



Agronomy Master Plan

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N2Africa

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



Summary

The agronomy master plan aims to create a common understanding of the guiding principles, key activities and timelines related to N2Africa's agronomic research. It directly addresses Objectives 2, 4 and 5 of the results framework, which deal with dissemination, improving legume productivity and situation analysis, respectively. The most important goals are understanding the major constraints to legume productivity, identifying the causes of yield variability and finding technological interventions to reduce this variability. Agronomy within N2Africa is characterised by an emphasis on on-farm trials and the use of a wide variety of data-collection and survey tools to obtain reliable information on important agronomic and socio-economic variables.

The master plan is structured around four activity clusters that consist of coherent sets of activities and tasks. The **Diagnosis** cluster aims to identify the main biophysical constraints to enhanced legume productivity, primarily by on-farm trials across a wide range of environmental conditions. The **Researcher-managed Agronomy** cluster consists of specialized agronomic trials meant to identify solutions to known constraints and to identify and remedy soils that show limited response to inputs. Within the **Demonstration** cluster, on-farm, participatory technology evaluations are implemented to establish the performance of promising technologies and to serve as a platform for co-development and dissemination of new technologies. In the **Adaptation** cluster, these technologies are evaluated by large numbers of farmers to determine their appropriateness for different farm types and conditions. Results obtained from the four activity clusters will inform activities in subsequent seasons, thereby contributing to N2Africa's feedback loops.



I. Introduction and justification

The N2Africa Master Plans are documents intended to foster a common approach across the five Core Countries. The plans are designed to achieve the N2Africa Vision of Success and the objectives set out in the Research Framework of the approved project proposal. This means all Master Plans need to ensure timely delivery of the outputs and outcomes.

This Master Plan directly addresses:

Objective 4: Tailor and adapt legume technologies to close yield gaps and expand the area of legume production within the farm

and through the Development to Research approach, engages closely with activities under:

Objective 2: Delivery and dissemination, sustainable input supply, and market access

Objective 5: Enable learning and assess impacts at scale through strategic M&E

By developing a single, integrated agronomy research plan we aim to ensure consistency in research designs and data collection to allow for meta-analysis across all N2Africa countries. Detailed research plans will be needed for each country, and in some cases for different regions of each country. Country plans must match the specific agro-ecologies, farming systems, institutional, policy and economic environments. Thus, the challenge we address is to ensure sufficient consistency to allow cross-comparisons, yet leaving sufficient opportunity for local adaptation and creativity. In addition to the master plan, more detailed research protocols will be distributed to help with the implementation of specific activities and to ensure common standards and formats for experimental procedures and data collection and handling.

Within Objectives 4, 2 and 5, this Master Plan provides an overall framework for implementing the activities highlighted in green in below Objective/Activity Table.

Table 1: Objectives and Activities as per the approved Results Framework. Activities highlighted in green are those addressed by this Master Plan. Note that the numbering of the Tasks later in the document is related to the Activity numbers in this table.

Objective 1: Project strategy, coordination and implementation and capacity strengthening
1.1. Hire internationally and nationally recruited project staff and procurement of equipment
1.2. Set up systems for monitoring and evaluating project progress
1.3. Engage research, development, private sector, and other relevant partners in each of the target countries
1.4. Develop and operationalize a project-wide internal and external communication strategy
1.5. Develop country-specific research & dissemination implementation plans, including a sustainable exit strategy
1.6. Organize seasonal/yearly project-wide and country-specific planning workshops
1.7. Develop and implement a degree (PhD and MSc)-related research plan
1.8. Develop and implement a non-degree-related capacity strengthening plan for relevant partners working within legume value chains
Objective 2: Delivery and dissemination, sustainable input supply, and market access
2.1. Constitute and facilitate in-country/in-region N2Africa stakeholder platforms
2.2. Facilitate N2Africa-led dissemination campaigns in the context of development-to-research learning cycles with specific attention to gender
2.3. Create widespread awareness on N2Africa technologies and interventions
2.4. Facilitate partner-led dissemination campaigns with specific attention to gender
2.5. Facilitate private-public partnerships towards the sustainable supply of inoculants and fertilizer
2.6. Facilitate the establishment of private sector-led and/or community-based legume seed systems
2.7. Engage agro-dealer and other last-mile delivery networks in supplying legume agro-inputs
2.8. Establish agri-business clusters around legume marketing and value addition
2.9. Assess the effectiveness and efficiency of various input delivery and marketing systems especially for women
Objective 3: Empower women to increase benefits from legume production
3.1. Sensitize partners, farmer associations, and farming households and mainstream approaches to



address gender inequity in farming and decision-making
3.2. Assess business opportunities for women in agro-input supply and legume marketing and value addition opportunities
3.3. Conduct dissemination campaigns targeting women farmers
3.4. Develop labour-saving pre- and post-harvest legume tools for female farmers
3.5. Evaluate the impact of environment (E) and management (M) on nutritional quality of legume grain
3.6. Develop legume product-enriched food baskets for smallholder families
Objective 4: Tailor and adapt legume technologies to close yield gaps and expand the area of legume production within the farm
4.1. Develop variety x inoculant x nutrient management recommendations for the target legumes and legume production areas based on yield gap analysis
4.2. Develop recommendations for rehabilitation of non-responsive soils for legume production
4.3. Intensify crop-livestock interactions through enhancing feed availability of legume crop residues
4.4. Evaluate the medium- to long-term impact of legumes on overall farming system productivity and natural resource conditions
4.5. Isolate, authenticate, and evaluate new strains of rhizobia for the target legumes for high symbiotic effectiveness
4.6. Identify elite rhizobium strains and inoculant formulations for beans, groundnut, and cowpea
4.7. Evaluate competitiveness and survival of introduced rhizobium strains as affected by M x E
4.8. Develop standard operating procedures for the production, quality control and application of rhizobium inoculants
Objective 5: Enable learning and assess impacts at scale through strategic M&E
5.1. Develop an innovative framework for strategic M&E, allowing for timely feedback loops
5.2. Set-up data collection, management, and analysis infrastructure
5.3. Conduct situation analysis, including the overall bio-physical, socio-cultural, and political environment and farming system and yield gap analysis for targeting legume interventions
5.4. Develop innovative ICT tools to collect data and provide feedback to stakeholder groups
5.5. Unravel $G_L \times G_R \times E \times M$ interactions for legume production towards the development of best-fit recommendations
5.6. Evaluate the effectiveness and efficiency of various D&D approaches for legume intensification
5.7. Conduct impact assessment studies with a specific focus on the sustainability of interventions

II. Underlying principles

N2Africa has repeatedly documented a large variation in the yields of all the major grain legumes when tested across a large number of farms. Yields in control plots often vary from >0.5 t/ha to >2 t/ha, and strongest responses are often found at control yields around 1 t/ha. This leads to the main aims of the agronomic research, namely to provide the necessary 'best fit' technologies to close the yield gaps on farmers' fields by achieving the following aims:

Aims

- To understand which production factors underlie the important legume yield gap in the major African farming systems
- To identify the key biophysical and management factors in the $(G_L \times G_R) \times E \times M$ interaction that determine legume productivity, yield and response to inputs (i.e. the phenotype).
- To reduce yield variability on smallholder farmers' fields to achieve minimum yields of 2 t/ha on >90% of grain legume crops by developing targeted technologies for yield improvement

Approach

- Experiments are implemented on-farm whenever possible. Sites will be carefully selected to locate large numbers of simple trials and test the performance of 'best bet' technologies across agro-ecologies and soil fertility gradients with a wide diversity of farmers.
- The success of these experiments depends on the collection of reliable yield data, combined with associated precise observations on location (GPS), soil properties, rainfall and (a)biotic stresses.



- The use of field books in which farmers and researchers document details of farm type, agronomy and growing conditions will be an important source of information to explain yield differences.
- Data collection, management and communication will be done to high standards, thereby using project protocols where possible.
- No specialized agronomic trials will be conducted until specific questions and problems arise, either from the diagnostic and demonstration trials, or due to the availability of new and better varieties, fertilizer blends, other technologies that require evaluation or feedback from stakeholders.

III. Activity clusters within the Agronomy Master Plan and relation to other Master Plans

The Agronomy Master Plan consists of **four interlinked activity clusters**, cutting across the Research and Development (R&D) and Delivery and Dissemination (D&D) components of N2Africa (Figure 1). The **Diagnosis** activity cluster aims at understanding the biophysical or abiotic (soil fertility, weather) and biotic (pests and diseases) constraints to enhanced legume productivity. The **Researcher-managed Agronomy** activity cluster aims to identify, understand and solve specific constraints for which there is not enough existing information to propose best-bet interventions that have a high chance of alleviating these constraints. The **Demonstration** activity cluster co-evaluates a portfolio of *best-bet* options together with farming communities to tackle constraints to legume intensification (including improved varieties, nutrient management, or agronomic practices) within best cropping systems (including improved intercropping arrangement, legume-cereal rotations, or relay cropping systems). The **Adaptation** activity cluster evaluates how individual farming households adapt selected best-bet options and how farmer management practices and environmental factors affect their performance. This step also provides the framework for translating *best-bet* options to *best-fit* options, with the latter referring to specific biophysical and economic conditions and farming resources available to individual households. Each activity cluster contains a number of specific tasks that relate directly to specific objectives in the results framework.

The Agronomy Master Plan interacts logically with the **other Master Plans**, particularly with the master plans for dissemination and M&E (Figure 1). Results from the Agronomy Master Plan will be fed into the Dissemination Master Plan where partners will promote and disseminate robust N2Africa technologies, partly through the establishment of public-private partnerships. The M&E and data management Master Plan will guide the collection of routine and learning M&E information in relation to agronomy activities; provide the database infrastructure and data tools to manage that information, and guide the assessment of the impact created towards the end of the project. The Agronomy Master Plan also interacts with (i) the Rhizobiology Master Plan, through integration of the most effective rhizobium strains and their delivery mechanisms, (ii) the Communication Master Plan, through the development of communication and awareness creation tools and approaches around the best N2Africa products, and (iii) the Partnership Platform Master Plan, through the integration of N2Africa within platform activities. The Gender Master Plan will ensure that gender dimensions are fully integrated in the various agronomy-related activities.

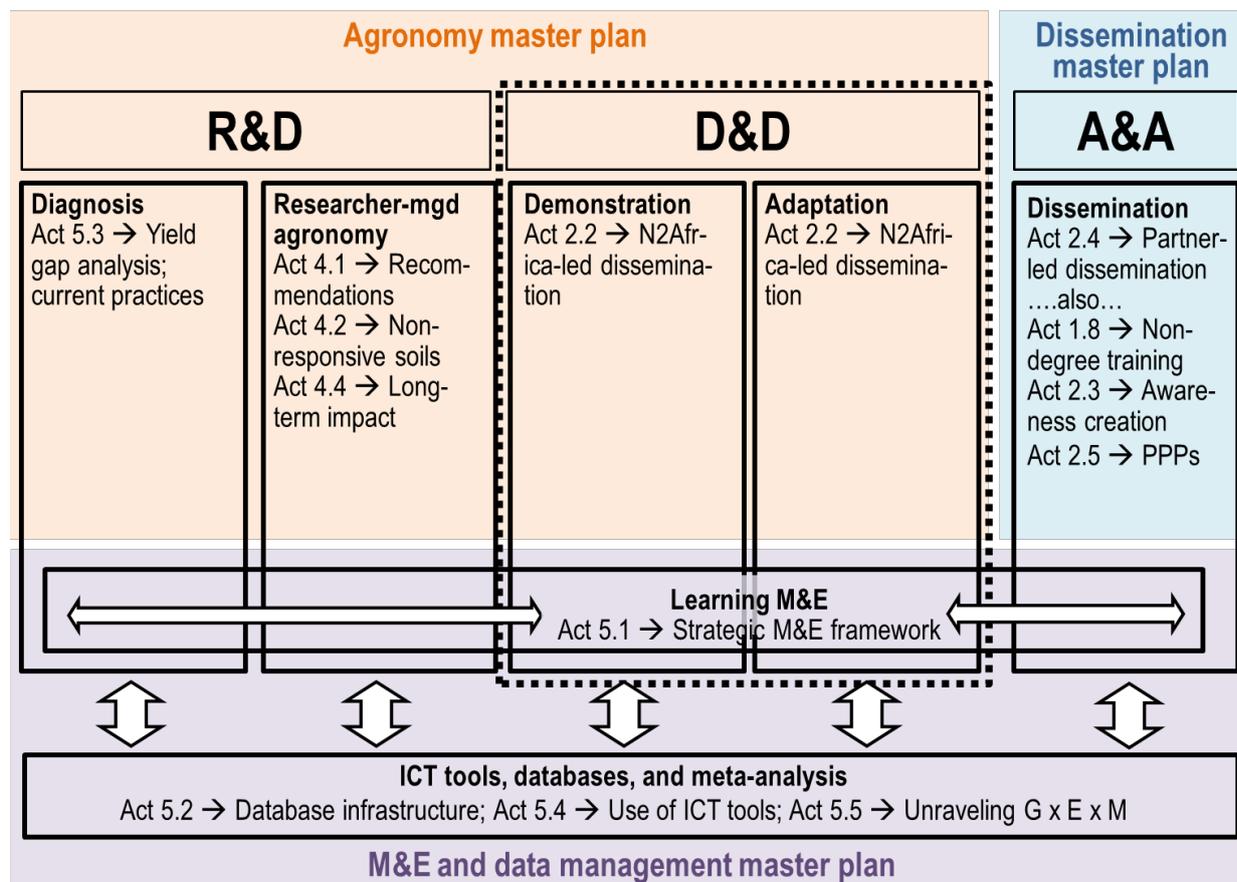


Figure 1: Content of the agronomy, M&E and data management, and dissemination master plans with specific reference to the activities as per the Results Framework of N2Africa phase II. The different activity clusters are delineated in boxes with the D&D activity clusters (surrounded in dotted lines) being the entry point of the agronomy master plan.

IV. Linkages between activity clusters

The **Demonstration activity cluster** will be initiated first and will build on information obtained from Phase I of the project or from the bridging grant and secondary information. Where possible, and related to the availability of information from earlier Demonstration activities, the **Adaptation activity cluster** will be activated as well, especially in the unimodal areas. The **Diagnosis activity cluster** will also be initiated soonest (season 2 in the bimodal areas and immediately in the unimodal areas) since this will provide a better understanding of the constraints to improved legume productivity for embedding in the **Demonstration** and **Adaptation** clusters. Although each of these three activities serves a unique purpose, they share the common goal of identifying the **constraints** affecting the success of N2Africa technology options. To maximize the benefit obtained from the different activity clusters and to make efficient use of time and resources, it is important to have **overlap** in the technologies used in the three activity clusters. Repeating some of the same treatment across **Diagnosis**, **Demonstration** and **Adaptation** activities will provide a large body of data that will enable learning at different scales. To guarantee that data collected across all experiments can be combined, it is also essential to sample a limited subset of trials from the demonstration and adaptation clusters to serve as so-called **focal trials**. In these focal trials, data collection will be performed by research partners according to uniform protocols and under strict supervision of N2Africa staff. Depending on the nature of the constraints identified during the **Diagnosis**, **Demonstration**, or **Adaptation** activities, **Researcher-Managed Agronomy activities** may be set up under controlled on-station,



greenhouse, or laboratory conditions. These activities need to address specific technical issues identified through the other activity clusters. Each of the activity clusters has distinct design and implementation characteristics (Table 2).

Table 2: General design and implementation characteristics for the different activity clusters. Note that the 'Dissemination' column is not part of the Agronomy Master Plan but added for reasons of clarity.

Activity Cluster:	Diagnosis	Researcher-managed agronomy	Demonstration	Adaptation	Dissemination
Type of trial	Researcher-designed diagnostic trials	Researcher-designed, specialised agronomic trials	Demonstration trials co-designed by researchers and farmer associations	Adaptation trials , co-designed by researchers and individual farmers	Designed by individual farmers
Main aim:	Understanding biophysical constraints on legume productivity	Addressing specific knowledge gaps on production constraints	Co-evaluation of a collection of best-bet options	Evaluation performance and adaptation of technologies under farmer management	Extensive, partner-led dissemination of best-fit technologies
Approximate number of trials per year	10-50 per target region, 30-100 per country	5-10 per target region, max 10 per country	50-150 per country	200-1000 per target region, 1000-5000 per country	Unlimited (any household can participate)
Site selection	Strict criteria based on biophysical characteristics and geography (ensure good spatial coverage)	Strict criteria based on biophysical characteristics (<i>on-station, greenhouse, or laboratory conditions</i>)	Co-determined by researchers and participating farmer associations Stratified using adoption domains	Determined by participating farmers Stratified using adoption domains	Fully determined by participating farmers
Implementation, management	Researcher-managed	Researcher-managed	Co-managed – research and farmer associations	Managed by individual farmers	Managed by individual farmers
Key partners for implementation, management and data collection:	Research partners (NARs, Universities)	Research partners (NARs, Universities)	Development partners (Extension, NGOs)	Development partners (extension, NGOs)	Private partners (agribusiness), reduced involvement of development partners
Level of N2Africa supervision	High	High	Medium	Medium	Low
Payment for labour	Paid by research	Paid by research	No payment	No payment	No payment



V. Cluster contents

Each activity cluster consists of a series of distinct tasks that will be described in detail below, for tasks involving field trials we provide guidelines for site selection, experimental design, implementation, observations and measurements.

V.1. Diagnosis

This activity cluster aims to identify the main biophysical constraints to enhanced legume productivity including soil fertility status and climatic conditions. It is expected that variety selection, trial management, and management of pests and diseases will occur using best practices.

Activity 5.3: Conduct situation analysis, including the overall bio-physical, socio-cultural, and political environment and farming system and yield gap analysis for targeting legume interventions

Task 5.3.1 Review of Phase I data, analysis of baseline information, and secondary literature review (Year 1)

This task will synthesize the state of knowledge on current agronomic practice and the potential determinants of yield differences and inoculant and fertilizer response. It will bring together experimental data from Phase I and the bridging grant, baseline data and published data from the literature. It will require timely sharing and analysis of existing data.

Task 5.3.2 Multi-locational yield gap analysis based on biophysical constraints (Year 1-2)

This task consists of targeted, multi-location researcher-managed **diagnostic trials**, that will address common biophysical constraints on yield and input response by linking trial yields to detailed observations on soil, rainfall and occurrence of biotic (i.e. pests and diseases) and abiotic stresses (i.e. drought, flooding, etc.). The **quality** of trial implementation and data, the consistent collection of **GPS coordinates** and a sufficient number of **replicates** are all critical to the success of these trials. Trial implementation, trial management and data collection is to be performed by research partners, using standardised protocols and under close supervision of N2Africa staff. The establishment of effective research partnerships therefore very important and should include capacity building to ensure institutionalization of relevant research skills. Experimental treatments should include remedies to the most likely soil-fertility constraints, such as P, K, organic matter etc. The number of treatments should preferably be limited to a maximum number of six. Although covering a representative range of biophysical conditions requires a relatively large number of trials, the need for replication needs to be balanced with the availability of manpower and technical capacity for taking data.

Site selection

Site selection will aim to cover the spread of variability faced in smallholder farmers' fields across the most relevant range of land types. This will be based on ex-ante assessment of weather, topography and soil parameters based on AfSIS and refined by local knowledge on soil fertility status.

Principles for site selection include:

- Legume types: This activity should focus on the priority legumes in each target region.
- Representativeness: trial fields should be typical of those used by farmers for (legume) cropping. To ensure this, it is important to reach timely agreements with farmers on the reservation of planting space. Only fields that are actually suitable for agriculture should be selected (e.g. excluding laterite soils).
- Geographic representation: trial locations should be sufficiently separated in space to increase the probability of biophysical differences across trials. This can be achieved by distributing trials over different districts/sectors and to maintain a minimum distance of separation for (groups of) trials within districts/sectors.



- Soil fertility status: The sites should span anticipated ranges of soil fertility conditions as obtained from the Africa Soil Information Service (AfSIS) and stratified by using cut-offs for classes of P (e.g., 10 mg/kg), pH (e.g., 5), texture (e.g., silt + clay 30%).
- Elevation and slope position: Site selection should ensure good representation of different levels of elevation and different positions along the slope.

Experimental design, treatment structure and number of replicates

- Design: Trials will be established using a single replicate at each trial location with maximally six treatments. This design is a randomised complete block design, with a single replicate per block (i.e. trial location = replicate).
- Replicates: Ideally about 50 replicate fields per target region (full replicates), with a minimum of 30 per country (ideally around 150). In case of multiple crops per target region, ensure at least 10 replicates per crop/treatment combination.
- Plot size (per treatment): 10 m x 10 m.
- Inoculation: Inoculation treatments should only be included if inoculants with tested efficacy are available for the target legume.
- Fertilizer use: Determining the appropriate fertilizer to apply is not always straightforward. Since this is about diagnostic trials, the proposed fertilizer treatments are 2: (i) a treatment with commonly available legume fertilizer (ideally only containing P and K – though NPK would be acceptable) and (ii) a complete nutrient fertilizer (NPK with addition of B, Zn, S, Cu, etc.). In case where the latter treatment outperforms the former, a follow-up trial may be needed to assess which of the nutrients are most limiting for a specific situation (assisted with data from the leaf sampling).
- Complete design: An example of a complete design could be a factorial design of 4 treatments: (1) control (no inputs), (2) + inoculant -standard fertilizer, (3) - inoculant +standard fertilizer, (4) +inoculant +standard fertilizer, which may be enhanced by 2 additive treatments: (5) +inoculant +standard fertilizer + complete nutrient fertilizer (6) +inoculant +standard fertilizer + complete nutrient fertilizer + manure.

Implementation and management

- Variety: All trials should have the same best-bet variety. It would be acceptable to set up 2 sets of trials with 2 varieties but these should be evaluated using a separate set of fields identified within the same overall soil fertility ranges.
- Agronomy: The trials should be implemented using best existing agronomic practices (density, planting time, weeding regimes, etc.).
- Pest management: Pest management is essential for cowpea, not for the other legumes. Please note the specific pest management practices (date, chemicals used, doses used, etc.).

Measurements and observations

Grey shading indicates specialized observations that should only be taken if sufficient technical expertise and manpower are available.



Measurement/ Observation	Details	Remarks
crop		
Grain yield	Fresh weight of shelled grain (unshelled for groundnut)	Use standard digital hanging scale with 10g precision (2 decimals)
Weight of above-ground residue at harvest	Fresh weight of all vegetative material on the plot.	Use standard digital hanging scale with 10g precision (2 decimals)
Peak aboveground biomass yield	Sampling of aboveground biomass at 50% podding	
Nodulation scoring		
Plant tissue analysis		
Location		
GPS coordinates	Latitude, longitude, elevation, of homestead and trial field	Use decimal degrees
Soil		
Topsoil fertility	Org C, total N, available P, pH, texture, ECEC (¹ measured in a central lab)	Sample top 0-20 cm before planting, at least 6 cores per plot, mixed, subsampled, air-dried, sent to reliable laboratory
MPN		
Weather		
Daily rainfall	Daily amount of rainfall recorded at a distance of maximally 5 km from the trial site	Local rain gauges, measure and empty each day throughout the growing season.
Key agronomic observations		
Emergence	% emergence in each plot	field book
Farm characterization	Data on household and farm characteristics	field book
Occurrence of (a) biotic stresses	Severity scores	field book
Cropping calendar	Dates of important management interventions, occurrence of stresses and phenological stages	field book
Photographs	Taken at 50% podding	Each plot will be photographed separately, resulting files will be registered and stored appropriately

V.2. Researcher-managed agronomy

This cluster aims to generate system recommendations for D&D. Main topics to address can include the management of non-responsive soils, evaluation of untested varieties, and identification of best input and management practices. This cluster directly addresses **Activities 4.1, 4.2, and 4.4** (Table 1) and is related to one key milestone on the integration of production recommendations in dissemination campaigns (Table 3). Activities under this cluster are restricted to addressing gaps identified during the Demonstration and Adaptation activities and should be based on hypotheses that are crucial to adapting technologies and closing yield gaps. These trials require serious reflection and clear understanding of findings from Demonstration and Adaptation trials.



Table 3: Cumulative targets per country, corresponding to the milestones under the researcher managed agronomy cluster. Note that it is anticipated to develop 2 extra production recommendations per country, starting from a total of 5 generated in Phase I

Milestone	2014	2015	2016	2017	2018
4.1.2. By Q4 of years 2-4, improved legume production recommendations integrated in the dissemination campaigns (recommendations)	5	5	10	15	15

Activity 4.1: Develop variety x inoculant x nutrient management recommendations for the target legumes and legume production areas based on yield gap analysis

Task 4.1.1. Meta-analysis of current agronomic data to identify gaps in knowledge related to yield gaps, variety, fertilizer and inoculant performance

These tasks involve the careful analysis of data from phase I and the results from task 5.3.2., with the aim of prioritising research questions on legume productivity to be addressed in a limited set of agronomic trials. Analysis of phase I data from different countries may identify candidate factors limiting legume yields and responses to inputs that may be tested by directed experiments.

Task 4.1.2. Agronomic trials to establish recommendations for improved legume production.

This task consists of implementing carefully designed, **specialised agronomy trials** to address specific knowledge gaps. The specifics of the trials will depend on: Aspects of site selection, experimental design, management practices, and observations will depend on the questions at hand and the approach followed to answer these (on-station field trials, greenhouse trials, laboratory work, etc.). It is anticipated that specific protocols for researcher-managed agronomy will be evaluated on a case by case basis.

Activity 4.2. Develop recommendations for rehabilitation of non-responsive soils for legume production

Task 4.2.1. Assessment of the occurrence of non-responsiveness

This task involves the careful analysis of data from phase I and the results from task 5.3.2., with the joint aim of prioritising research questions on legume productivity to be addressed in a limited set of agronomic trials and creating an inventory of potentially non-responsive soils that will lead to the formulation of hypotheses on major factors implicated in non-responsiveness. Also important would be to evaluate the results obtained through the NSF-BREAD project on non-responsive soils, implemented in Nigeria, Tanzania, Kenya, and DR Congo, and having soybean as a priority crop.

Task 4.2.2. Strategic trials to determine the mechanisms behind non-responsiveness

This task aims at unravelling what causes non-responsiveness and identifying, if relevant, practices to restore responsiveness. This task should only be initiated after observing the performance of multi-locational adaptation trials (see below) and evaluating the anticipated occurrence of non-responsiveness (e.g., less than 5% of the plots would not justify spending effort on this). Aspects of site selection, experimental design, management practices, and observations will depend on the observations made during the diagnostic and adaptation trials. It is anticipated that specific protocols for researcher-managed agronomy will be evaluated on a case by case basis.

Activity 4.4: Evaluate the medium- to long-term impact of legumes on overall farming system productivity and natural resource conditions

Task 4.4.1. Agreement on the appropriate design in close discussion with other initiatives investing in long-term trials (related to other crops).

This task, which involves decisions on the nature, design, location and duration of long term legume-based soil fertility trials, needs to be implemented in coordination with a new initiative on the establishment of a set of long term trials evaluating the sustainability aspects of Integrated Soil Fertility Management options, led and co-supported by IITA. It is expected that this task will advance toward the end of 2014.



Task 4.4.2. Establish long term Agronomic trials to assess farm-level benefits of enhanced legume production/productivity

Aspects of site selection, experimental design, management practices, and observations will depend on the observations made during the diagnostic and adaptation trials and will be agreed upon in consultation with above new initiative. It is expected that this task will advance toward the start of 2015.

V.3. Demonstration

This cluster is meant for relatively large scale on-farm demonstrations of tested (*best-bet*) technology options, aimed at overcoming *soil fertility and management constraints to legume intensification*. Together with the adaptation activity cluster, it addresses **Activity 2.2** (N2Africa led D&D), the milestone to which is listed in table 4. It also includes analyses that feed into objective 3.5 (impact of environment and management on nutritional quality).

Table 4. Targets of direct beneficiaries of per country of N2Africa led dissemination (cumulative).

Milestone	2014	2015	2016	2017	2018
2.2. Dissemination partners attain/surpass the anticipated number of households targeted	6,250	12,500	18,750	25,000	25,000

Activity 2.2: Facilitate N2Africa-led dissemination campaigns in the context of development-to-research learning cycles with specific attention to gender

Task 2.2.1 Implementation of co-managed demonstration trials

This task involves setting up large comparative demonstration of basket of best-bet technologies, i.e. **demonstration trials**, in coordination with farmer associations or kebeles (Ethiopia). The main aim of these trials is to demonstrate a relatively wide set of technology options that are designed to overcome different production constraints of local relevance. At the same time, they offer an opportunity for evaluating the performance of these technologies. For this reason, it is recommended to have some of the treatments from the diagnostic trials overlap with the larger set of treatments in the demonstration trials. This overlap will allow performance data for the two type of experiments to be combined, leading to more powerful analysis of production constraints and appropriateness of technology. Implementation and data collection will be done by development partners, but for a subset of 20-50 trials, so called **focal demonstrations**, data collection should be performed by research partners under close supervision of N2Africa staff, to create a reference dataset of high technical quality.

Site selection

The target is to reach 5000 households per year per country, which would equate to at least 25-150 associations, assuming 50-200 households/farmer association. One demonstration will be implemented per association. The sites should be selected so as to represent the adoption domains present in the target regions for a particular crop. Avoid extremely poor or good soils.

Experimental design, treatment structure and number of replicates

Co-designed with farmer associations around the themes: variety, input, management, systems. Organised discussions with representatives of farmer associations and extension agents should yield a set of technologies to be demonstrated. Chosen best-bet technologies may be targeted to solve specific, local agronomic problems or to meet certain market demands. Associations may also suggest inclusion of technologies that they have encountered outside N2Africa to test against N2Africa's best-



bet technologies (i.e. “best-guess technologies”). Different farmer associations may of course choose different technologies.

Some principles: a minimal number of plots needs to be included in each demonstration (>4), always include a zero input control and best local practice with farmer's variety and management. Include the same treatments as used in the diagnostic trials if possible, to allow for joint analysis. Ensure that selected treatments are a subset from a predetermined and limited set of options so as to ensure sufficient replication of treatments across trials. Trials will be replicated across trial locations but each location will only hold one replicate (i.e. each treatment will be implemented only once at each site), resulting in a total of approximately 25-50 replicates for the standard treatments (i.e. those treatments that are present at each site).

Plots will be 10 x 10m (per treatment). Since not all treatments are repeated across all demonstrations, the experiment as a whole will effectively be an incomplete block design. Assure that each crop/treatment combination is at least planted in 5 locations, so that statistical significance of differences with the standard treatments (present in all demonstrations) can be established.

Observations

Grey shading indicates specialized observations that should only be taken if sufficient technical expertise and manpower are available.

Measurement/ Observation	Details	Remarks
crop		
Grain yield	Fresh weight of shelled grain (unshelled for groundnut)	Use standard digital hanging scale with 10g precision (2 decimals)
Weight of above-ground residue at harvest	Fresh weight of all vegetative material on the plot.	Use standard digital hanging scale with 10g precision (2 decimals)
Grain nutrient analysis	Laboratory analysis to determine nutritional quality (3.5)	
Location		
GPS coordinates	Latitude, longitude, elevation, of homestead and trial field	Use decimal degrees
Soil		
Top soil fertility	Org C, total N, available P, pH, texture, ECEC (measured in a central lab)	Sample top 0-20 cm before planting, at least 6 cores per plot, mixed, subsampled, air-dried, sent to reliable laboratory
Key agronomic observations		
Emergence	% emergence in each plot	field book
Farm characterization	Data on household and farm characteristics	field book
Occurrence of (a) biotic stresses	Severity scores	field book
Cropping calendar	Dates of important management interventions, occurrence of stresses and phenological stages	field book
Participatory feedback	Evaluation of technology performance.	field book

Implementation and management

Demonstration trials will be co-managed with farmer associations. Planting and harvesting will be done by technicians, with guidance from N2Africa staff where possible. General management such as weeding and biocide application (where applicable) will be by done by participating farmers. Specialised management related to specific treatments should be overseen by technical staff.



Weeding and pest-control should be done according to best practices as recommended by national research institutions.

Comments

Demonstration trials involve the organization of planning meetings, mid-season field days and exchange visits and a post-harvest evaluation. Meetings and field days should involve a substantial number of participating farmers and should aim at the collective evaluation and comparison of the performance of the different technologies. The planning meeting before planting should serve to plan the trial, select the treatments and allow farmers to choose treatment(s) for the **adaptation trials**. At harvest, differences in yield and their probable causes may be discussed as well as suggestions for the subsequent season. The information generated through these meetings should be properly documented, summarised and communicated back to the farmer associations.

V.4. Adaptation

This cluster also addresses objective 2.2 (N2Africa led D&D) and involves a large number (> 200-1000 per year, per target region, >1000-5000 per Country) of small, farmer managed field trials that form satellites of the larger demonstration trials in task 2.2.1. These trials are intended to evaluate the effect of N2Africa technologies under farmer management, to document adaptations farmers make as they implement these technologies and to identify best-fit technologies.

Task 2.2.2. Implementation of farmer-managed adaptation trials.

Adaptation trials are small trials of the technologies included in the demonstrations. Because of the large number of trials, they will be implemented by development partners and data collection will mainly be in the form of farmer feedback by short questionnaires or mobile telephone. A subset of 25-100 participating farmers, so-called **focal farmers**, will be targeted for more intensive data collection in the form of GPS coordinates, yield measurements and in-depth evaluation of technology adaptation by research partners under close supervision of N2Africa staff.

Site selection

Participating farmers will generally be members of the associations involved in the demonstration trial. Farmers will be free to select the location of the trial and timely supply of inputs should ensure that site selection is not limited by availability of land. For focal farmers the exact location of the trial will be registered using GPS. The sites should be selected so as to represent the adoption domains present in the target regions for a particular crop.

Experimental design, treatment structure and number of replicates

Decided by farmers based on their interest, but limited to 2-4 treatments. During the planning stage of the demonstration trials, farmers should be presented with the technology options and asked for their interest in participating and preference for a specific treatment. If possible apply a fixed control treatment in each adaptation trial by offering a standard control (variety/input combination) as an option. An alternative to using a fixed control treatment is to use of the farmer's current practice as a control. In all cases, also for focal farmers, ensure a sufficient number of replicates (at least 10) for all treatment/control combinations. Data collection from the adaptation plots which are not monitored in detail (the majority of the adaptation plots) will be through farmer feedback.

Implementation and management

Technology packages containing labelled and measured inputs for 10 x 10 m control and treatment plots should be distributed, in time for planting, to farmers in accordance to their choice. Farmers will receive management recommendations for proper implementation of treatment(s) and control but will



be free to manage their plots as they wish. Changes made to the technology in terms of implementation and management form an important part of the learning from the adaptation trials and should be carefully documented for focal farmers using a standard feedback form.

Observations

Measurement/ Observation	Details	Remarks
crop		
Estimated grain yield	Farmer estimate (local unit) of yield of control and treatment	Reported on feedback form
Estimated residue yield	Farmer estimate (local unit) of amount of residue for control and treatment	Reported on feedback form
Grain yield	Fresh weight of shelled grain (unshelled for groundnut)	Focal farmers only
Weight of above-ground residue at harvest	Fresh weight of all vegetative material on the plot.	Focal farmers only
Location		
GPS coordinates	Latitude, longitude, elevation, of homestead and trial field	Focal farmers only
Other observations		
Participatory feedback on technology	Feedback on performance of the technology	Focal farmers only
Participatory feedback on adaptation	Feedback on management and adaptations made to the technology	Focal farmers only
Farm characterization	Data on household and farm characteristics	Focal farmers only

Table 5: Specific characteristics of the different tasks

Activity Cluster	Diagnosis	Researcher Managed Agronomy		Demonstration	Adaptation
Task number	<u>5.3.2</u>	<u>4.1.2., 4.2.2.</u>	<u>4.4.2</u>	<u>2.2.1</u>	<u>2.2.2</u>
Site selection	Priority legumes, priority areas; Representative range of soil types.	Representative soils and ecology	Typical soil and ecology.	1 demonstration for each of 25-50 associations. Avoid extremely poor or good soils. Stratified using adoption domains	Based on association/farmer interest. Stratified using adoption domains
Varieties used	Best improved	as required	Best improved	Improved and local	Best improved
No. of treatments	2-6	as required	3	4-6	2-4 (subset of demonstration)
Essential treatments	control, inoculation, best fertilizer, best fertilizer + inoculation	control, as required	Continuous cereal, continuous legume, rotation	Control, best practice, Selection from a limited set of options.	Control (current farmer practice or fixed)



Approx no. reps per trial location	1	>4	>4	1	1
Approx plot size	10 x 10 m	as required	>=10 x 10 m	10 x 10 m	10 x 10m
variables measured	grain/residue yield, (biomass, MPN, nodulation assessment, plant tissue analysis, BNF)	as required	biomass, MPN, nodulation assessment, plant tissue analysis, BNF	grain/residue yield,(grain nutrient analysis)	estimated grain yield (measured for focal farmers)
associated variables	GPS coordinates , farm typology, soil samples, soil depth, weather, reported biotic and abiotic stresses, photographs	as required	weather, pests, disease, soil samples, trial assessment form	GPS coordinates , farm typology, soil samples, soil depth, weather, reported biotic and abiotic stresses, participatory feedback on performance and suitability	input/output prices, participatory feedback on management and performance
Comments/	Measurements and associated observations need to be of very high quality	The number of trials of this type should be kept to a bare minimum and be reserved for testing promising solutions to important problems	Engage in an overall initiative on this; there will be an overall planning meeting on this once we get funds; need to plan well.	Make sure to limit the number of options as to ensure sufficient replication of treatments includes field days and exchange visits	A subset of "focal" farmers should be selected for more precise and in-depth evaluation and documentation of adaptive practices

VI. Approximate timing of activity cluster implementation

The Demonstrations will be modified for the different seasons in unimodal areas and retained for the two seasons in bimodal areas. Subsequent demonstrations will be modified based on feedback received from the various other activities. The Adaptation activities are distilled from the Demonstration results and will thus also be modified on an annual basis.

Most agronomic tasks will be updated and repeated several times throughout the project, with each repetition called a **Generation**. More details on the sequencing and timing of the various activity clusters are presented in table 6.



Table 6: Approximate timing for implementing the activity clusters for unimodal and bimodal areas (note: 'G' refers to 'Generation').

Unimodal regions										
Activity	2014		2015		2016		2017		2018	
Diagnosis	G1		G2		--		--		--	
Res-mgd agronomy	[as relevant]									--
Demonstration	G1		G2		G3		G4		--	
Adaptation	G1		G2		G3		G4		--	
Bimodal regions										
Activity	2014		2015		2016		2017		2018	
Diagnosis	--	G1	G2	--	--	--	--	--	--	--
Res-mgd agronomy	[as relevant]									--
Demonstration	G1	G1	G2	G2	G3	G3	G4	--	--	--
Adaptation	--	G1	G1	G2	G2	G3	G3	G4	--	--