N2Africa Podcaster no. 22

August, September and October 2013

STOP PRESS!! - As this issue was on it's way to be distributed we learned that the N2Africa Phase II US$25.3M grant has been officially approved!!

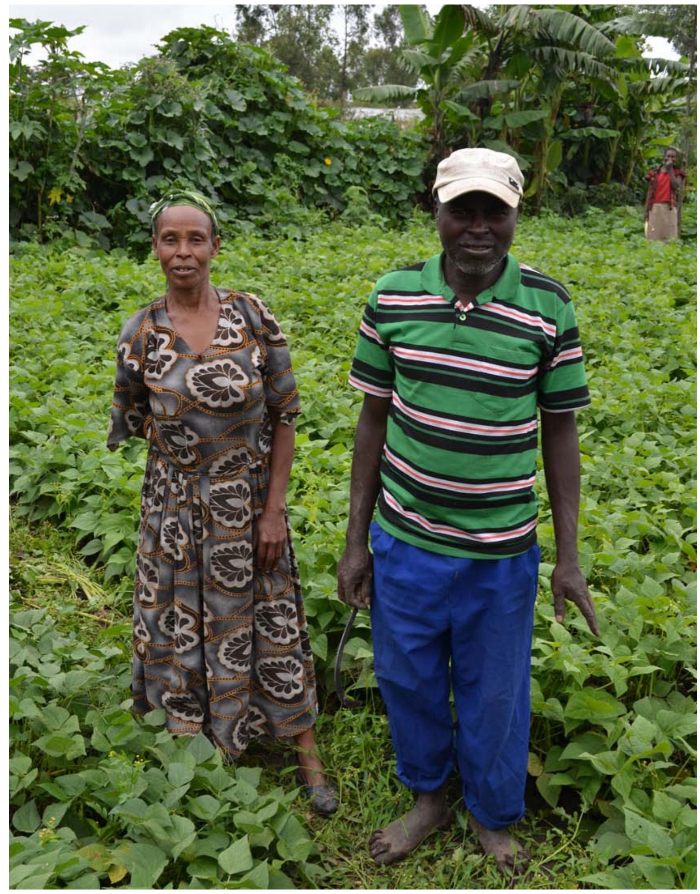
Introduction

Exciting times for N2Africa! We're gearing up for a major workshop to mark the end of N2Africa Phase I (see the invitation from Jeroen Huising) and to make detailed plans for N2Africa Phase II (as introduced by Charlene McKoin below). The first analysis of our "early impact assessment" is yielding lots of interesting insights and we share some of those with you in this Podcaster, as well as a number of other news items and updates. I'm delighted to share some articles written by our NGO partners from CADS, Zimbabwe and SG2000, Nigeria, as well as a study on the impacts of N2Africa on nutrition security of households in northern Ghana.

As part of our Phase I reflections we are collecting ideas on what makes the contribution of N2Africa? Some first suggestions are:

1. The Development to Research approach - focusing on immediate dissemination of the "best-bet" technologies and learning loops to ensure continuous improvement.
2. Proof of concept of the (G_L x G_R) x E x M equation – demonstrating that an integrated approach is needed to close legume yield gaps and get the important spill-over effects for residual benefits to crops and for livestock feeding.
3. The massive widespread testing of "best-bet" legume technologies that reveals huge variability in performance in farmers' fields.
4. The "learning loop" that has identified soil-specific nutrient deficiencies (of K, Ca, Mg, Zn) that have led to legume-specific fertilizer blends being developed and marketed (e.g. Sympal).
5. The "learning loop" using farming systems analysis that helps to identify opportunities and constraints of farm (land) size and poverty (lack of livestock and manure) that limit benefits to the poorest - YET - the flexibility of legumes means that there are technologies that can be identified as "best-fits" for every type of farmer. For the poorest households, intercropping and intensification using climbing beans can address hunger and food insecurity, the wealthier farmers can benefit from engaging with grain legume value chains.
6. The rejuvenation of applied rhizobium research to search for new strains and start to fill the "pipeline" of emerging technologies to enhance nitrogen fixation.
7. The massive dissemination - reaching more than 250,000 farmers in 4 years - although with less than full uptake due to problems with input supply, purchasing power…

Can you help us identify more highlights? This will be one focus of our meeting in Nairobi.



Almaz Bombey in her field of common beans with her husband Beyene Gabiso, Shelo-Abore Kebele, Borecha southern Ethiopia

N2Africa was profiled at the First International Conference on Global Food Security held last month in the Netherlands, which was a great success as reported by the BBC.

Through a generous bridging grant we have been able to start up activities in Ethiopia, Tanzania and Uganda already. I had the privilege to visit a number of farmers' fields together with Dr Endalkachew Wolde-Meskel a week ago. The farmers and local development agents were very excited about the new varieties of common bean: one farmer, Almaz Bombey commented "*Common bean is planted and managed by both women and men. This new bean podded as we have never seen before – it is the first time we have used rhizobium and it makes the plants strong!*" It was great to see how quickly we can move to demonstrate the benefit of the technologies. Now the challenge is the scaling up and out! I look forward to working with you all to achieve these goals in the coming five years.

Ken Giller

Message from Seattle

The Bill & Melinda Gates Foundation has supported the N2Africa project since 2009. Although proven in the context of US and Brazil, the N2Africa Phase I was the first major program to prove the efficacy of nitrogen fixation to enhance productivity at the smallholder level in Africa. During the four year project, N2Africa introduced smallholder farmers to biological nitrogen fixation by grain legumes; to the utilization of appropriate rhizobial inoculants; and to improved crop management practices to improve soil health and yields of both legumes and staple crops such as maize.

A potential N2Africa Phase II is in development. In addition to a continued focus on closing yield gaps through improved legume productivity, Phase II would address food security, family nutrition, soil health, gender empowerment and improved farmer income; all important initiatives or sub-initiatives under the foundation's strategic objectives. Not only would the second phase of the project introduce improved legume varieties to smallholders in eleven countries, it would also build capacities in national legume and rhizobial inoculant research, as well as provide training in nutrition and gender sensitization and empowerment.

A major concern of the Bill & Melinda Gates Foundation is the delivery to and subsequent sustainable adoption of new technologies, including agronomic practices and improved crop varieties, by small holders. By working with a variety of development and private sector partners, and with the assistance of N2Africa business development specialists, Phase II would link smallholders to local, regional, and international legume output markets to insure that farmers have the economic incentives that support adoption. Finally, by building private sector partnerships with seed and fertilizer companies and developing potential inoculant facilities, the project would work to improve input markets to ensure that sufficient inputs of good quality are available to smallholders on a timely basis.

N2Africa Phase I was able to reach more than 225,000 farmers. In Phase II, the project will scale to reach an additional 550,000 farmers over 5 years. Because the project will train not only smallholder beneficiaries but partner NGO staff and national researchers, the foundation believes that the "spill-over" effect of a second phase project could benefit many more farmers in communities neighbouring target geographies.

Charlene McKoin, Senior Project Officer, Bill & Melinda Gates Foundation

N2Africa Phase II

As indicated above, we have been busy the past few months with a proposal for Phase II of N2Africa. We ran a number of partnership workshops, including a workshop in Uganda where all countries were represented in June 2013, and submitted a proposal to the foundation in July. Since then we have worked closely together with our two senior project officers at the Bill & Melinda Gates Foundation, Charlene McKoin and Vi Shukla, to address a number of comments and concerns from referees.

N2Africa's new *Vision of Success* is to build sustainable, long-term partnerships to enable African smallholder farmers to benefit from symbiotic N2-fixation by grain legumes through effective production technologies including inoculants and fertilizers. The legacy will be strong national expertise in grain legume production and N2-fixation research and development. The capacity built will sustain the pipeline and delivery of continuous improvement in legume production technologies tailored to local settings. Activities will focus on cowpea, groundnut and soybean in Ghana and Nigeria, on common bean, cowpea, groundnut and soybean in Tanzania and Uganda, and on common bean, soybean, chickpea and faba bean in Ethiopia. Within five years, building on local expertise, legume production will be enhanced in the major legume growing areas in of each partner country, providing opportunities for the poor and addressing gender disparities. New value chains will be established and the food and nutritional security of the poor will be enhanced. In Phase II, N2Africa will reach more than 550,000 farmers.

Discovery research within N2Africa will move from a focus on inoculants for soybean to bioprospecting to identify new elite strains of rhizobium for the other major grain legumes – common bean, cowpea and groundnut. Molecular tools will be used to characterization rhizobial biodiversity. New elite strains will be made available to inoculant producers for scaling up the technology. N2Africa will play a catalytic role by engaging with public and private parties to create sustainable input supply chains. Delivery and dissemination approaches will be tailored to local settings focusing on "last-mile" delivery networks. New, innovative tools for monitoring and evaluation will strengthen feedback loops and enable continuous learning, allowing the concept of 'best fit technologies' at the field and farm-scale to be translated into 'best-fit approaches' at the country or regional scale. By the end of the project, sustainable supply and marketing chains will ensure availability of the best legume technologies for African smallholder farmers to ensure food and nutrition security.

Aligning with the new strategy and priorities of the Bill & Melinda Gates Foundation, N2Africa Phase II will focus on five core countries – Ghana, Nigeria, Ethiopia, Tanzania and Uganda – but will maintain activities in what we term the "Tier 1" countries – DRC, Kenya, Rwanda, Malawi, Mozambique and Zimbabwe. We hope to be able to share some positive news regarding Phase II soon!

Ken Giller and Bernard Vanlauwe

Rounding up Phase I of N2Africa, Hilton Nairobi, November 4th 2013

On November 4th, 2013, we welcome, at the Hilton Nairobi, the steering committee, our partners and stakeholders to the round-up event of the first phase of N2Africa. Four years ago, N2Africa embarked on a mission to put nitrogen fixation to work for smallholder farmers in Africa. Now, we are ready to present the results from our work over the past four years and the achievements of the project.

We have named the event "Putting nitrogen fixation to work for smallholder farmers in Africa using an development to research approach", aiming to learn from the experience in the project how to integrate delivery and dissemination of legume and biological nitrogen fixation technology better with research, to improve adoption and increase impact on smallholder farmer households.

The program for the day consists of four sections. The first will provide an overview of the project and give impressions that tell the story of what we have done and the impact the project has generated.

The second section is on results and outcomes of our work: the agronomy research, the rhizobiology work and the delivery and dissemination. We will discuss how to improve delivery of the results and outcomes achieved.

In the third section we will discuss the 'development to research' approach, with feedback from our partners and stakeholders in the public and private sector on how development is achieved, on the role of research is in this process and how the different partners and stakeholders reflect this through their activities.

In the final section we will draw conclusions on the lessons learned and gather views on the way forward to achieve sustainable impact for the smallholder farmer community through improving farming system productivity using legume and BNF technology.

We look forward to a lively interaction.

We will end with a reception to celebrate the successful close of this phase of N2Africa.

I bid you a warm welcome.

Jeroen Huising, N2Africa Coordinator

Targeting legume technologies

N2Africa has invested substantially in identifying the best grain legume varieties and appropriate management practices for integration into African farming systems. Variety trials were conducted to acquire promising varieties of bean, cowpea, groundnut and soyabean, comparing them to current lines for yield, N_2-fixing capacity and adaptation to abiotic and biotic stresses. Input trials are conducted to assign the best-fit agronomic practices to the best varieties.

In total 266 varietal tests were conducted across the project. About half of these related to soyabean and the rest the rest were divided over the three other crops. Three soyabean varieties for each of the impact zone were selected that are high yielding, early maturing, with high BNF potential and with farmer preferred characteristics. Five of these varieties were 'old' varieties and already well established with the farmers community: TGx1740-2F, TGx1448-2E, TGx1485-1D, Salintuya and Makwacha. SC-SAGA and TGx1987-62F were the 'new' varieties that are tolerant to soyabean rust. Six common bean varieties (4 climbing beans and 2 bush beans) were selected for the East and Central Highland area, all fixing on average more N_2 than the 51 kg/ha set as target value. Three cowpea varieties were selected for each, the West African and the Southern Africa region, and 7 groundnut varieties (3 for the West Africa region and 4 for the South Africa region), all meeting the targets for BNF, 55 and between 45 and 60 kg/ha respectively. As was postulated by the N2Africa project, enhancing the productivity of already existing legume varieties increases the BNF significantly.

For developing best-practice management options the project followed a stepwise approach depicted in Figure 1. Different types of phosphorus fertilizers were used depending on their local availability.

Yield increase following P application was recorded across the Impact Zones in 60% of trials, with yield increase of 5-50% depending on P-source, the type of legume and the site (e.g. Plate 1).

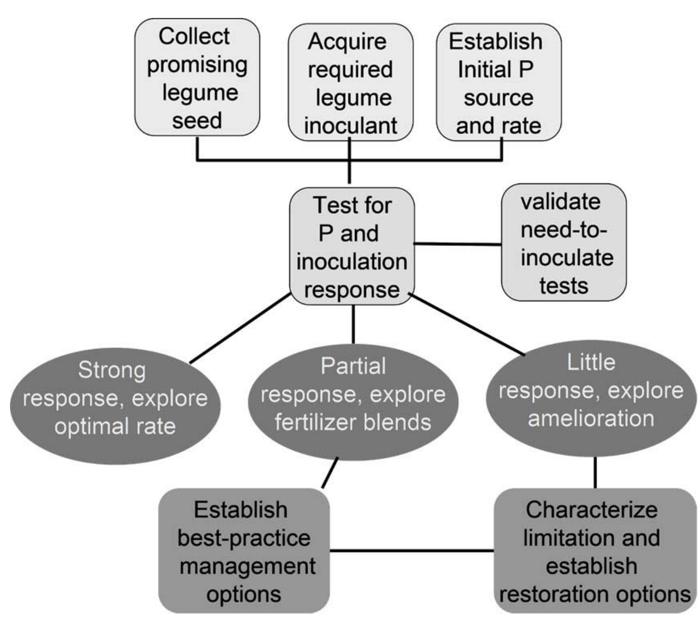


Figure 1. The stepwise approach to developing best-practice management options employed by N2Africa

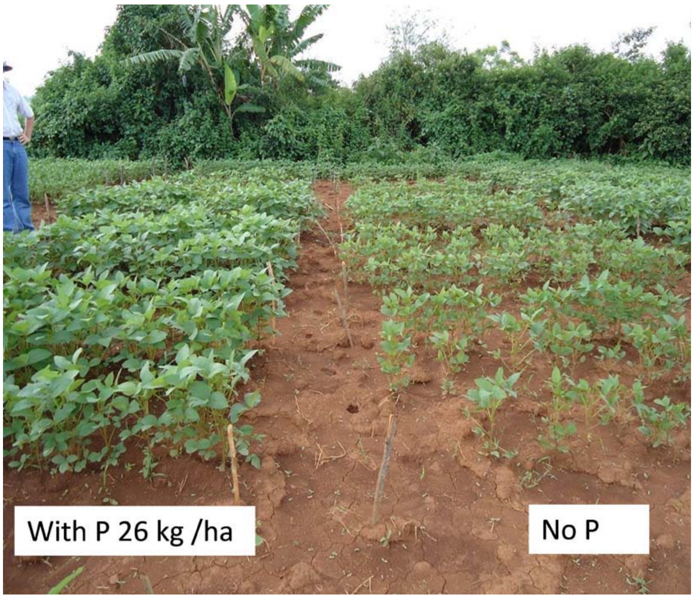


Plate 1. Response of soyabean to modest application of phosphorus was the first approach to better managing BNF

Application of inoculants in conjunction with P greatly increased soyabean yields at many sites, with an overall increase of 47% compared to no-inoculated controls.

Following deficiency symptoms observed on partially responsive sites in Kenya, experiment were done with the various additions to the P-fertilizer, which resulted in the end in a blend of the following composition: 0:23:15 plus 10% Ca, 4% S, 1% Mg and 0.1%Zn. This was tested on problem soils in Kenya, DRC and Rwanda and performed well, with yield increase from 6% to 15%). MEA Fertilizer Ltd. (Kenya) commercialized this blend under the name of Sympal. New legume fertilizer blends have also been tested in Nigeria and Zimbabwe.

Several other management considerations were addressed for inclusion into dissemination tools and extension messages including optimal plant spacing, pest and disease management, crop rotation and staking systems of climbing bean with key findings as follows:

- Optimum spacing for soyabean in Kenya is 45 cm between rows and 5 cm within row, but wider row spacings up to 75 cm are appropriate in West Africa.
- Rotation of grain legumes and maize emerged as a standard practice. Rotating maize after soyabean may result in a 1.3 t ha^{-1} yield increase. Crop rotation also reduces pressure of pest and disease.
- Strip cropping with several alternate rows of each crop is an alternative to mixed or row intercropping.
- Fungicide controls Asian rust on soyabean, particularly on the more susceptible varieties, increasing yields by 13%. For less rust susceptible varieties crop rotation is recommended or use of resistant varieties.

All three elements of improved production: inoculation, improved varieties and fertilizer addition, are important, but responses vary between zones and across agricultural landscapes, suggesting opportunities for more site-specific adaptation.

Freddy Baijukya, Paul Woomer and Jeroen Huising

Early impacts of the N2Africa project

The N2Africa project defined its Vision of Success for generating impacts that, given the magnitude of the constraints to agricultural development in the project countries, the innovative nature of this project, and the complexity of change dynamics, will take at least 5-10 years to achieve. Reaching the end of the first phase, we conducted an early impact assessment to establish progress made towards achieving the Vision of Success. The survey was carried out in each of the eight target countries amongst farmers who had received a technology packages in a season previous to when the survey was conducted and results were compared to results from the baseline survey conducted at the beginning of the project. In this manner we are able to assess current use of N2Africa technologies on farmers' fields.

The Vision of Success in N2Africa, Phase 1, project reads as follows: '*To raise average grain legumes yields by 954 kg/ha in four legumes (groundnut, cowpea, soyabean, and common bean), increase average biological nitrogen fixation (BNF) by 46 kg/ha, and increase average household income by $465, directly benefiting 225,000 households (1,800,000 individuals) in eight countries in sub-Saharan Africa*'.

Table 1. Targets and the progress made towards achieving the Vision of Success in N2Africa

Target in Vision of Success	Achieved
Directly benefit 225,000 households	252,347 households
Raise average grain yields by 954 kg/ha	
Bean	139 kg/ha
Cowpea	117 kg/ha
Groundnut	78 kg/ha
Soyabean	272 kg/ha
Increase biological nitrogen fixation by 46 kg/ha	
Bean	22 kg N/ha
Cowpea	9 kg N/ha
Groundnut	7 kg N/ha
Soyabean	41 kg N/ha
Increase average household income by $465	$355 per household

The data on households reached is obtained from the M&E records. The number of direct beneficiaries of the project is considerably higher than the targeted 225,000 households and this does not include an additional estimated 12,000 farmers reached through satellite activities.

The assessment of the impact of N2Africa technologies on legume yields in Table 1 is based on responses of legumes to the application of inputs in N2Africa's dissemination and demonstration trials and the current use of N2Africa technologies assessed in the early impact assessment. The increase in average grain yield is a weighted average amongst the different categories of adopters (e.g. in the case of soyabean: 'no use of inputs', 'inoculants only', 'P fertilizer only' and 'full adoption'). Not all farmers use all components of the legume package in their own fields and a considerable percentage does not use any of the inputs (Table 2). We see marked differences between countries in the adoption of the technology. Kenya stands out with the high rates of full adoption of the soyabean technology (61%). In Nigeria we see high partial adoption rates (only 6% that do not use any inputs for soyabean). In Nigeria we also see strong adoption in the use of fertilizers for the cowpea and groundnut (82% and 76% respectively). Generally the use of inputs for beans, cowpea and groundnut are considerably less than for soyabean, with Zimbabwe and Ghana scoring relatively low. We assume the partial adoption has much to do with the availability and accessibility of the inputs, and with the perception and preferences of the farmer.

For our assessment, we took an average yield and yield response observed in the dissemination and demonstration trials. This masks the fact that a wide variability in yields is recorded within areas, which is typical for multi-locational on-farm trials. Only in cases where average yield in a given area and season was exceptionally low, for instance due to drought, variability was reduced. This variability in responses greatly affected the profitability of the promoted technologies for an individual farmer. The average yield in the 25% highest yielding plots in the dissemination and demonstration trials gives an indication of the attainable yield in a region. These attainable yields were generally much higher than the average yields with current use of N2Africa technologies, or the expected average yield with full use of N2Africa technologies (Fig. 1). Full adoption of the N2Africa package increases yield, but to close the yield gap between current average and attainable yield and to achieve the yield increases stated in the Vision of Success more than the use of N2Africa technologies alone is needed. Enhanced understanding why certain farmers achieve only poor responses to N2Africa technologies is major research goal in the N2Africa project. If causes for low yields can be effectively tackled, it may be possible to achieve or exceed the impact on yield stated in the Vision of Success on the longer term.

The estimated increase in average household income is estimated at $355, which is below the target of $465, but more than may be expected given the modest gains in yield reported. Increases in legume area and rotational effects of legumes on a subsequent crop (in our assessment assumed to be maize) had a strong impact on net benefits.

Table 2. The percentage of farmer using specific legume inputs in their own fields, based on data from the N2Africa impact survey

	Non-use of inputs	+ inoculant only	+ P fertiliser	+ P and inoculant
DRC				
Soyabean	34	27	23	16
Bean	57	8	27	8
Kenya				
Soyabean	14	9	16	61
Rwanda				
Soyabean	55	10	18	17
Bean	72		28	
Ghana				
Soyabean	69	6	19	6
Cowpea	90		10	
Groundnut	85		15	
Nigeria				
Soyabean	6	11	57	26
Cowpea	18		82	
Groundnut	24		76	
Malawi				
Soyabean	50	10	15	25
Cowpea	77		23	
Groundnut	91		9	
Bean	67	4	27	2
Mozambique				
Soyabean	34	27	23	16
Groundnut	93		7	
Zimbabwe				
Soyabean	69	16	11	4
Cowpea	83		17	
Groundnut	97		3	
Bean	60	2	36	2

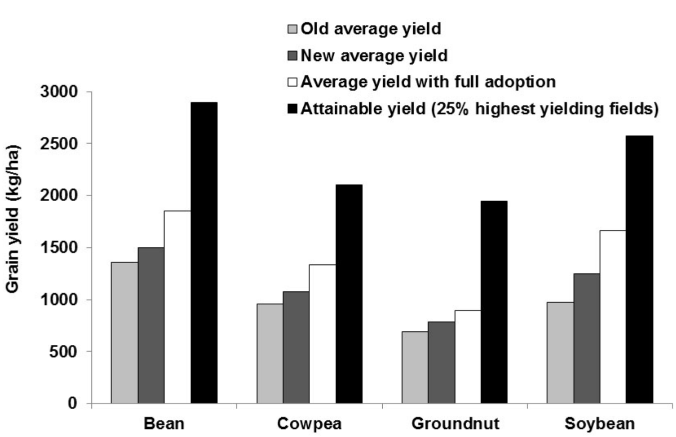


Fig. 1. Average yield achieved in the control treatment ('old' yield), average yield with the current use of N2Africa technologies ('new' yield), average yield achieved with complete use of N2Africa technologies, and the attainable yield as indicated by the 25% highest yielding plots in a region. Values for different crops were averaged across N2Africa countries and based on dissemination and demonstration trials in N2Africa.

The calculation of net benefits from enhanced legume cultivation is based on a partial budgeting exercise in which not all costs and benefits have been included. For instance, labour requirements have not been included, because of a lack of reliable data. We did include an estimation of monetary benefits that could have been earned from a crop (assumed to be maize) replaced by an expanding legume crop. In certain countries, e.g. in Mozambique, arable land is often not limiting and expanding the area under a legume crop does not always come at the expense of another crop (provided that the labour devoted to additional legume production does not reduce the farmer's ability to grow other crops). In the majority of N2Africa regions however, farmers have limited access to arable land, and an expansion of legume is likely to reduce the area under another crop. Furthermore, it is well possible that training, e.g. on home processing of soybean grain, resulted in value addition and higher net benefits, but this is not accounted for in the current assessment.

Given the large number of households reached and the considerable increase in average household income, the total net benefits of the project are much higher than the originally anticipated $31.9 million.

Jeroen Huising and Linus Franke

N2Africa Social Media Communications Strategy

Over the last few months, we have been preparing a social media strategy for N2Africa. The launch of this strategy will coincide with the November meeting, with a dedicated Facebook page as a central element. The Facebook page will promote N2Africa activity and link directly with partners and supporters, some of whom already have a social media presence. The N2Africa Facebook page will be updated regularly with videos, pictures and articles sourced from the Podcaster. If you have suggestions about what to feature, please let us know.

The N2Africa website will also be updated with a new interactive map. The map will pin videos and photos to project locations and is a means to demonstrate the geographic extent of N2Africa, as well as to illustrate and share our D2R successes and challenges. To begin with, the map will contain a select number of videos for each country, but will grow to include more videos as well as a library of photographs. Videos played in the map will be linked from new N2Africa 'channel', hosted on Vimeo. This dedicated video channel will host the N2Africa video archive of longer films and training materials.

The Facebook page, map and Vimeo channel will provide an extension to the Podcaster, to link, enhance and celebrate the work of a growing a federation of development and research partners. We look forward to connecting with you soon through Facebook.

Alastair Simmons

CADS partnership with N2Africa in Zimbabwe

Introduction

Cluster Agricultural Development Services (CADS) is a registered NGO whose work dates back to over 20 years when its predecessor VeCo Zimbabwe implemented programmes on sustainable agriculture and livestock production in Zimbabwe. CADS works with disadvantaged rural smallholder farmer organisations and its focus is to facilitate sustainable institutional strengthening, technology development, good agronomic practices, food processing, and input and output marketing. Integrated crop and livestock production, agroforestry and value addition are some of the major programmes in CADS' sustainable livelihoods development portfolio.

In its development work CADS mainstreams gender, nutrition, HIV and AIDS, and income generation in order to help mitigate, not only the impact of the HIV and AIDS pandemic, but also the cycle of poverty affecting rural households. To achieve maximum impact CADS networks with relevant stakeholders for the provision of technical and extension support services required by farmer syndicates.

Nitrogen Fixation Project and Activities

Since 2010/11 agricultural season, CADS and Centro Internacional de Agricultura Tropical (CIAT) through its Tropical Soil Biology and Fertility Institute (TSBF) in Harare are together implementing the research-based N2Africa Project in Zimbabwe. The project develops, disseminates and promotes appropriate nitrogen (N_2)-fixation technologies for smallholder farmers and focuses on grain legumes (soyabeans, sugar beans, cowpeas and groundnuts).

Fig1: Ground nuts harvesting-A-Frame Mudzi

The N2Africa project fits in very well with CADS' overall participatory intervention approach that emphasizes the following aspects; community and stakeholder involvement, capacity building of farmer organisations, development of new technologies that enhance soil fertility and increased yields, value addition and market linkages, mainstreaming of gender, nutrition, HIV and AIDS, mentorship, income generation and ability to spread project benefits to more members in the community.

CADS was responsible for the following activities for the N2Africa project; awareness raising, beneficiary selection, verification, registration, input distribution, establishment of demonstration sites, training of farmers in good agronomic practices, establishment of farmer groups, farmer field days, post-harvest handling and management, value addition and marketing.

The project used the Lead Farmer approach. Each lead farmer worked with an agreed group of mentored farmers who in turn cascaded knowledge and skills gained to non-beneficiary farmers. On the whole, nitrogen fixation programmes implemented in Mudzi and Goromonzi districts for the period 2010 to 2013 directly benefitted a total of 3988 farmers as shown in Table 1 below.

Table 1: N2Africa Project Beneficiaries 2010 to 2013

Year	District	Number of Lead Farmers	Farmers Reached by Lead Farmers	District Total
2010/11	Mudzi	20	300	320
2010/11	Goromonzi	23	345	368
2011/12	Goromonzi	50	950	1000
2012/13	Goromonzi	115	2185	2300
Total		**208**	**3780**	**3988**

Main project achievements

Farmers indicated an improved level of knowledge, increased yields and the need to increase hectarage in the production of leguminous crops. Introduction of the project complemented other CADS projects related to conservation agriculture (FAO), livestock production and fodder production (FAO, ILRI). Apart from nitrogen fixation, farmers 'suddenly' had another source of material for livestock feeds, value addition and income generation. This

Fig 2: Drama performance, Chinyika ward 16, Goromonzi

Fig 3: A Lead farmer, Mrs Marimo, demonstrating the inoculation process, Goromonzi 2011

provides positive sustainability and out-scaling of these crop varieties and associated inoculation technology. The existence of these symbiotic projects provides further room for growth of these legume crops.

Further examples of project achievements are shown below:

- Training of farmers on seed multiplication, resulting in, for example, harvesting of 350kg/farmer for sugar beans and 60 kg/farmer cowpeas during 2011/12 agriculture season.
- Provision of needed financial resources for farmer groups through establishment of Internal Savings and Lending (ISAL) for 24 farmer groups in Goromonzi district.
- Integration of small livestock into the N2Africa project has resulted in reduction of stock feed costs for poultry. A group of 20 farmers in Goromonzi are now using home grown soyabean feed formulation as a result of the N2Africa project.
- Commercialization of value addition wherein a group of 40 members in Goromonzi is running a value addition food shop at Juru Growth Point.
- Farmers benefited from a loan facility to expand their project resulting in some farmers expanding soyabean production to 2 ha (from the initial 0.05ha). The loans were repaid after harvesting.
- Farmer syndicates are now in a position to link directly with manufacturers of inoculants in the country.
- Farmers are now in a position to produce and sell legume seeds in the community.

Ongoing Collaboration

Given the existence of complementary projects in Goromonzi, the N2Africa project can play an instrumental role in assisting farmers to grow legumes productively and sustainably.

The project provided training materials that were very useful for training and extension work. These materials can be further improved to take into account the extended needs for farmers, climate change, new research findings, nutritional challenges and changing consumer needs.

N2Africa and CADS can explore further collaboration in capacity building at the level of the organization as well as approaches to community development such as lead farmer training and improvements for demonstration plots, providing technical support.

Conclusion

The combination of theory and practical demonstrations were effective as farmers were able to learn from their peers and from technical staff. Farmers also learnt new technologies such as the use of inoculants and single super phosphate (SSP) in legume production and how legumes enhance soil fertility as well as provide protein for families. An additional benefit of the N2Africa project is the use of these legumes (stalks and leaves) for fodder production for dairy and beef farmers. This extended product role of legumes has resulted in more farmers taking the initiative to expand on crop hectarage for these crops given their multiple role in enhancing soil fertility, arresting land degradation, providing needed nutrition, and animal fodder.

Fig 4: Harvesting and processing of cowpeas, ward 2 Goromonzi

Mrs Lillian Machivenyika

SG2000 partnership with N2Africa in Nigeria

Background

Sasakawa Global 2000 is an international NGO established in 1986 in Sudan and Ghana by late Ryoichi Sasakawa (a Japanese Philanthropist) with Nobel Laureate, Dr Norman Borlaug and former US President Jimmy Carter. SG2000 works in close collaboration with national agricultural extension services, improving their field operational effectiveness and strengthening their human resources. Based on the success of the first two countries in Africa that Federal Government of Nigeria invited SG2000 and signed a Memorandum of Understanding in 1992. Field activities started in 1993 and SG2000 works with and through the state agricultural development programmes to deliver proven technologies to smallholder farmers. SG2000 follows the value chain approach in disseminating technologies under five thematic areas: crop production enhancement and extension, postharvest handling and agro-processing, public-private partnerships and market access, human resource development and M&E. Training and close supervision are key to the success of SG2000. In the course of its work, SG 2000 partners with a number of institutions and programs; notable among them is the N2Africa project, which started in 2010 in Kano State.

Activities with the N2Africa project

SG2000 carried out technology dissemination to farmers as an N2Africa partner; disseminating the best agronomic practices in the production of some of the major leguminous crops (cowpea, groundnut and soyabean); specifically conducting trainings and demonstration on the use of inoculants and SSP fertilizer, with a view to increasing yield and improving soil fertility through effective nitrogen fixation. The partnership has directly reached 26,406 farmers over the three years period of the project. We demonstrated use of inoculum on soya bean, combination of inoculus and SSP on soya beans, varietal introduction and evaluation on cowpea ad groundnut and use of SSP on legumes. Based on evaluation carried out by extension agents guided by SG2000/N2Africa state coordinator using pair wise ranking and/or matrix system at each community, it was discovered that the treatment of i**noculant+phosphorus on soyabean** gave higher yields than the other 3 treatments (table1); the groundnut variety **Samnut 23 was superior over RMP 12** (Table 2) **and the local variety** in terms of grain and fodder yields across all locations. On the cowpea varietal demo plots, **60% of the farmers selected IT90k 277-2** due to its high grain and fodder yields compared to the other varieties while about **40% of farmers selected IT97K 499-35** over others due to its tolerance to the witchweed, Striga. The N2Africa concepts and approach fit well with the SG2000 Crop Production Enhancement and Extension Theme in transferring proven technologies to resource poor farmers by providing technological options. Farmers observed the benefits of the treatments, especially on crop vigour and final grain yields. Consequently, farmers were able to observe and make decisions on the promising options. This impacted significantly on the skills and productivity of the participating and non-participating farmers. Farmers now appreciate the use of fertilizers, especially SSP as well as

Table 1: Soya bean yield response to inoculum and P treatments

Crop	Variety	Treatment	Yield (kg/ha)
Soyabean	TGX1835-10E	Inoculum + P	1524
	“	Inoculum only	1198
	“	Phosphorus only	896
	“	No P No Inoculum	696
Soyabean	TGX 1904-6F	Inoculum + P	1616
	“	Inoculum only	1331
	“	Phosphorus only	1233
	“	No P No Inoculum	933

Table 2: Yields grain legume varieties

Crop	Variety	Yield (kg/ha)
Cowpea	IT 90K-277-2	1053
	IT 97K-499-35	778
	IT 89KD-391	884
Groundnut	SAMNUT 21	934
	SAMNUT 22	1433
	RMP 91	1135

Participants discussing and exchanging ideas at different locations on the demo farm

Demo plots under MARKETS II indicating inoculated (left) versus uninoculated (right) in Kaduna State

the positive effects of the rhizobium inoculant on soyabean productivity.

Scaling up and out

N2Africa/SG2000 collaboration succeeded in demonstrating the positive effect of inoculants on soyabeans and this is now a new, proven technology for soya production in farmers' fields. It is now being demonstrated in three LGAs of Kaduna State under the USAID/MARKETS II soyabean value chain project, where SG2000 serves as a service provider. Again, the use of inoculants has shown the difference between the treated plots and untreated plots and MARKETS II is likely to promote its use by farmers in the state. In addition, inoculants have been used for soyabean seed production in Jigawa for 2013 season under the routine SG2000 extension activities. A major challenge now is the supply of the inoculum in commercial quantities as farmers have started asking where they can purchase the product.

Dr Sani Miko

Drawing lessons from the variability in climbing bean productivity in Rwanda

Climbing bean is a key crop in the northern Rwandan cropping system, grown by 95% of the interviewed households in the N2Africa baseline survey. N2Africa promotes the use of improved varieties and P based fertilizers in climbing bean cultivation in Rwanda. Through dissemination trials, farmers get the opportunity to test new climbing bean technologies. N2Africa monitors in each country a sample of these multi-locations trials through a field book providing valuable information on driver of variability in yield and in performance of N2Africa technologies.

In this study, we monitored 115 dissemination trials with climbing bean in northern Rwanda, in which farmers compared climbing bean grown with organic inputs only with bean grown with both organic inputs and DAP (di-ammonium phosphate) fertilizer. We collected agronomic data, soil data, as well as information on the socio-economic background of the N2Africa farmer. In the analyses, we made use of a household typology based on resource endowment (Table 1). In Rwanda, a unique situation exists where rural households have been categorised according to a governmental typology called 'Ubudehe' (translated: local collective action). From Table 1, it can be seen that the majority of the N2Africa households belong to (very) poor households that have an arable farm size of less than 0.5 ha.

The average climbing bean grain yields in the dissemination trials equalled 1.40 t ha^{-1} in the control plot and 2.06 t ha^{-1} in the plots with DAP fertiliser. The addition of DAP to climbing bean in the dissemination trials gave a grain yield increase of more than 10% at 81% of the sites (Fpr < 0.001). Climbing bean grain yields varied widely between sites (Fig. 1), which is typical for on-farm, farmer-managed trials reflecting a wide variety in biophysical and management conditions.

Timing of crop management operations (planting, weeding) significantly affected productivity. The boundary analyses in Fig 2A indicate that maximum attainable yield rapidly declines if climbing bean is planted after the end of September. None of the individual soil parameters was significantly linearly correlated with grain yield in the two bean treatments. However, the yield enhancing effect of DAP fertiliser application indicated that P and possibly N limit climbing bean productivity in the vast majority of fields. Moreover, the scatter graph of percentage clay and silt and climbing bean yield (Fig. 2B) indicates that maximum attainable yield is less when the percentage clay and silt in the soil is below 50%. From concurrent detailed farm characterisations in the area, we know that staking density and organic input use are two other important variables correlated with climbing bean productivity.

Table 1. Description of Ubudehe household classes, the frequency distribution of the 1018 households in Gafuka cell, Burera, over household types, and the average arable farm size

Name	Name referred to in this article	Description	Frequency	Farm size (ha)
Umutindi nyakujya	-	No land, no livestock, begging for survival	1%	
Umutindi	Very poor	Very small landholdings, work for others to earn a living	16%	0.06
Umukene	Poor	Small landholdings, work mainly on their own farm	49%	0.34
Umukene wifashiye	Well-off	Larger farm land and livestock, sale of surplus from farm	27%	0.61
Umukungu	Rich	Large landholdings, cattle owning, sale of surplus from farm, often with off-farm income	7%	1.49
Umukire	-	Salaried jobs and farming is not the prime source of income	0.2%	

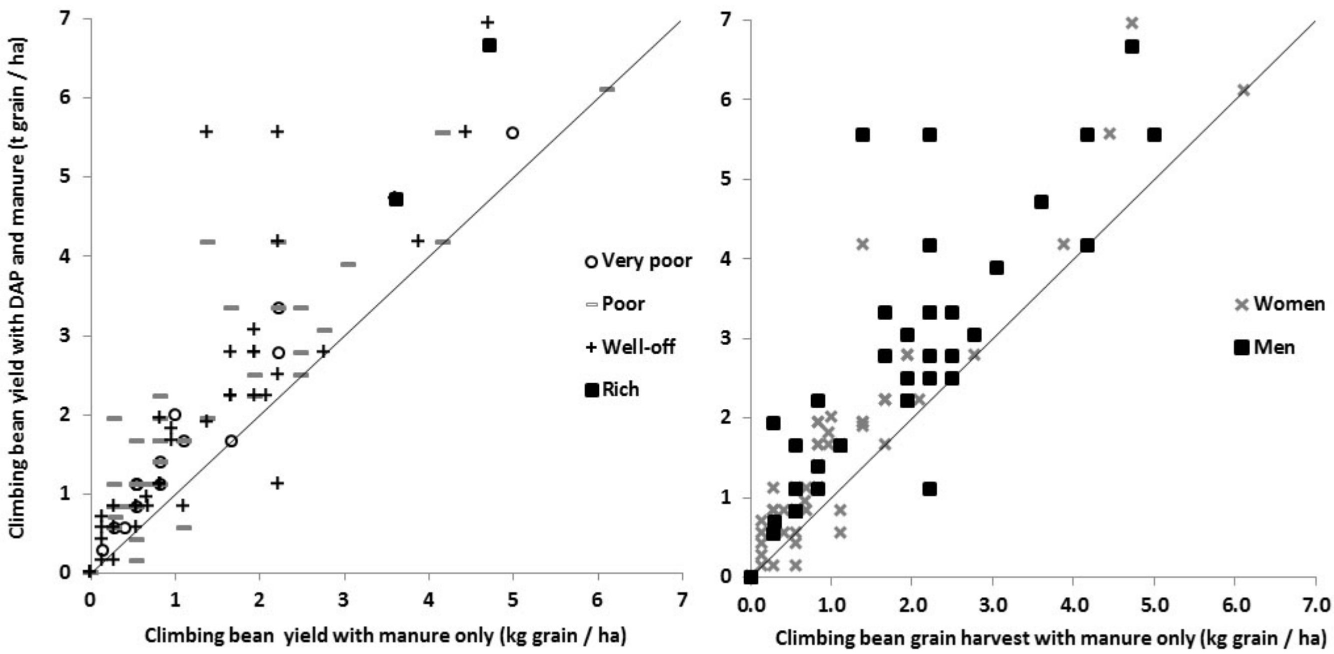


Fig. 1. Response of climbing bean fresh grain yield to the application of P fertiliser, segregated by (A) households classes and (B) gender of the farmer. The line represents the one-to-one line where the yield in the control plot (manure only) equals that in the plot with DAP fertiliser

Analyses of soil samples from the dissemination trials showed significant relationships between household class and soil fertility characteristics (Table 2). Poorer households have soils poorer in fertility as indicated by a lower C, N, available P and higher sand contents. Resource endowment was positively related to climbing bean productivity in the dissemination trials (Fig. 1A). Poorly resource endowed farmers were thus not only disadvantaged in term of farm size, but also in their production capacity per unit area. Moreover, the gender of the farmer implementing the trial was significantly related to grain yield of beans and maize (Fig. 1B). Female farmers achieved smaller average yields than their male counterparts. Female farmers did not belong more frequently to resource-poor households than male farmers and therefore, household resource endowment did not explain the difference in performance between male and female farmers. Resource endowment and gender can be seen as a proxy for a range of other factors that determine crop productivity, such as soil fertility, access to organic manure and mineral fertiliser, access to sufficient quality staking material, ability to conduct crop management operations on time, etc.

Conclusions

- A large inequity in resource endowment among rural households in Rwanda is reflected by differences in soil fertility, crop management and productivity, and most likely also in abilities to adopt new technologies. The poorest households can easily be by-passed in rural development programs such as N2Africa unless attention is paid to their particular challenges.
- Similarly, particular attention should be paid to the needs of women farmers who attained substantially

Table 2. Soil fertility characteristics of fields belonging to farmers in different resource endowment classes

Variable	Very poor	Poor	Well-off	Rich	Significance (Fpr)
pH (H2O)	5.4	5.7	5.5	6.0	n.s.
C (%)	1.3	2.5	2.5	4.2	0.018
Total N (%)	0.12	0.25	0.24	0.43	0.020
C/N ratio	10.7	10.2	10.5	9.9	n.s.
Avail. P (ppm)	6.7	20.5	19.1	35.9	0.005
Sand (%)	40.6	31.9	30.6	34.6	0.002
Silt (%)	27.3	35.3	35.7	43.3	0.002
Clay (%)	32.1	32.8	33.7	22.2	n.s.

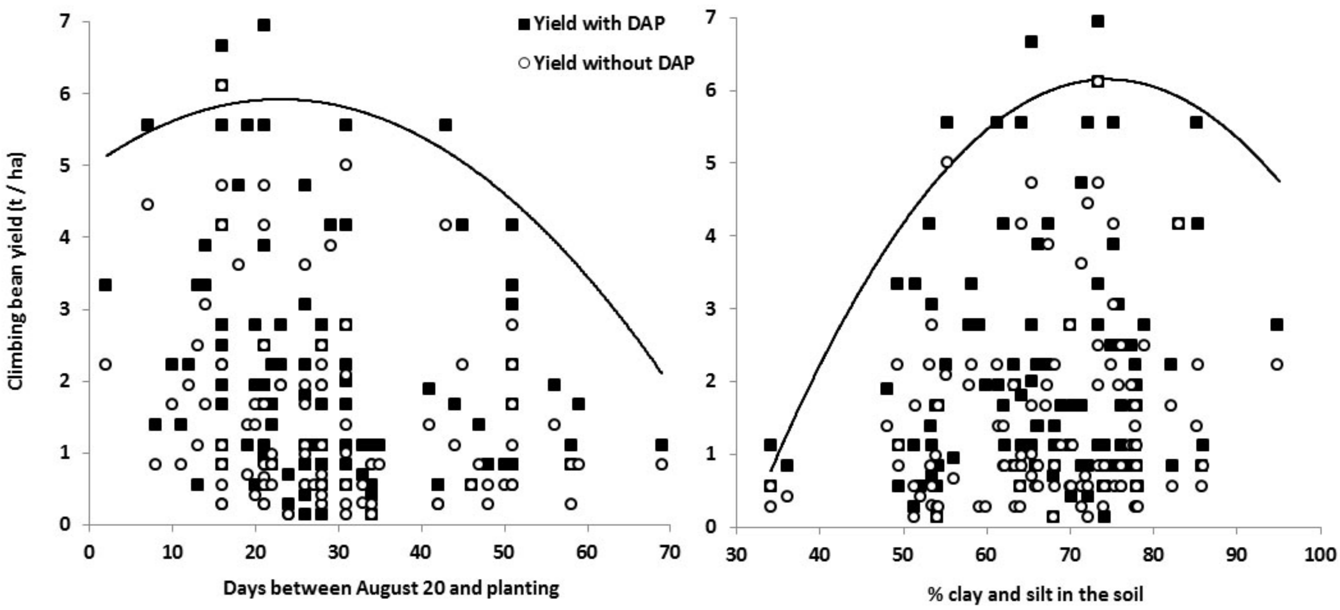


Fig. 2. Relationship between climbing bean grain yield and (A) days between August 20 and planting and (B) the percentage silt and clay in the soil. The lines in the graph indicate maximum obtainable yield at a given planting date or percentage clay and silt in the soil, derived through boundary analyses

smaller yields per unit area than men due to unequal access to resources within the household.

- The very small landholdings among the poor rural households observed in this study highlight a binding constraint to making any major steps forward in increasing crop productivity and food self-sufficiency for these households. While increases in crop productivity per unit area are important to relieve drudgery, off-farm income will be indispensable for these households to escape from poverty.
- While the regional average yield increase as a result of the use of DAP fertiliser is strong and highly significant, the variability in yields is very large. Understanding what causes this large variability in yield is key to improving the effectiveness of N2Africa's dissemination activities

Linus Franke, Freddy Baijukya, Speciose Kantengwa, Moritz Reckling, Bernard Vanlauwe, Ken Giller

N2Africa proposes standards for inoculant quality

N2Africa proposes standards for quality of inoculants to be adopted across countries in sub-Saharan Africa. Currently, none of the original eight countries targeted by N2Africa has regulations in place that specify requirements for the quality of inoculants, though several countries are in the process of establishing such regulatory framework. In Kenya, efforts are undertaken to develop and implement registration guidelines for microbial products including rhizobium inoculants, assisted by the COMPRO II and N2Africa project. The draft bio-fertilizer act, in which requirements for bio-fertilizers is stipulated, is before parliament. Similarly in Nigeria and Ghana efforts are underway to establish regulatory guidelines for bio-fertilizers. The Rwandan Bureau of Standards (RBS) has requested N2Africa to develop standards for quality control purposes.

Using uniform quality criteria and grading system would help producers to set targets for the quality of their inoculants. Hopefully it would help speeding up the registration process, if procedures for registration could be relaxed if that product is already registered in another country. The requirements for registration in some countries are quite involving (like field testing in three consecutive seasons).

Figure 1. The proposed grades and quality standards of legume inoculants under the N2Africa universal logo

Three grades are proposed, permitting inoculant manufacturers to meet a minimal standard upon market entry and then recognize improvement in their product with time.

The grading system we propose encompass the different standards adopted in various countries. Argentina, Thailand and France have the lowest requirement of 1 x 10^8 rhizobia cells per g, whereas Brazil, Australia and Canada demand > 1 x 10^9 viable cells per g. The number of contaminants is important in specifying quality requirements as they determine the shelf life of the product. We included requirements regarding the maximum number contaminants in similar way reviewing the standards in various countries.

The three grades (B, A and AA) together with the proposed logo are presented in Figure 1. These inoculants are solid, prepared from an organic carrier and may either be finely powdered to < 300 nm mesh for application to seed or pelleted for application to soil. The corresponding shelf life would be 2, 6 and 12 months respectively, if stored under proper conditions.

Imposing quality standards requires also procedures for quality control. Laboratory procedures for quality testing have been described by Bala (2011) in N2Africa Report 019. N2Africa is pleased to advise on regulatory frameworks and is collaborating with the COMPRO II project in assisting various African countries to develop and implement their own regulations.

Paul Woomer and Jeroen Huising

MSc thesis on quality control of legume inoculant on bean and soyabean in East and Central Africa: Isaac Balume from DRC

I did my MSc in Sustainable Soil Resource Management sponsored by N2Africa. After successfully following one year of course work I worked closely with Dr Paul Woomer in data collection, analysis and thesis writing. Paul became a personal friend who I will never forget. Under the supervision of Dr Paul Woomer, Prof Keya and Prof Nancy Karanja (University of Nairobi) I conducted research on Quality Control of Legumes Inoculant on Bean and Soyabean in East and Central Africa at the MIRCEN lab, University of Nairobi. I hope to publish two papers from his thesis: the first is under review for the journal “Applied and Environmental Microbiology”.

In May 2013 I presented my draft paper at a “writeshop” at Wageningen University in The Netherlands. I really appreciated this good opportunity to exchange knowledge and experiences with Prof. Ken Giller, Dr Linus Franke, Dr

Photo 1. Left to right: Prof Shellemiah Keya, the university supervisor, Isaac Balume, Dr Kironji, chairman of LATMAT Department Faculty of Agriculture /University of Nairobi

Photo 2. Serial dilution and plating

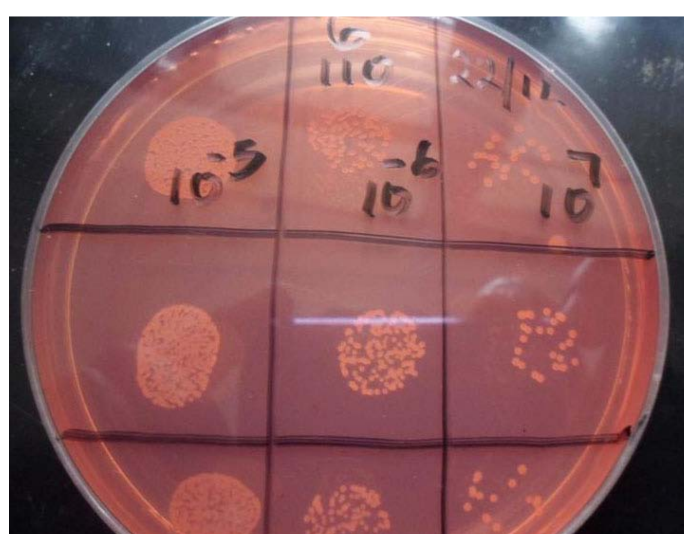


photo 3. Rhizobium colonies on Yeast-mannitol agar containing Congo Red

Jeroen Huising and Judith de Wolf and get support during the writing process. Since completing my MSc work I have continued rhizobiology activities within the N2Africa program at Kalambo research station, DRC for four months, where I have established quality control procedures in DRC, ensured proper storage of the NAC rhizobia collection, started early greenhouse screening of rhizobia using common bean as the host plant and secured the Walungu peat deposit for further inoculant production in the region.

Overall 107 isolates from Bintu collection were re-isolated and characterized in YEMA Congo red and BTB before to be assigned the NAC code N2AFRICA Congo. Over 500 packets on soyabean and 250 packets on common bean rhizobium inoculant using Walungu peat standards strains (USDA 110, SEMIA 5019, USDA 2667 and 422) were produced at Kalambo for this long rain season. National partners DIOBASS, PAD and SARCAF in partnership with the DFID project from the Wageningen University received inoculant for farmers training and input distribution. Quality control assessment was set in the objective of giving high quality product to farmers at least 10^9 cells g^{-1} of inoculant photo 2 & 3.

I express my gratitude to the whole N2Africa team and hope to continue work for the benefit of smallholder farmers in Africa.

Isaac Balume

N2Africa and its impact on human nutrition

Both protein-energy malnutrition and micronutrient deficiencies are highly prevalent in sub-Saharan Africa, especially among children and women of reproductive age. Undernutrition results in substantial increases in overall disease burden and mortality, decreases in intellectual development and reduction in productivity and economic development. Grain legumes add energy, proteins, minerals and B vitamins to the African diet. Evidence from randomized controlled trials show that the consumption of legume-based foods improves growth in children. Iron and zinc intake are low when consuming legume-based diets. However, methods like dephytinization and fortification seem to be promising in increasing iron and zinc bioavailability in legume-based foods and improving iron and zinc status of infants, children and women of reproductive age. Evidence concerning other micronutrients is inconsistent or poor (for more information see the literature review 'Nutritional benefits of legume consumption at household level in rural sub-Saharan Africa'.

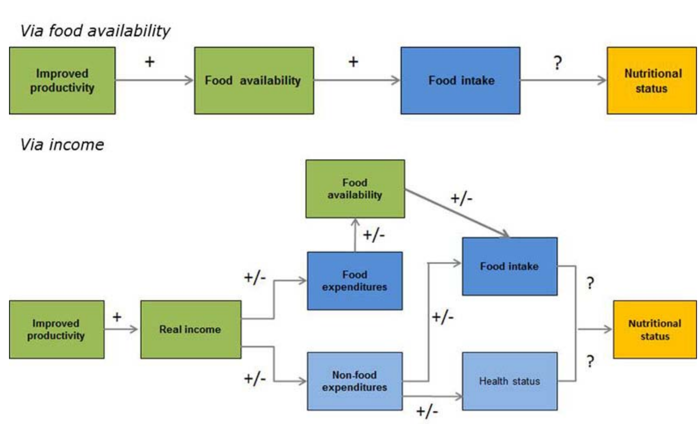
What is the impact of N2Africa on nutrition?
Recently, I conducted a nutrition case study in Northern Ghana (Karaga and Bawku West Districts) in February to March 2013, to investigate this question. The case study consisted of a quasi-experimental, cross-sectional study in villages that did and villages that did not receive N2Africa inputs between 2010 and 2012. Individual dietary diversity scores (IDDS) of children under 5 years of age were measured by 24-hour dietary recalls among their mothers. Nutritional status was measured by anthropometric measurements. Among N2Africa farmers, eight focus group discussions were held (four with male and four with female farmers).

Children of N2Africa participants have a significant more nutrient adequate diet as reflected by the individual dietary diversity score (IDDS) compared with non-N2Africa participants. Significantly more children of N2Africa participants consumed from the food group 'legumes, seeds and nut'. There is no difference in nutritional status between children

	N2Africa	Non-N2Africa
Individual dietary diversity score	5.5 (out of 14)	5.1* (out of 14)
Consumption 'legumes, nuts and seeds'	87 %	77 %*
Stunting (chronic malnutrition)	29 %	36 %
Wasting (acute malnutrition)	11 %	6 %
Underweight (chronic and acute)	23 %	24 %

*P<0.05

Ilse doing height measurements



of N2Africa and children of non-N2Africa participants. This can be explained by the fact that nutritional status is a long-term effect and most N2Africa participants included in the study have only received inputs in 2012.

Many steps link improved crops yields to nutrition. From the focus group discussions it seems that improved agricultural productivity may affect nutrition through different pathways: 1) via an increase in food availability for home consumption in case of female farmers and in case of farmers who received training on soybean preparation methods; 2) via an increase in income in case of male farmers. Whether an increase in income translates into improved nutritional status via an increase in food expenditures or non-food expenditures is unclear. Based on this study, to enhance benefits of agricultural interventions on nutrition via an increase in food availability for home consumption it can be recommended: to target female farmers, focus on crops mainly used for home consumption and provide training on preparation methods and general nutrition education.

Random walk method-spinning the pen

For more information keep an eye on www.n2africa.tv for the film "Nutritional Benefit of Legume Cultivation in Northern Ghana", that is to be released soon.

Ilse de Jager

SDSN report on Solutions for Sustainable Agriculture and Food Systems

N2Africa received the report of the SDSN Thematic Group 7 on Solutions for Sustainable Agriculture and Food Systems. It can be downloaded from this link.

This report discusses:
- Challenge domains for agriculture.
- Key pathways and principles for transforming agriculture and food systems.
- The contributions of agriculture to the post-2015 sustainable development agenda.
- Available solutions for early action and long-term needs.
- Considerations for planning and implementing action.

This report contributes to the ongoing process of defining the sustainable development goals, targets and indicators for the post-2015 period. The SDSN will continue to provide support to the Open Working Group appointed by the UN General Assembly, but also plans to launch a number of own solutions initiatives on agriculture, and create a range of online resources.

Announcement IFDC international training program

The training program The Fertilizer Value Chain – Supply System Management and Servicing Farmers' Needs "Pathways to Optimize Stakeholder Returns in Unstable Markets" will convene in Accra, Ghana, December 2-6, 2013. For more detailed information click here and read the detailed program description.