible, country teams should better engage with national news media.
5. The project has achieved humanitarian impacts not anticipated in the project proposal and case studies should be launched by the project's M&E team to capture them.

Finally, the report offers a revised Vision of Success based upon two years of project experience and household-weighted calculation of impacts *"To raise average grain legumes yields by 1010 kg/ha in four legumes (soybean, common bean, cowpea and groundnut), increase average biological nitrogen*

Table 3.13. Summary of N2Africa outreach activities in west Kenya from 2010 through Month 30.

Outreach action	2010 Long rains	2010-2011 Short rains	2011 Long Rains	2011-2012 Short rains	2012 Long Rains	Total thru Month 30
Number of on-farm demonstrations	52	35	43	44	50	224
Number of satellite technology tests	1500	1910	4500	8812[3]	12,500[3]	29,222
Number of new households reached	1500	815	4100	4100	8000	18,515
Inoculant deployed (kg)	12	28	122	521	650	1333
Inoculants packets distributed (BIOFIX)	120	1168	4084	10,412	15,500	31,284
Soybean seed distributed (kg)	920	565	3790	49,001[4]	73,000[4]	127 tons
Climbing bean seed distributed (kg)	58	98	85	220	58	519
Fertilizer distributed (t)	3.0	3.8	8.2	70.5[5]	126	85.5 tons
Seed multiplication sites[1]	10	13	19	21	24	87
Master farmers trained[2]	32	0	48	0	0	80
Master farmer manuals distributed	45	0	80	0	0	125
Extension manuals distributed	0	2100	2750	3000	8300	16,150
Articles published/radio shows conducted[6]	0	3	1	9	NR	13

[1] Does not include the two-for-one seed payback system initiated for Year 2 satellite technology tests with the returned seed inspected and bagged for new cooperators. [2] No Master farmer and grain processing training workshops conducted since May 2011 owing to late arrival of funds. [3]Includes 9212 Smart Logistics Satellite Farmers [4]Includes 90,121 kg soybean seed produced by N2Africa cooperators and then sold to Smart Logistic for planting by Satellite and Progressing Farmers. [5]Includes 67.1 tons extended on credit to Satellite Farmers. [6] Includes radio shows over three local FM stations, a bi-monthly article in Migori County Times and a well-attended exhibit at the Migori Agricultural Show during the 2011 short rains. Not reported (NR), no media events in last reporting interval owing to extremely late arrival of funds.

Table 3.14. Nodulation characteristics and grain yield resulting from soybean variety, inoculation with BIOFIX (strain USDA 110) and the addition of zinc to the Sympal fertilizer blend in west Kenya (2011-2012 SR, based on 20 farms, ± SEM).

management	inoculated	fertilizer	variety	nodule number	crown nodulation	red interior	grain yield (kg/ha)
1 SC-I	no	sympal	SC Samba	10 ± 0.5	0.14	0.35	641 ± 20
2 SC+I	yes	sympal	SC Samba	20 ± 0.8	0.45	0.78	1071 ± 39
3 SB19-I	no	sympal	SB19	14 ± 0.4	0.26	0.45	898 ± 31
4 SB19+I	yes	sympal	SB19	23 ± 0.6	0.61	0.57	1024 ± 41
5 SB19+I+Zn	yes	symp+Zn	SB19	27 ± 0.6	0.73	0.59	1345 ± 45

fixation (BNF) by 58 kg/ha, and increase average household income by $226, directly benefiting 300,000 households (2,400,000 individuals) in eight countries in sub-Saharan Africa (DRC, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda, Zimbabwe). Indeed, this project links the protein and nitrogen needs of poor African farmers directly to previously inaccessible, massive atmospheric reserves, provides them with new income-generating crop production enterprises, presents a mechanism of renewable soil fertility management, opens the door to the adoption of numerous, profitable accompanying farm technologies and value-adding enterprises and contributes to humanitarian goals among Africa's poorest and most vulnerable". For more information, see Milestone 4.4.1. Report.

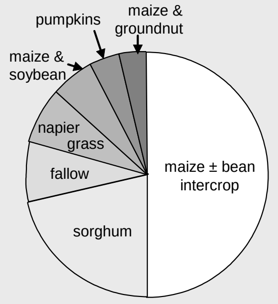
Milestone 4.4.2. Large-scale demonstration and dissemination campaigns held in each impact zone. Month 6, all years.

A large-scale demonstration and dissemination campaign was conducted in west Kenya during the 2011-2012 SR (September 2011 to January 2012) and another launched during the 2012 LR (starting in March 2012). During the 2011-2012 SR; 44 on-farm demonstrations were conducted leading to 23 farmer field days, we worked with 8812 farm households to plant over 49 tons of seed using 71 tons of fertilizer and 10,412 packets of inoculant containing 521 kg (Table 3.13). Characteristics of the 8000 New Farmers are presented in Box x. Results from these field demonstrations suggest that (Table 3.14): 1) SC Samba slightly outperforms SB 19 (our previous best-bet) by 5%, 2) inoculants increase yield for both specific (+67%) and promiscuously nodulating varieties (+14%), 3) Zn fortification of Sympal results in higher yields (+31%). During the past short rains, legume yields are considerably reduced compared to the previous 2011 LR (-39%, based on performance of inoculated SB 19). Increases were noted in response to inoculation of both specific and promiscuous varieties in nodule number (+79%), crown nodulation (+163%) and red interior pigmentation (+68%) (Table 3.14), suggesting enhanced BNF due to inoculation of soybean. Cereal-legume intercropping managements did not perform very well during the 2011-2012 SR owing to late season drought (data not presented). Characteristics of new farms entering the project in the 2011-2012 short rains growing season are presented in Figure 3.9.

Figure 3.9. Characteristics of new farms entering the project in the 2011-2012 short rains growing season.

Women farmers	60%
Household size	6 persons
Average farm size	2.2 acre (0.88 ha)
Striga infestation	84%
Strong interest in …	
Soybean	100%
Climbing bean	63%
Other legumes	42%

Land use prior to installing BNF TechnologyTest



A two-day outreach planning meeting for the current 2012 LR season was held at the Maseno Club, Western Kenya during15 and 16 February 2012 and attended by 38 persons. Detailed plans were made for all dissemination goals but were undercut by failure of TSBF-CIAT to provide promised funds in a timely manner. Nonetheless, we were able to install 50 on-farm demonstrations leading to 25 farmer field days, work with 12,500 farm households to plant over 73 tons of seed using 126 tons of Sympal fertilizer and 15,500 packets of inoculant containing 650 kg (Table 3.13). A detailed report on this 2012 LR planning meeting is available from the Kenya Country Mentor (plwoomer@gmail.com). These accomplishments despite a late release of funds by CIAT-TSBF to cooperators were achieved because 1) most cooperators are now self-sufficient in seed, 2) TSBF-CIAT purchased fertilizer and inoculants and arranged for shipment to Node Leaders, 3) our strong linkage to Smart Logistics soybean marketing operations and 4) the Kenya Country Mentor personally paying $3125 (= KSh 10,000 per cooperator) to allow for these inputs to be distributed to farmers and the installation of demonstrations.

Milestone 4.4.3. At least 3 extension events (e.g., field days, exchange visits) organized per season per country. Month 9, all years.

Our focus continues to be placed on farmer field days with 23 events held at the conclusion of the 2011-2012 SR between 8 and 30 December. These field days attracted 2443 participants, 91% of whom were farmers (51% women). On average, these events cost $245 each and attracted 106 participants. In addition to farmers, these field days were attended by 17 participants from the private sector, 24 government officers and 64 staff from NGOs. The most popular exhibits included grain legume technologies, inoculation and new legume varieties. Most of these field days (70%) had exhibits prepared by and specifically targeting women farmers and homemakers. The most frequently encountered problem was poor or late participation (35%), often due to late rains (13%), and the failure of planned exhibitors to participate (13%). Suggestions for improvement include arranging for more and different exhibits (30%), better mobilization of local communities (22%) and offering greater incentives to participants (17%) through prize-giving and contests. Plans are under way to also participate in two Provincial Agricultural Shows, Kisumu and Kakamega) planned for the end of the current season.

Milestone 4.4.4. At least 3 mass media events (e.g., radio programs, video documentaries) organized per hub. Month 12, all years.

Five media events were conducted during the past six months in west Kenya (November 2011 through April 2012). These media events take the form of four local radio talk shows and a biweekly local newspaper column, and this format appears to reach the right audience for little or no money. However, project achievements are newsworthy in themselves, and the Kenyan team should make a better effort to access local news coverage

Activity 4.5. Develop strategies for empowering women to benefit from the project products.

Milestone 4.5.2. A report documenting the involvement of women in at least 50% of all farmer-related activities produced. Month 9, years 2, 3 & 4.

It is uncertain which project partner is compiling information on this recurrent milestone as no requests for information were received over the past six months (attention M&E Specialist). Nonetheless, information on women's involvement continues to be compiled. During the 2011-2012 SR season, 60% of New Farmers conducting BNF Technology Tests were women (based on a sub-sample of 1624 farmers). Of farmers attending field days, 51% were women (see Milestone 4.4.3).

Milestone 4.5.3. At least 2 special events on the role of legumes in household nutrition and value-added processing conducted per country. Month 12, all years.

Sixteen special events relating to women's empowerment were conducted during the past six months, all in conjunction with farmer field days. These events included skits and poems performed by women (6%), legume variety appreciation (13%), local cooking contests (25%) and exhibition of value addition (56%). In

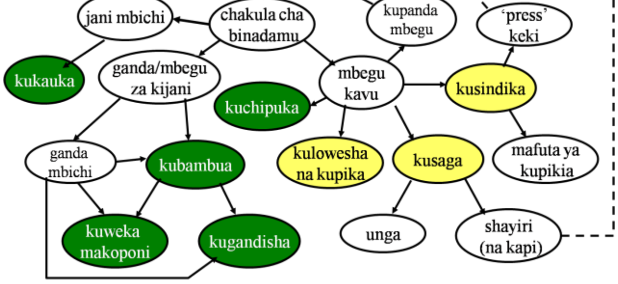


Figure 3.10. Local processing options of grain legumes drawn from the extension manual prepared in Kiswahili.

addition, an extension publication describing grain legume processing written in Kiswahili was printed and 2000 copies distributed in west Kenya ("*Kijitabu cha Usindikaji wa Nafuka Jamii Kundi"*, P.L. Woomer and W. Mulei, 2011, A5 size, 20 pp). This publication included post-harvest handling, value addition (Figure 3.10), nutritional information, recipes and a glossary. We were forced to suspend additional planned value-added processing activities at the grassroots-level due to delayed release of funds by TSBF-CIAT.

Objective 5. Develop and strengthen capacity for BNF research, technology development, and application.

Activity 5.2. Advanced training to MSc and PhD level of an elite young cadre of African scientists focused on topics filling identified knowledge gaps and operationalization of a gender-sensitive participatory monitoring and evaluation framework.

Milestone 5.2.1. At least 14 MSc and 7 PhD candidates selected for training from the impact zones. Month 6, year 1.

Five MSc students are affiliated with the project in Kenya. Ms. Maureen Waswa has completed her coursework and is actively screening NAK isolates for effectiveness on soybean in the MIRCEN greenhouse. Her work has already led to identification of four candidate elite strains for field testing and exchange with other laboratories (see Milestone 3.1.3). Two other MSc students are funded through the project. Ann Wekesa is conducting MSc studies at the University of Nairobi on identification and characterization of rhizobia. John Okoth Omondi is enrolled in Egerton University and is examining the effect of tillage on midseason drought on soybean in Western Kenya. He has completed his field work and is now writing his thesis. Samuel Mutuma is a seconded student at the University of Nairobi under AGRA scholarship. His research title is "*Farmer Perceptions, Adoption and Profitability of Biofix Inoculant Package on Soybean (*Glycine max*) Production in West Kenya*"**.** His surveys are now completed and will be conducted later this growing season. Calvince Ouko Othoo is a self-funded student interested in inoculation technology of bean and will commence his laboratory and field research in June 2012 following acceptance of a draft thesis proposal.

George Mwenda was recently accepted as a PhD candidate by Murdock University, Perth, Australia. He plans to conduct biodiversity studies using strains from the MIRCEN NAK collection and departs in May or June 2012. His leadership and hard work in the MIRCEN laboratory will be missed, and plans should be made to replace him ASAP.

Activity 5.3. Training-of-trainers workshops on legume and inoculant technologies for agricultural extension workers, NGO staff, and agro-dealers.

Milestone 5.3.2. At least 8 training-of-trainers workshops (1 workshop in each country), attended by at least 40 farm liaison staff, conducted on inoculation technology and legume agronomy. Month 10, years 2 & 3.

No training of Master Farmers was conducted during the past six months owing to excessive delay in the release of funds by CIAT-TSBF to project dissemination partners in west Kenya. No funds for Master Farmer training were released to dissemination partners by CIAT-TSBF during the first 23 weeks of the 26 week reporting interval! It is very important that this training be held so that the ratio of New Farmer to Master Farmer be narrowed. Plans to train an additional 100 Master Farmers are underway and will be described in the next report (Year 3).

Activity 5.4. Training workshops on legume and inoculant technologies for officers of farmer associations and community-based organizations.

Milestone 5.4.2. At least 2 grass-root training events organized by each of 320 to 640 trainers across all impact zones, with an expected attendance of 50 farmers per event [resulting in 51,000 farmers trained during year 3 and 132,000 during year 4]. Month 12, years 3&4.

No training of farmers at the grassroots level was conducted during the past six months owing to excessive delay in the release of funds by CIAT-TSBF to project dissemination partners in west Kenya. No funds for farmer training were released to dissemination partners by CIAT-TSBF during the first 23 weeks of the 26 week reporting interval! Nonetheless, we included training farmer materials into the BNF Technology test kits distributed to cooperators and informal training was offered at farmer collection points.

Milestone 5.4.3. At least 30 agro-dealers in each hub are trained in accessing, managing and distributing information on inoculant use each year [270 trained agro-dealers by year 4]. Month 10, years 2, 3 & 4.

A two-day training was organized by CIAT-TSBF, conducted at Maseno Club Hotel from 27th to 29th November 2011 and facilitated by scientists from MEA Ltd. and the Ministry of Agriculture. It was attended by 40 invited agro-dealers from west Kenya, including the area covered within the N2Africa West Kenya Action Site (Table 3.15). Financial support for this training was provided through several projects of CIAT-TSBF, including N2Africa. Facilitators included Dr. Paul Woomer, Dr. Roing, Mr. Wycliffe Okumu (DAO/Ministry of Agriculture Maseno) Mr. Charles Kamidi (Agrodealer/AGMARK trainer), Ms Teresa Wafula (MEA Ltd), Dr Fred Baijukya (CIAT Maseno), Mr. John Mukalama (CIAT Maseno), and Laban Nyambega (CIAT Maseno).

A rapid survey was made of the participating agro-dealers (Table 3.16). A majority of those in attendance were men who owned their businesses although 30% of agro-dealer participants were women. On average, participants had been in business for slightly over 7 years. Most fertilizers marketed contained nitrogen although 13% marketed superphosphates. Very few marketed lime. A majority market IR maize seed (to kill striga) and bean seed, many market soybean seed but few sell groundnut seed. Most sell seed in small packages and bags, but 10% market seed in sacks 10 kg or larger. Many agro-dealers stock BIOFIX inoculant but few refrigerate it. Stockists are well linked to extension agents, local NGOs and farmer groups and communicate with regulators. Most have received past training and 80% are certified by AGMARK. Credit relations vary, with 40% of agro-dealers receiving bank loans and 63% receiving inputs on credit from suppliers. Most agro-dealers extend inputs on short-term credit. Most agro-dealers seek further training, but few seek additional credit and equipment. These findings are preliminary, and based on a small sample, but offer direction to further enquiry. That so many stockists sell grain legume seed and inoculant at this stage of project activities is a very promising sign. A mechanism was established that connects these agro-dealers to MEA Fertilizers through the Western Chapter of the Kenya National Agro-Dealer Association and this activity will be covered in the next report.

Activity 5.5. Provide training, educational and extension resource materials to support activities 5.1 – 5.4.

Milestone 5.5.3. Support for undergraduate and postgraduate education will be provided through access to long distance education programs, visiting professorships or adjunct appointments in the area of N2 fixation at 25 African Universities, and the provision of resource materials to assist in course planning and evaluation. Month 12, year 2.

Table 3.15. Agro-dealers present at the two-day CIAT-TSBF training.

Name	Sex	Business	Location
Shem Luonga	M	Malaha Agrobusiness	Malaha
Charles Maulo	M	Bunyala Self Help Group	Malaha
Oscar Waudo	M	Navaholo Agro Business	Navaholo
Mary N Matsi	F	Bunyala Self Help Group	Malava
William Simiyu	M	Sincere Wish Iii Nderema	Nderema
Joshua Onyango Okoth	M	Evapa Agro Vet	Migori
Owino Valentine	M	Valentine Agrovet	Luanda
Herbert S.Luseno	M	Mumias Agrocare	Mumias
George Otieno Okwaro	M	Mamanox Agrovet	Yala
Jane Khaugani	F	Bumu Agrovet	Butere
Lawrence Ngongo	M	Mtulivu Farmlet Spot	Butere
David George Mukabi	M	Farmers Centre	Khwisero
Raymond T O Obondo	M	Racel Agrovet	Daraja Mbili
Vincent Ogola	M	Cropset Centre	Nyadorera
Florence Ambasa	F	Lela Farm Care	Lela
Alex O Magaga	M	Hagonglo F I Store	Ndori
Francis O Akello	M	Fips Africa	Siaya
Antony Rading	M	Rads Agrovet	Bondo
Benedicto Joseph Rading	M	Rads Agrovet	Bondo
Wesonga Rose	F	Rab Agrovet	Funyula
Clare Mukabanah	F	Agrowvet	Mumias
Elizabeth Wangila	F	Musale Agrovet	Webuye
Nelson Ogombe	M	Rafiki Wa Mkulima	Ngiya
Veronica Omito	F	Yala Farmland Store	Yala
William Ejakait	M	Teso Cbo	Teso
John Mungai	M	Giathi Vet Enterprises	Busia
Fredrick Ochieng Odongo	M	Froma Agrovet	Ugunja
Margaret Ogare	M	Yenga Farmers Centre	Yenga
Teresa Wafula	F	Mea Ltd	Nakuru
Jeremiah O Obure	M	Ravs Agrovet	Emuhaya
Seline Ogola	F	Selibo Agrovet	Siaya
Jonah Andanje	M	Huduma Agrovet	Kakunga
Moses Chamwada	M	Kesopa	Migori
Iresa M Samson	M	Mwanainchi Agrovet	Kehancha
Felix Onyango	M	Lucky Vet Services	Ndori
Albert Alumasa	M	Chama Agrovet	Mbale
Joan Okello	F	Ugunja Agrovet	Ugunja
Charles Khamidi	M	Mavuno Agrovet	Kakamega
Apollp Khabeko	M	Luanda Agrovet	Luanda

Table 3.16. Characteristics of agro-dealers present at the training workshop.

AD owner	90%
AD employee	10%
AD women	30%
Years in business	7.2
Markets DAP	90%
Markets CAN	90%
Markets urea	87%
Markets organics	20%
Markets TSP	13%
Markets SSP	13%
Markets foliar feed	13%
Markets NPK	13%
Markets lime	3%
Markets IR maize seed	73%
Markets bean seed	70%
Markets soybean seed	30%
Markets groundnut seed	7%
Markets seed < 1 kg packages	97%
Markets seed 1-2 kg bags	60%
Markets seed > 10 kg sacks	10%
Markets BIOFIX inoculant	17%
Has access to refrigeration	23%
Stores inoculant in refrigerator	3%
Linked to local extension agent	90%
Linked to local NGO	93%
Linked to local farmer group	97%
Linked to regulators	93%
Received past training	93%
Certified by AGMARK	80%
Receives bank loan	40%
Receives credit from suppliers	63%
Extends credit to customers	90%
Requires training	73%
Requires credit	37%
Requires additional equipment	10%

The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) is organizing its Biennial Conference on "*Strengthening Innovation Capacity, Adaptiveness and Responsiveness for Improved Livelihoods*". The conference will take place from 24–28 September 2012 in Entebbe, Uganda. The RUFORUM is a network of 29 universities in the Eastern, Central and Southern Africa (ECSA) region. It is a strategic network that works with stakeholders of agriculture and agricultural tertiary education in the ECSA region to build the innovative capacities of universities to engage with development processes in agriculture and related domains through effective training, research and outreach. The meeting will attract over 300 participants from more than 30 countries representing all continents. N2Africa plans to participate in this conference by presenting a presentation on opportunities posed by Milestone 5.5.3 and maintaining an exhibit where African universities can request specific training and research material from our project. In this way, we expect to reach the targeted number of universities. The results of this effort will be included in the Year 3 report.

Milestones 5.5.4. Training programs will organized in collaboration with selected private sector partners in each of the mandate zones for various categories of staff in key aspects of inoculant production and quality control. Month 3, year 3.

No contact was made by the Capacity Building Specialist requesting the involvement of MIRCEN or MEA Fertilizers Ltd, in this regard. When queried about their plans, the newly arrived Training Officer stated that there are no funds available for this purpose, something we dispute on inspection of the project's budget. In any event, the Rhizobiology team in Kenya stands prepared to assist in the completion of this overdue milestone, particularly with regard to our advances in inoculant quality assurance (see Milestone 3.3.2).

Milestone 5.5.5. Web-based support will be provided on key N2 fixation methodologies and techniques, the maintenance and trouble-shooting advice for scientific equipment used in BNF research, and N2 fixation extension materials for download and modification for local condition. Month 12, year 3 & 4.

The first phase of this recurrent milestone is due at the end of October 2012. As yet we have not heard from the project's IT Specialist, Capacity Building Specialist or Training and Information Officer in this regard. As it stands, the Kenyan team has three software utilities (MPNES, N2Africa Rhizobium Data Base and N2Africa Quality Assessment Utility), one training manual (Master Farmer Training in Biological Nitrogen Fixation and Grain Legume Enterprise, 184 pp, 14 files requiring 18 mb) and five farmer extension manuals ready to be uploaded. In some cases, it is necessary to modularize and hyperlink these files for ready access over the internet. Some of these materials were recently shared with the newly arrived Training and Information Officer and we look forward to seeing them more widely available.

Revised work plan

To date, the Kenya Country Team has remained abreast of all project milestone tasks and reporting requirements, even when funds are late arriving.. For this reason, our work plan during the final "16 month" Year 4 is described by the project document and, with stronger collaboration with Work Stream Leaders and restoration of funds for outreach sub-contractors, we foresee completion of all milestone tasks by October 2013.

Risk and mitigation

The largest risk to project success in Kenya continue to be late release of funds and overly-rigid administrative procedures by CIAT-TSBF. No funds were released to dissemination partners for the first 23 of the 26 week reporting period. This resulted in suspension of many M&E and outreach activities relating to Milestones 1.5.2, 4.3.3, 4.3.4, 4.4.4 and 4.5.2. Difficulties in working with CIAT-TSBF administrators have been raised in past reports. *Over the past six months, the Country Mentor and Node Leaders maintain essential project outreach actions through using funds diverted from other projects and their personal finances, but this is a stopgap measure at best.*

There may be no effective outreach actions by dissemination partners during the final 16 months of the project owing to an unexplained withdrawal of funding commitment. A recently circulated "final" project budget was recently circulated that omits funds for Kenya dissemination partners in Year 4. We immediately responded that Year 4 consists of two growing seasons in Kenya that recruits 16000 farmers through 24 FAs and 4 Node Leaders, and funds were required by partners to do so. Funds are also essential for achieving targets in women's empowerment (Milestone 4.5.2), legume value addition (4.3.4), and in conducting extension and media events (Milestones 4.4.3 and 4.4.4). This same budget places DR Congo in a similar situation as Kenya, but not Rwanda and Zimbabwe (also administered by CIAT-TSBF). Our most important activities are in farmers' fields, and within their local associations as they transition into market forces, and we are expected to learn important lessons from this trajectory. *We must correct Year 4 budget in Kenya (and DRC) to reflect this reality. In the original project budget, more funds were allocated to dissemination with time, and proportionately more of that was allocated to partners (sub-contractors). Recently this strategy has changed, and this will likely result in D&D shortcomings as the project moves towards its exit strategy which leaves partners able to promote BNF technologies beyond the project cycle.*

For reasons never explained, little progress is being reported on the long-overdue Milestone 1.4.2 that provides a quantities baseline to BNF in farmers' fields. We cannot achieve our full Vision of Success without this information, combined with similar measurements of our best BNF technologies. *The Research Work Stream Leader and the Legume Agronomy Leader must place greater priority on quantifying BNF in farmers' fields.*

Updated administrative information

Dr. Ken Dashiell left as Project Leader in February. Alastair Simmons for the moment acts as his replacement. Dr. John Musioka has joined CIAT-TSBF as the replacement Training and Information Officer. He provided some of the information on Kenyan graduate students used in this report (Milestone 5.2.1) and is liaising with the Regional Universities Forum to engage Kenya in Milestone 5.5.3.

Appendix 3.1. Performance in quantitative goals during the 30 month reporting period by the N2Africa team in the West Kenya Action Site.

Goal	Unit	Source	Expected	Realized	Achievement	Comment
Reach rural households by month 30	no	Activity 1.2	21000	29222	139%	Includes 4500 SL Satellite Farmers
Increase legume grain yield	kg/ha/se	Vision Statement	954	334	35%	Based on 2011 Short Rains soybean yields
Increase legume grain yield	kg/ha/yr	Vision Statement	955	1174	123%	Based on annual two season soybean yields
Increase household income	$/yr	Vision Statement	465	68	15%	Assumes $0.52 per kg, LR & SR yield on 0.2 ha
Increase BNF by grain legumes	kg	Vision Statement	46	23	50%	Estimated from SR yield increase, seed N, NDF & NHI
Increase BNF by grain legumes	kg	Vision Statement	47	71	151%	Estimated from annual yield increase, seed N, NDF & NHI
Engage Action Sites (communities)	no	Milestone 1.2.1	10	25	250%	Assumes each community is an Action Site
Conduct market analysis of inoculants	no	Milestone 1.3.3	1	1	100%	Market analysis submitted to M&E Specialist
Identify promising soybean varieties	no	Milestone 2.2.1	1	4	400%	Varieties SB 19 & 25, SC Saga and Squire
Identify promising bean varieties	no	Milestone 2.2.2	1	1	100%	Climbing bean cv Kenya Tamu
Explore tree & forage legumes	no	Milestone 2.4.1	2	2	100%	Calliandra & lablab leading candidates
Conduct adaptive reserarch campaigns	no	Milestone 2.5.1	3	3	100%	Soybean inoculation, PKS+ fertilizers, bean staking
Conduct MPN counts	no	Milestone 3.1.2	50	24	48%	Excludes MPNs from Rwanda & DRC soils
Isolate and screen native rhizobia	no	Milestone 3.1.3	250	208	83%	Excludes 80 isolates prepared from DRC & Rwanda
Select candidate strains for field testing	no	Milestone 3.1.3	12	9	75%	5 for soybean, 4 for bean examined in 2012 LR
Develop QA atandards and logo	no	Milestone 3.3.3	1	1	100%	candidate logo and grading standards distributed
Upgrade rhizobiology laboratories	no	Milestone 3.4.2	1	1	100%	Lab and greenhouse operating in UoN MIRCEN
Commercialize inoculant distribution	no	Milestone 3.4.3	12500	15500	124%	50% of hub target 25000/yr over six months
Develop dissemination tools	no	Milestone 4.2.1	4	5	125%	Soybean, climbing bean, seed, soymilk and PH packages
Communities produce improved legume seed	%	Milestone 4.3.2	50%	64%	128%	16 cooperators produced 73 tons of seed
Communities linked to legume markets	%	Milestone 4.3.3	50%	79%	158%	19 groups marketed 217 tons of grain
Conduct three extension events per season	no	Milestone 4.4.3	3	23	767%	23 demonstrations hosted field days
Conduct three media events per year	no	Milestone 4.4.4	3	5	167%	Includes 4 FM radio broadcasts & newspaper column
Involve women in all farmer-related activities	%	Milestone 4.5.2	50%	60%	120%	975 women of 1624 New Farmer sub-sample
Conduct annual events on human nutrition	no	Milestone 4.5.3	1	4	400%	4 cooking contests (9 FD exhibits not included)
Train technical staff in rhizobiology	no	Milestone 5.1.2	3	0	0%	No technician training organized by Objective 5 team
Train MSc candidates	no	Milestone 5.2.1	2	5	250%	Coursework complete, all starting their research
Train PhD candidate	no	Milestone 5.2.1	1	1	100%	G. Mwenda accepted by Murdock U, WA
Conduct Master Farmer workshops	no	Milestone 5.3.1	40	0	0%	No funds released for Master Farmer Training
Conduct grassroots training	no	Milestone 5.4.1	8000	8000	100%	160 BNF Technology Tests per 50 demonstrations
Train agro-dealers in BNF products	no	Milestone 5.4.3	10	47	470%	Conducted in November 2011 in Maseno
Overall average (%)	%				157	Simple overall average

4. Malawi Country Report on Month 30 of the N2Africa Project

Prepared by Anne Turner, Joseph Mhango and Gloria Kasongo[1] N2Africa/IITA-Malawi

Summary

This report covers N2Africa project activities in Malawi from November 2011 through April 2012. It is structured by project Objectives, Activities and Milestones relevant to this reporting period. Since the growing season Malawi does not end until June, many of the results presented are preliminary and will only be confirmed in early July, when all data have been analyzed and partners have submitted their final reports for the season. Nevertheless, some observations can be and are presented. A very late start of the rainy season (end December 2011) as well as prolonged mid-season drought in many areas of Malawi where we are working had an adverse impact on growth and most likely yield of all four legume crops included in our activities (soybean, groundnut, bean and cowpea). High incidences of pests and diseases in many areas, exacerbated by the drought, also reduced crop growth and productivity. Nevertheless, farmers working with us in both agronomy and delivery and dissemination (D&D) trials generally expressed a keen interest in many of the legume technologies used in trials. Agro-dealers, who were brought on board for the first time this season similarly found the soybean technologies which they are demonstrating to be positive innovations. Having the agronomy trials implemented by N2Africa staff rather than partners appears to have corrected the problems encountered last year (trials implemented late, poor attention to their management and data collection, etc.) and we anticipate having reliable agronomy trial results this season. Increasing the number of farmers involved in the D&D trials did pose a logistical challenge, with the result that in some places the trial protocols were not followed correctly. The severe fuel shortage which has been prevailing in Malawi for over one year made it challenging for both the N2Africa team and our partners to get out to the field as often as we would have liked, to monitor activities on the ground. At a review meeting convened in late April, however, partners expressed only interest in future work and all resolved to find ways around the fuel shortage next season. One very interesting development which occurred over this reporting period was the beginning of some serious work under Objective 3, rhizobiology. Soybean nodules were collected and bacteria from same isolated. An MSc student pursuing a rhizobiology topic for her research work received hands-on training from an American PhD student attached to IITA-Malawi. Plans have been drawn for achieving the Objective 3 milestones and for the first time the Malawi N2Africa team has hope of some success in rhizobiology. Another positive development was that legume seed was “repaid” to the community by 66% of the farmers for distribution to new beneficiaries, although the amounts to be repaid were in many cases not respected. Finally, several farmers undertook initiatives of their own planning, from “trials” of treatments not included in the N2Africa protocols to taking over the role of extension agents where the latter did not perform their duties responsibly.

Objective 1. Establish a baseline of the current status of N2-fixation, identify niches for targeting N2-fixing legumes in the impact zones, M&E and impact assessment.

Activity 1.3. Identify new opportunities for targeting legume technologies to increase BNF and enlarge the area under the priority legumes.

Milestone 1.3.2. New opportunities identified prior to each new cropping season. Month 3, years 2, 3&4.

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[1] Assistance provided my N2Africa M&E Specialist Judith de Wolf is gratefully acknowledged.

[2] Farmers in Malawi call all soybeans “soya” – they are not aware there are more than one “variety” of the crop

[3] Given that cowpea is grown primarily for household consumption in Malawi, it is not surprising that taste is the primary characteristic of interest.

[4] We would have liked to train more agro-dealers, however the funds available for this activity in the budget resulted in our being limited to just 13.

[5] The government’s lifting of an export ban on soybean – with the huge demand in neighboring

Sympal fertilizer, imported to Malawi from MEA/Kenya, appears to have boosted root growth and number of nodules formed from informal evaluation conducted on D&D trials with soybean.

Objective 2. Select multi-purpose legumes (food, fodder, stakes, and soil fertility management) for enhanced BNF and integrate these into farming systems.

Note: Due to the failure of the 2010/11 agronomy work to yield any valid results in Malawi, trials to address this milestone are being repeated this season, and are reported under Objective 2 below. Trials this season were implemented entirely by the N2Africa Malawi team (due to very poor results achieved with partners last season).

Activity 2.1. Identify and field test best varieties of soybean for high N2-fixation capacity and adaptation to abiotic and biotic stresses.

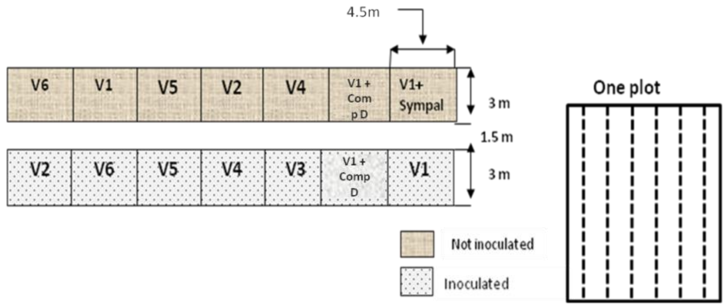
Milestone 2.1.2. At least 3 new soybean varieties with high BNF potential identified. Month 12, year 2. Seven soybean variety trials were established in the 2011/12 growing season, covering three districts in Malawi's Central Region, with the goal of assessing varietal performance in heterogeneous environments (soil types, rainfall patterns and elevation) as well as their response to inoculation. Trial design was split plot so as to test two sources of variation: the variety and inoculation treatment. One replication typically consisted of two strips, each with seven plots/treatments which were the different varieties (or variety-fertilizer combination). These were the sub-plots, the main plots in the split design layout were the 2 strips and their variation was the inoculation, one strip was inoculated while another was not inoculated. A third layer of variation was added by setting the trials in different agro ecological zones. The table below shows the treatment structure as well as the field designs of the trials in detail:

Table 4.1: Treatment structure for soybean variety trials:

Plot	Legume	Variety	Inoculant	Fertilizer*
1	Soybean	Tikolore** (IITA)	With	TSP (105kg/ha)
2	Soybean	Solitera (SeedCo)	With	TSP (105kg/ha)
3	Soybean	Makwacha (SeedCo)	With	TSP (105kg/ha)
4	Soybean	Soprano (SeedCo)	With	TSP (105kg/ha)
5	Soybean	Nasoko (NARS)	With	TSP (105kg/ha)
6	Soybean	PAN1867 (Pannar Seed)	With	TSP (105kg/ha)
7	Soybean	Tikolore (IITA)	With	Compound D (100kg/ha)
8	Soybean	Tikolore (IITA)	Without	TSP (105kg/ha)
9	Soybean	Solitera (SeedCo)	Without	TSP (105kg/ha)
10	Soybean	Makwacha (SeedCo)	Without	TSP (105kg/ha)
11	Soybean	Soprano (SeedCo)	Without	TSP (105kg/ha)
12	Soybean	Nasoko (NARS)	Without	TSP (105kg/ha)
13	Soybean	PAN1867 (Pannar Seed)	Without	TSP (105kg/ha)
14	Soybean	Tikolore (IITA)	Without	Compound D (100kg/ha)

*Compound D=8:18:15, TSP=0:46:0
**Tikolore is the Malawi name given to TGX-1740-2F

Figure 4.1: A sketch of the field layout Design for one replication of the soybean variety trial. All trials followed the skeleton of this layout:



To provide a meaningful blocking effect as well as to reduce the risk of losing a lot of data, most trials were split by replication and each replication was given to a different farmer. The trials were set up in the districts of Dedza, Lilongwe and Salima and were directly managed by the local N2Africa team without partners, due to poor performance of the partners engaged over the 2010/11 growing season. In Lilongwe and Dedza, the trials were planted in late December 2011 and early January 2012, as opposed to normal practice in Malawi (farmers normally plant in early December). This was due to a dry spell that prevailed in December in most of the impact zones. In Salima District, the dry spell persisted until late January so some trials were planted mid to late January. All trials were farmer managed using recommended local crop management practices, and followed with close supervision by the N2Africa Research Officer and locally hired technicians (Extension Staff and independent consultants).

The original plan was to include the specially formulated (by MEA in Kenya) legume fertilizer “Sympal” in some of the trials, however a mix-up in the N2Africa storage facilities resulted in all Sympal being sent out for use in the Delivery &Dissemination trials prior to the commencement of the rainy season. Fertilizer (TSP or Compound D) was applied two weeks after emergence in all trials and agronomic data was collected in accordance to N2Africa agronomy data templates. All data collected will be analyzed centrally by the N2Africa agronomists based in Kenya and Wageningen University in the Netherlands. This includes data on germination rate, average nodule counts, biomass yields (this included weighing biomass fresh weights, sampling, drying and determining the fresh to dry matter ratio to determine yield and grinding samples in readiness for further analysis in Kenya), pest and disease incidence records as well as yields. Soils were also sampled from all these trials for normal NPK analysis and testing for the need-to-inoculate under objective 3.

Most trials reached physiological maturity in April and harvesting started towards the end of the month. GPS data has been collected for all these trials for easy location. There is currently no GIS software within N2Africa-Malawi to help in mapping out this spatial data and relating it to the agronomic data collected to make sense of the performance of the trials in the different agro ecological zones. This will hopefully be done centrally within the larger N2Africa community.

Milestone 2.4.2. Sufficient planting materials are available for at least 2 multipurpose tree legumes and 4 forage legumes with high BNF capacity that have been identified across the impact zones. Month 12, year 2.

Not applicable to Malawi as decision was taken by other members of the N2Africa team not to conduct this activity here.

Activity 2.5. Identify best-fit agronomic practices for maximizing potential benefits of legume and inoculant technologies on increasing and stabilizing productivity.

Milestone 2.5.1. At least 9 adaptive [impact zone-specific] research campaigns focusing on major gain legume (soybean, cowpea, groundnut, beans) implemented in the impact zones. Month 6, year 2. Input trials were set up under this activity for the four different mandate crops in the three impact zones selected in Malawi. Four input trials were set up for soybean, three for groundnuts, three for cowpea and 2 for common beans. All these trials employed a split plot design that had two main sources of variation that were of particular interest; for cowpea and groundnuts, the main treatment was the variety with the sub treatments being fertilizer types (and, for groundnut, additional of gypsum) as determined by pre-designed protocols prepared by the N2Africa agronomist.

Table 4.2: Treatment structure for Groundnut and Cowpea input trials.*

	Legume	Variety	Fertilizer
1	Groundnut	CG7	None
2	Groundnut	CG7	TSP (105kg/ha)
3	Groundnut	CG7	Compound D (100kg/ha)
4	Groundnut	CG7	TSP plus Gypsum (Gyp; 250kg/ha)
5	Groundnut	CG7	Super D (100kg/ha)
6	Groundnut	Nsinjiro	None
7	Groundnut	Nsinjiro	TSP (100kg/ha)
8	Groundnut	Nsinjiro	Compound D (100kg/ha)
9	Groundnut	Nsinjiro	TSP plus Gypsum (Gyp; 250kg/ha)
10	Groundnut	Nsinjiro	Super D (100kg/ha)
11	Cowpea	Sudan 1	None
12	Cowpea	Sudan 1	TSP(100kg/ha)
13	Cowpea	Sudan 1	Compound D(100kg/ha)
14	Cowpea	Sudan 1	Super D(100kg/ha)
15	Cowpea	IT 16	None
16	Cowpea	IT82E	TSP (100kg/ha)
17	Cowpea	IT 16	Compound D (100kg/ha)
18	Cowpea	IT82E	Super D (100kg/ha)

*Super D=10:24:20+6B

For the common bean and soybean, the main treatment was inoculation with Legumefix inoculant for soybean and SPRL inoculants (from Zimbabwe) for the common beans. The sub treatment was type of fertilizer type (TSP, Super D and Compound D).

Table 4.3: treatment structure of soybean and common bean input trials:

	Legume	Variety	Fertilizer	Inoculant
1	Bush bean	Kholophethe	None	With
2	Bush bean	Kholophethe	TSP	With
3	Bush bean	Kholophethe	Compound D	With
4	Bush bean	Kholophethe	Super D	With
5	Bush bean	Kholophethe	None	Without
6	Bush bean	Kholophethe	TSP	Without
7	Bush bean	Kholophethe	Compound D	Without
8	Bush bean	Kholophethe	Super D	Without
9	Soybean	Makwacha	None	With
10	Soybean	Makwacha	TSP	With
11	Soybean	Makwacha	Compound D	With
12	Soybean	Makwacha	Super D	with
13	Soybean	Makwacha	None	Without
14	Soybean	Makwacha	TSP	Without
15	Soybean	Makwacha	Compound D	Without
15	Soybean	Makwacha	Super D	Without

In all the trials, there was a control plot with local recommendations on the main-sub treatment combination. Programming for these trials was done simultaneously with objective 2.1.2 above hence all these trials were planted during the same period and were affected by the same environmental conditions. Some of these smaller input trials were also managed by the same farmers managing the soybean variety trials (Milestone 2.1.2).

All data collected and activities done on the fields were also similar to those reported under Milestone 2.1.2 since a generic data template was followed. Harvesting has already been done for most of the crops, particularly cowpea, common bean and soybean although most of the groundnuts are still in field. Biomass samples should be ready to send to Nairobi by the end of June 2012. Data entry and submission for inclusion in the N2Africa database has been projected for the end of June 2012.

Observations applicable to all activities conducted under Objective 2 in Malawi

Implementation of trials by N2Africa staff rather than partners resulted in far better and more timely establishment of trials (including better choice of sites/farmers), improved management and oversight of trials and timely and thorough data collection. Better selection of farmers where trials were installed resulted in improved crop management, compared to last season.

There were, nevertheless, setbacks caused primarily by the very late start of the rainy season, as well as pro-longed mid-season drought in most areas. Late planting and drought both contributed to a higher level of pest and disease infestation (stressed plants being more susceptible to same), notable termite attack – made all the easier by the very dry soils – in soybean and groundnut, rosette virus in groundnut, especially variety CG7, bean stem maggot (beans) and viral outbreaks in cowpea. For all legumes, earlier maturing varieties performed, to a large extent, better than the later maturing ones.

Farmers' responses to/perceptions of some of the input applications will best be known after the Field Book Evaluation has been completed and the data analyzed. Preliminary indications are that farmers are still resistant to applying mineral fertilizers to legumes, but did acknowledge positive response to some formulations in soybean trials.

Objective 3. Select superior rhizobia strains for enhanced BNF and develop inoculum production capacity in sub-Saharan Africa, including private sector partners.

Activity 3.1. Assess the need-to-inoculate for the target legumes and identify elite strains across the impact zones.

Milestone 3.1.3. At least 2,000 strains screened for effectiveness under greenhouse conditions to select the top 5% for field testing. Month 6, year 3. An American PhD student (see Milestone 3.2.2 below) will be determining the nitrogen fixation capacity of a selection of 100 unique soybean rhizobia strains collected in Malawi over the 2011/12 growing season. Additionally, a Malawian MSc student hopes to conduct similar trials on rhizobia she plans to isolate from cowpea.

Milestone 3.1.4. The benefits of inoculation of soybean and beans with at least 2% of the elite strains demonstrated in the impact zones. Month 12, year 3.

Activity 3.2. Establish and characterize a rhizobium germplasm bank in the impact zones.

Milestone 3.2.2. At least 10 nodules of soybean and beans collected in at least 200 sites in the impact zones, for isolate characterization and inclusion in the germplasm bank. Month 4, year 2.

A PhD student from North Carolina State University (NCSU), Mary Parr, extracted and cultured rhizobia from 500 soybean nodules collected from soils from the Ekwendeni region of Malawi. Samples will be sent to Nairobi; additionally, Ms. Parr will take these cultures to NCSU where she will use PCR to confirm that they are indeed rhizobia, and then will use molecular finger-printing techniques (PCR using the BOX A1R primer) to assess the diversity of strains in her collection as well as identifying unique strains. She will then choose 100 unique strains to further characterize using multi-locus sequencing to determine species of the different rhizobia.

Activity 3.3. Formulate improved inoculant products and develop cost-effective production methods, including quality assurance procedures.

Activity 3.4. Expand and upgrade inoculant production capacity in sub-Saharan Africa.

Milestone 3.4.3. At least 50,000 inoculant packets produced per year in at least 3 cooperating laboratories. Month 12, year 2, 3 & 4.

The "rhizobiology" laboratory at the NARS Chitedze Research Station claims to be producing inoculants, which it sells to Malawian farmers. Analysis of many samples of the inoculants by Mary Parr revealed them to contain no rhizobia.

Objective 4. Deliver legume and inoculant technologies to farmers throughout sub-Saharan Africa.

Activity 4.1. Create strategic alliances for facilitating dissemination of legume and inoculant technologies in the impact zones.

Milestone 4.1.3. At least 10 additional satellite sites have been identified per impact zone. Month 12, year 3.

For the 2011/12 growing season, eight new sights (as well as two new partners: National Smallholder Farmers' Association of Malawi (NASFAM) and Catholic Relief Services (CRS)) were included, in addition to scaling up the existing sites, as shown in the table below. One district not included in last season's trials (Kasungu) was also added through our partnership with CRS.

Table 4.4. List of Malawi D&D partners and sites for the 2011/12 growing season.

District	Partner	Site	Status
Lilongwe	DAES	Mngwangwa EPA	Old
Lilongwe	NASFAM	Ukwe Association	New
Lilongwe	World Vision	Nkhoma ADP	New
Lilongwe	World Vision	Chilenje ADP	New
Dedza	AISAM	Linthipe Trading Centre	New
Dedza	World Vision	Tchesa ADP	New
Dedza	DAES	Linthipe EPA	Old
Ntcheu	Concern Universal	TA Makwangwala	Old
Salima	DAES	Makande EPA	Old
Salima	DAES	Chinguluwe EPA	Old
Salima	AISAM	Chinguluwe EPA	New
Dowa	World Vision	Lipiri ADP	Old
Dowa	World Vision	Kafulu ADP	Old
Dowa	World Vision	Kasangadzi ADP	Old
Kasungu	Catholic Relief Services	Nkhamenya Suboffice	New
Mchinji	NASFAM	Msitu Chapter	New
Mchinji	NASFAM	Mkanda Chapter	New
Mchinji	World Vision	Mlonyeni ADP	New
Mchinji	AISAM	Mkanda, Kapiri and Kamwendo Trading Centres	New

With the partners listed in Table 4.4, the following number of farmers has been reached with provision of inputs (seeds, fertilizer and soybean inoculants) as well as training over the first two seasons of N2Africa activities in Malawi:

Table 4.5. Total number of Malawian farmers who have received inputs and training from N2Africa since beginning of activities in country*.

District	Partner	2010/11 Season	2011/12 Season	Male	Female
Target	All Partners	2000	7000		
Lilongwe	DAES	181	268	96	172
Lilongwe	NASFAM	0	183	114	69
Lilongwe	WV	0	630	361	269
Lilongwe	DARS	500	0	0	0
Dedza	DAES	621	950	399	551
Dedza	WV	0	800	420	380
Ntcheu	CU	253	485	228	257
Salima	DAES (Chinguluwe)	191	1268	789	479
Salima	DAES (Makande)	375	491	223	268
Dowa	WV	622	1407	844	563
Kasungu	CRS	0	2207	1040	1167
Mchinji	NASFAM	0	223	120	103
Mchinji	WV	0	749	343	406
Mchinji	CDI	667	0	0	0
Total		**3410**	**9661**	**4977**	**4684**

*Figures for 2011/12 are preliminary ones, based on partners' interim reports, and will need to be confirmed at the end of season.

In addition to the 9661 farmers N2Africa who have received the full "package" in 2011/2012, there are 1258 farmers who benefitted by receiving 1 kg of legume seed, produced by participating farmers in the first season, as well as training by lead farmers in the 2011/12 season. The breakdown on source and amounts of seed, location of beneficiary farmers and gender is given in Table 4.6 below.

Table 4.6. Farmers receiving seed from repayment scheme as well training from Lead Farmers in the 2011/12 season in Malawi

District	Partner	No. of Farmers who Contributed to Seed Repayment	Amount of Seed Repaid (kg)	No. of Farmers Who Received Seed from Repayment Scheme	Percentage of Female Beneficiaries/District
Lilongwe	DAES	189	119	119	51
Dowa	World Vision	622	869	107	60
Dedza	DAES	621	1155	901	60
Ntcheu	Concern Universal	253	416	79	41
Salima	DAES	566	913	52	27
Total		**2251**	**3472**	**1258**	**57**

Higher seed repayment rates from Dedza district were most likely due to a combination of much better rainfall experienced there in 2010/11 together with the strategic planning and dedication of the partner, DAES-Dedza. Repayment rate from the 2011/12 season has yet to be determined, for reasons explained under the section "Risks" below.

Other farmers are most likely benefitting, in a more indirect manner, from N2Africa's activities with agro-dealers, as explained under Milestone 5.4.3 below.

Milestone 4.3.3. At least half of the farming communities engaged in the project are actively linked to legume market outlets. Month 12, year 2.

Currently farmers are being linked to the market for the 2011/12 season. About 45% of the farmers in the season will be linked to markets. Some of the prospective markets include ACE (Agriculture Commodity Exchange) facilitated markets. ACE is also constructing a warehouse at one of the N2Africa sites with World Vision in Dowa District for market linkages. Currently over 1000 (10% of all farmers under the N2Africa Project) are now linked to ACE through the warehouse construction activities as well as through registration with ACE offices in Lilongwe via the IFAD-funded Integrated Soil Fertility Management (ISFM) Project as well as in other sites.

Rab Processors and NASFAM are some of the prospective contacted markets. NASFAM purchases soybean and ground-nuts. NASFAM market could service about 35% of the farmers under the N2Africa project. They do not have limits on the volumes which they are willing to purchase, however they do have stringent quality standards (e.g. moisture content, foreign matter and for ground-nuts aflatoxin level). Rab Processors expressed a willingness to buy all of the four N2Africa legumes and in any quantities, but again, quality standards must be met, and unless the farmers are able to guarantee minimum volumes assembled at specified collection points, the farmers will be responsible for delivering their grain to the company's factory on the outskirts of Lilongwe.

Milestone 4.3.4. At least half of the farming communities engaged in the project are linked to legume processing initiative. Month 12, year 3.

While attempts have been made to interest the poultry feed industry, which is in great need of soybean, in considering sourcing their grain from our farmers, no progress has been achieved. We are hopeful that the marketing and agri-business training activities being led by the IFAD-funded project, will result in our farmers being better placed to achieved the specifications (quality, quantity, packaging and timeliness of delivery) set by the poultry feed industry, as well as other processors (e.g. Rab Industries for peanut butter).

Activity 4.4. Conduct collaborative legume and inoculant technology dissemination campaigns and create awareness in rural communities in all impact zones.

Milestone 4.4.2. Large-scale demonstration and dissemination campaigns held in each impact zone. Month 6, all years

Demonstration trials were established in the seven districts of Malawi where N2Africa is working, involving 9661 lead+satellite farmers, and the additional 1258 farmers benefitting from seed-repayment. The demonstrations covered a range of N2Africa technologies with soybean, groundnut, cowpea and common bean. For all trials, the size of the lead farmer's plot was 20m x 20m, and that of the satellite farmers was 10m x 10m.

Soybean

In Malawi, the two most important issues which needed to in soybean dissemination trials were (1) the fact that soybean **varieties**[2] exist, with different varieties having different characteristics and (2) that it is worth the cost to use P fertilizers on the crop. Choice of varieties had to be determined by availability of seed, which was extremely problematical for the 2011/12 season. Prices for soybean in Malawi rose significantly following the 2010/11 harvest, creating a strong demand for soybean seed. We had wanted to use just two with different seed characteristics (Makwacha and Nasoko)so that farmers can truly see the difference, but had to resort to adding two additional varieties (Ocepara 4 and Solitaire) to meet our seed needs. Since farmers were already (for the most part) convinced of the value of using inoculants, we inoculated all seed used for variety trials, which we also hoped would increase the amount of seed available for the 2012/13 season. The protocols used for soybean demonstrations in 2011/12 were therefore:

- Soybean input trials: using one variety (either Makwacha, Nasoko, Ocepara 4 or Solitaire), with/without Sympal fertilizer and inoculants (source Biagro, Argentina).
- Soybean variety trials: comparison of two varieties (Makwacha, Nasoko, Ocepara 4 or Solitaire), all plots inoculated (source Biagro, Argentina) and with/without Sympal fertilizer

Bean

Many farmers in Malawi intercrop bean with maize to which Compound D fertilizer is applied, so we decided to focus on demonstrating varietal differences for two common varieties with differing maturities, Kalima and Kholophete, with and without Compound D fertilizer. Our goal was to try to show farmers the benefits of fertilizer applications – in the absence of a maize crop – on beans, as well as demonstrating how different maturities perform in an uncertain climate, given that we are facing global climate change. The protocol followed in the 2011/12 season was therefore a bean variety and fertilizer trial using varieties and Compound D fertilizer.

Groundnut

The one message which was clearly conveyed by all D&D partners last season in Malawi to N2Africa was "WHY are you recommending use of mineral fertilizers on groundnuts???". The government has for years discouraged use of mineral fertilizers on this crop (manure/compost being the standard practice), and changing this mentality is extremely difficult. Our original plan was to focus on different groundnut varieties, as this subject is very interesting to farmers. We also thought it was important to show the benefits of planting on time to avoid pest/disease problems, drought, etc. since all too many sow groundnuts late, after everything else has been planted. In the end, we were convinced by the N2Africa agronomist to include use of a P fertilizer on just four rows of each subplot. Unfortunately, the partners and extension agents did not understand/follow these instructions, and instead spread the very small amount of fertilizer provided across the entire subplot. The groundnut trial employed was a groundnut variety and planting date trial, using varieties Nsinjiro and CG7 and two planting dates, separated by two weeks.

Cowpea

[2] Farmers in Malawi call all soybeans "soya" – they are not aware there are more than one "variety" of the crop

In Malawi, as in most southern African countries, cowpea is considered to be a crop grown for home consumption only (both the leaves as "relish" and the grain). Farmers consider it to be too low in value to merit the use of mineral fertilizer, which is after all very expensive in Malawi. Nevertheless, we decided it worthwhile to include a fertilizer treatment. Since there are only two cowpea varieties (released) in Malawi, the fertilizer treatment was combined with this varietal comparison, in the following manner: two varieties, Sudan-1 and IT82E-16, with and with TSP fertilizer. Since insect pests are a problem in cowpea, including the role they play in transmitting viruses to the crop, each cowpea farmer also received seed of Tephrosia vogelii, to plant so as to encourage them to use an extract from the leaves for insect management.

After the demonstration plots were established, farmers started observing the legume crops and the technologies in their plots as well as through training sessions and field days. Some of the farmer observations include the following:

Soybean

Most farmers are just being introduced to the concept of soybean "varieties". As a result, many are still learning to recognize that there are indeed varietal differences; preliminary indications were noted with respect to which varieties they prefer, with yield being the primary characteristic of importance. Variety Makwacha appears to be the variety of choice for most Malawian farmers, mainly to the fact that plants produce smaller amounts of leaf biomass/canopy compared to other varieties, which farmers perceive as there being "more pods per plant" (and therefore higher yields) compared to the other varieties. This impression is enhanced by the large sized pods of Makwacha. Makwacha also appeared to respond more to Sympal fertilizer application than other varieties used in the D&D trials, as per informal observations taken on root growth and number/size of nodules in addition to plant vigor, but this has not yet been confirmed by agronomic data. Farmers did express an appreciation of the effect of soybean inoculants, as measured by greater plant vigor compared to those which were not inoculated. While many farmers indicated they were impressed by the impact of Sympal fertilizer on crop growth and vigor, results from the Field Evaluation survey are needed before we can confirm this observation. With respect to termite damage, which was exacerbated by prolonged drought in many areas, there were no apparent differences between input treatments or varieties in terms of extent of attacks or degree of damaged caused.

Cowpea

Of the two cowpea varieties available in Malawi, most farmers prefer IT82E -16, because of what they consider to be its "better taste"[3]. Additionally, the only other variety available, Sudan-1, may have larger sized seeds, but ranks lower on the farmer preference scale than IT82E -16 since the former variety is considered to be a "wild" cowpea strain in Malawi. It has been grown and promoted extensively in Salima District but locals still prefer IT82E -16 for relish (made from leaves) and grain consumption. The other advantage of IT82E -16 is that it is earlier maturing than Sudan-1, making it easy for farmers to grow it twice in one growing season, or to succeed in growing it to maturity as a relay crop to maize (the crop of primary importance). With respect to farmers' response to use of mineral fertilizer on cowpea, most felt that there was no visual crop growth or vigor. Results from the Field Evaluation survey will hopefully provide more conclusive results concerning fertilizer impact.

Groundnut

Incidence/impact of rosette virus appeared to be greater in the groundnut variety CG7, the variety recommended by government extension services, compared to the other variety used in D&D trials (Nsinjiro). Reasons for CG7's apparent greater susceptibility to rosette are yet to be confirmed but its growth characteristics may contribute its apparent higher infection rate vis a vis Nsinjiro. CG7 is slower to emerge and establish a crop, and since the virus vector (aphids) have a fast population growth rate, aphid levels are likely to be already high when CG7 seedlings are still young and more susceptible to disease infection. Additionally, CG7 tends to be more determinate and slower in its above ground rate of growth while Nsinjiro tends to spread out and form more leaves; as a result, the symptoms of rosette virus tend to be more noticeable in CG7. There was also a poor rate of germination in CG7

[3] Given that cowpea is grown primarily for household consumption in Malawi, it is not surprising that taste is the primary characteristic of interest.

compared with Nsinjiro. This is likely to be a seed quality problem since the problem occurred across all agro ecological zones, both in Malawi and Mozambique. Despite these drawbacks, farmers expressed a preference for CG7 because they generally believe it is more resilient to dry spells and yields higher than other varieties, including Nsinjiro. These locally expressed beliefs could be mainly due to promotion of CG7 by the government extension services in Malawi. N2Africa has yet to confirm the validity of these farmer-based perceptions; hopefully data collected with the Field Evaluation will help us to do so.

Common Bean

Fertilizer treatments promoted with by N2Africa seem to have done little convince Malawian farmers of the potential value in using mineral fertilizer in common bean. In the most import area for bean production in the Central Region, namely Dedza District, farmers complained of prolonged vegetative growth and delayed flowering and subsequent pod development in beans grown with fertilizer. As an example, one of N2Africa's lead farmers (who is one of our best - if not our best - performer) in Dedza "Mrs Hassan" informed us her "club" farmers clearly disliked the fertilizer provided by N2Africa for use in their bean trials, claiming that the crops grown with mineral fertilizer produced "too much leaf biomass and very few pods". Once we have got results from the Field Evaluation survey (and agronomic trials), the N2Africa team in Malawi has got to evaluate what sort of fertilizers should be promoted for common beans and at what rates. We do have to acknowledge that years of government extension staff telling farmers mineral fertilizers should not be applied to legumes is an impediment to our advises to the contrary, and develop a better strategy (including choice of formulation) to encourage farmers to at least try fertilizer on a portion of their bean crops.

One interesting development with respect to beans this season in Malawi is that farmers let us know they were happy about the re-introduction of the variety Kalima, which was developed through Bunda College's breeding program, as it was earlier maturing than Kholophethe.

All Crops

As noted under Objective 2 above, the late onset of the rains together with prolonged mid-season drought in many areas where D&D trials were conducted adversely impacted crop performance and exacerbated pest and disease problems. At an N2Africa Partner Review meeting convened 27 April, two areas identified as needing attention prior to the next growing season were mitigation measures for global climate change and improved techniques for pest and disease management. Further discussion of these subjects together with development of strategies to address both will take place at the Partner Planning Meeting to be held in July 2012.

Conclusions

Farmers have had a better chance to evaluate N2Africa's Technologies between November 2011 and April 2012 than they did during the same period last year. There was a larger scope for evaluating the impact of N2Africa technologies this season, given that to a large extent, protocols were understood and implemented correctly, and partners followed up on their work with more motivation and direction than last season. Having high quality data captured in both the M&E tools and the Field Book survey is essential for providing us the information we need to evaluate the effectiveness of our D&D work for the 2011/12 growing season. With this more reliable means (quantitative data) of measuring the outcome of our work, we hope to find that it supports the visual and qualitative observations captured by the N2Africa team with respect to our achievements under the D&D workstream.

In summary, Malawian farmers showed a high level of interest in N2Africa technologies in the 2011/12 season, and we are hopeful about achieving a high level of positive impact after all data are in and analyzed.

Milestone 4.4.3. At least 3 extension events (e.g., field days, exchange visits) organized per season per country. Month 9, all years.

During the 2011/12 season, N2Africa partners, often with participation from the Farm Liaison Officer, convened Field Days. Discussions were held around the different legume technologies, and farmers provided input on which were preferred and why, as well as what was not going well. All D&D sites conducted field days, as shown in

Field days were conducted in all the sites of the project. Farmers were able to learn more BNF technologies from the four legume crops being demonstrated by the project. During these field days farmers also made observations on the preferred varieties and the reasons. During the field days, over 10, 000 farmers participated in all sites, as indicated in Table 4.7 below:

Table 4.7. Field days convened at Malawi D&D sites by end of April 2012.

District	Partner	Total No. of Participants	Percentage Female Participants	No. of Field Days
Ntcheu	Concern Universal	1560	59	13
Kasungu	Catholic Relief Services	177	66	25
Salima	Makande & Chinguluwe EPA	762	48	10
Dedza	World Vision	825	41	15
Dedza	Linthipe EPA	4621	49	28
Lilongwe	World Vision	662	35	8
Lilongwe	Mngwangwa EPA	394	79	3
Lilongwe	NASFAM	82	40	1
Mchinji	NASFAM	234	27	2
Mchinji	World Vision	934	57	13
Dowa	World Vision	1255	63	7
Salima, Dowa & Mchinji	AISAM*	163	31	4
Total		**11669**	**51**	**129**

* Agri-Input Suppliers Association of Malawi (AISAM)

N2Africa partner World Vision also convened “review meetings” in Dowa District to bring all lead farmers and participating extension officers together so as to discuss progress of the demonstration trials across the district. A total of 61 lead farmers and 11 extension officers participated in the meetings, which were held in three different locations in the district.

Milestone 4.4.4. At least 3 mass media events (e.g., radio programs, video documentaries) organized per hub. Month 12, all years.

From November 2011 to the end of April 2012, N2Africa Malawi organized both radio broadcasts and news articles about project activities. The radio programs were supported financially by Farm Voice Radio, which is funded by the Bill and Melinda Gates Foundation. A total of five programs were broadcast on Malawi Broadcasting Corporation Radios 1 and 2 in Chichewa (the local language), covering the following subjects:

- An overview of N2Africa (objectives and activities in Malawi)
- Use of legume crops and technologies to improve livelihoods and contribute to sustainable agricultural development
- The nitrogen cycle and biological nitrogen fixation
- Farming as a business

Additionally, an article titled ‘Making nitrogen fertilizer the Natural Way’ was posted on the on Agfax website (www.agfax.net), and two local newspapers (The Nation and The Daily Times) published one article on field days conducted jointly by AISAM (members of which underwent N2Africa training in September 2011) and N2Africa.

Activity 4.5. Develop strategies for empowering women to benefit from the project products.

Milestone 4.5.2. A report documenting the involvement of women in at least 50% of all farmer-related activities produced. Month 9, years 2, 3 & 4.

More accurate estimation of women’s involvement in project activities for the 2011/12 season will be made once the season has ended. However, some preliminary figures are encouraging. With the exception of farmers reached with the full input package (48% female), women outnumbered men in the following activities:

Activity	Percentage of Female Participants
Beneficiary of Seed Repayment	57
Field Days	51
Nutrition and Processing Training	68

Milestone 4.5.3. At least 2 special events on the role of legumes in household nutrition and value-added processing conducted per country. Month 12, all years.

While most nutrition and processing activities will commence soon after all the legume crops have been harvested, some have already been conducted in Malawi. Concern Universal in Ntcheu, DAES in Dedza and Salima all started on nutrition training (protein content of legumes, importance of protein for pregnant/lactating women and children under the age of 5, importance of heating soybean to inactivate trypsin inhibitors), as well as processing legumes into a variety of products. The participating farmers are now able to make a range of legume products, from glazed groundnuts to soybean milk, snacks, cakes and porridge. In Salima, the training was included in a field day, and an exhibition of the legume products was put on display. The number of participating farmers is as follows:

Ntcheu:	30 farmers (8 female and 22 male)
Dedza:	56 farmers (45 female and 11 male)
Salima:	141 farmers (102 female and 39 male)

Objective 5. Develop and strengthen capacity for BNF research, technology development, and application.

Activity 5.2. Advanced training to MSc and PhD level of an elite young cadre of African scientists focused on topics filling identified knowledge gaps and operationalization of a gender-sensitive participatory monitoring and evaluation framework.

Milestone 5.2.1. At least 14 MSc and 7 PhD candidates selected for training from the impact zones. Month 6, year 1.

Two Malawians who are being sponsored by N2Africa for MSc degrees continued to work towards completing their course work at Malawi's Bunda College of Agriculture. Both also developed and successfully defended their research proposals. One student, who is pursuing a study on interaction between soybean varieties, inoculants and phosphorus fertilizer will start his research using N2Africa D&D trials during the next growing season. The other student will be isolating and evaluating effectiveness of rhizobia from different cowpea varieties. This second student received hands-on training courtesy of Mary Parr so as to help her master some of the basic lab techniques. Both are expected to complete all degree requirements before N2Africa comes to an end on October 31 2013.

A PhD student began his work at Wageningen University, and is expected to return to Malawi for his field research before the next growing season. Research topic is socio-economics and rural sociology; M&E Specialist Judith de Wolf is overseeing his research.

Activity 5.3. Training-of-trainers workshops on legume and inoculant technologies for agricultural extension workers, NGO staff, and agro-dealers.

Milestone 5.3.2. At least 8 training-of-trainers workshops (1 workshop in each country), attended by at least 40 farm liaison staff, conducted on inoculation technology and legume agronomy. Month 10, years 2 & 3.

Attempts to get the rhizobiology lab at the Chitedze Research Station to make good use of the training their staff underwent (MIRCEN and SPRL) once again failed to achieve any results. The person in charge of the lab has shown no interest in making use of his training to help to build rhizobiology knowledge and skills in Malawi.

Activity 5.4. Training workshops on legume and inoculant technologies for officers of farmer associations and community-based organizations.

Milestone 5.4.2. At least 2 grass-root training events organized by each of 320 to 640 trainers across all impact zones, with an expected attendance of 50 farmers per event [resulting in 51,000 farmers trained during year 3 and 132,000 during year 4]. Month 12, years 3&4.

All trainings were conducted by N2Africa Malawi staff, and, in four of the seven target districts in conjunction with the market and agribusiness training being supplied by the IFAD-funded ISFM project. The individuals selected for training in the first year of the project continue to show no interest in participating in our training events. To be fair, their selection did not undergo the rigorous background research in order, and all simply lacked to capacity to absorb and disseminate the training they received. The N2Africa and IFAD-ISFM staff have, however, grasped all technical materials concerning BNF and N2Africa technologies and are able to handle these training activities on their own.

Over the months of November 2011 through April 2012, the following topics were covered in trainings conducted by the N2Africa Farm Liaison Officer, in collaboration with staff from the IFAD-funded ISFM Project:

a) Pre-harvest crop management
b) Crop harvest and post-harvest handling
c) How to reduce development of aflatoxin in groundnuts
d) Marketing/agri-business development
    - Business plan development
    - Record keeping
    - Participatory market research
    - Collective marketing
e) Seed repayment

Details on these trainings are provided in Table 4.8 below.

Table 4.8. Trainings conducted for D&D partners November 2011-April 2012.

District	Partner	Lead Farmers	Extension Officers	Total
Ntcheu	CU	15	5	20
	CU	15	5	20
Dowa	WV	137	22	159
Salima	DAES	50	12	62
	DAES	50	10	60
Mchinji	NASFAM	10	2	12
	WV	40	7	47
Lilongwe	NASFAM	10	1	11
	WV	40	11	51
	DAES	16	2	18
Kasungu	CRS	102	22	124
Dedza	DAES	66	9	75
	WV	78	16	94
Total		**629**	**124**	**753**

Milestone 5.4.3. At least 30 agro-dealers in each hub are trained in accessing, managing and distributing information on inoculant use each year [270 trained agro-dealers by year 4]. Month 10, years 2, 3 & 4.

Thirteen[4] Malawian agro-dealers underwent training in September 2011, as well as inputs and technical support for them to conduct demonstration trials (soybean with Sympal and inoculants). The agro-dealers have reported that surrounding farmers have been keen to learn from the demonstrations, which further extends the potential "reach" of N2Africa in Malawi. As a result, the level of interest on the part of the agro-dealers was high, and we had hopes of assisting them to import Sympal from MEA next season. The severe shortage of foreign currency in Malawi may however block this initiative, together with the devaluation of the local currency. In spite of this challenge, the agro-dealers are for the most part convinced of the benefits of using P fertilizer and inoculants on soybeans, as are many of the farmers in their zones of work.

Activity 5.5. Provide training, educational and extension resource materials to support activities 5.1 – 5.4.

[4] We would have liked to train more agro-dealers, however the funds available for this activity in the budget resulted in our being limited to just 13.

Milestone 5.5.3. Support for undergraduate and postgraduate education will be provided through access to long distance education programs, visiting professorships or adjunct appointments in the area of N2 fixation at 25 African Universities, and the provision of resource materials to assist in course planning and evaluation. Month 12, year 2.

A BSc student from Toulouse University in France was attached to N2Africa Malawi from October 2011-February 2012. The late start of the rains compromised to some extent the amount of learning which could be achieved (crops were still a long way from approaching harvest by the time he left), however a report compiled by the student (BSc report Parachini is available via the N2Africa website) showed that he did master considerable knowledge in BNF and N2Africa technologies, as well as how to set up and run an experimental trial (soybean +/- inoculants and a variety of soil amendments).

Milestones 5.5.4. Training programs will organized in collaboration with selected private sector partners in each of the mandate zones for various categories of staff in key aspects of inoculant production and quality control. Month 3, year 3.

Milestone 5.5.5. Web-based support will be provided on key N2 fixation methodologies and techniques, the maintenance and trouble-shooting advice for scientific equipment used in BNF research, and N2 fixation extension materials for download and modification for local condition. Month 12, year 3 & 4.

Revised work plan

Unless solutions can be found to our achieving milestones under Objective 3, we will fall significantly short of almost all goals. Mitigation measures currently planned are (a) for former Research Officer Joseph Mhango to take over training the Chitedze technicians in rhizobiology techniques as well as to implement and oversee work towards the Objective 3 milestones. This will only be possible if Mr. Mhango is offered the opportunity of pursuing an MSc in rhizobiology in Kenya, the possibility of which depends on his securing a place at either University of Nairobi or Edgerton University. Should we be unsuccessful in this endeavor, we will need to send Mr. Mhango's replacement for training in rhizobiology, which will delay this work being undertaken in Malawi and perhaps result in our falling short of our goals in the limited time remaining.

Risk and mitigation

All activities in Malawi have been adversely impacted by the political and economic problems the country has faced for over one year. Fuel continues to be extremely hard to procure locally, and the additional costs affiliated with purchasing same in neighboring Zambia is having a serious impact on what we can realistically expect to achieve over the next 16 months. We have tried to address this problem by combining trips, both within our project and between ourselves and others, however given the diverse demands for field trips, this has only slightly eased this constraint. We are hopeful that a visit from the IITA Director General to southern Africa in Junes, where this issue will be raised, may assist us in planning the way forward.

Devaluation of the local currency has resulted in very large increases in costs of living, for our staff as well as our farmers. With respect to the latter, their willingness to participate in seed repayment has declined greatly, as they are desperate for cash, and with the rising prices for soybean and groundnut[5]. Project staff are ever more inclined than ever to give priority to economic survival (side businesses, seeking out the least expensive sources of basic goods, etc.) rather than project work. While IITA-Malawi succeeded in getting our Headquarters in Ibadan to agree to a pay raise for all

[5] The government's lifting of an export ban on soybean – with the huge demand in neighboring countries – has seen the price for soybean grain escalate. Add to this the serious drought in many of the areas where we work, with resulting severe reductions in yields of all crops has farmers are even more desperate for cash. Expecting them to respect soybean seed repayment needs to be re-considered. Additionally, groundnut and soybean seed prices have doubled, so we should be ready for many beneficiary farmers to fail to respect seed repayment of this crop.

national staff, the continued price rises on all goods leaves one wondering how we will continue to address this situation.

Research Officer Joseph Mhango, who was very capably handling the agronomy work as well as contributing to rhizobiology activities is resigning from N2Africa. Given the general lack of strong capacity in local staff (as well as willingness to take initiative, an area where Joseph has been outstanding), it may be difficult to “fill his shoes” and thereby ensure we are able to procure the high quality data needed. We have advertised for a replacement, and barring any administrative hassles from IITA, have got the funds offer a remunerative package to a more senior and well qualified candidate.

Serious shortages in foreign currency continue to make it difficult to convince the private sector to undertake importation of inoculants and P fertilizer (none being produced in country). With just one season left, chances of our succeeding in truly bringing the private sector on board are slim.

5. Mozambique Country Report on Month 30 of the N2Africa Project

Prepared by Steve Boahen, Country Mentor; Henrique Colial, Artur Fernando, other project technicians and partners (Technoserve and IKURU)

Objective 1. Establish a baseline of the current status of N2-fixation, identify niches for targeting N2-fixing legumes in the impact zones, M&E and impact assessment.

Activity 1.3. Identify new opportunities for targeting legume technologies to increase BNF and enlarge the area under the priority legumes.

Milestone 1.3.2. New opportunities identified prior to each new cropping season. Month 3, years 2, 3&4.

Several trials were established using new soybean and groundnut varieties to determine the appropriate test planting dates, row spacing and P application rate and to evaluate their responses to inoculation, liming and starter N across agro-ecologies. New groundnut varieties, P and lime application and early planting at the appropriate spacing enhanced yields and among the major new opportunities identified during the season to be promoted. Two of the groundnut varieties are rosette disease resistant, have large seeds, are high-yielding and are preferred by farmers.

Milestone 1.3.3. Complete market analysis for inoculum in representative areas of the three hubs reported on, including cost/benefit analysis at smallholder level; recommendations for private sector engagement made. Month 6, year 2.

This analysis will be organized by the project leadership. Any information requested will be provided

Activity 1.4. Quantify the current on-farm N2-fixation in the target farming systems and its impact on livelihoods (income, nutrition).

Milestone 1.4.2. A baseline report quantifying the current level of BNF and its contributions to rural livelihoods is available for all impact zones. Month 12, year 1.

Plant samples have been sent to Kenya for ^{15}N Natural Abundance analysis to quantify BNF level

Activity 5. Monitor impact of investments and uptake of legume and inoculant technologies in the impact zones.

Milestone 1.5.2. A monitoring and evaluation framework used for evaluating progress and planning subsequent activities during planning. Month 3, years 2, 3 & 4.

Several standardized M&E forms including farm characterization, dissemination packages, on-farm technology evaluation, lead farmer assessment, field days, capacity building events, distribution of publications and media events have been completed for project evaluation and planning.

Milestone 1.5.3. An external project review has been conducted, with representatives of the Bill & Melinda Gates Foundation. Month 6, year 3.

The project leadership is responsible for arranging the review.

Activity 1.6. Evaluate the impact of introduced legume and inoculant technologies on farmer's livelihoods and soil health in the impact zones.

Milestone 1.6.1. A report on the impact of N2-fixation technologies on farmers' livelihoods is produced. Month 12, year 4.

The project leadership will be responsible for this milestone

Objective 2. Select multi-purpose legumes (food, fodder, stakes, and soil fertility management) for enhanced BNF and integrate these into farming systems.

Activity 2.1. Identify and field test best varieties of soybean for high N2-fixation capacity and adaptation to abiotic and biotic stresses.

Milestone 2.1.2. At least 3 new soybean varieties with high BNF potential identified. Month 12, year 2.

Five soybean varieties from the TL II project and one variety from a Seed Company in Zimbabwe, SeedCo were evaluated using inoculants and P application. The varieties differ in maturity duration; hence individual farmer preferences differ depending on the location and time of planting. All six varieties are susceptible to soybean rust disease. Hence efforts are being made to identify and introduce rust tolerant genotypes. Currently, the following TGx varieties: TGx 1987-20F, TGx 1987-38F and TGx 1987-62F are being evaluated.

Milestone 2.4.2. Sufficient planting materials are available for at least 2 multipurpose tree legumes and 4 forage legumes with high BNF capacity that have been identified across the impact zones. Month 12, year 2.

This milestone doesn't apply to Mozambique

Activity 2.5. Identify best-fit agronomic practices for maximizing potential benefits of legume and inoculant technologies on increasing and stabilizing productivity.

Milestone 2.5.1. At least 9 adaptive [impact zone-specific] research campaigns focusing on major gain legume (soybean, cowpea, groundnut, beans) implemented in the impact zones. Month 6, year 2.

Adaptive trials were established on both on-station and on-farm at 20 sites in 4 provinces (Nampula, Zambezia, Manica and Tete) using either soybean or groundnuts. Six soybean and 5 groundnut varieties were evaluated. For soybean, the BNF technologies tested include inoculants, SSP application, planting date and row spacing whereas, SSP, lime and starter N application, and row spacing were tested in the groundnut trials.

Activity 2.6. Evaluate contributions of best fit agronomic practices to system productivity and livelihoods with specific attention to trade-off analysis between competing enterprises.

Milestone 2.6.1. Household benefits from specific BNF interventions quantified for the four major grain legumes in the impact zones. Month 12, year 3.

This is yet to be arranged by project leadership for input from Mozambique.

Objective 3. Select superior rhizobia strains for enhanced BNF and develop inoculum production capacity in sub-Saharan Africa, including private sector partners.

Activity 3.1. Assess the need-to-inoculate for the target legumes and identify elite strains across the impact zones.

Milestone 3.1.3. At least 2,000 strains screened for effectiveness under greenhouse conditions to select the top 5% for field testing. Month 6, year 3.

Lack of Lab facilities in Mozambique is a major constraint to the implementation of this milestone. Nodules samples are sent to Microbiology Lab in Ibadan for isolation. Only 12 isolates were obtained from the first batch of soybean nodules sent to Ibadan for rhizobial isolation. Results of the second batch of nodules sampled this season are not available at this time.

Milestone 3.1.4. The benefits of inoculation of soybean and beans with at least 2% of the elite strains demonstrated in the impact zones. Month 12, year 3.

The Mozambique project team plans to request some of the Kenyan isolates and those from other countries for evaluation in Mozambique to enable us catch up on this milestone.

Activity 3.2. Establish and characterize a rhizobium germplasm bank in the impact zones.

Milestone 3.2.2. At least 10 nodules of soybean and beans collected in at least 200 sites in the impact zones, for isolate characterization and inclusion in the germplasm bank. Month 4, year 2.

Nodules were collected from several sites in Mozambique in March 2012 and sent to the Microbiology Lab in Ibadan for isolation. Results are not available at this time.

Activity 3.3. Formulate improved inoculant products and develop cost-effective production methods, including quality assurance procedures.

Milestone 3.3.2. Cost effective inoculant production methods including fermentation technologies, carrier selection, inoculant formulation, enhanced shelf life developed. Month 12, year 2.

Milestone 3.3.3. Universal logo representing quality assurance standards adopted among cooperating laboratories. Month 6, year 3.

Activity 3.4. Expand and upgrade inoculant production capacity in sub-Saharan Africa.

Milestone 3.4.3. At least 50,000 inoculant packets produced per year in at least 3 cooperating laboratories. Month 12, year 2, 3 & 4.

Hundred and sixty (160) kg of peat-based inoculants packaged in 400g packets were imported from Laboratorios Biagro, Argentina to establish demonstration plots and for promotion activities. The manufacturer produced only 400g packets; hence farmer groups shared packets of inoculants and coordinated their planting schedules accordingly. Technoserve also imported more than 3,000 packets of peat-based inoculants in 200g package from Total Biotecnologia, Brazil to establish demonstration plots and for sale to farmers at subsidized price to promote inoculation.

Milestone 3.4.4. Potential private sector inoculant producers invited to planning meeting and interim assessment workshops month 6, years 1, 2 & 3.

Objective 4. Deliver legume and inoculant technologies to farmers throughout sub-Saharan Africa.

Activity 4.1. Create strategic alliances for facilitating dissemination of legume and inoculant technologies in the impact zones.

Milestone 4.1.3. At least 10 additional satellite sites have been identified per impact zone. Month 12, year 3.

More than 20 satellite sites were identified in each of the demonstration regions to test at least one BNF technology during the 2011/2012 growing season. We expect to collect agronomic data from more than 150 satellite farmers in addition to about 250 farmers who had demonstration plots on their farm.

Activity 4.2. Produce specific dissemination tools, including inoculant packets, adapted to the needs of farmer groups, agro-dealers, and development partners.

Milestone 4.2.1. At least 1 dissemination tool for each action site related to legume and inoculant use is produced per impact zone, resulting in about 24 different tools by the middle of year 3. Month 6, years 2, 3 & 4.

New dissemination tool developed this season included groundnut production package consisting of improved Virgina and Spanish - type groundnut varieties with lime, P-fertilizer and starter N

Activity 4.3. Engage with legume seed system, market, and nutrition initiatives operating in the impact zones.

Milestone 4.3.3. At least half of the farming communities engaged in the project are actively linked to legume market outlets. Month 12, year 2.

The legume seed market, in particular, soybean and groundnuts is dominated by IKURU and NGOs like Technoserve and CLUSA who routinely purchase seeds for resale at the beginning of the growing season. They have out grower schemes which facilitate seed production and purchasing. Other newly formed Seed Companies including MozSeeds and Lozane Farms purchase seeds for seed production. There are also linkages between soybean grain producers and processors including Albilio Atunes, Novos Horizontes and Getty Lda who purchase directly from farmers and process into poultry feed.

Milestone 4.3.4. At least half of the farming communities engaged in the project are linked to legume processing initiative. Month 12, year 3.

More than 90% of the farmers in the N2Africa project communities are linked to soybean processors (mainly poultry feed) either directly or through farmers association. The farmers send their grains to collection points where they are purchased and transported in bulk to processing centers. In addition, using Training of Trainers approach, farmers are being introduced to home processing and utilization of soybean.

Activity 4.4. Conduct collaborative legume and inoculant technology dissemination campaigns and create awareness in rural communities in all impact zones.

Milestone 4.4.1. Dissemination and extension process and Proof of Principle in pilot site testing documented. Month 10, year 1.

Already completed

Milestone 4.4.2. Large-scale demonstration and dissemination campaigns held in each impact zone. Month 6, all years.

The project procured inputs for demonstration and dissemination activities for the 2011/12 season and also trained farmers on setting up demonstration plots in the project communities. 1.6 tons of soybeans were obtained from the project's multiplication activities and purchased 1.5 tons of groundnut seed from ICRISAT, 7 tons of SSP, 160kg of inoculants from Argentina and 1 ton of lime. Technoserve and IKURU also reached more farmers through demonstration, input dissemination and training. Most farmers completed harvesting by the end of May and are still threshing or shelling their soybean and groundnuts, respectively. The project reached 7,455 soybean farmers (28% females) and 1350 groundnut farmers (851 females = equivalent to 63%) during the 2011/12 growing season through demonstration and dissemination activities across project communities.

Milestone 4.4.3. At least 3 extension events (e.g., field days, exchange visits) organized per season per country. Month 9, all years.

Six field days were organized across project sites for farmers to visit on-farm and on-station trials and provide feedback. Two exchange visits were organized between farmers associations in Ruace and Tetete communities. One radio program was organized in Angonia, Tete Province.

Milestone 4.4.4. At least 3 mass media events (e.g., radio programs, video documentaries) organized per hub. Month 12, all years.

One radio program was organized in Angonia on basic practices farmers should follow to enhance soybean yield.

Activity 4.5. Develop strategies for empowering women to benefit from the project products.

Milestone 4.5.2. A report documenting the involvement of women in at least 50% of all farmer-related activities produced. Month 9, years 2, 3 & 4.

The project trained 471 lead farmers on improved crop production practices. Two hundred and six (206) [44%] were females. IITA established 134 demonstrations on 134 farmers' fields. Twenty-nine percent (29%) of these farmers were women. IKURU established 11 groundnut demonstrations on 11 farmers' field; 10 were female farmers and only one was a male farmer. Technoserve established 93 soybean demonstrations plots but the number of females with demonstration plots is not known yet. In addition, the project reached 7,455 soybean farmers (28% females) and 1350 groundnut farmers (851 females = equivalent to 63%) during the 2011/12 growing season through demonstration and dissemination activities across project communities.

Milestone 4.5.3. At least 2 special events on the role of legumes in household nutrition and value-

added processing conducted per country. Month 12, all years.

In collaboration with the other projects (Platform Mozambique and TLII), CLUSA and community groups, the N2Africa project conducted training and demonstrations in soybean home processing and utilization in Zambezia province. The training and demonstrations were conducted through the Training-of-Trainers (ToTs) approach whereby selected individuals from community groups were trained and thereafter go back to the communities to train their group members. The focus of the training was on biofortification of commonly eaten carbohydrate foods to enhance protein and energy quality of the diets. The recipes introduced included soy milk, soy fortified thin and thick porridge, soy-vegetable soup, soy-wheat flour bread, and soy-wheat flour cake. In the last 6 months, 979 people (770 females and 209 males) were trained in the following communities in the Gurue district: Lioma (209 females and 123 males), Ruace (239 females and 26 males) and Tetete (322 females and 60 males).

Objective 5. Develop and strengthen capacity for BNF research, technology development, and application.

Activity 5.2. Advanced training to MSc and PhD level of an elite young cadre of African scientists focused on topics filling identified knowledge gaps and operationalization of a gender-sensitive participatory monitoring and evaluation framework.

Milestone 5.2.1. At least 14 MSc and 7 PhD candidates selected for training from the impact zones. Month 6, year 1.

The admission process for the two applicants selected for the M. Sc. Scholarships from Mozambique delayed but they have been recommended by the Department of Crop and Soil Sciences, Bunda College, Malawi for admission. Due to the disruption of the academic calendar at Bunda College, they are expected to start studies when the academic year begins in October 2012. The applicant who received the Ph.D. scholarship is preparing to travel to Brazil on 24 June 2012 to begin his studies.

Activity 5.3. Training-of-trainers workshops on legume and inoculant technologies for agricultural extension workers, NGO staff, and agro-dealers.

Milestone 5.3.2. At least 8 training-of-trainers workshops (1 workshop in each country), attended by at least 40 farm liaison staff, conducted on inoculation technology and legume agronomy. Month 10, years 2 & 3.

Training (ToTs) workshops were organized in collaboration with Technoserve and IKURU in Gurue on 27-28 Feb 2012 and in Manica on 6-7 March 2012. Extension agents and technicians from NGOs, CBOs and private seed producers attended the training which focused on soybean and groundnut variety selection, inoculation, disease prevention and control, and general crop management. Fifty-seven people [41 males and 16 females] participated in the training workshops.

Activity 5.4. Training workshops on legume and inoculant technologies for officers of farmer associations and community-based organizations.

See ***milestone 5.3.2***

Milestone 5.4.2. At least 2 grass-root training events organized by each of 320 to 640 trainers across all impact zones, with an expected attendance of 50 farmers per event [resulting in 51,000 farmers trained during year 3 and 132,000 during year 4]. Month 12, years 3&4.

During the period under review, 471 lead farmers were trained on improved crop production practices; 238 farmers who had demonstration plots on their farms were trained on inoculation and crop management; 979 farmers were trained on home processing and utilization of soybean; and 8,805 soybean and groundnut farmers were reached through dissemination and promotional activities which involved training or learning.

Milestone 5.4.3. At least 30 agro-dealers in each hub are trained in accessing, managing and distributing information on inoculant use each year [270 trained agro-dealers by year 4]. Month 10, years 2, 3 & 4.

Three organizations (IKURU, Technoserve and Mozseed) were provided information on accessing and importing inoculants from Brazil to Mozambique. Through this, IKURU imported inoculants during the 2011/12 growing season for sale to some soybean farmers.

Activity 5.5. Provide training, educational and extension resource materials to support activities 5.1 – 5.4.

Milestone 5.5.3. Support for undergraduate and postgraduate education will be provided through access to long distance education programs, visiting professorships or adjunct appointments in the area of N2 fixation at 25 African Universities, and the provision of resource materials to assist in course planning and evaluation. Month 12, year 2.

Six students [4 males and 2 females] from three local universities: 2 from Musa Bin Bique University; 3 from Catholic University, Cuamba and one from the University of Zambeze joined the project team in January-June 2012 for a 6-month training attachment. The program provided the students with hands-on practical training on field experimentation and field plot techniques. The students will use part of the data collected to write their thesis in partial fulfillment of their Bachelors' degree.

Milestones 5.5.4. Training programs will organized in collaboration with selected private sector partners in each of the mandate zones for various categories of staff in key aspects of inoculant production and quality control. Month 3, year 3.

The project lack facilities to implement this activity.

Milestone 5.5.5. Web-based support will be provided on key N2 fixation methodologies and techniques, the maintenance and trouble-shooting advice for scientific equipment used in BNF research, and N2 fixation extension materials for download and modification for local condition. Month 12, year 3 & 4.

Revised work plan

RESEARCH - OBJECTIVE 3- Rhizobiology: The activities were designed based on the assumption that all the countries have Rhizobiology lab and greenhouse facilities that will only require upgrade. This is not the case; hence some revision is necessary considering that the project doesn't have basic facilities for most of the activities.

Proposed mitigation: IIAM recently gave the project a Lab to use for Rhizobiology activities but we need to procure basic Microbiology equipment within the next few weeks for the Lab to allow us to conduct some activities

Updated administrative information

No updates at this time.

6. Nigeria Country Report on Month 30 of the N2Africa Project

Introduction

This present report summarizes the progress made by the Nigeria N2Africa project from January to June 2012. In the last six-month period, large-scale dissemination activities and adaptive research were carried out. Data computerizing from the 2011 agronomy and rhizobiology work complied and transferred to the project partners in Wageningen for statistical analyses. Two Agro-dealers training in handling and commercializing rhizobial inoculant held. The annual planning meeting was held, and the activities for the season planned. We have followed the projected objectives and activities table to report on the outputs so far achieved by the project for the present bi-annual reporting.

Objective 1. Establish a baseline of the current status of N_2-fixation and identify niches for targeting N_2-fixing legumes in the impact zones, M&E and impact assessment

Activity 1.1. Establish project management structures

This ongoing project activity was started at the project inception phase is pursued in year 3, with the annual project planning meeting organised in Kano in between 28 - 29 March 2012. Invited participants were the project stakeholders, local government Extension Agents (EAs), national research institute (NARs) partners, Non-governmental organizations (NGOs) representatives, the national university researcher's partners and IITA. Participants reviewed the level of implementation of project in Year 2 especially in respect of the attainment of milestones under the various thematic objectives of the project. Four project objectives were reviewed for each of their milestones to be delivered in the year 2.

Activity 1.3. Identify new opportunities for targeting legume and inoculant technologies to increase BNF and enlarge the production areas of prioritized grain legumes

Key's biological Nitrogen fixation technologies for the predominant grain legume's species: soybean, cowpea and groundnut grown on farming systems from each target mandate area were identified from various trials established in the respective agro-ecological zones of the Nigeria. The trials involved eight varieties of soybean, seven varieties of cowpea and 5 of groundnuts. The soybean trials also had an inoculation and non-treatment. Different maturity groups of each legume species were used to respond to limitation due to each agro-ecological zone. Results from trials permitted to identify some preliminary technological packages that include improved germplasm, soybean specific rhizobial inoculant (Legume fix) and minimal use of P fertilizers (20 kg ha P as SSP) to raise soybean grain yield to about 50 % in the respective mandate areas (Table 6.1). The trials are being repeated in the year 3 for result confirmation and the requested inputs (germplasm, inoculant, P fertilizer) distributed and sowing commenced.

Activity 1.4. Quantify the current on-farm N_2-fixation in the target farming systems and its impact on livelihoods (income, nutrition).

Soybean, groundnut and cowpea biomass samples were collected at 50 % flowering from the various field trials established to quantify the N_2 fixation resulted either or effective inoculation with efficient rhizobial inoculation (this apply for soybean only) or the beneficial effect resulted from indigenous rhizobial strains present in each soil type. Samples are being processed to measure the estimate of N2 derived from atmospheric fixation for each and cultivar tested. Study on the impact of the BNF was carried out by a student from Wageningen and the results are still awaited.

Activity 1.5 Monitor impacts of investments and uptake of legume and inoculant technologies in the impact zones

The project external review initially planned in April will be held in June from June 24-26 2012.

Table 6.1. Biological Nitrogen fixation technogical package tested identified in the respective location.

Agro-ecological Zone	Legume Species	Selected Improved cultivar	Inputs requested(*)	Rhizobial inoculant	Matury group	Tested location
Sudan Savanna agro-ecological zone	Soybean	TGX 1835-10E	20 kg P	Legume fix	EM	Bichi, Garko
	Cowpea	IT90K-277-2	20 kg P	NRI		Warawa, Albasu
	Groundnut	SAMNUT 21	20 kg P	NRI		Garko,Wudil
Northern Guinea Savanna agro-ecological zone	Soybean	TGX1448-2E	20 kg P	Legume fix		Tudun Wada, Giwa
	Cowpea	IT90K-277	20 kg P	NRI		Maigana
	Groundnut	SAMNUT 21	20 kg P	NRI		Igabi, Tudun-Wada
Southern Guinea Savannah	Soybean	TGX1448-2E	20 kg P	Legume fix		Kachia, Zangon Kataf
	Cowpea	IT90K-277-2	20 kg P	NRI		Kachia
	Groundnut	SAMNUT 21,22	20 kg P	NRI		Zangon Kataf

(*) P is provided in form of Single Super phosphate (SSP) and applied at planning period

NRI: Non response to rhizobial Inoculation. EM =early Maturity, MM=Medium maturity, and LM=Late Maturity.

Objective 2. Select multi-purpose legumes providing food, animal feed, structural materials and high quality crop residues for enhanced BNF and integrate improved varieties into farming systems

Activity 2.1. Select best varieties of soybean and common beans for high N_2-fixation capacity and adaptation to abiotic [low soil P, soil acidity, etc] and biotic stresses [pests and diseases].

The Institute of Agricultural Research (IAR) of Zaria and the Bayero University of Kano were subcontracted for the activity 2.1, to conduct field screening of soybean varieties with high N2-fixation potential under different inoculation regimes in three agro-ecological zones of Northern Nigeria. Five soybean varieties of the different maturity group were used (name of the varieties) with/without inoculation. Field's experiments were established in 2011and biomass samples harvested at 50 % flowering, and the nodulation and biomass parameters collected. Grain yield measurement was done in at the final harvest. During the period January- June 2012, data are computerized and transmitted to partners from the University of Wageningen for subsequent statistical analyses and results reporting.

Activity 2.3. Select cowpea and groundnut varieties with high N_2-fixation capacity and adaptation to abiotic and biotic stress conditions

The Institute of Agricultural Research (IAR) of Zaria and the Bayero University of Kano were subcontracted also for the activity 2.2 to conduct field screening of cowpea and groundnut varieties with high N_2-fixation potential and their adaptation to abiotic stress in three agro-ecological zones of Northern Nigeria. Five groundnut and three cowpea cultivars (each also for different maturity group) were tested in presence/absence of P fertilizer application (20 kg P ha^{-1}). Field experiments were established in 2011, plants were harvested at 50 % flowering and the nodulation and biomass parameters collected, grain yield measurement was done in at the final harvest. Preliminaries results from data indicated that: at Warawa, Albasu, Soba, TudunWada, and Kachia, no significant grain yield differences were observed amount cultivars, while significant increase of cowpea and ground yield were observable following P application.

Activity 2.4. Explore the N_2-fixing potential of multi-purpose forage legumes for intensive meat and milk production and environmental services

Initially planned for the year 2, the current activity only begun in the year 3. In the absence of the use of adoption of forage legumes other grain legumes in the agricultural production systems of small farmers in the Northern Guinea savanna of Nigeria for legumes such as Mucuna and stylosantes species, dual purpose groundnut and cowpea varieties were identified and protocols to test their potential to produce fodder and grain yield developed. The objectives are :(1) to evaluate the folder production of selected cowpea and groundnut varieties across a range of soil types and agro-ecology, (2) to evaluate the grain yield production of dual-purpose cowpea and groundnut under different inputs regimes, and (3) to assess the rotational benefit of maize succeeding legume's plants. Field's sites are identified, and the required inputs prepared for the establishment of the trials. Sowing have commenced in the respective site.

Activity 2.5. Identify best-fit agronomic practices (system design, need for amendments) for maximizing potential benefits of legume and inoculant technologies on increasing and stabilizing productivity

Eighteen on-farm adaptive trials were conducted in 2011 to assess the input response of soybean, groundnut and cowpea. The aims were to determine under varying biophysical conditions (i) the response of soybean to Rhizobial inoculation and (ii) the response of cowpea, groundnut and soybean to fertilizer P fertilizer and micronutrients application. The inputs used as treatments in the trials were (i) single superphosphate (SSP), which is the commonly available P straight fertilizer in the country, (ii) 'Crystaliser', a commercially available rock P (RP) fertilizer that is mined from Sokoto in Nigeria, and (iii) 'Agrolyser' (AGRL), a commercially available blend of micronutrients (Mn, Fe, Mo, Bo, Cu) and some secondary elements (Ca, Mg, S).

Objective 3. Select superior rhizobia strains for enhanced BNF and develop inoculum production capacity in sub-Saharan Africa, including private sector partners

Activity 3.1.

Activity 3. 1.1 Quality assurance protocols are developed for legume inoculants based on existing knowledge

1250 units of 200 g packs of Legume-Fix soybean rhizobial were purchased from Legume Technology in the United Kingdom and purchased by N2Africa Nigeria. The inoculants were air-freighted to Nigeria and the entire delivery process (from pick up at Legume Technology to delivery at IITA) took about two weeks. Two packs were randomly selected from each box and submitted to QA tests based on cell counts using the drop plate method, and on contamination based on the PGA (Peptone - Glucose - Agar) method. The results are still awaited.

Activity 3.1.2. Assess the need-to-inoculate for the target legumes and identify elite strains across the impact zones

This activity was subcontracted to ABU to assess the need of inoculation for several soils sampled from farmers' fields in the Northern Guinea and Sudan savannas of Nigeria. The needs to inoculate of 31 soil among the 45 sampled were established. The inoculation response (IR) and the relative efficiency to inoculation (RE) of each soil were calculated following the equations 3.1 and 3.2.

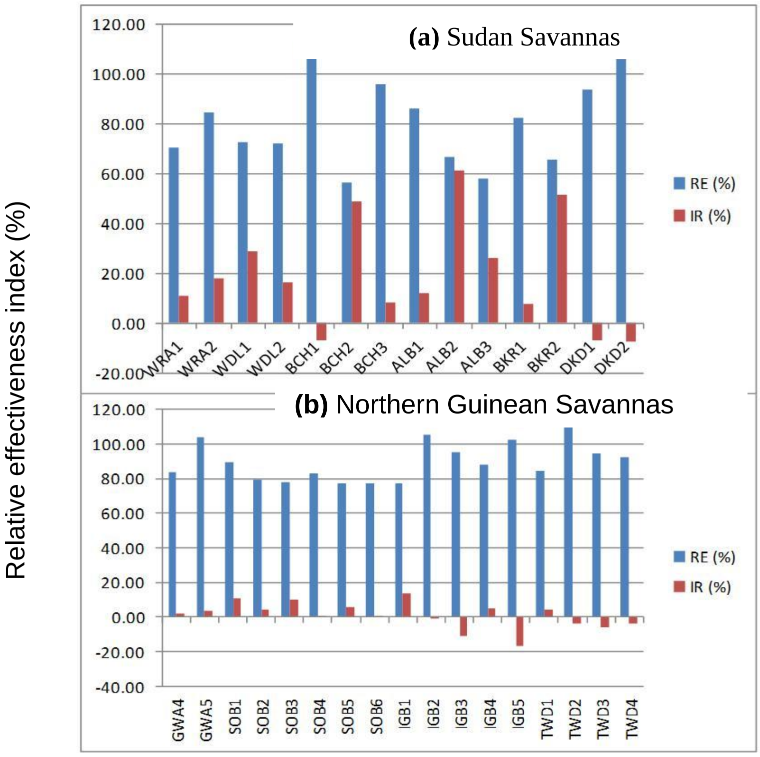


Figure 6.1 Effectiveness of native rhizobia (RE) and responses to applied inoculants (IR) of selected soils of Nigeria as assessed under greenhouse conditions

(Eq. 3.1), .IR = 100 (c-a)/a, where a= dry matter weight in control treatment, and c= dry matter weight of inoculated treatment;

(Eq. 3.2), RE= Relative efficiency (RE) = 100a/b., b = dry matter weight in plus N treatment

For a few selected soils from the Northern Guinea savannas, the need-to-inoculate was also assessed by estimating the numbers of indigenous rhizobia using MPN counts.

Large differences were observed between soils; Soil samples from the Northern Guinea savannas were shown non-responsive while drier soils responded more readily to inoculation (figure 6.1). The results of MPN counts indicated numbers of rhizobia ranging only 305-3456 cells/g soil for the Northern Guinean, suggesting a low inoculum potential of soils of this area (figure 6.2). The lack of response to inoculation suggests there are still other limiting factors (such as soil physical-chemical properties) that need to be also addressed. This approach, once validated, may serve as a complement to conducting MPN assays alone.

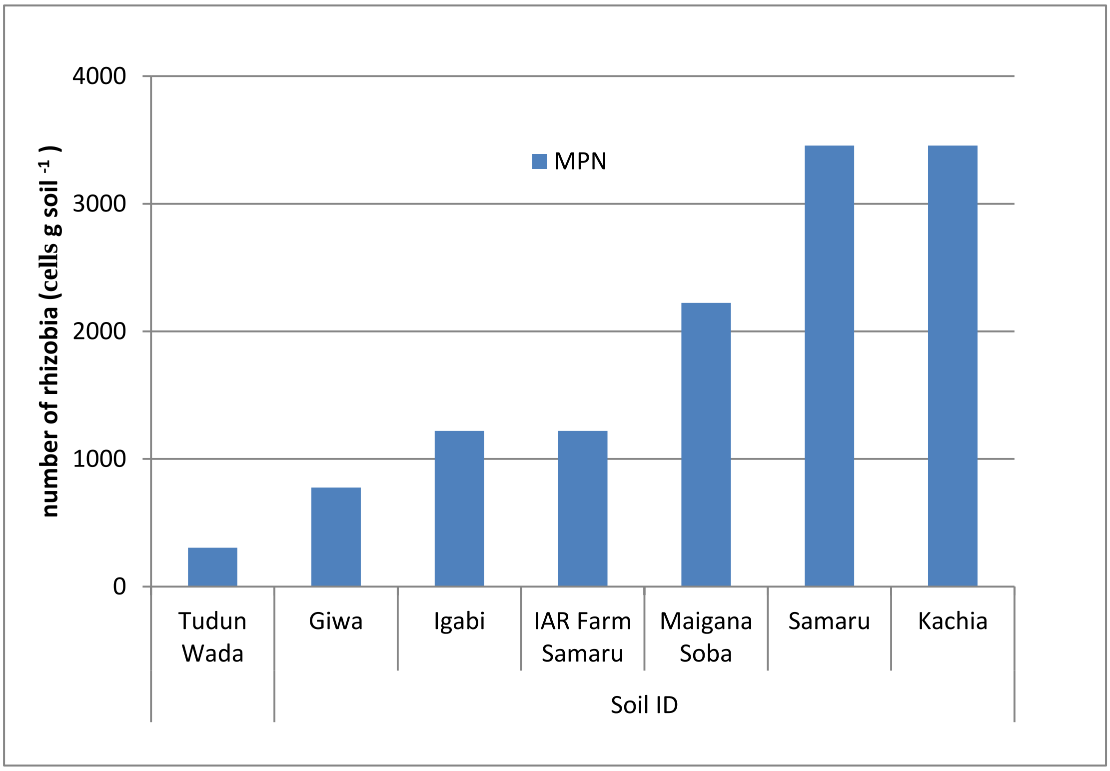


Figure 6.2 Inoculum potentiel of selected NGS soils in Nigeria as assessed using the MPN method for rhizobia enumeration

An additional need-to-inoculate bioassay was conducted for 30 soils collected from 15 localities. This was to assess potential inoculation response of homesteads as compared to bush park lands. Preliminary results suggest significant differences among localities in the inoculation response (Figure 6.3). There were also indications that distance from household could more or less impact response of legumes depending of the community.

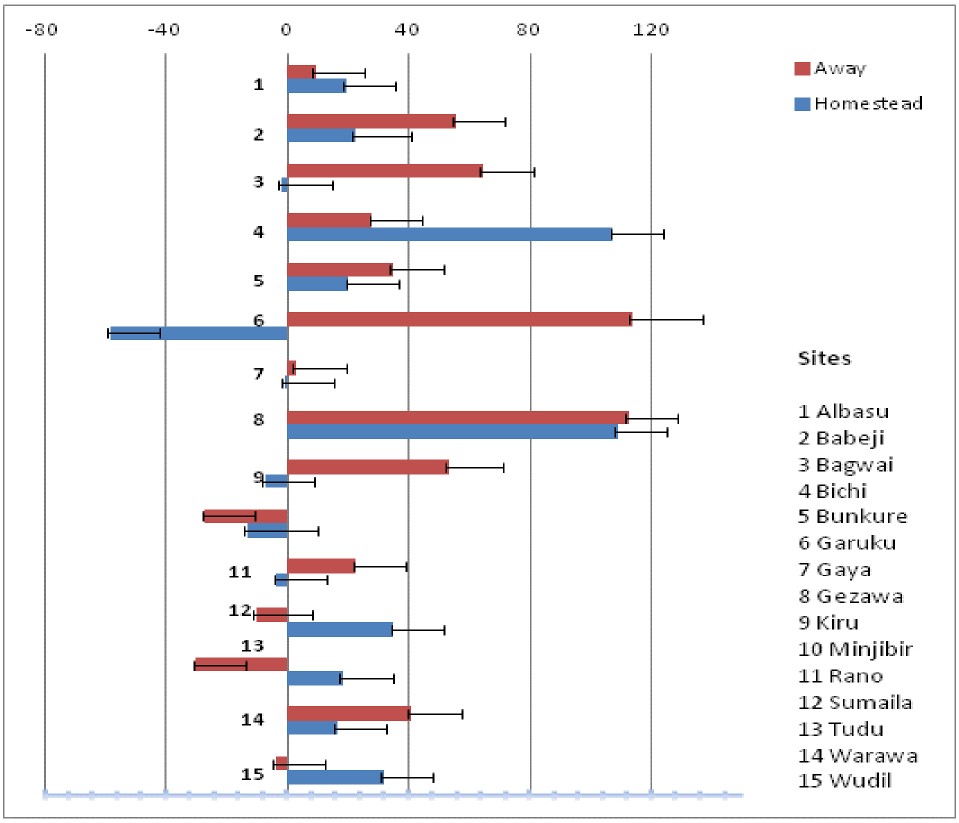


Fig 6.3. Inoculation Response (IR %)

Activity 3.2. Establish and characterize a rhizobium germplasm bank in the impact zones

Following the completion of the need-to-inoculate trials in the green house at IAR Zaria, about 20 soybean nodules were collected from the control treatments of soil sampled from 45 sites giving a total of 900 nodules collected and kept on silica gel. The isolation of these nodules started in the first week of October 2011 and over 80 nodule bacteria have already been isolated. Additional nodules have been collected from plants sampled from 50 demonstration plots managed by farmers. These nodules are also being stored on silica gel at the IITA Kano Station. Nodule collections, bacteria isolation and rhizobial authentification resumed in July 2012.

Activity 3.5. Conduct and advocate policy review on inoculant quality and cross border movement.

A potential inoculant producer has been identified and has expressed a willingness to set up an inoculant plant in Nigeria. The proposed plant manager attended the inoculum training course organised at and planning meeting and the external review program organised in Kano in June 2012. The investor participated in field visits of soybean farms with N2Africa staff in September 2011. Africa staff has continued to provide the investor technical support towards the establishment of an inoculant plant to be ready for the 2013 planting season. The project has not yet started working with regulatory agencies of Nigerian government to facilitate policy review on rhizobial inoculants. However, the model put in place during implement and development of COMPRO I and COMPRO II projects will used to ensure adequate for inoculant quality control and use are in place.

Objective 4. Deliver legume and inoculant technologies to farmers throughout sub-Saharan Africa

Activity 4.1. Create strategic alliances for facilitating dissemination of legume and inoculant technologies in the impact zones

In continuing the present activity initiated from year 1 &2, the project worked to develop strong partnerships along the entire value chain of the mandate crops by engaging with existing development programmes, legume seed production and marketing activities, farm input, commodity marketing and processing initiatives, and household and children's nutrition programs operating in the country. For the campaign 2012, the project engaged the Federal University of Technology of Minna as new included partners.

Activity 4.3.Engage with other legume seed production and marketing activities, farm input, commodity marketing and processing initiatives, and household and children's nutrition programs operating throughout the impact zones

In collaboration with other developmental projects at IITA in the mandate area (TLII and Striga project) for the seed production scheme, the N2Afria has worked towards setting up community seed producers only in communities where other sister projects had implemented as to avoid duplication of the same initiative. For the 2012, large proportions of the used seeds were sources from the community seed producer trained in 2011 campaign.

Activity 4. 4. Conduct collaborative legume and inoculant technology dissemination campaigns and create awareness in rural communities in all impact zones

In the 2011 season, the project worked to cover 11,868 households in the respective project impact zone of the Northern Nigeria though establishment of 624 demonstration (DEMO) plots of which 55 % were made-up for soybean (318 DEMO plots), 35 % of cowpea (202 DEMO plots), and 15 of groundnut (104 DEMO plots). During the 2012 demonstration campaign, the project is targeting to work to engaged 30600 household in the respective impacts zone (Table 6.2).

Table 6.2. Number of established demonstration engaged household, and extension t agents to supervise field demonstration campaign in 2012.

	Established demonstration plots per crop per commodity used				Number of engaged household in the Demonstration campaign per commodity				Extension agents
State/LGA	Soybean	Cowpea	Groundnut	Total	Soybean	Cowpea	Groundnut	Total	
Kaduna State									
Soba	39	7	18	64	975	175	450	1600	8
Giwa	39	15	10	64	975	375	250	1600	8
Igabi	39	18	7	64	975	450	175	1600	8
Kachia	64	0	0	64	1600	0	0	1600	8
Z/Kataf	64	0	0	64	1600	0	0	1600	8
Kajuru	64	0	0	64	1600	0	0	1600	8
Lere	64	0	0	64	1600	0	0	1600	8
Total	**373**	**40**	**35**	**448**	**9325**	**1000**	875	1600	**56**
Kano sate									
Doguwa	64	0	0	64	1600	0	0	1600	8
Tudunwada	40	12	12	64	1000	300	300	1600	8
Bunkure	40	12	12	64	1000	300	300	1600	8
Dawakinkudu	30	17	17	64	750	425	425	1600	8
Wudil	40	12	12	64	1000	300	30	1600	8
Gaya	20	22	22	64	500	550	550	1600	8
Albassu	25	19	20	64	625	475	500	1600	8
Garko	40	12	12	64	1000	300	300	1600	8
Bichi	25	19	20	64	625	475	500	1600	8
Total	**324**	**125**	**127**	**576**	**8100**	**3125**	3175	1600	**72**
Niger State									
Zone 1	40	16	24	80	1000	400	600	2000	10
Zone III	16	64	40	120	400	1600	100	3000	15
Total	**56**	**80**	**64**	**200**	**1400**	**2000**	1600	5000	**25**
Grand Total	**753**	**245**	**226**	**1224**	**18825**	**6125**	**560**	**30600**	**153**
Zone 1	40	16	24	80	1000	400	600	2000	10
Zone III	16	64	40	120	400	1600	100	3000	15
Total	**56**	**80**	**64**	**200**	**1400**	**2000**	1600	5000	**25**
Grand Total	**753**	**245**	**226**	**1224**	**18825**	**6125**	**560**	**30600**	**153**

The design of the Demonstration plot remains similar as in 2011 and similar hierarchy of organisation each farmers group in the different community. The Lead farmer in each group managed demonstration plots of 30 m x 20 m, while the other 24 members (herein after called satellite farmers) each had plots of 20 m x 10 m dimension. Each lead farmer was provided with 2 kg of seeds of improved varieties and 8 kg of P fertilizer in form of single superphosphate (SSP). In addition, soybean farmers (both Lead and satellite farmers) had rhizobial inoculant sufficient for the plot size being managed. Lead farmers of cowpea and groundnut were, in addition to seed and fertilizer, supplied with 1litre of insecticide. All satellite farmers were each given .0.5 kg of seeds of improved varieties and 2 kg of SSP. A functional innovation platform made up of governmental and non-governmental organisations, improved coverage and quality of demonstration in many communities. Inputs are distributed against a token fee of 200 – 1200 Naira (1. 25 – 7.5 USD) depending on the crop and the role of farmer in the project.

Activity 4.5. Develop strategies for empowering women to benefit from the project products

Because of cultural history of small farmers in Northern Nigeria, female are less engaged in field activities such as planting, weeding or land preparation for sowing. In reverse, female are more involved housework. To encourage their participation in the project, modules in legume processing technologies were developed and trainings were held for over 282 women from 8 communities during the last season. This activity is to continue 2012.

Objective 5. Develop and strengthen capacity for BNF research, technology development, and application

Activity 5.2. Advanced training to MSc and PhD level of an elite young cadre of African scientists focused on topics filling identified knowledge gaps and identified through competitive calls

The PhD nominee for N2A fellowship, Aliyu Abdullahi Anchau, was offered a scholarship by Murdoch University in Rhizobiology to pursue the PhD work training program at Murdoch University under the supervision Prof John Howieson and Dr Graham O'Hara during the stay in Australia. There are also a number of students who work partly financed by the project though subcontract grant to national university partners. The Msc Student from Zaria succeeded to isolate 88 indigenous rhizobial strains from the soybean roots from diverse soil of the northern Nigeria.

Activity 5.3. Training-of-trainers workshops on legume and inoculant technologies for agricultural extension workers and NGO staff

Pre-season trainings are being held presently for extension agents and lead farmers at the beginning of season of 2012. Extension agents are trained on optimal condition to mix seed with inoculant, explained of the field design and precaution to take care for the demonstration installation. How SSP fertilizer should be applied. Subsequent mid-season training will be organised for evaluation, and field days with farmers group.

Activity 5.4. Training workshops on legume and inoculant technologies for agro-dealers and officers of farmer associations and community-based organizations

Two trainings for Agro-dealers in handling and commercialisation of inoculants were held in Kano and Kaduna where 30 agro-dealers were trained in the inoculants technologies.

7. Rwanda Country Report on Month 30 of the N2Africa Project

By Frederick Baijukya (country mentor), Speciose Kantengwa (Farm Liaison Officer) and Mathilde Uwizerwa (Rhizobiologist)

Objective 1. Establish a baseline of the current status of N2-fixation, identify niches for targeting N2-fixing legumes in the impact zones, M&E and impact assessment.

Activity 1.3. Identify new opportunities for targeting legume technologies to increase BNF and enlarge the area under the priority legumes.

Milestone 1.3.2. New opportunities identified prior to each new cropping season. Month 3, years 2, 3&4.

The Government of Rwanda has promoted soybean become one of priority crops in the country. This follows the laying of a foundation stone to construct a soybean/sunflower oil extraction plant at Kayonza, the project jointly funded by the Rwanda Government, Clinton Hunter Foundation and other private investors. As a result, soybean is now grown on consolidated land as a key rotational crop with cereals (maize and rice). The newly introduced soybean varieties Saga and Squire appear to have greater yields in Rwanda and resistance to soybean rust disease. These varieties are undergoing characterization in preparation for release. Another opportunity is the formalization of bean market through the established Rwanda Agribusiness Industry. Under this initiative, the government, through Development Bank of Rwanda has supported construction of warehouses in beans growing areas where beans are received, sorted, graded and parked according to market requirements. This has increased interest of farmers to cultivate improved bean varieties which have been identified for high BNF as they have high market de mand. N2Africa, through her partners has put in place a strategy to multiply seeds of these varieties in order to meet increasing demand.

Milestone 1.3.3. Complete market analysis for inoculum in representative areas of the three hubs reported on, including cost/benefit analysis at smallholder level; recommendations for private sector engagement made. Month 6, year 2.

The microbiology laboratory at RAB Rubona continues to produce inoculants to meet the local demand. Inoculants are produced in packets of 80 g which is sold at RWF 500 (about USD 0.8). This price is highly subsidized as it does not take into account the cost of labor, electricity, supplies etc. Inoculants demand in Rwanda is not well established information on the quality of produced inoculants is generally missing. A breakdown of production cost and profit including a detailed feasibility study is needed to establish the potential market established. This information will help COCOF, a partner who has shown interest invest in inoculate to make the right decisions. On this aspect the expertise of Dr. Paul Woomer is highly need.

Activity 1.4. Quantify the current on-farm N2-fixation in the target farming systems and its impact on livelihoods (income, nutrition).

Estimates of BNF were done based on data from agronomy and Delivery and dissemination (D&D) trials and from detailed farm characterization done in Rwanda, and results presented in Milestone report 1.4.2. However, the estimates followed an approach used in crop models where *BNF = (legume yield x grain nitrogen content x NDF) / NHII* following lack of results of natural abundance of N^{15} analyses of the samples collected from trials as well as farmers fields. For Rwanda, estimates of BNF is reported to range between 33 and 51 kg/ha for soybean, 43 to55 kg/ha for bush bean and 63 to78 kg/ha for climbing bean, depending on the site as well as on the use of P fertilizers, inoculants and their combination. The actual estimates of BNF and the potential benefits of BNF will be provided as ^{15}N analyses results become available.

Milestone 1.4.2. A baseline report quantifying the current level of BNF and its contributions to rural livelihoods is available for all impact zones. Month 12, year 1.

Activity 1.5. Monitor impact of investments and uptake of legume and inoculant technologies in the impact zones.

Milestone 1.5.2. A monitoring and evaluation framework used for evaluating progress and planning subsequent activities during planning. Month 3, years 2, 3 & 4.

Several routed M&E forms continue to be filled by partners and subsequently forwarded to the M&E specialist for analysis and advice. Use survey tool developed by the M&E team was applied to monitor the uptake of legume technologies by beneficiaries in 13 action sites. The survey started in December 2011 and was completed in March, 2012. Data entry was completed in April and sent to Data work stream leader for analysis.

Milestone 1.5.3. An external project review has been conducted, with representatives of the Bill & Melinda Gates Foundation. Month 6, year 3.

The external project review is delayed because the contracted evaluator Dr. John Lynam fell sick during the period he had to conduct the evaluation. His visit to Rwanda is planned for late June, 2012.

Activity 1.6. Evaluate the impact of introduced legume and inoculant technologies on farmer's livelihoods and soil health in the impact zones.

Milestone 1.6.1. A report on the impact of N2-fixation technologies on farmers' livelihoods is produced. Month 12, year 4.

Not yet done for Rwanda

Objective 2. Select multi-purpose legumes (food, fodder, stakes, and soil fertility management) for enhanced BNF and integrate these into farming systems.

Activity 2.1. Identify and field test best varieties of soybean for high N2-fixation capacity and adaptation to abiotic and biotic stresses.

Four soybean varieties namely SB 24 (Namsoy), SB 8, Sc Saga, Sc Squire and Sc Sequel were selected for biomass accumulation (BNF potential) and yield. These varieties, under good soil and climatic conditions, do respond well to rhizobia inoculation and P fertilizers giving yield ranging between 1,800-4,000 kg/ha (Figure 7.1). The variety SB 24 is earmarked for release this year while other varieties (SB 8, Sc Saga and S Squire) are under national variety performance test (NPT) at 16 sites in preparation for release next year. The same varieties continue to be tested for response to rhizobia and inoculation at the NPT sites.

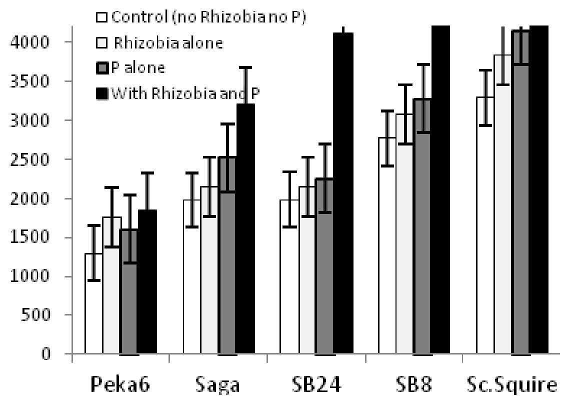


Figure 7.1: Response of selected soybean varieties to rhizobia, P and their combination in relation to the local check (Peka6)as observed at Rukara site in Kayonza action site during 2011B growing season.

Activity 2.4. Explore the N2-fixing potential of multi-purpose tree and forage legumes for intensive meat and milk production and environmental services.

Milestone 2.4.2. Sufficient planting materials are available for at least 2 multipurpose tree legumes and 4 forage legumes with high BNF capacity that have been identified across the impact zones. Month 12, year 2.

Sufficient seeds were available for two tree legumes *Lucaena pallida* and *Lucaena diversifolia* and seven herbaceous legumes *Medicago sativa, desmodium distorotum, Stylothanses guianensis, Stylosanthes scabra, Clitoria ternatea, Desmantus vulgates and Macroptilium atropurpuleum.* Two demonstration plots have been established at Kamonyi and Gakenke action sites for farmers to learn on management of species. 40 cattle or goat keeping farmers (20 from each action site) are also testing the species in their farms, where a farmer is testing one tree legume and 1-2 herbaceous legumes, depending on size of his/her farm. In the demo and farmers' fields, the herbaceous legumes species are established on a 4 m by 4m plot while the tree legumes are established on the farm boundaries or plot boundaries. Monitoring of the performance of established legumes is ongoing.

Activity 2.5. Identify best-fit agronomic practices for maximizing potential benefits of legume and inoculant technologies on increasing and stabilizing productivity.

Milestone 2.5.1. At least 9 adaptive [impact zone-specific] research campaigns focusing on major gain legume (soybean, cowpea, groundnut, beans) implemented in the impact zones. Month 6, year 2.

Trials to examine the effect of combined use of different sources of P fertilizers (DAP, TSP and Sympal) on soybean and maize yields, effect of liming acidic soils in the northern highlands on beans response to application of P fertilizers and inoculants and benefit of application of farm yard manure in beans continues in 13 action sites. A total 15 trials were established in 2011 short rains season and data processing and entry has just been completed. About the same trials were repeated in the 2012 long rains growing season where data collection is ongoing. Results from trials in these two seasons will be presented in year 3 report.

Activity 2.6. Evaluate contributions of best fit agronomic practices to system productivity and livelihoods with specific attention to trade-off analysis between competing enterprises.

Milestone 2.6.1. Household benefits from specific BNF interventions quantified for the four major grain legumes in the impact zones. Month 12, year 3.

Compilation of data necessary to quantify benefit from BNF interventions for soybean and beans in various action sites of Rwanda continues and results will be presented in Year 3 report.

Objective 3. Select superior rhizobia strains for enhanced BNF and develop inoculum production capacity in sub-Saharan Africa, including private sector partners.

Activity 3.1. Assess the need-to-inoculate for the target legumes and identify elite strains across the impact zones.

Milestone 3.1.3. At least 2,000 strains screened for effectiveness under greenhouse conditions to select the top 5% for field testing. Month 6, year 3.

The rhizobiology laboratory at RAB-Rubona has isolated and characterized a total of 252 rhizobia isolates (90 from soybean and 162 from a bean). The isolates are being screened for effectiveness against commercial rhizobial strains CIAT 899 (for beans) and USD 110 for (soybean). In addition, a total of 1000 nodules have been collected (400 from soybean and 600 from beans) for strain isolation. Bio-prospecting work will continue to include diverse ecosystems ranging from the lowlands of Akagera agroecosystem, the highland of Burera in the north to the Nyungwe forest in South West.

Milestone 3.1.4. The benefits of inoculation of soybean and beans with at least 2% of the elite strains demonstrated in the impact zones. Month 12, year 3.

Not achieved yet. This will depend on the availability of elite strains from activity 3.1.3.

Activity 3.3. Formulate improved inoculant products and develop cost-effective production methods, including quality assurance procedures.

Milestone 3.3.2. Cost effective inoculant production methods including fermentation technologies, carrier selection, inoculant formulation, enhanced shelf life developed. Month 12, year 2.

This has not been attempted in Rwanda. Analysis of the situation in Rwanda indicate that the rhizobiology lab at RAB-Rubona is capable of doing quality control and produces on average 2,800 packets of rhizobium inoculants. However, produced noculants contain between 10^3 and10^6 rhizobial cells, the number which, is far below the N2Africa standard set at 10^9 to10^{10} cells. This is attributed to several factors including inefficient sterilization of carrier materials, poor control of pH of carrier material (acidic peat with pH below 3 is used), use of low quality strains and poor storage methods of inoculants. Staff in this lab have low capacity to implement such activities, thus support from experienced rhizobiologist is needed.

Milestone 3.3.3. Universal logo representing quality assurance standards adopted among cooperating laboratories. Month 6, year 3.

The proposed candidate logo and accompanying grading system by N2Africa and distributed to rhizobiologists at RAB has been is currently been discussed by RAB scientists and feedback will be provided as soon as the decision is made. RAB-Rubona finds this a good contribution to the desire by Rwanda Government to have a standard for microbial products including rhizobia.

Activity 3.4. Expand and upgrade inoculant production capacity in sub-Saharan Africa.

Milestone 3.4.3. At least 50,000 inoculant packets produced per year in at least 3 cooperating laboratories. Month 12, year 2, 3 & 4.

As mentioned before, RAB-Rubona continues to produce inoculants to meet local demand. Currently the lab is producing about 2,800 packets (of 80 g) each per month despite low quality. For the coming season the lab is charged to produce about and now is charged to produce about 437,500 packets enough for use on 35,000 ha of soybean crop.

Milestone 3.4.4. Potential private sector inoculant producers invited to planning meeting and interim assessment workshops. Month 6, years 1, 2 & 3.

COCOF a key partner in D&D and a driver of soybean industry in Rwanda has showed interest to produce inoculants. COCOF is requesting N2Africa for advice and to support conduct a feasibility study before it can formally apply for assistance from potential donors. Again, we will need support from experienced rhizobiologist to implement this activity.

Objective 4. Deliver legume and inoculant technologies to farmers throughout sub-Saharan Africa.

Activity 4.1. Create strategic alliances for facilitating dissemination of legume and inoculant technologies in the impact zones.

Milestone 4.1.3. At least 10 additional satellite sites have been identified per impact zone. Month 12, year 3.

Three satellite sites serving more than 3,800 households have been established. The sites are operated by EPR church (working with 167 households), Medicus monde (working with 125 households); the Clinton Foundation (working with 3,013 households) and farmer cooperatives working under COCOF out of her usual action sites (with about 200 households). All the action sites are testing several N2Africa technologies including use of inoculants, improved seeds soybean processing.

Activity 4.2. Produce specific dissemination tools, including inoculant packets, adapted to the needs of farmer groups, agro-dealers, and development partners.

Milestone 4.2.1. At least 1 dissemination tool for each Action Site related to legume and inoculant use is produced per impact zone, resulting in about 24 different tools by the middle of year 3. Month 6, years 2, 3 & 4.

Four new dissemination tools were composed for use in 2012B growing season. These include use of fertilizer Sympal in demo plots established at 8 sites in Kamonyi, 8 sites in Bugesera and 3 sites in Kayonza; testing of 2 new Seed co soybean varieties Sc Saga and Sc Squire planted in 6 demo sites (3 in Kamonyi and 3 in Kayonza); use of sisal strings as an alternative method of staking climbing beans in northern Rwanda and testing of 3 new fortified climbing bean varieties currently promoted by RAB and Harvest Plus project.

Activity 4.3. Engage with legume seed system, market, and nutrition initiatives operating in the impact zones.

Milestone 4.3.3. At least half of the farming communities engaged in the project are actively linked to legume market outlets. Month 12, year 2.

In Rwanda, all soybean producers are well linked to organizations COCOF and SOSOMA industries key buyers and processors of soybean. Farmers in all action sites, through their cooperative societies are linked to the newly established Rwanda Agribusiness Industry which is supporting the construction of warehouses and providing sorting, grading and parking materials to meet the market requirements. The large volumes of grains collected under these facilities are bought by Government institutions including schools, colleges and Prisons. CARITAS-Rwanda through its food security (Postharvest handling and storage) department has established the grain collection centers in Bugesera district. The centers are run by the farmer cooperatives and grains sold to customers from within and outside the district.

Milestone 4.3.4. At least half of the farming communities engaged in the project are linked to legume processing initiative. Month 12, year 3.

A group of 26 women from all 13 action sites were trained in processing and value addition of soybean and beans in September 2011. The training was offered by specialized section of COCOF factory and 2 nutritionists form Ministry of agriculture. The trained farmers have in turn trained 320 farmers in various action sites. Farmers growing beans were trained on postharvest processing and storage of beans through their respective cooperatives working under Rwanda Agribusiness Industry.

Activity 4.4. Conduct collaborative legume and inoculant technology dissemination campaigns and create awareness in rural communities in all impact zones.

Milestone 4.4.1. Dissemination and extension process and Proof of Principle in pilot site testing documented. Month 10, year 1.

The information from Rwanda was provided and contributed to Milestone 4.4.1. Report.

Milestone 4.4.2. Large-scale demonstration and dissemination campaigns held in each impact zone. Month 6, all years.

Sixteen large scale demonstration and dissemination campaigns were established during 2011B in 13 action sites with the participation of 5,000 households. The focus is on climbing bean-maize rotation (in Burera and Gakenke), maize-soybean rotation, cassava-beans intercropping and soybean rhizobia inoculation (in Kamonyi, Kayonza and Bugesera). Additional eighteen demonstration and dissemination campaigns were proposed during a 2 day planning meeting held in February, 2012 and launched at the beginning of 2012B growing season (Early April, 2012). The focus is on new Seed co soybean varieties in action sites Kamonyi, Kayonza and Bugesera (3 demos); new Zn and Fe rich climbing bean varieties in Gakenke and Burera (2 demos) and soybean inoculation +Sympal fertilizers in Kamonyi, Bugesera and Kayonza (3 demos). Ten (10) demos on climbing bean-maize rotation (in Burera and Gakenke), maize-soybean rotation and cassava-beans intercropping continues in Kamonyi, Kayonza and Bugesera action sites with participation of 11,050 households.

Milestone 4.4.3. At least 3 extension events (e.g., field days, exchange visits) organized per season per country. Month 9, all years.

Thirteen field days were conducted by partner organization in their respective mandate areas in December 2011. All partner organizations participated in open days organized in their respective districts (Burea, Gakenke, Kamonyi, Bugesera and Kayonza) between February and March 2012, where N2Africa technologies were exhibited. In November 2011, 5 farmers (one from each impact zone) participated in the study tour in Kenya. N2Africa team in Rwanda will participate to the National Agricultural show planned for June this year.

Milestone 4.4.4. At least 3 mass media events (e.g., radio programs, video documentaries) organized per hub. Month 12, all years.

Nine media events were conducted between November 2011 and April 2012. These we in the form of radio show (3 by partner COCOF in HUGUKA FM-radio, 4by partner DRD on Radio Musanze FM, 1 by farm liaison officer on HUGUKA FM radio), TV show (1 by partner COCOF) and bulletin (1 by partner CARITAS).

Activity 4.5. Develop strategies for empowering women to benefit from the project products.

Milestone 4.5.2. A report documenting the involvement of women in at least 50% of all farmer-related activities produced. Month 9, years 2, 3 & 4.

Information on current participation of women on project activities between March-May 2012 is being collected. However, during 2012 B growing season, on average,60% of farmers participating in project activities were women in the following order; partner COCOF 83%, partner DRD 60%, partner EPR 37% and partner CARITAS 60%.

Milestone 4.5.3. At least 2 special events on the role of legumes in household nutrition and value-added processing conducted per country. Month 12, all years.

A total of 26 women participated to a 2 day Training of Trainers (ToT) on soybean processing which was organized in November, 2012. Training topics included: general nutrition, soybean as a crop, hygiene in the kitchen, soybean recipes and was delivered in theory and practice (2 day training). These women have to date trained about 580 women and continue to do. Follow-up on use of gained knowledge by farmers is planned for July this year.

Objective 5. Develop and strengthen capacity for BNF research, technology development, and application.

Activity 5.2. Advanced training to MSc and PhD level of an elite young cadre of African scientists focused on topics filling identified knowledge gaps and operationalization of a gender-sensitive participatory monitoring and evaluation framework.

Milestone 5.2.1. At least 14 MSc and 7 PhD candidates selected for training from the impact zones. Month 6, year 1.

Training of MSc and PhD continues as follows:

i) MSc
   - Student Alfred Rumongi registered with Nairobi University completed his course work but waiting to research some exams in August.
   - Student Domitilla Mukamkubana registered National University of Rwanda continues with coursework but has started developing her research proposal with the working title “Evaluation of effectiveness of extension approaches by different institution in Rwanda”

ii) PhD
   - The candidate Edward Rurangwa is undergoing admission process at WUR

Activity 5.3. Training-of-trainers workshops on legume and inoculant technologies for agricultural extension workers, NGO staff, and agro-dealers.

Milestone 5.3.2. At least 8 training-of-trainers workshops (1 workshop in each country), attended by at least 40 farm liaison staff, conducted on inoculation technology and legume agronomy. Month 10, years 2 & 3.

The following training of trainers workshop were conducted during the reporting period:

i) Training on community seed production conducted by RAB to 94 farmers (50 men 44 women) one farmer from each cooperative society implementing project activities.
ii) 26 women 3 from each mandate area were trained on soybean processing.
iii) 34 agrodealer working under COCOF were trained on fertilizer and seed handling.
iv) 45 farmers from Kamonyi and Kayonza were trained on use of PICS bags.

Activity 5.4. Training workshops on legume and inoculant technologies for officers of farmer associations and community-based organizations.

Milestone 5.4.2. At least 2 grass-root training events organized by each of 320 to 640 trainers across all impact zones, with an expected attendance of 50 farmers per event [resulting in 51,000 farmers trained during year 3 and 132,000 during year 4]. Month 12, years 3&4.

Before onset 2012 A seasons, 104 members of local authorities were sensitized by project partners on the importance of project with focus on BNF technologies. In additional our partner Caritas has trained 46 Master Farmers to facilitate its program on food security.

Milestone 5.4.3. At least 30 agro-dealers in each hub are trained in accessing, managing and distributing information on inoculant use each year [270 trained agro-dealers by year 4]. Month 10, years 2, 3 & 4.

In November 2011, 34 agro-dealers from the mandate areas Kamonyi and Kayonza were trained on fertilizer and seed handling. The training was facilitated by seed and fertilizer specialists from RAB. These same agro-dealers will be trained by rhizobiologist from RAB on handing, use and storage of rhizobia.

Activity 5.5. Provide training, educational and extension resource materials to support activities 5.1 – 5.4.

Milestone 5.5.3. Support for undergraduate and postgraduate education will be provided through access to long distance education programs, visiting professorships or adjunct appointments in the area of N2 fixation at 25 African Universities, and the provision of resource materials to assist in course planning and evaluation. Month 12, year 2.

Although not directly related to the milestone, various training materials developed by N2Africa have been used as valuable resources for BSc, MSc and PhD students attached to the project.

Milestones 5.5.4. Training programs will organized in collaboration with selected private sector partners in each of the mandate zones for various categories of staff in key aspects of inoculant production and quality control. Month 3, year 3.

No training has been organized. However, the newly recruited project training officer has been contacted in this regards. This training is crucial for staff working in the microbiology laboratory at RAB- Rubona to enhance their capacity in production of quality inoculants.

8. Zimbabwe Country Report on Month 30 of the N2Africa Project

Prepared by Judith de Wolf (Country Coordinator), Isaac Chabata (Farm Liaison Officer), Talkmore Mombeyarara (Agronomist), Byron Zamasiya (IFAD Liaison Officer), SPRL

Objective 1. Establish a baseline of the current status of N2-fixation, identify niches for targeting N2-fixing legumes in the impact zones, M&E and impact assessment.

Activity 1.3. Identify new opportunities for targeting legume technologies to increase BNF and enlarge the area under the priority legumes.

Milestone 1.3.2. New opportunities identified prior to each new cropping season. Month 3, years 2, 3&4.

In the 24-month report (December 2011), we reported on the new opportunities that were identified prior to the 2011-12 cropping season. Since there is only one raining season per year in Zimbabwe, we have only just begun to evaluate the 2011-12 season and have yet to come up with new opportunities for the 2012-13 season. Data collection is going according to plan and therefore recommendations from agronomy trials and the information from the Field Books will be available well in time for the next season which starts around November. A review and planning meeting to be conducted with all D&D partners on 18-19 June 212 will also identify adjustments and recommendations from the 2011-12 season.

So far, SPRL has not found possibilities to produce smaller sachets of inoculant, particular for soybean. This would be a most appropriate initiative as the current sachets are sufficient for an amount of soybean to plant one hectare. The large majority of smallholder farmers in the communal areas in Zimbabwe do not cultivate such surfaces with soybean. SPRL acknowledges the importance of smaller packs and together we will continue to explore options.

In collaboration with the IFAD-funded project entitled ‘Increasing smallholder farm productivity, income, and health through widespread adoption Integrated Soil Fertility Management (ISFM) in the Great Lake Regions and Southern Africa’, we are piloting the use of hermetic bags in the action sites, particularly for cowpea and some for common beans.

Milestone 1.3.3. Complete market analysis for inoculum in representative areas of the three hubs reported on, including cost/benefit analysis at smallholder level; recommendations for private sector engagement made. Month 6, year 2.

The responsibility/ies for the implementation of the activities for this milestone have shifted several times. At present we have a comprehensive analysis from Kenya (Paul Woomer) which will assist in performing a similar analyses in Zimbabwe.

Activity 1.4. Quantify the current on-farm N2-fixation in the target farming systems and its impact on livelihoods (income, nutrition).

Milestone 1.4.2. A baseline report quantifying the current level of BNF and its contributions to rural livelihoods is available for all impact zones. Month 12, year 1.

Project report no. 39 by E. Ronner and A.C. Franke of April 2012 reports on this Milestone.

Activity 5. Monitor impact of investments and uptake of legume and inoculant technologies in the impact zones.

Milestone 1.5.2. A monitoring and evaluation framework used for evaluating progress and planning subsequent activities during planning. Month 3, years 2, 3 & 4.

Overall, the M&E tools have readily been accepted by the D&D partner organsations in Zimbabwe. A significant part of the funding that was made available for M&E by the former Project Leader had been transferred to these partners and in general there are no major problems in getting them to collaborate on data collection. The Farm Liaison Officer is very active in ensuring D&D partners comply with delivery of data. Data entry is organised and supervised by the Farm Liaison Officer and is being done as data is coming in from the different action sites. Input distribution, field days and training events have been received from the action sites. The larger part of the Lead Farmer Assessment has been received and entered, though this data is somewhat time consuming to analyse, evidence from other countries indicates that this tool could give useful insights into who the Lead Farmers are and their capability to train their fellow farmers. The Use Survey is scheduled for the later part of June and first week of July.

The partner organisation that was implementing activities in Guruve district, CLUSA, disengaged from the N2Africa project due to a change in their focus of work. We followed their recommendation to continue implementation of N2Africa activities with a local CBO, the Lower Guruve Development Association (LGDA). Due to problems of transport and heavy workload of the field officer assigned to N2Africa, this partner is not readily fulfilling all N2Africa activities, including the M&E requirements.

The IFAD-funded project has been provided with the N2Africa M&E data collection tools. For the input distribution the N2Africa Farm Liaison Officer actually ensure the collection of the data. These data sheets have been handed over, but unfortunately the data has not been entered. The IFAD Liaison Officer has used the data collection forms for the trainings that he facilitated. As these trainings are currently still on-going, we are yet to get the data from him. Some of the field days we jointly organized by N2Africa and IFAD and therefore we can be certain that the data is captured.

Milestone 1.5.3. An external project review has been conducted, with representatives of the Bill & Melinda Gates Foundation. Month 6, year 3.

The necessary documents from Zimbabwe have been forwarded to external evaluator. The team in Zimbabwe stands ready to receive him in-country and co-learn from this external project review.

Activity 1.6. Evaluate the impact of introduced legume and inoculant technologies on farmer's livelihoods and soil health in the impact zones.

Milestone 1.6.1. A report on the impact of N2-fixation technologies on farmers' livelihoods is produced. Month 12, year 4.

The crops of the 2011-12 season have recently been harvested and data collection and entry is on-going. In close collaboration with the economist from the IFAD-funded project we aim to prepare simplified cost-benefit analyses to disseminate with D&D partners to farmers. This is deemed necessary in the perspective of diversifying D&D approaches in the upcoming 2012-13 season in which we aim to engage more closely with private sector partners.

Objective 2. Select multi-purpose legumes (food, fodder, stakes, and soil fertility management) for enhanced BNF and integrate these into farming systems.

Activity 2.1. Identify and field test best varieties of soybean for high N2-fixation capacity and adaptation to abiotic and biotic stresses.

Milestone 2.1.2. At least 3 new soybean varieties with high BNF potential identified. Month 12, year 2.

Elite soybean varieties from SeedCo, SC Saga, SC Squire and Safari, continue to be evaluated across the different agro ecological regions in agronomy trials. Total biomass production (biomass and grain yield) is used as a proxy for biological nitrogen fixation.

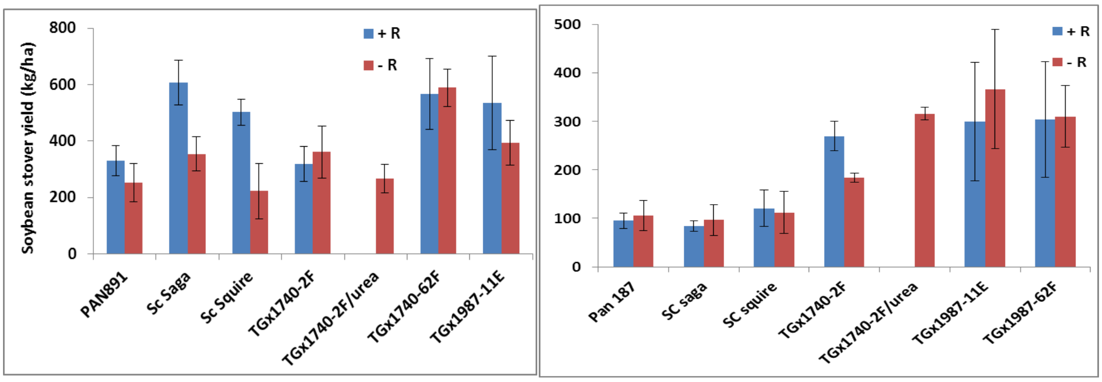


Figure 8.1: Soybean biomass yield in two different areas in Zimbabwe

SC Saga and SC Squire have shown some high yielding characteristics. The promiscuous varieties from IITA were superior in biomass yield, especially in clayey soils. The varieties SC Saga and SC Squire are readily available on the market and widely promoted across Zimbabwe while the promiscuous IITA varieties, which have also yielded high even without inoculation, are not readily available on the market. TGx1740-2F, TGx1987-11E and TGx1987-11E all had relatively high yield comparable to SC Squire in some instances, but superior in other cases. The same variety trials have been repeated in the 2011-12 season, although on a wider variety of soils to capture adaptability and yield differences across the different farming environments. Yields results are pending analysis, but similar yield trends are expected.

Activity 2.4. Explore the N2-fixing potential of multi-purpose forage legumes for intensive meat and milk production and environmental services.

Milestone 2.4.2. Sufficient planting materials are available for at least 2 multipurpose tree legumes and 4 forage legumes with high BNF capacity that have been identified across the impact zones. Month 12, year 2.

The first milestone under this activity (Milestone 2.4.1. Four forage legumes with high BNF capacity have been identified across the 3 impact zones) was originally scheduled for month 12 of year 1. Within the project it was decided to delay this milestone and this work therefore started in the second season of N2Africa implementation in Zimbabwe.

In this second season for N2Africa in Zimbabwe, trials to evaluate adaptability of multipurpose trees have been set-up across different ecological zones in the country. The selection of species and trial design has been done in partnership with Professor Barbara Maasdorp from the Department of Crop Science, University of Zimbabwe and Ms. Dorah Mwenye, agroforestry specialist from Agritex.

The multipurpose tree species that are being evaluated in Zimbabwe are *Acacia angustissima*, *Cajanus cajan* (pigeonpea), *Gliricidia sepium, Leucaena esculenta, L. leucocephala, L. pallida* and *L. trichandra*. The growth of these species will be evaluated over the two years. Response to inoculation is also being tested across the different ecological zones namely, Chikwaka (Natural Region II) Hwedza (Natural Region III) and Mudzi (Natural Region IV). Seedling survival and biomass yield will be determined across the different agro-ecological regions. The farmers hosting the trials are dairy farmers who appreciate the value associated with these forages.

For the annual forages the following have been selected: velvet bean (*Mucuna pruriens* var. *utilis*), trailing cowpea (*Vigna unguiculata*), lablab (*Lablab purpureus*), sunnhemp (*Crotalaria juncea*), sunnhemp (*C. ochroleuca*), and forage soybean (*Glycine max*, promiscuous, likely derivative of Hernon 147). Biomass yield and adaptability to different areas will be determined with and without addition of mineral fertilizers. These experiments are ongoing and results are still pending harvesting and analysis. Sufficient seed will be available after harvesting from the farmers' fields in the 2012 season for further dissemination of the promising species.

Activity 2.5. Identify best-fit agronomic practices for maximizing potential benefits of legume and inoculant technologies on increasing and stabilizing productivity.

Milestone 2.5.1. At least 9 adaptive [impact zone-specific] research campaigns focusing on major gain legume (soybean, cowpea, groundnut, beans) implemented in the impact zones. Month 6, year 2.

Reference is made to the 24-month report from Zimbabwe for a complete overview of agronomic research in Zimbabwe in the 2010-11 season (see also Appendix 8.1).

In the 2011-12 seasons, the following agronomy practices are being explored:

- Rhizobium inoculation;
- P-fertilizer additions;
- Combinations of different P-fertilizers with dolomitic lime;
- Fertilizer blends;
- Soil liming (dolomitic lime);
- Addition of organic manures;
- Timely disease control in cowpeas using pesticides.

Results from the 2010-11 season from non-responsive soils were very low and this has led to the combined use of cattle manure at a rate of 5t/ha and with fertilizer in soybean production in the agronomy trials in the 2011-12 season. The non-responsive sandy soils yielded below 700 kg/ha grain of soybean in the 2010-11 season. Yields above 1.5 t/ha are expected from the same soils but with a history of manure application, and with combination of manure and mineral fertilizer in this same season.

Table 8.1: Overview agronomy trials (input, variety & forages), 2011-12 season, Zimbabwe

District	Legume	Input or Variety Trial	Location	No. established	Planting date
Chegutu	Common bean	Input	Mhondoro	1	n/a
Chegutu	Soybean	Input	Mhondoro	3	15/12/2011
Chikwaka	Annual forages	Forage	Chikwaka	3	15/02/2012
Chikwaka	Tree Legume	Forage	Chikwaka	3	14/02/2012
Guruve	Annual forages	Forage	Ward 7	3	n/a
Guruve	Common bean	Input	Ward 7	2	19/01/2012
Guruve	Soybean	Input	Ward 7	2	18/01/2012
Guruve	Tree Legume	Forage	Ward 7	3	29/03/2012
Hwedza	Annual forages	Forage	Makwarimba	2	16/02/2012
Hwedza	Common bean	Input	Chigondo	3	24/01/2012
Hwedza	Soybean	Input	Chilonge	3	29/12/2011
Hwedza	Tree Legume	Forage	Makwarimba	3	17/02/2012
Makoni	Cowpea	Input	Rukweza	4	01/12/2011
Makoni	Groundnut	Input	Rukweza	4	30/11/2011
Mudzi	Annual forages	Forage	Ward 14	3	28/02/2012
Mudzi	Soybean	Input	Makanjera	3	26/01/2012
Mudzi	Soybean	Variety	Makanjera	1	27/01/2012
Mudzi	Tree Legume	Forage	Ward 14	3	29/02/2012
Murehwa	Common bean	Input	Chikwati	2	31/01/2012
Murehwa	Common bean	Variety	Chikwati	1	01/02/2012
Murehwa	Groundnut	Input	Ward 12	2	06/12/2011
Murehwa	Soybean	Input	Chikwati	3	12/06/2011
Murehwa	Soybean	Variety	Chikwati	2	06/01/2012
Murehwa	Cowpea	Input	Ward 12	2	29/11/2011

Activity 2.6. Evaluate contributions of best-fit agronomic practices to system productivity and livelihoods with specific attention to trade-off analysis between competing enterprises.

Milestone 2.6.1. Household benefits from specific BNF interventions quantified for the four major grain legumes in the impact zones. Month 12, year 3.

Household benefits will be quantified for most households in the 2011-12 season through the implementation of the N2Africa Field Book for technology evaluation. In total, 300 households have been targeted for the survey spread across the seven Action Sites and implementation is currently underway.

Objective 3. Select superior rhizobia strains for enhanced BNF and develop inoculum production capacity in sub-Saharan Africa, including private sector partners.

The work under Objective 3 on rhizobiology in Zimbabwe is implemented by the Soil Productivity Research Lab (SPRL, under of the Chemistry and Soil Research Institute in the Department of Research and Specialist Services (DR&SS) in the Ministry of Agriculture, Mechanisation and Irrigation Development). Their work has been seriously delayed. This is only partly due to the delay in finalization of the MoU with DR&SS as even when MoU was finalized and funds were transferred to the institute, speed of implementation has not picked up as would have been desirable. In the meantime two no-cost extensions have been done with DR&SS, the last one expiring on the 30th of March 2012. Due to pending submission of final reports, we have not yet been able to initiate a subsequent MoU. The information below mostly originates from the 2nd draft of the final report from SPRL, submitted to CIAT-Harare on the 21st of May 2012. Adjustments were sent back to SPRL the same day, another version is still awaited from SPRL. Also the Rhizobium database is not yet filled.

Activity 3.1. Assess the need-to-inoculate for the target legumes and identify elite strains across the impact zones.

Milestone 3.1.2. By month 12 of year 1, at least 400 soil rhizobial counts (MPN) and accompanying need-to-inoculate trials conducted for soybean and beans, representing existing soil heterogeneity in 3 impact zones.

Most Probable Number (MPN) estimations and need-to-inoculate experiments were run using soils collected from six districts in which N2Africa is implementing research trials namely: Chegutu (Mhondoro), Guruve, Mudzi, Goromonzi, Hwedza and Murehwa. In both sets of experiments, common bean and soybean were used as test crops on all soils (see Appendix 8.2 for the location of the sites for collection).

Need-to-inoculate experiments were run using potted field soils collected from all the areas indicated above. A total of 23 soils were collected across the different sites. All soils were characterized for pH (Table 8.2). Soils used for need-to-inoculate experiments were corrected to pH 5.5 on the CaCl2 scale. Soybean and common bean were planted to six replicates of potted soil per area sampled. The experiment was run for six weeks under greenhouse conditions. Moisture was maintained at field capacity using distilled water. Plants were harvested and data was collected on nodule counts, nodule mass, and dry masses of shoots and roots (Table 8.3).

MPN estimations were carried out in growth pouches and the various nodulation patterns have now been recorded (for each soil) after at least 4 weeks after inoculation with (each of the) the various soils. The two experiments were run in the greenhouse before it was refurbished and a major challenge was the lack of climate control (in the greenhouse). The MPN set-up in growth pouches had a weaker buffering capacity to the temperatures due to its smaller volume in comparison to the need-to-inoculate set-up in potted field soil and this might have had some contribution to the results obtained. Nodulation patterns from the MPN experiments indicated lack of rhizobia or very little rhizobial populations in nearly all of the soils for both soya bean and common bean (Table 8.2). Additionally, soils were sampled just before the rains when microbe populations are known to be at their lowest due to seasonal fluctuations contributing to the observed low counts. However, it was necessary to sample at such a time because the results are indicative of when farmers have an early crop planted with the first rains. It was therefore decided to repeat the MPN experiment well into the rainy season to evaluate the extent of fluctuation (Appendix 8.2). MPN counts observed from the second sampling will be used to explain expected nodulation by indigenous strains when a farmer has a late crop. Soil samples were collected again from the previously mentioned six districts with an additional four districts in search of elite indigenous strains. Marondera, Chinhoyi, Bindura and Macheke were the additional districts. Growths pouches have been setup and inoculation with the soils has been done. With at least 4 sites per district, this experiment will give at least 80 MPNs (40 for soya bean and 40 for sugar bean).

46 MPNs were done and 62 MPNs are currently running. Need to inoculate trials for soybean and common bean have been completed on a total of 23 soils from 6 districts.

Table 8.2: Most probable number counts of soils without a history of soybean and common bean inoculation, sampled before seasonal rains (1st round, October 2011)

Site	District	Soil pH (CaCl2)	Soybean Rhizobial Cells g^{-1} Soil	Common bean Rhizobial Cells g^{-1} Soil
Marekeso, Chigodora	Wedza	6.75	4.19	0
Murasiranwa Jonathan	Wedza	4.4	0	0
Gororo	Wedza	5	0	0
Muzuva	Wedza	5.22	0	0
Nhemachena	Guruve	4.77	0	0
Mupfurutsa	Guruve	6.68	0	1.12
Taurai	Guruve	5.6	0	0
Maringisa	Guruve	4.66	2.29	0
Masuko	Mudzi	6.05	2.09	0
Chiripanyanga Mapindu village	Mudzi	5.85	1.02	1.12
Shorani, Mudzimu village	Mudzi	6.04	0	0
Nyakatambo	Mudzi	6.27	0	0
Gukwe	Goromonzi		0	0
Chigora	Goromonzi	4.06	0	0
Mawoko	Goromonzi	6.4	0	0
Chakuvinga	Goromonzi	5.83	0	0
Chinamhora	Goromonzi	4.97	0	1.12
Mapuranga	Goromonzi	5.95	0	0
Kadyamurune	Murewa	4.6	1.02	0
Chitemere	Murewa	4.25	2.25	0
Chakanetsa	Murewa	6.2	0	1.12
Darare,	Murewa	4.65	0	0
Zinyengere	Mhondoro	4.54	0	0
Sibanda	Mhondoro	5.81	0	0

Table 33: Nodulation and plant biomass of common bean and soybean grown in potted field soil without rhizobial inoculation.*

Source of potted soil (District)	Farmer	Nodule count	Nodule Mass	Plant dry mass(g/pot)	Root dry mass(g/pot)
Sugarbeans					
Mudzi	Shorani	74	0.283	0.967	5.12
Mudzi	Masuko	104	1.335	1.835	3.09
Wedza	Jonathan	30	0.147	2.695	3.43
Wedza	Muzuva	132	1.480	2.127	3.34
Wedza	Gororo	170	0.131	0.970	1.95
Mrehwa	Chakanetsa	2	0.005	0.360	1.06
Guruve	Mupfurutsa	29	0.070	1.150	3.13
Mhondoro	Zinyengere	35	0.006	0.460	0.68
Goromonzi	Chakuvinga	269	2.521	1.440	4.41
Soybeans					
Goromonzi	Gukwe	3	0.108	0.46	1.18
Goromonzi	Gukwe	6	0.150	1.15	3.83
Goromonzi	Maoko	1	0.027	2.07	3.87
Goromonzi	Chakuvinga	40	0.556	1.76	3.88
Guruve	Maringanise	11	0.218	1.16	4.01
Guruve	Taurai	5	0.096	2.11	5.61
Guruve	Mupfurutsa	3	0.077	1.42	4.52
Guruve	Nhemachena	3	0.148	1.19	3.36
Mudzi	Nyakatambo	1	0.012	1.05	2.15
Mudzi	Masuko	1	0.034	2.03	3.06
Mudzi	Nyakatambo	3	0.016	1.66	3.77
Wedza	Jonathan	4	0.038	2.02	2.94

**Data from pots that showed no nodulation not included the table above.*

Milestone 3.1.3. At least 2,000 strains screened for effectiveness under greenhouse conditions to select the top 5% for field testing. Month 6, year 3.

Isolation of indigenous strains: A choice of genetically-stable rhizobia is essential for recommendation as commercial inoculants, especially where stressful environmental conditions are observed frequently (Hungria *et al*., 2000). A need therefore arises to isolate and characterise indigenous rhizobia that have adapted to local conditions and that fix considerably greater amounts of N_2. SPRL seeks to isolate indigenous rhizobia and assess their N_2 fixation capabilities for possible inclusion in the rhizobium bank. These, if proven to fix more N_2 as compared to the strains in the current bank, will be recommended for use in commercial inoculants in order to improve inoculation benefits. SPRL has already started the work to isolate indigenous strains by collecting nodules from un-inoculated soybean and common bean across Zimbabwe. Nodule collection ran concurrently with the soil collection from the ten districts already listed. In the six sites where N2frica is active, nodules were collected from un-inoculated plots planted under soybean and common bean (Appendix 8.2). In the four additional districts, samples were collected from sites last inoculated more than three years ago. This was for the re-isolation of inoculant strains to assess for adaptation to local conditions. A total of 38 nodule isolates were successfully plated on agar plates (Table 8.4) and are currently being assessed on laboratory media and will subsequently be assessed under greenhouse conditions from June 2012 to September 2012. On-station field trials will be run from November 2012.

Nodules collected from ten Zimbabwean districts have been isolated onto agar plates (Table 8.4) and are currently undergoing laboratory characterisation. Infectivity authentication is scheduled to follow immediately then a biological nitrogen fixation assessment will be done in the greenhouse.

Table 34: Nodule isolates successfully plated on agar plates that are currently being characterized in the laboratory

Source / District	Total number of nodule isolates successfully plated on agar
Chinhoyi	4 soybean isolates, 0 common bean isolates
Bindura	3 soybean isolates, 2 common bean isolates
Marondera	3 soybean isolates, 1 common bean isolates
Mhondoro	5 soybean isolates, 1 common bean isolates
Goromonzi	3 soybean isolates, 2 common bean isolates
Macheke	3 soybean isolates, 2 common bean isolates
Murewa	2 soybean isolates, 2 common bean isolates
Hwedza	3 soybean isolates, 2 common bean isolates

Milestone 3.1.4. The benefits of inoculation of soybean and beans with at least 2% of the elite strains demonstrated in the impact zones. Month 12, year 3.

Activity 3.2. Establish and characterize a rhizobium germplasm bank in the impact zones.

Milestone 3.2.2. At least 10 nodules of soybean and beans collected in at least 200 sites in the impact zones, for isolate characterization and inclusion in the germplasm bank. Month 4, year 2.

Nodules collected from ten (10) Zimbabwean districts have been isolated onto agar plates (Table 8.4) and are currently undergoing laboratory characterisation. Infectivity authentication is scheduled to follow immediately then a biological nitrogen fixation assessment will be done in the greenhouse.

Activity 3.3. Formulate improved inoculant products and develop cost-effective production methods, including quality assurance procedures.

Milestone 3.3.2. Cost effective inoculant production methods including fermentation technologies, carrier selection, inoculant formulation, enhanced shelf life developed. Month 12, year 2.

Formulation of improved inoculant products and development of cost-effective production methods, including quality assurance procedures: SPRL seeks to improve rhizobium inoculant quality by exploring alternative sterilization of carrier material through gamma irradiation and reducing the particle size of the carrier material through milling. Gamma irradiation will also improve SPRL's ability to quickly respond to any major changes in real inoculant demand because a large number of sachets with carrier media can be stored and remain sterile for longer periods. These can be taken from storage and loaded with rhizobia more easily and faster as opposed to sterilizing the media first by autoclaving.

Milling the bagasse to a finer texture will increase the surface area in a sachet on which rhizobial cells will survive. A finer texture will therefore improve the keeping quality of inoculants and greater cell populations can be sustained in the sachet.

SPRL searched for gamma irradiation service providers in the region. For service providers in South Africa a major challenge was going to be freight charges to sent the carrier material to be irradiated and back. However another search revealed that gamma irradiation is now offered at Parirenyatwa hospital in Harare, Zimbabwe. SPRL is still in the process of communicating with the hospital officials to this end.

Millers were also contacted for milling the bagasse carrier and unfortunately they were reluctant to mill the bagasse due to its density which varies from their usual grains. They expressed fear that the bagasse may clog their mills. However, communication with Triangle pvt ltd (were sugarcane is milled) is in progress to find ways of having them mill the bagasse to a finer texture (to below 150um).

Samples from these two treatments will be assessed for shelf life with varying inoculum formulations. These samples will also be used in experiments assessing the shelf life of inoculant sachets with various media.

Quality assurance and testing: The inoculant factory in Zimbabwe has been producing inoculants through the last fifty years. There is a quality control procedure that has a standard for inoculants based on (i) purity and (ii) viable counts. Inoculants used in all N2Africa work in Zimbabwe were quality assured at the microbiology laboratory which supports the Legume Inoculant factory. The quality control routine involves the quality testing of two randomly picked sachets from every batch of 500 inoculants made from pure cultures injected into bagasse carrier medium which has been steam sterilized in autoclaves. The counts were determined using the drop plate method on Congo Red YEMA. The average rhizobial counts were 1.16×10^9 C.F.U. per gram of bagasse based inoculant (Table 8.5). The counts ranged from 6.04×10^8 to 2.4×10^9 C.F.U. per gram of bagasse based inoculant. These data had a variability of 39.1 (CV = 39.1%). Assuming an inoculation rate of 100 kg soybean seed per ha and 5000 seeds per kg, this supplies 2.2×10^{14} rhizobial cells per seed, well above the FAO recommendation of 1×10^5 rhizobial cells per seed for large seeded legumes, e.g. soybean.

Table 8.5: Quality control of inoculants used in N2Africa project activities for 2011-12 season, Zimbabwe

Inoculant	Source	Rhizobial count mean	Variability (CV %)	Sampling frequency
SPRL Soybean	Zimbabwe	1.16×10^9	39.1%	0.004

In November 2011, the N2Africa project requested SPRL to test four inoculants from Argentina that were to be used by the project in Malawi. The results were made availbale on the 25th of February 2012. The inoculants were tested for purity and plate counts. The inoculant carrier was labelled as peat (Sphagnum moss) bearing strain USDA 110. The rhizobial load was labelled as 2 billion (2 x 109) C.F.U. per gram of inoculant at the expiry date, labelled September 2012. There were no contaminants observed. Colonies were typical Bradyrhizobium colonies which were clean with no contaminants observed.

Plate counts: Average: 2.2 x 105 C.F.U. per gram
Range: 1.00 x 105 to 3.89 x 105 C.F.U. per gram
pH: All samples fell within the range pH 7.8-7.9

Milestone 3.3.3. Universal logo representing quality assurance standards adopted among cooperating laboratories. Month 6, year 3.

Activity 3.4. Expand and upgrade inoculant production capacity in sub-Saharan Africa.

Milestone 3.4.3. At least 50,000 inoculant packets produced per year in at least 3 cooperating laboratories. Month 12, year 2, 3 & 4.

Government funded total Rhizobium inoculant production for the 2011-12 growing season was at 60,435 sachets. Of these inoculants 56,943 were for soybeans, 2,576 for common bean, 711 for groundnut, 165 for peas and 40 for lucerne. An inoculant sachet was sold for USD 5. Inoculants were distributed to district AGRITEX offices such as Chinhoyi (1000), Rusape (500), Bindura (1000) and Hwedza (150). The N2Africa project purchased a total of 675 sachets for soybean and 510 sachets for common bean at the commercial price of USD 5. ICRISAT purchased 8 sachets for groundnuts and 2000 soybean sachets were exported to Mozambique. Distribution of inoculant is furthermore done through seed companies.

The monitoring and follow-up of distribution of inoculants from the production facility at SPRL is generally not done. The N2Africa team in Zimbabwe aims to collaborate with SPRL to begin to set up some systems of tracking the inoculants, their storage, usage, sale etc.

Milestone 3.4.4. Potential private sector inoculant producers invited to planning meeting and interim assessment workshops. Month 6, years 1, 2 & 3.

Stakeholder meetings: SPRL organized and facilitated a stakeholder workshop on inoculant use on 15 May 2012. At the time of reporting to the project, this workshop had not yet taken place. It was aimed to draw stakeholders from NGOs, national farmer unions, oil expressers, feed industry and agricultural research. It was reported that the stakeholders had been contacted and had shown keenness to attend. For the meeting is was foreseen that there would be deliberations on multi-stakeholder participation towards improving legume production (with inoculant use) in Zimbabwe across the production sectors from small-scale communal to large-scale commercial. Challenges would be discussed and possible solutions for increasing grain legume productivity. SPRL was also seeking to sensitize legume inoculant use among stakeholders in legume production.

Objective 4. Deliver legume and inoculant technologies to farmers throughout sub-Saharan Africa.

Activity 4.1. Create strategic alliances for facilitating dissemination of legume and inoculant technologies in the impact zones.

Milestone 4.1.3. At least 10 additional satellite sites have been identified per impact zone. Month 12, year 3.

In Zimbabwe no new satellites had been identified for the current season, which is the second season for N2Africa in Zimbabwe. The project is being implemented in 7 districts by the partners that were engaged at the start of the 2011-12 season (one new partner in Guruve district because former partner CLUSA changed focus of their activities away from agricultural production). In order to facilitate the increased numbers of farmers to be reached in the 2011-12 season (6400), the number of wards per Action Site was expanded. All other partners except Agritex in Makoni district had to increase the number of wards compared to the ones they were working in the first season.

This coming season might see the project setting up demonstrations into two new sites, at the request of two Members of Parliament (MPs) who were impressed by the yields that were obtained by an N2Africa farmer at a field day in Mudzi district. The farmer had obtained a yield of 960 kg from 0.4 ha. He was given 25 kg of Natal Common groundnut seed, 50 kg gypsum and 25 kg SSP for N2Africa for seed multiplication. After attending the field day, the MPs requested that the project be extended into their constituencies which were previously not in the areas covered by the project. They said they would sponsor the purchase of inputs and invite the N2Africa staff to train farmers and establish demo plots for the farmers to learn about the new BNF technologies. In other districts, District Administrators recommended that that the project be implemented in other wards not covered so that all farmers benefit from the project.

It may also be ideal to target areas with potential for legume (especially soybeans) and establish demos for farmers in those areas to benefit from the project. According to a report given by farmers at the Rhizobial Inoculant Use stakeholders Workshop held in Harare on 15 May 2012, most farmers have no proper knowledge on the use of inoculants and their use. Reports came out that in Bindura district (80 km from Harare) farmers were buying a 100g sachet of inoculant at USD 15 instead of the normal price of USD 5.

At the upcoming review and planning meeting for D&D in Zimbabwe, discussions will be initiated with the several partners in D&D to diversify our strategy in terms of both the Lead Farmer approach and the input distribution. We have begun to explore several options:

- One fertilizer company is engaging with farmers and provides inputs on credit at 15% per annum (Windmill in Goromonzi district). Plans are underway to adopt the model to other districts.
- We have been approached by the International Committee of the Red Cross (ICRC) to assist with legume production at prison farms.
- Catholic Relief Services (CRS) in Malawi has been a valuable partner. While initially N2Africa in Zimbabwe had engaged with CRS, it did not work out at the time because of their mode of operation and geographical area of operation. Possibly the leader of D&D may re-engage with CRS to explore opportunities in Zimbabwe.
- The arrangements with the agro-dealer network Feya feya fell through in preparation for the 2011-12 season, we want to target a couple of districts where both their network and our Action Sites

overlap; Feya Feya are refocusing their target market into districts with tobacco and cotton farmers where there is high demand for agro-inputs such as fertilisers and herbicides.

- There is urgent need to streamline the distribution of inoculant and making these more easily accessible to the smallholder farmers in the communal areas in Zimbabwe. Though SPRL distributes inoculants to Agritex, this is never monitored nor followed-up, and it is clear that farmers are hardly ever aware that they should be able to purchase inoculants from or through their Agritex officers. The non-commercialisation of inoculant production is constantly cited as a reason for their weak follow up on inoculant distribution to their customers. Moreover, although SPRL has a fixed retail price for the inoculants, if they access the inoculants, farmers may be asked double or even triple the price set by SPRL. Although we have repeatedly encouraged/insisted with SPRL to improve on this part of their chain, not much seems to change. We therefore feel obliged to try and engage more actively with them on this aspect to make inoculant better accessible for small-scale farmers in communal areas and at a fair price.

If we manage to get at least some of these plans going, it will be very feasible to identify several additional satellite sites in Zimbabwe. These efforts fit into the changed direction we are taking towards more sustainable interventions in closer collaboration with private sector. Although it is necessary to do so because of budgetary constraint, we also believe this will result in a more sustained impact.

Activity 4.2. Produce specific dissemination tools, including inoculant packets, adapted to the needs of farmer groups, agro-dealers, and development partners.

Milestone 4.2.1. At least 1 dissemination tool for each action site related to legume and inoculant use is produced per impact zone, resulting in about 24 different tools by the middle of year 3. Month 6, years 2, 3 & 4.

In Zimbabwe we are using the Guidelines for Lead Farmers, developed by Paul Woomer (N2Africa Scientist based in Kenya) which have been translated by the Farm Liaison Officer into vernacular for ease of use by farmers. The Farm Liaison Officer in Zimbabwe has also developed legume production guidelines for the four N2Africa legumes (cowpeas, groundnuts, soybean and common beans) and for moisture conservation in arable lands.

These tools were used in all the training-of-trainers by the N2Africa partners and government extension agents. All Lead Farmers were provided with the Guidelines for Lead Farmers and the appropriate production guidelines. In some other districts where the N2Africa project is not being implemented Agritex has also requested for copies of the Guidelines for Lead Farmers in Shona to facilitate capacity building of farmers – as these extension officer have been impressed by the comprehensiveness of the booklet.

In addition, we are testing a simplified version of the above-mentioned guidelines developed by Anne Turner (N2Africa Dissemination Specialist). We are yet to get feedback from farmers as how effective the simplified version of the guidelines is. The IFAD Liaison Officer is training farmers on collective marketing and is using a Collective Marketing Training Manual entitled ‘From farming to agriculture’ in the trainings that are being targeted in four districts where the project is being implemented (Guruve, Mudzi, Hwedza and Goromonzi).

Activity 4.3. Engage with legume seed system, market, and nutrition initiatives operating in the impact zones.

Milestone 4.3.3. At least half of the farming communities engaged in the project are actively linked to legume market outlets. Month 12, year 2.

Farmers in the different districts are linking to markets for their different products. Of importance are Mudzi and Guruve where farmers have put large hectarages to groundnuts and common beans respectively. In Mudzi, the Grain Marketing Board (GMB) and Agricom are buying legume grain from farmers and the companies have set camps in the respective wards where the N2Africa project is being implemented; they are purchasing both shelled and unshelled groundnuts from the farmers. This year the prices of the commodity have increased from that of last year. One tonne of unshelled groundnuts costs between USD 400 to 500 while shelled groundnuts are selling at USD 750. The prices are expected to increase further as the crop has only recently been harvested and generally prices go up as time goes on.

In Guruve most farmers, after realizing the profitability of common beans, have put more of the crop in their fields. Farmers have grown more common bean than the main staple crop, maize. Common bean is being sold at the farm gate price of USD 1200 per tonne. Most agro-dealers are buying the crop from farmers and reselling the crop in the capital, Harare where the prices are even more lucrative. Common bean offers a good alternative of the traditional cash crops tobacco and cotton.

In Goromonzi district Windmill is offering new marketing opportunities to farmers. Windmill is a fertilizer company that has diversified into manufacturing animal feeds and veterinary medicines. The company subcontracts to produce crops like maize, soybeans and other crops. Farmers are provided with all inputs needed and after harvest they will sell their produce to the company. The farmers are required to pay back the value of the inputs with an interest of 15% per annum.

Furthermore, the collaboration between N2Africa and the IFAD-funded project in Zimbabwe is enhancing opportunities for farmers to engage in marketing of their legume crops. In pursuit of sustainably linking smallholder farmers in the project sites to remunerative legume markets, the project has trained Lead Farmers on collective marketing in the districts of Goromonzi, Guruve, Hwedza and Mudzi (IFAD collaborative effort). The objectives of the training were to equip farmers with the necessary skills to understand markets, conduct market research, make intelligent assessments of where to sell, who to sell to along the market value chain and when to sell their produce profitably. The training also prepared farmers with the basic skills they need in order to be able to negotiate with buyers at various stages of the market chain and ways of preparing their produce so that they can sell directly to processors as opposed to other middlemen. Furthermore, the training enlightened farmers to engage in market-driven production as this minimizes chances of being stranded with their produce or product dumping to opportunistic buyers. As opposed to taking the lead in directly linking farmers to markets, the current approach prepares farmers to be able to take the lead in linking with markets with assistance from project staff. As the training was provided to Lead Farmers of the N2Africa project, it is assumed that the knowledge gained will be cascaded to other farmers. With the help of resident extension officers, farmers in project sites are presently conducting market research.

Table 8.6: Number of people trained in 'Linking farmers to markets'

District	Number of farmers trained			No. of extension workers trained	Total trainees
	Female*	Male	Total		
Goromonzi	23	17	40	3	43
Guruve	7	31	38	2	40
Hwedza	29	34	63	7	70
Mudzi	8	32	51**	5	56

** These numbers of female farmers represent the following percentages: Goromonzi 57.5%, Guruve 18.4%, Hwedza 46 % and Mudzi 20%*
*** Of 11 participants the gender is not confirmed*

Milestone 4.3.4. At least half of the farming communities engaged in the project are linked to legume processing initiative. Month 12, year 3.

Three of the partners implementing the N2Africa project form part of the Zimbabwe Adding Value to Sustainable Agriculture Produce (ZAVSAP) which is a network that works with farmers to process crops and to achieve value addition for their harvested produce. In July their annual Food Fair will take place in which these organisations will participate (CADS, LGDA, CTDT).

Farmers are undergoing some trainings on legume processing initiatives. The basic type of trainings done is the processing of the grain. Farmers are encouraged to shell and grade their groundnuts that are earmarked for marketing. The crop for household consumption is to remain unshelled since shelled groundnuts quickly lose their quality. Farmers are processing groundnuts into peanut butter, apart from the use on bread and with sweet potatoes, it is also used in cooking of vegetables, dried meat and maize porridge. Cowpeas are being pounded into flour and the product is being used for making porridge for children and ‘rupiza’, a relish that goes with sadza, the staple maize porridge in Zimbabwe. One of the N2Africa partners Cluster Agriculture Development Program (CADS) have employed a fulltime field officer who is responsible for nutrition and value addition which she does by numerous trainings of farmer groups. As these trainings have been taking place since early April and are still on-going, we are yet to receive the detailed information from the various districts. As part of some of the complimentary activities to the N2Africa project, the IFAD project coordinator has approved funds for training of farmers on value addition and processing in Hwedza, Guruve and Mudzi through the help of a hired nutritionist. The training will target the N2africa Lead Farmers and aims to capacitate farmers in processing and value addition activities both for household and market. We hope that increased consumption of processed foods would improve household nutrition and dietary diversity. The marketing of the processed foods will also boost household incomes as is already happening in Goromonzi district where farmer groups have opened a shop to sell their processed foods.

Activity 4.4. Conduct collaborative legume and inoculant technology dissemination campaigns and create awareness in rural communities in all impact zones.

Milestone 4.4.1. Dissemination and extension process and Proof of Principle in pilot site testing documented. Month 10, year 1.

Milestone 4.4.2. Large-scale demonstration and dissemination campaigns held in each impact zone. Month 6, all years.

In total, 320 demonstrations have been established in the country for the current season. Dissemination campaigns were held through trainings, field days and other meetings which were organized. The table below (Table 8.7) shows the total number of farmers reached by the project during the 2011-12 season. In reality, it is highly likely that the total numbers of farmers reached will be somewhat higher. We rushed to finalize the database of input distribution in order to allow for the drawing of the sample for the implementation of the Field Book. Since then, we are following up with for example Guruve to get the records completed.

Table 8.7: Number of Lead Farmers and other farmers, 2011-12 season, Zimbabwe

District	Lead Farmers			Other Farmers			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Murewa (CTDT)	14	21	35	220	427	647	234	448	682
Chegutu (CTDT)	15	16	31	185	374	559	200	390	590
Makoni (Agritex)	18	32	50	239	711	950	257	743	1000
Hwedza (Agritex)	27	22	49	348	598	946	375	620	995
Mudzi (Agritex)	42	16	58	488	470	958	530	486	1016
Goromonzi (CADS)	22	27	49	272	625	897	294	652	946
Guruve (LGDA)	33	15	48	464	469	933	497	484	981
Total Numbers	***171***	***149***	***320***	***2216***	***3674***	***5890***	***2387***	***3823***	***6210***
%	***53***	***47***	***100***	***38***	***62***	***100***	***38***	***62***	***100***

On average, almost 47% of the Lead Farmers are women, this is caused by low percentages of female Lead Farmers in Guruve (31%) and Mudzi (28%) – in the other districts it is much higher (between 45% and 64%). Overall, the average percentage of women farmers is 62%, the lowest percentage in Mudzi at 48%, the highest in Makoni at almost 75%.

As reported in the 24-month report, N2Africa facilitated the purchase and distribution of inputs to farmers financed by the IFAD-funded project in three districts; Guruve, Mudzi and Hwedza. The 907 farmers who benefited from these additional inputs from IFAD had been reached by the N2Africa in the 2010-11 season when they had benefitted from N2Africa input distribution. To enable them to increase production with a view to produce marketable surpluses, these farmers were given larger packs of 5 kg of seed (while N2Africa gives 1 kg).

Milestone 4.4.3. At least 3 extension events (e.g., field days, exchange visits) organized per season per country. Month 9, all years.

In total, 17 field days were organized this year and the total number of people who attended these field days was 3546 (58% of the attendees were women, see also Table 8.8). The field days were mainly organised by partner organisations. Local authorities were invited to officiate the field days. In two of the action sites Members of Parliament attended the field days alongside local councillor, village heads and other government departments.

Oftentimes, women performed dramas and sang about N2Africa project and its benefits to the in the communities. Items like value added products from the four legumes were on display at these field days and farmers learnt about the use of inoculants and recommended fertilizers for used in growing legumes. At one of the field days, in Guruve, staff from the Soil Productivity Research Laboratory (SPRL) attended and they explained to and advised farmers to use inoculants in soybean and sugar bean production since they are a cheaper option to grow the crops and they assist in soil fertility.

Table 8.8: N2Africa field days, season 2011-12, Zimbabwe

District	Partner Organisation	Ward	Village	Date	Attendance		
					Male	Female	Total
Murewa	CTDT	14	Chanetsa	07-Mar-12	68	137	205
Murewa	CTDT	15	Muziwi	14-May-12	54	84	138
Makoni	AGRITEX	27	Rukweza	05-Mar-12	38	188	226
Makoni	AGRITEX	27	Mutungwazi	27-Mar-12	172	219	391
Makoni	AGRITEX	27	Chamunorwa	13-Mar-12	79	118	197
Guruve	LGDA	15	Chihwe	26-Mar-12	37	73	110
Guruve	LGDA	7	Karambwe	22-Mar-12	59	87	146
Guruve	LGDA	5	Wachenuka	21-Mar-12	57	81	138
Guruve	LGDA	23	Chouwa	29-Mar-12	79	54	133
Guruve	LGDA	16	Chomugwada	27-Mar-12	74	101	175
Hwedza	AGRITEX	8	Nyahungwe	14-Mar-12	79	132	211
Hwedza	AGRITEX	9	Chinyanyiwa	08-Mar-12	72	104	176
Hwedza	AGRITEX	8	Chiswa	07-Mar-12	42	83	125
Goromonzi	CADS	18	Chimani	12-Mar-12	80	118	198
Goromonzi	CADS	10	Kamwendo	15-Mar-12	106	140	246
Goromonzi	CADS	11	Marimo	06-Mar-12	102	104	206
Guruve	LGDA	18	Mukwenya	28-Mar-12	85	77	162
Mudzi	AGRITEX	12	Chimwara	09-Mar-12	138	95	233
Mudzi	AGRITEX	16	Kanyoka 1	13-Mar-12	68	62	130
				Total	**1489**	**2057**	**3546**
				Total %	**42 %**	**58 %**	

As part of our N2Africa and IFAD project collaboration activities for the 2011/12 season, we jointly arranged exchange visits for farmers in Hwedza and Makoni districts. The purpose of the exchange visits was to accord farmers from the two districts an opportunity to learn and share their experiences about the legume production and marketing in their respective districts. For the exchange visits, we targeted the main ward field day in each of the two districts. The farmers who participated in the exchange visits were selected by their resident agricultural extension officers.

The first exchange visit was held on the 13th of March 2012 in Chigondo ward (ward 8) in Hwedza district. On this day, we transported 10 lead farmers (6 males and 4 females) from Makoni district to the field day. Three AGRITEX officers (2 females and 1 male) from Makoni attended the field day.

The second exchange visit was held in Makoni district on 28 March, where 12 (6 males and 6 females) farmers from Hwedza district attended a field day in Makoni District. The farmers learnt a lot from the field day since they saw that the farmers were more organised and the design of the N2Africa plot was up to standard. Staff from AGRITEX (3 males and 1 female), expressed their concerns and also had a chance to compare how farmers in different districts take projects.

The farmers from the two districts had an opportunity to share experiences in legume production and they learnt farmers from each district grew their crops and marketed their crops and the opportunities that existed for farmers to increase legume production.

Milestone 4.4.4. At least 3 mass media events (e.g., radio programs, video documentaries) organized per hub. Month 12, all years.

No mass media events were carried out in Zimbabwe. It is very challenging to do so in the current political situation in the country which restricts NGOs to go public with their activities. Any activity by NGOs attracts suspicion by authorities. Usually by investing time and energy, the government staff involved can be made to understand the true nature of the activities of the N2Africa project. Now that the collaboration with government staff at district level has much improved, we hope that there might be options for mass media events in Zimbabwe in the 2012-13 season. At the same time, the possibility of upcoming elections in the country inevitably increases tension again. For N2Africa Zimbabwe, safety of staff members, NGO and Agritex collaborators and farmers is most important.

Activity 4.5. Develop strategies for empowering women to benefit from the project products.

Milestone 4.5.2. A report documenting the involvement of women in at least 50% of all farmer-related activities produced. Month 9, years 2, 3 & 4.

For current season 62% of the farmers involved in the project are women. At present the data for 16 training events has been collected and entered; two trainings have missing data on participants, in the remaining 14 trainings, 49% of the participants were women. Looking at the available data for the field days, we find that 58% of the participants in these field days are women. Most of value addition activities for home consumption are being done by women.

Milestone 4.5.3. At least 2 special events on the role of legumes in household nutrition and value-added processing conducted per country. Month 12, all years.

Value addition trainings are being done in Goromonzi, Murewa, Chegutu and Mudzi districts for all Lead Farmers in the N2Africa project. Soya beans are being processed into flour, fritters, soya cakes. Groundnuts are being shelled and processed into peanut butter in all the districts. Cowpeas are being pounded into flour and used to make porridge and other products for household feeding. As these trainings started from Mid-April onwards, we are yet to obtain all detailed information on these trainings. The upcoming ZAVSAP food fair will also be a special event in which three of N2Africa's D&D partners will participate.

Objective 5. Develop and strengthen capacity for BNF research, technology development, and application.

Activity 5.2. Advanced training to MSc and PhD level of an elite young cadre of African scientists focused on topics filling identified knowledge gaps and operationalization of a gender-sensitive participatory monitoring and evaluation framework.

Milestone 5.2.1. At least 14 MSc and 7 PhD candidates selected for training from the impact zones. Month 6, year 1.

The two MPhil students on N2Africa scholarship are progressing well. Ms Dunjana has finalized her fieldwork and has started to write up. Her study is entitled "A socio-economic analysis of the determinants of legume production among smallholder farmers in Zimbabwe". The student and her supervisors, Dr. Mutambara and J. de Wolf are determined to finish this thesis work by December 2012.

Ms. Kainga has experienced delay in her fieldwork but is fortunately getting some results from the 2011-12 season. Her study is entitled "Symbiotic Effectiveness of Rhizobia in Smallholder Soyabean Production in Zimbabwe". She will be challenged by the fact that the requirement for MPhil at the Department of Soil Science and Agricultural Engineering at the University of Zimbabwe is to have data from at least two agricultural seasons. Without notifying N2Africa, Prof Mafongoya, the then Country

Coordinator of N2Africa in Zimbabwe, paid both students their stipend backdated to January 2010. However, the students were well aware of the fact that the N2Africa scholarship was for two years only – sufficient to do an MPhil, accepted this. Therefore N2Africa should not accept (financial) responsibility for the additional expenses that may be incurred.

The PhD candidate, Mazvita Chiduwa (nee Murwira, employed by SPRL, DR&SS), has accepted the offer letter from Murdoch University, Perth, Australia. She is preparing her departure for June, but is hindered by the requirements of Murdoch to pre-finance both the visa application as well as the ticket. Her preliminary research topic/area is "Inoculant optimization of the Zimbabwe Legume Inoculant Factory product".

In addition, N2Africa has hosted Brenda Manenji who did her MSc research from Wageningein in Zimbabwe. Her thesis is entitled "Understanding the current role of legumes and their significance for Biological Nitrogen Fixation (BNF) in smallholder farming systems of Zimbabwe". Another MSc student from Wageningen, Wietske van der Starre, did research on non-responsive soils. She was greatly assisted by SPRL in Marondera. We are awaiting her thesis.

In May 2012, N2Africa Zimbabwe organized a half day research meeting in which the Zimbabwean students participated by presenting their research and lively debates with all people involved.

Activity 5.3. Training-of-trainers workshops on legume and inoculant technologies for agricultural extension workers, NGO staff, and agro-dealers.

Milestone 5.3.2. At least 8 training-of-trainers workshops (1 workshop in each country), attended by at least 40 farm liaison staff, conducted on inoculation technology and legume agronomy. Month 10, years 2 & 3.

Training-of-Trainers sessions were conducted in the different districts (as this is far more cost effective than organize a training at a central place). These ToTs target government extension officers from Agritex, NGO field officers and Lead Farmers. In these ToTs a total of 9 NGO staff members were trained and 36 extension staff from the government. Of the trained staff 38% were women (for the division of gender amongst Lead Farmers, see section under milestone 4.4.2).

Activity 5.4. Training workshops on legume and inoculant technologies for officers of farmer associations and community-based organizations.

Milestone 5.4.2. At least 2 grass-root training events organized by each of 320 to 640 trainers across all impact zones, with an expected attendance of 50 farmers per event [resulting in 51,000 farmers trained during year 3 and 132,000 during year 4]. Month 12, years 3&4.

For the 2011-12 season, 320 Lead Farmers were trained on inoculants and legume agronomy in the country and these lead farmers cascaded the training to other 5890 farmers.

Milestone 5.4.3. At least 30 agro-dealers in each hub are trained in accessing, managing and distributing information on inoculant use each year [270 trained agro-dealers by year 4]. Month 10, years 2, 3 & 4.

The training of agro-dealers has been delayed in Zimbabwe for several reasons; one of the reasons being that we had planned to organize this training with Feya Feya, an organization of agro-dealers in Zimbabwe. This plan fell through too close to the season to be able to organize an alternative training. Since training of agro-dealers is not favorable during the agricultural season, it was decided to postpone this training to August/September 2012, in time for the next 2012-13 season.

Activity 5.5. Provide training, educational and extension resource materials to support activities 5.1 – 5.4.

Milestone 5.5.3. Support for undergraduate and postgraduate education will be provided through access to long distance education programs, visiting professorships or adjunct appointments in the area of N2 fixation at 25 African Universities, and the provision of resource materials to assist in course planning and evaluation. Month 12, year 2.

Milestones 5.5.4. Training programs will be organized in collaboration with selected private sector partners in each of the mandate zones for various categories of staff in key aspects of inoculant production and quality control. Month 3, year 3.

Training on Quality Control in Nairobi, attended by Cathrine Mushangwe (nee Kabade), principle research technician at the Soil Research Productivity Lab (SPRL).

Milestone 5.5.5. Web-based support will be provided on key N2 fixation methodologies and techniques, the maintenance and trouble-shooting advice for scientific equipment used in BNF research, and N2 fixation extension materials for download and modification for local condition. Month 12, year 3 & 4.

Revised work plan

Agro-dealer training rescheduled for August or September 2012.

For the 2012-13 season, N2Africa in Zimbabwe is supposed to reach 16.000 farmers. We have to change our approach in D&D, since there is no budget line for input purchase for the 2012-13 in the D&D workstream. Although a significant amount of seed has already been acquired, an implication of this limitation is that only an incomplete package can be distributed to farmers. One important option is to engage with the private sector (contract farming, credit facilities), but we believe it is important to acknowledge that this requires a different skill-set as compared to more conventional dissemination, working with extension officers and farmers, etc. In addition we might look for other partners who do not need funding from N2Africa and/or not inputs from the project.

In addition, we will look for diversification of the Lead Farmers approach. While the approach has its merits, at times it has proven not to be completely compatible with organizing structures of partner organisations. It may also put a strain on extension staff and cascading of knowledge is problematic if a Lead Farmer fails to comprehend. The assumption that indeed knowledge is properly cascaded has been insufficiently tested within the project. The country programme hopes the D&D specialist will engage fully with the redesign of the D&D strategy for Zimbabwe.

Risk and mitigation

1) Project sustainability

For various reasons, the N2Africa project in Zimbabwe has not paid sufficient attention to forming sustainable linkages to markets. We recognise that over 60% of the businesses folded at the onset of the dollarization era (February, 2009) and this has had an effect on business capital and the market structure. Consequently, the number of marketing players is still very limited and the demand patterns are still unstable. This thin market has precipitated conditions for collusive behaviour among the monopolistic players who are setting the prices of most legumes. However, we do believe it is a threat to project sustainability if we do not try to forge linkages between project farmers and the businesses actors. For us, it is related to the issue mentioned above on the uniform model of Lead Farmers and the mitigation of this threat therefore lies in diversification of our approach, with (much) more emphasis on linking fertilizer and seed companies to groups of farmers, training agro-dealers on N2Africa technologies (particularly inoculation), working more closely with the inoculant production facility at SPRL to make inoculants available to smallholder farmers through Agritex and agro-dealers, possible contract farming arrangements with legume processors, etc.. We re-emphasize that this requires a different skills set, particularly from the Farm Liaison Officer and it is questionable whether within the overall N2Africa project sufficient backstopping can be made available.

2) Climate

In the past two seasons we have seen great variability in climatic circumstances. Rains seem to start later than in the past, regions that are ‘normally’ doing well are suffering from erratic and low rainfall. We have also witnessed poor distribution of rain with some districts receiving all the season’s rainfall in one month. This has affected both farmers’ fields and trials, with some trials giving no results due to lack of rain. With the uneven rainfall patterns in some areas, it has at times been difficult for farmers who were sharing inoculants to plant on the same day.

These climatic risks might be (partly) mitigated by being well prepared in good time, have good contacts to quickly receive the latest information from the wards, possible adjustment of design of agronomy trials to test responsiveness of N2Africa technologies to climatic variability.

3) Lack of clarity about budgets

The continued uncertainty with regards to available budgets for the 2012-13 and the changes in what was considered to be a set budget made it very difficult to make concrete plans and even live-up to previously made agreements. Work on rhizobiology is at risk of being halted due to the fact that at present we can not enter into a new agreement while the previous agreement has expired.

In addition, in previous versions of the budget, the funds available for D&D have always be very low which resulted in a lack of commitment of D&D partners while we really need them to achieve the N2Africa objective of reaching the large numbers of farmers. While the Country Coordinator has been able to make more funds available for input purchase and disbursement to D&D partners, this was partly done using carry-overs which were apparently not available (though the Project Leader approved). We therefore risk to have over-spent.

4) Dependence on partners

While we acknowledge that this is at the same time a strength, there are also risks related to the dependence on partner organisations for the implementation of project activities and thus achieving project objectives. A partner may not live up to agreements made, they may prioritize other work, do not adhere to project principles (for instance in the previous season, one partner hand-picked Lead Farmers mostly along main road) or decide to shift (geographical) focus. In case partner organisations are also involved in data collection, they might not always prioritize your work.

Mitigation: Ensure there is a thorough understanding of what the project is about, why data is being collected, etc., feedback results, generally maintain good contact particularly with people working on the ground, provide some financial tokens of appreciation.

5) Data collection

The fact that a lot of the data from agronomy trials has to be collected at the same time in the different districts threatens the quality of the data to be collected. Although more people could be engaged to collect the agronomy data, in many cases the presence of the agronomist in required to ensure the data collected is of good quality. The agronomist will however strategize to temporarily engage one or two people to assist in the data collection. In addition, feedback will be provided to those involved to ensure future commitment to good quality data collection.

Due to the sampling strategy for the Field Book, the actual implementation of the Field Book started very late. To mitigate low quality and belated data collection, at least one person is identified in each district to assist with the data collection for the Field Book. In general, these are people already engaged in N2Africa project activities and therefore they have a good understanding of the project and its objectives. This person will receive some enumeration for the additional work and a financial contribution towards possible transport costs.

6) Uniform 'Lead Farmer model'

The rather rigid application of the Lead Farmer model might be a threat to the sustainability of the N2Africa project interventions. Previously, one partner organization identified a risk in the strategy of using lead farmers in extension. While they acknowledged "it was good for lowering training costs, there was a risk that Lead Farmers who were poor facilitators might not perform well". The partner organisation noted that some Lead Farmers performed poorly and therefore the farmers they supported also tended to perform poorly because they copied from poor performers. Therefore, in the coming 2012-13 seasons, we will diversify our D&D intervention strategy. Although we had hoped to be able to do this in close collaboration with the IFAD-funded project, at present we are not certain what activities IFAD will commit to in the 2012-13 season.

7) Political situation in Zimbabwe

We are working in a politically uncertain environment in Zimbabwe. If indeed elections draw close and campaigning starts in all seriousness, it is likely that NGOs and other organisations will be targeted. This may result in:

a. Failure to go to certain areas and thus execute work there;
b. Displacement of (target) beneficiaries due to unrest related to political developments;
c. Too much involvement of administrators and politicians at district level who are otherwise not involved in agricultural activities;

d. Damage to vehicles, trials, demonstration plots, increased difficulties paying casual labour on trial fields;
e. Increased ‘paperwork’ to get clearance at district level which can be very time-consuming and does not necessarily have workable results. It may also increase distrust of N2Africa activities by farmers and lower level extension workers.
f. CIAT might be banned from certain areas.

In the past seasons we have gained experience of how to deal with challenges related to the political environment in Zimbabwe. Although all places have their challenges, Mudzi district has been the most challenging in the current season. Lessons from Mudzi:

- Involve local authorities at district level as much as possible, make them understand what you are doing, particularly by taking them out to the field, share experiences (councillors, DA, CEO of RDC, MPs, etc.);
- Attend meetings at district level related to N2Africa activities (e.g. social welfare committee meeting of the Rural District Council (RDC));
- Building rapport, good personal relationships;
- Continuous assessment of the situation and have decision making power to withdraw from a district.

The above mentioned actions do require more time – time that is not spend in the field with farmers – and money to implement (more time away from office, accommodation, per diems, travel costs). It is difficult to predict the likelihood of the threat occurring and within what timeframe.

8) Failure to recover seed from farmers

Some partners feel that because of poor performance of crop production, insufficient awareness and understanding, farmers may fall short on repaying seed back to the N2Africa project. A lot has already been done to spread a clear message on the need to repay seed. We further aim to mitigate this risk by continuous awareness raising and emphasizing the message that the recovered seed will be distributed within the same area. We hope this will encourage farmers to pay back seed. Rather than having it send back to Harare, it will be collected within the district, sorted, treated (bags and pesticides provided by N2Africa) and stored locally and redistributed into the same areas in the next season to assist farmers in the same or neighbouring communities.

9) Overall funding situation at CIAT-Zimbabwe office

Due to the very limited number of projects currently being implemented by CIAT Zimbabwe, the N2Africa budget becomes overloaded with expenditures, particularly on staff that does not solely work for N2Africa. Moreover, such decisions with regards to the budget allocations for staff members have always been taken without involvement of the Country Coordinator.

10) Other:

- Vehicles giving problems due to heavy use. Higher costs of maintenance. The agronomist and the Farm Liaison Officer have now been assigned one particular vehicle each rather than switching between the two N2Africa vehicles. It is envisaged that this will enhance careful use of the vehicles.
- Due to workload the Farm Liaison Officer it is challenging for him to further his education as he wises to do. This is a risk as it may affect his work satisfaction (staff issue).
- At present Driver used by other projects while N2Africa is paying for salary (auditing issue).
- Use survey might need revision as it seems to become a rather expensive tool to implement.

Updated administrative information

Related to the risk mentioned above, at present there is also a driver and a field technician on the Zimbabwe N2Africa budget. Otherwise there are no major administrative changes in Zimbabwe.

Appendix 3.1: Workstream Research & Data (from 24 month report)

OBJECTIVE 2: Select multi-purpose legumes providing food, animal feed, structural materials and high quality crop residues for enhanced BNF and integrate improved varieties into farming systems

Activities 2.1, 2.2, 2.3: Selection of best legume varieties: 2.1 Select best varieties of soybean and common beans for high N_2-fixation capacity and adaptation to abiotic [low soil P, soil acidity, etc] and biotic stresses [pests and diseases]. 2.2 Select best varieties of common beans for higher N_2-fixation capacity and adaptation to abiotic and biotic stress conditions. 2.3 Select cowpea and groundnut varieties with high N_2-fixation capacity and adaptation to abiotic and biotic stress conditions.

Activity 2.5: Identification of best-fit agronomic practices

Outputs 2.1, 2.2, 2.3, 2.5.1: By month 12 of year 2 three new soybean and common bean breeding materials with high BNF traits identified and tested, (2.1.2 only soybean) and then by month 12 of year 3 forwarded to TLII and other breeding initiatives for inclusion in their respective programs. (2.1.3). By month 6 of year 1, at least 3 existing common bean varieties with proven higher BNF potential and sufficient seed availability identified for the respective impact zones. (2.2.1). By month 6 of year 1, at least 3 existing cowpea and groundnut varieties with proven high BNF potential, tolerant to biotic and abiotic stresses, and sufficient seed availability identified for the respective impact zones. (2.3.1). By month 6 of year 2, at least 9 adaptive [research campaigns focusing on major gain legume (soybean, common bean, cowpea, groundnut) implemented in the 3 impact zones. (2.5.1)

Accomplishments and challenges: Agronomy trials have been implemented by the CIAT agronomist in the first N2Africa season in Zimbabwe (2010-2011). The data from the trials has been collected, but these are yet to be analyzed. The University of Zimbabwe was not able to implement the agronomy trials as anticipated and stipulated in the MoU, and as a result, the CIAT agronomist took over all responsibility and implementation of the agronomy activities. Variety and input trials were done on all four legume crops in Zimbabwe in four of the seven action sites identified in Zimbabwe for D&D.

Groundnuts – *Evaluation of response of groundnuts varieties to P and Ca application under target areas in Zimbabwe.* Two trials were established in Murewa in early December. Varieties used in this experiment are Nyanda, Natal common, Valencia 3, Ilanda, Makulu red and Valencia 2. Nyanda, Natal common and Ilanda were purchased from Agriseeds while the remainder were sourced locally from the farmers in Murewa. Germination was almost 100%.

Groundnuts – *Determination of appropriate input requirements for the target grain legumes in Zimbabwe.* Two trials established in Murewa district, the Nyanda variety has been used for the trials. The seed was acquired from Seedco breeders, as it was unavailable on the market. Germination was about 100%.

Cowpeas – *Determination of appropriate input requirements for the target grain legumes in Zimbabwe*. Two trials were planted in Mhondoro in early December and the other two trials meant for Wedza where not planted due to delayed consent from the key partner in Wedza. IT18 /CBC1 variety was used. Germination was generally good except in some plots where Compound L was applied. This could have been caused by prolonged periods of low moisture after planting resulting in fertiliser burn.

Soybean – *Determination of appropriate input requirements for the target grain legumes in Zimbabwe*. Four trials have been established in Mhondoro, Mudzi, Murewa and Hwedza. The soya bean variety used in this trial is SC Squire from Seedco. One trial in Mudzi had very poor germination due to prolonged low moisture conditions. The trial was replanted and germination was good.

Soyabean – *Evaluation of soybean varieties for their response to inoculation in target areas in Zimbabwe*. A total of 8 trials have been planted in 4 intervention districts in Zimbabwe: Mhondoro, Mudzi, Murewa and Hwedza. The varieties used in the trials are SC squire and SC saga from Seedco Zimbabwe; PAN 891 from PANNAR Zimbabwe; TG x 1740 – 2F, TG x 1987 –628 and TG x 1987 – 11E from IITA Malawi and Magoye a cultivar developed in Zambia. Germination in these trials was generally good except for Magoye which failed totally to germinate. This is most probably because the seed was stored for too long hence was no longer viable. In some areas PAN891 was used but its germination was also very poor at about 60%.

Bush beans – *Evaluation of bush bean varieties for their response to inoculation in target areas in Zimbabwe.* Two trials have been planted in Mudzi district. The following varieties have been used: Cardinal, PAN 148, PAN 159, Speckled Ice and Bounty. 3 more trials were planted later in Murewa.

Challenges: The agronomist employed by CIAT under the N2Africa project has installed and managed all the trials without any involvement or assistance from the University of Zimbabwe. This has result in having to few staff for proper implementation of the agronomy trials in Zimbabwe which subsequently suffered in terms of timing of planting and management and data collection. An intended partner organisation in two of the districts informed us very late that they would not be actively collaborating in N2Africa and therefore it was only possible to plant one soybean trial. By then it was too late to find alternative sites for trials.

A major challenge related to inputs is the availability of the relevant varieties needed for both agronomy trials and dissemination. This included groundnut varieties, bush bean varieties and soya bean varieties. Only three certified groundnut varieties were available on the market and the other varieties had to be sourced from local farmers.

Time of availability of soya bean seed: varieties from Malawi were available for planting only at the end of December due to logistical reasons including challenges of importing new varieties with the local authorities. This meant that all eight soybean variety trials were planted late. Experimental fields: some of the fields meant for the experiments that had been sampled, referenced and the cropping history recorded were unfortunately planted by the farmers due to our late use of their fields. This meant that new fields had to be sourced, sampled again and referenced for use by the agronomist. Some of the newly assigned fields were found to be marginal fields.

Quality of seed: some of the seed purchased for the trials and dissemination had serious germination challenges. Soybean seed from PANNAR variety PAN891 had serious germination problems in some of the agronomy trials but their were no reports of poor germination in farmers fields. The IT18 cowpea variety bought from ARDA was a mixture of IT18 and CBC1.

Heavy downpours: excessive rainfall within short periods of time resulted in heavy wash away of some farmers' fields in some parts of Hwedza. Some parts of Mudzi were not be accessible after heavy downpours because small bridges, which easily overflow.

Makoni and Wedza: all trials intended for Makoni were not planted. Only soya bean was planted in Wedza. This was due to the fact that the intended partner organisation in these areas informed us very late that they would not be actively collaborating in N2Africa.

Table 8.9: List of trials planted across different districts, season 2010-11, Zimbabwe

District	Village	Trial	Legume	Varieties used	Inputs tested
Wedza, Chigondo Ward	Svinurai	variety	soyabean	TG x 1740 – 2F; TG x 1987 – 628; TG x 1987 – 11E; SC Squire; SC Saga; PAN891	SSP, Dolomitic lime, KCl
	Bhake	Input	soyabean	SC Squire	Compound L, SSP, Dolomitic Lime,
	Chiwenga	Input	soyabean	Sc Squire	Compound L, SSP, Dolomitic Lime
Chegutu, Mhondoro	Chakwenya	input	soyabean	Sc Squire	
	Mushayi	variety	soyabean	TG x 1740 – 2F; TG x 1987 – 628; TG x 1987 – 11E; SC Squire; SC Saga; Magoye	SSP, Dolomitic lime, KCl
	Chikwanha	input	cowpea	CBC1	Compound L, SSP, Dolomitic Lime,
	Mandebvu	input	cowpea	CBC1	Compound L, SSP, Dolomitic Lime,
Murewa, Musami	Gwindi	variety	groundnuts	Nyanda, Natal common, Valencia 3, Ilanda, Makulu red and Valencia 2.	SSP, Dolomitic lime, calcium sulphate
	Kadadi	input	soyabeans	SC Squire	Compound L, SSP, Dolomitic Lime,
	Kadadi N	variety	sugarbeans	Cardinal, PAN 148; PAN 159; Speckled ice; Bounty	SSP, Dolomitic lime, KCl
	Ngundu	variety	soyabean	TG x 1740 – 2F; TG x 1987 – 628; TG x 1987 – 11E; SC Squire; SC Saga; Magoye	SSP, Dolomitic lime, KCl
	Muchemwa	input	groundnuts	Nyanda	Compound L, SSP, Dolomitic Lime,
	Madekufamba	variety	sugarbeans	Cardinal, PAN 148; PAN 159; Speckled ice; Bounty	SSP, Dolomitic lime, KCl
	Bhunu	variety	groundnuts	Nyanda, Natal common, Valencia 3, Ilanda, Makulu red and Valencia 2.	SSP, Dolomitic lime, Calcium sulphate
Mudzi	Joromani	variety	soyabean	TG x 1740 – 2F; TG x 1987 – 628; TG x 1987 – 11E; SC Squire; SC Saga; PAN891	SSP, Dolomitic lime, Calcium sulphate
	Makanjera	variety	soyabean	TG x 1740 – 2F; TG x 1987 – 628; TG x 1987 – 11E; SC Squire; SC Saga; PAN891	SSP, Dolomitic lime, Calcium sulphate
	Masuko	input	soyabean	SC Squire	Compound L, SSP, Dolomitic Lime,
	Chanhasi C	input	sugarbean	Speckled ice	Compound L, SSP, Dolomitic Lime,
	Chanhasi A	variety	sugarbean	Cardinal, PAN 148; PAN 159; Speckled ice; Bounty	SSP, Dolomitic lime, Calcium sulphate
	Masuko A	variety	sugarbean	Cardinal; PAN 148; PAN 159; Speckled ice; Bounty	SSP, Dolomitic lime, Calcium sulphate
	Goromonzi	input	sugarbean	Speckled ice	Compound L, SSP, Dolomitic Lime,

Update: From the 33 trials originally planned in Zimbabwe for the 2010-2011 growing season, 23 trials were established and only 10 eventually gave yield data. The bulk of the trials were lost due to management issues. Over-ambitious planning and poor performance of the implementing partner (UZ) caused this large difference between the plan and the actual achievements. Yield data were collected from one bean, two cowpea, two groundnut and five soybean trials. Five of these trials (including all groundnut trials) were located in a particular region of Murehwa, just a few kilometres apart from one another. Yields attained were generally low, the main reason being poor soil conditions. Late field selection resulted in most experiments being established in poor sandy outfields which were rather unsuitable for legume production.

Groundnut: Groundnut yields ranged from 200kg/ha to about 400kg/ha in the two input trials established. The results do not show significant differences on the inputs applied. Treatments with Compound L showed signs of fertiliser burn. This was mainly evident in the very early stages of the crop (2-4 weeks after emergency) and affected the crop growth rate through the growth phase.

Cowpea: Yield data from the two experiments did not give conclusive results. One of the trials had very high biomass yield due to the high soil N status, but the grain yields were low. A negative correlation between grain and biomass existed in this particular trial; the higher the biomass the lower the grain yield because vegetative growth was at the expense of reproductive growth. Plots were compound L was applied gave low grain yield but high biomass yield due to the additional N in the compound L. The other trial was on a poor sandy soil hence there was a positive response to fertiliser application. However the grain yield was very low because of the poor soil conditions but also due to poor rainfall distribution especially during the pod filling stage. No significant differences were recorded between the different fertiliser amendments but the biomass yields showed a general response to P application.

Soybean: The results showed very strong responses to inoculation suggesting very low effective rhizobial population in the poor soils and low soil N availability. Clear responses to applications of Compound L and SSP, and not to dolomite alone in some of the trials proved that at these low yield levels, P and/or S limited soybean growth, and not Ca or Mg. Also the additional elements in Compound L (K and B), relative to SSP, did not affect yield. In the input trials, Compound L and SSP proved to be the best fertilisers to use for soybean production.

Results were attained from only 3 trials; some other trials were harvested by the farmers before the agronomist could reach them. The results showed high biomass yields from the promiscuous TGx varieties from IITA compared to the local SeedCo varieties. Grain yield was generally higher in the local SeedCo varieties but in some instances comparable. The TGx varieties did not respond to inoculation while the local SeedCo varieties responded well to inoculation.

Common bean: Data was collected from only one bean variety trial in Murewa after all the trials planted in Mudzi had dried up due to severe drought stress. The best variety was Cardinal in this trial which yield higher grain and biomass yield compared to the other varieties. During the season, there were visible differences between inoculated and uninoculated.

See also article on agronomy trials in Zimbabwe, N2Africa Podcaster no. 10, October 2011, pp4-6.

For the 2011-12 season, the number of trials has been reduced. Instead of the large factorial experiments replicated on one site, simple experiments replicated by farmer are going to be established. Better fields fit for legume production have been selected and less trials will be put on the poorly fertile soils, especially in Murehwa. Soybean and bean trials will also be held at sites with a higher silt and clay content, e.g. in Guruve and Chegutu districts.

In addition, the agronomy team will start data collection in a large number of D&D trials. These trials cover a much wider variation in soil types and climate conditions than the agronomy trials, and therefore give a better overall picture of the performance of legume technologies than the agronomy trials conducted at a limited number of sites. So far 6 groundnut and 6 cowpea trials have been planted and planting of both soybean input trials and variety trials is in progress. A better opportunity to partner with UZ in establishing agronomy trials exists this season because of the presence of a Masters student based at the UZ who will be implementing trials in the same N2Africa intervention districts.

Detailed protocols for the agronomy trials on varieties and inputs are available.

Appendix 8.2: Sites where nodule and soil samples were collected for the purposes of performing Most Probable number counts (second round) and isolating indigenous Rhizobium strains.

Type of Sample taken			**District**	**Site**	**G.P.S. coordinates**	**Elevation**	**Cropping history**
Soil for MPN	**Soya nodules**	**Bean nodules**					
				CHEGUTU (MHONDORO)			
■	■		Mhondoro	**Nevanji**, Nevanji village, ward 10	S 18°07.613' E 030°43.044'	1338m	Groundnuts-Maize-finger millet
■	■		Mhondoro	**Zambe**, Monera village, Ward 10	S 18°07.174' E 030°44.485'	1351m	Fallow for 10 years
		■	Mhondoro	**Zambe**, Monera village, Ward 10	S 18°07.174' E 030°44.485'	1351m	Maize-groundnuts-maize-groundnuts
■	■		Mhondoro	**Mutasa**, Mushingaidze village, Ward 10	S 18°06.749' E 030°44.184'	1350m	Maize-Maize-Maize
■	■		Mhondoro	**Mushayi**, Mushingaidze village, Ward 10	S 18°06.647' E 030°44.580'	1351m	Maize-grondnuts-maize-maize
■	■		Mhondoro	**Chakwenya**, Mushingaidze village, Ward 10	S 18°06.668' E 030°44.431'	1356m	Maize-Groundnuts-sweet potatoes
■		■	Mhondoro	**Mutandwa**, Kujokera village, Ward 10	S 18°06.785' E 030°44.376'	1353m	Maize-fallow
■	■		Mhondoro	**Matambanadzo**, Kujokera village, Ward 10	S 18°06.722' E 030°44.184'	1350m	Maize-maize-sweet potatoes-sugarbeans
				CHINHOYI			
■	■		Chinhoyi	**Chivenda**, Tembale village, ward 5	S 18°07.613' E 030°43.044'	1338m	Groundnuts-Soyabeans-maize-maize
■	■	■	Chinhoyi	**Kagondo**, Chifundi village, Ward 5	S 18°07.174' E 030°44.485'	1351m	Maize-cotton-maize
■	■	■	Chinhoyi	**Muchineripi**, Chifundi village, Ward 5	S 18°07.174' E 030°44.485'	1351m	fallow-soyabeans-maize
■	■	■	Chinhoyi	**Razau**, Chifundi village, Ward 5	S 18°06.749' E 030°44.184'	1350m	Soya-Maize-Soya-wheat
■		■	Chinhoyi	**Chifamba**, Chifundi village, Ward 5	S 18°06.647' E 030°44.580'	1351m	Soya-wheat-soya-maize
■	■	■	Chinhoyi	**Mwenyendiyana**, Chifundi village, Ward 5	S 18°06.668' E 030°44.431'	1356m	Maize-Cotton-maize-soya
				HWEDZA			
■	■		Wedza	**Dewedza**, Chigondo	Not available	Not available	maize-groundnuts-maize-maize
■	■		Wedza	**Masimbira**, Chigondo ward	Not available	Not available	Maize-maize-groundnuts-finger millet
■	■	■	Wedza	**Svinurai**, Chigondo ward	Not available	Not available	Maize-maize-groundnuts-pearl millet-finger millet
■			Wedza	**Headman Ushe**, Ushe ward	Not available	Not available	maize-cowpea-fallow

			Wedza	**Mashonganyika**, Goto ward	Not available	Not available	Soyabean-maize-groundnut-maize-groundnut
			Wedza	**Masenda**, Goto ward	Not available	Not available	Maize-maize-maize
BINDURA							
			Bindura	**Zhakata**, Munemo village, ward 16	S 17°33.705’ E 031°27.166’	1222m	Groundnuts-maize-groundnuts
			Bindura	**Guvamombe**, Chirodza village, ward 16	S 17°33.914’ E 031°26.681’	1213m	Fallow for 4 years
			Bindura	**Pindama**, Chirodza village, ward 16	S 17°33.685’ E 031°26.919’	1220m	Maize-groundnut-maize-maize
			Bindura	**Kwaramba**, Mudotwe irrigation scheme, Chandavengerwa village, Ward 16	S 17°32.503’ E 031°28.682’	1202m	Maize-sugarbean-maize-peas
			Bindura	**Kanyowa**, Mudotwe irrigation scheme, Kanyowa village, Ward 16	S 17°32.123’ E 031°29.168’	1183m	Maize-wheat-maize-soybean
			Bindura	**Paraziva**, Mudotwe irrigation scheme, Kanyowa village, Ward 16	S 17°32.123’ E 031°29.168’	1183m	Maize-wheat-maize-wheat
			Bindura	**Maponga**, Mudotwe irrigation scheme, Chandagonera village, Ward 16	S 17°32.123’ E 031°29.168’	1183m	vegetables-maize-sugarbeans
GOROMONZI							
			Goromonzi	**Marimo**, marimo village, ward 11	S 17°39.885’ E 031°28.739’	1235m	Maize-zviyo-maize-groundnut
			Goromonzi	**Munemo**, marimo village, ward 11	S 17°39.860’ E 031°28.694’	1234m	Maize-groundnut-maize-groundnut
			Goromonzi	**Mundawarara**, marimo village, ward 11	S 17°39.739’ E 031°28.893’	1234m	Groundnut-maize-maize-fallow
			Goromonzi	**Marembo 1,** dehwe village, ward 11	S 17°37.314’ E 031°27.385’	1204m	Soyabean-fallow
			Goromonzi	**Marembo 2**	S 17°36.774’ E 031°27.532’	1209m	Not available
			Goromonzi	**Mhlanga**, Gwamura village, dzete ward	S 17°32.561’ E 031°31.016’	1194m	Maize-maize-maize
			Goromonzi	**Nzvimbo**, Gwamura village, dzeta ward	S 17°32.381’ E 031°31.044’	1189m	Soyabean-maize

				GURUVE			
			Guruve	**Muzhona L,** wachenuka village, ward 5	Not available	Not available	Cowpea-maize-cotton
			Guruve	**Kamumvuri Y**, mupfurutsa village, ward 5	Not available	Not available	Groundnut-maize-fallow-cowpea
			Guruve	**Gora G.**, matekenya village, ward 5	Not available	Not available	Maize-cowpea-maize
			Guruve	**Chaparadza,** Chigova village, ward 5	Not available	Not available	Bean-bean-bean-bean-maize
			Guruve	**Mupfurutsa**, mupfurutsa village, ward 5	Not available	Not available	Maize-groundnut
			Guruve	**Karambwe,** karambwe village, ward 7	Not available	Not available	Groundnut-maize-cotton-soyabean
				MUDZI			
			Mudzi	**Masuko N,** champion village, ward 12	S 17^{0}04.859’ E 032^{0}46.688’	693m	maize
			Mudzi	**Shereni H,** mushonga village, ward 12	S 17^{0}05.506’ E 032^{0}47.022’	708m	maize
			Mudzi	**Masuku T (1),** ward 12	S 17^{0}05.657’ E 032^{0}46.245’	706m	Mapfunde-history of manuring
			Mudzi	**Masuku T (2),** ward 12	S 17^{0}05.625’ E 032^{0}46.227’	707m	Mapfunde-history of manuring
			Mudzi	**Nyahodza,** makanjera village, ward 12	S 17^{0}05.593’ E 032^{0}46.660’	708m	Not available
				MACHEKE			
			Macheke	**Makumbe**			
			Macheke	**Tanga G,** ward 24, tanga village	S 17^{0}56.600’ E 031^{0}48.834’	4643m	Wheat-maize-maize
			Macheke	**Matika,**	S 17^{0}55.713’ E 031^{0}48.292’	4610m	Not available
			Macheke	**Nhidza,** Mwanjera village, ward 24	S 17^{0}55.724’ E 031^{0}50.629’	4712m	Not available
			Macheke	**Makunde farm**	S 17^{0}46.399’ E 031^{0}48.413’	4490m	Not available
			Macheke	**Kuimba,** Chitsanza farm, ward 24, chipwere village	S 17^{0}47.017’ E 031^{0}48.588’	4468m	Not available
			Macheke	**Sigauke,** tanga village, ward 24	S 17^{0}55.713’ E 031^{0}48.292’	4611m	Maize-wheat
				MARONDERA			
			Marondera	**Mapingire**, Igava	Not available	Not available	Maize-beans
			Marondera	**Ngundu**, Igava	Not available	Not available	Maize-groundnut
			Marondera	**Chikonyora**, Igava	Not available	Not available	Not available
			Marondera	**Green pastures**, Wenimbi	Not available	Not available	Not available
			Marondera	**Chingoka,** Kent farm	S 17^{0}54.612’ E 031^{0}36.322’	1399m	maize-tobacco-tobacco

			Marondera	**Manda**	S $18^0$23.955’ E $031^0$20.683’	1525m	Not available
			Marondera	**Munzverengi,** Einherd farm	S $18^0$20.741’ E $031^0$30.594’	1456m	maize-tobacco-maize-tobacco
				MUREWA			
			Murewa	**Mapanga**, ngundu village, ward 14	S $17^0$40.995’ E $031^0$41.370’	1339m	Not available
			Murewa	**Arex field**, chanetsa village, ward 14	S $17^0$46.218’ E $031^0$41.020’	1400m	Not available
			Murewa	**Kadadi**, chikwati village, ward 14	S $17^0$43.392’ E $031^0$41.884’	1362m	Not available
			Murewa	**Mbirimi**, Chanetsa village, ward 14	S $17^0$45.488’ E $031^0$41.779’	1424m	Maize-groundnut-maize
			Murewa	**Gwindi**, chikwati village, ward 14	S $17^0$42.873’ E $031^0$41.681’	1376m	Groundnut-maize-groundnut
			Murewa	**Ndombo**, goto village, ward 15	S $17^0$45.977’ E $031^0$42.560’	1430m	Bean-sweet potato

List of project reports

1. N2Africa Steering Committee Terms of Reference
2. Policy on advanced training grants
3. Rhizobia Strain Isolation and Characterisation Protocol
4. Detailed country-by-country access plan for P and other agro-minerals
5. Workshop Report: Training of Master Trainers on Legume and Inoculant Technologies (Kisumu Hotel, Kisumu, Kenya-24-28 May 2010)
6. Plans for interaction with the Tropical Legumes II project (TLII) and for seed increase on a country-by-country basis
7. Implementation Plan for collaboration between N2Africa and the Soil Health and Market Access Programs of the Alliance for a Green Revolution in Africa (AGRA) plan
8. General approaches and country specific dissemination plans
9. Selected soybeans, common beans, cowpeas and groundnuts varieties with proven high BNF potential and sufficient seed availability in target impact zones of N2Africa Project
10. Project launch and workshop report
11. Advancing technical skills in rhizobiology: training report
12. Characterisation of the impact zones and mandate areas in the N2Africa project
13. Production and use of Rhizobial inoculants in Africa
18. Adaptive research in N2Africa impact zones: Principles, guidelines and implemented research campaigns
19. Quality assurance (QA) protocols based on African capacities and international existing standards developed
20. Collection and maintenance of elite rhizobial strains
21. MSc and PhD status report
22. Production of seed for local distribution by farming communities engaged in the project
23. A report documenting the involvement of women in at least 50% of all farmer-related activities
24. Participatory development of indicators for monitoring and evaluating progress with project activities and their impact
25. Suitable multi-purpose forage and tree legumes for intensive smallholder meat and dairy industries in East and Central Africa N2Africa mandate areas
26. A revised manual for rhizobium methods and standard protocols available on the project website
27. Update on Inoculant production by cooperating laboratories
28. Legume Seed Acquired for Dissemination in the Project Impact Zones
29. Advanced technical skills in rhizobiology: East and Central African, West African and South African Hub
30. Memoranda of Understanding are formalized with key partners along the legume value chains in the impact zones
31. Existing rhizobiology laboratories upgraded
32. N2Africa Baseline report

33. N2Africa Annual country reports 2011
34. Facilitating large-scale dissemination of Biological Nitrogen Fixation
35. Dissemination tools produced
36. Linking legume farmers to markets
37. The role of AGRA and other partners in the project defined and co-funding/financing options for scale-up of inoculum (banks, AGRA, industry) identified
38. Progress Towards Achieving the Vision of Success of N2Africa
39. Quantifying the impact of the N2Africa project on Biological Nitrogen Fixation
40. Training agro-dealers in accessing, managing and distributing information on inoculant use
41. Opportunities for N2Africa in Ethiopia
42. N2Africa Project Progress Report Month 30
43. Review & Planning meeting Zimbabwe
44. Howard G. Buffett Foundation – N2Africa June 2012 Interim Report
45. Number of Extension Events Organized per Season per Country
46. N2Africa narrative reports Month 30

Partners involved in the N2Africa project

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Caritas Rwanda

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