



N2Africa in northern Ghana

Context to the recent quantitative Impact Study
A qualitative impact assessment in four villages

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N2Africa

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



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Short summary

In May and June 2019 we visited four villages in northern Ghana where N2Africa has been active and which have been included in N2Africa's Impact Study. With the aim of adding qualitative context to the quantitative Impact Study, we discussed the experiences with N2Africa in an open way in individual interviews and focus group discussions with villagers.

When N2Africa commenced in the study villages, many villagers were eager to learn about new farming practices that would generate a good cash return. Most respondents sounded very content about what N2Africa had brought them: technology options to experiment with that resulted in production increases, especially for soyabean. New varieties were much-appreciated, although they were considered too input-demanding sometimes. Very many respondents liked the method of fertiliser application in a furrow next to a row of seeds. This method was now used on legumes as well as on other crops for efficient fertiliser use. Respondents did not know or care much about inoculants, and they were considered difficult to access. Fertiliser application and row planting were considered very good but tedious practices and a larger workforce was required to get the work done, compared to broadcasting inputs. Labour was sought first in the family, and then among friends and labour groups. Labourers are scarce at the start of the growing season, when everyone is occupied at the same time. The starchy staple crops received priority in terms of land, labour and cash investment. If farmers had investment capacity left, they could invest in legumes as well.

N2Africa could only work with a limited number of villagers directly, and it differed per village whether information was pro-actively shared with people that were not directly involved. Those who took most initiative by themselves were most likely to be involved in projects and to benefit most from them. Respondents recommended future agricultural development projects to focus on improving varieties (short-duration, drought-resistant) and on mechanisation (land preparation and processing).

Keywords

Ghana, impact, evaluation, feedback, learning, labour, collaboration, competition.



1 Introduction

N2Africa is a research-and-development project that aims to put nitrogen fixation by leguminous crops to work for smallholder farmers in Sub-Saharan Africa. Grain legumes are a source of nutrition and cash while they make use of an infinite source of nitrogen – the air – through a symbiosis with rhizobacteria. With funding from the Bill & Melinda Gates Foundation, N2Africa researches effective productive technologies and builds capacity along the legume value chain – working with farmers, traders, extension officers, MSc and PhD candidates, and entrepreneurs. N2Africa works together with many local partners via public-private partnerships, to ensure a strong collaborative network. N2Africa has been active since 2009 in DR Congo, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda and Zimbabwe, and since 2013 in Ethiopia, Tanzania and Uganda.

N2Africa's Results Framework includes five strategic areas of aimed impacts i) increased productivity; ii) increased income; iii) increased nutrition status of women and children iv) improved natural resources systems (use of inputs in sustainable rotations; and v) national systems leading emerging legume technologies evidenced. To reach these goals, N2Africa identified opportunities during Phase I (2009-2014) and research and development activities commenced. During Phase II (2014 – 2019) activities were scaled out. The project formally ends this month – June 2019, and N2Africa left a legacy of knowledge and partnerships to ensure continuation through partners.

As N2Africa was phasing out, an impact assessment study (hereafter referred to as the Impact Study) was carried out in focal areas between September and November 2018. A structured household questionnaire was used to get information about legume technology awareness and knowledge, management practices, cost and sources of inputs, crop yield, access to output markets and revenue, communication and information source, etc. The Impact Study was a largely quantitative exercise with mostly closed and multiple-choice questions, and little room for further explanations and feedback from the respondents. For that reason, we decided to revisit some of the targeted villages and discuss the role and impact of N2Africa in a more open way, to see what additional insights this would provide.

This case study was carried out in Ghana. Ghana is one of N2Africa's core countries, with activities in both of the project Phases (Figure 1). Table 1 shows the agronomic technologies that were tested, improved and disseminated by N2Africa in Ghana, developed in feedback loops involving farmers, researchers and partners. Focal legumes in Ghana were cowpea, soyabean and groundnut. N2Africa also supported capacity building for a solid socio-economic environment in which agronomic practices could take place (Table 2). The most important partners in Ghana were the Ministry of Food and Agriculture (MoFA), Urban Agriculture Network URBANET, Evangelical Presbyterian Development and Relief Agency YENDI (EPDRA-YENDI), Green-Ef Eco-Business Village Limited (Green-Ef) and CABI-IITA: Gender and the Legume Alliance (GALA).

The aim of this case study was to obtain qualitative insights of the impact of N2Africa, as an addition to the larger quantitative Impact Study. We wanted to learn more about how targeted farmers perceived N2Africa as a whole, and how they engaged with N2Africa and other projects. N2Africa wanted to reach many farmers with legume technologies, so we studied how information and any other possible project benefits are shared within and beyond the main beneficiaries. The Impact Study did not contain much detail about the labour demand of the technologies N2Africa had demonstrated, and we were curious to learn how easily the improved practices could be implemented, so labour was another focal topic during this case study.

The methods are explained in the next chapter. Chapter 3 contains a description of all four case study villages, including characterizing quotes from respondents. Chapter 4 and 5 describe the focus group discussions we held about labour availability and about sharing project training and outputs. Chapter 6 is about how farmers perceive and engage with N2Africa and other projects. In chapter 7 we align some of our key observations with the data from the Impact Study, to see if trends we saw were also evident across countries, legumes and technologies. In Chapter 8 we reflect about N2Africa's legacy in the case study villages and the future of farming.

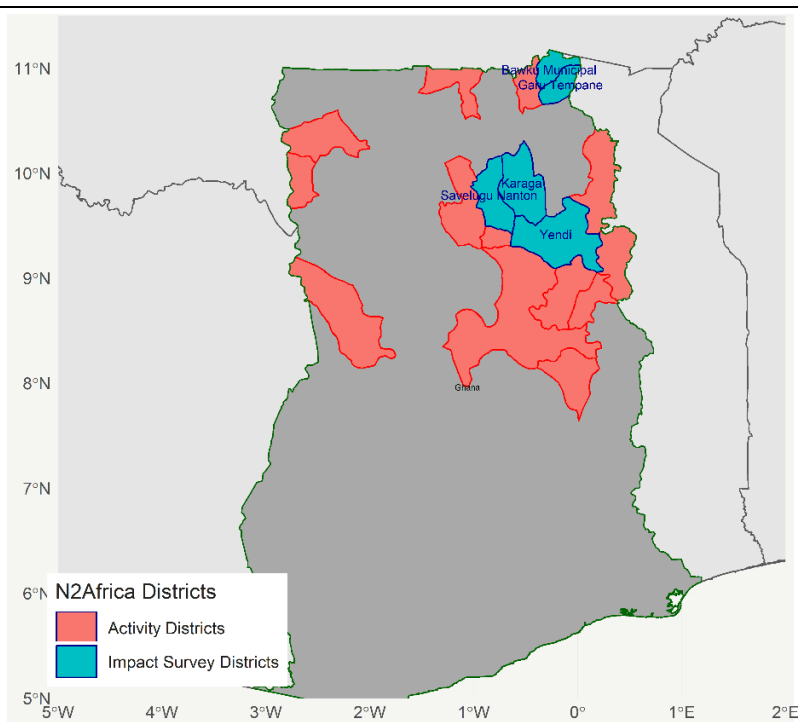


Figure 1. Focal areas of N2Africa in Ghana. Map credit: Andrew Farrow.

Table 1. A basket of options for smallholders.

	Variety	Planting	Inoculant	Fertilizer
Cowpea	UWR: Padi-Tuya UER & NR: Wang-Kae Apagbaala Zaayera Awassa Dume Songotra	Row spacing: 50 Plant spacing: 30 Seeds per hole: 2	SEMIA 6462 5 g/kg seed.	New YARA Legume 250 kg/ha, applied two weeks after planting in a furrow 5-10 cm away from the planting rows. TSP MgSO ₄ , ZnSO ₄ , CaO, Borax, MgO
Groundnut	UER & WR: Samnut 22 Samnut 23 'Chinese variety' Yenyawoso	Row spacing: 50 Plant spacing: 20 Seeds per hole: 2	No inoculant. Biofix	
Soyabean	NR: TGx 1448-2E (Jenguma) UWR: TGx 1834-5E (Afayak) UWR: TGx 1789-8E (Suongpungun) UWR: TGx 1835-10E	Row spacing: 50 Plant spacing: 10 Seeds per hole: 2	Nodumax 7-10 g/kg seed.	

* UWR: Upper West Region; UER: Upper East Region; NR: Northern Region; WR: Western Region
Grey letters show technologies that were tested and compared by researchers and farmers and were considered less suitable than the technologies written in black.

Table 2. Activities by N2Africa and partners, parallel to the dissemination of agronomical technologies.

Activity		
Capacity building*	Public Private Partnerships	Guidelines and protocols
<ul style="list-style-type: none"> - Agribusiness - Processing - Marketing - Product storage - Rhizobiology 	<ul style="list-style-type: none"> - Input / output market access 	<ul style="list-style-type: none"> - Quality-declared seed & inoculant

* In some cases specifically for women



2 Methods

For the Impact Study, villages were selected in a stratified random manner on the basis of agro-ecological zone, market access and intensity of N2Africa's activities. The sampling procedure is described in detail in ref. In each of the selected villages, ten household heads took part in a survey that took one to one and a half hours. From the villages included in the Impact Study, we randomly chose four villages where N2Africa had been active – two in Savelugu district and two in Bawku Municipal. In each village we tried to revisit all ten respondents who had taken part in the Impact Study. We randomly allocated one or two days of study to a village: in Savelugu, we spent two days in Nyoglo and one day in Chamkpem. In Bawku, we spent two days in Ariziem and one day in Naranbeog. On a second day, we executed a focus group discussion with (most of) the main respondents and anyone they wanted to bring along. Table 3 shows the number of respondents per village.

Table 3. Study sites in Ghana in May and June 2019. FGD: focus group discussion.

District	Village	# Respondents		Year of 1 st N2Africa demo
		Individual	FGD	
Savelugu	Nyoglo	10	40+	2015
Savelugu	Chamkpem	5	No FGD	2018
Bawku Municipal	Ariziem	10	40+	2017
Bawku Municipal	Naranbeog	8	No FGD	2017

Prior to our arrival, contact persons from partners of N2Africa – MoFA and URBANET – had informed the village chiefs about our intended research and they had presented them with gifts as per local custom. These contact persons had also mobilized the respondents such that they gathered at a central spot upon our arrival. In a plenary introduction, we presented ourselves and the purpose and methods of our research. Afterwards, the respondents could disperse and we commenced with individual interviews of approximately 40 minutes each. The semi-structure of our interviews can be found in Appendix I. We had different translators in Savelugu and in Bawku Municipal. Both translators were retired extension officers who had worked with N2Africa before, either on demonstration trials or during the Impact Study.

The study was conducted at the start of the rainy season, at the end of May 2019. Some early rains had fallen and people were preparing their land or still training their bullocks for ploughing. The finalization of our study coincided with the outset of the main planting activities. Our study also coincided with the Ramadan, which spanned from 7 May until 4 June 2019. Most of the respondents were Muslim and they were fasting between sunrise and sunset. This meant that their energy levels dropped during the afternoon, so we did not continue with interviews beyond 15:00 with Muslim respondents.

Our main study interests were the labour demand of legume technologies and the sharing of information and project benefits. We discussed these topics during the individual interviews and also in focus group discussions.

We tested the trends we observed with the data from the Impact Study with a Fisher's exact test or chi-square test for independence between input use, cropping system and legume varieties.

3 N2Africa in four villages

3.1 Nyoglo, in Savelugu district

Throughout the lifetime (30 – 65 years) of the respondents, Nyoglo has grown and become more accessible. The road between the village and main roads has improved, and the community has opened up. Many villagers now own motorbikes and frequently move out of and into the village. Big lorries can now access the village, and NGOs visit whereas they did not use to before. Water was scarce during the childhood of the respondents, but these days there are several boreholes in the village for easy access to drinking water. An electricity network was also installed, improving life conditions of the villagers. Thatch roofs on houses have been replaced with zinc sheets. A school was built and young children now have education.

In terms of farming, respondents mentioned that the work used to be heavier. People used to prepare their land with the use of hand hoes, and that practice has almost entirely been replaced by tractors and animal traction.

Ny3: *“Before, there was serious man-labour. It was very heavy and everybody used hand hoes. These days more and more people use animal traction or tractors.”*

Farmers used to learn farming practices from their parents and others in the communities, and in recent times extension workers started coming to train them and introduce new practices and varieties. Yellow maize was replaced with white maize, new varieties of cowpea and sorghum were brought. During the respondents' childhoods, main crops were maize, rice, yam and groundnuts. Many people also grew Bambara beans and cassava. Groundnuts, Bambara beans, cassava, and yam have largely been replaced by soyabean, cowpea and vegetables (greens and tomato). The new crops were better suited to the soils and climate, and they bring in more cash than the crops they replaced.

Ny10 (M): *“This is the time of these crops. It is now important that you grow crops that you can eat and also sell”.*





Some respondents mentioned that soil quality has deteriorated in some parts of the farm land, and that the periods with rain have become shorter over time. New, early-maturing crop varieties help to deal with these constraints, and is now common for farmers to apply fertiliser. The availability and accessibility of these inputs has greatly improved, mainly through government programs, but also through NGO activities.

Soyabean is a new crop, introduced by NGOs and MoFA, that is much appreciated because of its profitability and because it can be used in many local dishes such as koko, gabla and wagasi. Yam is no longer grown much because it started yielding less and less. Groundnuts and Bambara beans have become less common as a result of diseases. Many farmers still grow some groundnuts because they are an important ingredient of soups and especially women appreciate the crop. Because of the poor yields, most respondents considered groundnuts as their least successful crop.

Ny2 (F): *"The [diseased groundnut] leaves become like leopards."*

As their most important crop most people mentioned maize, and in some cases soyabean. Maize is the most important food crop and farmers usually allocate most of their land to it. Soyabean is appreciated because its good market value and because maize yields well in rotation with soyabean.

Ny5 (M): *"You can never abandon maize."*

Translator: *"You are not considered a serious farmer if you don't grow maize."*

In preparation for N2Africa's activities, an extension officer had come to Nyoglo and neighbouring communities to collect names of those who were interested in participation. Those people then joined during the first field day at a N2Africa's demonstration trial in 2015. Later on, as other farmers saw their neighbours experiment with new varieties and practices, more and more people joined in N2Africa's activities.

Ny3 (M): *"My neighbour said to me: 'If you join, you get education, that is worth more than riches'."*

New, short-duration varieties of any crop are much appreciated because such varieties are suitable for the present weather conditions. Farmers do not always actually buy these seeds, however. When agricultural projects visit Nyoglo, people often hope to get some free or subsidized inputs. Some people thought the seed quantities in N2Africa's input packages were enough for multiplication, and some others thought it was much too little to save seed.

Us: *"How do you acquire the seeds of the variety you want to plant?"*

Ny1 (M): *"By asking others, by exchanging seeds, and the last resort is buying."*

A large constraint perceived by respondents is the benefits of improved legume varieties are only realised when they receive fertiliser and if they are treated with herbicides and pesticides. Especially cowpea is sensitive to pests and weeds. Not all respondents were willing or able to pay for these chemicals and they therefore resorted to planting local varieties rather than improved varieties. Those who are able to pay for the inputs appreciate the yields of the early-maturing varieties. The herbicides save the labour for manual weeding.

When we asked about the labour-demand of the demonstrated practices, many people mentioned the row planting practice. Planting in rows is considered more labour-intensive than broadcasting; the workload per person remains the same, but more people are required to do the work. If these extra labourers are available, the labour demand for row planting is not considered a problem. The improved spacing does contribute to larger legume yields than the respondents achieved with denser spacing



after broadcasting. Thus, though row planting requires more labour, many respondents perceived that this extra labour is offset by the higher yields.

From the technologies shown on the demonstration trials, people mentioned the use of fertiliser and compost and the practice of planting in rows as useful technologies for legumes. These technologies improve the yields of legumes. Inoculants were new to most respondents, and the benefits of inoculation were mainly seen in reduced damage by soil organisms for the treated legumes. There is a lady in Nyoglo who sells inoculant. People either do not know about others selling inoculant, or those agro-dealers are much too far to visit.

Upon arrival of N2Africa, respondents expected to get more knowledge about farming and 'plenty money' as a result of those improved practices. In most cases people were satisfied with the actual impact of the project as the improved varieties or practices indeed impacted their income, but some expected more income or more free inputs.



3.2 Chamkpem, in Savelugu district

Chamkpem is a small village. Throughout the lives of the respondents, many of the thatch roofs were replaced by zinc sheets, an electricity network was built, and a dam was constructed to make water more easily accessible. In terms of farming, the respondents explained that they used to work their land with use of a hand hoe, whereas now animal traction and tractors have become more common. Herbicides have replaced the need for heavy labour for weeding. People used to grow maize, yam and sorghum, and they still do so. However, the yellow maize was replaced by white maize, and new crops were added: soyabean, rice, cassava and new varieties of groundnut and cowpea.

After the first couple of interviews, it was evident that the N2Africa project had been very poorly implemented in Chamkpem. Only three people had received a package with groundnut seeds and / or fertiliser, and those were the first persons who came forward to talk with us when we discussed the order of our interviews after our plenary introduction. They were not familiar however with the name N2Africa, and it turned out that they had received no training or explanation at all. Some people had seen the demonstration trial or even helped installing it, and that is how they learned something about row planting. Those respondents did not like that planting practice however, because the work required too many people.

The respondents had learned through channels other than N2Africa about legume technologies. MoFA had come with a 'cinema van', showing a video about the application and the effects of inoculants on soyabean. MoFA also held a workshop in a neighbouring community for women, to teach them how to process and cook soyabean. There used to be a phone service: farmers could call with questions about timing of weeding or harvesting for any crop. The Millennium Development Authority had taught them about the benefits of rotating crops like maize with legumes. Some people had noticed that maize indeed yielded better when it was grown after soyabean.

New varieties of cowpea and groundnut were primarily introduced by MoFA. It is possible that N2Africa has also been involved in some of the above activities because N2Africa has been working together a lot with partners. In any case N2Africa's main activities did not effectively reach Chamkpem.

The respondents who had actually received some inputs from N2Africa were two brothers and a woman. The brothers were unhappy with the quantities of groundnut seed they had received, and they no longer planted that variety because they had not saved the seed. The younger brother explained however that that small quantity of groundnut seed he had received had also generated enough money for him to buy a goat. The woman apparently received enough groundnut seed for an acre of land, and the technical

Chamkpem village, June 2019





officer who gave it to her proposed an arrangement such that he would support her financially for the land preparation and he would take half of the produce. This man was the one who managed the demonstration trial. He promised to the respondents that he would also provide training, but he never did. The respondents also remarked that they did not know where to get improved seeds, fertiliser or inoculant in the future.

Ch3: *"I am not disappointed. At least I got free inputs once, and I bought a goat from the profit [from groundnuts]. I still think of N2Africa when I see that goat."*

After we talked with the farmers who had received inputs, some others gathered around: they had been interviewed for more than an hour as part of the Impact Study in October, yet they felt like N2Africa had done nothing for them! Why did we come to evaluate a project that had not even been implemented? There had been a demonstration trial that people could visit, but no information was provided and the input packages were only given to a few people. One person in particular was sharing his frustrations with N2Africa, and others (four to eight, as people came and went) backed him up.

A man: *"When we heard that you [the authors] were coming, we wondered: are we going to tell them the truth or are we going to lie? Now that we see that the project ends and that you come to ask what we think, we tell you how we really feel."*

This group of people expressed that they wished that N2Africa had provided them all with inputs like improved seed and fertiliser, and ideally with tractors or other technologies to decrease the labour requirements for land preparation.



3.3 Ariziem, in Bawku district

During the lifetime of the villagers, food became more bountiful. Almost everybody we spoke to explained that they used to be hungry when they were younger, and that these days there is sufficient food for everybody throughout the year, while the population has increased.

Ar2 (M): *“Getting food to feed on was not easy. Nowadays, we don’t need to struggle to have enough food anymore.”*

These improvements in food availability are attributed to the introduction of new crops by MoFA around 15 years ago: maize (first yellow, later white), rice, groundnut, soyabean and a new variety of cowpea. These legume varieties originated with IITA and ICRISAT. These crops largely replaced millet and sorghum, which took long to mature. The new crops yielded much better than millet and sorghum, and they were nutritious and they brought in cash.

The importance of maize as a main staple was often emphasized. Farmers first secure the cultivation of the main food crops like maize, rice, some millet or sorghum. Other crops – even if they are fully consumed and not sold – are much less important as they are just condiments to the dishes made with the main staples.

Upon asking about the popularity of groundnuts and the scarcity of their cultivation:
Ar9 (M): *“It is an appetizer. It goes in soup. Why cook soup if there is no TZ*?”*
*TZ, or tuo zaafi, is a ball of cooked maize dough.

There were other positive developments in the community. Work that was originally done with a hand hoe is now done with use of bullocks or with one of the three tractors that are used by the villagers. With these bullocks or tractors farmers now cultivate larger areas of land. Wells for drinking water have been dug in the village, and an electricity network was installed.

Two persons in Ariziem, the chairman and his friend, heard about N2Africa on the radio: N2Africa was introduced and listeners were invited to reach out if they were interested in participating in the project. After hearing this, the two farmers went to the MoFA office in Bawku to attend a meeting where N2Africa was making its plans with its partners. They were instructed to gather participants in groups of approximately 15, whom would be the direct beneficiaries of N2Africa’s training activities. For this purpose, an existing group of 60 was broken up into smaller ones.

Ar7 (M): *“It was costly to travel to Bawku by motorbike, to get the fuel. For the group mobilization I had to talk well with everyone, and explain well. I brought some group members along to meetings in Bawku, but who to bring? I had to talk, talk, talk.”*

There were more requirements: to be a viable group, they needed to save and have a savings account at a bank. They saved for a year at Bessfa Bank in Bawku and this helped them acquire fertiliser inputs, enough for an acre per person. Throughout this time, N2Africa commenced with the installation of the demonstration trial on the chairman’s land, and with the distribution of input packages with improved seed among the group members. The whole community was invited to events – e.g. planting or fertiliser application – at the demonstration trials. The men who had taken the initiative to reach out to N2Africa also took effort to spread the information throughout the village.

Ar7: *“When the beneficiaries are planting they invite the others. No info is hidden. Only those who are sick may miss it.”*

When we asked people about their expectations of N2Africa, most people mentioned that they were eager to learn new things about farming, and that they did. Indeed, the respondents in Ariziem could



explain in great detail what they had learned from N2Africa. Although many respondents had been familiar with the use of artificial fertiliser and compost for a long time, it was new to most of them that these inputs are also beneficial for legumes. Especially the method of applying fertiliser had made a big impression on the farmers. Almost every respondent started drawing on the ground the method of fertiliser application.

Ar8 (M): *“Plant seeds in lines, and make a furrow next to it for fertilizer application next to the seeds, and cover the furrow.”*

This method was completely new, and many farmers expressed that the micro-dosing had greatly improved the efficiency of their fertiliser use. The fertiliser did not flush away after burying it, and it did not burn the seeds because it was not applied directly onto them. Farmers now use this practice on their legumes and also on other crops, primarily on maize, and it improves their yields. The practice is labour intensive however and a larger labour force is required. Paying for these extra labourers is a constraint for some farmers.

Ar3 (F): *“The technology is good, but you need to employ more people. [...] If I have help, I’ll apply fertiliser in a furrow. If not, I’ll apply it together with the seed. [...] Capital to pay for labour is not always there. These days there is no free labour, only paid.”*

Ar4 (M): *“Yes, I am still benefitting. The fertiliser on cowpea and maize works well. The furrow-and-burial method for fertiliser application is done by almost everyone. Same for spraying on cowpea, and weeding. I like the close spacing of soya, it needs a bit less weeding. Cowpea requires most care.”*

The respondents liked the improved varieties of groundnut, cowpea and soyabean that were brought by N2Africa. Many farmers like groundnuts a lot because of their good taste; it is an important ingredient in soup. For many years however, yields of common Chinese groundnut varieties have been declining as a result of diseases and many people stopped growing it. N2Africa reintroduced the crop with disease-resistant varieties. However, still only few farmers grow it because it is often stolen. Children and even adults tend to dig up the groundnuts as a snack. Despite this obvious demand for the crop, farmers do not want to grow it unless everybody grows it and the small plots are no longer a keen target by thieves. This reason was consistently mentioned by the respondents. Some people also mentioned that improved seed was difficult to find.

Farmers mentioned many constraints of growing and storing cowpea. The improved variety (Wang-Kae) requires frequent spraying because it is very sensitive to pests (especially during flowering) and to weeds. After harvest it is necessary to treat the grains with chemicals to avoid damage by weevils during

Focus group discussion in Ariziem village, June 2019





storage. People were used to intercrop their cowpeas with maize, but the new variety is not tolerant to shade. Their local variety creeps and searches for light. Some people therefore grow the improved variety as a sole crop, and the local variety as an intercrop with maize. After maize, cowpea is the most important crop for food and cash.

N2Africa demonstrated the improved soyabean varieties Afayak and Jenguma, which are still grown in Ariziem. These varieties are early-maturing and the pods do not shatter in the field; those qualities were considered as great benefits compared to the varieties farmers grew before.

Inoculants were also a new technology. Nobody mentioned anything about nodules or nitrogen fixation, and the benefit of inoculant application was seen in a reduction of damage by insects to the seeds. Inoculation improved germination. For some that was enough reason to want to continue applying inoculants, but hardly anybody knew where to acquire inoculants. Our translator – a retired extension officer – knew that the present extension officer could arrange a supply of inoculants to Ariziem, if the community communicates their bulked demand.

In Ariziem, row planting was already very common for any crop because people plough their land with bullocks or tractors, creating small ridges on their land. These ridges would simply be followed during planting. The width of the ridges was not exactly the optimal spacing recommended by N2Africa, but it was considered good enough.

Several respondents expressed their concern that new knowledge on farming – especially information about new varieties – would not reach them now that N2Africa has phased out there.



3.4 Naranbeog, in Bawku district

Just like in the other villages, the farmers in Naranbeog had seen a change in main crops about 15 years ago, which greatly improved food availability. People used to grow sorghum, millet and Bambara nut, and MoFA introduced maize, cowpea, soyabean and sweet potato. The new crops yielded better, they matured earlier, and they were less attractive to birds compared to sorghum and millet, so this change in main crops established quite rapidly. Alongside these crops fertilisers and pesticides were introduced. Those inputs used to be uncommon and difficult to access, and now their use is widespread. It was often mentioned that fertiliser is presently improving yields. Several people mentioned that the fertiliser is compensating for a decreasing soil fertility, and that the early-maturing varieties require fertiliser in order to yield well. A few farmers also grow some vegetables like onion, green pepper and eggplant in the dry season, using wells that were dug a few years ago.

Over time, the pressure on land has become higher and higher. When farmers started to use bullocks instead of hand hoes for land preparation, farmers also started to farm on larger areas. An increasing population is now countering this trend by causing land fragmentation. During our visit many farmers were training bullocks for preparing the land, or already ploughing. Most of the land – which contained a lot of stones – showed the newly-made ridges or what was left of the ones from last year. Tractors were only used further away from the village in some rice fields.

MoFA is N2Africa's main partner in Naranbeog. MoFA introduced N2Africa to the community and selected a group of 10 direct beneficiaries. These beneficiaries received input packages and were most intensively involved in installing the demonstration trial. Many more people were invited to attend any activities at the demonstration trial, to observe and help out. It was emphasized that the direct beneficiaries share their knowledge and experience with passers-by and at gatherings.

Us: *"Not everyone is part of this group. How do others learn?"*

Na6 (M): *"We always let the community know. When we got the seed from N2Africa, others wanted to know where they can acquire it and how to use it. They can freely come and see."*

There were two technologies from N2Africa's demonstration trials that farmers clearly found most useful: narrower row spacing for soyabean, and the method of fertiliser application. People were already used to planting legumes and other crops in rows, but the spacing recommendations improved their production. The fertiliser application method involved putting small quantities of fertiliser in a furrow next to the seeding holes, and then covering that furrow again with soil. This technology is now applied by many farmers on maize, sometimes sweet potato, and on their legumes. The food crops have priority for fertiliser allocation. Legumes will receive fertiliser if farmers still have the capacity to invest in fertiliser and labour after securing the production of their main food crops. Many considered it a quite tedious method, but the extra yield is worth it.

Us: *"Did N2Africa meet the expectations you had at the beginning of the project?"*

Na2 (M): *"Yes, it is of great use, I am now using the recommended fertilizer placement method on my farm. I also teach others about the recommended practices."*

Us: *"What do you think of the labour demand of the fertilizer placement methods?"*

Na2 (M): *"It is tedious, but I have enough family labour available to do the job. As for weeding, this is done in communal labour groups. In return, you have to prepare food for those who work on your farm."*

The group of direct beneficiaries is working together in a labour group to share their workload. There are several other labour groups. Even households with enough family labour available may be active in such labour groups.

Us: *"Those with a large family, do they even need the group for labour?"*

Na6 (M): *"If you rely on your family you may not have seen N2Africa practices. If you involve also others, you may learn new practices."*



Apart from the fertiliser application method, it was also new to many that legumes can benefit from fertiliser. Although maize and sweet potato are the priority crops in terms of fertiliser allocation, more and more farmers these days apply some fertiliser to their legumes as well.

Only one man mentioned black substance – inoculant, and he explained that it is used to prepare seeds, that it improves germination and that it prevents insects from damaging the seeds. Some farmers used to apply inoculants, but not anymore. There used to be a lady around who would come to ask who was interested in inoculants, and she then arranged their supply. Since she left, nobody is using the inoculants anymore.

When N2Africa arrived, the respondents expected to learn new things and hopefully improve their income. The respondents thought that their expectations were met, although there is no limit to learning, and production can always be better.

The respondents explained that they have enough food throughout the year, and enough money to send their children to school. Cash availability is highly periodic however, and it is challenging for some to invest in farming at the beginning of the growing season. Often people use fertiliser on only part of their land. At the end of the interview, several people suggested that we – or any future project – assist farmers in getting connected with banks to access loans. The fertiliser investment is considered high, as are the expenditures for hiring a tractor. Cash availability is highly fluctuating, and many farmers are cash-constrained at the beginning of the growing season when they need to invest. Some of the labour groups in Naranbeog simultaneously function as saving groups, and alternating group members can use the group's savings for some investment. These savings are mostly used for special events, like name-giving and burial ceremonies.



Naranbeog village, June 2019



4 Labour availability throughout the year

Row planting and fertiliser application were often mentioned as good practices for legumes, but they are also considered labour intensive. We wondered how that labour relates to other farming practices, so we discussed the cropping calendar and labour demands in a group in Nyoglo. We commenced with 30 participants, and throughout the meeting more and more people joined.

On the ground we drew five lines, representing a timeline for the five main crops in Nyoglo: maize, rice, soyabean, groundnut and leafy vegetables. For every crop, we asked someone else (men and women) to start marking moments of certain activities during the cropping season. The rest of the group supported that person with suggestions on activities to include and their timing. The resulting timelines are shown in Table 4.

Table 4. Timeline of farming activities of the five main crops in Nyoglo. Crops in order of importance.

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
	Beginning of rainy season			Rainy season			Dry season			Harmattan		
Maize	land prep.	land prep.	planting (fert. appl. compound)	weeding (2 nd fert. appl.)	weeding	weeding	harvesting	processing				
Rice	land prep.	land prep.	planting (fert. appl. compound)	weeding (2 nd fert. appl. ammonia/urea)	weeding	weeding	harvesting	processing				
Soybean			land prep.	planting	weeding	fert. appl. (TSP)		harvesting	processing			
Groundnut	land prep.	planting	weeding				harvesting	processing				
Leafy vegetables							land prep.	planting	weeding	harvesting		

Four periods – each of approximately three months – were distinguished: the beginning of the rainy season with sporadic rains from April to June, the rainy season from July to September, the dry season from October to December and the Harmattan period with strong, warm winds from January to March.

Land is prepared for cropping at the end of May, and crops are planted throughout June or at the start of July. Soon after planting some fertiliser is applied and/or the land is weeded for the first time. This is particularly busy period and labour can sometimes be scarce. For planting, members of three or four households gather and work on their fields sequentially. For weeding people may do the same, or hire labour. Those without farm land (for instance children and young adults), farmers short of money and elderly offer by-day labour for which they get paid.

Most of the weeding is done by hand hoe, although herbicides are sometimes used on maize. Planting, weeding and fertiliser application are done by women and by men. When crops require labour input at the same time, maize has priority, then rice and then soyabean.

Harvesting occurs at the start of the dry season. The men tend to uproot the crops, and women are then responsible for drying, winnowing and processing.

Only few people sell some maize or rice. Soyabean is put in sacks and stored, and sold when the maize stock is finished.

Although almost all attendants said that they grow vegetables during the dry season, but vegetables are not considered a main crop. Land preparation for vegetables occurs at the same time as maize harvest. The vegetables are irrigated with use of a pump, or water is brought with buckets. Some of the vegetable fields are managed by women and some by men.

Because women are responsible for processing, the dry season is a busy period for them. For men, harvesting is the busiest period during the year.

Us: *“Women do much processing during the dry season. How do they manage when there is also harvesting going on?”*

A woman [laughing]: *“Men and women quarrel then! On whose field to work first?”*

Another woman: *“Us women will thresh rice in the morning, harvest vegetables in the afternoon, and cook dinner afterwards.”*

N2Africa’s recommended practices of row planting and applying fertiliser in a furrow are considered more labour intensive than broadcasting seeds and fertiliser. In order to manage to apply these practices, people tend to hire some extra labour to do the work quickly and then tend to the other farm work that is necessary at the same time (fertilising and weeding maize and rice). Farmers who do not grow soyabean are usually available to help in return for reciprocal labour on their land and for lunch.

The following quotes from the individual interviews clarify some more details about labour constraints:

Ch4 (M): *“Groundnut consumes most labour. For soyabean some facilities are available for shelling. For planting you need more labour for groundnut than for soyabean. Harvesting and shelling of groundnut is difficult.”*

Ch3 (F): *“Groundnut labour picks into my other work. I used to pick shea fruits, but now I am growing groundnut and I need to be on the farm. Shea picking happens at the same time as groundnut planting. Now, I will pick shea when I am not planting groundnut. Planting time is a busy period during the year.”*



Focus group discussion in Nyoglo village, May 2019



Ar3 (F): *“When the rainy season begins, there is competition to do everything. It is difficult to plan. It also depends on when it rains. The problem is at planting [because everybody wants to do that exactly at the same time]. At weeding the group functions well. You have to give them lunch. If you can’t, you’ll hesitate to ask for help.”*

Ar8 (M): *“Sometimes we organize communal labour, where we work on each other’s land in turns. Fertilizer application is timely. By the time communal labour is available, the time for fertilizer application may have passed, so communal labour is usually not used for fertilizer application – only sometimes, but people are mostly busy. Communal labour is mainly used for weeding and harvest.”*

Ny9 (M): *“I apply fertiliser only on maize and not on soya, although the soil is too poor to get good soya yields. Maize is planted earlier than soya. By the time I want to plant soya I am out of money for inputs.”*

Labour intensity was often interpreted as the number of persons required to do the work. Rather than spending more time on a practice, farmers would ask for help or hire labour. Improved practices will be applied to soyabean or groundnut only if the priority staples are covered in terms of labour and cash inputs.



5 Sharing project benefits

An assessment of a project's impact requires a comparison to a control site, without project activities. This posed a challenge for N2Africa's Impact Study because N2Africa's goal was to reach many people, and for information to continue to spread after project activities ceased. We were wondering whether information about N2Africa's recommended technologies indeed spread beyond the direct beneficiaries which have received a package of inputs. In the individual interviews we had asked whether people sometimes ask or get questions from others about farming. We also asked whether people have the impression that some people tend to benefit more from agricultural projects than others.

Us: *"How did you get involved with N2Africa?"*

Na6 (M): *"People from MoFA came and sensitized the community and they asked who was interested. I was."*

Us: *"Why were you interested?"*

Na6 (M): *"I want to be the first one to try. It [the training] will only benefit those who immediately try."*

Us: *"Why do the first benefit most?"*

Na6 (M): *"They benefit most. 'First come, first serve'. The first will receive proper training. If the trainers come back later, the training may be partly or fully skipped."*

Us: *"Do you think it was like this with N2Africa?"*

Na6 (M): *"Yes, those ten who were involved in the demo understand the technologies best."*

Us: *"Do you think that some people benefit more from N2Africa than others?"*

Ny3 (M): *"Yes, but not so much. Those who are involved will tell if you ask. They will not go and share actively, but you can ask. Those who benefit most from the technologies are those who are most serious: they pay attention and apply technologies correctly."*

Us: *"You said you were telling others about your soya bean production and about N2Africa, why?"*

Ny4 (M): *"If you gain knowledge, and you keep it to yourself, it is not good. So you share the benefits. I brought all the people who participated in the Impact Study to N2Africa!"*

Us: *"Do people come to ask you questions about your farming practices?"*

Ny4 (M): *"Not everyone received packages after the field day. Fifty farmers got something, but there were more people present. I supervised as a technical officer. Some of the people who did not get anything, they give up. Some don't have cowpea and soyabean. I plan to continue with cowpea and soyabean."*

Us: *"Do you think some people benefit more than others?"*

Ny4 (M): *"Yes. Those who understand more will do better. They may share info with others, but information is always lost from one person to another."*

Us: *"How do you become a group leader?"*

Ny4 (M): *"By active participation. You have to be the front leader for mobilization, and for selecting land for demos."*

We wanted to learn more about how people perceived agricultural projects that visit and that train only a certain number of people. To discuss this topic, we invited the respondents of the individual interviews and anyone else in who was interested in participating, in Ariziem. More than forty people gathered and some people joined or left during the discussion. We decided to put the attendants into the shoes of the management team of a hypothetical agricultural project – N2Africa or any project like it. That project has a limited budget to spend on training individuals, and the project can use several strategies for spending that money. We divided the participants into three groups of around 14 persons – two groups of women and one group of men – and we asked them to discuss the different project strategies and then explain which one of them had their preference. We separated men and women for the group discussion because we were interested to find out whether they would have different preferences. Additionally, men expressed that because of ramadan they preferred not to mix with women, although they would readily do so at any other moment.

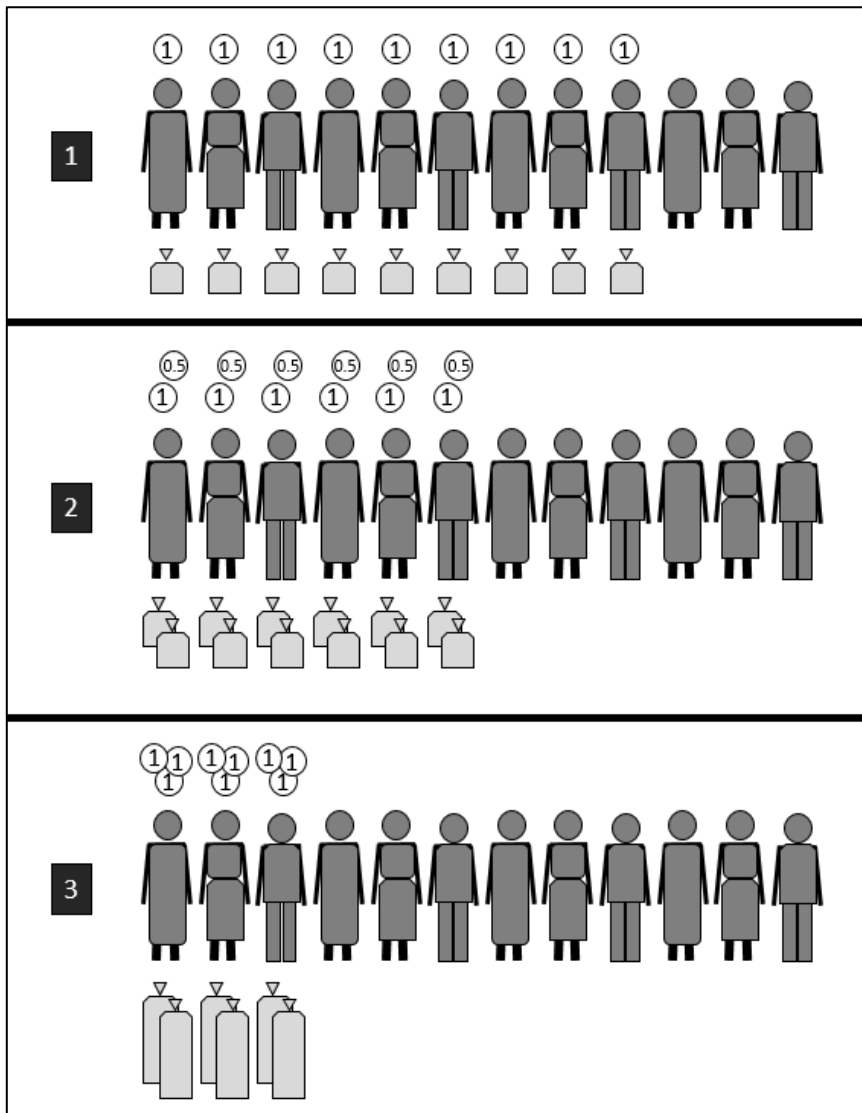


Figure 2. Three project strategies for investing a budget in training individuals. Coins above a person represent money invested in giving that person training on improved agricultural practices. The bags below that person represent the quantity of extra produce generated by that person as a result of the training. We assumed that more intensive training would result in a larger yield output.

We explained the following scenario: a hypothetical project arrives in a community of 12 people and has a total of 9 Ghanaian cedi to spend on training about agricultural practices. The project management can choose between three alternative project strategies:

1. Spend 1 cedi per person and give 9 people training. With this training, those beneficiaries generate 1 extra bag of crop produce.
2. Spend 1.5 cedi per person and give 6 people a more elaborate training. With this training, those beneficiaries generate 2 extra bags of crop produce.
3. Spend 3 cedi per person and give 3 people the full training. With this training, those beneficiaries generate a lot of extra crop produce, equivalent to approximately 5 bags.

A person who has received training can in turn train others so that they can also generate an improved crop output. The participants received a sheet of paper with the image shown in Figure 2, illustrating the project strategies.

The discussions in all groups were lively. After 10 minutes, we asked a spokesperson of every group to explain their preference for a project strategy.

The first group was a women's group. They had counted the total number of bags that each option would yield and assumed that the total amount of extra crop produce was largest with strategy 3. They therefore concluded that this strategy was the best one. The extra produce could be shared among those who did not receive training and who had no extra output. The people who were trained would share their knowledge with the others.

The second group of women also checked out which of the strategies resulted in the largest amount of extra crop produce. However, instead of strategy 3 they chose strategy 2 because they wanted more people to benefit from training. They explained that if half of the community is trained, those people can easily share information and their extra produce with the other members of the community.

The group of men also compared the total of extra produce per strategy. They thought the quantities were similar for strategy 2 and 3. With strategy 2, more people benefit for training. Additionally, the men reasoned that the 12 bags produced by the 6 trained persons good easily be shared with the other community members, resulting in 1 bag per person.

Strategy 1 was disliked because the total quantity of extra produce is smallest, and the quantities in strategies 2 and 3 are shareable.

Each group assumed that the extra crop produce generated by trained persons would be shared with others. We asked plenary whether this happens. The participants explained that they compared the group of 12 persons in Figure 2 with their own group of N2Africa beneficiaries: some of them had received some more training or were more involved with the demonstration trial. The seed from N2Africa's input packages was multiplied and then distributed with others in that group, and the produce from N2Africa's demonstration trial was also shared.

Ar (M): *"If someone would get a package, there is no rule about harvest sharing, but it is embodied in the group to help each other either with info or with produce."*

We asked whether they would feel different about the scenarios if the 12 persons involved represented a larger community rather than a fixed group. It was stressed by several people that there are social norms about sharing and unity within the community, so people may share info and produce beyond the



Focus group discussion in Ariziem village, June 2019



'N2Africa group'. For instance, there is also a larger group of Muslims wherein the method of fertiliser application (micro-dosing in a furrow next to the line of seeds, and then covering the furrow) was discussed.

Of the men who were present, all men (7) except one had received the training from N2Africa. From the 33 women only 2 had received the training. We asked whether those persons that had not received the training from N2Africa directly, has still learned something. Hands were raised by 11 women who claimed that they had learned about the recommended practices. When the members of the 'N2Africa group' were receiving the training at the demonstration trial, these women were also there to observe and help out.

We then reasoned that it may be necessary for a farmer to fully sell his or her improved crop output to be able to save and generate the same output in the next season. If that person shares the output, he or she may not be able to do the same next year. People had not looked at the strategies like that, but there was little room anymore to go into further detail and discuss it plenary. Our translator noticed that people captured the concept and were discussing it as we wrapped up.

In Ariziem respondents emphasized a lot that people share information with each other, and in Nyoglo and Naranbeog this happened as well. In Chamkpem the respondents expressed much less signs of cooperation among villagers. In Chamkpem people did not ask each other much about farming, and nobody had a question for us. Our translator explained there that neighbours compete, and that they may not share information, or only part of it. The group discussion about sharing information and outputs we held in Ariziem could therefore easily have different outcomes in villages where groups for sharing information are not as established.



6 Being 'part of N2Africa'

During the individual interviews and during the group discussion about sharing project benefits, people often spoke in terms of being part or member of N2Africa. Attendants took care that we wrote down their name on a list. Some people explained that projects tend to come, collect names, and then come back to work with those selected people. You have to be around when names are collected, otherwise you will not be targeted by a project. Participants understood very well that projects are unable to include everyone in a community in an extension program, or provide inputs to everybody.

Ny (F): *"A while ago MoFA came and they gave livestock to some women, and soyabean seed to some men. However not everyone had their names written and they were left out of this programme."*

Us: *"Is it always the same people who are involved in projects?"*

Ny3 (M): *"Organisations involve only a certain number, not always the same, only partly. N2Africa does not have that limited number."*

Us: *"Projects come and go, what do you think about them?"*

Ny7 (M): *"Some people benefit from the project. I am now benefitting, may that last! The next project will benefit some others, may their benefit last!"*

There was diversity among respondents about the extent to which they were involved in N2Africa's activities. Some respondents took much initiative by themselves, others were mainly happy to receive free inputs, some learned from neighbours rather than from N2Africa extension staff and others were frustrated about the lack of inclusion effort (Chamkpem). N2Africa worked with partners, and that meant that in different villages and regions the exact procedures for sampling, planning and implementation of legume extension differed as well.

We asked whether projects sometimes brought something that was actually useless to them, or that simply was not successful. The respondents mentioned that in some cases a project worker had come to ask about constraints and demands in the community, but any follow-up never came. Similarly, someone had come and promised support in terms of cash and tractors, but he never returned. Such behaviour lowered expectations and increased frustrations about projects among villagers.

Many of the respondents expressed their appreciation of the regular check-ups by N2Africa. This may be largely politeness and people definitely thought that the Impact Study was tedious, but some respondents explained that repeated visits imply that the researchers or project see much potential in a technology and also that they care much about the community. Additionally, each visit serves as a reminder about the technologies a project brought.

Na3: *"Thank you for coming to see how things went. It is a sign to those who did not try it yet: they will now try!"*

One man (Ny10) explained how he was no longer using "old knowledge" to grow groundnuts, but N2Africa technologies instead. He sounded enthusiastic and we asked him what made him happy about his groundnuts. He then explained that people had already come twice to ask him questions about groundnuts, so they must be important crops with good production potential! These examples show how the frequency and nature of interactions between farmers and project staff influence how people engage with the technologies that had been introduced.

Of course there were also other reasons why farmers valued repeated visits. People would love a steady supply of free or subsidized inputs; the more the better. Others were worried about how they would learn about new farming technologies after the project phases out.



Ny3: *“Can you convince the ‘big men’ to increase the number of years of project activity? No one is ever satisfied with the amount of info they get. Every time there are new varieties, how will we learn about them?”*

We explained that projects have an end, and that partner organisations are remaining active.



7 Comparing trends across countries

The case study described in the previous chapters only involved a limited number of people in only four Ghanaian villages. We identified the following trends during the village visits:

- Legumes form a prominent component of the farm, after the starchy staple crops. Legumes serve as food and as cash crops.
- Inputs can be difficult to access. Shortages of cash reduce the quantities of fertiliser bought for legumes. Seeds are often multiplied, saved and exchanged.
- Improved legume varieties yield well, but only if they receive fertiliser and pesticide inputs.
- The legume technologies demonstrated by N2Africa were not always new to the targeted farmers.
- People learn about improved farming technologies in various ways, and groups are an important means among others.

The larger quantitative dataset from the Impact Study allows us to test and compare (across countries, legumes or technologies) these trends in legume production, as discussed per trend below.

- **Legumes form a prominent component of the farm, after the starchy staple crops. Legumes serve as food and as cash crops.**

Figure 3 shows the crop area allocation as averages and distributions in different countries. In Ghana and Tanzania legumes and staples are most commonly planted as sole crops, whereas in Nigeria, Ethiopia and Uganda legumes are also often intercropped with staples. Intercropped or not, the total area with legumes constitutes at least one-third of the cultivated area on average. Note that the sampled households were in areas identified as having a good potential for legume production; the data do not represent the country as a whole. Percentages of legume produce sold and consumed are given in Table 5, which is unfortunately incomplete due to a technical error. Soyabean is sold relatively often compared to other legumes.

Table 5. Percentages of fresh and dry legume produce sold and consumed. Unfortunately no data about this were available for Ghana, only partially for Uganda, and for groundnuts, because of a technical error during data collection. Percentages in the table do not add up to 100: the remainder of legume produce is fed to livestock.

Country	Legume	Fresh				Dry			
		Sold		Consumed		Sold		Consumed	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Nigeria	Cowpea	40	42	33	40	56	36	36	35
Nigeria	Soybean	90	0	8	3	87	10	8	3
Ethiopia	Bush bean	0	0	53	48	57	44	40	41
Ethiopia	Chickpea	2	12	89	30	42	25	49	26
Ethiopia	Climbing bean	5	22	91	23	0	0	65	40
Ethiopia	Faba bean	2	11	96	18	44	30	50	30
Ethiopia	Soybean	0	0	40	57	75	28	23	32
Uganda	Bush bean	0	0	100	0	70	33	20	17
Tanzania	Bush bean	0	0	89	33	41	35	50	37
Tanzania	Chickpea	13	18	88	18	38	53	63	53

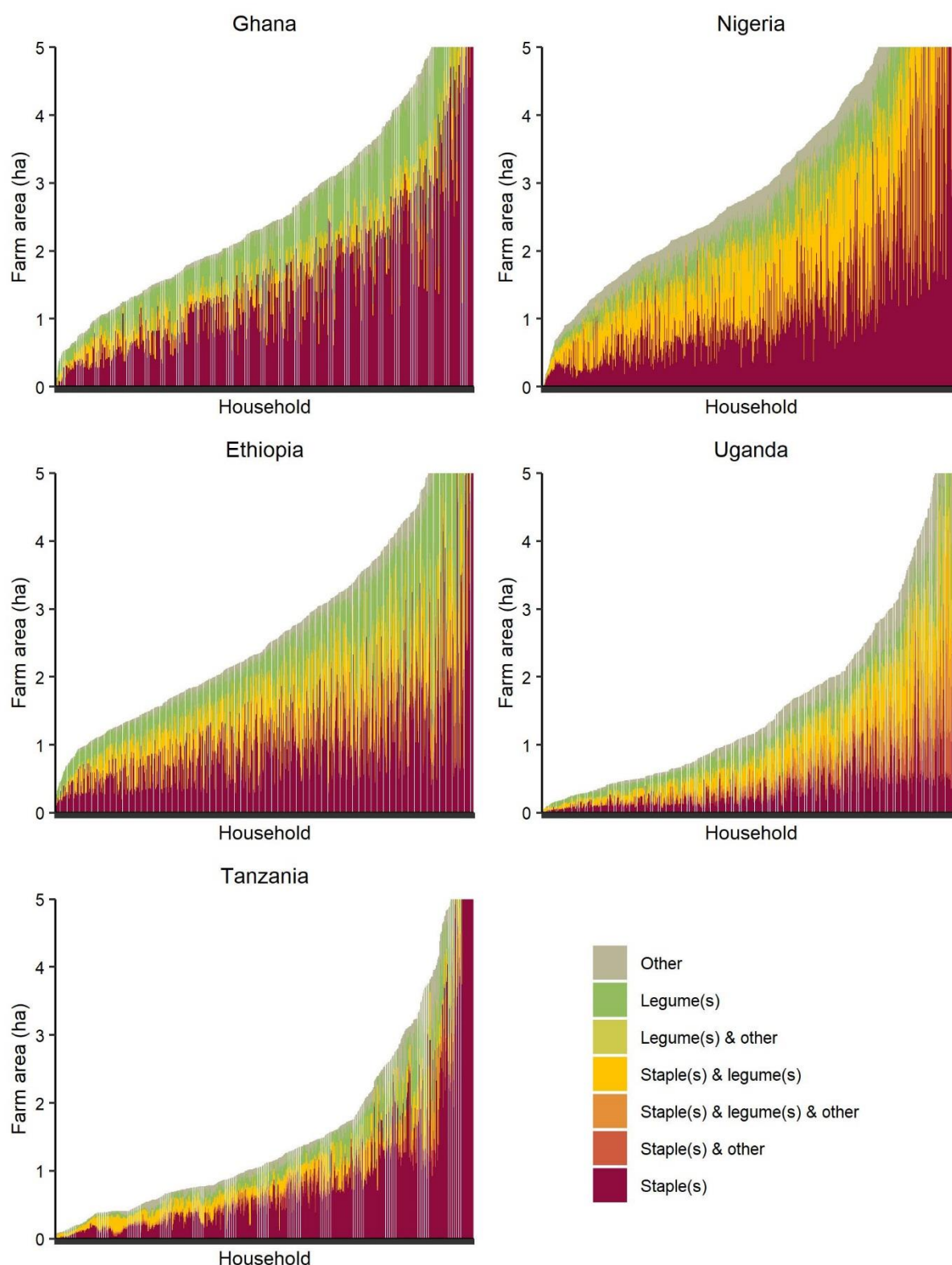


Figure 3. Allocation of (inter)crop area per household (rolling means per 20 households) on all land they have in use (owned and rented-in land) in 2018. Staples include banana, barley, cassava, Irish potato, maize, millet, rice, sorghum, sweet potato, teff, wheat and yam. Legumes include soyabean, cowpea, groundnut, chickpea, common bean and faba bean. Other crops include cacao, coffee, fodder, grasspea, sesame, sunflower, tobacco, vegetables and other.



- **Inputs can be difficult to access. Shortages of cash reduce the quantities of fertiliser bought for legumes. Seeds are often multiplied, saved and exchanged.**

Table 6 shows the most common sources of inputs and the means used by farmers to acquire them. Fertiliser is most commonly locally sourced at the market or with a local agro-dealer. The next most common source is the urban agro-dealer. Compared to fertilisers and inoculants, improved seed is much more often obtained from fellow farmers, sometimes for cash, sometimes for free. Seed can be multiplied of course, and easily shared with or sold to others. Seed is also most often received as a gift from extension workers and NGOs. For improved seed, the source 'own farm' implies the practice of saving seeds. 271 respondents indicated that they got this seed for free – they had it save. 354 respondents however indicated what they 'bought [it] with cash', perhaps referring to the first occasion in which they required that seed as a means of requiring.

We expect that there have been different interpretations of sources of inputs and means of inputs among the respondents and perhaps even the enumerators. The categories 'local market', 'farmer group', and 'other farmer' might have been interpreted as being the same or similar. Lack of cash and unavailability of inputs were the most commonly mentioned reasons for stopping with a technology after trying it out. The Impact Study data also show whether respondents have access to credit or not; the mention of lack of cash as a reason for stopping was independent of whether these respondents received credit or not.

Table 6. Number of inputs acquired per source, across countries and legumes. Numbers under 10 are written in a lighter shade for an easier overview of all values. * Exchanged for goods or inputs.

Source of	Fertiliser						Improved seed						Inoculants					
	Bought with cash	Gift/free	Borrowed	Exchanged*	Other	TOTAL	Bought with cash	Gift/free	Borrowed	Exchanged*	Other	TOTAL	Bought with cash	Gift/free	Borrowed	Exchanged*	Other	TOTAL
Rural agro-dealer	1648	4	1	2	3	1658	494	14	3	1	0	512	37	0	1	0	0	38
Urban agro-dealer	1031	6	0	0	3	1040	294	2	2	0	0	298	35	3	0	0	0	38
Local market	1007	4	0	2	2	1015	1306	26	8	1	3	1344	15	4	0	0	0	19
Extension worker (government)	390	9	2	2	1	404	183	142	2	0	1	328	91	56	0	1	0	148
Cooperative	369	1	26	0	0	396	29	3	3	0	0	35	17	5	1	0	0	23
Own farm	51	2	0	0	0	53	354	261	2	2	28	647	1	2	0	0	0	3
Farmer group	28	2	0	0	1	31	31	33	0	0	1	65	3	1	0	0	0	4
NGO	17	31	0	0	1	49	55	203	1	0	0	259	13	30	0	0	4	47
Other farmer	16	7	1	0	4	28	602	142	16	22	11	793	9	4	0	0	0	13
Seed company	8	0	0	0	0	8	32	3	0	0	0	35	2	3	0	0	0	5
Other	4	9	0	0	0	13	35	30	3	1	2	71	12	8	0	0	0	20
Community-based seed producer	1	0	0	0	0	1	11	3	0	1	1	16	0	0	0	0	0	0
TOTAL	4570	75	30	6	15	4696	3426	862	40	28	47	4403	235	116	2	1	4	358

- **Improved legume varieties yield well, but only if they receive fertiliser and pesticide inputs.**

It was frequently mentioned during interviews that in general improved varieties are more input-demanding than local varieties. We wondered whether farmers indeed treat improved varieties differently. Figure 4 shows the proportions of legume plots receiving fertiliser or pesticides in 2018. Pesticide and fertiliser treatment was not independent of the variety planted in Ghana (cowpea and soyabean), Nigeria (cowpea, groundnut and soyabean) and in Uganda (bush bean) ($p < 0.05$). In all these cases fertilisers and pesticides were allocated more often to improved varieties relative to local varieties, except for soyabean in Ghana: here a larger proportion of the plots with a local variety received fertiliser.

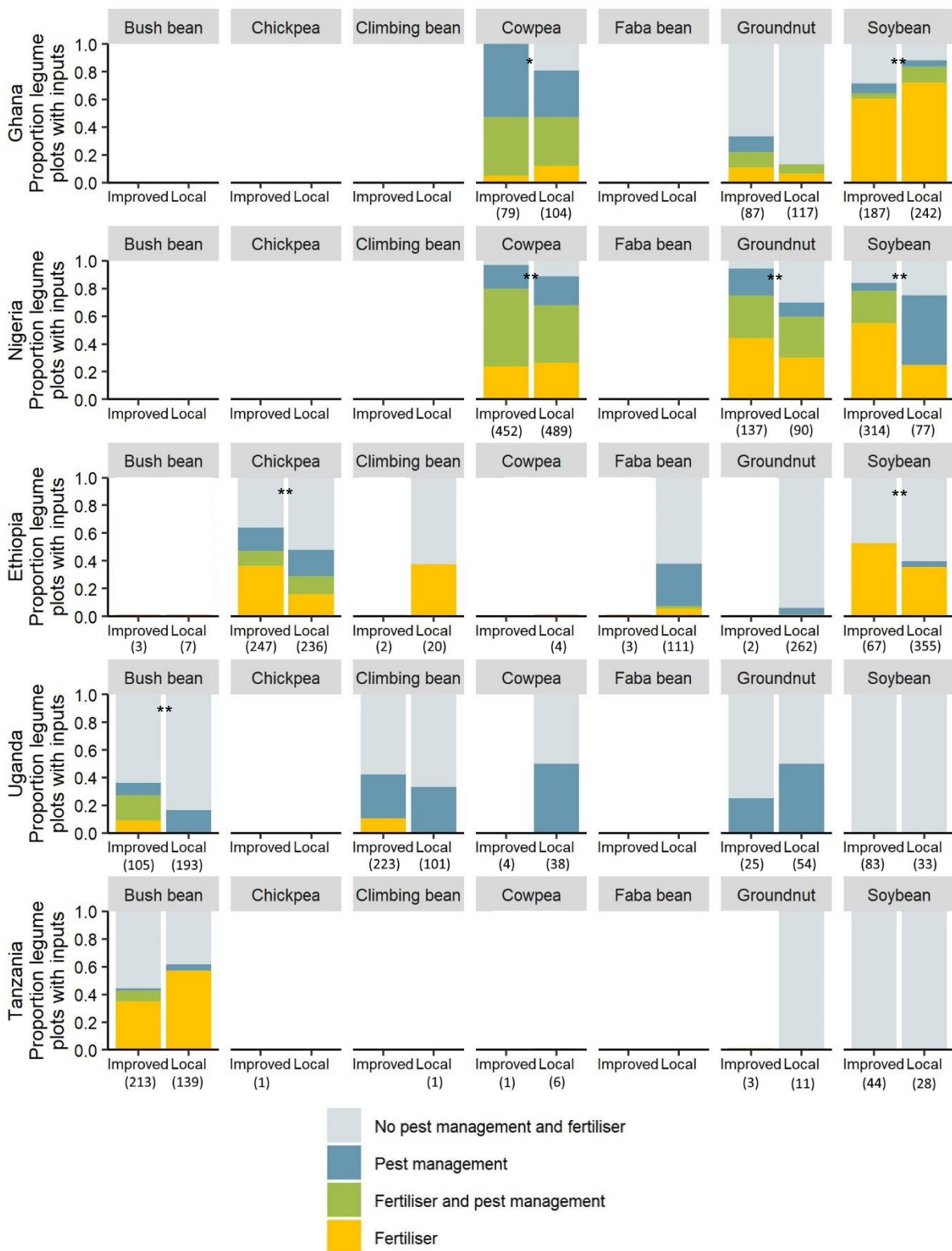


Figure 4. Proportion of legume plots in 2018 which received inorganic fertiliser and/or pest management. The number of plots is shown between brackets. Figures were omitted if the number of plots was below 10. Independence between legume variety (improved/local) and treatment (fertiliser and/or pest management) was tested in a Fisher's exact test. The null hypothesis of independence was rejected at a significance level of $p = 0.05$ (*) and $p = 0.01$ (**). Legume plots were only included if the respondent was aware of the use of fertiliser and pest management on legumes.



for groundnut in Nigeria where plots with improved varieties are on average twice as large ($p < 0.05$; figure not shown).

Figure 4 also shows differences in treatment preferences for the same crop in different countries. Soyabean receives a lot of pesticides and fertiliser in Ghana and Nigeria, a bit less in Ethiopia, and no inputs at all in Uganda and Tanzania. The use of fertilisers on groundnuts differs between Nigeria, Ghana and Uganda as well. Fertiliser use on bush bean is more common in Tanzania than in Uganda. In fact, hardly any fertiliser is used at all in Uganda. In Nigeria almost all legume plots receive inputs, whereas in other countries a larger proportion of legume plots receives no inputs. These differences may be explained by regional pest pressures and soil fertility status and farmers' perceptions about effects of mineral fertilizer but possibly also to differences in access to inputs and history of cropping practices. It was beyond the scope of this study to check these hypotheses.

- **The legume technologies demonstrated by N2Africa were not always new to the targeted farmers.**

The respondents of our case study in Ghana N2Africa were often aware of the use of fertilisers, but not necessarily about its effectiveness on legumes, and they often remarked that they welcomed projects so that they might learn about new varieties and potentially new practices. N2Africa's aim was not necessarily to introduce farmers to something new – but rather to improve legume productivity and to demonstrate a number of technological options that might interest farmers. Still, we were interested to find out how aware farmers were about different legume technologies before N2Africa came.

In the Impact Study, respondents who had heard about a legume technology were asked to give the year in which they first heard about or used a legume technology. Tables 7 – 10 show the percentages of respondents that heard about the legume technology before N2Africa first installed a demonstration trial in their village, from the total of respondents that had heard about the legume technology. For instance in Ghana, 185 respondents had heard about NPK for legumes, and 91% of them had heard about it before a demonstration trial was installed. The totals in the tables below are a subset of the respondents in the Impact Study. From the respondents who were aware of legume technologies, the tables include only those who live in villages with a demonstration trial from N2Africa. Respondents who visited a demonstration trial or field day in another village and the control villages were excluded.

Table 7. Percentage of respondents who heard about or used an inorganic fertiliser before N2Africa installed a demonstration trial in their village. Cells are marked gray if that technology was not demonstrated in that country. Values are coloured gray if the number of respondents was less than 10.

Fertiliser	Ghana		Nigeria		Ethiopia		Uganda		Tanzania	
	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)
DAP					85 (13)	62 (8)	61 (23)	55 (11)	72 (157)	51 (101)
Minjingu									73 (11)	0 (3)
NPK	91 (185)	91 (179)	98 (152)	97 (145)			50 (14)	56 (9)	87 (75)	69 (42)
NPS					33 (12)	27 (11)				
SSP	50 (2)	100 (1)	88 (103)	66 (96)			25 (8)	20 (5)		
TSP	44 (39)	56 (9)					58 (19)	64 (14)	67 (3)	(0)
Urea	91 (82)	69 (62)	98 (166)	94 (163)	100 (8)	100 (7)	50 (2)	50 (2)	88 (112)	40 (82)
New Yara Legume	47 (134)	45 (80)							13 (8)	0 (3)

Table 8. Percentage of respondents who heard about inoculant brands before N2Africa installed a demonstration trial in their village. Cells are marked gray if that technology was not demonstrated in that country. Values are coloured gray if the number of respondents was less than 10.

Inoculants	Ghana		Nigeria		Ethiopia		Uganda		Tanzania	
	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)
Biofix							100 (1)		0 (6)	0 (1)
Legumefix	33 (3)	100 (2)	0 (1)				0 (2)	0 (2)	0 (9)	0 (3)
Makbiofix							31 (16)	44 (9)		
Menagesha					0 (10)	0 (3)				
Nodumax	44 (106)	30 (30)	44 (86)	34 (50)						



Table 9. Percentage of respondents who heard about an improved practice before N2Africa installed a demonstration trial in their village. Cells are marked gray if that technology was not demonstrated in that country. Crop rotation: rotations including legumes; pest management: pesticide use and timing of application; weed management: use of herbicides and timing of weeding; row planting: planting in rows rather than broadcast seeds; plant spacing: crop-specific spacing recommendations. Values are coloured gray if the number of respondents was less than 10.

Practices	Ghana		Nigeria		Ethiopia		Uganda		Tanzania	
	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)
Crop rotation	79 (29)	74 (27)	93 (54)	80 (54)	90 (10)	100 (10)	81 (78)	73 (78)	85 (34)	50 (16)
Pest management	79 (61)	78 (58)	45 (88)	70 (44)	88 (8)	75 (8)	57 (21)	65 (17)	45 (95)	55 (93)
Weed management	80 (167)	79 (167)	80 (65)	60 (62)	75 (8)	75 (8)	55 (38)	46 (37)	72 (140)	48 (138)
Row planting	86 (164)	80 (163)	89 (36)	89 (36)	64 (11)	70 (10)	62 (82)	49 (76)	66 (62)	57 (61)
Plant spacing	67 (45)	69 (45)	80 (41)	60 (40)	0 (1)	0 (1)	47 (43)	38 (39)	47 (32)	29 (28)

Table 10. Percentage of respondents who heard about or used an improved variety before N2Africa installed a demonstration trial in their village. Cells are marked gray if that technology was not demonstrated in that country. BB: bush bean; ChP: chickpea; CB: climbing bean; CoP: cowpea; GN: groundnut; SB: soyabean. Values are coloured gray if the number of respondents was less than 10.

Improved seed	Ghana		Nigeria		Ethiopia		Uganda		Tanzania	
	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)	Heard % (total)	Used % (total)
BB: Jesca									67 (89)	42 (59)
BB: Lyamungu 90									58 (129)	44 (107)
BB: NARO bean 15							48 (27)	36 (22)		
BB: Nabe 4							70 (30)	67 (21)		
BB: Njano uyole									50 (118)	36 (100)
BB: ROBA 1							47 (17)	50 (10)		
BB: RWR 2154							32 (22)	40 (15)		
BB: RWR 2245							60 (15)			
ChP: Arerti					35 (17)	20 (15)				
CB: NARO bean 4C							66 (41)	37 (30)		
CB: NARO bean 5C							69 (49)	56 (43)		
CB: Nabe 12C							62 (40)	60 (35)		
CB: Nabe 26C							63 (27)	44 (16)		
CoP: Apagbaala	67 (30)	65 (20)								
CoP: IT89KD-288			52 (27)	44 (25)						
CoP: IT99K-573-1-1			76 (37)	61 (33)						
CoP: IT99K-573-1-2			89 (38)	62 (34)						
CoP: Padiutuya	31 (13)									
CoP: UAM-1046-6-1			91 (44)	81 (36)						
CoP: Wang Kae	10 (10)									
GN: Chinese	84 (70)	80 (64)							0 (1)	0 (1)
GN: SAMNUT 21			94 (18)	81 (16)						
GN: SAMNUT 22	53 (34)	50 (24)	92 (60)	71 (52)						
GN: SAMNUT 23	28 (25)	38 (8)	90 (20)	79 (14)						
GN: Serenut 14R			100 (1)	100 (1)			28 (18)	27 (11)		
GN: Serenut 5R							33 (24)	29 (14)		
SB: Afayak	35 (85)	33 (55)								
SB: Jenguma	67 (91)	70 (79)								
SB: Maksoy 3N							26 (23)	24 (17)		
SB: Maksoy 5N							0 (14)			
SB: SC Semeki									8 (12)	
SB: Soungpungu	43 (23)	40 (15)								
SB: TGX 1448-2E			85 (33)	71 (28)						
SB: TGX 1904-6F	100 (1)	100 (1)	80 (10)	78 (9)						
SB: TGX 1951-3F			63 (71)	41 (69)						
SB: TGX 1955-4F			71 (41)	56 (39)						
SB: UY Soya 2									41 (46)	7 (14)
SB: UY Soya 4									29 (17)	



From the people who were aware of legume technologies rather many had heard of them before they saw it on a demonstration trial by N2Africa – although this differs much per country and technology. In these cases N2Africa may have had a role primarily in showing options for comparison and showing the effects of combinations of technologies.

The inoculant brands in Table 8 had never been introduced in Ghana before N2Africa came, but not all percentages in Table 8 are zero. Villagers may either have heard about these inoculant brands from people from other villages where N2Africa had arrived earlier, or the year in which they first heard about the technology was not remembered right.

In our case study, many farmers mentioned the fertiliser-application method (using a furrow) as a very useful new technology. They apply it now on their legumes and also on their main starchy staple crops. The Impact Study data unfortunately do not allow for identifying impacts that go beyond the legume crops.

- **People learn about improved farming technologies in various ways, and groups are an important means among others.**

In our case study we always asked about the changes the respondent had seen throughout his or her lifetime. Many respondents spoke about improvements in accessibility in terms of infrastructure and connectivity. Villagers went more frequently outside the village and agro-dealers and extension workers came. More and more people owned radios over time. We also asked about how people share information with each other, as discussed in Chapter 5. Our impression was that the farmer groups had a prominent role in information sharing. As can be seen in Figure 5, the Impact Study data do not show farmer groups as a very prominent source of information in Ghana. However it is very likely that there is considerable overlap in the categories 'fellow farmer', 'farmer group' and 'family and friends'. Respondents could only give one answer; the main source of information. These categories are very prominent especially in Nigeria and Tanzania. Government extension is clearly the main information source in Ethiopia and is also important in Ghana.

Only in Ghana, many respondents mentioned the radio as a source of information. In our case study, the villagers from Ariziem had actively reached out to N2Africa after hearing about the project on the radio, and URBANET and MoFA have broadcasted information about legume technologies in collaboration with N2Africa.

Because N2Africa worked through partnerships, the respondents may not always have associated demonstrated technologies (solely) with N2Africa, but rather with a partner organisation. N2Africa's name is mainly linked with information about inoculants, especially in Uganda, but also in Nigeria and Ghana.

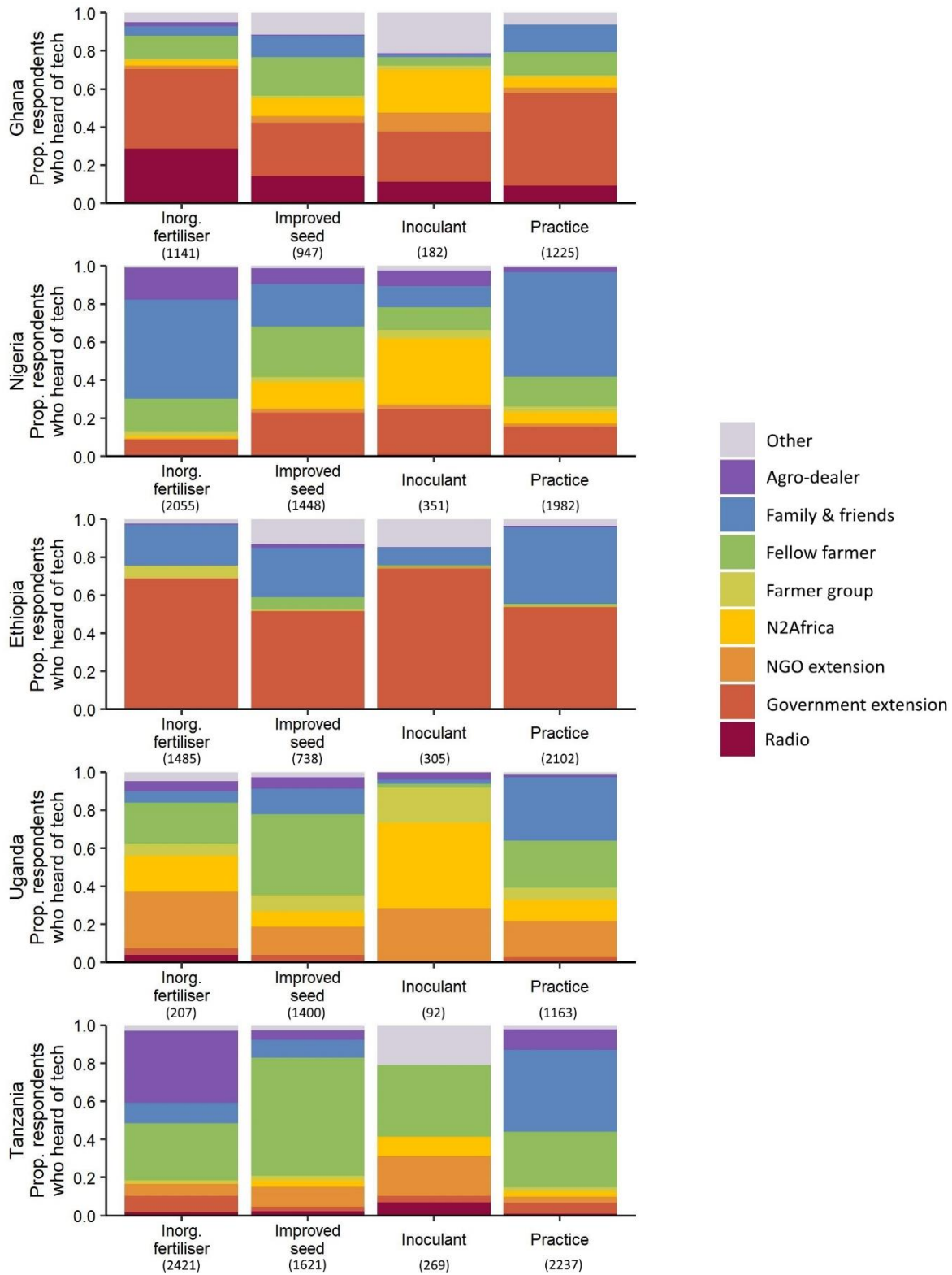


Figure 5. Information sources mentioned for each legume technology the respondents had heard of. Respondents named the main source of information per input and there could be multiple inputs per technology (e.g. TSP and DAP for inorg. fertiliser, see Tables 7 – 10 for all input types per technology).



8 Summary and conclusions

Many of the people we spoke with were very eager to learn. When N2Africa came to their village, they expected that they would increase their knowledge about farming and that their improved farming practices would generate them 'plenty money'. Whether politeness or not, most respondents sounded content about what being 'part of N2Africa' had brought them: technology options to experiment with, and improvements in production – especially for soyabean. Some respondents had hoped for a larger income increase or more free inputs. New varieties were much appreciated, as was the demonstrated method of fertiliser application. Planting legumes in rows was new for only a part of the respondents, and the method was seen as effective (in terms of yield) but also tedious. Fertiliser application and row planting therefore often required an extra investment in labour: a larger workforce rather than more hours per person. Only if the family was not large enough, labour was sought among friends and labour groups. Lunch and/or labour was then given in return. It could be difficult to find labour during planting, fertilizer application and weeding, and it could more easily be found around harvesting because the harvesting time is spread out over a slightly longer period. Women were responsible for processing, and they would welcome a larger number or more versatile machines for processing their grain legumes. The starchy staple crops received priority in terms of land, labour and cash investment. If farmers had investment capacity left, they could invest in legumes as well.

Agricultural development projects that come to the village reach only some of the villagers directly. Although direct beneficiaries may actively share information with others, it was recognized that information is lost along the way. In Ariziem, the respondents had actively reached out to N2Africa in order to be included in N2Africa's dissemination work. The villagers seemed very pro-active about sharing information with each other, but this happened less in the other case study villages. Respondents understood well that projects cannot work with everybody in a community. They take care to be present when names are collected when a project comes for the first time. Different projects do not always work with the same people, but those who take more initiative are more often involved.

Inoculants were referred to as black powder, chemicals. Nodules as stones. The function of inoculation for nitrogen fixation was not understood, but its effects on germination, crop growth and reduction of pest damage were seen. Access to inoculants could depend on a single middleman, whereas there appeared to be more access channels for other inputs.

Throughout the lifetimes of respondents, the accessibility of their village had improved and inputs and information have become more within reach. Access to inputs was now limited by capital availability at critical times during the year. School fees formed some of the most important expenditures limiting cash availability for farming. Parents tended to hope that one or some of their children might get a 'white-collar' job and then the others could be farmers. Many respondents emphasized the importance of the farming sector. Who else would produce food? The challenges in farming that await ahead are also readily identified. As the number of people continues to increase, farm areas per person decline. Lands are continuously cropped, without fallow periods., and the soils are losing fertility. The crops rely on fertiliser to obtain good yields. Young farmers do not want to use a hand hoe for farming. The use of bullocks for ploughing has made land preparation a lot easier, but the future is in mechanisation: tractors. In most cases, tractors are considered much too expensive to purchase, and there is great competition for their use in a limited time frame. Inputs of cash – direct payments or discounts on agricultural products – or tractors at the beginning of the growing season are seen by farmers as effective support measures to advance them in farming in the future. These cash inputs can be loans, as long as these can be paid back bit by bit, after the growing season. The farmers need a starter investment to get going.

N2Africa phased out and many respondents expressed their concern that new knowledge on farming – especially information about new varieties – would no longer reach them. All projects have an end and N2Africa's partners remain with the knowledge base and the network that was built.

This small-scale qualitative case study does not allow for many general conclusions about farmers, N2Africa, different legumes or different countries. The findings – however anecdotal – improved our understanding of people's engagement with N2Africa, some key constraints in labour and capital



investment and information flows. We found that one of the main impacts (as perceived by farmers) was in improved fertiliser use on legumes and other crops. We see much diversity among farmers within a village and among different villages. A large dataset like the one generated in the Impact Study allows for seeing patterns and trends, but they are very difficult to explain and interpret. We therefore recommend agricultural development projects that want to study their impact, to rely less on large-scale and long surveys, and to invest in in-depth case studies.



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Appendix

The following topics were usually covered in a survey, but not all of these questions. We let the conversation flow naturally although we steered towards farming, then legumes and then interactions with N2Africa.

Introduction (usually plenary)

We are Harmen and Eva, researchers from Wageningen University in the Netherlands. We focus on farming. We work together with N2Africa on the production of legumes in this area.

Unfortunately projects have an end date and N2Africa has come to an end. Now that N2Africa stops, we want to be sure to advise partners and other projects on how best to reach farmers.

We want to understand better and better why some farming practices and varieties are sometimes useful and sometimes useless. Production may improve here but not there, or now but not in another season. Some people may benefit more than others.

Last August/September you were interviewed by our colleagues, to assess the impact of N2Africa. We are here to ask a few follow-up questions. We don't want to bother you again with very many! It will take maybe 40 minutes, but you can let us know at any time if you feel like it is enough. Last time questions were much like 'do you do this? Yes / no', and now we want to discuss more openly what is your opinion about the things that you found useful and also what you did not find useful. Please feel free to give your honest opinion! If you did not like things, it is important for us to know.

Do you have questions for us?

Opening questions

How long have you lived in this village?

What changes have you seen in the village in that time?

Farming

Have there been changes in farming in that time?

Why did things change?

What is your most successful crop? Why?

What is your least successful crop? Why?

Which legumes do you grow? Why do you grow it?

Involvement with N2Africa

Why did you take part in the N2Africa project?

How did you get to take part?

When the project came, what did you expect that N2Africa came to do?

Did your expectations come true?

Did you change anything in your farming practices since N2Africa came around?

What are some of the main things you learned?

Was that of any use? Why?

Were there also things that you did not find useful?

Agricultural projects come and go. We are wondering whether these projects focus on the topics you also find most important. If you could choose what they would focus on, what would it be?

Labour

You say you now do things differently. Do you need more labour now or is it similar or less than before?

How do you solve this?

How do you get labourers? What do you give in return?

What is a really busy time during the year? Why?

Are there some things that are only done by women or only by men?

Information

You spoke of all the practices you apply in farming. Do you sometimes get questions from others about what you do? What do they ask?

Do you sometimes ask questions to others about what they do?



Projects interact with some people but not with everyone in the community. What do you think about that? Do people share information or do you have to go and ask? Do you think some people benefit more from projects than others?

End

Thank you very much for answering our many questions. Do you have any questions for us?
Gift



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 soyabean, common bean, cowpea, and groundnut varieties with proven high BNF potential and sufficient seed availability in target impact zones of N2Africa Project
10. Project launching 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 seeds 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 seeds 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. 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



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66. Media events in the N2Africa project
 67. Launching 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 Launching 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
 94. The role of legumes in sustainable intensification – priority areas for research in western Kenya
 95. N2Africa Early Impact Survey, Phase I
 96. Legumes in sustainable intensification – case study report PROIntensAfrica
 97. N2Africa Annual Report 2016
 98. OSSOM Launch and Planning Meeting for the west Kenya Long Rains 2017
 99. Tailoring and adaptation in N2Africa demonstration trials
 100. N2Africa Project DR Congo Exit Strategy



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101. N2Africa Project Kenya Exit Strategy
 102. N2Africa Project Malawi Exit Strategy
 103. N2Africa Project Mozambique Exit Strategy
 104. N2Africa Project Rwanda Exit Strategy
 105. N2Africa Project Zimbabwe Exit Strategy
 106. N2Africa Annual Report 2017
 107. N2Africa review of policies relating to legume intensification in the N2Africa countries
 108. Stakeholder Consultations report
 109. Dissemination survey Tanzania
 110. Climbing bean x highland banana intercropping in the Ugandan highlands
 111. N2Africa Annual Report 2018
 112. N2Africa Annual Report 2018 Ethiopia
 113. N2Africa Annual Report 2018 Ghana
 114. N2Africa Annual Report 2018 Nigeria, Borno State
 115. N2Africa Annual Report 2018 Tanzania
 116. N2Africa Annual Report 2018 Uganda
 117. N2Africa training and extension materials
 118. Responses to inoculation of Phaseolus beans
 119. N2Africa in northern Ghana 2019



Partners involved in the N2Africa project

