N2Africa Annual Report 2017

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N2Africa

Putting nitrogen fixation to work for smallholder farmers in Africa

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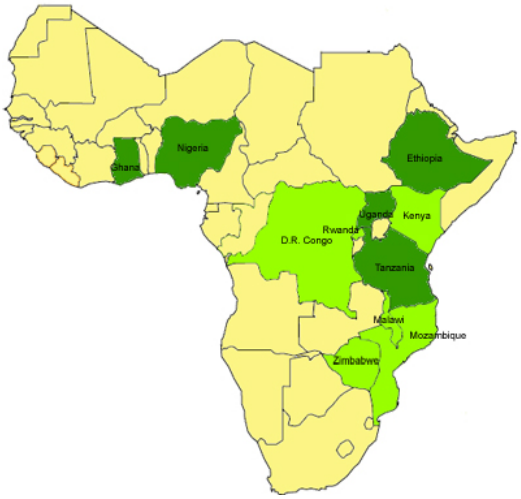
Acronyms and Abbreviations

Acronym	
2SCALE	Toward Sustainable Clusters in Agribusiness through Learning in Entrepreneurship
AFAP	Africa Fertilizer and Agribusiness Partnership
CARE	Cooperative for Assistance and Relief Everywhere
CRS	Catholic Relief Services
CV	Community volunteers
GCL	Guavay Company Limited
IFDC	International Fertilizer Development Center
KNUST	Kwame Nkrumah University of Science and Technology
MoU	Memorandum of Understanding
ODK	Open Data Kit
TOSCI	Tanzania Official Seed Certification Institute
QDS	Quality Declared Seeds
RAA	Regional Agricultural advisory
RESULTS	Resilient and Sustainable Livelihoods Transformation Project
RUDI	Rural Urban Development Initiatives
SILT	Sustainable Intensification of Legume Technology
SME	Small and Medium Scale Enterprises
SMS	Short Message Service
SSP	Spraying Service Provider
SSP	Single superphosphate
TSP	Triple Super Phosphate (TSP) Fertilizer
VBAA	Village- based agricultural advisors

A Snap Shot

This N2Africa Annual Report 2017 presents the results and progress made against the five project objectives in the 11 countries in 2017 and forms the final report capturing the results of the project in the Tier 1 countries. The report also provides insights into specific opportunities and challenges faced in the core countries.



N2Africa Project Core countries (dark green), Tier 1 countries (light green).

To achieve the vision of success "build sustainable, long-term partnerships to enable African smallholder farmers to benefit from symbiotic N2-fixation by grain legumes through effective production technologies, including improved seeds, inoculants and fertilizers", N2Africa implemented sets of interventions through 681 broad formal partnership agreements in 2017, linking scientific knowledge with capacity building, dissemination of technologies, and access to input and output markets. Through the partnerships, N2Africa has evolved from a direct implementation approach (Phase I) to a knowledge provider in Phase II in core countries (Nigeria, Ghana, Ethiopia, Uganda, and Tanzania) and Tier 1 countries (DR Congo, Kenya, Rwanda, Malawi, Mozambique, and Zimbabwe).

N2Africa focused on disseminating Phase I products to partners for scaling up as part of a gradual exit strategy, institutionalized legume expertise within national systems, and shifted activities to other donors and private partners through co-funding. In Ethiopia, Ghana, Nigeria, Tanzania, and Uganda (termed core countries), N2Africa also focused research on key questions emanating from the partnerships and feedback.

Throughout the years, all the participating countries have achieved varied degrees of success and established systems for sustaining the results of project interventions. Smallholder farmers are guaranteed access to key technologies such as inoculants, improved seeds, and fertilizers through private sector partners. The capacity of national systems was developed and project activities aligned/mainstreamed into the national plans of all the participating countries to continue dissemination and adaptation of technologies.

As the project exits in the Tier 1 countries, several strategies have been discussed with partners to ensure the sustainability of results (see Section 5 for summaries of the Tier 1 countries exit strategies). It is expected that all implementing partners will remain committed to the project – especially the private sector – to invest in the input and output supply chains and national systems will continue to mainstream the key technologies and methods into their programs.

[1] This number focuses on broader PPPs (e.g Cluster of PPP in Ethiopia, ISL in Nigeria and Borno, AGINSIBA in Uganda) but leaving out sub-agreements that are linked to Letter of Intents and also sub-contracts related to Collaborative agreements. This means individual PPPs within the 68 are made up of other sub-contracts

Key Achievements

• *Public-Private Partnerships as Catalyst for Scaling*: to ensure scaling of technologies and integration into national systems, 68 implementation partnerships were formally signed with partners in 2017 and 93% of the 2016 partnerships were consolidated in 2017. Input and output markets are addressed by 68% of the partnerships whereas dissemination and capacity building are covered by 66% and 61% respectively. In addition to the partnerships, other national, regional, and district stakeholder platforms were used to address areas such as coordination and policy issues within legume value chains. The partnerships provide various models to gain access to input and output markets and the preferred and widely used models were the "producer collective" already used by 44% of the partnerships and the "buyer-driven" models used by 18%. These models provide collective and ready input and output markets to Farmer groups when needed.

• *Capacity Strengthening to Sustain Delivery*: Capacity building activities focused on both partner staff and value chain actors. A total of 60,854 persons have been trained since 2014 with 43% of the beneficiaries being female. This is a combination of persons trained by training of trainers' (ToTs) to do further trainings (such as lead farmers) as well as direct trainings to value chain actors by ToTs and other value chain actors (agro dealers, processors). Training of trainers' constitute 14% of the total persons trained with 34% of female participation. Partner staff (mainly the ToTs) conducted about 89% of the total trainings with N2Africa staff providing backstopping where needed. These trainings cover various capacity gaps identified along the value chains and covers actors such as farmers, agro dealers, processors. The ToTs also provide technical backstopping in the technology dissemination activities (demonstrations, adaptations, field days, etc). In addition, the project supported 50 students at MSc and PhD levels, with 36% of female participation.

• *Awareness of Proven Technologies*: In 2017, a total of 179,085 farmers were reached (47% female) through various dissemination approaches. A total of 553,802 farmers were reached[2] by the end of 2017. This number exceeded the target (415,000 farmers) by 133%. Key among the dissemination approaches was the organization of demonstrations, adaptations, field days, media events, and video shows. The effectiveness of these approaches has been assessed in Tanzania and Ghana in collaboration with partners through MSc students and the project's end-of-season evaluation sessions. Findings from an MSc study (Mitschke, V. (2015) indicates that although radio programmes had the potential to reach more farmers in a cost-effective way, demonstration plots had a stronger influence on the depth of knowledge of farmers and their intention to adopt the promoted practices. A mix of different approaches is important (e.g., demonstration plots, radio programs, comics, and SMS). It is important that information provided is coherent, linked to the farmers' agro-ecological zones and regions, and presented in a way that they can understand. Project evaluations revealed that there was varied participation in and preference for the above approaches. The use of the technologies was not directly correlated to the number of times a farmer participated in one or more than one approach. This implies that participation in a single approach such as demonstrations could influence the use of the technologies depending on its organization, e.g., farmers' degree of ownership and commitment in setting up demonstrations.

• *Access to Inputs through Last-Mile Delivery Systems*: Access to inputs has always been a priority as many farmers become familiar with the technologies. Across the countries in 2017, most farmer groups quantified their input needs (seeds, fertilizers, and inoculants) with the aim of obtaining such inputs jointly. Various models are being implemented (in Tanzania using Village-Based Agricultural Advisory (VBAA) model). At project level, 74% of the 2017 target (4,620 t year-1) of the volume of seeds used by farmers was achieved. About 74% of volume of the inoculant target (39 t year-1) and 64% of the volume of the fertilizer target (7,700 t year-1) were also achieved. This is evidenced by the sales given by seed companies, agro-dealers/other input suppliers and community based seed

[2] Reach means awareness and knowledge gained through dissemination approaches such as demonstrations, adaptations, field days, radio, video shows, SMS, etc by group of farmers

producers in 2017. On average, 67% of quantified demand for seeds was used by selected farmer groups and 70.4% of the seeds produced by selected seed producers were sold.

• *Output Markets as a Driving Force for Adoption of Technologies*: Stimulating access to profitable markets enhances investment in input usage by smallholder farmers. By the end of 2017, a total of 149,818 persons (46% female) were involved in collective marketing, achieving 77% of the target for 2017 (195,000). Soyabean, common beans and bush beans are the legumes commonly sold through collective marketing with soyabean having much of formal markets with signed agreements with companies such as Hule & Sons in Nigeria, Silverland, G2L in Tanzania and Savannah Company in Ghana. Value addition activities are considered critical to provide options for the food basket for the poor. Activities were mainly related to processing of soyabean into various products and groundnut oil extraction. About 15% of women in 13 Farmer groups of 1,692 members have integrated processed products at a household level whereas 120 women in 26 groups are doing legume processing at the commercial level (SME). In all, over 12,000 women were involved in processing various products and using various legume technologies between 2016 and 2017.

• *Access to Labour-saving Tools as Entry Point to Reduce Drudgery*: Farmers have started using their preferred labour-saving tools after a series of validations to showcase tools and obtain feedback. A total of 46,698 farmers are using planters, threshers, and herbicides as major labour-saving tools. The project has surpassed its target of 30,500 farmers through the continuous use of various herbicides. This is due to their availability in agro-dealer shops in communities.

- *Moving from Best-Bet to Best-Fit Technologies:*

In adaptation trials, mean yields significantly increased on N2Africa plots compared with the farmers' own legume plots. Farmers generally saw an increase of 300 to 800 kg ha-1 on the N2Africa plot compared with their own legume plots. In relative terms, farmers growing cowpea or bush bean in Tanzania and soyabean in Nigeria on average (more than) doubled their yields. More than half of the farmers had a yield increase of > 50%. In Ghana, New Yara legume fertilizer was tested as a new blend against triple superphosphate (TSP) fertilizer and outperformed TSP in cowpea, groundnut, and soyabean. In Tanzania bush beans showed a good response to inoculants in demonstration trials and in Uganda liming is now recommended for climbing beans.

Learnings and Focus to Sustain Results

• *Ensuring Impact and Continuity through Partnerships*: Through the establishment of the various partnerships across the years, with agreed work plans and yearly implementation across countries, many partners have embraced the technologies introduced through their partnership with N2Africa and have integrated these into their development programmes. Examples are groundnut varieties introduced by N2Africa in Northern Ghana (Samnut 22, 23, and 24) have been accepted by all partners and promoted. Again, CRS in Nigeria expanded activities into Sokoto State with their own funding in 2017; YARA Ghana Ltd blended the new legume fertilizer based on field results generated together with N2Africa, etc. The continuing impact of the project is assured through the partnerships and the continuity of the legume interventions. The focus for 2018 to ensure this is realized after project exits is to highlight the major gaps in relation to the three major exit strategies across the core countries and develop interventions together with partners.

• *Effective Approaches for Continuous Technology Dissemination*: Various approaches have been used across the countries to disseminate technologies. Partners provided feedback on the use of such approaches and the feedback is used to improve the approach for subsequent activities. Examples are where partners in Ghana preferred video shows to the media as these offered an opportunity to interact more with the audience. The cost of such approach was comparable to the use of the media or even less in some situations and in Nigeria where some partners modified the demonstration plots to suit the preferred model by expanding the plots sizes to enable participation of more farmers at community level (e.g. SG2000 using 50x50 plot size instead of 20x20 as proposed by the project). One of the key factors for continuous dissemination of technologies by

partners on their own after N2Africa exits will depend on the cost effectiveness of the approaches to be used and to some extent the continuation of the partner initiatives. In 2018, our focus is on compiling study results of the best cost-effective approaches and making them available to partners across all countries, also approaches for labour-saving and input-output market models.

• *Sustaining Private Sector Commitment for Input Delivery*: the rigorous engagement with the private sector since 2016 has led to an improvement in access to inputs. Seed companies such as Agriseed (Tanzania), Heritage (Ghana), Jirkur (Borno State), and Simlaw (Uganda) have already contracted community seed producers trained under the various partnerships across the countries. This engagement has already provided greater volumes of seeds (over 870 tons) needed by selected farmer groups in 2017. Seed companies have been engaged in the various partnerships as key actors with specific interventions geared towards resolving their challenges (e.g. capacity building in legume seed production, information on preferred varieties and market sizes-demand quantification, access to foundation seeds of preferred varieties, etc). This has sustained the interest of some companies in the partnerships. The challenge, however, as expressed by most seed companies, is sustainable access to breeder and foundation seeds for the new, introduced varieties since most of them are still provided through research institutions. Our focus in 2018 to sustain their interest in seed production is to ensure the availability of breeder and foundation seeds through agreed strategies and linkages. Similarly, farmer groups are making efforts to quantify their demands which is key to such inputs being stocked by agro-dealers in future. Most farmers are still unable to accurately quantify their needs or lack the communication channels to ensure such demands are forwarded on time to input-dealers. This is crucial, especially with inoculants, as agro-dealers were wary to stock them owing to their limited shelf life and would prefer to know the demand first. Partners in Tanzania have adopted the village-based agricultural advisory system for input demand quantification to be used in 2018 based on assessment of previous systems. ICT systems for quantification of input demands being piloted in Ethiopia, Ghana, Nigeria, and Uganda will be assessed and rolled out.

• *Linking Farmer Groups to Output Markets*: In 2017 various output market models were reinforced in the partnership implementation plans across all countries which resulted in increased numbers of farmers participating in collective marketing or having access to markets individually. Though the project target for 2017 is yet to be met we are close. The key challenge remains meeting market requirements (quality and quantity of grains produced), developing the right contracts with buyers (taking into account the needs of both buyers and farmers-early payments, assist with storage where possible, respecting the price and volumes to be delivered) and providing platforms for market information which will provide farmers with alternative markets. The focus for 2018 is to integrate specific interventions, such as building the organizational capacity of farmer groups to meet market requirements (e.g integrate specific market standards into post-harvest activities, getting farmers to establishing the basic requirements to negotiate contractual agreements, etc). Furthermore, it will be prudent to document the effectiveness of the different output market models in the partnerships (based on existing information) and recommend the most effective to partners.

• *Making Best-Fit Technologies Available for Continuous Dissemination*: The use of farmers' feedback in evaluation of technologies to reshape technology packages has resulted in more preferred options. The changes made in options and the processes used to obtain such changes are currently being documented to be made available for wider use by partners as the project exits. The focus for 2018 is to analyse the farmer technology feedback, combine this with current best-fit technologies and the learning pathways, and document sets of best-fit technologies and location-specific options to ensure their availability to partners for continuous dissemination.

Keywords

Annual report, Key milestones, objectives, progress, biological nitrogen fixation, grain legumes, Nigeria, Borno State, Ghana, Tanzania, Ethiopia, Uganda, DR Congo, Rwanda, Kenya, Malawi, Zimbabwe, Mozambique.

1 Progress narrative

The N2Africa Annual Report 2017 presents the results and progress made in reaching the N2Africa vision of success. Results and progress were evaluated against the five project objectives in the eleven countries, as follows:

1. Project strategy, coordination and implementation, and capacity strengthening;
2. Delivery and dissemination, sustainable input supply, and market access;
3. Empower women to increase benefits from legume production;
4. Tailor and adapt legume technologies to close yield gaps and expand the area of legume production within the farm;
5. Enable learning and assess impacts at scale through strategic management &evaluation.

The achievements against each milestone are presented in Appendix 1. The progress narrative provides more detailed information behind the numbers presented in the table. The report also includes summaries of exit strategies in the Tier 1 countries. The main sources of information for this report include the N2Africa Annual Country Reports 2017, the country planning and review meetings, the ODK database, and the success stories/highlights.

1.1 Project strategy, coordination and implementation, and capacity strengthening

1.1.1 Project strategy

The project strategy as outlined in the Master Plans allows project teams and partners to update country plans. Feedback from the project annual meetings (held in Mbale, 2017) allows countries to focus on the gaps identified at project level. Based on this, more visibility and focus were on activities to improve access to input and output markets, labour-saving technologies, business opportunities for women, and household nutrition. Country-specific mid-term review and planning meetings in 2017 held with partners resulted in more detailed annual country work plans and reports which were aligned with the overall project focus.

The main project communication channels remained the Podcaster and the N2Africa website which provided information to partners and collaborators. In 2017, eight podcasters were broadcast, mostly to inform the N2Africa network about successes of individual beneficiaries and/or groups in various aspects of the legume value chain, updates of the degree trainings from supported students, and the exit strategies of the Tier 1 countries.

1.1.2 Coordination and implementation strategy

The main implementation strategy of N2Africa has been through Public-Private Partnerships (PPPs) with development organizations, international and local non-governmental organizations, and public institutions. Research-based knowledge is shared through various dissemination approaches and designed feedback loops both within the project and with stakeholders within the partnerships. These guarantee the achievement of the N2Africa vision of success. Establishing PPPs and their coordination therefore play a key role in the achievement of the project's results in all countries.

1.1.2.1 Public-Private Partnerships

The dissemination of technologies is one key objective of N2Africa and its strategy defines the pillars for partnership development. In all countries, partnerships cut across four pillars (i) Capacity Building, (ii) Input Supply, (iii) Output Markets, and (iv) Technology Dissemination. Monitoring and Evaluation generate feedback for delivery, dissemination, and research. In 2017, the main areas of support continued to expand, compared to 2016 (Fig. 1). The number of new partners was particularly related to sustainable input supply systems, output markets, and dissemination of technologies. This was to ensure the achievement of targets was related to access to inputs and

output markets to ensure sustainable supply chains. Three of such partners in Tanzania are Guavay Co. Ltd, Beula and Agriseed (in fertilizer and seed supply chains); and G2L (in output market). In addition, some countries engaged new dissemination partners to enable dissemination activities to be expanded and reach new farmers (e.g., Uganda and Ghana). However, the number of dissemination partners at project level decreased as compared to 2016. This is since most Tier 1 countries did not continue with the formal partnership agreements as the project ended in 2017 in such countries but instead focused on ensuring the exit strategy of the project was well articulated among the partners. Dissemination activities were therefore implemented mostly through informal agreements. There were new partners related to technology dissemination (e.g., RESULTS, CARE, and 2SCALE in Ghana).

The input and output market pillars continued to receive much attention in 2017 because of N2Africa's challenges to achieve targets for input use by farmers across the countries in 2016. This has resulted in an increased access to inputs and output market (see Section 1.2.3.2.).`

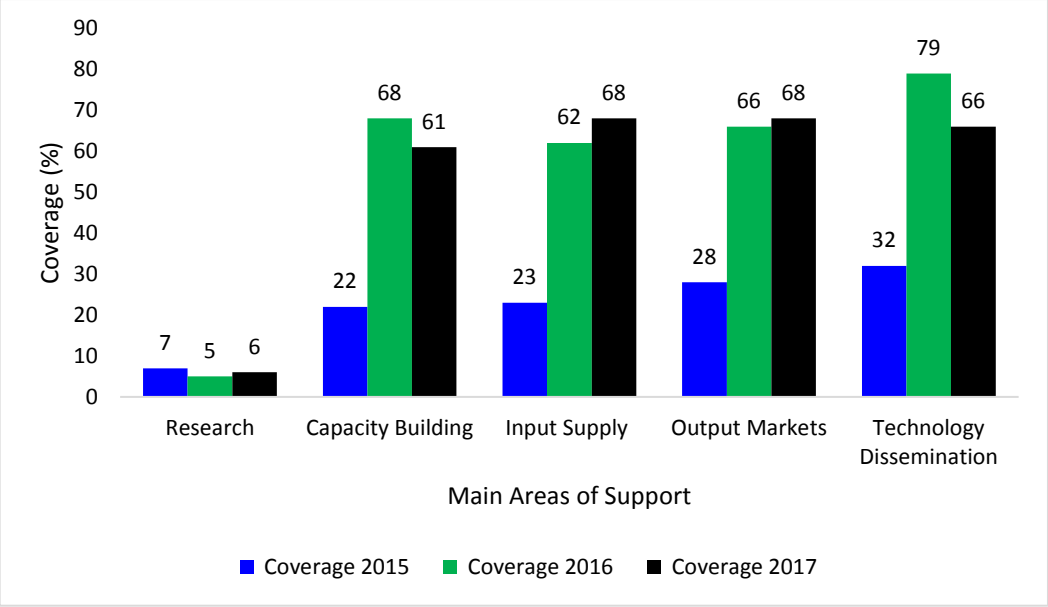


Figure 1. Main areas of support for partnerships in 2015, 2016, and 2017.

In relation to the **number of partnerships,** the project formally continued to implement its activities through the 68 signed partnership agreements in 2017. Although the project exceeded its target by over 100%, the number was reduced as compared to 2016 (90). This is caused by the informal engagement of most partners in Tier 1 countries due to the limited scope of work. Most core countries also assessed the strength of their partnerships in 2016 in terms of achieving the set targets. The new partnerships established in 2016 to strengthen access to input and output markets are still in place and the focus for 2017 was to strengthen such partnerships for sustained access to input and output markets. Figure 2 indicates the total number of partners at project level.

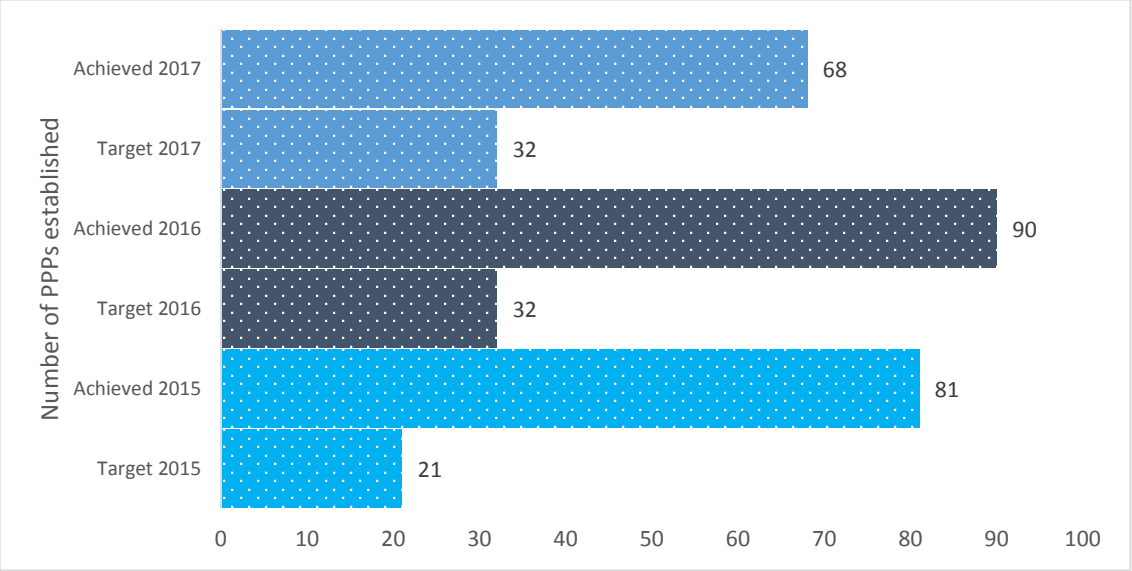


Figure 2. Total number of partnerships (targeted and achieved) in 2016 and 2017.

The disengagement from some partners due to non-performance and the end of project of some value chain partners also contributed to the reduced number of partnerships. The types of partners remain agricultural research institutes, universities, local and international non-governmental organizations, other governments' institutions, private input suppliers, legume buyers, processors, and development partners (Appendix I).

1.1.2.2 **Partnership agreement types**

The types of agreements help to know to what extent the project leverages on existing resources for scaling. The Cooperative-Collaboration agreements and Sub-contract agreements (Fig. 3) continued to be the most often used partnership agreement types across the countries. Sub-contracting can be done within any form of partnership and overlaps in other forms of agreements (e.g., Cooperative-Collaboration agreements). The two Sub-contracts with cost share mainly cut across other partnerships in Nigeria. The Sub-contracts are mostly developed within partnerships to engage a partner to extend its expertise to other partners outside its operational areas or to implement interventions beyond its scope. The number of Cooperative-Collaboration agreements was reduced in 2017 because of some value chain projects ending. However, most of the Sub-contract agreements remained as the NGOs were mostly willing to expand their expertise to new area

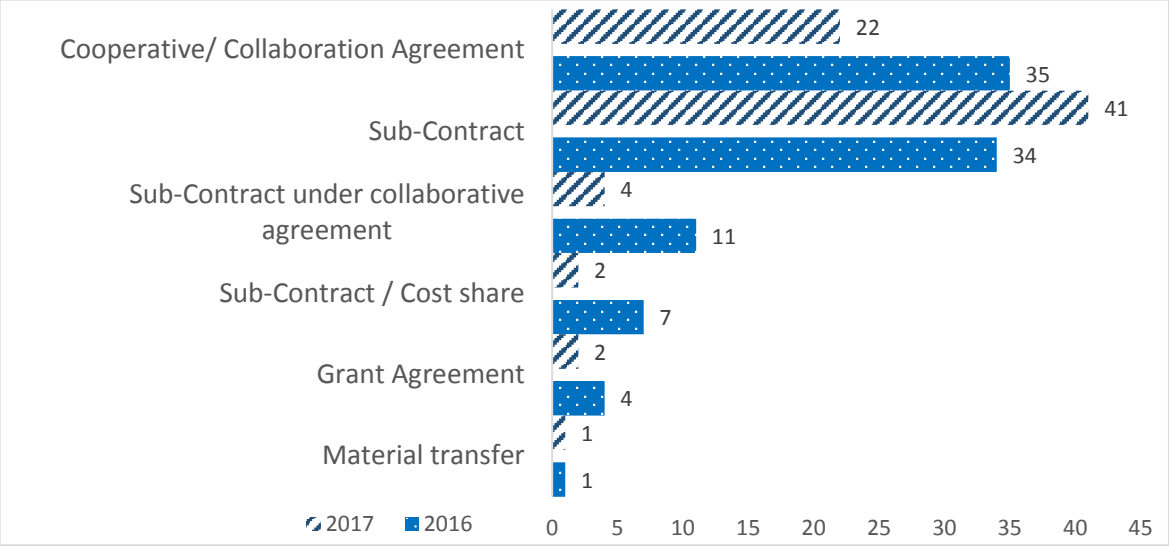


Figure 3. Number of signed partnership agreements per type in 2016 and 2017.

1.1.2.3 Partnerships per business model

The partnerships continued to use the various business models as indicated in 2016, the main purpose being sustainable access to input and output markets. The Producer Collective model[3] (44%) and the Buyer model[4] (18%) continued to be the most frequently used models in partnership agreements in 2017 (Fig. 4). This reflects the increased collective purchase of inputs and produce marketing in 2017, (e.g. about 68% of groups supported by BRiTEN in Tanzania participated in collective input purchase and output market). Both models have been seen to be the most preferred choice of farmers - linking them to input and output markets collectively.

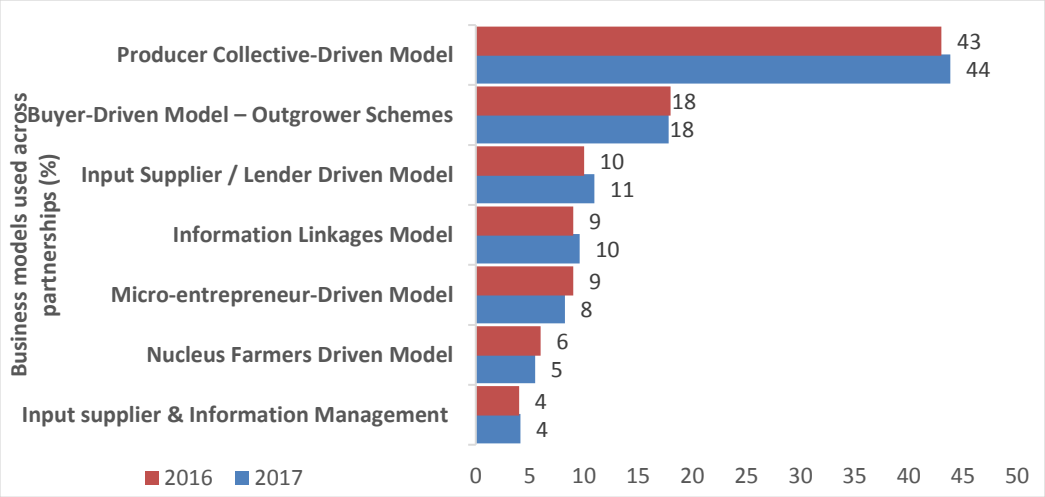


Figure 4. Percentage of business models used across partnerships[5] in 2016-2017.

[3]Focuses on building farmer collectives and infrastructure and was used in all countries.
[4]Also known as contract farming, is defined as binding arrangements leading to a vertical integration of the agricultural value chain, through which a firm ensures its supply of agricultural products by individual farmers or Farmer groups.
5 Analyses are done for 68 partnerships with unique value chain or cross-cutting input supply models.

In Ghana, EPDRA-Yendi and EPDRA-Saboba organized and linked over 205 Farmer groups (with over 4,000 farmers) to output markets. In Uganda, participation of farmers in collective marketing increased from 845 in 2016 to 3,264 in 2017 with a sale of 212.5 t sold collectively through bulking centres involving over 2,000 farmers. This increase can be attributed to increased buyers such as Mount Meru, Mukwano, agents of other processors/middlemen and some refugee camps adding up to 2016 buyers. Though the nucleus farmer-driven model seems to be minimally used (5%) owing to its implementation challenges (limited access to land by nucleus farmers, capital, etc.) it has the potential to organize farmers in large numbers with a few nucleus farmers. Example is the nucleus farmer model used by ADVANCE project (ACDI-VOCA) in Ghana with which 64 nucleus farmers provide inputs and access to the output market for over 10,000 farmers.

BOX I: Public-Private Partnership as a mechanism to achieve sustained access to inputs in Ghana

N2Africa demonstrates the benefits of phosphorus fertilizers in legume production in Northern Ghana through its research activities. The evaluation of technologies by farmers has also shown phosphorus fertilizers as the preferred technology in increasing the productivity of grain legumes. However, its use by farmers had been constrained by inaccessibility since Agro-input companies operating in Northern Ghana were reluctant to stock legume fertilizers because of inadequate information on its efficacy. This resulted in a partnership between N2Africa Ghana and YARA Ghana Ltd with the aim of promoting a sustainable supply of legume inputs among smallholder farmers in Northern Ghana.

Following a successful implementation of field trials with results of about 815 kg ha^{-1} increase in yield due to TSP application, YARA Ghana made available quantities of TSP in some retail shops in major farming communities in Northern Ghana which resulted in a sale of about 200 t in 2016.

As YARA indicated TSP alone lacked certain nutrients, a new fertilizer blend for legumes was developed and evaluated in 2016 through the same partnership agreement. The use of the new blend (which is made up of 4%N, 18%P_2O_5, 13%K, 14%CaO, 2.8%Mg_2O, and 0.3%B) resulted in about 100% increase in grain yield of soybean compared to control without any fertilizer. The yield difference between TSP and the new YARA blend was about 271 kg ha^{-1}.

N2Africa through its expertise in legume production and partnership with the Ministry of Food and Agriculture (MoFA), was requested to provide technical advice to the committee under Ghana's new agricultural program '**Planting for Food and Jobs in** which soybean is one of the component crops. Through its advice, the new fertilizer blend was accepted as part of the fertilizer subsidy program. 1n May 2017, MoFA signed a contract with YARA Ghana to supply about 33,000 bags (1,650 t) of the YARA legume fertilizer to farmers under the Planting for Food and Job program. Currently all the soybean farmers participating in the program have been supplied with phosphorus fertilizer for their fields.

The key achievement of this PPP has been the availability of TSP, the development of the new fertilizer blend for legumes and the subsequent integration of the fertilizer into the government program. It took the project two years to get legume farmers to benefit from the government's fertilizer subsidy program which has not before included legume specific fertilizers.

It took experimentation, information-sharing, and advocacy to get the legume fertilizer into the market and also included in the government fertilizer subsidy program. The key elements that made our action successful included persistence, experimentation, sharing of data (relevant to decision making), advocacy and lobbying policy makers.

1.1.3 Stakeholder Platforms

Stakeholder platforms are key to ensure that country-specific strategies on access to inputs guarantee the sustainable supply of high quality/improved seeds, inoculants, and legume-specific fertilizers. Stakeholder Platforms and Public-Private Partnerships differ in important respects and represent complementary approaches. Stakeholder Platforms have useful functions in embedding N2Africa within the wider national efforts around legume intensification in each of the N2Africa countries (Allan, 2014). N2Africa has participated in existing platforms and/or supported in establishing legume-specific platforms through the partnerships with varied partners and diverse roles and responsibilities. Table 1 shows examples of existing national and regional stakeholder platforms in which N2Africa participates.

Participation in the platforms has contributed to scaling of technologies and integration of N2Africa strategies into national systems to ensure sustainability. Through the PPP stakeholder platform meetings in Ghana (involving MoFA, YARA, and seed companies), the varieties promoted by N2Africa have been integrated in a national program (Planting for Food and Jobs). A partner seed company in Northern Ghana supplied about 150 t of soyabean seeds to support implementation of the national program. In addition, the new legume fertilizer blend (YARA Legume) was also used for the said government flagship program (See Box I). In Tanzania, N2Africa funded two stakeholder workshops coordinated by its partners (RUDI consortium, CRS, and G2L) with the participation of Farmer groups, Community volunteers (CV), Quality Declared Seeds (QDS) producers, agro-dealers, input companies (fertilizers and seeds), Regional Agricultural Advisory (RAA), District Agricultural Irrigation and Cooperative Officers (DAICOs), researchers, Tanzania Official Seed Certification Institute (TOSCI), breeding program, processors and development organizations. This resulted in developing and affirming its exit strategy that defined roles and forged linkages among seed stakeholders and input providers.

Table 1. Examples of stakeholder platforms.

Country	Name of stakeholder platform	Level
Tanzania	Three platforms: • The soybean innovation platform led by East African Grain Council (EAGC) • The Legume Alliance led by CABI-ASHC • Seed policy platform led by AFAP	Regional
Uganda	Two platforms: • SNV –OSSUP • National maize and beans platform	National
Ghana	Two platforms: • Soybean Innovation Lab • Emerging Platform (MoFA, Input suppliers-YARA, Seed/Inoculant companies, off- takers)	Regional National
DR Congo	One platform: Humid Tropics III – R4D	Regional

1.1.4 Capacity development

To ensure continuous delivery of legume production technologies among partners in the project target areas, two key strategies have been used: (i) non-degree trainings and (ii) degree trainings.

1.1.4.1 Non-degree training

The non-degree trainings are in the form of training of trainers (ToTs) for implementing partner staff and selected Lead farmers and step-down training (for value chain actors, e.g., farmers, agro-dealers, processors, marketers, youth agripreneurs in different business ventures). The objective of the ToT is to provide a step-down training in the form of formal trainings for actors such as agro dealers, processors and farmers (on topics such as value addition, post-harvest handling, group

dynamics) or through dissemination approaches such as demonstrations, adaptations, filed days, video shows to create awareness and capacity among farmers in the use of the technologies. These trainings are done with minimal backstopping from the project staff. Table 2 shows that a total of 1,982 ToTs have been conducted in 2017 across all partnerships compared to its target of 320 persons for 2017. This forms 7% of the total persons trained in 2017 with a gender participation of 34%. The trainings focused on gaps identified by partners in previous years and also the general curriculum for new partner staff. The ToTs have so far covered 8,750 persons across all countries. Topics of the general training were related to legume agronomy including seeds, collective marketing, group dynamics, strategies to access inputs, legume processing, and access to credit and savings. The selection of training topics is done in conjunction with partners during planning meetings and the curriculum is developed for such trainings.

Table 2. Total number of ToTs in 2016 and 2017.

Persons trained in 2015 (#)	Persons trained in 2016-cumulative (#)	Persons trained in 2017 (#)	Persons trained up to date (#)
2,467	6,768	1,982	8,750

Table 3. Total number of participants trained: Step-down trainings 2015 to 2017.

Persons trained 2015 (#)	Persons trained up to 2016 (#)	Persons trained up to 2017 (#)
5,194	25,949	52,104

A total of 60,854 persons have been trained directly either through ToTs or step-down training of which ToT forms 14%. Overall participation in the step-down trainings has been 43% (women), and 57% (men), respectively, and step-down training per country in 2017.

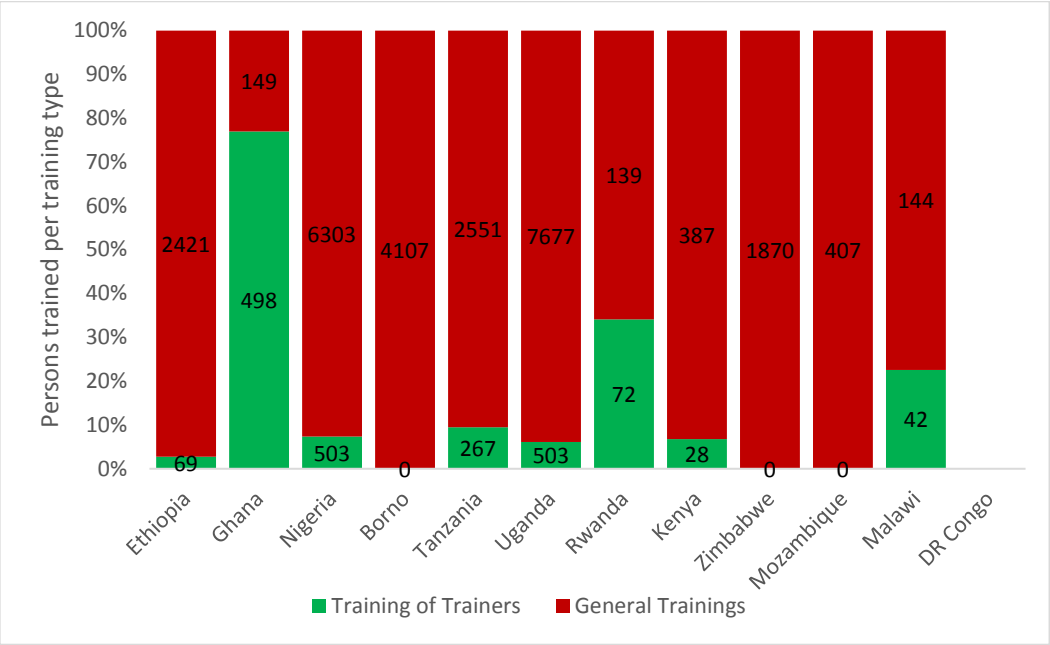


Figure 5. Total number of participants trained through non-degree training per country in 2017.

As indicated above and from Figure 5, each country perceives and uses the ToTs differently. Most countries (Ethiopia, Nigeria, Borno State, Tanzania, Kenya, Zimbabwe, and Mozambique) reach out to more value chain actors directly using the ToTs. Other countries, such as Ghana, Rwanda, and

Malawi, make use of the ToTs through the dissemination approaches. Ghana in addition attracted three new value chain projects in new locations where partner staff required both ToTs and step-down trainings. Ghana also did ToTs on market standards as for selected farmer group leaders and key partner staff.

It can also be seen that the number of ToTs is reduced in comparison to general trainings. This is because many of the partner staff have been trained since 2015 and have acquired the necessary knowledge. Some places (Borno State in Nigeria, Mozambique, and Zimbabwe) also made use of already trained trainers for general trainings in 2017. This can be an indication of partner staff continuing the provision of services and knowledge after the project ends.

1.1.4.2 **Degree training**

The degree training targets students at different levels (e.g., MSc and PhD). Table 4 shows that 42 MSc/MPhil students (29% female) and 17 PhD students (35% female) contributed to research activities. Details on research topics, institutions, and gender of students are presented in Appendix II. A total of 15 students (14 MSc/MPhil and one PhD) have graduated so far. The graduate from Zimbabwe has already been hired as a young technical expert at a new agro- company in Zimbabwe to train farmers on the use of rhizobia and other agro-chemicals.

Table 4. Breakdown of total number of MSc and PhD students trained through a degree training in 2017.

Country	Student level				Total	Status
	MSc students		PhD students			
	Male (#)	Female (#)	Male (#)	Female (#)	**(#)**	
Ghana	7	2	2	0	**11**	Five MPhil/MSc students (three male, two female) graduated during 2016/2017 academic year. Students theses have been uploaded on the N2Africa website
Nigeria	7	1	1	2	**11**	Four MSc students (three male, one female) have completed and the rest are on final stages of thesis defence and data collection. Students theses have been uploaded on the N2Africa website
Borno State	2	3	1	2	**8**	One PhD student (female) completed and others expected to complete in 2018. Students theses have been uploaded on the N2Africa website
Tanzania*	2	3	1	0	**6**	Four MSc students (two male, two female) have graduated. Students theses have been uploaded on the N2Africa website
Uganda	2	1	1	0	**4**	Theses of two MSc students (male) have been submitted for external examination.
Ethiopia	8	0	2	0	**10**	Six MSc students (all male) completed and theses uploaded on the N2Africa website

The Netherlands*	1	1	2	2	**6**	
France	1	0	0	0	**1**	
Rwanda	0	0	1	0	**1**	Underway
Zimbabwe	0	1	0	0	**1**	Graduated
Total	**30**	**12**	**11**	**6**	**59**	

*An additional five interns (40% female) worked with N2Africa Tanzania in 2017. Four interns, studying on weather forecasting were linked to KUKUA, a company working on weather forecasts using digital weather stations and attached to demonstration trials in Moshi and Lushoto Districts. One intern in Tanzania worked on dynamics of pests and diseases in Maize-legume intercropping systems in Northern Tanzania.

1.2 Dissemination, sustainable input supply, and output market access

1.2.1 Farmers reached through various dissemination activities

N2Africa and its partners continued in 2017 to introduce the technologies to smallholder farmers in target areas through the various dissemination activities, such as demonstration and adaptation trials, field days, and video shows. In 2017, a total of 179,085 farmers were reached (47% female). In total, an increase of 33% has been achieved over the target for 2017 (Fig. 6).

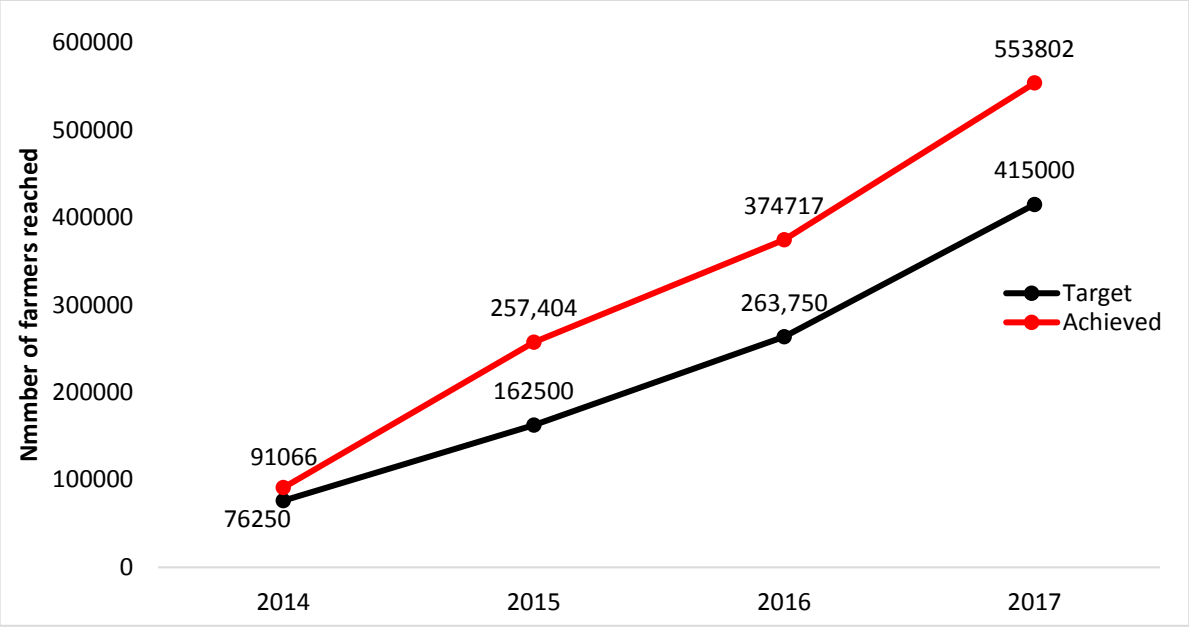


Figure 6. Total number of farmers reached from 2014 to 2017.

Figure 7 indicates achievements at country level between 2016 and 2017. All countries surpassed the number of farmers to be reached in 2017 except in Borno State and Ethiopia where each will require additional dissemination activities to achieve their targets. Borno State had the challenge to expand geographically owing to the insurgency. Tanzania has already achieved its project end target of 65,000 farmers in 2018 and countries such as Ghana, Nigeria, and Uganda will require fewer dissemination activities to achieve their end targets. These targets were achieved through the expansion of partner target areas, engagement of larger bilateral projects (e.g., N2Africa in Tanzania partnered with NAFAKA-Africa RISING project, funded by USAID, the IBB project funded by AGRA, and the SILT project funded by CIDA. N2Africa Ghana partnered with RESULTS implemented by Canadian Feed the Children, CARE international, 2SCALE project implemented by IFDC, and cowpea project from ICRISAT.

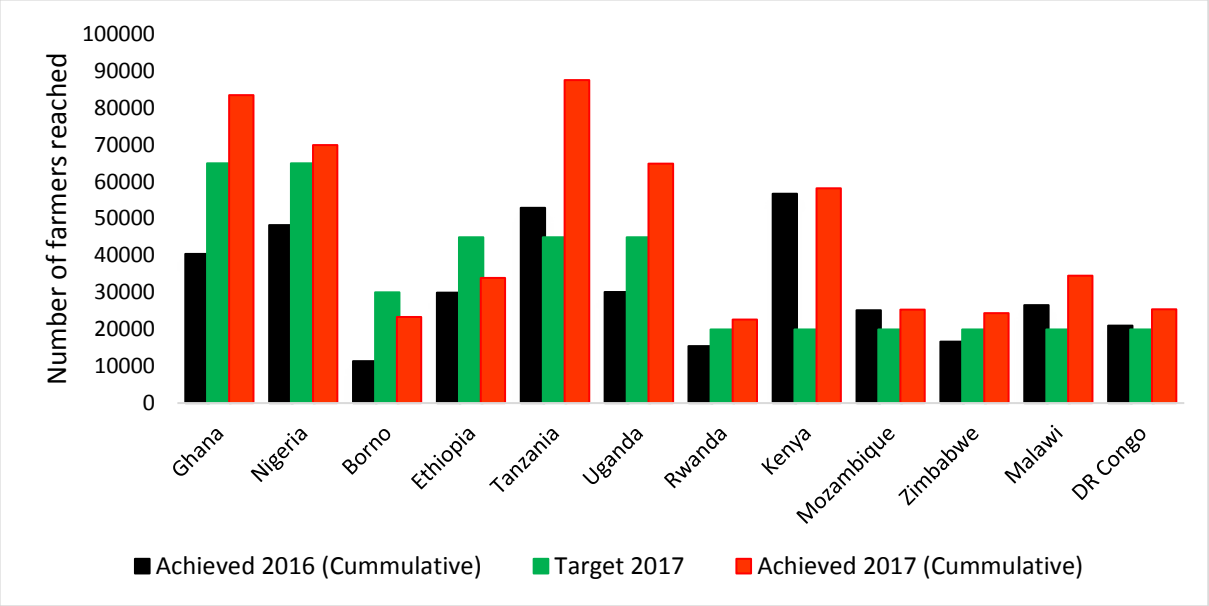


Figure 7. Total number of farmers reached per country in 2016 and 2017 (targeted and achieved).

1.2.2 Effectiveness of dissemination approaches

The project and its partners continued to use the different dissemination approaches to reach out to beneficiaries. Demonstrations, adaptations, field days, media events, and video shows are key among them. In total, 1,454 demonstrations and 25,071 adaptation trials were established in 2017 across all countries. Most households (49%) were reached through demonstration trials followed by field days and agricultural shows (27%). Through the end- of-season evaluation feedback sessions about 90 Farmer groups across Ghana, Uganda, and Kenya evaluated the different approaches (demonstrations, field days, and other media events - radio talk shows) whereas 76 groups evaluated adaptations in Ghana and Uganda. Table 5 indicates the various percentage ratings for each of the approaches.

Table 5. Dissemination approaches as rated by farmer groups

Dissemination approach	Ratings (%)			
	Very Good	Good	Fair	Poor
Demonstrations	62	27	11	0
Adaptations	43	50	7	0
Field days	57	42	1	0
Other media events - Radio	14	39	13	34

More than half of the groups rated demonstrations and field days as very good dissemination approaches. Farmers indicated they preferred demonstrations as they give an opportunity for them to see, learn, and do, when organized together. Demonstrations are also old platforms that the farmers are used to and make it easier to engage in, and also fit in with existing partner systems. It was indicated however by the 11% that the selection of Lead farmers somehow affects the participation of some group members -some Lead farmers consider the plots as their own and do not allow full participation of other farmers.

Also, the engagement of non-supportive extension agents does not allow for full participation and leads to poor learning at the end. Field days also offer a platform to link with other value chain actors such as agro-dealers and produce buyers, creates linkages to access inputs and output markets, and also offers broader learning as other farmers participate.

> *"Working in group demonstration helped us realize the need to cooperate and make work easy. We learnt good practices (spacing, weeding, staking, and spraying) and shared learning on climbing beans. Each member got seeds to plant out of the shared harvest".*
>
> *A quote from farmer groups in Noozi and Nyakafura villages in Rwamucucu subcounty*

Regarding adaptations, almost half of the groups evaluated these as both very good and good. Farmers indicated the unique opportunity given to individuals to practice the use of the technologies outside the group and also to change it as preferred. However, farmers complained of the limited access to the packages given, mostly plots not doing as well as the demonstration plots. Media events, on the other hand, were evaluated by 22 groups as their use has been limited. The 34% poor rating is because many farmers did not participate in media events as these were not planned from the partner's side owing to the high cost of engaging radio stations. The few who participated indicated limited coverage.

Box II: Effectiveness of dissemination strategies in Ghana and Tanzania

Results of several studies on the effectiveness of different information dissemination approaches are summarized in this text box. The GALA project, partnering with N2Africa, assessed the effectiveness of different media and combinations of media in increasing awareness and adoption of legume technologies. Baseline surveys were conducted in Ghana and Tanzania in 2017 (Kansiime et al., 2017; Macharia et al., 2017). Results in both countries showed that farmers currently relied mostly on information from their own experience and from neighbours, combined with extension agents, radio, and other household members. There were significant differences ($p<0.01$) between men's and women's access to information. In Ghana, women were more likely to seek information from other household members and agro-dealers, men from extension workers, radio, and demonstration plots. In Tanzania, women relied on own experience and other household members for their information; men were more likely to receive information from radio. Demonstration plots, extension, radio and agro-dealers were important information sources in promoting production inputs and new practices (e.g. soil testing, use of inoculants, use of lime and PICs storage), while farmers' experience was mainly used as information source for well-known practices such as early field operations. The majority of farmers (63% in Ghana and 82% in Tanzania) shared information with others, but primarily about well-known agricultural practices. Information sharing on new practices was minimal. New practices were also least used by farmers due to limited awareness, limited access to inputs and high cost for obtaining the inputs. Conclusions from both studies were that there is still margin for improving learning and knowledge of more recently introduced practices. Given the observed dynamics of intra-household information sharing, targeting information to various gender and age categories provides an opportunity to ensure information can effectively reach different household members.

In collaboration with the IFAD-funded UP-scaling Technology in Agriculture through Knowledge and Extension (UPTAKE) project, the impacts of selected ICT services in generating awareness and adoption of bean technologies in Tanzania was assessed (Silvestri et al., 2017). In 2016, a 16 week campaign on beans was promoted using radio and SMS, and the effectiveness of radio only (n=59), SMS only (n=117) and radio & SMS (n=65) messages was measured. The combination of radio & SMS allowed farmers to learn more than the single treatments. The Radio and SMS treatment was the most effective in increase uptake especially for practices around planting and pests and diseases. SMS alone seemed to be more effective than radio alone. The practices that brought new insights to farmers were mostly related to planting, seeds and use of fertilizer. However, in terms of uptake, the largest effects of the campaign were on the control of pest and diseases (spraying pesticide), planting (measuring and ensuring a more regular plant spacing), and seeds (buying certified seeds). A total of 70% of farmers declared they had done something different after the campaign. The lack of information about where to get inputs limited the implementation of practices, indicating an important gap along the value chain.

References

Kansiime, M., Macharia, M., Adraki, P. & Obeng, F. (2017). Gender and the Legume Alliance. Deliverable 2.3: Intra-household household survey in Ghana. Nairobi: CABI.

Macharia, M., Kansiime, M., Baars, E., Rutatora, D. & Silvestri, S. (2017). Gender and the Legume Alliance: Integrating multi-media communication approaches and input brokerage. Intra-household survey report – Tanzania. Nairobi: CABI.

Ganatra, D. & Baars, E. (2017). Deep dive study: Assessing the effectiveness of different delivery approaches and communication channels on increasing awareness and adoption of agricultural practices: An application to radio and SMS. Nairobi: CABI

Though there were varied levels of participation and preferences for each approach, the use of the inputs, however, is not directly correlated to participation in more than one approach. Some farmers in Uganda (182) participated in demonstrations only and 124 (68%) used the introduced varieties (Maksoy 3N). A total of 4,385 farmers who participated in the evaluation in Ghana and Uganda had participated in demonstrations and 1,312 of them again in adaptations. However, 54% of total farmers used at least a single technology with the majority being introduced varieties, spacing, fertilizers, and inoculants (in descending order). Adaptation allows farmers to have a one-time access to the technology packages but does not guarantee the continuous use of such technologies.

In addition to the project end-of-season evaluations, various studies were conducted together with partners in assessing the efficiency and effectiveness of the technologies. Box III presents a summary of findings of selected studies conducted in Ghana and Tanzania.

Box III: Effectiveness of Radio and Demonstration Plots

An MSc student assessed the cost-effectiveness of different dissemination approaches employed by N2Africa and partners in the Maharage Bingwa Campaign in Tanzania (Mitschke, 2015). The research focused on the effects of radio broadcasts and demonstration plots on the knowledge level of farmers (n=166) regarding improved practices for common bean cultivation and their willingness to adopt the practices promoted. To determine cost effectiveness, the increase in knowledge was mirrored against the cost per farmer reached for each dissemination approach. The cost-benefit ratio for radio programs was more favourable than for demonstration plots (Table B1). Although radio programs had the potential to reach more farmers in a cost-effective way, demonstration plots had a greater effect on the knowledge level of farmers and their intention to adopt the promoted practices. A factor analysis on the components influencing the farmers' willingness to change their behaviour revealed that access to the demonstration plot and the credibility of the information presented during the radio show have a highly significant positive effect on farmers' willingness to adopt improved practices promoted by the dissemination approaches. The study recommended a focus on good accessibility of demonstration plots and on ensuring that information sources and presenters of a radio program are trustworthy and credible. A mix of different approaches is important (e.g., demonstration plots, radio programs, comics, SMS), in which the information provided needs to be coherent, presented in a way that farmers can understand, and tailored to agro-ecological zones and regions.

Table B1: Cost-effectiveness-analysis of demonstration plots and radio programs (mean score = mean score of an exam on the information disseminated).

	N	Mean Score	SD	Ø Knowledge Level Increase	Ø Costs per Farmer	Cost-Benefit Ratio
Control	50	0.3660	0.1645			
Demonstration Plot	60	0.5283	0.1510	16.2%	1.88USD	0.13
Radio Program	56	0.4589	0.1488	9.3%	0.36USD	0.065
Total	166	0.4560	0.1671			

Reference

Mitschke, V. (2015). Farmers' constraints vis-á-vis the adoption of improved bean varieties and seeds in Hai District, Tanzania. Wageningen: Wageningen University. http://www.n2africa.org/content/farmers%E2%80%99-constraints-vis-%C3%A1-vis-adoption-improved-bean-varieties-and-seeds-hai-district.

1.2.3 Sustainable input supply

1.2.3.1 Inoculant production

The project continued to facilitate the availability of inoculants in all countries through PPP. Table 6. Inoculant distribution channels and volumes produced (tons and number of packets year^{-1}). summarises the status of inoculant supply in each country.

Table 6. Inoculant distribution channels and volumes produced (tons and number of packets year^{-1}).

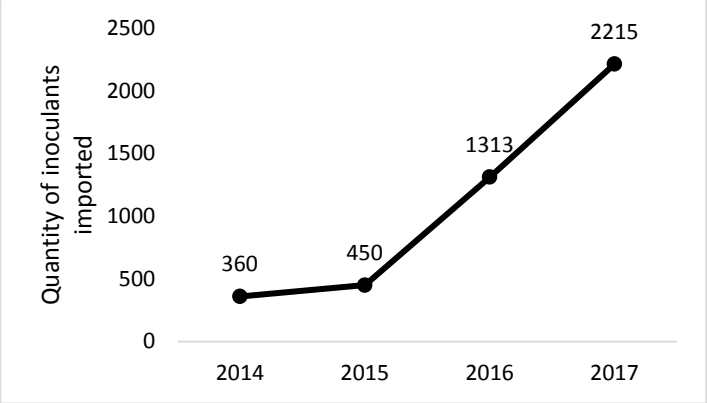
Country	Mode of availability	Inoculant brand	Main producer /importer	Quantity produced/ imported (t year^{-1})	Quantity produced/ imported (# of packets year^{-1})
DR Congo	Local production	Inoculant	IITA	0	0
Ghana	Importation	LegumeFix	Greenef	0.7	2,800 packets of 250 g
Ethiopia	Local production		Menagesha Biotech Industry Plc	25.9	300,000 packets of 25 g
Kenya	Local Production	BioFix	MEA Ltd	1.01	20,200 packets of 50 g
		RhizoLiq	SeedCo		12,000 packets of 400 ml
Malawi	Local Production	NitroFix	Agro-Input Suppliers Limited	12.5	250,000 packets of 50 g
Mozambique	Importation	LegumeFix MasterFix	N2Africa and Partners	0	0
Nigeria	Local Production	NoduMax	IITA	11.6	116,000 packets of 100 g
Rwanda	Local Production	Rizobiyumu	Rwanda Agricultural Board	0.96	12,000 packets of 80 g
Tanzania	Importation	LegumeFix	IITA/GCL	2.2	8,400 packets of 250 g
Uganda	Local Production	MakFixer	Makerere University	0.8	8,000 packets of 100 g
Zimbabwe	Local Production	N-Fixer	SPRL	15.5	155,000 packets of 100 g

Table 6 shows that nine out of the 11 countries either continued to import or produced inoculants through public and private suppliers. A total of 71.2 t and 12,000 sachets (400 ml per sachet) year-1 of inoculants were either produced or imported into nine target countries. The volume of inoculants imported and/or produced in countries such as Tanzania, Ethiopia, Nigeria, and Zimbabwe increased by 69%, 21%, 76%, and 24% respectively and in addition, countries managed to sell the greater part of the inoculants (68%) owing to the increased demand and the expanded distribution channels established in these countries. Guavay Co. Ltd (GCL), a private partner in Tanzania, took over the distribution of inoculants through hub agro-dealers. The Business Incubation Platform in Nigeria expanded its customer base from IITA-based projects in 2016 to 45 customers in and around

the West African sub-region. In addition to above, Ghana (Nodumax) and Uganda (LegumeFix) registered additional products in 2017 following their successful efficacy evaluations. Ghana already has a private partner to lead importation and distribution whereas Uganda will be identifying a business representative in 2018 to take up importation. Box IV shows progress of inoculant demand

BOX IV: Inoculant importation and distribution from 2014 to 2017

In Tanzania, the quantities demanded of rhizobia inoculant by farmers continue to increase since its introduction in 2014. The demand information is collected by partners and agro dealers. The volumes then informs the quantities to be imported. The actual demand of soyabean inoculants has increased from 1,313 kg in 2016 to 3,025 kg in 2017 and this is equivalent to an increase of 169%.



The involvement of the private sector partner like Guavay Company Limited and its linkage to hub agro dealers for distribution will ensure the sustainability of this strategy. Guavay will also take over the direct importation of the inoculants in 2018 as its engagement in 2017 was late for importation.

and importation in Tanzania since 2014.

On the other hand, some countries such as DR Congo and Mozambique did not import or produce inoculants for sale in 2017. Inoculant importation is done by projects in Mozambique and the activities of the major partner were delayed in 2017. In DR Congo, funds were not secured to continue production at the IITA laboratory.

1.2.3.2 **Dissemination of legume inputs**

To address the challenge of limited access to and use of legume seeds, inoculants, and fertilizers, the countries continued to pursue the various strategies put in place in 2016. To sustain the production of certified seeds for the introduced varieties, countries, especially core countries, supported national systems (e.g., ARI Uyole, Tanzania) to produce foundation seeds to supply to seed companies for further production of certified seeds. Others have linked seed companies and other partners directly to institutions that produce foundation seeds (e.g., The Inventive Minds and EGALF Ventures in Nigeria have been linked to the University of Agriculture in Makurdi where they access foundation seeds for their community seed producers). A total of 48 t of foundation seeds was produced and/or accessed across the selected countries. Though the above seems to work in some countries, greater quantities of foundation seeds are still supplied by the project to seed companies and community seed producers for certified seeds. Seed companies have therefore indicated the need to ensure a reliable supply of breeder and foundation seeds to sustain the production of certified seeds. As part of the country's exit strategies, Ghana has planned to secure breeder seeds of introduced varieties for selected seed companies to produce their own foundation seeds.

To ensure legume seeds are available at community level, the countries continued to engage the seed companies and community based seed producers in producing certified and quality declared seeds. Most countries (Ethiopia, Nigeria, Ghana, Uganda, and Tanzania) continued to support over 4,000 farmers in the production of the seeds across the countries. These farmers are certified by the countries certification bodies. Table 7 shows that 70.4% of the seeds produced are sold either directly by farmer groups in their communities to other farmers or mopped up by seed companies and agro-dealers. Soyabean seeds are much produced and sold across the countries and the least produced are climbing beans only in Uganda.

Table 7. Seed quantities produced and sold by seed companies and farmers in selected countries[6] in 2017.

Legume Type	Quantity Produced	Quantity Sold	Sold
	(t year^{-1})	(t year^{-1})	(%)
Soyabean	1,081	836	77
Groundnut	481	271	56
Cowpea	173	97	56
Climbing Bean	28	25	87
Bush Bean	494	361	73
Total	**2,258**	**1,590**	**70**

*Source of data: Project ME&L (Seed companies, Agro dealers, community seed producers embedded in producer groups)

In aligning the local agro-dealers marketing seeds with grass root producer groups, a total of 1,590 t of seeds was sold by seed companies, agro-dealers, and community based seed producers, increasing the cumulative volume of seeds used by producer groups to 3,399 t from 1,809 t in 2016, a 74% achievement of the target for 2017 (4,620 t). Agro-dealers sold about 30% of the seeds in 2017 to farmers.

Table 8 shows that supported Farmer groups had access and used 67% of seeds demanded across the various legumes. Some Farmer groups indicated their interest and the volume required but did not purchase owing to varied reasons which included limited access to agro-dealers, and climatic changes. Thus, some varieties are not resistant to drought and there was poor market access for those varieties.

Table 8. Seed quantities demanded and used by farmers in Ethiopia, Tanzania, Nigeria, Uganda, Ghana, Malawi, and Rwanda in 2017 (t year^{-1}).

Legume Type	Quantity Needed	Quantity Used
	(t year^{-1})	**(t year^{-1})**
Soyabean	642.7	498
Groundnut	207.4	140.5
Cowpea	162.8	93.2
Climbing Bean	111.3	60.4
Bush Bean	181.8	85.9
Total	**1,306**	**878**

**n* = 1,916 groups

[6]Ghana, Nigeria, Ethiopia, Tanzania, Uganda, Kenya, Malawi, and Rwanda.

A total of 36,046 farmers from the 1,916 groups used seeds of the various legumes, representing 60% of the total farmers in the groups (59,764). In 2017; the volume of inoculants and fertilizers used by farmers increased compared to 2016 (Figs 8 and 9). About 79% of the volume of inoculant and 65% of the volume of fertilizer were achieved in relation to targets of 39 t year-1 and 7,700 t year-1. Several strategies implemented together with partners contributed to this success. Agro-inputs Suppliers Ltd (AISL) in Malawi, for instance, invested in the distribution chain by procuring 15 solar-driven coolers for proper Nitrofix inoculant storage in 15 of its outlets and has constructed a permanent and fully equipped laboratory for inoculants production.

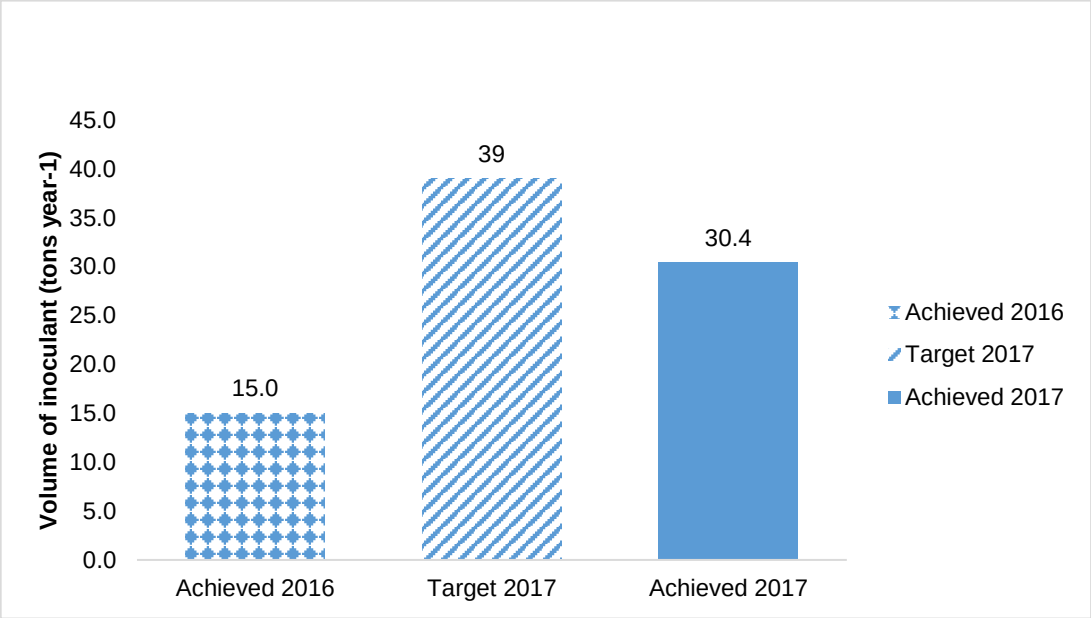


Figure 8. Volume of inoculants used by farmers in 2016 and 2017 (targeted and achieved) (t year^{-1}). Data are based on available records from N2Africa Farmer groups.

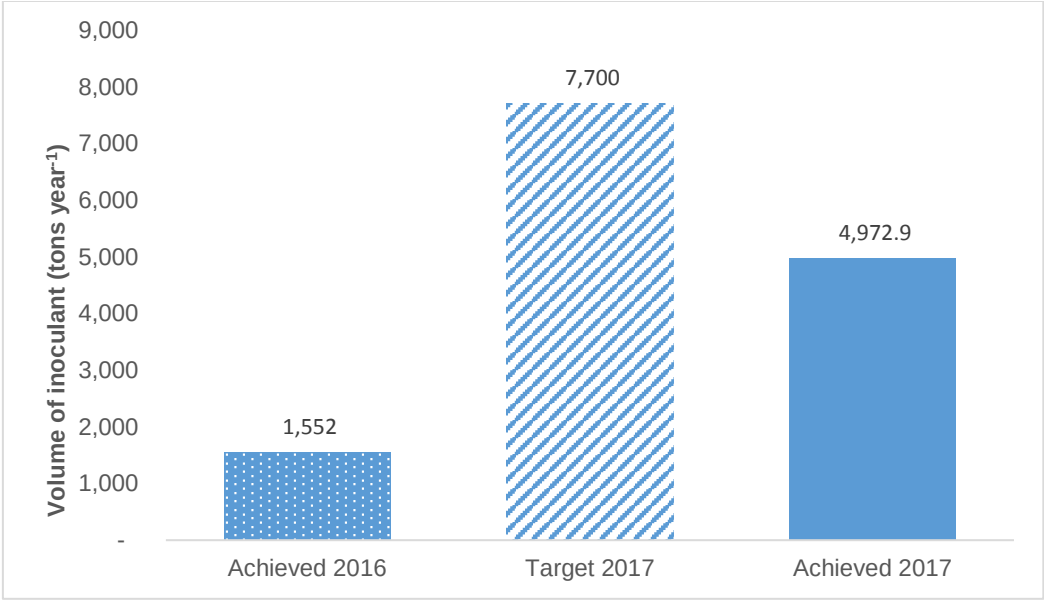


Figure 9. Volume of fertilizers used by farmers in 2015 and 2016 (targeted and achieved) (t year^{-1}). Data are based on available records from N2Africa farmer groups.

Though the overall targets for 2017 have not been met, the strategies implemented in 2017 will continue to yield results as the private sector continues to invest. For example, in Ghana, dissemination activities with YARA resulted in an increase in P-fertilizer used by farmers (e.g., from 150 t in 2016 to 194.6 t in 2017) excluding quantities distributed through the government of Ghana's

Planting for Food and Jobs program and this partnership is envisaged to continue in 2018. In Nigeria, the ABP program contributed to 78% sales of inoculants in 2017.

To sustain accessibility to improved seeds, countries have put in place various strategies including seed companies contracting trained seed producers as out-growers (e.g. Agriseed in Tanzania has contracted 15 farmers for the upcoming season, Heritage seeds in Ghana has contracted over 400 farmers). Other countries have also linked seed producers to seed companies for mopping up of seeds produced (e.g., farmers producing bush bean seeds in Uganda have been linked to Simlaw seed company and other packages). In addition, many more agro-dealers (136) were engaged and linked to various Farmer groups. About 32% stocked more than one legume input (seeds and fertilizer; seeds, fertilizers and pesticides/herbicides; seeds, fertilizers and inoculants). 68% stocked seeds, 32% stocked fertilizer (NPK, Urea, TSP, SSP, new YARA blend, etc.) and 28% stocked inoculants. Most inoculants were distributed in Ethiopia through cooperative unions in addition to two agro-dealers.

In addition, many farmer groups could quantify the input demanded, before the start of the season. Over 900 groups estimated quantities of inputs especially seeds needed for the season. However, this needs further support to ensure timely compilation and delivery to the input-dealers and access to input price information by farmers. Assessment of these systems has been done and an ICT-based demand quantification system is being piloted in Ethiopia, Ghana, Nigeria, and Uganda. Tanzania, however, has adopted the Village Based Agricultural Advisors (VBAA) and Community Volunteers (CV) models for input demand quantification for the upcoming year, based on the limitations of the previous system where farmer groups quantified their demands but lacked price information and there was a late delivery of quantities to input-dealers.

1.2.4 Output market access and collective marketing

The output market being a driving force for investment in inputs has been given the necessary attention in the project, in addition to adding value to grain to ensure household consumption and alternative income generation from legumes. In total, 149,818 persons (46% female) were involved in collective marketing and value addition. The scales of operation were at both household and commercial levels. Table 10 indicates that 77% of the 2017 target has been achieved for participation in collective marketing.

The increase in number of farmers that accessed output markets was more in 2016 as compared to 2017. Farmers complained of delayed payments when they had collectively sold to major buyers and limited access to market information in comparing prevailing market prices to those being offered by buyers; low quality grain and high storage cost for bulking. In Tanzania, the introduction of VAT on animal feeds that has led to an increase in prices which consequently reduced the demand. Animal feed processors could not process soyabean purchased in 2016 as there was no demand. This decision has been reversed and hopefully the demand for soyabean will revert in 2018.

These are still major challenges that need to be addressed. On the other hand, the price margin between collective marketing and individual selling is minimal in Borno State, for instance, due to high demand for the produce. Most farmers among groups therefore sold individually without participating in the collective sales.

Table 9. Number of farmers accessing output market in 2016 and 2017 (targeted and achieved).

Achieved 2016(#)	**Targeted 2017**(#)	**Achieved 2017**(#)
119,690	195,000	149,818

1.3 Empower women to increase benefits from legume production

To empower women to benefit from the legume value chain, various interventions are implemented in the areas of gender-specific themes for dissemination activities, identifying and supporting the establishment, value addition, and promoting access to labour-saving tools to resolve drudgery. These interventions are an integral part of all partnership agreements depending on the needs.

1.3.1 Overall women participation

Participation of women in the various interventions outlined above is key to ensuring their empowerment. About 39% of Lead farmers who hosted dissemination trials (e.g., demonstration and adaptation) were female; 43% of the participants for step-down trainings and 34% for ToTs were female. Women again form 47% of total farmers reached in 2017. Though the above indicates a relatively high female participation in most activities a gender study conducted in Uganda indicated a low participation in the marketing of climbing beans in Kabale districts. A summary of findings is presented in Box V.

BOX V: Gender-based factors influencing farmer participation in the marketing of climbing beans in Uganda

A study on gender-based factors influencing farmer participation in the marketing of climbing beans (*Phaseolus vulgaris* L.) in Kabale district, south western Uganda, has been conducted by an MSc student (Eriya B. Kule). The study revealed a low participation of women in bean- related businesses and control of incomes accrued due to engagement in time-consuming reproductive roles, restrictive cultural norms, low literacy and numeracy skills, lack of financial capital and ownership of transport means. Briefing of both women and men to overcome gender stereotypes on marketing roles and organizing them to access financial capital, better markets, and labour-saving technologies and building business skills and financial capital is needed to overcome the gender dynamics that affect women's participation in grain legume marketing. Also, to be noted is that partners have continued to include gender awareness and briefing arrangements and inclusion of all on legume production and marketing. For women's groups such as Bedigen and Bugarra, we continue to include the men (husbands) in the design for support and advice in business development.

1.3.2 Legume processing tools improving nutritional status

With the trainings and supported interventions within the partnerships, many individuals in farmer groups, and communities in general have integrated legume processed products in their household diets. About 15% of women in 13 farmer groups of 1,692 members have integrated processed products at household levels whereas 120 women in 26 groups are doing legume processing at commercial level (SME). In all, over 12,000 women were involved in processing of various products and using various legume technologies between 2016 and 2017.

1.3.3 Labour-saving tools

After the validation of many labour-saving tools, farmers and service providers have integrated planters, threshers, and herbicides in the production activities. Herbicides are widely used across Ghana, Kenya, Nigeria, Malawi, Tanzania and Uganda). Threshers are mostly used in Nigeria, Malawi and Rwanda whereas planters are used mainly in Nigeria. Access to the tools (herbicides) is mainly through direct purchases from agro-dealers and through group purchases and/or service provision for planters and threshers. A total of 30,663 farmers (41% female) used the various labour-saving tools in 2017. Table 11 shows the number of farmers per tool used in 2017 and Figure 10 shows the 2017 target compared with what was achieved. Herbicides continue to be the most used labour-saving tool (92%) as compared to 80% in 2016). They are easily accessed in most agro-dealer shops and affordable. The use of spraying service providers continue to provide access to

many farmers especially women who hitherto did not have access. This is one key initiative by N2Africa in Nigeria within the Borno Agripreneur to create jobs for the youth. The use of planters on the other hand is very much limited. Many prototypes have been validated but most do not meet the criteria of farmers and service providers. Feedback from the validation exercises should be used to modify the prototypes where possible. Also the possibility of engaging local fabricators will reduce the cost as farmers/service providers complain of the high cost of most of the validated planters.

Table 10. Number of farmers using labour-saving tools in 2107.

Tool Type	Number of persons using (#)
Herbicides	28,099
Planters	364
Threshers	2,200

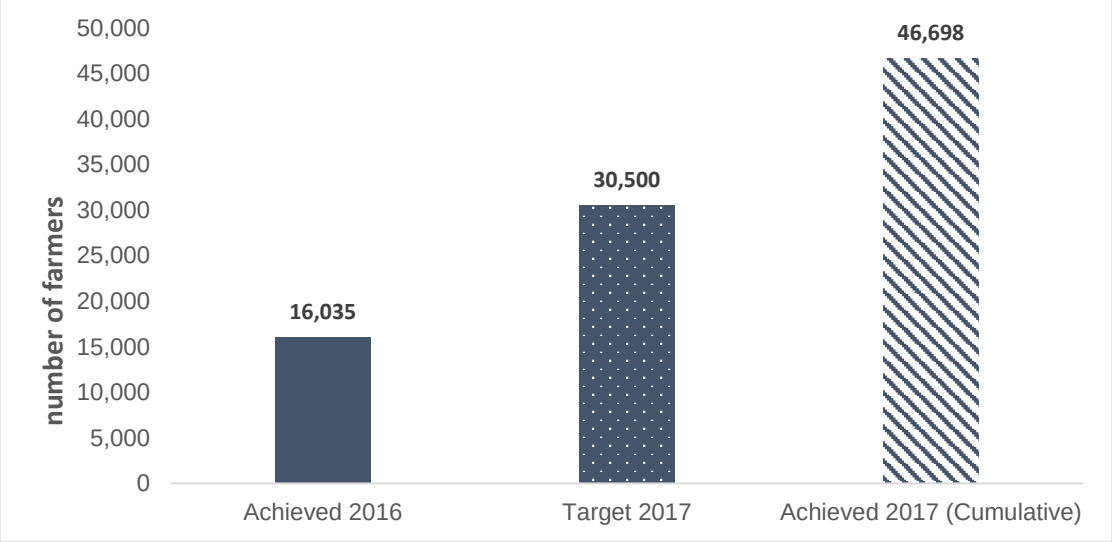


Figure 10. Number of farmers using labour-saving tools in 2016 (targeted and achieved).

In 2017, the project surpassed its target of farmers using labour-saving tools by 35% (Fig. 10). The service provider model will have to be assessed further for implementation in 2018.

1.3.4 Businesses established and led by women

A total of ten businesses are expected to be established and led by women by the end of the project in 2018; all to be established in 2017. Figure 11 shows the number of businesses established by women at project level and Figure 12 the number of women involved. Ten new businesses were established in Ghana, Tanzania, Kenya, and Nigeria making a total of 27 businesses established. These businesses include seed production (27%), bulking and marketing of grain legumes (38%), processing (31%), and livestock feed using residue (4%). There was also a 22% increase in the number of women involved with about 60% being in seed production. Livestock feed as a niche market was identified in Northern Ghana by one of the N2Africa PhD students (Daniel Akapo).

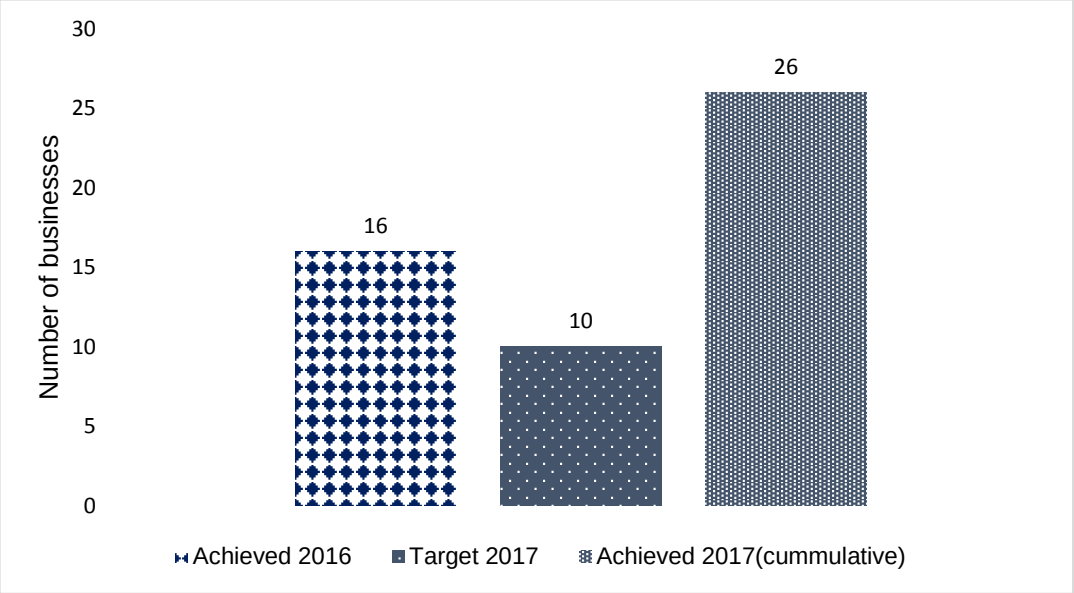


Figure 11. Number of businesses established by women in 2016 and 2017.

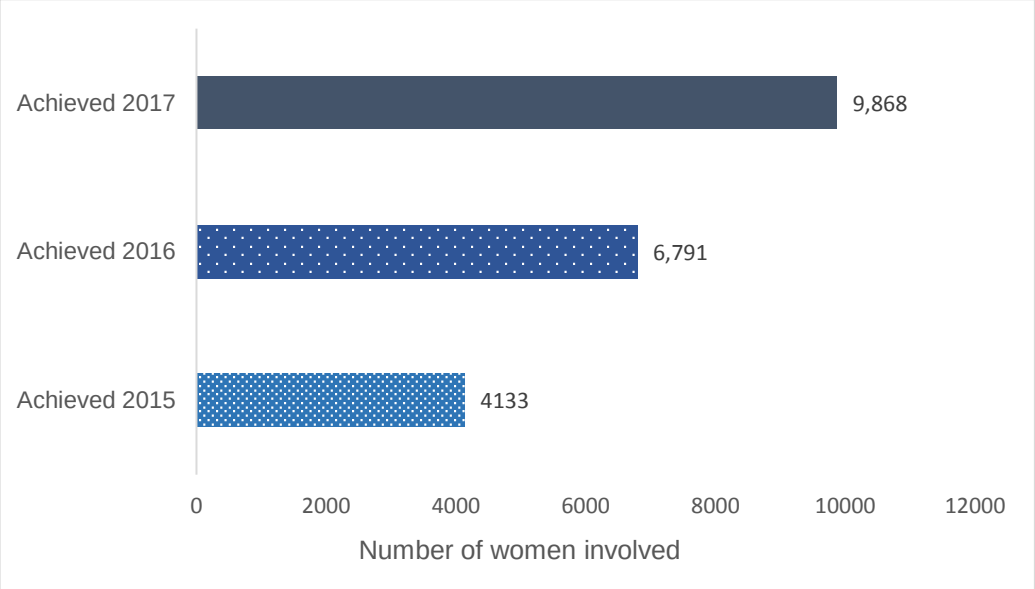


Figure 12. Number of women involved in the businesses: 2015, 2016, and 2017.

1.3.5 Engaging youth in agri-business opportunities within legume value chains

This section of the report focuses on the ‘’Youth engagement for profitable agribusiness and sustainable livelihood within the legume value chains” in the Borno State project. The report captures the enterprise activities of the targeted youth with the progress made so far because the intervention. This includes a strategic look into the key elements of the milestone.

To date, a total of 300 young people (42% female) have been directly trained and re-oriented to embrace agriculture and agribusiness as an income generating activity. The youth have been empowered (equipped with agripreneurship skills and starter packs), and are currently engaged in various agricultural value chain activities under the N2Africa project. Consequently 300 individual businesses and four cooperative business groups have been established along the grain legumes value chain. All the enterprises and business clusters are fully registered with the appropriate (national/state) regulatory agencies.

Accordingly, the youth agripreneurs through their business activities have created a total of 2,293 direct and downstream job opportunities for other men/women in the value chain, ranging from input supply to production, processing, and marketing activities around crops and livestock production activities. Specific progress was made in the following areas:

1) One hundred and fifty-three direct job opportunities created among graduates, and 147 among school leavers (usually the ''hard-to-reach'' category of the youth; and 1,993 downstream (permanent and casual) jobs in the grain legumes value chain.
2) Remarkable impact on labour-saving farm activities and participation of women through the introduction of the Spray Service Providers' (SSP) concept, and consequent provision of services particularly for women that constitute about 40% of the farmers reached in the project area.
3) A major industrial (processor) output market mandate (GCOML) was secured to mop up products while a sustainable input/output supply market is being institutionalized through the on-going CBN Anchor Borrowers Program (ABP) in the project area.
4) Establishment of three value chain based cooperative associations with an apex coordinating union.
5) About seventy-seven million naira (US$323,000) injected into the local markets/economy in business support package for the young beneficiaries with great multiplier effects for individuals and households in the project area.
6) Injected grants have been multiplied to the tune of about one hundred and fifty million naira in current investments value, representing liquid cash, savings, and physical assets within a period of 3 to 24 months of business activities.
7) Gradual accumulation of assets such as farmlands, livestock structures and equipment, grain processing mills, tricycles, shops/stores, etc., and indeed a growing business profile that can eventually stand as acceptable collateral for access to credit from financial institutions, which has hitherto been difficult.
8) Aside from other critical staple foodstuffs such as leaf and fruit vegetables, fish, and livestock products produced, about 364,300 kg of grain legumes and cereals (soyabean, cowpea, groundnut, maize, rice, sorghum) were produced and/or traded during the 2017 season, with significant impact on the inter-state and international grains market (Biu, Wandali/KwayaKusar, Gombe, Onitsha, Lagos) that are linked to the project communities.
9) Establishment of administrative and cooperative groups' operating offices for the youth agripreneurs in Maiduguri (Northern Borno) and Biu (Southern Borno) for sustainability beyond the projects' life span.
10) Establishment of online networking platforms for business promotions and continuity.
11) Successful linkage with Bank of Industry (BOI) for term loans under the Youth Empowerment Scheme (YES) program; and First City Monument Bank (FCMB) and Keystone Bank for special credit financing for the established grain processing mills for sustainability.
12) Established partnership with Olam Grains International and Keystone Bank for a special Youth Agripreneurs' farm settlement scheme for agribusiness production activities at scale, as an exit strategy.

The critical message at this stage therefore is that despite the difficult terrain of the project area, socio-economic stressors of an economy in distress, with galloping inflationary trends and associated challenges of business neophytes (young entrepreneurs); we can conveniently assert at this point that there is a steady progress in breaking the aura of drudgery and perpetual poverty associated with agriculture among the younger generation.

Thus, 300 trained and empowered young adults are currently employed in agricultural value chain business activities, with an average cost benefit-ratio (CBR) of 1:1.5, and are most importantly creating job opportunities for other young men and women in Borno State, Nigeria. Therefore, going at the current rate, by the grant end year of November 2018; it is envisaged that each of the empowered young people should, on average, create job opportunities for at least ten other young

men/women, leading to and/or surpassing the set milestone of job opportunities in agri-business for at least 2,000 of the youth in Borno State.

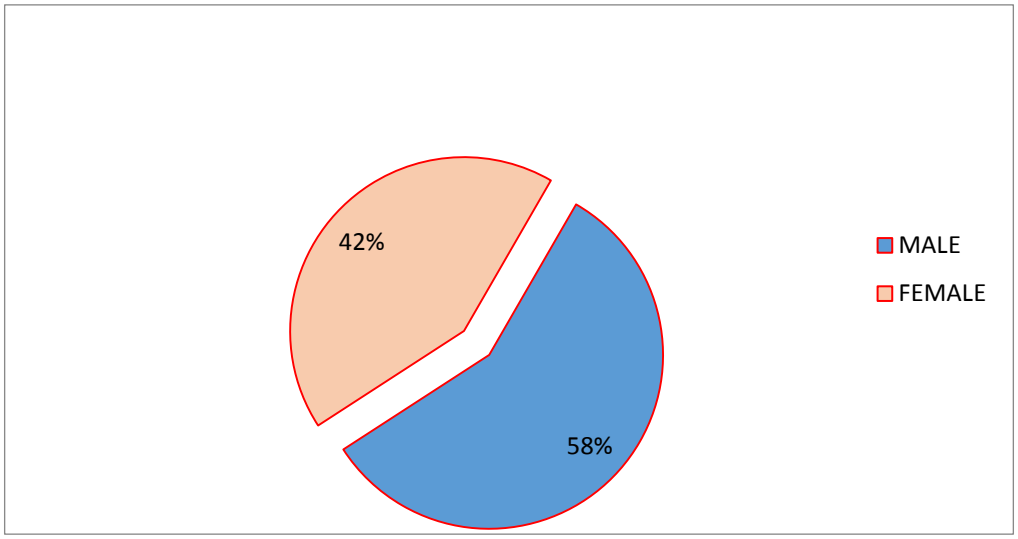


Figure 13. Participants by gender (without SSPs).

1.4 Tailor and adapt legume technologies to close yield gaps and expand the area of legume production within the farm

1.4.1 Diagnostic, demonstration, and adaptation trials

A total of 53 diagnostic trials were established in 2017 responding to key research questions, mostly about nutrient management (Table 11). A total of 1,454 demonstration trials were established focusing on disseminating a single technology or a combination. The demonstration trials showcased the best-best technologies to large numbers of farmers and are used to collect data on the performance of these technologies. Evaluation of these technologies is conducted with farmers to ascertain their preferred technologies which are used to reshape the technology packages to be accessed by farmers. Adaptation trials are small trials established and managed fully by farmers (with limited backstopping) to determine how technologies are adapted by farmers to their settings. Inputs that farmers received for these trials consisted of an improved legume variety with P-fertilizer and/or inoculants. In 2017, farmers established 25,071 adaptation trials. A selection of these adaptation trials was monitored to assess the performance of the technologies under the heterogeneous farmers' conditions and management. Table 11 gives an overview of the total number of trials established in the Core and Tier 1 countries in 2017.

Table 11. Total number of diagnostic, demonstration, and adaptation trials established per country in 2017.

	Diagnostic trials (#)	Demonstration trials (#)	Adaptation trials (#)
Ghana	8	261	1,679
Nigeria	-	445	5,148
Borno State	-	80	320
Ethiopia	34	79	2654
Tanzania	25	146	4,418
Uganda	20	170	13,506
DR Congo	-	47	-
Kenya	-	15	-
Malawi	-	116	-
Mozambique	-	-	-
Rwanda	-	111	-
Zimbabwe	-	50	-
Total	**87**	**1,520**	**27,725**

In the adaptation trials, mean legume yields varied from 300 to 2,600 kg ha-1 on the N2Africa plots, and from 400 to 2300 kg ha-1 on the own legume plots (measurements on 10 x 10 m plots) (Table 12). Mean yields significantly increased on all N2Africa plots compared with the own legume plots, except for Uganda (differences not significant). Farmers generally saw an increase of 300 to 800 kg/ha on the N2Africa plot compared with their own legume. In relative terms, farmers growing cowpea or bush bean in Tanzania and soyabean in Nigeria on average (more than) doubled their yields. Generally, more than half of the farmers had a yield increase of > 50% (except for Uganda). Note, however, that there is an experimental error associated with the use of measurements on sub-plots which may inflate the proportion of fields with more than 50% yield gain.

The lack of increase in legume yields on the N2Africa plots in Uganda may have been caused by dry spells in parts of the country which limited the number of trials that could be harvested and depressed legume yields (cf. yields of bush bean and soyabean). In Tanzania, the positive effect of the use of P-fertilizer in adaptation trials of cowpea was larger in Eastern Tanzania than in other parts of the country, suggesting that P-fertilizer is especially recommended on cowpea in this area.

Table 12. Preliminary results from adaptation trials in 2017.

Country	Legume	Mean yield N2A	Mean yield own	Mean absolute increase	LSD*	Mean relative increase	Proportion of plots with gains > 50%	Sample size
		kg ha^{-1}	kg ha^{-1}	kg ha^{-1}		%	%	N2Africa vs. own plot comparisons (#)
Ghana	Cowpea	1045	647	407	83	86	63	41
Ghana	Soyabean	1484	940	550	80	64	59	73
Nigeria	Soyabean	1369	656	713	126	144	80	10
Ethiopia	Faba bean	2205	1470	735	215	58	50	10
Tanzania	Bush bean	1603	849	753	87	126	76	80
Tanzania	Cowpea	1216	407	806	66	514	90	143
Uganda	Bush bean	322	425	-103	220	-16	20	5
Uganda	Climbing bean	2617	2272	346	384	37	21	29
Uganda	Soyabean	749	415	334	491	77	38	13

**Fishers Least Significant Difference test*

1.4.2 Recommendations for best-fit technologies

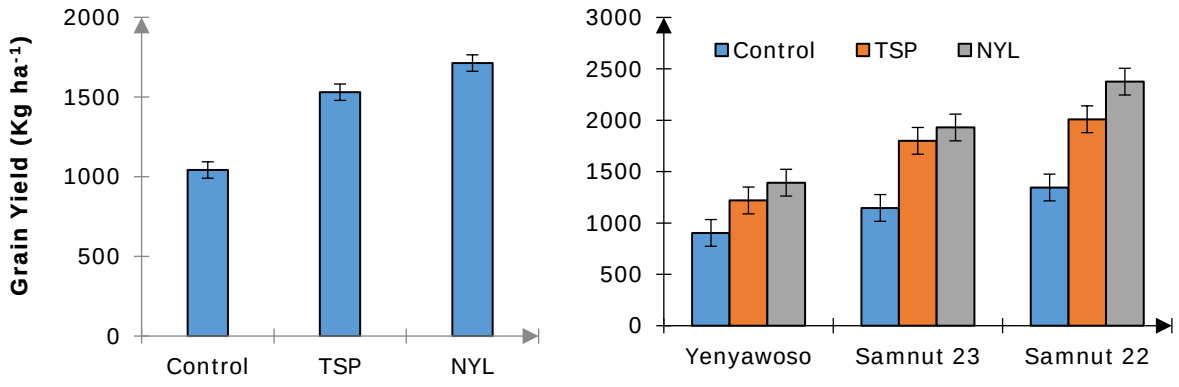
The combined results of yields and farmers' evaluations of diagnostic, demonstration and adaptation trials over multiple seasons led to the development of best-fit recommendations for the different legumes in the Core countries (Table 13).

Table 13. Best-fit recommendations for legume cultivation based on diagnostic, demonstration and adaptation trials.

Country	Legume	Treatment
Ghana	Cowpea	Varieties Padi-tuya (Upper West Region) or Wang-Kae (Upper East and Northern Regions); New Yara Legume fertilizer (250 kg NYL ha^{-1}, equivalent to 20 kg P ha^{-1})
Ghana	Groundnut	Variety Samnut 22; New Yara Legume fertilizer (250 kg NYL ha^{-1}, equivalent to 20 kg P ha^{-1})
Ghana	Soyabean	Varieties Afayak (farmer preferred) or Suongpungun in Upper East and Northern Regions, or TGX 1985-10E (early maturing) in Upper East and West Regions; New Yara Legume fertilizer (250 kg NYL ha^{-1}, equivalent to 20 kg P ha^{-1}); inoculants (7g kg^{-1} seed)
Nigeria	Soyabean	Varieties TGx 1951 - 3F; TGx 1955 – 4F; TGx 1904 – 6F or TGx 1835 – 10E; farm yard manure; SSP fertilizer; inoculants
Nigeria	Groundnut	P+K fertilizer
Ethiopia	Bush bean	P-fertilizer; inoculants

Ethiopia	Chickpea	P-fertilizer; inoculants; 30 kg ha^{-1} of S (northern Ethiopia)
Ethiopia	Soyabean	P-fertilizer; inoculants; 60 kg ha^{-1} of K_2O and 4.6 t ha^{-1} of lime (acidic soils in western Ethiopia)
Tanzania	Bush bean	Variety Lyamungu 90; NPK-fertilizer (0:52:34) at 47 kg ha^{-1} of P_2O_5; inoculants at planting (northern Tanzania)
Tanzania	Cowpea	Varieties Tumaini, Raha 1; P-fertilizer 20 kg^{-1} applied 1 week after germination depending on soil moisture (eastern and central Tanzania)
Tanzania	Groundnut	Variety Pendo; farm yard manure (5 t ha^{-1}); Minjingu Rock Phosphate (MRP) - organic hyper phosphate 28% P_2O_5 at planting, gypsum ($CaSO_4$) 100 kg ha^{-1} at flowering
Tanzania	Soyabean	Varieties Soya 2, Soya 4, Semeki; Line 8; P fertilizers (46 kg ha^{-1} of P_2O_5); inoculants)
Uganda	Soyabean	Variety Maksoy 3N; 15 kg ha^{-1} P (TSP); inoculants (200g 16kg^{-1} of seed)
Uganda	Climbing bean	NABE 12C; 2 t ha^{-1} farmyard manure, 15 kg ha^{-1} P (TSP-fertilizer)

In Ghana, New Yara Legume fertilizer (NPK, Ca, OMg2, OB; 4:18:13:14:2.8:0.3) was tested against TSP fertilizer. In all three legumes, New Yara Legume (NYL) resulted in larger yields than TSP (see examples for soyabean and groundnut (Fig.14). Yields of cowpea were also significantly larger with 1250 kg ha-1 for TSP and 1380 kg ha-1 for NYL (P< 0.05)). The difference in performance of cowpea and soyabean varieties in different parts of the country in both diagnostic and demonstration trials led to tailored recommendations about the suitability of varieties for different parts of the country. The early maturing soyabean variety TGX 1985-10E was outperformed by the other two improved varieties in terms of yield but was still considered suitable in case of late planting.



Soybean *Groundnut*

Figure 14. Grain yields of soyabean (left) and groundnut (right) without and with TSP or New Yara Legume (NYL) in Ghana

In Ethiopia, agronomic studies to develop recommendations for soils non-responsive to inoculation and P-fertilizer showed that additional application of 30 kg ha-1 of S (sulfur) was recommended for chickpea production in Northern Ethiopia, while combined application of K2O (60 kg ha-1) and lime (4.6 t ha-1) was recommended for soyabean production in acidic soils in Western Ethiopia.

In Tanzania, bush beans in Northern Tanzania with the combination of (N)PK fertilizer and inoculants resulted in the largest yields. Largest yields of groundnut were attained with a combined application

of farm yard manure, Minjingu Rock Phosphate (MRP), and a little gypsum. Farmers also gave a high rank to this treatment as these inputs are readily available and less costly to smallholder farmers. Aflasafe, a bio-control agent to control fungi producing aflatoxin was added on top of fertilizer treatments to assess the impact of agronomic practices on its efficacy. There were higher levels of aflatoxin contamination on groundnut from plots that were not treated with Aflasafe and no difference between two biocontrol methods as they both reduced aflatoxin levels up to about 95%.

In Uganda, diagnostic trials were conducted to identify the nutrients that are needed to close the yield gap related to soil fertility, as previous trials had shown that neither application of P and inoculation nor manure and P could close yield gaps of soyabean and climbing beans respectively. In soyabean, inoculation and lime resulted in significant increases in yields compared to the control or lime alone, and yields of inoculation and liming with P were significantly better (1526 kg ha-1) than without P (1,383 kg ha-1). The addition of K, N, Mg, Ca, and micro-nutrients did not result in a significant change in yield until manure was added, resulting in a maximum yield of 1872 kg ha-1. The economic viability of the nutrient combinations – particularly inoculants alone, inoculants + P, and inoculants + P + manure – should be assessed and related to farmers' capacity to purchase. Climbing bean grain yields showed significant responses to lime application and combined application of lime + P. This reiterates the need to manage soil acidity in the highland areas to improve climbing bean productivity. It could also explain the responses to manure and P application in some demonstration trials in previous years; manure probably playing some liming role. The liming contribution of manure needs to be evaluated, as manure could be a potential alternative option to agricultural lime in climbing bean production for those who can have access to it.

In 2017, we also captured the "learning pathways" that have led to changes in demonstration trials from 2014 up to 2017; describing the main reasons behind moving from best-bets to best-fits[7]. Common reasons to discard varieties in demonstrations were poor yields (often the result of increasingly irregular rainfall patterns). Introduced varieties were therefore in most cases selected based on their drought tolerance (early maturing varieties replacing late maturing varieties) and better yields. For groundnut, there was also a clear selection towards varieties with high oil content and with a good taste to accommodate market demand. Changes in inputs described specifically for 2017 were that LegumeFix was added to bush beans in demonstration trials in Tanzania because results elsewhere (Ethiopia, Rwanda) indicated a response to inoculation in common bean. In Ghana, TSP was replaced by New Yara Legume for fertilizing cowpea and soyabean. In Uganda, herbicide Beans Clean was introduced in 2015B to produce bush beans, climbing beans, and soyabean to reduce the labour intensity of weeding. Some weeds persisted after the application of Beans Clean so a stronger, broad-spectrum glyphosate herbicide was introduced in 2017 to use in combination with or instead of Beans Clean.

Feedback from farmers was very often the basis of changes. Evaluations with farmers are clearly necessary to steer practices towards best-fits within a regional context with its specific weather and market conditions. Other lessons learned from capturing these changes were the need for varieties that are more tolerant to changing and irregular weather conditions while still being high-yielding and marketable. The availability and accessibility of legume-specific inputs such as certain rhizobium strains (Ethiopia), TSP (Tanzania, Uganda) or DAP (Ethiopia) were often a problem, stressing the importance of networking with partners and of lobbying with policymakers.

1.4.3 Rhizobiology

The rhizobiology work in N2Africa continued its focus on the isolation, authentication, and evaluation of new strains for the target legumes. In Ghana, seven candidate rhizobium strains were identified for groundnut. A study was conducted to select and recommend elite strains from these seven strains to produce inoculants both for cowpea and groundnut. The results showed that isolate 2NAG 53e increased cowpea grain yield by as much as 65% compared with the control; isolate 2NAG 08e

[7] http://www.n2africa.org/content/tailoring-and-adaptation-n2africa-demonstration-trials

increased groundnut yield by 19% compared with the control. Thus, isolates 2NAG 52e and 2NAG 08e are further field-tested and could be recommended for local inoculant production.

In Nigeria, on-farm trials were set up to test seven rhizobium strains for soyabean, seven for cowpea, and six for groundnut in three locations per crop. A number of publications have appeared on this topic in 2017:

1. van Heerwaarden, J., Baijukya, F., Boahen, S., Adjei-Nsiah, S., Ebanyat, P., Kamai, N., Wolde-Meskel, E., Kanampiu, F., Vanlauwe, B., Giller, K.E. (2017). Soyabean response to rhizobium inoculation across sub-Saharan Africa: patterns of variation and the role of promiscuity. Agriculture, Ecosystems and Environment, in press, ISSN 0167-8809,

In Ethiopia, 195 new strains (50 common bean, 61 chickpeas and 74 faba bean) were collected from areas potentially suitable for growing the targeted legumes. In addition, 10 elite rhizobial strains (3 chickpea, 4 common beans and 3 faba bean) were evaluated for their symbiotic effectiveness across different locations. Some of the chickpea and common bean rhizobia were also genetically characterized as part of the PhD work. Common bean strain HB-A-15, characterized as best performing strain in trials in 2016, was used for 300 adaptation trials in 2017. Preliminary observation indicated that plots inoculated with HB-A-15 accomplished better than HB-429 (the strain currently used for commercial inoculant production) in many farms. This strain may replace or will be used along HB-429. The multi-locational variety x inoculant strain trials aimed to recommend the best rhizobia and legume variety combinations to different agro-ecologies. Preliminary results indeed revealed an interaction of the rhizobial strains with different varieties and locations. For instance, faba bean variety Dosha responded well to inoculation with FBW-145, while variety Wolki was better with FB-15 strain on a vertisol at Adadi. On a nitosol, however, variety Wolki yielded better with EAL 110 (commercial strain) than FB-15. A comprehensive analysis of these trials for all three legumes over two seasons still needs to be done. Eventually, the selected strains can be supplied to inoculant production company MBI for production. It needs to be noted, however, that different performances across location will have cost implications for inoculant production and marketing.

In Tanzania, 23 elite rhizobia strains (six for groundnut, seven for cowpea, seven for soyabean, and three for common bean) were tested. Common bean, cowpea, and soyabean showed a clear need for inoculation, but there were no significant differences in yields among the tested strains and elite strains did not outperform commercial strains. Groundnut responded to inoculation in the northern zone but not in the southern highlands. Strains MJR 493, SNN 343, and NC 92 recorded the largest yields. Trials will be repeated in 2018 to confirm these results.

The rhizobiology work in Uganda focuses on the identification of effective strains to produce common bean inoculants through PhD research. Partner Makerere University is engaged in the evaluation of strains for soyabean, cowpea, and groundnut under Africa-wide multilocational experiments coordinated by Nodumax.

1.4.4 Inoculant quality control

Standard Operating Procedures (SOPs) for quality control were prepared in collaboration with expert from the COMPRO project (a BMGF-funded IITA project for commercial products). SOPs cut across production (factory) to independent reference labs for product quality control along complete distribution channels. Like MIRCEN in Kenya, Kwame Nkrumah University of Science and Technology (KNUST) ensured that independent quality control was done on products (LegumeFix and Nodumax) distributed in Ghana. In Nigeria, quality control is done by N2Africa along distribution channels to document Nodumax product, although this should be done by NAFDAC (which benefited earlier from training on the topic).

The MIRCEN laboratory at the University of Nairobi, Kenya, is now a certified KEPHIS Bio-Fertilizer Testing Facility. Procedures for inoculant testing were developed in collaboration with N2Africa during Phase 1. The quality of the BIOFIX inoculant has been consistently controlled for the various host legumes including bean and soyabean. Tests followed N2Africa protocols for drop plating onto Congo Red YMA. Test results for 2017 revealed that the fraction of rhizobia in the BIOFIX products (for bean and soyabean hosts) always exceeded the minimum threshold (CFU > 1 x 109 per g) by a factor of 3.2 to 6.7. The contamination threshold was also consistently crossed (0.5 x 106 per g).

The contaminants were in most cases actinomycetes rather than other bacteria or fungi. Progress is being made, however, in the reduction of contamination through the following measures: (1) wetting of the carrier before sterilization to 60-65% of water-holding capacity, (2) applying a second round of autoclaving after 48 hours to allow for spores to germinate, and (3) avoiding over-loading the autoclave to improve exposure to pressurized steam. The BIOFIX that was acquired by the One Stop shops and others during the 2017 long rains season contained adequate rhizobia but the contaminants may pose a problem if it is stored without refrigeration.

In Nigeria, Nodumax packets were sampled in duplicate at distribution points of various agro-dealers in Benue and Abuja twice in one month during the 2017 cropping season. Quality tests were performed using the drop plate method. Rhizobia counts were above the minimum threshold in the mid-August sampling period (± 30 days from delivery to factory gate), showing that Nodumax packets contained proper rhizobia densities for adequate inoculation of soyabean seeds during the planting in August. Rhizobia counts in the Nodumax packages were sometimes below the threshold in the samples from mid-September (± 75 days from delivery to factory gate, after the planting period) in Benue State. This may have been the result of mismanagement of the inoculant package as some holes in the packages were observed.

The amount of contamination varied a lot and increased by roughly 103 cells per gram inoculant between the two sampling instances. The contaminants may have benefited from the warmer ambient temperatures during transportation and distribution as compared to the cool conditions at the factory.

In Ghana, KNUST has a laboratory for testing the quality of imported inoculants. Hence, samples of inoculants that were sold by GreenEf were sent to KNUST for a quality check before they were sold to farmers. Under the framework of the SARI inoculant production, an arrangement has been put in place for KNUST to perform a quality check on every batch of rhizobium inoculant produced under the venture.

No inoculant quality control exists in Ethiopia yet. There is a growing concern on quality of inoculants and effort is being made, in collaboration with MoA, to bring into effect quality control system.

In Uganda, quality control measures are now being implemented following the distribution chains to assess quality dynamics with handling and storage.

1.5 **Enable learning and assess impacts at scale through strategic M&E**

One of the key focuses of this objective is to provide feedback and ensure its integration into dissemination activities and research. One key area of such feedback has been farmers' evaluation of technologies. The Monitoring and Evaluation provides guidelines for the evaluation of technologies introduced to farmers. This guideline includes giving farmers an opportunity to select their own criteria to evaluate a treatment which includes improved varieties, fertilizer, inoculants, and good agricultural practices. Refer to Section 1.4.2 for integration of farmer feedback in shaping technology packages.

1.5.1 The N2Africa impact design

The project impact evaluation will be based on the theory of change and its related results framework with distinct results at output, outcomes, and impact levels. The design will combine both quantitative and qualitative methods to ascertain the impact of the project. The assessment of the baseline indicates the absence of relevant baseline data in different countries that include all the outcomes of interest against which the end-line is going to be compared. This has conditioned the type of approach to be used for the impact assessment. Areas of potential impact have been selected across all core countries regardless of the existence of baseline data. A mixed approach will therefore be used to collect data as well as to estimate impact. The quantitative methods will include the use of Propensity Score Matching (PSM) and Endogenous Switching Regression (ESR) to compare the beneficiaries with non-beneficiaries of the project. Due to the challenge of assessing the effects between the treated and non-treated using the PSM which focuses on observed

variables, the ESR will be used in addition to model the counterfactuals through the inclusion of an instrument in the survey tool to measure the unobserved.

With regards to qualitative methods, focus group discussions and key informant interviews will be used to collect additional information across areas that the impact evaluation might not cover and also areas where the project was implemented but the country teams do not expect observable change. These cases and the reasons for the lack of change will be assessed based on the experiences of country teams and partners, with additional focus group discussions with farmers and other key stakeholders where necessary. The assumptions underlining the theory of change will be tested here as well, forming the basis of the guiding questions. Also, institutional information and community level data will be collected using qualitative methods. Assessment of the effectiveness and efficiency of dissemination approaches and input supply strategies has been conducted in Tanzania, Ghana, and Nigeria. A similar study is to be done in Ethiopia, Nigeria and Uganda. These studies can serve as additional background information to the impact assessment.

2 Achievements in relation to project milestones

Table 14.Progress Key Milestones 2017

Milestone	Indicator	Cumulative target at grant end	Target 2017	Achieved 2017	% achieved target 2017
Objective 1					
1.3. Partners along the legume input and output value chains cooperate actively towards achieving the overall N2Africa goals.	Number. of partnerships developed and active.	32	32	68	over 100%
1.4.1. By Q3 of Year 1, an internal and external communication strategy developed	Communication plans	1	1	1	100%
1.5.1. By Q4 of Year 1, country-specific research and dissemination implementation plans formalized, including an exit strategy.	Number of specific research and dissemination plans formalized.	5	5	6	120%
1.7.1. By Q4 of Year 1, a research plan, engaging at least five PhD and 10 MSc candidates, developed.	Project-wide research plans to engage PhD and MSc students developed and number of PhD and MSc students (men/women) engaged.	1	1	1	100%
1.4. By Q4 of Year 5, at least 320 partners trained in N2Africa technologies and approaches.	Number of persons trained (gender-disaggregated data) in N2Africa technologies and approaches and number of N2Africa technologies (by type) in which the persons were trained. *(Note: Count the total number of persons trained from the*	320	320	ToT: 8,750 (34% women) Step down: 52,104 (43% women)	Over 100%

Milestone	Indicator	Cumulative target at grant end	Target 2017	Achieved 2017	% achieved target 2017
	collaborating partners for dissemination. Disaggregate data by gender).				
Objective 2					
2.2. Dissemination partners attain/surpass the anticipated number of households targeted and continue to engage in legume intensification post-project.	Number of target households (men/women) reached *(outcome level: these farmers continue to engage in legume intensification activities after participating in dissemination activities).*	555,000	415,000	553,802 (47% women)	over 100%
2.3. Local agro-dealers marketing fertilizers, seeds, and inoculants are aligned with grassroot producer groups and input wholesalers and manufacturers.	*Volume of seeds, fertilizers, and inoculants used per targeted producer group per land area, *Volume of seeds, fertilizers, and inoculants sold by agro-dealers.	6660; 11,100; 56	4620; 5075; 25	Seeds (3,399.4 tons); Fertilizers (1,551.8 t); Inoculants (15.4 t)	Seeds (74%); Fertilizers (31%) Inoculants (62%)
2.3.1. By Q4 of Years 1-4, at least two media events (e.g., radio, newspaper articles, field days, etc.) per country implemented.	Number of media events implemented.	50	40	116	over 100%
2.4. A pre-set (see Returns-on-Investment calculations) number of households engaged in the collective marketing and value addition of legume grains and value-added products.	Number of households (men/women) engaged in collective marketing, value addition of legumes, and value-added products. Volume of produce sold through collective marketing, volume of value addition products, and types of value added products.	275,000	195,000	149,818 persons with 46% women	77%

Milestone	Indicator	Cumulative target at grant end	Target 2017	Achieved 2017	% achieved target 2017
2.5.1. By Q4 of Years 1–4, inoculants available through public-private partnerships, through importation and/or local production, the latter facilitated by the inoculant production pilot plant.	Number of inoculant outlets in the target areas, volume of inoculants imported and/or produced in the identified outlets.	5	4	11 Volume imported/produced (55.67 tons)	275%
Objective 3					
3.2.2. By Q4 of Years 4–5, at least two businesses led by women established per country.	Number of businesses established and led by women & number of women involved in the businesses established.	10	10	27	Over 100%
3.3. Better knowledge of and access to household-level legume processing tools improve the nutritional status of women and children in at least two target countries.	Number of women using household-level legume processing technologies	5,000	4,000	12,000	Over 100%
3.4. Women use pre- and postharvest labour-saving tools, resulting in higher net profits from legume production and processing.	Number of women using pre- and postharvest labour-saving tools.	55,500	30,500	46,698	Over 100%
3.5.1. By Q4 of Year 3, relationships between grain nutritional quality and management/environmental conditions quantified.	Number of relationship equations quantified	5	5	Relationship equation not yet quantified. A study carried out on effects of N and P on two common bean varieties (Gloria and NUA 45), P alone, or N	In progress

Milestone	Indicator	Cumulative target at grant end	Target 2017	Achieved 2017	% achieved target 2017
				+ P at 20 kg/ha P and 40 kg/ha N in Zimbabwe Analysis of other crops is being done	
Objective 4					
4.1. Recommendations for the intensification of legume production result in at least 50% increase in legume productivity	Percentage change in legume productivity among target households participating in adaptation trials (early adoption instead of adaptation trials) Number of target households (men/women-headed) with 50% increased productivity through adaptation trials	275,000	195,000	-Range: 37% to over 500% for soyabean, groundnut, climbing bean, and cowpea; 20%-90% of plots (depending on crop/country) had yield gains of 50% and above in 2017 (16,518 farmers)	
4.1.2. By Q4 of Years 2–4, improved legume production recommendations integrated in the dissemination campaigns	Number of improved legume production recommendations (based on diagnostic trials) integrated in dissemination campaigns	15	15	19	Over 100%
4.2. Inoculant producers avail improved inoculant formulations for the target legumes resulting in at least 10% increase in legume productivity and BNF	Number of inoculant formulations applied/used by inoculant producers for target legumes in core countries (Productivity will be measured by milestone 4.1)	3	2	3 (soyabean, beans, and groundnut)	Over 100%

Milestone	Indicator	Cumulative target at grant end	Target 2017	Achieved 2017	% achieved target 2017
4.6.2. By Q4 of Year 5, elite strains used for inoculant production for beans groundnut, and/or cowpea	# new effective and elite rhizobia identified	6	6	920 candidate strains evaluated for chickpea, common bean, faba bean, and soyabean in Ethiopia, climbing bean in Uganda, common bean in Tanzania, and cowpea in Nigeria	In progress
4.8.1. By Q4 of Year 2, standard operating procedures of quality control (storage), product registration, and application of inoculants used by inoculant producers and retailers	Number of inoculant producers and retailers (public private suppliers) using standard operating procedures.	5	4	11	Over 100%
Objective 5					
5.1.1. Throughout the project, a strategic M&E framework provides timely feedback to learning and future planning	Existence of M&E framework that outlines the types of feedback for planning, and provides timely data	1	1	1	100%
5.2. Dissemination partners integrate effective and efficient dissemination approaches for legume technologies in their future development initiatives	Number of dissemination partners integrating effective and efficient dissemination approaches in their programs across target countries (Effectiveness and efficiency of dissemination approaches will be measured by Activity 5.6)	16	68 partnerships across the countries have integrated various dissemination approaches into programs		Refer to section 1.2.2 for effectiveness of dissemination approaches

Milestone	Indicator	Cumulative target at grant end	Target 2017	Achieved 2017	% achieved target 2017
5.5.1. By Q4 of Year 4, the relative important of G_L, G_R, E, and M understood for specific legumes and production environments and integrated in improved recommendations	Number of quantified relationships integrated in improved recommendations. Best-fit recommendations available to all target legumes in each country	16	8		In progress
5.7.1. By Q4 of Year 4, the sustainability of legume interventions for smallholder farmers evaluated through impact assessment studies	Project-wide impact assessment conducted with available report indicating level of sustainability of project interventions	1	1		The design for the impact assessment has been discussed and finalized. The study will be conducted in 2018 across all core countries (refer to section 1.5.1 for summary of the design)

3 Lessons learned

3.1 Tanzania

- Private input companies are willing and ready to invest in production of legume seeds as well as import and distribute inoculants but they lack capacity to explore the demand. As a result, the project has managed to involve two seed companies to produce and distribute improved legume seeds and one Fertilizer Company to import and distribute inoculants. Along with this, N2Africa, in collaboration with partners has designed the model to promote input use that involve Village Based Agricultural Advisors (VBAA) and Community Volunteers (CV) that will be tested in 2018.
- Availability of various extension materials on legume technologies (protocols, manuals, leaflets, and technology briefs) at different extension offices for reference is crucial for continued use of disseminated technologies. We have observed frequent changes of extension staff in various partner institutions where the new staff lack knowledge on legume production. The referred materials would be used by new extension officers to acquire knowledge even after the project has ended.

3.2 Uganda

- Sustainability of the partnerships hinges on tangible benefits from the grain legume technologies. So far, the seed producers are able to link easily with the foundation seed producers and this will continue. Likewise, linkage to inoculant producers is slowly growing but challenged by the delicate nature of inoculants and a lack of articulated demand warranting large trade. Business cases showing the real benefits need to be articulated and so continued support to develop a system for demand forecasting is necessary from the project side
- So far only seeds seem to be important to producers; they have limited interest in mineral fertilizers because they perceive them to be costly. Sustainable input supply will depend on sustainable market outlets and this has been seen from the efforts to find a market for common bean seeds leading to increased production over the years. A continued effort to identify suitable market linkage models is a key strategy in the final year of the project. PICs bags, although considered expensive, have been in high demand by smallholders and the micro-entrepreneur model has helped in their wider dissemination and uptake in the project regions. This now must be integrated with village agents for sustainable supply and needs a business model to be established between NECOFAM and Village agents.

3.3 Ghana

- Public-Private Partnership and joint experimentation with YARA, a fertilizer manufacturing company in Ghana, have resulted in the development of a fertilizer blend for legumes. Through lobbying and advocacy with MOFA, this fertilizer blend has been adopted by the Ministry as fertilizer for legumes and has been included in the government's fertilizer subsidy program.
- The PPP arrangements with the input companies (YARA, Heritage Seed, and Greenef Company) have resulted in the increase in input use by farmers. Upon the request from MOFA, our seed company partners have been linked to the Ministry for the supply of soyabean seeds for its soyabean production program.

3.4 **Rwanda**

- An enabling political/policy environment is very important for the sustainability of interventions, e.g., the national policy on mineral fertilizer distribution, land consolidation, and crop intensification program has facilitated the scaling-up of BNF technologies in Rwanda.

3.5 **Nigeria and Borno State**

- Demand uncertainty is a major constraint in linking producers with input and output markets.
- Provision of tangible starter pack, soon after training, is critical to business take-off, while access to bank credit is important to growing the business of the young people.
- Young adults of non-agricultural background could be productive and earn good income and livelihood in the sector, if properly trained and motivated.

3.6 **Mozambique**

- Mozambique is a large relatively sparsely populated country with limited road infrastructure which has implications for the prices of inputs for smallholder farmers. The current voucher intervention could consider the inclusion of more legume crops as well as its expansion to remote areas. To address the limited network of agro-dealers, we propose a direct support to emerging entrepreneurs who can support marketing efforts of input supply companies either directly or through larger agro-dealers.
- Despite the positive impact of P-fertilizers in boosting legume productivity, mineral fertilizers are expensive in Mozambique. The country could make a substantial contribution in reducing fertilizer costs through exploration of existing phosphate rock which can be used to produce P.

3.7 **Kenya**

- It is important that inoculant producers and distributors should understand the role of quality assurance and be willing to pay modest fees to have their products tested. Laboratories providing these tests must issue their results in a way that is understandable for inoculant suppliers and their customers. The quality of threshold of > 1 x 109 rhizobia g-1 is readily achieved using locally available technologies but suppressing contaminants has proven to be more difficult.
- The paradigm shift in technology dissemination during 2017 from working at the grass roots level to supporting "last mile" agro-dealers was timely and necessary. Many farmer groups were eager to begin commercial input supply to their members and communities and input distributors are ready to supply them.
- Isolated grain legume farmers find it difficult to market their produce, even when they develop local collection points. It is through coordinating these collection points that sufficient quantities are bulked to interest top-end buyers. Branding farmers' soyabean in standard 50 kg bags assists marketing operations but too few buyers are willing to pay higher prices for the best quality soyabean.

3.8 **Malawi**

- For soyabean, yield increases of 27% were achieved in inoculated plots compared with non-inoculated plots. Largest yields were obtained through a combination of Nitrofix inoculant and organic manure.

- An average yield increase of 52% in groundnut and 54% in cowpea was achieved on double-row planted plots versus single-row planted plots (the standard practice).

3.9 **Ethiopia**

- Corrective measure for non-responsive soils are possible: diagnostic trials on non-responsive soils revealed that application of the recommended amount of Sulfur (S) fertilizer for chickpea in Northern Ethiopia and Liming and Potassium (K) fertilizer for soyabean on acid soils in Western Ethiopia enhance yields of the respective crops.
- Computer Aided Telephone Interview (CATI) revealed that smallholder farmers are willing to buy technology (improved seeds, inoculants, pesticides etc) if this is made available timely. However, the input supply system (the service providers) should be in place.

4 Opportunities

4.1 Ghana

- Introduction of the government flagship program Planting for Food and Jobs has provided a platform for farmers to obtain legume inputs. The programme which is providing subsidies for soyabean inputs will increase the productivity of legume farmers. The integration of legume inputs such as improved varieties and legume fertilizer made it easier for farmers to obtain inputs.
- Presence of development projects targeting legumes contributes to the scaling of technologies to many more farmers. They also provide leverage in terms of resources to reach out to more farmers.

4.2 Uganda

- Development of market chains with partners. This requires networking and providing evidence.
- Closing input and output market gaps by developing a brokerage system to support knowledge and information sharing and inclusion of last-time delivery mechanisms.
- Identify alternative markets for beans: organize farmers to produce fresh beans which fetch a higher price than dry grain and link them with the niche markets in urban centres such as Kampala.
- Integration of value chains within cropping systems through the work with other partners (e.g., IFDC).

4.3 Nigeria

- Abundant commercial gaps exist in the grain legumes value chain, and available input and output markets can be explored. Farmers and agro-dealers are to be assisted to use these opportunities.

4.4 Borno State

- Farmers and communities are asking to be involved after seeing the benefits of the technologies among N2Africa contact farmers, and many have started to adopt the technologies. More farmers will be included in the project to accommodate the demand.
- Several agricultural finance schemes and the youth in agribusiness initiatives are available to leverage. Young adults are to be informed about this opportunity.

4.5 Ethiopia

- Increasing popularity and demand of inoculants: increased involvement of ILRI-N2Africa in business facilitation/deals between MBI and Farmers' Cooperative Unions; increased private sector inoculant production capacity of with due attention given to maintaining an acceptable level of quality product
- Inoculant and seed demand/supply information system strongly required by private seed and inoculant companies. The fertilizer supply/demand information is enforced by the government and confirmed by Farmer Cooperative Unions. Government needs to be aware that a similar structure is needed for seed and inoculants.
- Increases in market prices for especially chickpea and soyabean enhances farmers' interest in legume cultivation. Legume values chains to be strengthened through existing PPP platforms.

5 Challenges

5.1 Tanzania

- There was a lack of a market for soyabean attributed to the government instituting VAT on animal feeds. This led to an increase in prices of animal feeds which consequently reduced the demand. According to animal feed manufacturers, they could not process soyabean purchased in 2016 as there was no demand for animal feeds. However, the Tanzania government has reversed its decision and slowly soyabean demand is on the increase.
- Late onset of the season and poor rain distribution in central Tanzania leading to low yields of both cowpea and groundnut.
- Labour-saving tools appropriate for the smallholders are not readily available in the country and those available require large cost outlays beyond the reach of our target farmers.
- Price falls dampen efforts to scale up and out the use of grain legume technologies and this is sometimes due to factors beyond project jurisdiction. East African markets are connected and political instability can drastically affect marketing as we saw with the price of soyabean crashing in Uganda during the elections in Kenya.

5.2 Ghana

- Low producer price of grain legumes, particularly soyabean due to importation.
- Poor grain yield resulting from erratic rainfall and shortening of the growing season.

5.3 Borno State

- The inability to expand project interventions due to insurgency is hampering the scaling of the technologies to more farmers as requested by the communities.

6 Summary exit strategies Tier 1 countries

6.1 DR Congo

N2Africa's exit strategies in DRC are centred on the soyabean value chain in North and South Kivu through three initiatives. The first of these furthers more collaboration with youth agripreneurs and small soyabean producers. These partners are grouped and linked to big processing plants such as Centre Olame and Maizeking. Centre Olame and Maizeking provide the farmers with good-quality seeds, ensuring a good-quality soyabean product to process. In the second initiative, four youth organizations active in soya agribusinesses decided to build a consortium: The Youth Agripreneurs Soy Value Chain. This collaboration will strengthen soyabean production and processing. Each organization brings something different to the table, such as processing soyabean oil; collective marketing and delivery of produce to processing plants; breeding and sales of eggs and chickens for which side-products from soyabean processing can be used as components of poultry feed and the sale of soyabean products. In the third initiative, sustainable input supply for soyabean will be ensured through the sales of small quantity input packages of 1 to 5 kg by farmer groups in their shops. Moreover, private-sector seed companies AGRIFORCE and Shalom, and the bio-fertilizer company LOBIKO are gathered in local business networks to bring sellers closer to farmers. New small input shops were set up so that inputs are available to every farmer group. N2Africa facilitated in the soyabean value chain mainly by linking soyabean farmers and through capacity building on the topic of market access and marketing. A strong network will ensure continuity.

6.2 Kenya

In the final year of N2Africa in Kenya, a paradigm shift from community-based outreach to "last-mile" agro-dealer support was undertaken. This allowed for BNF product testing by customers and outreach via open houses. One of the great advantages to BNF technology promotion in Kenya is that inoculants, blended fertilizers, and seeds of improved legume varieties are available as products from the private sector. N2Africa worked with stakeholders to ensure that these technologies were available to farmers through our agro-dealer network and outreach partners. Close collaboration continued with the University of Nairobi MIRCEN in all areas of rhizobiology. MIRCEN will continue to provide independent testing of bio-fertilizers and legume inoculants.

Three kinds of stakeholder partnerships established by N2Africa in Kenya will continue: a) profitable input supply, b) profitable processing and trade in soyabean, and c) continued networking among stakeholders and extension service providers. MEA Ltd will continue to manufacture BIOFIX legume inoculant and Sympal to produce legume fertilizer and package these inputs into sizes appropriate for investment by small-scale farmers. Agriseed (SeedCo) Ltd will continue to produce and market soyabean seed that are suitable for different food and industrial purposes, and actively market them to small-scale farmers. Agriseed also distributes Bayer's RhizoLiq Top liquid inoculants. The Western Kenya Soybean Seed Growers for Community Seed Bulking will continue to assist in community-based seed production. County-level agricultural extension in key soyabean production areas will link with these input suppliers and distribution channels. N2Africa's dissemination strategy in Kenya during the final year focused upon the establishment of the One Stop Shop Operation Mechanism (OSSOM). This mechanism combined 15 "last-mile" One Stop Shops that stock and sell legume production inputs as well as providing extension services for legume crop production. These shops were strategically linked to farmer associations and county extension services. Many of these shops not only market inputs but also coordinate local commodity collection points and operate value-added processing facilities.

Recently, linkages to two R&D programmes were forged. These are Kenya Industrial Research and Development Institute that established three accredited soyabean processing factories open to tenancy agreement, and the Kenya Agriculture and Livestock Research Organization (formerly known as KARI) that operates an accredited seed grower network, as well as conducting research on legume production. The latter programme permits community-based organizations to produce accredited legume seeds, a much-needed development. The Deputy President's Office has established a soyabean Task Force to oversee commercial production of soyabean through county governments. OSSOM serves as a member of that Task Force. The Ministry of Industrialization is providing services on soyabean product development and offering common manufacturing facilities for commercial processing and packing of certified soya products by small businesses for a nominal fee. OSSOM members take advantage of this opportunity to produce a range of licensed soyabean-based food products. In Kenya both BNF input manufacture and grain legume processing are fully commercialized, in part through eight years of assistance from N2Africa, and the exit strategy largely depends upon their continuation.

6.3 **Malawi**

N2Africa in Malawi has worked on technology dissemination, input supply, output marketing, and community seed production with partners such as government's Department of Agricultural Extension Services - District Agriculture Development Offices (DAES-DADOs), World Vision (WV), Catholic Relief Services (CRS), National Smallholder Farmers Association of Malawi (NASFAM), Agro-Input Suppliers Limited (AISL) and Inter-church Organization for Development Cooperation/Churches Action in Relief and Development (ICCO/CARD).

Smallholder farmers under DAES-DADO will be the driving forces at grass root level in the continuation of dissemination of technologies under the guidance of Lead farmers and supervision of AEDCs/AEDOs. At a review and planning meeting held in November 2017 in Lilongwe, officers from these DADOs lined up activities such as mounting demonstrations by Lead farmers, conducting field days, and facilitating exchange visits as some of the major highlights in the 2017/2018 season. The partnership between N2Africa and AISL, a private sector firm, should ensure the scaling-up of the production of inoculant. N2Africa trained two technicians from AISL at the IITA Ibadan labs and the inoculants have been widely tested and proved to be effective in increasing soyabean yields in Malawi. In the previous 2016/2017 season, AISL sold more than 200,000 sachets of the rhizobium inoculant in Malawi. It is expected that production in the current 2017/2018 will exceed 500,000 sachets of inoculant branded as Nitrofix, reaching over 10,000 farmers and covering over 7,000 ha of land.

Through the four cooperatives established under ICCO/ CARD's watch and having built the capacity of the cooperatives' members, there are high chances of continuity in their activities of areas of soyabean production and collective output marketing. Farmers belonging to the seed production association intend to add value to their seeds through packaging and branding. CARD aims to ensure that the cooperatives continue their activities by linking them to big agro-dealer companies such as Farmers World, Sunseed Oil Co, and others.

6.4 **Mozambique**

Towards the end the N2Africa project focused on a "business-led" approach. This involved engaging government, development organizations, and the private sector, creating awareness on N2Africa technologies and approaches, and facilitating dissemination campaigns. The project focused on soyabean and cowpea agronomy, input supply systems, and local capacity building for government extension officers, agro-dealers, and individual community seed producers.

Access to new seed varieties is a common and long-standing stumbling block for smallholder farmers in Mozambique. Working with seed companies, smallholder farmers' associations, and rural agro-dealers, N2Africa helped farmers in remote areas in evaluating the performance of soyabean and cowpea varieties while building long-term sustainable supply chains. In a remote community of Angónia district, Maria Brigida Miguel Noé is an emerging entrepreneur who has benefited from N2Africa and is making progress in removing the stumbling blocks. Trained by N2Africa on good agricultural practices for soyabean production she is now commercializing seeds for other farmers. Maria is one example of how N2Africa works towards Objective 3 of the project: Empower Women to increase benefits from legume production.

While inoculants have proven to have high return on investments, inoculant quality is also of major importance. To address the issue of inoculant quality control, N2Africa purchased and equipped a rhizobiology laboratory that was donated to IIAM, the main government research institution in Mozambique. Two newly recruited IIAM technicians will be trained and supported by Dr Amaral Chibeba, a former N2Africa PhD awardee, at IITA-Mozambique on basic aspects of inoculant control.

6.5 **Rwanda**

BNF technologies promoted by N2Africa in Rwanda were centred on two legume species: common bean (bush and climbing), and soyabean. The policy environment of Rwanda is very favorable to ensure the continuity and sustainability of BNF technologies introduced/promoted by N2Africa partners. Examples are the crop intensification program (CIP), the input distribution network, especially for mineral fertilizers, and an extension system (Twigire Muhinzi) which is like the demonstration plots used by N2Africa and managed by Master/Lead farmers. The main challenge met is the popularization of legume inoculants, which are being produced and distributed by a government institution (Rwanda Agriculture Board – RAB). With the end of N2Africa, the chance becomes small that farmers will still have access to inoculants. There is a crucial need to ensure transition from the government institution to private institutions for the production and distribution of legume inoculants at a large scale. The role of the government would be to ensure quality control.

6.6 **Zimbabwe**

Beginning from January 2016, the N2Africa team in Zimbabwe sought to place extension and other stakeholders at the forefront, with the role of core project staff limited to technical backstopping. The project sought to reach new farmers using fellow farmers as 'new 'experts' for technology dissemination. These successful farmers became hotspots for local dissemination of technologies into the future. We actively ensured that district-level extension planning mainstreamed grain legume production, including a dedicated session on grain legumes at ward and district-level agricultural shows. The confidence-building measures we adopted in working with local partners are part of our vision for the sustained use of technologies before the active N2Africa project period ends.

Smallholder farmers have often failed to reach large-scale buyers, such Olivine Industries in Harare, owing to the small volumes per transaction that are associated with large transaction costs. Training in collective marketing and the formation of viable community marketing associations have removed this constraint. Organization of training activities on collective action was anchored at the local level, a necessary recipe for sustainability.

Zimbabwe's economy has a huge agrarian inclination. This is one of the reasons why the Soil Productivity Research Lab (SPRL) has been continuously supported by governments since the 1960s to ensure that the country has sufficient inoculants. N2Africa has supplied some critical equipment to the laboratory and gave opportunities to local staff for training on current inoculant technology practices. The direct and mutual relationships that SPRL and seed

companies have natured over the past few years are likely to fuel sustainability. Independent technology dissemination by partners, especially through demonstration trials by seed companies, will continue in different farming communities.

While the University of Zimbabwe has been leading the project during Phase II, it is important to highlight that the University is a local institution that will continue research and dissemination activities as most of the research is done on-farm. Through N2Africa, a lot of interest on grain legumes has been created among faculty and graduate and undergraduate students. This is the greatest hope we have – enhanced human capacity is the gateway to the future!

Appendix I – Overview of active partnerships

Table 15. Active public-private partnerships in 2017.

Country	N2Africa lead partner	Type of organization*	Type of partnership**	Main areas of support***
DR Congo	PAD	NGO	Cooperative/Collaboration Agreement	Capacity building, technology dissemination
DR Congo	Plantations Ndagano	NGO	Cooperative/Collaboration Agreement	Seed multiplication, Capacity building, technology dissemination
Ethiopia	Menagesha Biotech Industry PLC (MBI) – AGRA-SSTP	Private Organization	Grant Agreement	Dissemination, Input Supply, Market linkage, Capacity building
Ethiopia/Chewaqa	International Fertilizer Development Centre (IFDC)—2SCALE Project	NGO	Cooperative/Collaboration Agreement	Dissemination, Input Supply, Market linkage, Capacity building
Ethiopia/Chewaqa	Anno Agro Industry Plc.	Private Organization	Subcontract under collaborative agreement	Seed supply
Ethiopia/South East	Bale Green Spice and Development Plc. (BSGD)	Private Organization	Cooperative/Collaboration Agreement	Dissemination, Input Supply, Market linkage, Capacity building
Ethiopia/South East	Bale Green Spice and Development Plc. (BSGD)	Private Organization	Subcontract under collaborative agreement	Capacity building, Input Supply, Market linkages, Dissemination
Ethiopia/Chewaqa and South East	Oromia Agricultural Research Institute (OARI)	Research Institution	Subcontract under collaborative agreement	Dissemination
Ethiopia/Central Shoa	SNV/Agriterra-Cooperatives for Change (C4C)	NGO	Cooperative/Collaboration Agreement	Dissemination, Input Supply, Market linkage, Capacity building
Ethiopia/Pawe	Ethiopian Institute of Agricultural Research (EIAR)–Pawe Agricultural Research Centre	Research Institution	Cooperative/Collaboration Agreement	Dissemination, Input Supply, Market linkage, Capacity building
Ethiopia / Central Shoa and Pawe	Ethiopian Institute of Agricultural Research (EIAR)	Research Institution	Subcontract under collaborative agreement	Dissemination
Ethiopia/Jimma	Facilitator for Change (FC)	NGO	Cooperative/Collaboration Agreement	Dissemination, Input supply, Market linkage, Capacity building
Ethiopia/Jimma	Facilitator for Change (FC)	NGO	Subcontract under collaborative agreement	Dissemination, Input supply, Market linkage, Capacity building
Ethiopia/South	Hawassa University (HwU)	Research Institution	Cooperative/Collaboration Agreement	Dissemination, Input supply, Market linkage, Capacity building
Ethiopia/South	Hawassa University (HwU)	Research Institution	Subcontract under collaborative agreement	Dissemination, Input Supply, Market linkage, Capacity building

Country	N2Africa lead partner	Type of organization*	Type of partnership**	Main areas of support***
Ethiopia/South	Soddo Catholic Secretariat (SCS)	NGO	Subcontract under collaborative agreement	Capacity building, Input supply, Market linkages, Dissemination
Ethiopia/North	Tsehay Multi-Purpose Cooperative Union (Tsehay Union)	Other	Cooperative/Collaboration Agreement	Dissemination, Input Supply, Market linkage, Capacity building
Ethiopia/North	Amhara Region Agricultural Research Institute (ARARI)	Research Institution	Subcontract under collaborative agreement	Capacity building, Input supply, Market linkages, Dissemination
Ghana	Evangelical Presbyterian Development and Relief Agency YENDI (EPDRA-Yendi)	NGO	Subcontract	Capacity building, Input supply, Market linkages, Dissemination
Ghana	Urban Agriculture Network (UrbANET)	NGO	Subcontract	Capacity building, Input supply, Market linkages, dissemination
Ghana	Sungbawiera Foundation (SBF)	NGO	Subcontract	Capacity building, input supply, market linkages, Dissemination
Ghana	CSIR-Savanna Agricultural Research Institute, Ghana (SARI, Ghana)	Research Institute	Subcontract	Capacity building, input supply, market linkages, dissemination
Ghana	Kwame Nkrumah University of Science and Technology (KNUST)	Government Organization	Subcontract	Rhizobiology, Evaluation of non-responsive soils
Ghana	The Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance (ACDI/VOCA)	NGO	Cooperative/Collaboration Agreement	Dissemination, Input supply, Market linkage, Capacity building
Ghana	Green-Ef Eco-Business Village Limited (Green-Ef)	Private Organization	Cooperative/Collaboration Agreement	Input supply and ICT information management
Ghana	CABI-IITA: Gender and the Legume Alliance: Integrating multi-media communication approaches and input brokerage (GALA)	NGO	Cooperative/Collaboration Agreement	Dissemination, Input supply, Market linkage, Capacity building
Kenya	Annapolis Wonder Enterprises (AWE)	Private Organization	Subcontract	Market LInkage, Technology dissemination
Malawi	Agro-Inputs Suppliers Limited (AISL)	Private Organization	Cooperative/Collaboration Agreement	Capacity building, Input supply, Market linkages, Technology dissemination
Mozambique	The National Cooperative Business Association. CLUSA International (NCBA CLUSA)	NGO	Cooperative/Collaboration Agreement	Capacity building, Technology dissemination
Nigeria	Kaduna State Agricultural Development Project (KADP)	NGO	Subcontract	Dissemination
Nigeria	Niger State Agricultural and Mechanization Development Authority (NAMDA)	Government Institution	Sub-Contract	Dissemination

Country	N2Africa lead partner	Type of organization*	Type of partnership**	Main areas of support***
Nigeria	CRS Support to Vulnerable Households for Accelerated Revenue Earnings (CRS-SHARE)	NGO	Cooperative/Collaboration Agreement	Dissemination, Input supply, Market linkage, Capacity building
Nigeria	CRS Support to Vulnerable Households for Accelerated Revenue Earnings (CRS-SHARE)	NGO	Subcontract under collaborative agreement	Dissemination, Input supply, Market linkage, Capacity building
Nigeria	Institute for Agricultural Research (IAR) Ahmadu Bello University, Zaria	Research Institute	Subcontract	Diagnostics
Nigeria	Abednego Youth Development Foundation (AYDF) under the IFDC-2SCALE Project	NGO	Subcontract/Cost share	Dissemination, Input supply, Market linkage, Capacity building
Nigeria	The Inventive Minds (TIM) - Makurdi – Benue under the IFDC-2SCALE Project	NGO	Subcontract/Cost share	Dissemination, Input supply, Market linkage, Capacity building
Nigeria	The Inventive Minds (TIM), Gboko, Benue under the IFDC-2SCALE Project	NGO	Subcontract/Cost share	Dissemination, Input supply, Market linkage, Capacity building
Nigeria	Palm Valley Nigeria Limited (PVNL) under the IFDC-2SCALE Project	Private Organization	Subcontract/Cost share	Dissemination, Input supply, Market linkage, Capacity building
Nigeria	Palm Valley Nigeria Limited (PVNL) under the Millennium Village Project	Private Organization	Subcontract	Dissemination, Input supply, Market linkage, Capacity building
Nigeria	Hybrid Agro-business Consultant Limited (HABC) under the IFDC-2SCALE Project	Private Organization	Subcontract/Cost share	Dissemination, Input supply, Market linkage, Capacity building
Nigeria	Federal University of Technology Minna (FUT Minna)	Research Institute	Subcontract	Diagnostics
Nigeria	Bayero University Kano (BUK)	Research Institute	Subcontract	Diagnostics
Nigeria	EGALF Ventures Limited (EGALF)—MARKETS-II	Private Organization	Subontract under collaborative agreement	Dissemination, Input supply, Market linkage, Capacity building
Nigeria	Intrio Synergy Limited (ISL)	Private Organization	Subcontract/Cost share	Dissemination, Input supply, Market linkage, Capacity building
Nigeria (Borno)	The Borno State Agricultural Development Project (BOSADP)	NGO	Subcontract	Dissemination, Seed systems, Market linkages
Nigeria (Borno)	Leventis Foundation	NGO	Subcontract	Capacity building—Spray service providers (SSP_
Nigeria (Borno)	Intrio Synergy Limited (ISL)	Private Organization	Subcontract/Cost share	Dissemination, Input supply, Market linkage, Capacity building
Tanzania	Nelson Mandela Africa Institute of Science and Technology (NM-AIST)	Research Institute	Subcontract	Rhizobiology
Tanzania	Farm Radio International (FRI)—Scale up of improved legume technologies through	NGO	Cooperative/Collaboration agreement	Dissemination, Input supply

Country	N2Africa lead partner	Type of organization*	Type of partnership**	Main areas of support***
	sustainable input supply and information systems (SILT)			
Tanzania	Farm Radio International (FRI) - New Alliance ICT Extension Challenge Fund: Up-scaling of interactive information and communication technologies to increase uptake of agricultural innovations in Tanzania (UPTAKE)	NGO	Cooperative/Collaboration agreement	Dissemination
Tanzania	CABI—Renewal of Africa Soil Health Consortium (ASHC-II)	NGO	Cooperative/Collaboration agreement	Dissemination, Input supply, Market linkage, Capacity building
Tanzania	Catholic Relief Services (CRS) – Soya ni Pesa Project	NGO	Cooperative/Collaboration agreement	Dissemination, Input supply, Market linkage, Capacity building
Tanzania	Rural Urban Development Initiatives (RUDI) - Integrated Project to Increase Agricultural Productivity in the Breadbasket Area of Southern Highlands of Tanzania Project	NGO	Cooperative/Collaboration agreement	Dissemination, Input supply, Market linkage, Capacity building
Tanzania	Clinton Foundation Imitative (CDI) - Farmers First: Building a Path Out of Poverty in Tanzania and Beyond / The Anchor farm Project	Private Organization	Cooperative/Collaboration agreement	Dissemination, Input supply, Market linkage, Capacity building
Tanzania	Agricultural Research Institute, Makutupora (ARI Makutupora)	Research Institute	Subcontract	Dissemination, diagnostics
Tanzania	Agriculture Research Institute -Uyole (ARI-UYOLE)	Research Institute	Subcontract	Dissemination, diagnostics
Tanzania	FAIDA MARKET LINK (FAIDA MaLi)	NGO	Subcontract	Market linkage, Capacity building
Tanzania	ARI—SELIAN (ARI—SELIAN)	Research Institute	Subcontract	Dissemination, Diagnostics
Tanzania	Building Rural Incomes Through Enterprise (BRiTEN)	NGO	Subcontract	Dissemination, Input supply, Market linkage, Capacity building
Tanzania	CABI-IITA: Gender and the Legume Alliance: Integrating multi-media communication approaches and input brokerage (GALA)	NGO	Cooperative/Collaboration agreement	Dissemination, Input supply, Market linkage, Capacity building
Tanzania	Agriseed Technologies Limited (AgriTech)	Private (seed) organization	Subcontract	Input supply
Tanzania	Guavay Company Limited (GCL)	Private (fertilizer) organization	Subcontract	Input supply

Country	N2Africa lead partner	Type of organization*	Type of partnership**	Main areas of support***
Tanzania	Beula Seed Co. & Consult LTD (BSCC)	Private (seed) organization	Subcontract	Input supply
Tanzania	G2L Company Limited	Private organization	Subcontract	Market linkages
Uganda	World Vision, Uganda (WVU)	NGO	Cooperative/Collaboration agreement	Dissemination, Input supply, Market linkage, Capacity building
Uganda	World Vision, Uganda (WVU)	NGO	Subcontract under collaborative agreement	Dissemination, Input supply, Market linkage, Capacity building
Uganda	National Agricultural Research Laboratories (NARL)	Research Institute	Subcontract	Diagnostics
Uganda	National Crops Resources Research Institute (NaCRRI)	Research Institute	Subcontract	Dissemination
Uganda	Africa 2000 Network Uganda (A2N)	NGO	Subcontract	Diagnostics, Dissemination, Seed systems, Capacity building
Uganda	Netherlands Development Organization (SNV) - The Uganda Oilseed Subsector Platform (OSSUP)	NGO	Cooperative/Collaboration agreement	Innovation Platform (IP)
Uganda	National Agricultural Research Organization (NARO)	Research Institution	Subcontract	Groundnuts, Diagnostics, Dissemination, Capacity building
Uganda	Agricultural Innovation Systems Brokerage Association Limited (AGINSBA)	Private Organization	Subcontract	ICT-Platform—Dissemination, Input and output market linkages
Uganda	CARD Uganda Agribusiness Development Solutions (CARD)	Private Organization	Subcontract	Capacity building, Market linkages, Technology dissemination
Uganda	Simlaw Seeds Company Uganda Ltd	Private Organization	Cooperative/Collaboration agreement	Seed supply
Uganda	Agency for Sustainable Rural Transformation Limited (AFSRT)	Private Organization	Subcontract	Capacity building, Market linkages, Technology dissemination
Uganda	Palladium Group (U) Ltd	Private Consulting firm	Cooperative/Collaboration agreement	Capacity building, Market linkages, Technology dissemination
Zimbabwe	International Livestock Research Institute (ILRI)—University of Zimbabwe (UZ)	Research Institute	Material transfer	Capacity building, Technology dissemination

* Type of organization: Farmer association/cooperative (fa), NGO (ngo), Government institution (gi), research institution (ri), private organization (po), others
** Type of partnership: Sub-contract (s), Collaboration agreement (ca), Grant agreement (ga), Project support consultancy agreement (psca), Material transfer (mt)
*** Main areas of support: Capacity building (cb), Input supply (is), Market linkages (ml), Technology dissemination (td)

Appendix II – PhD and MSc student overview

Table 16. Overview of PhD students involved in N2Africa Phase II.

Country	Name	Gender	Research topic
DRC	Bintu Ndusha	F	*Working with the output of Phase I* Started field work April 17
Ethiopia	Ashenafi Hailu Gunnabo	M	Use of crop residues for livestock.
Ethiopia	Mesfin Dejene Ejigu[1]	M	Options for improving the yield and nutritive value of maize and grain legume residues for ruminants in East African farming systems (Partially funded by N2Africa Defended-final comments under incorporation)
Ethiopia	Tamiru Amanu	M	Understanding the role of Public-Private Partnerships in overcoming institutional barriers to technology adoption
Ghana	Daniel Brain Akakpo	M	Use of grain legume residues as livestock feed resource for smallholder farmers in Northern Ghana.
Ghana	Michael Kermah	M	Exploring opportunities for sustainable intensification of grain legumes towards improving crop productivity, food security and livelihoods of smallholder farmers in northern Ghana.
Kenya	George Mwenda	M	Characterization of nitrogen-fixing bacteria from Phaseolus vulgaris L. in Kenya
Mozambique	Amaral Machaculeha Chibeba	M	Characterization of rhizobia isolated from soyabean in Mozambique and strategies to maximize the contribution of biological nitrogen fixation.
Nigeria	Aliyu Anchau Abdullahi	M	Exploring the genetic diversity of groundnut-nodulating rhizobia in moist and dry savannas in Nigeria for increased symbiotic nitrogen fixation and productivity.
Nigeria	Comfort Ojo Tinuade	F	Host legume x rhizobium strain interactions in cowpea.
Nigeria	Tolorunse Kehinde Dele	M	Phenotyping and Yield Stability Studies in Soyabean (*Glycine Max* (L.) Merrill) Under *Rhizobia* Inoculation.
Nigeria	Adediran Olaotan Abimbola	F	Physiological Responses of Cowpea (*Vigna Unguiculata* (L.) Walp) Varieties to Rhizobia Inoculation, Nutrient Management and Sowing Dates in Nigeria Southern Guinea Savannah.
Borno State	Faruk Galadanchi Umar	M	Response of Groundnut Varieties to *Rhizobia* Inoculation in The Sudan And Northern Guinea Savannas of Nigeria.
Borno State	Binta Ali Zongoma	F	Impact Assessment of Improved Cowpea Varieties on Women Farmers in Southern Borno State, Nigeria
Borno State	Jennah Fatima Bebeley	F	Evaluation of the productivity and profitability of high and low input soyabean production systems in northern Nigeria
Rwanda	Edouard Rurangwa	M	Improving nitrogen fixation in common beans and soyabean in Rwanda.
Tanzania	Eliakira Kisetu Nassary	M	Intensification of maize-bean cropping systems in Northern Tanzania.
The Netherlands	Ilse de Jager	F	Agriculture and nutrition linkage in N2Africa.
The Netherlands	Esther Ronner	F	Impact of sustainable intensification of agricultural production through legume technologies on smallholder farming systems in sub-Saharan Africa.
The Netherlands	Wytze Marinus[1]	M	Using the NUANCES approach to examine benefits of legumes in farming systems of East Africa

Zimbabwe	Mazvita Chiduwa	F	Symbiotic performance of soyabean root nodule bacteria (RNB) recovered from Zimbabwe.
Zimbabwe	Tatenda Kainga	F	
The Netherlands	Eskender Andualem Beza[1]	M	Citizen science and remote sensing for crop yield gap analysis

M= male, F= female

[1] PhD candidate having collaborative research with N2Africa

Table 17. Overview of MSc students involved in N2Africa Phase II.

Country	Name	Gender	Research topic
Ethiopia	Beza Shewangizaw Woldearegay	M	Response of chickpea (*Cicer aritienum* l.) to sulphur and zinc nutrients application and *Rhizobium* inoculation in north western Ethiopia.
Ethiopia	Negash Teshome	M	Response of Soyabean to Potassium fertilizer and Liming at Gobu-Sayo District, Western Ethiopia.
Ethiopia	Getahun Negash Takele	M	Symbiotic and phenotypic characteristics of indigenous rhizobia nodulating faba bean (*Vicia faba* L.) growing in some parts of Wello, Northern Ethiopia.
Ethiopia	Tadele Ereso	M	Symbiotic effectiveness of rhizobia from chickpea (*Cicer arietinum* L.) and phenotypic characteristics of faba bean (*Vicia faba* L.) nodulating rhizobia.
Ethiopia	Mesfin Fenta	M	Adoption of improved chickpea technologies in North Gondar zone of Ethiopia: the case of Gondar Zuria district
Ethiopia	Galmesa Abebe	M	Determinants of Adoption of Improved Soyabean Production Practices: The Case of Chewaka and Gobu Sayo Districts, Oromia Region, Ethiopia.
Ethiopia	Dagmawit Getachew	F	Analysis of Legume Technology Adoption Preference: The Case of Chick Pea and Common Bean Producing Smallholder Farmers in Boricha and Damot Gale Districts, SNNPR.
Ethiopia	Yitbarek Tegegne	M	Factors affecting adoption of legume technology and its impact on income of farmers: the case of Sinana and Ginir Woredas of Bale zone.
Ethiopia	Sisay Belete	M	Effects of phosphorus fertilizer and inoculation on yield and nutritive values of grain and haulm of selected grain legumes in mixed crop-livestock production system of Ethiopia.
France	Ugo Verlingue	M	Guiding varietal choice for soyabean in Africa: A comparison of bottom-up and top-down modelling approaches to assess water limited potential yields.
Ghana	Kennedy Ahlija	M	Response of soyabean to rhizobial inoculation and nitrogen management options in the Southern Guinea savannah zone of Ghana.
Ghana	Wuni Mawia	M	Effect of genotype and plant population on growth, N-fixation and yield of soyabean in Northern Guinea Savanna zone of Ghana.
Ghana	Gifty Kumah	F	Effect of genotype and plant population on growth, nitrogen fixation and yield of soyabean (*Glycine max*. L. Merrill) in Guinea savanna agro-ecological zone of Ghana.
Ghana	Kuma Florence Jessicah	F	Influence of P sources and rhizobium inoculation on growth, nodulation, N & P uptake and yield of three soyabean genotypes in Tanchera soil series of the northern Guinea savannah zone of Ghana.
Ghana	Godfrey Wilson	M	Symbiotic effectiveness and saprophytic competence of selected indigenous rhizobia isolates for groundnut inoculation in northern Ghana.
Ghana	Gregory Mensah	M	Implementation of N2Africa Project in Ghana:Putting Nitrogen Fixation to work for smallholder farmers in Ghana.
Ghana	Kwasi Gyan	M	Market research.

Ghana	Joseph Twumasi Dankwa	M	
Ghana	Ibrahim Issifu	M	Effect of liming, phosphorus application and rhizobial inoculation on growth, N-fixation and yield of soyabean.
Ghana	Abdul Rahaman Karim	M	Effect of farmers' storage practices on soyabean seed viability, vigour and germination.
Ghana	Robert Tumyagewor Atawura	M	Adoption of Improved Technologies by Legume Farmers in The Upper West Region of Ghana.
Kenya	Martin Kiagayu Koinange	M	Influence of biochar amendment on the effectiveness of elite Kenyan rhizobia nodulating common bean (*Phaseolus vulgaris* L.).
Kenya	Wycliffe W. Waswa	M	Evaluation of yield potential and management practices affecting soyabean production in western Kenya.
Malawi	Donald Siyeni	M	Effect of rhizobia inoculation and phosphorus fertilizer on nodulation and yield of soyabean (*Glycine max* (L.) Merril) in Dedza, Kasungu and Salima districts of Malawi.
Nigeria	Ngwu Chuwudi Hillary	M	Genotype X Environment Interaction and Stability Analysis for Yield and Its Components In 24 Lines of Soyabean (*Glycine Max*) in Three Agro Ecological Zones of Nigeria.
Nigeria	Muhammed Mustapha Ibrahim	M	Optimization of biological nitrogen fixation and yield of groundnut (*Arachis hypogaea* L.) in a savanna alfisol through fertilizer application and soil amendment.
Nigeria	Musa Muhammed	M	Response of Cowpea Varieties to Rhizobium Inoculant and Phosphorous Fertilizer in Sudan Savanna.
Nigeria	Muhammed Haliru	M	Determinants of Inputs Demand and Adoption of Grain Legumes and Associated Technologies of N2africa in Kano State, Nigeria.
Nigeria	Andy Okpoho	M	Effects of Tillage, Variety and Starter Nitrogen on Soil Physical Quality, Root Profile, Biological Nitrogen Fixation and Inoculated Soyabean Performance at Minna, Nigeria.
Nigeria	Ekle Angu Sunday	M	Effects of inoculation, chemical fertilizers and manure on nutrient uptake and yield of soyabean in savanna zone of Kano State.
Nigeria	Damilola Samuel Abikoye	M	Assessment of The N2africa Project on Empowering Women Involved in Soyabean (*Glycine Max*).
Nigeria	Joy Ekaette	F	Soyabean Response to Inoculation in Niger State.
Nigeria – Borno	Muhammad Nurudeen ISA	M	Characterization and evaluation of indigenous *Rhizobia* of cowpea for biological nitrogen fixation and improved crop yield in the Nigerian savanna.
Nigeria – Borno	Hauwa Mohammed Alkali	F	Analysis of Market Participation by Women Soyabean Farmers in Kwaya Kusar Local Government Area, Borno State, Nigeria.
Nigeria – Borno	Maryam Baba Kyari	F	Analysis of Cowpea Marketing in Biu Local Government Area, Borno State, Nigeria.
Nigeria – Borno	Muhammad Sheriff ALI	M	Effect of different single superphosphate (SSP) rates and plant spacing on yield of groundnut in Sudan savanna zone of Borno State, Nigeria.

Nigeria – Borno	Sahbong Lucy Kamsang	F	Gender difference in the adoption and impact of improved soyabean varieties in Southern Borno State, Nigeria.
Tanzania	Yusuph Namkeleja	M	Isolation, authentication and evaluation of symbiotic effectiveness of elite indigenous rhizobia nodulating *Phaseolus vulgaris* L. in Hai District, northern Tanzania.
Tanzania	Fides Temu	F	Dynamics of Common Bean (*Phaseolus Vulgaris L.*) Insect Pests with Altitudes, Cropping Seasons and Cropping Patterns in Hai District Tanzania.
Tanzania[2]	Scolastica Gatty[1]	F	Effectiveness of Alternative Extension Methods in Raising Knowledge, Stimulating Uptake and Increasing Profitability under Different Improved Farming Practices: A Case Study of Common Bean Farmers in Southern Highlands of Tanzania.
Tanzania[2]	Ernesta Gerald Sanga[1]	M	Determinants of adoption of improved common bean technologies among small farmers in Southern Highlands in Tanzania: cost-effectiveness of dissemination approaches.
Tanzania[2]	Nimbona Daphrose[1]	M	Gender Differences in Reception of Information and Its Effects on The Adoption of Improved Soybean Technologies in Njombe Region-Tanzania.
Tanzania[2]	Amina Mustapha[1]	F	Cost-Effectiveness of Extension Methods for Scaling Up Improved Common Bean Technologies Among Small-Scale Farmers in Babati District, Tanzania.
Tanzania[2]	Charles Byalugaba Lugamara[1]	M	Effectiveness of Communication Channels and Smallholder Famers Adoption of Improved Legume Technologies: A Case of Morogoro Region, Tanzania.
Tanzania	Verena Mitschke	F	Inducing the adoption of good agricultural practices by educating Tanzanian smallholder farmers – what works best and at what costs?
Tanzania	Henry Tamba Nyuma	M	Response of three groundnut (*Arachis hypogaea* L.) genotypes to calcium and phosphatic fertilizers.
Tanzania	Zephania Simon	M	Isolation and characterization of nitrogen fixing rhizobia from previously cultivated and uncultivated soils of northern Tanzania.
The Netherlands	Eva Thuijsman	F	Light and nutrient capture by common bean (*Phaseolus vulgaris* L.) and maize (*Zea mays* L.) in the Northern Highlands of Tanzania.
The Netherlands	Eva Thuijsman	F	Adaptation of improved climbing bean (*Phaseolus vulgaris* L.) technologies in the Ugandan highlands.
The Netherlands	Kohji Nakasaka	M	Evaluating farmers' decision making on choosing technologies and practices in adaptation trials.
The Netherlands	Tijmen Kerstens[1]	M	Findings on: Environmental impact in Dutch arable farming, experimental data on soyabean yield potential, the yield gaps of sugarcane and sugar beet, and N2Africa baseline studies.
The Netherlands	Lisa Piper[1]	F	N2Africa Public Private Partnership Review.
The Netherlands	Laurie van Reemst	F	Understanding drivers behind the implementation and adaptation of improved climbing bean (*Phaseolus Vulgaris* L.) technologies by smallholder farmers in Kapchorwa district, Eastern Uganda.
The Netherlands	Jan Huskens	M	Climbing bean (*Phaseolus vulgaris L.*) cultivation and its diffusion in Kapchorwa District, Uganda.
The Netherlands	Nikolaj Meisner Vendelbo	M	Internship: Dynamics of pests and diseases in maize-legume intercropping systems in Northern Tanzania.

The Netherlands	Dorien Westerik	F	Simple farm simulation model of smallholder farms in Ghana.
The Netherlands	Mats Hoppenbrou-wers	M	The financial sustainability of concrete technology options for grain legumes: An economic evaluation of input adoption by smallholder farmers in Ghana.
The Netherlands	Susana Prieto Bravo	F	Analysis and revision of the N2Africa focal adaptation survey, a tool for monitoring technology performance and untangling yield variability.
The Netherlands	Suzanne Roelen[1]	F	Exploring the current state of ruminant value chains in northern Ghana, and the role of grain legume residues as a livestock feed resource.
Tanzania / The Netherlands	Hannah Broerse	F	Kukua delivery weather data prediction to smallholder farmers and the extent to which local smallholder farmers are willing to use and pay for weather prediction services.
Tanzania / The Netherlands	Sandra Gonza	F	Kukua delivery weather data prediction to smallholder farmers and the extent to which local smallholder farmers are willing to use and pay for weather prediction services.
Tanzania / The Netherlands	Pepijn Bras	M	Kukua delivery weather data prediction to smallholder farmers and the extent to which local smallholder farmers are willing to use and pay for weather prediction services.
Tanzania / The Netherlands	Justin Hoek	M	Kukua delivery weather data prediction to smallholder farmers and the extent to which local smallholder farmers are willing to use and pay for weather prediction services.
Tanzania / The Netherlands	Robin Hooft van Huysduynen	F	Kukua delivery weather data prediction to smallholders farmers and the extent to which local smallholder farmers are willing to use and pay for weather prediction services.
Uganda	Kennedy Mwesigewa	M	Characterizing nutrients limiting soyabean production in central Uganda.
Uganda	Eriya B. Kule	M	Unravelling intra-household gender dynamics affecting women participation in climbing bean marketing in Kabala, Uganda.
Zimbabwe	Vongai Chekanai	F	Nitrogen, phosphorus and rhizobia inoculation interactions on nutritional components of common bean (*Phaseolus vulgaris* L.) in Zimbabwean smallholder farms.

M= male, F=female

[1] Student having collaborative research or internship with N2Africa

Appendix III – Definition of terms

Word	Acronym	Definition
Buyer model		Business model that aims to increase quantity and/or quality of crop sales, also known as contract farming.
Cooperative-Collaboration Agreement	(ca)	Agreements made by consenting organizations to share resources to accomplish a mutual goal.
Grant Agreement	(ga)	Agreements made between organizations where money or something of value is transferred from one organization to the other to accomplish a mutual goal.
Information linkage model		Business model that involves brokering information between actors.
Input & Information model		Business model that aims at brokering general value chain information and input sales (demand quantification).
Input supplier model		Business model that aims to increase input sales.
Material Transfer	(mt)	Agreements made where organizations agree to the transfer of tangible research material for their individual research purposes.
Memorandum of Understanding	(MOU)	An agreement between two or more parties, indicating an intended common line of action. It is often used in cases where parties either do not imply a legal commitment or in situations where the parties cannot create a legally enforceable agreement.
Micro-entrepreneur model		Business model that aims to generate income from input and service sales.
Nucleus farm model		Business model that aims to group of farms to generate income.
Producer collective model		Business model that involves producer groups driving access to inputs, services by members.
Sub-Contract Agreement	(s)	Agreements made between organizations where the sub-contracted organization undertakes activities on the behalf of the other.
Sub-Contract Agreement under Cooperative-Collaboration Agreement	(sca)	Agreements where the Lead partner or other partner of the Cooperative-Collaboration Agreement is subcontracted based on expanded scope of work or extra expertise.

Appendix IV – 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
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
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

Appendix V – Partners involved in the N2Africa project

A2N

Bayero University Kano (BUK)

Caritas Rwanda

Diobass

Eglise Presbyterienne Rwanda

Ethiopian Institute of Agricultural Research

Kwame Nkrumah University of science and Technology

MIRCEN
University of Nairobi MIRCEN

Resource Projects-Kenya

Sasakawa Global; 2000

Université Catholique de Bukavu

University of Zimbabwe

Urbanet