



**The role of legumes in
sustainable intensification –
priority areas for research in
northern Ghana**

Stakeholder workshop report

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**Putting nitrogen fixation to work
for smallholder farmers in Africa**

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Summary

A fruitful one day stakeholder workshop was held in Tamale, northern Ghana on June 23, 2016 as part of N2Africa's selection as case study in the PROIntensAfrica project. The workshop aimed to verify results obtained from a case study (literature study, stakeholder interviews and household survey) on drivers of change, legume intensification and sustainability of agriculture in northern Ghana, and to identify priority areas for research on the role of legumes in sustainable intensification. The workshop was attended by participants including farmers, the Ministry of Food and Agriculture, universities, NGO's, research institutes, agro-chemical dealers, seed sector and grain traders.

Key **drivers of change** identified during the case study were: population pressure; improved availability of inputs; external development agencies/projects; government policies; climate change; disease pressure

During the workshop participants added:

- Improved education has led to a better educated youth, of which an increasing proportion does not want to go into farming anymore. In addition, farms are getting smaller due to population pressure, thus making farming less profitable. This further reduces the willingness of youth to go into farming.
- Credit facilities for smallholder farmers (i.e. contract farming) were reported to be less successful as presented under "External development agencies/projects".
- The driver "Government policies" should perhaps be renamed into "Poor government policies" as workshop participant mainly reported on the ineffectiveness and lack of investment in the agricultural sector. Historically however, agricultural extension and national research institutes have played an important role in improving agricultural production in northern Ghana (e.g. introduction of new maize and legume varieties). It was also noted that disease (and pest) pressure is important for all legumes, and not in particular for groundnut.

Next, case study results on the **current status of legume cultivation and sustainable intensification** of agriculture in northern Ghana were discussed:

- Soybean has clearly taken the lead in terms of cultivated area and importance as cash crop compared with cowpea and groundnut.
- The popularity of soybean in the Northern Region (Savelugu) also resulted in a bigger share of the farm cultivated with legumes in Northern Region than in Upper East (Bawku area), which was confirmed by the stakeholders.
- Cowpea and groundnut are stable or reducing in area due to yield limiting constraints (cowpea, high pest pressure; groundnut, high disease pressure), the low availability of seed of improved varieties, and the cost for crop protection (needed for cowpea).
- Current developments around increased availability of legume inputs (P based fertilizer, inoculants) were mentioned as an interesting development. Stakeholders expected good uptake of inoculants. P-based fertilizers were only expected to be profitable/attractive for smallholders if the current fertilizer subsidy program was extended to P-based fertilizers.

Priority areas for research on the role of legumes in sustainable intensification identified during the workshop were:

- Farming as a business – interesting for the youth.
- Agro-processing – to add value to the generally low profitability of agriculture.
- Improving productivity of farming systems – to increase profitability and food security.
- Legume intensification – to increase productivity and the positive impacts of legumes.

The role of government was discussed as cross-cutting theme.

Keywords

PROIntensAfrica, northern Ghana, sustainable intensification, indicators



1 Introduction

N2Africa is a large scale, science-based “research-in-development” project focused on putting nitrogen fixation to work for smallholder farmers growing legume crops in Africa (www.n2africa.org). The project’s 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. With funding from the Bill & Melinda Gates Foundation, N2Africa began a second phase on the 1st of January 2014. The project will run for five years and is led by Wageningen University (WUR) together with the International Institute of Tropical Agriculture (IITA) and the International Livestock Research Institute (ILRI). The project works through many partners in Ghana, Nigeria, Ethiopia, Tanzania and Uganda (Core countries), and in DR Congo, Rwanda, Kenya, Mozambique, Malawi and Zimbabwe (Tier 1 countries).

N2Africa was selected as a case study within the PROIntensAfrica initiative (www.intensafrica.org). PROIntensAfrica aims to build a long-term research and innovation partnership between Africa and the European Union, focusing on the improvement of food and nutrition security through sustainable intensification. N2Africa as case study focuses on the potential role of legumes in sustainable intensification. The case study was conducted in two of the N2Africa countries, Ghana and Kenya, and involved literature research, stakeholder interviews and a household survey. An important part of the case study also involved the discussion and verification of the results with a range of stakeholders during workshops in Ghana and Kenya.

This report describes the results of the one day stakeholder workshop held in Tamale, northern Ghana on June 23, 2016 (Appendix I). The objectives of the workshop were twofold:

1. To verify and deepen the understanding on drivers of change in agriculture in northern Ghana and to discuss results of the household level case studies that were done to describe the relation between legume intensification and sustainability.
2. To identify priority areas for research on the role of legumes in sustainable intensification, building on the results of objective one.

The workshop was attended by 28 participants, including farmers, the Ministry of Food and Agriculture, universities, NGO’s (local and international), research institutes (national and international), agro-chemical dealers, seed sector and grain traders. A full list of participants to the stakeholder workshop can be found in Appendix II.

This report focuses on stakeholders’ contributions during the workshop and the joint development of four priority areas (including key knowledge gaps, intensification options and research questions) for the role of legumes in sustainable intensification in northern Ghana. Presentations of the initial case study results can be found in Appendix III.

Results of this workshop will be used to develop a research agenda for the PROIntensAfrica project.



2 Workshop report

Workshop opening

The workshop was opened by Samuel Adjei-Nsiah, N2Africa Country Coordinator, who welcomed all participants and initiated a round of introductions. This was followed by a brief introduction on the N2Africa project (Appendix III).

Introduction to PROIntensAfrica and the day program

Esther Ronner, WUR, presented the objectives of IntensAfrica and the PROIntensAfrica case studies (Appendix III). The presentation included the question: "What does sustainability mean to you?". After a brief discussion, participants mentioned:

- Adaptability/possibility to adapt for farmers
- Continuity of newly promoted technologies, adoption
- Socio-economic sustainability for households
 - Livelihoods
 - Health/safety
- Long term productivity
- Self-supporting and profitable agriculture
- Crop diversity
- Not to undermine the resource base (for future production).

Drivers of change and agricultural development in northern Ghana

Wytze Marinus, WUR, presented a study on important drivers of change and their effects for northern Ghana (Appendix III), which was based on stakeholder interviews and literature research.

Comments from stakeholders

- Improved education in northern Ghana was identified as an important additional driver/effect. A negative effect is that young, better educated people do not want to go into farming anymore. A positive effect may be that better educated people who do go into farming might go into a different mode of farming, e.g. commercial farming.
- Climate change and population pressure both resulted in a reduction of cultivated area of sorghum and millet and an increase in cultivated area of maize.

Participants were asked for their opinion on possible changes in cultivated area of cowpea (increased/decreased/the same?). A number of challenges in cowpea cultivation were mentioned: pests, weevil infestation of grain after harvest, improved varieties need to be sprayed at least three times while local varieties give poor yields, availability of seed of improved varieties (although Heritage Seeds started multiplication in cooperation with N2Africa last year, which was a success. Other companies and farmers saw the success and will also start multiplication in the coming season). However, farmers still regard cowpea as an important crop, so the cultivated area might have remained stable.

Breakout session on drivers of change

Following the presentation, participants were split into four groups. Each of the groups were given sticky notes to vote on 'flip-over' sheets (one sheet per driver of change and its important effects). Since the list with drivers and effects was too long for each group to vote on all, the list was split in two. Two groups voted on the first half of the drivers and effects and the second group on the second half. The results were discussed in plenary afterwards.

- **Population pressure** was indeed considered to be an important driver of change. Continuous instead of fallow cropping and migration (within and out of northern Ghana) and increased cultivation in less densely populated areas (by people from highly populated areas) were confirmed as important effects. Although the increase of the cultivated area of maize was



indeed partly related to population pressure (maize gives a better response to fertilizer than millet and sorghum and maize gives higher yields, which is needed due to continuous subdivision of land), the increase of maize in Upper east was also partly due to climate change. Cultivation of (early) millet has reduced and was replaced by maize. One of the participants also mentioned reducing soil fertility as a reason why sorghum and millet yields were decreasing. Because sorghum and millet poorly responded to fertiliser, they were replaced by maize.

- **Improved availability of inputs** was confirmed as driver of change. Improved availability was indeed caused by fertilizer subsidies and privatization of the trade in agrochemicals. This privatization has led to an increase of agro-chemical traders and retailers and therefore increased availability. Both subsidies and liberalization of trade resulted in increasing fertilizer use and increased use of crop protection agents and herbicides.
- **External development agencies/projects:** all effects listed under this driver (increased production of soybean and cowpea, increase in irrigated vegetables, and alternative methods for extension to circumvent the reduced number of AEA's) were ranked as important effects. Only the presented effect on improved access to credit for smallholder farmers was voted as not important. The private sector (WIENCO and YARA) initiated Masara N'Arziki program (Hausa for prosperous maize growth) was discussed as an example with mixed results. One of the participants felt that farmers were exploited (higher interest rates for fertilizer and seed credits, guaranteed prices were said to change over the season). Another participant who worked with Masara N'Arziki explained that the story was more complex. Farmers for instance do not handle fertilizer well. When they were supplied with three bags for one acre (on credit), they might use one of these bags to pay for tractor ploughing services (one acre ploughing normally costs GH¢ 50/acre while one bag of fertilizers costs GH¢ 110). Then they might also give one to the labourers that prepare the field and do the planting. Sometimes they even sell a bag for GH¢ 35-50 as they need cash money in the lean season. So at the end fertilisers were not used in the field, farmers did not reap the benefits and could not repay their loans. If they would have used the supplied hybrid seed (Panar), planted the advised density and used fertilizers well, they can benefit from Masara N'Arziki. As a reply to some of the critique it was added that guaranteed prices only changed if they increase during the season, not the other way around. Another stakeholder mentioned that variability in rainfall (risk) is not considered in Masara N'Arziki's and MoFA's block farming credit schemes. 'If the seasons comes badly, they don't have a solution for it and farmers can't repay.' At the end it was asked how many farmers were currently joining Masara N'Arziki and whether it could be considered as a success. The former employee of Masara N'Arziki explained that numbers were still increasing and that although initially there were issues, overall farmers were now positive. Specific fertilizer rates were brought up as part of the discussion. Based on the MoFA advice, 150 kg (3 bags) per acre are advised as a blanket recommendation, but it was questioned what the basis was for this advice. The chief executive officer for Greenef (an agro-input dealer organization) mentioned that they have now started soil analysis to be able to give specific advice to farmers. Other stakeholders also mentioned that there should be a stronger focus on other factors than nitrogen that influence the yield gap, e.g. weeding, right planting date (soil moisture) etc.
- **Government policies** were seen as ineffective or having little effect on agricultural development. Reduced growth of the agricultural sector from 8 to 2% per year was mentioned as an example. Tractor ploughing services, presented as a result of government subsidies, are currently mostly run by private actors, participants said. And although indeed part of the tractors was imported by the government and sold at subsidised prices, most were imported by private companies as second hand tractors. Participants also pointed out the poor funding of the agricultural sector by the government. National research institutes and government extension service for instance largely depend on funding from donors, not the government. And even budgetary allocation to the Ministry of Food and Agriculture (MoFA) does not always come or arrives late at the municipal or district level, resulting in immobility of Agricultural Extension Agents (AEA's) whose number keeps on dwindling. The same counts for subsidised fertiliser which arrives very late in the season, after many farmers have already planted. Even this year, less subsidized fertilisers are supplied to companies than previous years. The subsidy system also became increasingly cumbersome for smallholder farmers. The AEA has



to register them by taking a picture and uploading personal details, including their mobile phone number. On this number, farmers get a text message with a personal registration number. Many farmers however lose this number or do not know how to use this number/mobile phone texting. When using the number at the agro-chemical dealer the central (national) registration system does not always work. At the end many farmers fail to join or are otherwise discouraged to apply for subsidised fertilizers.

- **Climate change** was voted as important driver, resulting in more erratic rains, less cultivation of early millet (Upper East) and yam (Northern Region).
- **Disease pressure in groundnut** was voted as not important. It was mentioned that pest and diseases are a general issue, in particular in legumes, and not a specific issue for groundnut. Other participants (SARI researcher and N2Africa country coordinator) that were not among the groups that had voted for this driver objected: in particular Rosette disease and leaf spot are important reasons why farmers do no longer want to cultivate groundnut. New varieties (e.g. Samnut 22 and 23) are tolerant to these diseases, but as one of the participants mentioned, 'that we have a solution doesn't mean that it already helps farmers'. In Bawku area farmers also indicated that the soils no longer support groundnut (a soil fertility issue?). This could be another cause for reducing areas of groundnut. It was concluded that indeed there are issues with diseases in groundnut, but groundnut is not wiped out yet and there are solutions (new varieties).

Additional drivers of change

Stakeholders also reported additional drivers and effects. Some of these additions were also describing the current state or already geared towards solutions.

People move out of agriculture due to higher income levels in other sectors, which is an important reason why people move from rural areas to towns and cities. Better education further strengthens this trend. People do not want to be in agriculture anymore and are looking for different types of work. People who do remain in agriculture might be better educated, which could result in improved agricultural practices.

Research and extension were named as a major driver that cannot go without each other. For instance, researchers brought white maize varieties to the north and AEA's demonstrated them. Research was also important for increased soybean cultivation: SARI developed the first non-shattering variety for northern Ghana, Jenguma. The introduction of Jenguma was an important reason why soybean cultivation picked up.

Agro-processing can be an important option for change. ITFC (commercial-led mango plantation) and maize out-growers scheme, owned by WIENCO were given as examples where mangos are processed and sold for high prices as export product. Agriculture itself is not profitable, prices are too low. Only through value adding agriculture can become profitable!

Consumers in the cities in the south want clean products of cowpea and rice and do not want to pick out the stones and weevils before cooking. This is why imported cowpea from Burkina Faso is popular in the south. Farmers in northern Ghana should adjust to changing demands from customers and invest in clean produce.

Current status of legume cultivation and sustainable intensification in northern Ghana

The second presentation by Wytze Marinus focussed on the current status of legume cultivation and agricultural intensification in northern Ghana (Appendix III) to understand the starting point for future scenarios and research. A general description of the current status of agriculture in northern Ghana based on stakeholder interviews and literature research was followed by a presentation of results of the household survey held in Savelugu and Bawku West.

One participant commented that the flow of remittances from the south (cities like Kumasi, Tema, Accra) might be less important nowadays. The north is developing and he himself was sending money



to his family in the south for instance. The idea that migration to the south is important might be outdated and this was confirmed by other participants.

A number of questions for discussion were asked to the participants (see Appendix III):

- *Inputs for legumes (TSP, inoculant) are not yet widely available for farmers while in particular for inoculants, demand is rising. Are legume inputs attractive enough for agro-chemical dealers to stock and sell?* A representative from Greenef, a private sector company that started the supplying of legume inputs to agro-chemical dealers this season (in cooperation with N2Africa) explained that this is the first time that the private sector is involved in selling inoculants. Storage is currently centralized in Tamale. The aim is to have good connection with agro-chemical dealers to enhance detailed ordering and delivery close to the planting season. Eventually they want to move towards portable solar-energy cold storage for agrochemical dealers. Mr Wumpini, an established agro-chemical wholesaler and chairman of the Ghana Agri-Input Dealers Association, commented that this could be a good model. Some areas don't even have light, so solar energy coolers could be a good solution. One of the farmers present mentioned that he didn't know who to contact, as he did not know about Green-eff. Green-eff started with radio announcements to enhance awareness.
- *Are farmers willing to buy TSP?* The first response was: yes farmers will adopt if results are spectacular (e.g. like glyphosate – it works well so farmers don't have to dig anymore). Then one of the participants asked: have we seen such an improvement in yield with P-fertilizer? A representative of SARI pointed out that responses to inoculant and TSP are good, but also stressed that to get these responses other improved agronomic practices like good spacing and weeding are needed as well. In addition to the earlier discussion, he also mentioned that inoculants can stay at somewhat higher temperatures for shorter periods and don't need to be cooled if they remain, for instance, in a farmers' house a few days before planting. A farmer mentioned that inoculants are better because TSP is more expensive. Farmers need inoculants instead of TSP. Another farmer confirmed this; he had been using inoculants last year and was planning to repeat this in the coming season with a group of other farmers. "TSP is good, but too expensive". Farmers are currently not using inoculants yet because they are not widely available, not because of their cost. The SARI researcher mentioned that inoculants are not a substitute to TSP, they should both be used, not one or the other. Farmers replied with a plea for subsidy on TSP.

Assessing (future changes in) sustainability of farming systems

Before moving on to the presentation of results of the household survey, participants were asked: "What is a desirable future for farming according to you"? Answers can be found below (Figure 1).

What is a desirable future for farming according to you?

- Farming with irrigation systems
- Farming as a business, sell after harvest, evaluate the profit. Use profit to take care of children
- Soil testing is important – we should know what should be replaced
- Extension officers should farm them self as well, not only talk about it.
- Educated people should take farming as business, and teach it to their children.
- At policy level: young farmer clubs in schools. Can start from primary school, school gardens.
- Farmer should take account of what he/ she invests and gets, even if farmers don't sell and don't do farming as business, to know about profitability.
- Conservation agriculture – in north, considering climate and challenges, can be an option there.
- A larger variety of crops should be cultivated to deal with risks of climate change.
- Crop-livestock integration should be improved because of poor soils.

Figure 1. Answer to the question: what is a desirable future for farming according to you?



The main discussion points raised and resulting comments from the workshop participants are discussed below.

The household survey indicated that food self-sufficiency was lower in Bawku West than in Savelugu, while food security was similar in Bawku West and Savelugu. Cross-border trade and other cross-border activities in Bawku West (with Burkina Faso and Togo) was mentioned as an important alternative source of income that is not present in Savelugu, which could explain this difference.

Participants confirmed that farmers with more land cultivate a larger share of their land with legumes, in particular with soybean. Soybean is seen as a cash crop, usually cultivated in pure stand in larger plots. Poorer farmers give priority to food crops, mostly maize. Poorer farmers sometimes also grow erect, short duration cowpea as an early food crop. Some of these farmers, however, prefer local, yellow maize as early food crop as it doesn't need spraying, while cowpea does need spraying. Poorer farmers do appreciate legumes as they "can do well without fertilisers".

Cowpea as cash crops is often only grown in smaller areas (erect type, pure stand). It is also grown in mixed cropping with sorghum or millet (often creeping, local varieties), mostly for home consumption. Mixed cropping of cowpea (e.g. with millet or sorghum) is more common in Upper East (Bawku West) than in the Northern Region (Savelugu).

Soybean is more popular in the Northern Region (around Savelugu) and has gained popularity due to involvement of women in soybean cultivation. This was mentioned as reason why, generally, a larger share of the farms in Savelugu were cultivated with legumes than in Bawku West. In Bawku West, legumes may be grown on a larger number of fields than in Savelugu, but as they are commonly grown in intercropping, legumes cover a smaller total area than in Savelugu.

Identifying priority areas for research on the role of legumes in sustainable intensification

Four priority areas for research were identified based on the discussions and presentations during the first half of the day:

1. *Farming as a business*

- What will be the effect of decreasing number of people in agriculture?
- Is there a trend towards better educated farmers? → How will this alternate livelihoods?
- Is agriculture worth investing in – current gross margin is very low?
- Is there a way to make agriculture more attractive for youth? What role for legumes?

2. *Agro-processing*

- What are opportunities for processing legumes?
- What processing can take place in northern Ghana?
- How can the changing demands in cities be linked to farmers' production?

3. *Improving productivity*

- Poor soil fertility and land degradation, climate change and changing cropping patterns: how can legumes play a role? Is crop livestock integration an option?

4. *Legume intensification*

- Improving availability of inputs (seeds, inoculants, fertilizer): what is needed to improve access and use of these inputs. Use of manure?
- Dissemination of new varieties of groundnut?
- How to improve yields of soybean?
- Are there adverse effects of intensification? E.g. increased use of pesticides (cowpea), herbicides – environmental sustainability, health effects?

Participants could choose one of these topics and were asked to identify three key priorities and important knowledge gaps for their topic during a breakout session. Government policies were taken on board as a cross-cutting topic: what should be the role of government, e.g. in terms of fertilizer subsidies on TSP, or farming clubs in school?



Feedback from breakout sessions on priority areas for research

1. *Improving productivity*

Key priority areas identified by this group were:

1. Intercropping legumes with cereals
2. Climate resilient practices
3. Highly efficient nitrogen fixing legumes

Which resulted in the following knowledge gaps:

1. Best intercropping patterns within each crop (cereal-legume spacing and density)
2. Best social, economic and ecological methods of minimum tillage suitable for northern Ghana.
3. Which of the legume varieties fixes most nitrogen? With high N₂-fixation, the in-season flow of N from N₂-fixation can be higher than the 10% that is currently common in cereal legume intercropping.

Following a question, it was explained that one of the participants was part of an NGO that had imported rippers from Tanzania to be used in reduced tillage systems. So far however, they had not yet identified as successful method that worked in northern Ghana. Crop emergence was poor. Currently, they experiment with different timing of ripping to improve germination. It was added that another climate resilient practice could be to identify high yielding short duration varieties for each crop currently cultivated in northern Ghana.

2. *Legume intensification*

Key priority areas identified by this group were:

1. Availability and affordability – access to legume inputs
2. Mechanization of legume production
3. Dissemination of improved varieties to farmers, how to transfer knowledge?

Which resulted in the following knowledge gaps:

1. Availability of and access to inputs: need for partnering with input suppliers, sale of small quantities of seed and outlets in villages.
2. How can land preparation, weeding, seeding, harvesting, threshing and fertilizer application be mechanized to reduce the labour demand of legumes? Government focusses on fertilizer subsidies and ploughing, not on more labour demanding activities. A major complaint from farmers is that harvesting and processing of soybean is tedious. Mechanization of these activities is therefore key.
3. What could be alternative methods for extension? E.g. demonstration trials, use of media events.
4. Limited data on the use of manure on legumes, most is on cereals. How should farmers use their limited organic inputs on legumes? Promote ISFM in legumes

Adjei-Nsiah commented that farmers don't know whether they need to re-inoculate a field once it has been cultivated with inoculated legumes – is this also a knowledge gap? Dr Ahiabor from SARI answered that this is a knowledge gap, but because inoculants are cheap it is advisable to inoculate until there is no response anymore.

One of the participants also noted that the application of appropriate crop protection at the right time [for cowpea] is also a knowledge gap. Farmers just apply anything.

Apart from the availability of seed, are there any difficulties in the supply of good quality seed from breeders to growers? Farmers are not used to buying seed – they recycle seed. We cannot force farmers to buy seed, so we have to create awareness. We know that when there is demand from farmers for new varieties and more seed, suppliers will supply!

3. *Farming as a business*

This group took the perspective of farmers and identified key priorities for farmers when they would take farming as a business.

- Farmers should do a market survey to identify which crops are in high demand and what prices they fetch. They could also make contracts with buyers.
- Farmers should keep records to make a crop budget from which profitability can be analysed.



- They should make their own cropping calendar for appropriate timing of activities.

Knowledge gaps were also considered from farmers' perspective:

- Soil types, farmers don't know on what soils they cultivate.
- What are suitable crops to cultivate?
- Cost of inputs, keep records for accounting.

This group explained that the decreasing number of people in farming could result in increased land availability. Increased land availability in turn could lead to room for commercialization and mechanization in agriculture. They also explained that currently more educated people were going back into agriculture, which could be an option for increased productivity. There are however no statistics to back up the latter statement.

4. *Agro-processing*

This group identified five processing priorities for legumes:

- Oil processing (small to medium scale enterprises (SME's))
- Feed mills (SME's) for crop-livestock integration: cakes, concentrates → pigs fish, poultry
- Bailers (crop residues)
- Flour mills'
- Domestic/household uses (soymilk, dawadawa, kebab, winimix)

How could this be done? What are the three key priority areas?

1. Increasing production of legumes through youth women groups, making use of improved varieties and ensuring availability of inputs
2. Use of small/medium scale equipment with support grants from government, NGO's, self-help groups.
3. Support producers/farmers through value chain training to process high quality legume grains.

The group recognized that there used to be large processing plants in Tamale, but they are all shut down. This is why they proposed to start with small to medium scale enterprises as a more appropriate option for the region. Processing could also employ part of the unemployed youth (who are not into farming anymore).

One of the participants asked what "support" means, and support by whom? Handouts do not work. Herbicides are so successful because they work. Farmers need things that they can resource from. The group answered that support should be in training, not in money or in kind. E.g. training on farmers' production of good quality seed. Participants appreciated the suggestion of SMEs that could produce soymilk or 'Winimix', products that are currently only processed and produced in the south and then brought back to the north.

3 Way forward

The lively discussions and valuable additions to the case study work so far led to the identification of four priority areas for research and related key research questions. The priority areas and key questions will be translated, together with the results from a similar case study in Kenya, into a research agenda on the potential role of legumes in sustainable intensification of agriculture in sub-Saharan Africa. This research agenda forms part of N2Africa's contribution as case study within the PROIntensAfrica project. Ultimately, PROIntensAfrica serves as input for the development of a long-term partnership between Africa and the European Union.



Appendix I – Workshop program



Stakeholder workshops ProIntensAfrica, northern Ghana



24st June 2016

Radach Lodge & Conference Center, Tamale

Workshop objectives

The objectives of the ProIntensAfrica stakeholder workshop are to:

- Discuss important drivers of change / agricultural development in northern Ghana
- Achieve a common understanding of criteria and indicators to measure sustainable intensification of agriculture through legume production
- Develop a research agenda around sustainable intensification through legume production

Tentative programme

9.30-9.00	<i>Arrival</i>
9.00-9.15	Welcome and introductions (<i>Samuel Adjei-Nsiah</i>)
9.15-9.45	Introduction to ProIntensAfrica (<i>Esther Ronner</i>)
9.45-10.15	Drivers of change and agricultural development in northern Ghana (<i>Wytze Marinus</i>)
10.15-10.45	<i>Coffee break</i>
10.45-11.15	Break-out sessions to reflect on drivers of change; plenary feedback session
11.15-11.45	Legume intensification as pathway for sustainable intensification (<i>Wytze Marinus</i>)
11.45-12.30	Break-out sessions to reflect on criteria and indicators for sustainable intensification through legumes; plenary feedback session
12.30-13.30	<i>Lunch break</i>
13.30-14.00	Introduction research agenda for sustainable intensification through legumes (<i>Esther Ronner</i>)
14.00-14.45	Break-out sessions to identify knowledge gaps around sustainable intensification
14.45-15.15	Arrive at a common research agenda for sustainable intensification through legumes in northern Ghana (<i>Esther Ronner</i>)
15.15-15.30	Closure and way forward



Appendix II – Participants list

	Name	Organisation	Position	Location
1	Daniel Waja	FBO	Chairman	Yendi
2	Issahaku Yakubu	Urbanet	Farmer	Savelugu
3	Charles Akwotiga	MoFA	Director	Bawku
4	Peter Anyagri	MoFA	AEA	Zebilla
5	Yussif Sulemana	MoFA	DDA	Zebilla
6	Jibreel Mohammed Bassit	Urbanet	Head of programmes	Tamale
7	Anaadumba Abdulai Ernest	YARO	Head of agric programme	Mion District
8	Azam Imoro	Borina Kusu enterprise	Procurement manager	Savelugu
9	Asungre Peter	CSIR - SARI	Millet breeder	Bawku
10	Francis A. Naindow	Department of Agric (MoFA)	MDA	Pong Tamale
11	Abdulahi Aligu	Solidaridad – West Africa	Senior programme officer	Tamale
12	Charles N. Kojo	EPDRA - Yendi	Project officer	Yndi
13	Vincent K. Avornyo	University for Development Studies	Representative for Dean	Nyankpala
14	Fugluu George Nego	AGXTENSION Africa ltd	Director of operations	Tamale
15	George Awuni	Soyabean Innovation Lab	Researcher	Nyankpala
16	Zakaria S. Iddrisu	Heritage Seeds company	Managing Director	Tamale
17	Andy Tsatsu	SARI	S.T.O	Nyankpala
18	Benjamin Ahiabor	SARI	Senior Research Scientist	Nyankpala
19	Sachibu Mohammed	Green-EF	CEO	Tamale
20	Mahamah Aaron	Green-EF	Project coordinator	Tamale
21	Esther Ronner	WUR	PhD researcher	Netherlands




Name	Organisation	Position	Location
22 Mahamah A. Rahaman	YARA Ghana Ltd	Commercial manager	Tamale
23 Alhassan Moses Joshua	YARA Ghana Ltd	Intern	Tamale
24 Samuel Adjei - Nsiah	IITA	Country coor. N2Africa	Tamale
25 Andrews Opoku	KNUST	Lecturer	Kumasi
26 Wytze Marinus	Wageningen University	Researcher	Netherlands
27 Basit Alabi Ussif	IITA	FLO – N2Africa	Tamale
28 Arnold S. Ampiah	IITA	Data Analyst – N2Africa	Tamale



Appendix III – Presentations



- | | |
|--------------------|---|
| Samuel Adjei-Nsiah | – N2Africa project: an overview |
| Esther Ronner | – N2Africa case study for PROIntensAfrica |
| Wytze Marinus | – Drivers of change: Northern Ghana |
| Wytze Marinus | – Current status of legume cultivation and sustainable intensification in northern Ghana |
| Esther Ronner | – Identifying priority areas for research on the role of legumes in sustainable intensification |



N2AFRICA PROJECT AN OVERVIEW

S. Adjei-Nsiah


Putting nitrogen fixation to work for smallholder farmers in Africa

N2Africa


- Funded by Bill & Melinda Gates Foundation
- Led by Wageningen University, IITA, ILRI and AGRA with many national partners
- Total funding US\$25M
- Focus on enhancing production of the major grain legumes
 - Common bean, cowpea, groundnut and soybean in Ghana, Nigeria, Tanzania and Uganda
 - Chickpea and faba bean in Ethiopia

Putting nitrogen fixation to work for smallholder farmers in Africa



Increasing inputs from N₂-fixation

- Increase the area of land cropped with legumes (targeting of technologies)
- Increase legume productivity (agronomy, P-fertilizer)
- Select better legume varieties
- Select better rhizobium strains and inoculate
- Link to markets and create new enterprises to increase demand for legumes




Putting nitrogen fixation to work for smallholder farmers in Africa



Vision of Success

- 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 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**
- **New value chains** will be **established** and the **food and nutritional security of the poor** will be enhanced


Putting nitrogen fixation to work for smallholder farmers in Africa



The project puts a major emphasis on:

- 1) Institutionalizing N2Africa technologies, approaches, and expertise;
- 2) Fostering long-term sustainability of:
 - seed, inoculant, and fertilizer supply chains;
 - access to profitable legume markets;
 - knowledge transfer.


Putting nitrogen fixation to work for smallholder farmers in Africa

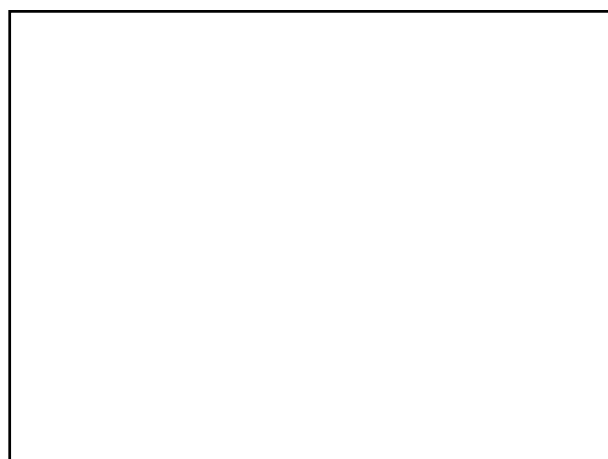
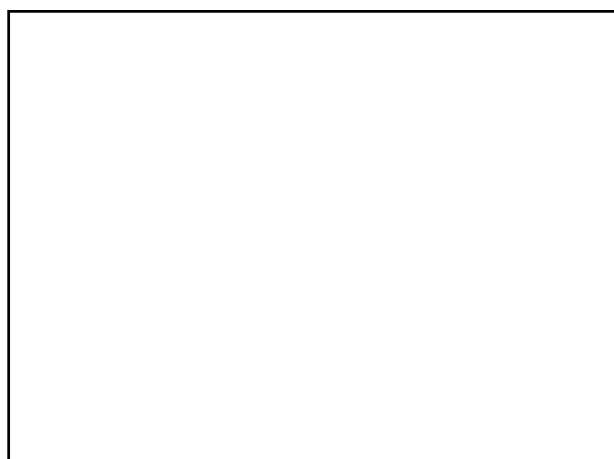
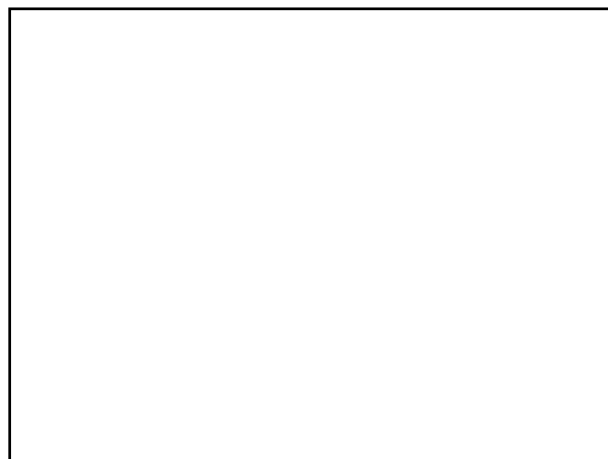
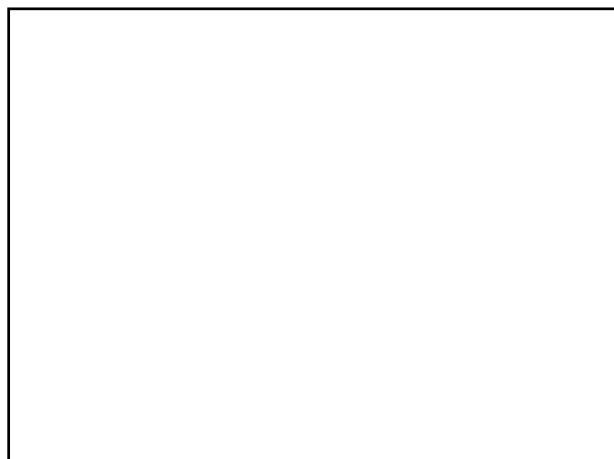
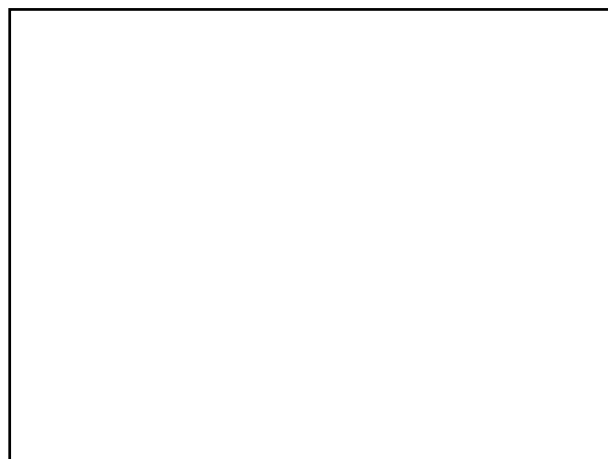




PARTNERS

ORGANIZATION	TYPE OF PARTNERSHIP	Operational Zone
KNUST	RESEARCH	Northern Ghana
CSIAR-SARI	RESEARCH	Northern Ghana
EPDRA-Yendi	DISSEMINATION	Yendi
EPDRA-Saboba	DISSEMINATION	Saboba
URBANET	DISSEMINATION	Savalugu
MOFA	DISSEMINATION	Upper East and West
ADVANCE	DISSEMINATION	Northern Ghana
SEND-GHANA	DISSEMINATION	Northern Region

Putting nitrogen fixation to work for smallholder farmers in Africa

PARTNERS		
		
ORGANIZATION	TYPE OF PARTNERSHIP	Operational Zone
IFDC	DISSEMINATION/RESEARCH	Northern Ghana
GREENEF	PPP/INPUT SUPPLY	Northern Ghana
HERITAGE SEEDS	SEED PRODUCTION	Northern Ghana
EPDRA-Saboba	DISSEMINATION	Saboba
URBANET	DISSEMINATION	Savalugu
Putting nitrogen fixation to work for smallholder farmers in Africa		







N2Africa case study for PROIntensAfrica


Putting Nitrogen fixation to work for smallholder farmers in Africa

Wytze Marinus, Esther Ronner, Fred Kanampiu, Samuel Adjei Nsiah, Ken Giller, Gerrie van de Ven, Greta van den Brand



Background PROIntensAfrica

- IntensAfrica: long-term research and innovation partnership between Europe and Africa:
 - Improve farmers' livelihoods, food and nutrition security...
 - ...with support of the relevant policy environment
- PROIntensAfrica: development of proposal for this partnership
 - *How* can we exploit the potential of African agriculture?
 - Diversity of pathways

Background PROIntensAfrica

- PROIntensAfrica is funded by EU, led by FARA, CIRAD (France) and Wageningen University (Netherlands)
- Development of a partnership proposal:
 - What do we still need to know to identify and implement effective pathways for agricultural development (what)
 - What is the added value of a partnership for both continents in addition to ongoing partnerships? (why)
 - What financial and governance structures can adequately support the partnership? (how)

Background PROIntensAfrica

- Understand *diversity* and *effectiveness* of current agricultural systems
- How can we exploit the potential of agriculture, without depleting resources?



Sustainable intensification





Sustainable intensification

What does sustainability mean to you?






Diversity of pathways...

- What do we need to know to identify and implement effective pathways for agricultural development
- Case studies in East, West, Southern and Central Africa, e.g. on...
 - Mixed crop-livestock farming systems
 - Cocoa production in Central Africa
 - Highland production systems in Madagascar
 - Seed potato production in Eritrea

N2Africa as a case study

- N2Africa: grain legumes
- What is the role of legumes in sustainable farming systems?
 - 'Sustainability' of farms with or without legumes
 - If we want to enhance production in a sustainable way, how would legumes play a role?



Northern Ghana & Western Kenya



Why Ghana and Kenya?




- East and West-Africa
- Involved since 2010

Why are we here?

- Bottom-up, creative ideas from different perspectives
- Priority areas/ key questions for research on legumes in northern Ghana
- Opportunity to showcase N2Africa in Ghana
- Potential long-term investment in similar work

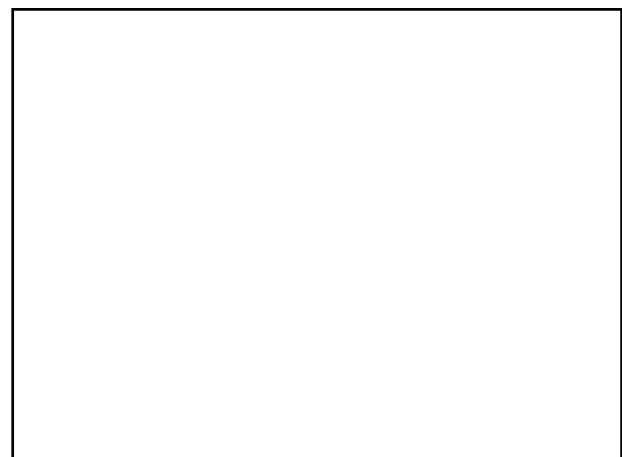
What have we done so far?

- Literature study:
 - How do others define sustainability
 - How can we measure this?
- Household surveys in Ghana and Kenya
 - How do households (not) cultivating legumes 'score' on sustainability?
- Stakeholder interviews
 - How has agriculture changed from the past?
 - What trends do we see in agriculture and rural development?


What are we going to do today?

- 'Stakeholder workshop'
 - Reflections from different perspectives
- Verify what we have found
 - Changes in agricultural/ rural development in northern Ghana
 - Sustainability of current farming systems
 - Did we measure the most important things?
 - How can we explain differences between farmers?
- Where do we want to move in future?
 - Defining priority areas for research on role of legumes in sustainable intensification



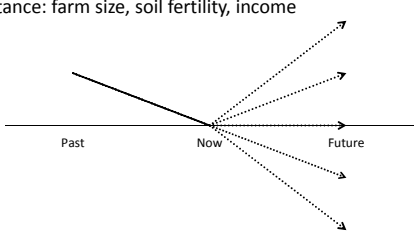


Drivers of change Northern Ghana


Change

For instance: farm size, soil fertility, income



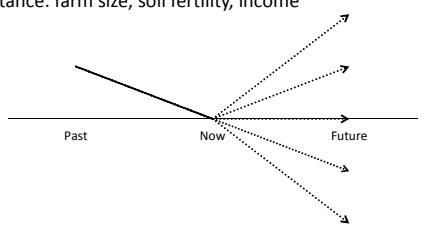
Past Now Future

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Change

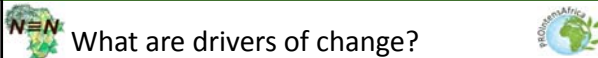
For instance: farm size, soil fertility, income



Past Now Future

What is driving this?

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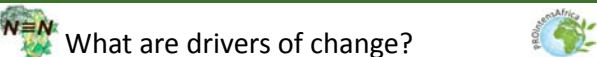
What are drivers of change?

‘any natural- or human-induced factor that brings change in an agricultural production systems’


Objective:

- To identify where we come from,
- Where we are now and,
- To understand how to move to desirable future in a sustainable way

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What are drivers of change?



<http://www.foodandagpolicy.org/media/gallery/drivers-change>


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Methods

- Stakeholder interviews
 - Savelugu
 - Bawku West
- Household survey
- Literature research

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What are drivers of change?




Drivers of changes in northern Ghana?


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Overview drivers of change




- Population pressure
- Improved availability of inputs
- External development agencies/projects
- Government policies
- Climate change
- Disease pressure




Population pressure




- Continuous instead of fallow cropping systems
- Migration to and cultivation in less densely populated areas (north of Savelugu, Karaga)
- Maize becoming more dominant in search of more productive crops (recently in Bawku-West)




Improved availability of inputs




- Availability of inputs through fertilizer subsidies, and private sector (agro-dealers) instead of government only
 - Increasing fertilizer use (also related to increased dominance of maize requiring more inputs than sorghum/ millet)
 - Increasing use of crop protection agents and herbicides




External development agencies/projects





- Increased soybean and cowpea(?) production
 - Popularity of short duration cowpea varieties
 - Poor availability of cowpea seed
- Irrigated vegetable gardens providing income in dry season (Bawku-West)
- Improved access to credit facilities
 - Availability inputs on credit (Masara M'Ariziki – Tamale)
 - Strengthening farmer groups for credit facilitation
- Reduced number of government extension officers
 - Training of lead farmers and community extension volunteers
 - Last mile extension in cooperation with agro-dealers





Government policies





- Subsidies for NPK and Urea
- Tractor ploughing services (in Savelugu, not Bawku-West)
 - Reduced labour demand
 - Soil degradation?
- Block farming scheme
 - Benefits youth or larger farmers?
- No replacement of extension workers at retirement

 **Climate change** 

- Rainfall patterns more erratic and less reliable
 - Decreasing cultivation of early millet as source of food after lean season in Upper East/Bawku
 - Decreasing cultivation of yam (in combination with intensive labour and management requirement)

 **Disease pressure** 

- Groundnut cultivation largely wiped out (in combination with reduced government subsidies)
 - Reduced production leads to high market prices



 **What do you think?** 

What are the most important effects of the drivers of changes?


What are we missing?

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Current status of legume cultivation and sustainable intensification in northern Ghana




WAGENINGEN UNIVERSITY
WAGENINGEN NL



IITA
Research in Northern Africa

Where are we now?

- Growth in cities, rural development lags behind
 - Importance of remittances
 - Still a need for labour intensive projects
- Many initiatives
 - Development projects
 - Electrification of rural areas
- Still low fertiliser use, limited use of hybrid maize



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Where are we now?

- Good soybean markets
 - Middle men taking large share?
- Quality and cleanness of soybean grain is concern for buyers
- Poor availability of certified seed for cowpea and groundnut
 - poor cooperation between breeders, seed multipliers and seed inspection unit of MoFA
- Poor availability of inputs for legumes
 - Limited availability of inoculants around Savelugu
 - TSP not available
 - Fertilizer subsidies for NPK and Urea only



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Where are we now?

- Limited use of manure around Savelugu (no cattle keeping around the homestead but outsourced to Fulani)
- Striga incidence
- Pest pressure in cowpea and high insecticide costs
 - Cowpea less attractive for poorer farmers?
 - Preference of local, creeping cowpea varieties
- Limited use of hybrid varieties in maize (import only)
- Remittances from migration to urban centres (Accra, Kumasi)



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Questions

- Increasing demand from farmers for inputs for legumes → attractive enough for agro-dealers to stock?
 - Inoculants?
 - TSP? DAP?
 - Cowpea less attractive for poorer farmers due to high insecticide costs?

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Future of farming in northern Ghana

What is a desirable future?

- How would you see the future for your children if you were a farmer?
- What are sustainable farming systems according to you?

→ Discuss with your neighbour, 2min, how should this look like?

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Analysing farming systems

- Where are we now?
- Where do we want to move?

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Analysing farming systems

- What are important aspects of sustainability?
- How can we monitor change?

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Principles for sustainable farming systems

Principles: fundamental aspects of sustainable farming systems

PROIntensAfrica:

- Productivity
- Viability
- Resilience
- Social wellbeing
- Environment

Do we consider everything?

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Analysing farming systems

Indicators: to assess the impact on principles

Detailed household survey

- Savelugu (10 households)
- Bawku West (10 households)

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Analysing farming systems

Indicators: to assess the impact on principles

What are important indicators?

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Indicators

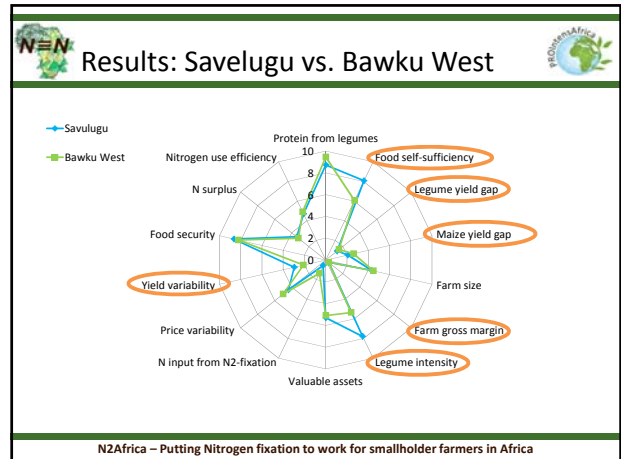
Productivity		Social wellbeing	
Protein from legumes	% of required in diet	Share of women in labour	%
Food self-sufficiency	% of months	Women empowerment	Score
Legume yield gap	%	Food security	%
Maize yield gap	%	Post harvest storage	Score
Viability		Market access	Minutes
Farm size	ha	Frequency of extension services	Score
Farm gross margin	Ksh/AE/minimum wage	Environment	
Legume intensity	%	Crop protection use	Score
Valuable assets	Score	N surplus	kg N/ha
Resilience		Nitrogen use efficiency	%
N input from N ₂ -fixation	kg/farm area	Erosion control	Score
Agro-diversity	Simpsons diversity index		
Price variability	Score		
Yield variability	Score		

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Indicators

Productivity		Social wellbeing	
Protein from legumes	% of required in diet	Share of women in labour	%
Food self-sufficiency	% of months	Women empowerment	Score
Legume-yield gap	%	Food security	%
Maize yield gap	%	Post harvest storage	Score
Viability		Environment	
Farm size	ha	Crop protection use	Score
Farm gross margin	Ksh/AE/minimum wage	N surplus	kg N/ha
Legume intensity	%	Erosion control	Score
Resilience			
N input from N2-fixation	kg/farm area		
Agro-diversity	Simpsons diversity index		
Price variability	Score		
Yield variability	Score		

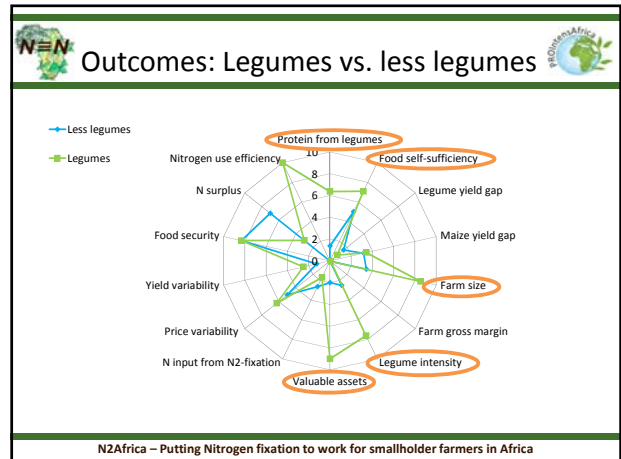
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Discussing results

- Are legumes more common in Savelugu than Bawku West?
- Are their in Bawku West more alternative sources of income?
- Is farming worth investing in?

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Discussing results

- Do better-off households cultivate more legumes?



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Summarising results

Growing population → What future for agriculture?
 Crop diseases and climate change affecting productivity

Increased input use (fertiliser, crop protection), what is next?
 Can youth take part? What are alternatives?

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 Summarising results 

Challenges for legumes

- Groundnut, how can new varieties be disseminated?
- Cowpea, for whom is it attractive?
- Soybean, how to increase yields?

Input use on legumes still very low

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 Summarising results 

How to further develop agriculture?

What roles for:

- MOFA
- NGO's/projects
- Private sector

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 Lunch time! 




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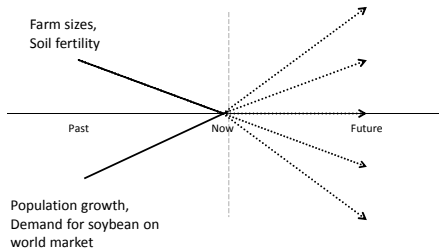



Identifying priority areas for research on the role of legumes in sustainable intensification







Which direction do we want to move?



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1) Improving productivity




Low soil fertility and land degradation
Climate change
Changing cropping patterns

How can legumes play a role?
Is closer crop-livestock integration an option?

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2) Legume intensification




Improving availability of inputs
– Seeds, inoculants, fertilizer
→ What is needed to improve access and use of these inputs?


Use of manure?
Dissemination of new varieties of groundnut?
How to improve yields of soybean?

Are there adverse effects of intensification? E.g. increased use of insecticides (cowpea), herbicides – health, environment?

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3) Farming as a business




What will be the effect of decreasing number of people in agriculture? Is there a trend towards better educated farmers?
→ How will this alternate livelihoods?

Is agriculture worth investing in – current gross margin very low?
Is there a way to make agriculture more attractive for youth?
What role for legumes?

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4) Agro-processing



What are opportunities for processing legumes?
What processing can take place in northern Ghana?

How can the changing demands in cities be linked to farmers production?

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 **Four groups** 

- 1) Improving productivity
- 2) Legume intensification
- 3) Farming as a business
- 4) Agro-processing

Cross-cutting: Government policies (fertilizer subsidies TSP, farming clubs in schools)

What is a desirable future for farming in northern Ghana?
How can legumes play a role?

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 **Priority areas for research** 

What are three key priorities for your topic

What are the most important knowledge gaps?

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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 soyabeans, 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
47. Background information on agronomy, farming systems and ongoing projects on grain legumes in Uganda
48. Opportunities for N2Africa in Tanzania
49. Background information on agronomy, farming systems and ongoing projects on grain legumes in Ethiopia
50. Special Events on the Role of Legumes in Household Nutrition and Value-Added Processing
51. Value chain analyses of grain legumes in N2Africa: Kenya, Rwanda, eastern DRC, Ghana, Nigeria, Mozambique, Malawi and Zimbabwe
52. Background information on agronomy, farming systems and ongoing projects on grain legumes in Tanzania
53. Nutritional benefits of legume consumption at household level in rural sub-Saharan Africa: Literature study
54. N2Africa Project Progress Report Month 42
55. Market Analysis of Inoculant Production and Use
56. Identified soyabean, common bean, cowpea and groundnut varieties with high Biological Nitrogen Fixation potential identified in N2Africa impact zones
57. A N2Africa universal logo representing inoculant quality assurance
58. M&E Workstream report
59. Improving legume inoculants and developing strategic alliances for their advancement
60. Rhizobium collection, testing and the identification of candidate elite strains
61. Evaluation of the progress made towards achieving the Vision of Success in N2Africa
62. Policy recommendation related to inoculant regulation and cross border trade
63. Satellite sites and activities in the impact zones of the N2Africa project
64. Linking communities to legume processing initiatives
65. Special events on the role of legumes in household nutrition and value-added processing
66. Media Events in the N2Africa project
67. Launch N2Africa Phase II – Report Uganda



68. Review of conditioning factors and constraints to legume adoption and their management in Phase II of N2Africa
69. Report on the milestones in the Supplementary N2Africa grant
70. N2Africa Phase II Launch in Tanzania
71. N2Africa Phase II 6 months report
72. Involvement of women in at least 50% of all farmer related activities
73. N2Africa Final Report of the First Phase: 2009-2013
74. Managing factors that affect the adoption of grain legumes in Uganda in the N2Africa project
75. Managing factors that affect the adoption of grain legumes in Ethiopia in the N2Africa project
76. Managing factors that affect the adoption of grain legumes in Tanzania in the N2Africa project
77. N2Africa Action Areas in Ethiopia, Ghana, Nigeria, Tanzania and Uganda in 2014
78. N2Africa Annual report Phase II Year 1
79. N2Africa: Taking Stock and Moving Forward. Workshop report
80. N2Africa Kenya Country Report 2015
81. N2Africa Annual Report 2015
82. Value Chain Analysis of Grain Legumes in Borno State, Nigeria
83. Baseline report Borno State
84. N2Africa Annual Report 2015 DR Congo
85. N2Africa Annual Report 2015 Rwanda
86. N2Africa Annual Report 2015 Malawi
87. Contract Sprayer in Borno State, Nigeria
88. N2Africa Baseline Report II Ethiopia, Tanzania, Uganda, version 2.1
89. N2Africa rhizobial isolates in Kenya
90. N2Africa Early Impact Survey, Rwanda
91. N2Africa Early Impact Survey, Ghana
92. Tracing seed diffusion from introduced legume seeds through N2Africa demonstration trials and seed-input packages
93. The role of legumes in sustainable intensification – priority areas for research in northern Ghana



Partners involved in the N2Africa project

