Opportunities for N2Africa in Ethiopia

Workshop Report

E. Ronner, K. Descheemaeker,
G.J. van den Brand and K.E. Giller

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N2Africa

Putting nitrogen fixation to work for smallholder farmers in Africa

N2Africa is a project funded by The Bill & Melinda Gates Foundation by a grant to Plant Production Systems, Wageningen University who lead the project together with CIAT-TSBF, IITA and many partners in the Democratic Republic of Congo, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda and Zimbabwe.

Email: n2africa.office@wur.nl
Internet: www.N2Africa.org

Authors of this report and contact details

Name: E. Ronner
K. Descheemaeker
G. van den Brand
K. Giller

Partner acronym: WUR

Address: P.O. Box 430
6700 AK
Wageningen
The Netherlands

E-mail: esther.ronner@wur.nl
katrien.descheemaeker@wur.nl
gretaj.vandenbrand@wur.nl
ken.giller@wur.nl

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Introduction

N2Africa is a large scale, science research project focused on putting nitrogen fixation to work for smallholder farmers through increasing grain legume production in Africa. N2frica is funded by The Bill & Melinda Gates Foundation and The Howard G. Buffet Foundation through a grant to Plant Production Systems, Wageningen University, in the Netherlands. It is led by Wageningen University together with CIAT-TSBF, IITA and has many partners in the Democratic Republic of Congo, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda and Zimbabwe. Currently, new partnerships are established in Ethiopia, Uganda, Tanzania, Liberia and Sierra Leone. More information on the N2Africa project can be found on our website: www.n2africa.org.

To explore the opportunities for expansion of N2Africa to Ethiopia, a workshop was organized in Addis Ababa from 30 April to 2 May. Main partner in the organization was ILRI. The aim of the workshop was to develop a proposal for N2Africa activities in Ethiopia, together with potential project partners. This report summarizes the proceedings of the workshop. An overview of the workshop programme is presented in Appendix A.

Monday 30 April: Opportunities for N2Africa in Ethiopia

The first day of the workshop was a discussion, open to all organizations interested in the N2Africa project, around the opportunities for N2Africa in Ethiopia. A complete list of workshop participants is presented in Appendix B.

Objectives of this first day were:
- To explore the role of legumes in Ethiopian livelihoods
- To discuss ways in which N2Africa could enhance legume production in Ethiopia
- To identify opportunities to increase benefits from biological nitrogen fixation in legumes
- To identify knowledge gaps that N2Africa should address through research

Workshop opening
The workshop was officially opened by Dr. Tilahun Amede from ILRI, and Dr. Fentahun Mengistu from ARARI gave a welcoming speech on behalf of the governmental and regional research institutes.

Presentation 1: Introduction N2Africa
Prof. Ken Giller – Wageningen University
See presentation 1

Discussion/ comments:
- Will legumes fit in Ethiopian farming systems, where land areas are very small? Crop rotation may not always be feasible. Currently the area under legumes is very small (probably less than the 10% that was mentioned). So, how can we achieve an impact from such a small area?
- In the presentation Prof. Giller acknowledged that the value chain approach may not reach poorer farmers and would favour wealthier farmers. Divergent views were expressed as well as the question about how one can promote interventions if market access is not secured or improved. It was recognized that we need a value chain approach, but it should not be seen as the sole solution for reducing poverty. We have to think about things we can do to target the poor and increase their livelihoods.
- In order to reach the ambitious targets of the project, we will have to target the diversity of markets and tackle the big constraint of the input supply side. For that we have to partner with others (e.g. IFDC), so that we can focus on our expertise (agronomy) and others can focus on their expertise around marketing. Another prerequisite for reaching the ambitious targets is testing at scale: across regions, countries, partners.

Presentation 2: Opportunities for increasing benefits from biological nitrogen fixation in soybean
Mr. Zinaw Dilnesaw – EIAR Pawe
See presentation 2

Discussion/ comments:
- Making soybean a priority crop, and promotion soybean cultivation should go hand in hand with market development. Technologies such as inoculants and improved varieties are available, but the question is how to scale up these technologies, and how to get them to farmers. This is only feasible with production for markets. In terms of the local/household market, it will be important to facilitate the uptake of soybean in the local diet and train people about the use of soybean for different purposes (food products, feed). Also the involvement of all stakeholders, including agro-processors, in market development is important.
- Soybean has great potential: the demand for soybean is higher than the supply, and this will increase in future due to the demand from newly establishing processing factories and the potential for area expansion. Furthermore, soybean is potentially a very important crop due to its protein and oil content. It is responsive to inoculation.

Presentation 3: Opportunities for increasing benefits from biological nitrogen fixation in highland pulses
Dr. Gemechu Keneni – Holetta Research Centre
See presentation 3

Discussion/ comments:

- Also for chickpea/ highland pulses the most important question is how to get technologies to farmers.
- In some areas chickpea and faba bean production is actually declining (e.g. Arsi/ Bale), due to mechanization of wheat production – chickpea and faba bean disappeared from the crop rotation, since they do not fit in mechanized production. However, Faba bean could be a very useful crop to break cereal monocropping.
- The problem of communal green pod consumption from the fields would be easy to overcome.

Presentation 4: Opportunities for increasing benefits from biological nitrogen fixation in forages
Solomon Mengistu – EIAR Debre Zeit
See presentation 4

Discussion/ comments:

- Due to limited land availability, it is not likely that farmers will use forages in their crop rotation. Other ways to improve cultivation of forages are therefore to grow forages around fences, in intercropping, etc.
- Have there been any intercropping experiments with forages? Intercropping is only successful with maize; it has not been successful in systems with wheat, barley, teff.

Break-out groups: 'conversation mapping' of suggestion for N2Africa in Ethiopia
Five groups with discussion around knowledge gaps and research questions for N2Africa on:

1. Food legumes – germplasm development and farming systems
2. Fodder legumes – germplasm development and farming systems
3. Dissemination and scaling
4. Rhizobiology
5. Markets/ value chains

Group 1: Food legumes
For highland pulses in Central Ethiopia important issues are:

- Stress mitigation
- Self-pollinating vs. cross-pollinating varieties
- Staff gaps (low capacity, high staff turnover)
- Rhizobium production

Opportunities for N2Africa:

- Expansion of legume production, which also enhances the productivity of cereal crops
- Market demand for legumes
- Variety selection

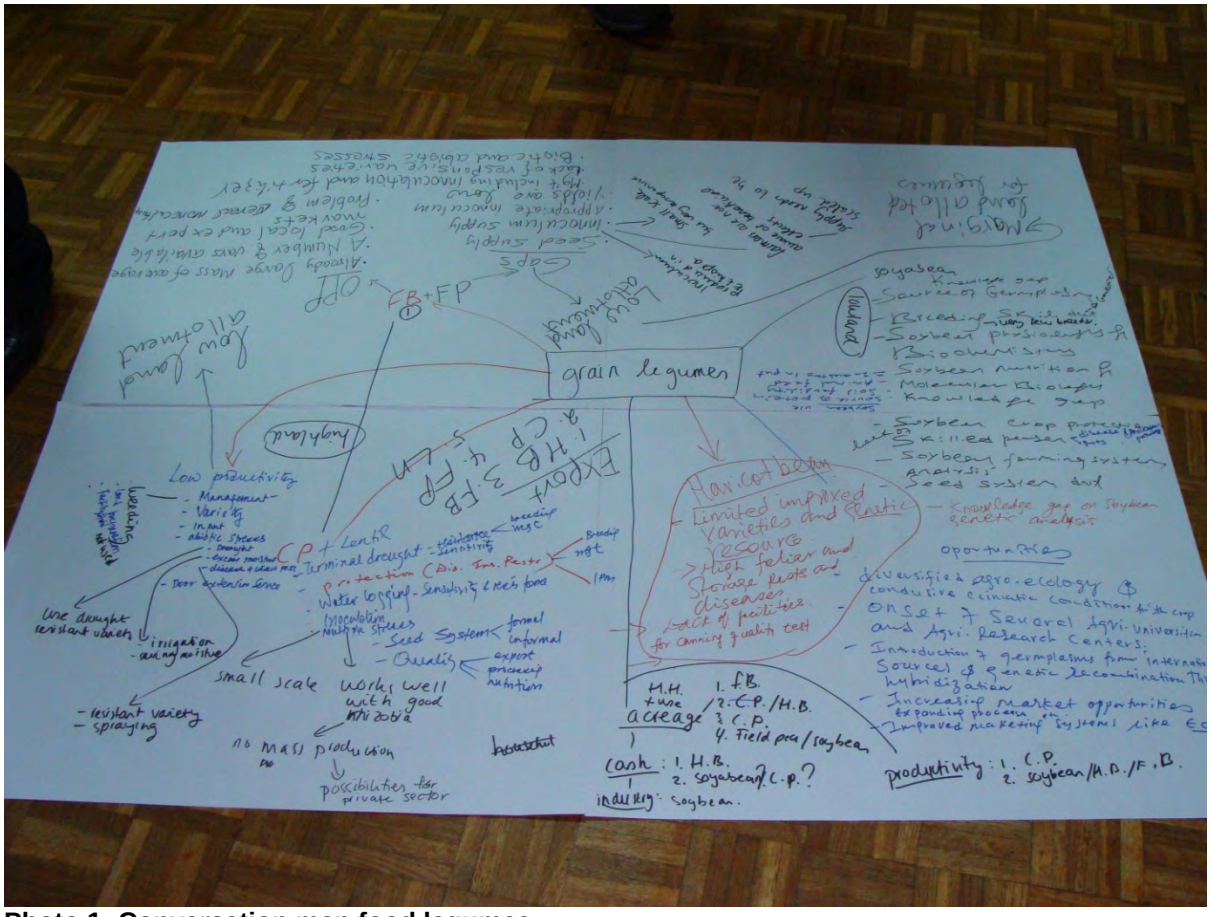


Photo 1: Conversation map food legumes

Group 2: Forage legumes
Forages are not often used because of:

- Availability of seeds
- Land pressure (farmers prefer food crops)
- Markets are not well developed

To tackle this problem N2Africa should:

- Target the right niches
- Work on capacity building around forages

Photo 2: Conversation map forage legumes

Group 3: Dissemination and scaling
Most important issues around dissemination and scaling-up of technologies are:

- Seed multiplication/ availability of seeds
- Low fertilizer/ chemical use
- Training needs
- Access to credit

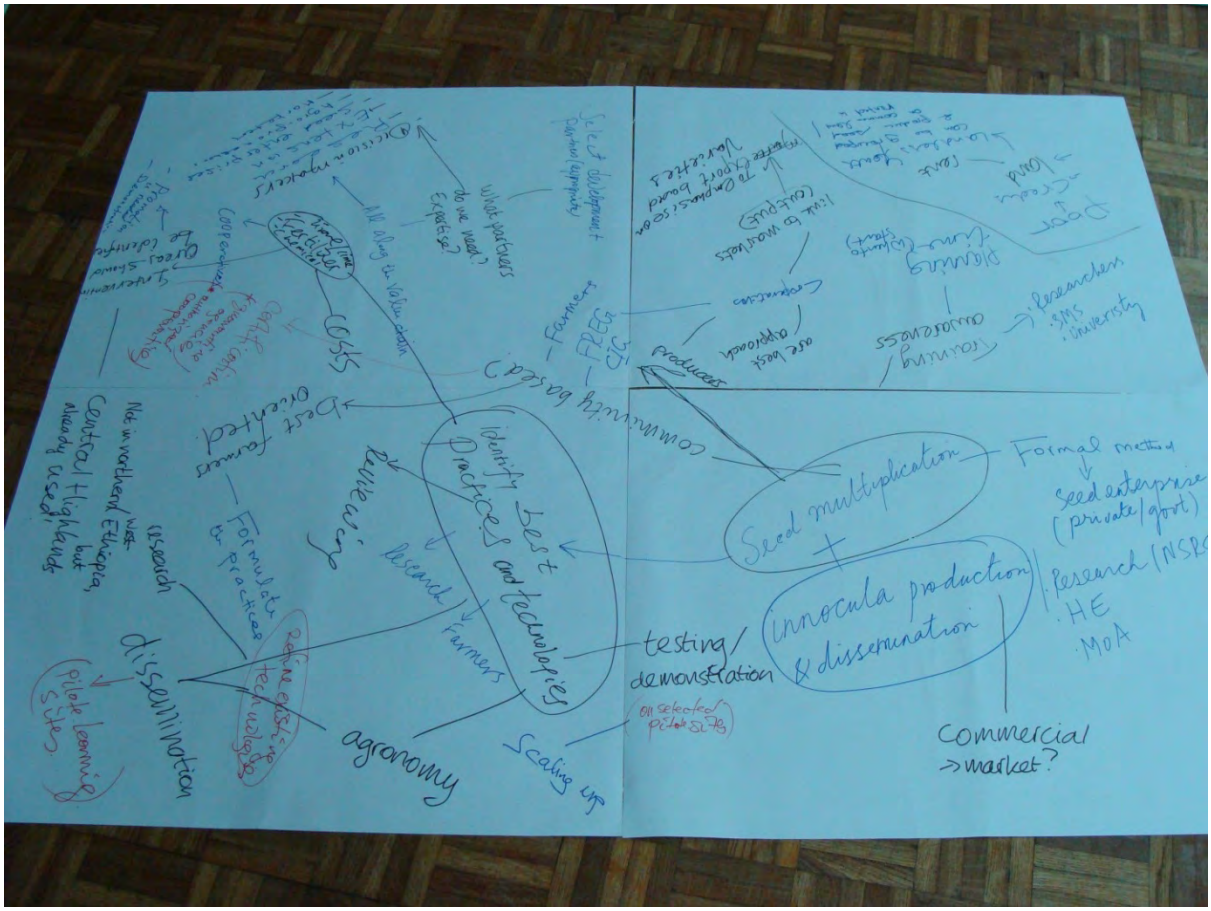


Photo 3: Conversation map dissemination and scaling

Group 4: Rhizobiology
Issues identified for rhizobiology are:

- Production of inoculants
- Institutional capacity/ staff
- Policy support
- Interaction with nutrients

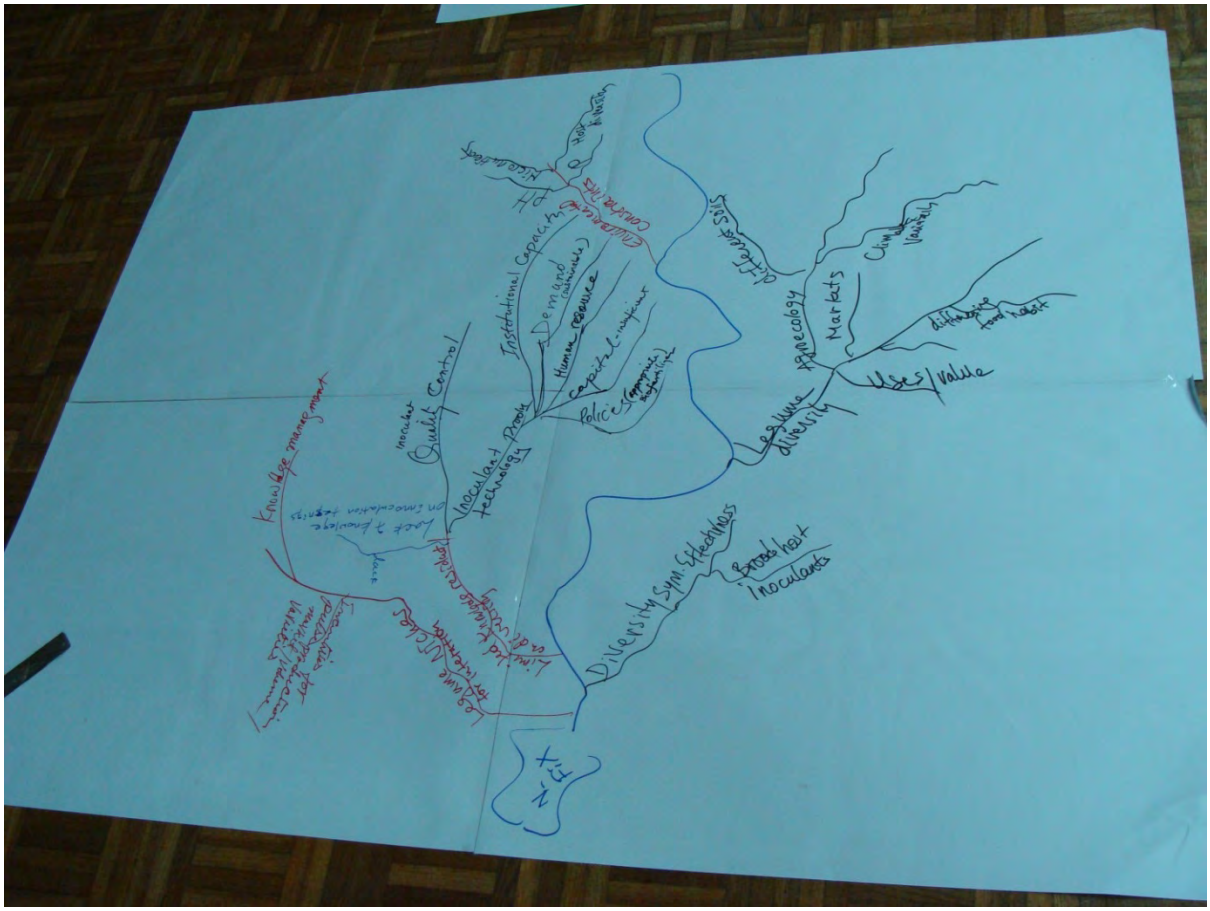


Photo 4: Conversation map rhizobiology

Group 5: Markets and value chains
Issues identified for markets and value chains are:

- There is no private sector involvement in forages
- Milk production could be promoted
- New crops could be introduced
- Seed availability and quality
- Quality of inoculants
- Need for cooperatives
- Action research
- Infrastructure/ market access, both in space and time
- Low use of inputs (knowledge gap)
- Poor links between research and extension

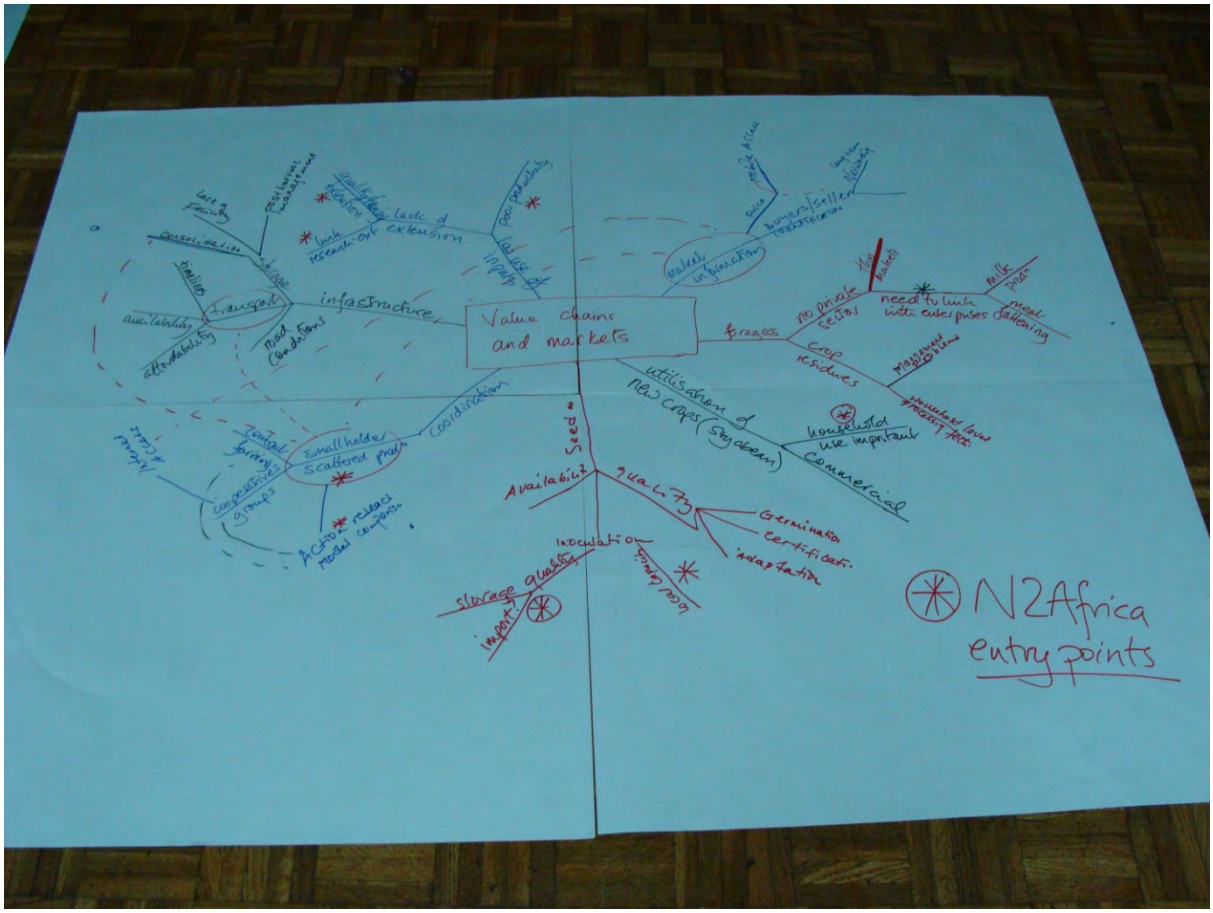


Photo 5: Conversation map markets and value chains

Tuesday 2 May: Proposal preparation

On day 2, the workshop continued with a limited number of participants to write a draft project proposal. Objectives of this second part of the workshop were:

- Introduce N2Africa in Ethiopia
- Identify knowledge gaps in grain and forage legumes research in Ethiopia
- Decide which legumes to work on in which locations
- Identify partners to work with in these locations
- Define activities and approach for N2Africa in Ethiopia
- Prepare/ draft a project proposal for N2Africa in Ethiopia
- Planning of limited number of seed activities in second half 2012

About N2Africa and the workshop
N2Africa is going to be an important project for Ethiopia, with the potential to raise currently low agricultural productivity and address both malnutrition and land degradation. When legume yields are higher, they change from 'a life saver to a livelihood saver'. Ethiopia can also provide opportunities to N2Africa, since it is a very diverse country, hosting various niches and as such representing a kind of laboratory for legume technology testing. Also, the presence of numerous institutes can provide good opportunities for cross learning, so that technologies can spread fast.
N2Africa has a strong field focus with its core being development and dissemination. Monitoring and evaluation provides the link to research, and feeds back into the field activities. The resulting cyclic nature of the project allows for adaptive co-learning among project partners and beneficiaries. For legumes, 80% of the yield gap can be taken back to agronomic management (e.g. inoculation, P fertilizer, integrated pest and disease management). Therefore, there is a strong emphasis on the M in $(G_L \times G_R) \times E \times M$, which is embedded in an understanding of farming systems functioning in different socio-ecological niches. Pathology is also important as a supporting factor and is embedded in $(G_L \times G_R) \times E \times M$. In other projects in Ethiopia, breeding already takes an important position, so N2 Africa can be complementary to these projects by focusing on agronomic aspects and working with promising existing genotypes.
The major outcome of the workshop will be the shape of a project proposal with tasks assigned to different people and a plan on how to use the seed money ($ 24,000) for activities in the remainder of 2012.

Legume niches
Niches refer to the fit for technologies, which can be identified by understanding systems at different temporal and spatial scales in terms of their agro-ecology and socio-economics (taken together as "socio-ecological niches", as mentioned above).
Criteria for selection of legume niches were identified and prioritized through a plenary discussion:

1 Land coverage
2 Utilization by farmers
3 Markets
4 Compatibility
5 Potential to make a change
6 Geographical distribution
7 Response to inoculation
8 Peculiarity

The five first criteria were used by participants to select the legumes to focus on in Ethiopia (table 1).

Table 1: Selection of grain and forage legumes

Grain legumes	scores	Forage legumes	scores
Faba bean	7	Cowpea	9
Common bean	9	Vetch	5
Chickpea	9	Tree Lucerne (Tagasaste)	1
Soyabean	7	Soya	2
Fieldpea	4	Hedgerow trees (Sesbania, Caliandra)	5
Cowpea	3	Trees in cropland (Faidherbia, Acacia)	2
Groundnut	1	Pigeonpea	6
Lentil	2	Alfalfa	1
Grasspea	1	Grasspea	2
		Lablab	2

Food legumes identified for Ethiopia are therefore faba bean, common bean, chickpea and soybean. Forage legumes selected are cowpea, pigeonpea, vetch and hedge rows. A further justification for each of these legumes based on the selected criteria is presented in tables 2a and b.

Table 2a: Justification food legumes

	potential for change	land coverage	markets	utilization	problems
Faba bean	efficient N_2-fixer, even without fertilizer; productivity can be increased in acid-prone areas: lime, acid tolerant Rhizobia strains; introduce chocolate spot resistant varieties	different agro-ecologies, important in wheat/barley systems; huge area under faba bean production – faba is disappearing in commercializing/ mechanized systems; grows in acid soils, moisture stressed areas	export to Middle East, there is high demand – but seed type/ quality suitable for export?	part of cereal rotations; staple food	chocolate spot
Common bean	N_2-fixation and response to inoculation can be improved; monocropped systems can be developed. 38 new varieties released; climbing varieties can intensify systems and address food security (e.g. enset systems, systems under land pressure)	widely grown	potential for export; currently being traded; agro-processing needs promotion	used by farmers in the maize and enset systems; intercropping; mono-cropping in dry areas	
Chickpea	N_2-fixation can be improved (by securing adequate soil moisture and avoiding areas prone to waterlogging); land races responsive to inoculation; potential to release P in soil; adaptation to climate change (drought resistant, grows on residual moisture); irrigation can be opportunity; double cropping on residual moisture could be a niche;		export markets are booming + local markets	multiple uses: forage, grain; important food security crop	seasonality: restricted to residual moisture; N_2-fixation is low

Soybean	high N_2-fixation; adaptability; improving soil fertility; food security crop (protein and oil content); multi-purpose crop	adaptable to different agro-ecologies and soil types; W-Eth.; currently grown in small niches	demand grows by 70% p.a.; demand by big companies - e.g. contract farming; need to develop local market (home consumption); soyamilk processing factories are developing; top priority in policy	multi-purpose crops (nutritious feed, cash, food)	no compatible Rhizobia available in Ethiopia; can you convince farmers to grow a cash crop?; outlet market is needed

2b: Justification forage legumes

	potential for change	land coverage and niche	markets	utilization	Problems
Forages (general)	Small ruminants; Crop residues	Niche for forages is spatial and temporal. Hedgerows, plot boundaries, along soil bunds	Small ruminants; limitation for milk markets		land/population pressure
Cowpea	easy to propagate	drought tolerance; widely used; intercropped; many niches	grain market;	drought tolerance, multipurpose;	
Vetch	developing dairy and fattening industry	part of crop rotations and intercropped; short fallows, mixed with other forages (oats-vetch); timing of harvest + conservation of fodder: provide feed in other periods; possibility to grow on residual moisture	dairy markets; milk cooperatives; meat to the cities	cut and carry	
Hedgerow	no competition for cropland; less labor after establishment ; coppicing potential	reclaiming degraded lands; shed for coffee; intercropping; Tree lucerne in cold highlands; on coffee plantations	dairy markets; milk cooperatives; meat to the cities	multipurpose (fuel, feed, stakes, soil fertility/ land restoration); provide stakes for climbing beans	
Pigeonpea	soil conservation; when used as hedgerow no competition with prime land; facilitate feed market	annuals and perennials; intercropping; fit in marginal areas (e.g. acid soils, dry areas)	grain and livestock markets (through feed – high biomass production)	multipurpose (fuel, feed, food, as hedgerows)	

Topics to include in N2Africa for forages could be:

- Problematic seed systems and link to markets. There might not be huge opportunities to develop fodder markets in itself, but the small ruminant markets present great opportunities for smallholders and might pull (instead of push) the use of high quality. So the forage interventions will need to be linked to the livestock value chains for meat, and to a lesser extent milk.
- Use of crop residues: in Ethiopia, crop residues, and legume residues in particular play a very important role as fodder source.

Presentation 5: An overview of IFDC activities under the AGP-AMDe (Agricultural Growth Program-Agribusiness and Market Development)
Mr. Abey Meherka – IFDC
See presentation 5

Potential areas of partnership with N2Africa:

- Capacity building of cooperatives and farmers
- Supply and distribution of inputs
- Cooperation in research
- Geographical areas (but: AGP areas are high potential areas, where direct impact is expected. This is perhaps not suitable for N2Africa objectives).

Discussion/ comments:

- There is a lack of options for fertilizers and often lack of potassium is a constraint. However, the government has started working on some pilot activities on soil testing and will develop fertilizer recommendations.
- Many farmers do not use fertilizer or use amounts below recommended amounts. The government has a program on fertilizer recommendations.
- Supporting the market side is important. Farmer cooperatives are a key entry point here, because cooperatives can buy fertilizers in much larger quantities and distribute among their members.
- The woredas selected for the AGP-AMDe are high potential areas. We should think of ways to go beyond those if N2Africa wants to collaborate with IFDC also in lower potential areas.

Presentation 6: Soybean value chain project
Mr. Yared Sertse – Coordinator soybean value chain project
See presentation 6.

Opportunities for cooperation with N2Africa:

- household consumption of soybean
- improve productivity

Discussion/ comments:

- Value chains are usually very long and complex with a lot of transaction costs along the line. If farmers are organized in cooperatives the value chains become shorter and the benefits are shared among less people.
- Demand and supply are projected to increase +/- fivefold in 4 years and demand is projected to stay higher than supply. Whether the increase in soybean production comes from (a) area expansion at the expense of other crops or natural vegetation or (b) from increased productivity is not entirely clear and could be subject of more detailed research
- A major constraint is the huge cost associated with transport

Target regions
Ethiopia is a highly diverse country, with different agro-ecological niches. Criteria for selecting regions are (1) the potential for maximum leverage, to generate positive energy and trigger the system and (2) the presence of partners and research institutions. Before expanding one crop, however, it is important to think about how expansion of one crop will affect the others.

Suggested regions for N2Africa to work on in Ethiopia:
- Oromia: faba bean, common bean, chickpea, soybean
- Amhara: chickpea, faba bean, soybean, common bean
- SNNPR: common bean, chickpea, faba bean, soybean
- Benishangul-Gumuz: soybean, common bean

Identification of partners
In each of the regions, partners and projects for potential cooperation were identified (table 3).

Table 3: Partners and projects in Oromia, Amhara, SNNPR and Benishangul-Gumuz

Oromia	Amhara	SNNPR	Benishangul-Gumuz
Debre Zeit EIAR	TL II project (chickpea)	SARI	Assossa ARC
Merkassa EIAR	ATA/ Pepsico	Hawassa University	BoA
Kulumsa EIAR	ILRI	CASCAPE	Ass. Union
Jimma EIAR	ARARI/ EIAR	Inter Aid	Soybean value chain project
Jimma University	BDU Debre Birham	Food for Hunger	UNICEF
Adama University	Gonder University	Self Help	Action Aid
AGP/ AMDe	Debre Tabor University	SOS Sahel	BFED (SIDA)
Facilitator for Change	Debre Markos University	Office & Agriculture	Commercial farmers
CIAT-TSBF / Compro	Wollo University	ILRI	Pawe ARC
	Woldia University	Wolaita Sodo University	Cooperatives
	BoA		Agri-service
	CASCAPE		Sasacana Global
	LSB		ACIR
	ICARDA		CIMMYT
	Cooperatives		IITA
	IWMI		

Problem trees
In breakout groups, problem trees were identified per region (see Appendix C). The same type of problems were identified for many of the regions, such as low institutional capacity and low productivity through a lack of seeds, lack of access to improved varieties, low soil fertility, poor agronomic management, etc.

Justification for N2Africa in Ethiopia – what is new or different?
- Low productivity results in malnutrition and land degradation. Legumes in farming systems can contribute to healthy ecosystem functioning, e.g. through breaking cereal monocultures. However, for this to happen, legumes have to be more competitive (in terms of productivity) and attractive (e.g. in terms of market value, household use)
- There are many niches, agro-ecological zones and a high diversity of legumes → Ethiopia can also be sort of laboratory for N2Africa
- High opportunities for cross-learning across institutes and regions, so the technologies can spread quickly
- Contribution to livestock through forages
- The project will allow studying how we can address different types of farmers and analyze trade-offs that come with the choice for certain crops (=methodological progress)

- When legume yields are increased, they change from ‘a life saver to a livelihood saver’.
- The current state of knowledge in Ethiopia is cereal dominated, and breeding dominated. Rhizobiologists are not able to reach farmers.
- There are so many projects already, but after the project ends, the outcomes are often not sustainable. What is different now is that we will aim to work at a very large scale with thousands of households across regions and agro-ecologies.
- Emphasis on linking to ongoing initiatives, use them and learn from previous experiences.
- We can build on the huge dynamics in the country, e.g. there is a lot of investment in agricultural research in Ethiopia at the moment.

Wednesday 2 May: Approach, objectives and activities

Short introduction of the CASCAPE project (Dr. Arie van Kekem and Dr. Eyasu Elias) and the activities of the Dutch Embassy (Joep van den Broek)
The CASCAPE project is a large scale project operating in 5 regions with input from different local partners, including 6 universities and the local Bureaus of Agriculture. The project works around scaling up best-bet practices and aims to understand what are the enabling and constraining factors for adoption of interventions. To achieve this, the project combines on-farm research to test and validated technologies with the development of knowledge networks. Innovation teams work around value chains, crops and broader issues like e.g. erosion.
The Dutch embassy is supporting various agricultural research and development projects, notably an integrated seed sector development initiative, working with seed producing cooperatives in four regions, and the oil seeds and soya project.
It is clear that synergies can be created between N2Africa on the one hand and CASCAPE and Embassy related projects on the other hand. These would mostly focus around seed systems, legume constraints and opportunities and adoption/upscaling issues. A forum for sharing experiences around adoption could be a concrete way of doing this.

Comments/discussion:

- There is room for research in the issue of upscaling because we need to increase our understanding of the enabling factors for innovations to flourish and to be adopted and the modalities for scaling up. Furthermore, different technologies need different upscaling strategies. E.g. new varieties need approaches that are very different from knowledge-intensive technologies like e.g. agro-forestry systems.

Vision of success (for 5 year project)
To raise average grain legume yields two-fold in four legumes (faba bean, common bean, soybean, chickpea) by extensification (common bean chickpea, soybean) and intensification (Faba bean), and to increase the productivity of livestock products and services by increasing biomass and quality of forages. To increase average biological nitrogen fixation (BNF) by ?? kg/ha, and improve household food security and increase household income by ??, directly benefiting 40,000 households (?? individuals).

Comments/Discussion:

- Legumes as entry points to improve livelihoods through improved agricultural productivity
- Legumes as intensifiers of systems
- To expand grain legume production and forage legumes
- Targeting niches; no blanket approach for all legumes. For instance: there are differences between legumes and areas: some legumes are grown for export, others for food; some areas are highly populated, so expansion of legumes is not feasible everywhere (e.g. for faba bean the goal should not be expansion but intensification, whereas for soybean, chickpea and common bean it could be an increase in area). Extensification (common bean, chickpea, soybean) vs intensification (Faba bean)
- increasing the area under legumes for international markets
- Expanding crops into new areas (e.g chickpea, common bean). Increasing legume production can also be done through crop rotations.
- Not only diversification in space, but also in time. Legumes can contribute to a diversification into different seasons through the use of residual moisture and irrigation for chickpea cultivation (irrigation of legumes feasible for smallholder farmers? – introduction of chickpea in existing smallholder irrigation schemes).
- Farming systems should define the legume niche
- Reduce the risks of farmers. Crops as live savers. Food crops should be the first priority, which can grow into cash crops later on.
- Ethiopia provides a laboratory for Africa – there is a high diversity of environments, large diversity of legume crops, and the greatest diversity of livestock resources in local areas

- Legume residues are valued as much as grains; they are used as livestock feed.
- improving local access to inputs

What is the yield gap we can fill? In general, there is potential to double yields (table 4).

Table 4: Area under cultivation, average yields and potential yields in Ethiopia (2010)

	Land area (ha)	Yield (t/ha)	Potential yield (t/ha)
Faba bean	459,183	1.5	5.0
Field pea	203,991	1.3	
Common bean	237,366	1.4	3.0
Chick pea	208,388	1.5	3.0
Lentil	77,334	1.0	
Vetch	131,043	1.5	
Soybean	11,261	1.4	4.0

Source: Ethiopian Central Statistics Agency, 2010

Dissemination approaches
The classical dissemination approach is: training of trainers, lead farmers training other farmers, etc. In Ethiopia there is experience with:

- model farmers training other farmers ('five to one')
- Farmer field schools/ groups (for research)
- farmers extension groups (for development). Group size: 10 to 20 farmers.
- FREG: farmer research and extension groups - also used for seed multiplication.

At least for inoculation we will have to work with some demonstration plots – people need to become familiar with the technology.
Another approach to dissemination could be to look for partners that do dissemination on behalf of N2Africa – they use N2Africa technologies in their dissemination work. Dissemination could also be part of the research question: test different approaches/ models in different areas. Adapting a strategy based on experimental and control villages might give the project a stronger scientific basis.
We should also look for boundary partners, such as local seed businesses, and use their dissemination model. The availability of seeds is often a problem now, and is the major bottleneck for reaching an exponentially growing number of farmers. We will have to distinguish between foundation seed and community seed. In N2Africa we could start with some foundation seed, but this has to be multiplied through seed loans, seed companies, etc. Currently, an extension approach in Ethiopia is the distribution of mini-packs. They are sold for 2 or 3 birr, so everyone can afford to try them. But: free seed supplies can destroy the local seed systems, so the project will avoid giving any input for free!
In the project we will have the opportunity to test and compare the effectiveness of different dissemination approaches.

Objectives and activities
Break out groups developed the different steps for reaching the vision of success for each legume separately:

FORAGES
Vision: Increasing the productivity of the livestock products (milk and meat) and services (draft power, transport, energy) by increasing the biomass and quality of forages. Making forages available during seasonal fluctuations of feed scarcity, through adequate management and improvement of natural resources.

Justification: Ethiopia is the African country with the largest numbers of livestock resources, with more than 100M of diverse animal species. There is an increasing demand for livestock products with increased urban and rural population and also potential export markets. There is however a very large gap between supply and demand of feed resources in Ethiopia, that seriously limits the livestock productivity.
There are currently about 40M of small ruminants in Ethiopia. Small ruminants are very important for both local and export markets and have therefore great potential for a fast impact on livelihoods

income and better diets if feed becomes available to fatten the animals more efficiently through the year. Forage legumes can play important multiple roles on food, feed, natural resources (soil fertility, soil erosion control, water retention, drought tolerance), fuel, shading, medicines, fencing, housing.

Objectives:
Increase the meat production and quality of small ruminants in Ethiopia
Reduce the negative effects of livestock on environment (over grazing, erosion, and deforestation) by proving quality feed that will support more and better quality animals
Improve soil fertility and soil use by complementing the current systems with multipurpose legumes that with give more food and income to farmers and at the same time will improve their natural resources.

How to achieve it:
Choosing selected forage types that can be widely used/adopted/expanded in the small farm households and integrate them efficiently into the crop-livestock systems of Ethiopia, to complement feeds available from crops residues:
Cowpea – Easy to propagate, drought tolerant, widely used and adopted, good for intercropping, grains have good market, it has a multiple purpose
Vetch – already part of the crop rotation, used for short fallows, good to mix with oats (and complement feed systems), good for conservation of fodder, can provide feeds in scarcity periods,
Pigeonpea – good for soil conservation, does not compete with prime land, there are annual and perennial types, good for intercropping, Grows well in marginal areas (acid soils, dry areas), good potential for food and feed markets. It has multipurpose use (food, feed, fuel, hedgerow).
Hedge row (Sesbania, Leucaena, Tree lucerne for cold highlands) –No competition for cropland, few labour needed after establishment. Good to reclaim degraded lands. Good shed for coffee systems, stake for climbing beans, good for intercropping. Great to increase milk production, cut and carry, multipurpose (fuel, feed)

Activities
- Documenting existing practices, identifying gaps and niches for each project regions.
- Identifying best bet technologies for each context and feasibility to use them
- Identify suitable partners and establish relevant links with them
- Implementation and monitoring of activities
- Evaluate the impact and document, problems lessons learned and
- Sharing experiences with farmer field visits

Expected outputs:
- Increase meat production (fast fattening and quick cash returns and better nutrition for livelihoods) and improve the hives quality of small ruminants.
- With more feeds available for small ruminants we expect to fatten each animal in a shorter period of time. There is also a potential to produce larger animals (about 10kg per animal in a shorter period of time).
- Increasing productivity of animals (faster and more efficient weight gain) will reduce environmental impacts caused by large numbers of animals with low productivity.
- Healthier and well fed animals will have skins of better quality and size that will be better marketed.
- Complementing forage demand driven from the on-going community based small ruminant breeding schemes already developed by other projects.
- Opportunity to introduce local breeding technologies developed from the initiative above, into our N2Africa pilot sites.

Key partners (location specific)
Universities
MOA
EIAR + Regional NARs
NGO's
CGIAR: ILRI, ICARDA, ICRAF, IWMI, CIMMYT, CIAT, IITA
Use key professional resource people when needed

Capacity Building
Educate farmers on new/improved forage seed production and management
Provide in service training for extensions
Creating platforms for researchers joint learning and action
Update and disseminate extension manuals

COMMON BEAN
Vision: to increase the yield of common bean from 1.3 ton/ha to 3 ton/ha through the introduction of high yielding varieties, improved agronomic management and improved inoculation

Objectives:
- To introduce high yielding and high N fixing common bean varieties to farmers
- To introduce and scale up improved agronomic management practices
- To select, multiply and promote effective inoculants for common bean

Steps:
1. Introduction of high yielding varieties
    a. Explore what is available locally and through import (EIAR, seed enterprises, farms, NGOs)
    b. Select the most promising varieties
    c. Seed multiplication through community based activities, individual farmers, research stations
    d. Supply of seed to project target farmers through FREGs (Farmer Research and Extension Groups), cooperatives, Farmer Training Centres
2. Improving agronomic management
    a. Explore the available improved practices, including sowing dates, sowing rate, disease and pest control, fertilizer application (timing and amount), intercropping
3. Improved inoculation
    a. Explore the available inoculants and inoculant technologies
    b. Assess the inoculant effectiveness in relation to soil and climate constraints
    c. Identify variety x strain compatibility
    d. Enhance the inoculant production capacity by building on existing facilities and developing new ones
    e. Distribute the most promising inoculant technologies to the target farmers

Key partners

EIAR/RARI (National Soil Testing Centre):
- Inoculants
- Seed accession
- Agronomic practices
- Dissemination
- Implementation

Universities
- Sources of inoculants
- Know how/training
- Implementation/dissemination

NGOs/ private sector
- Organic seed institute
- Local seed businesses
- Pioneer

MoA/BoA, government extension structures (FREG, FTC)

Capacity building
Long term training (MSc, PhD): legume agronomy, Rhizobiology
Short training
- farmers
- development agents (DAs)
- technicians: universities, research centres

Inoculant production facilities
Quality control systems for seed (community based, individual farmers) and inoculant

FABA BEAN
Project setup
1. Review the R&D plan with REFLAC (stakeholder platform)
   a. Selection of woredas with REFLAC on woreda level
   b. Selection of target PAs (Peasant Association, = Kebele)
   c. Identify dissemination partners (through REFLAC) and decide on D&D approach through a brainstorm with these partners
2. Training of stakeholders
   On inoculant handling, agronomic practices, seed production
   a. Development Agents, Subject Matter Specialists, Unions
   b. Farmers
3. Research
   a. Rhizobiology
      i. Assessment of available knowledge
      ii. If necessary: strain introduction, collection, evaluation
      iii. Demonstration of inoculant utilization to farmers
      iv. Strengthening the National Soil Testing Centre + Holetta
   b. Agronomic management
      Including: land preparation, weeding, fertilizer, soil acidity amendments
      Factorial trials in different locations (AEZ): strain x host x management
4. Scaling-up

Of available production technologies and new technologies generated through testing

Partners (Arsi)
- REFLAC (further identification at local level)
- National soil laboratory
- Holetta research centre
- Universities: Addis Ababa, Jimma, Hawassa, Haramaya
- Woreda extension service
- Kulumsa research centre

CHICKPEA
Vision: to double the productivity of chickpea from 1.5 to 3 ton/ha and to improve the market access

Activities:

- Packaging improved technologies
- Improved adapted varieties
- Inoculants
- IPDM (Integrated Pest and Disease Management): root rot/wilt, Bollworm
- Agronomic practices: starter fertilizer, cropping system (relay, intercropping), supplemental irrigation

Organization

Yr1:

- 2 kebeles, each with 100 households selected
- Identify interest groups (in clusters)
- Recruit 1 facilitator per kebele + regional coordinator
- Training
- 3 field days for farmers
- Farmer to farmer seed dissemination (1 → 3)
- M&E: Evaluation of results and refinement of objectives and methodology
- Project workshops at regional and national scale

Yr2:

- 100 original farmers + 300 new farmers: 400 farmers per kebele
- Establish links between farmers and market and the seed growers

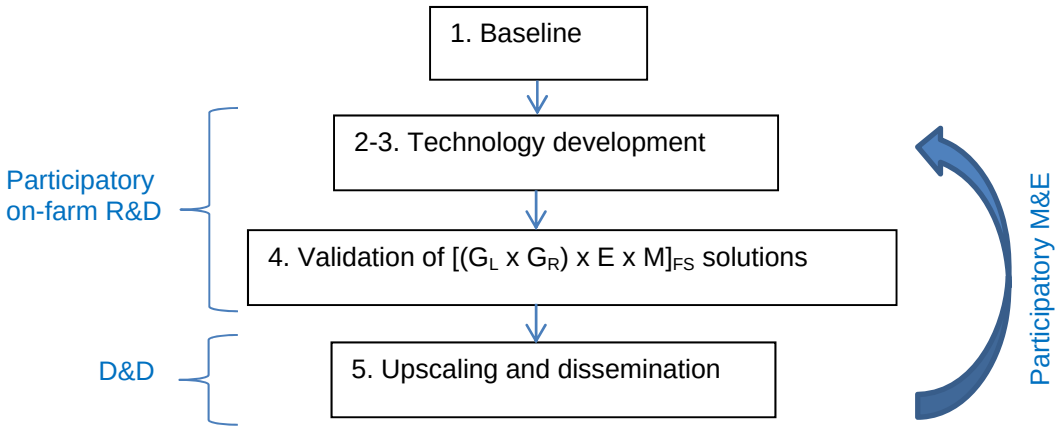
Partners:
Research centres, Universities, BoA, NGOs, projects

Capacity building
Research centres and universities: long-term (MSc, PhD), short-term, experience sharing visits
Extension agents, farmers, SMS: short-term trainings
Laboratory development

SOYABEAN
Justification for including soyabean:

- high N_2-fixation
- wide adaptability to different soil conditions and climates
- improving soil fertility
- raw material for food and feed industries
- demand>supply, and both are projected to increase
- improve food security
- high potential for export
- multi-purpose
- improving rural protein supply
- adapted to current climatic variability

Structure of the different project steps



1. Baseline: understanding the current situation
    a. Farming systems and livelihoods
        i. Review literature, past project information
        ii. Baseline survey
    b. Institutional mapping
        i. Key stakeholders
        ii. Policies
    c. Current and potential market situation
        i. Local market (household and commercial)
        ii. Export
        iii. Value chain analysis
    d. Gap identification
        i. Knowledge and technology gaps
        ii. Gaps in capacity of farmers, government and research institutions, private sector
2. Improve the access to seeds of adapted varieties
    a. Breeding activities
    b. Developing seed systems (+ comparing the effectiveness of different “models”)
        i. Public sector seed enterprise
        ii. Community based, including the farmer unions
        iii. Private sector (e.g. contract farming)

    Partners: BoA, LSB (local seed business) project, IFDC, FC, CIDA, commercial farmers
    Capacity building: Researchers, farmers, DAs

    c. Participatory on-farm variety testing
    On-farm factorial trials combined with agronomic practices, and inoculants (see 4)

3. Improve the access to high quality inoculants
    a. Increase the production of inoculants
        i. Import of high quality inoculants
        ii. Collection of local isolates
        iii. Multiply inoculants
        iv. Develop local labs
        v. Support commercial production and marketing

Partners: Holetta, National Soil Lab, ?Jimma Uni, ?Awassa Uni, ?PAWE, commercial producers
Capacity building: Researchers, commercial producers (e.g. Ambasel)

b. Participatory on-farm inoculant testing
On-farm factorial trials combined with agronomic practices, and crop varieties (see 4)

4. Development and validation of $[(G_L \times G_R) \times E \times M]_{FS}$ solutions

On-farm (can be smallholder/commercial) factorial trials:

In different AEZs: climate (humid hot, dry hot), soils (acidic, fertile, non-fertile)
In different farm typologies (resources, labour, …)
In different socio-economic settings (market access, population density)

Variety x Rhizobium strain x agronomic practice

Agronomic practice can include: fertilizer treatments, weeding, seed spacing and rate, rotation, land preparation, planting time

Partners: BoA, Jimma University (community based research network), Bahir Dar and Awassa University
Capacity building: Extension agents (training of trainers) via the extension linkage departments in the research centres; students

5. Upscaling and dissemination

Comparing different models of dissemination:

- model farmer approach
- minipacks (promotion/production)
- demonstration (through FREGs, farmer training centers)

Partners: SIMLESA, CIAT-TSBF-COMPRO, LSB, CASCAPE, Soya Project, PPPO, NGOs (e.g. FCE)
Capacity building: Farmers, Extension agents

Discussion/ comments on presentations
Forages:

- Instead of focusing on the adoption of forages it is better to focus on livestock markets and the demand side; 'pull instead of push'.
- Small ruminants might be a good niche. They provide farmers with higher income and better diets when the animals can be fattened throughout the year.

Soybean:

- Inoculant production should be ensured. Currently, one private company has started inoculation production in Ethiopia.

Common bean:

- Yield can be increased mainly through intensification

General approach for N2Africa:
Dissemination and up-scaling → learn what is working where → refine technology → dissemination of new/ adjusted technology (figure 1).

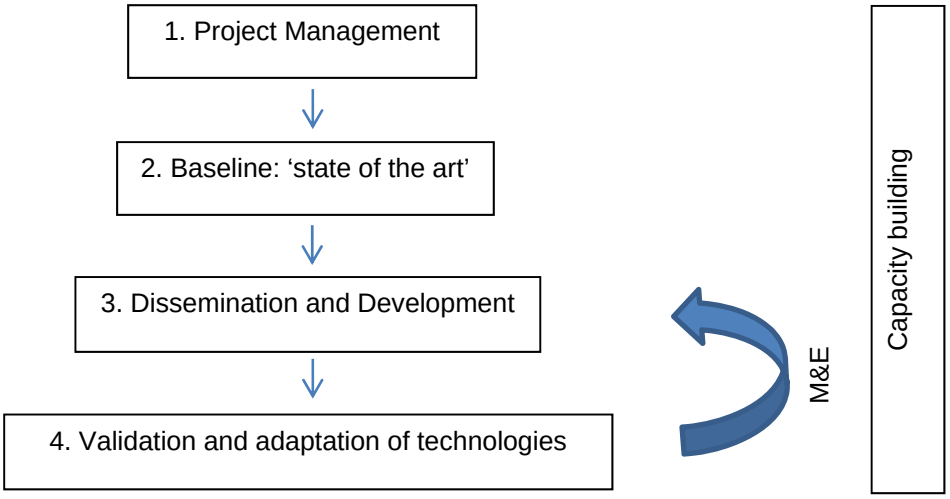


Figure 1: General approach N2Africa in Ethiopia

The farming systems component in N2Africa should address niches in space and time as well as trade-offs. Legumes should become more important for farmers (in terms of labour, inputs, etc.), and so the systems component is essential for success. The utilization of each of the legumes should be considered.
A livelihood approach can help to identify constraints and trade-offs of technology adoption. These are not limited to nutrients and water, but include labor issues as well.

Selection of locations
In each of the four regions, gradients in agro-ecologies over short distances (from highlands (faba bean, chickpea) to lowlands (soybean + common bean) should determine the site selection. If these gradients cannot be found in the areas identified, then two contrasting sites close to each other can be chosen. The areas identified for N2Africa to work in are:

Oromia:
Debre Zeit (chickpea + vetch, hedge rows) – Melkassa (common bean + cowpea) – Asela (faba + vetch, hedge rows). Distance: 150 km. This site has a good market potential due to its proximity to Addis Ababa.

SNNPR:
Damot (chickpea, soybean + vetch, hedge rows) – Alaba (common bean + cowpea) – Hawassa (soybean, common bean + cowpea, hedge rows). Distance: 200 km

Amhara:
Worreilu highlands (faba + vetch, hedge rows) – Jamme vertisol (faba, chickpea + cowpea) – Merkabet dry area (common bean + cowpea). Distance: 110 km

Benishangul-Gumuz:
Pawe or Assossa (soybean, common bean + cowpea, hedge rows) – to be decided by the regional team.

Further guidelines for site selection based on partners to work with, randomized control trials, etc. should be developed.

Rhizobia/ inoculation

1. Quality control (QC)
    a. Establishing a QC system for testing inoculants is first priority.
    b. This should be housed at EIAR Holetta who are already developing a QC system and have a government mandate.
    c. The QC system should be checked and established with international and national experts to ensure top quality standards.
2. Inoculum will be promoted directly as part of the agronomic management packages for soyabean and chickpea. Further research is needed to confirm the need for inoculation with common bean and faba bean.
3. Inoculum supply – criteria to be considered are quality, accessibility and affordability. All inoculants will be sold, even in small packs for farmer testing.
    a. Importation - A short-term approach is to import the best quality inoculants. Research to date through COMPRO has identified that the best quality product tested is Legumefix, so we could rely on using their inoculants. If orders are placed three months in advance there is no problem with importation. If strains from Ethiopia are preferred these can be sent to Legumefix for inclusion in the inoculants.
    b. Local production – it is important that small amounts of inoculants can be made by research laboratories in Ethiopia to allow field testing of elite strains from screening and selection programmes.
    c. Commercialization of local inoculant production will be encouraged once a sufficient market demand is demonstrated.
4. Laboratory capacity for rhizobiology at EIAR Holetta and EIAR Jimma has been strengthened through the COMPRO project and other grants. N2Africa will invest in university laboratories for MSc and PhD training through research. Training will be needed in handling and use of inoculants for research, extension and development agents. It is essential that these courses are designed and given by experts in the field. Trainings can differ but include 1-2 week courses that will be needed at each of the four main locations of activity.
5. Topics that will need further research will include experiments to understand the lack of response in some soil types such as specific acid or alkaline soils where these are observed.

Seed activities

In the remainder of 2012, the seed activities will be focused around seed multiplication, identification of actual sites to work in (Kebeles=PAs for each agroecology in the four regions), and identification of boundary partners. As such, we will be ready to roll out the activities of the pilot phase from January 2013 onwards. We have $ 24,000 to spend. (Baseline surveys will not be part of this year's seed activities, but can start from January 2013 onwards).
Seed multiplication will be the responsibility of the different regional research institutes, and this will be coordinated by the following focus persons:

- forages: ILRI – Alexandra Jorge
- soybean: EIAR Pawe – Zinaw Dilnesaw
- common bean: Melkassa – Kasay Negash. Contact to be established through Dr. Asefa Taa
- faba bean: Holetta or Kulumsa research centre – Gemechu Keneni and Tadesse Sefere
- chickpea: EIAR Debre Zeit – Asnake Fikre

To estimate the required quantity and varieties, the sites (kebeles) and partners in the sites should be identified. Variety suitability for each site will have to be assessed based on existing information and information from key partners. The regional focus persons (below) will have to interact with the research center focus persons (above) to come to final decisions on which varieties to work with.
The regional focus persons to decide the kebeles to work in are:

- Amhara: dr. Fentahun Mengistu - ARARI
- Oromia: dr. Assefa Taa – ORARI
- SNNPR: dr. Walellign Worku – Hawassa University
- Benishangul-Gumuz: Zinaw Dilnesaw – EIAR Pawe.

Another issue around seed is regulation: for grain legumes, only released varieties can be multiplied. For forages this regulation does not exist. But: all responsible people should check these regulations!

In the pilot phase, we aim to work with 50 to 100 farmers per kebele. Costs for seed production are estimated at $2000 per ha (mainly labour costs). Seed can also be purchased from the market, but in this phase we should focus our efforts on getting the research centers on board to produce the first foundation seed.

Writing tasks
Justification legumes:
Alexandra Jorge: forages
Zinaw Dilnesaw + Yared Sertse + Girma Tadesse: soybean
Endalkachew Wolde-meskel + Walellign Worku: common bean
Asnake Fikre: chickpea
Gemechu Keneni: Faba bean

Justification locations:
Assefa Taa: Melkassa
Enyew Adgo + Fentahun Mengistu: Amhara
Zinaw Dilnesaw + Yared Sertse + Girma Tadesse: Benishangul-Gumuz
Endalkachew Wolde-meskel + Walellign Worku: Hawassa

Endalkachew: literature on rhizobiology

Appendix A: Workshop programme

Wageningen University & ILRI
N2AFRICA WORKSHOP
30 APRIL – 02 MAY, 2012
Addis Ababa, Ethiopia

Monday, April 30, 2012

TIME	ACTIVITY	LEAD PERSON	VENUE
12:00-12:30	Arrival and registration		In front of Large Auditorium
12:30-13:30	LUNCH		
13:30-13:40	Workshop opening	Dr. Tilahun Amede – ILRI/ IWMI	Large Auditorium
13:40-13:50	Welcoming word research institutes	Dr. Fentahun Mengistu - ARARI	Large Auditorium
13:50-14:00	Introduction of participants	Dr. Tilahun Amede	Large Auditorium
14:00-14:30	Introduction N2Africa project	Prof. Ken Giller – Wageningen University	Large Auditorium
14:30-15:00	Opportunities for increasing benefits from biological nitrogen fixation in soybean	Mr. Zinaw Dilnesaw – EIAR Pawe	Large Auditorium
15:00-15:30	Opportunities for increasing benefits from biological nitrogen fixation in highland pulses	Dr. Gemechu Keneni – EIAR Holetta	Large Auditorium
15:30-16:00	COFFEE BREAK		
16:00-16:30	Opportunities for increasing benefits from biological nitrogen fixation in forage legumes	Dr. Solomon Mengistu – EIAR Debre Zeit	Large Auditorium
16:30-17:00	What issues should N2Africa address in Ethiopia?	Breakout groups	Break-out rooms
17:00-17:20	Short presentation of outcomes of the discussion groups	One presenter per group	Large Auditorium
17:20-17:30	Closing of the workshop	Tilahun Amede, Ken Giller	Large Auditorium

Tuesday, May 01, 2012

TIME	ACTIVITY	LEAD PERSON	VENUE
8:30-9:00	Introduction, workshop purpose/ objectives, project planning	Ken Giller	Large Auditorium
9:00-10:00	Decide on legume niches for Ethiopia (legumes + areas)	Tilahun Amede	Large Auditorium
10:00-10:20	Presentations about soybean value chain and IFDC (AGP/AMDe) project	Yared Sertse, Abey Meherka	Large Auditorium
10:20-10:30	Explanation assignments breakout groups	Katrien Descheemaeker	Large Auditorium
10:30-11:00	COFFEE BREAK		
11:00-11:30	Identify partners/projects to work with in each of the regions	Breakout groups	Breakout rooms
11:30-12:30	Develop a problem and objectives tree	Breakout groups	Breakout rooms
12:30-13:30	LUNCH		
13:30-15:30	Define activities, outputs, outcomes and training needs	Breakout groups	Breakout rooms
15:30-16:00	COFFEE BREAK		
16:00-17:00	Report back in plenary session	Ken Giller	Large Auditorium
Evening	Ethiopian cultural dinner		

Wednesday, May 02, 2012

TIME	ACTIVITY	LEAD PERSON	VENUE
8:30-10:15	Synthesis: overall N2Africa D&D, M&E and research, with specific activities and approach per legume niche	Ken Giller	Info centre
10:15-10:30	Project management structure	Ken Giller	Info centre
10:30-11:00	COFFEE BREAK		
11:00-12:30	Finalizing and planning of activities, estimation of budget	Breakout groups	Breakout rooms
12:30-13:30	LUNCH		
13:30-15:00	Concrete action plan for pilot activities 2012	Tilahun Amede	Info centre
15:00-15:30	Any remaining issues to be discussed	Tilahun Amede	Info centre
15:30-16:00	COFFEE BREAK		
16:00-16:45	How to move forward?	Ken Giller	Info centre
16:45-17:00	Thanks and closing	Tilahun Amede, Ken Giller	Info centre

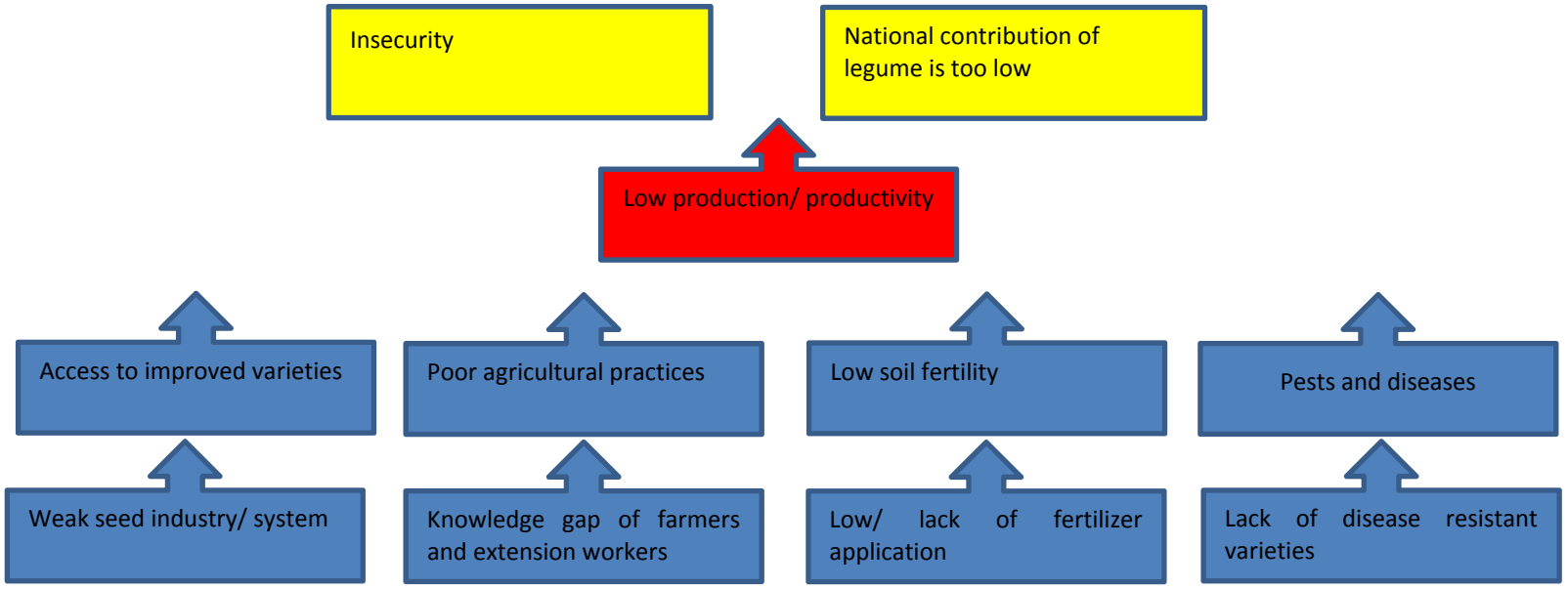
Appendix B: List of participants

No	Name	Position	Organization	Town
1	Abey Meherka	Input specialist	IFDC	Addis Ababa
2	Abush Tesfaye	PhD Student EIAR Jimma	EIAR-Jimma	Jimma
3	Alemayehu Mengistu	Visiting Associate Professor	Addis Ababa University	Addis Ababa
4	Asefa Taa	Deputy Director General	Oromia Agricultural Research Institute	Addis Ababa
5	Asfaw Hailemariam	Senior Researcher	National Soil Testing Center	Addis Ababa
6	Asnake Fikre	POF-Research Coordinator	EIAR	Debre zeit
7	Dawit T.	Coordinator, AECEFL-EIAR	EIAR	Addis Ababa
8	D. Valbuena	Post doc	ILRI	Addis Ababa
9	Dinkinesh Miressa	Junior researcher	National Soil Testing Center	Addis Ababa
10	Endalkachew Wolde-meskel	Researcher	Hawassa University	Hawassa
11	Enyew Adgo	Lecturer	Bahir Dar University	Bahir Dar
12	Esther Ronner	Researcher- N2Africa	Wageningen University	Wageningen
13	Fassil Assefa	Associate Professor	Addis Ababa University	Addis Ababa
14	Fentahun Mengistu	Director	Amhara Agricultural Research Institute	Bahir Dar
15	Fikre Mulugeta	Project Manager	FAO	Assela
16	Greta van den Brand	Researcher- N2Africa	Wageningen University	Wageningen
17	Gemechu Keneni	Senior Researcher	EIAR-AAU	Holetta
18	Girma Tadesse	Crop Researcher	EIAR-Assosa	Assosa
19	Joep Van den Broek	Advisor	EKN	Addis Ababa
20	Kahsay Berhe	Research Officer	ILRI-IPMS	Addis Ababa
21	Katrien Descheemaeker	Assistant Professor	Wageningen University	Wageningen
22	Kebebe Ergano	Research Officer	ILRI	Addis Ababa
23	Kemal Ali	Director, PPRC	EIAR	Addis Ababa
24	Ken Giller	Professor, Plant Production Systems	Wageningen University	Wageningen
25	Maria Alexandra Jorge	Genebank Manager	ILRI	Addis Ababa
26	Solomon Mengistu	Forage researcher	EIAR	Debre zeit

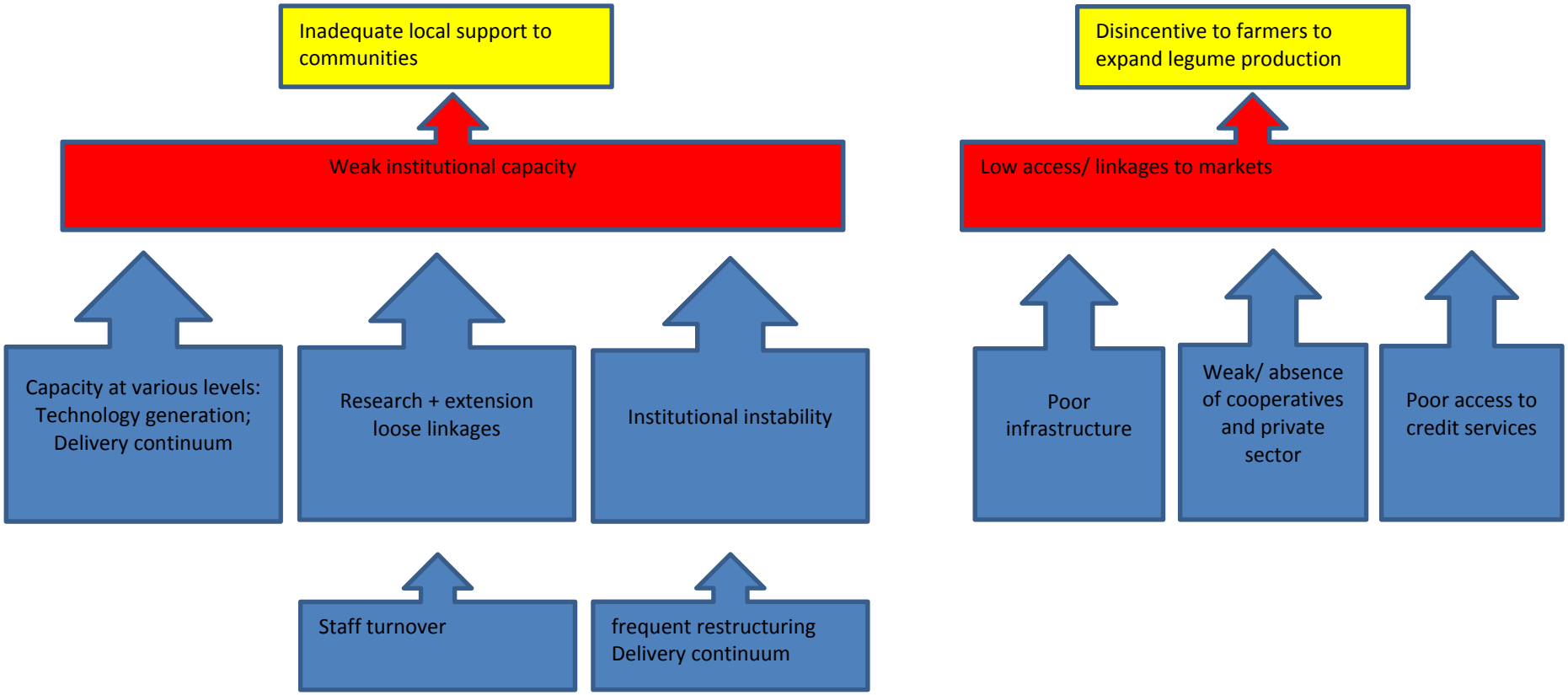
27	Tefera Zeray	Senior expert for pulse	Agricultural Transformation Agency (ATA)	Addis Ababa
28	Teka Reda	VC Specialist	ACDI/VOCA = AGP/AnDe	Addis Ababa
29	Tesfu Kebede	Soil & Water representative	EIAR-Jimma	Jimma
30	Tilahun Amede	Nile Basin Leader, CGIAR-CPWF	ILRI-IWMI	Addis Ababa
31	Tizazu Degu	Assistance researcher (Soybean crop protection)	EIAR-Pawe	Pawe
32	Walelign Worku	Associate Professor	Hawassa University	Hawassa
33	Yared Sertse	Value chain consultant	OWW	Addis Ababa
34	Yihenew G. Selassie Mengesha	Associate Professor	Bahir Dar University	Bahir Dar
35	Zinaw Dilnesaw	Researcher (Soybean breeder)	EIAR-Pawe	Pawe
36	Mulugeta Habtemichael	Research Technician	ILRI-IWMI	Addis Ababa

Appendix C: Problem trees

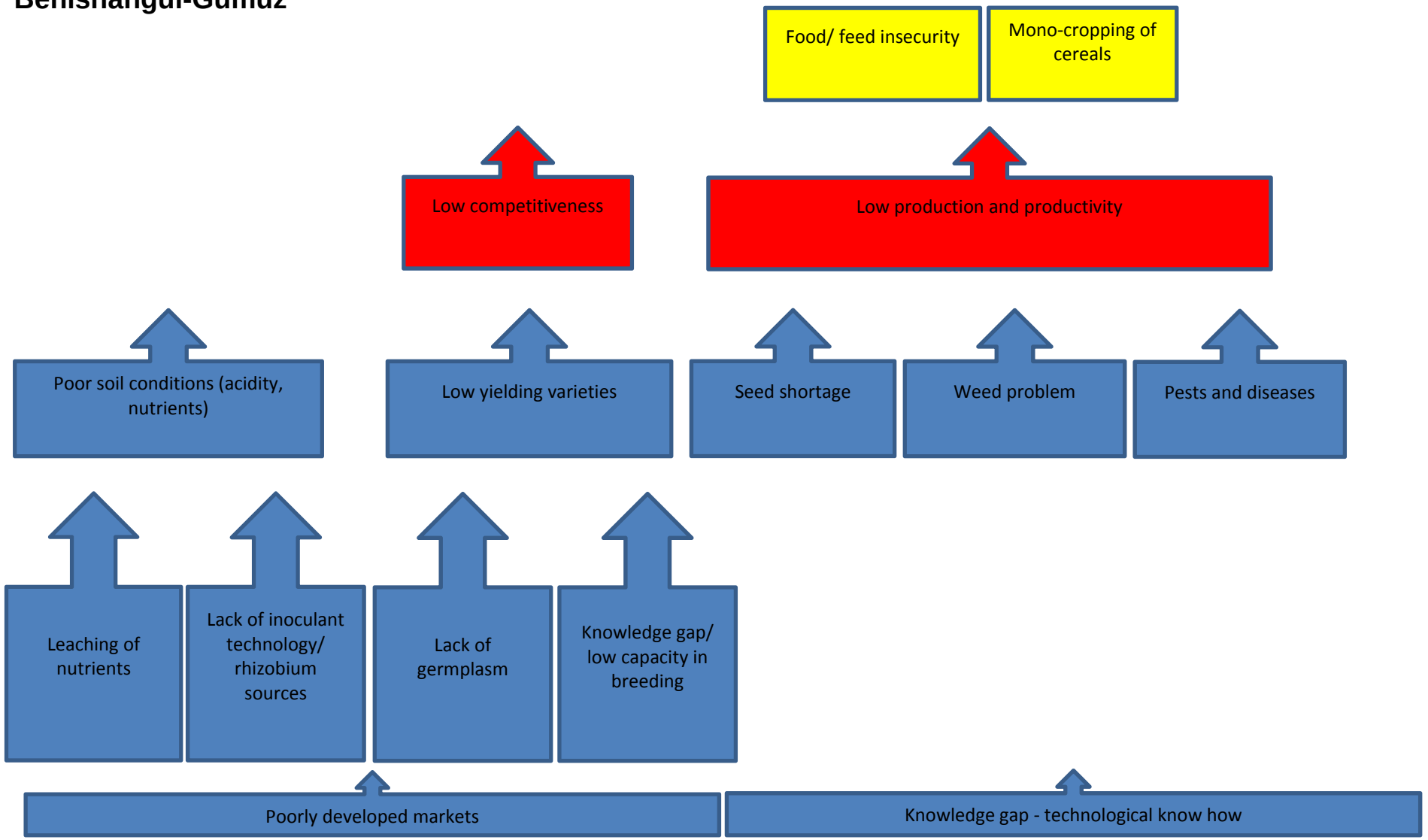
Amhara (1)



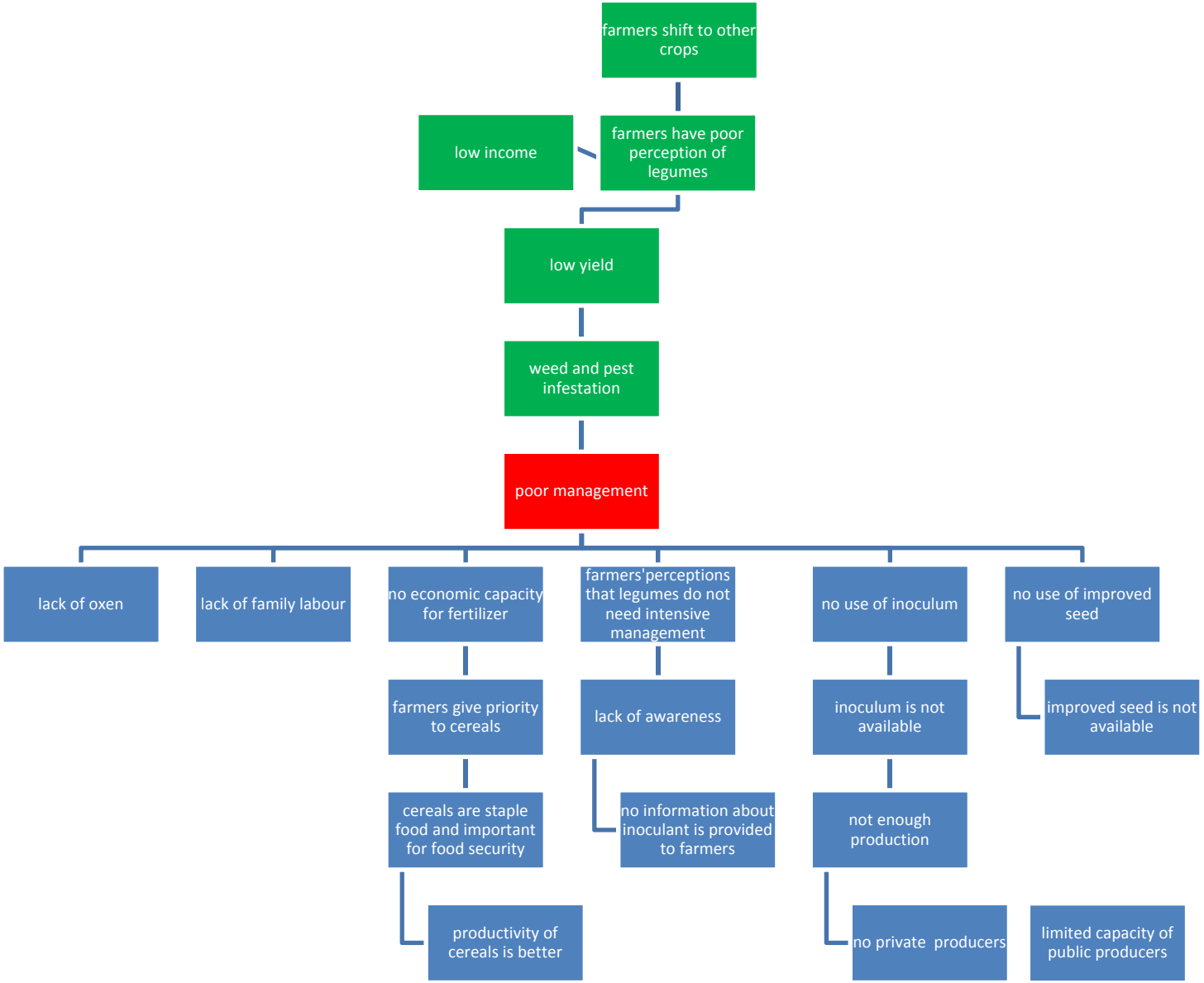
Amhara (2)


Inadequate local support to communities
Weak institutional capacity
Capacity at various levels: Technology generation; Delivery continuum
Research + extension loose linkages
Institutional instability
Staff turnover
frequent restructuring Delivery continuum
Disincentive to farmers to expand legume production
Low access/ linkages to markets
Poor infrastructure
Weak/ absence of cooperatives and private sector
Poor access to credit services

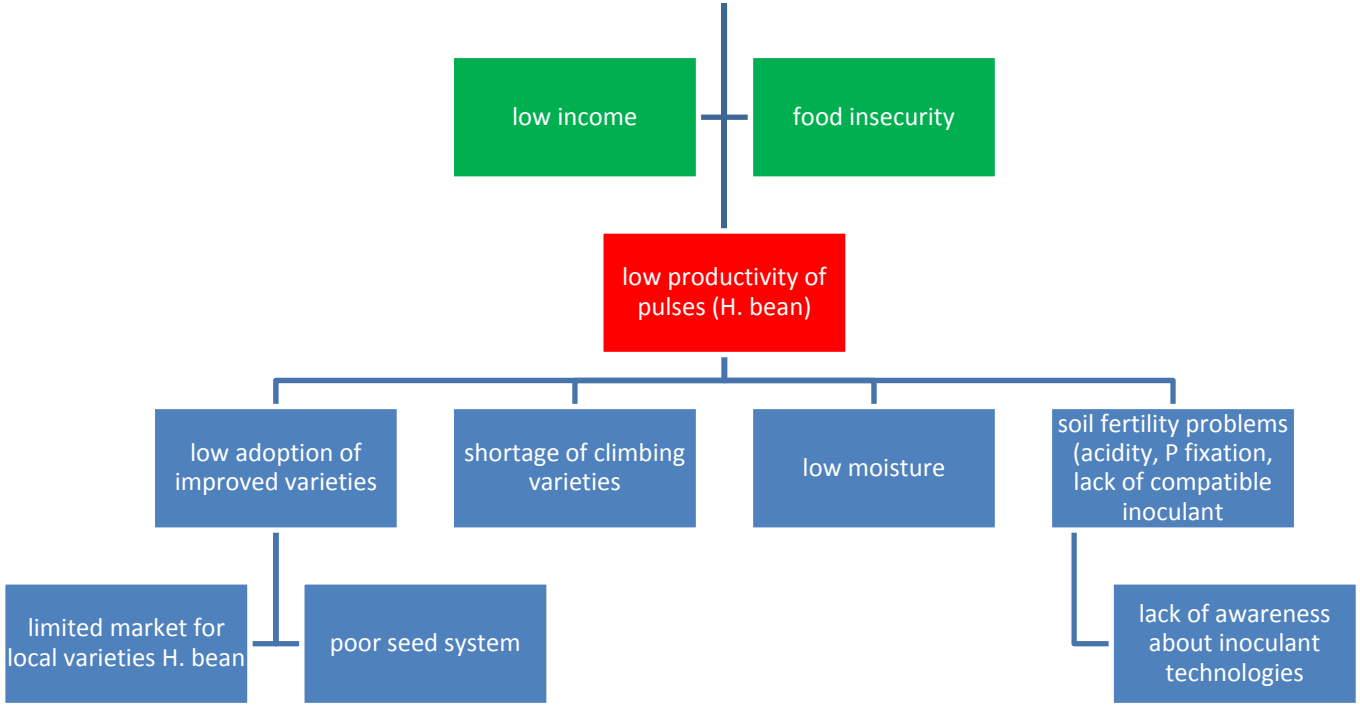
Benishangul-Gumuz



Oromia


farmers shift to other crops
low income
farmers have poor perception of legumes
low yield
weed and pest infestation
poor management
lack of oxen
lack of family labour
no economic capacity for fertilizer
farmers'perceptions that legumes do not need intensive management
no use of inoculum
no use of improved seed
farmers give priority to cereals
lack of awareness
inoculum is not available
improved seed is not available
cereals are staple food and important for food security
no information about inoculant is provided to farmers
not enough production
productivity of cereals is better
no private producers
limited capacity of public producers

SNNPR


low income
food insecurity
low productivity of pulses (H. bean)
low adoption of improved varieties
shortage of climbing varieties
low moisture
soil fertility problems (acidity, P fixation, lack of compatible inoculant
limited market for local varieties H. bean
poor seed system
lack of awareness about inoculant technologies

Appendix D: Presentations

The problem

- Maize-dominated farming systems
- Declining soil fertility
- Need for diversification

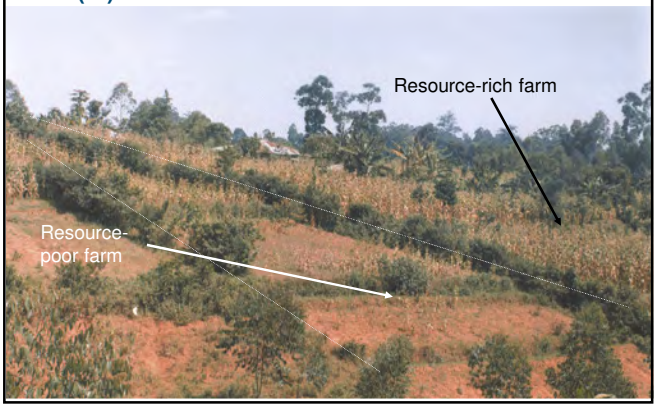
Potential solutions - Nitrogen fixing legumes

Green manures on smallholder farms

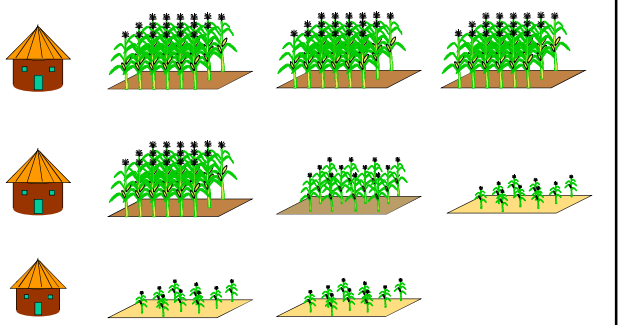
…there are no silver bullets….

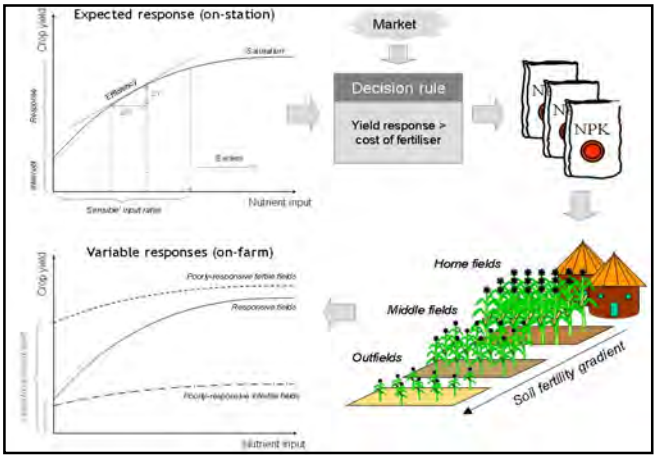
Soil fertility gradients

Farm(er)s are not all the same!



Farm(er)s are not all the same!

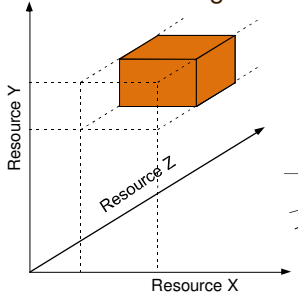




Legume technologies in Western Kenya

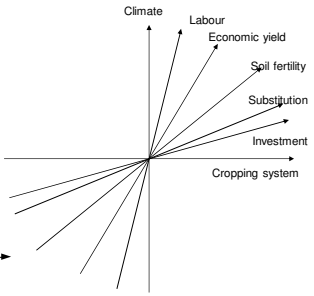
"But what can we use these crops for?

The 'niche' for legumes



The niche as an 'n' -dimensional hyperspace
Hutchinson (1957)

The socio-ecological niche



The legume 'niche' has agroecological and socioeconomic dimensions

Ojiem, de Ridder, Vanlauwe & Giller (2006) *Int. J. Agric. Sust.* **4**, 79-93.

On-farm comparisons of legume technologies

Chikowo, Mapfumo, Nyamugafata & Giller (2004) *Agric. Ecosyst. Environ.* **102**, 109-131

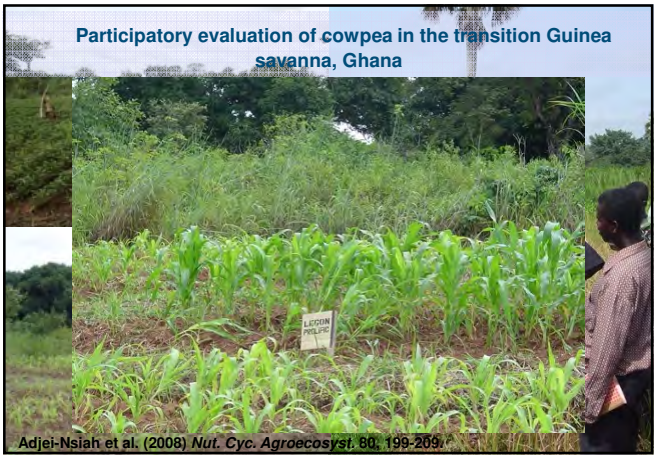
Participatory evaluation of legume technologies

- First choice – grain legumes
- Second choice – multi-purpose grain legumes
- Third choice – fodder legumes, fodder trees
- Fourth choice – woody legumes

- …very last choice – green manures, cover crops and fertilizer trees
- 'pseudo-adoption' due to artificial market for seed of green manures or trees

Evaluations conducted in Ghana (Adjei-Nsiah), Kenya (Ojiem), Uganda (Ebanyat), Rwanda (Bucagu), Zimbabwe (Chikowo)

Participatory evaluation of cowpea in the transition Guinea savanna, Ghana



Adjei-Nsiah et al. (2008) *Nut. Cyc. Agroecosyst.* 80, 199-209.

How to increase the inputs from N_2-fixation

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

Vision of success

To raise average grain legumes yields by 954 kg/ha in four legumes (groundnut, cowpea, soybean, and common bean), increase average biological nitrogen fixation (BNF) by 46 kg/ha, and increase average household income by $465, directly benefiting 225,000 households (1,800,000 individuals) in eight countries in sub-Saharan Africa (DRC, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda, Zimbabwe).

This project links the protein and nitrogen needs of poor African farmers directly to previously inaccessible, massive atmospheric reserves, provides them with new income-generating crop production enterprises, presents a mechanism of renewable soil fertility management and opens the door to the adoption of numerous, profitable accompanying farm technologies and value-adding enterprises.

Objectives

1. Establish a **baseline** of the current status of N_2-fixation, identify farm enterprises and **niches for targeting N_2-fixing legumes** in the impact zones, and establish mechanisms for **monitoring and evaluation** (M&E) and **impact assessment**
2. **Identify and field-test multi-purpose legumes** providing food, animal feed, structural materials and high quality crop residues for enhanced N_2-fixation and integrate improved varieties into farming systems
3. **Collect and characterize superior rhizobia strains** for enhanced N_2-fixation and **develop inoculum production capacity** in sub-Saharan Africa through collaboration with private sector partners
4. **Deliver** legumes, inoculant technologies and associated N_2-fixation technologies to farmers throughout sub-Saharan Africa
5. Develop and **strengthen capacity** for N_2-fixation research, technology development, and application

Genotype × Environment × Management

$$(G_L \times G_R) \times E \times M$$

Where:
G_L = legume genotype
G_R = rhizobial strain
E = environment
- climate (temperature x rainfall x daylength etc) - to encompass length of growing season etc
- soils (nutrient limitations, acidity and toxicities)

M = management
- agronomy – inoculation, seeding rates, plant density, weeding
- (Diseases and pests are also a function of G x E x M....)

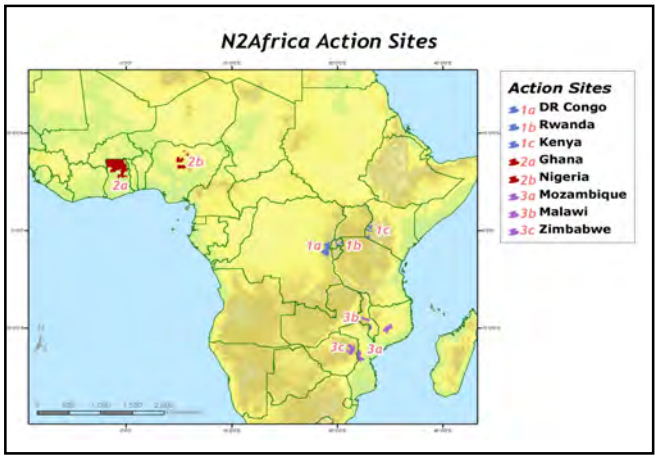
N_2Africa – target countries and legumes

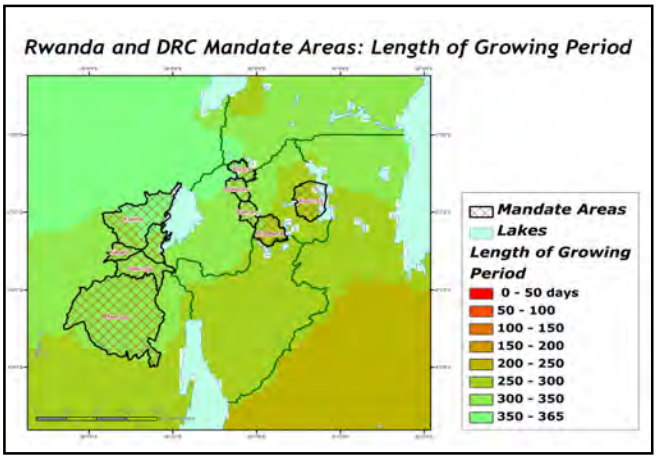
West Africa
- Cowpea, groundnut, soybean

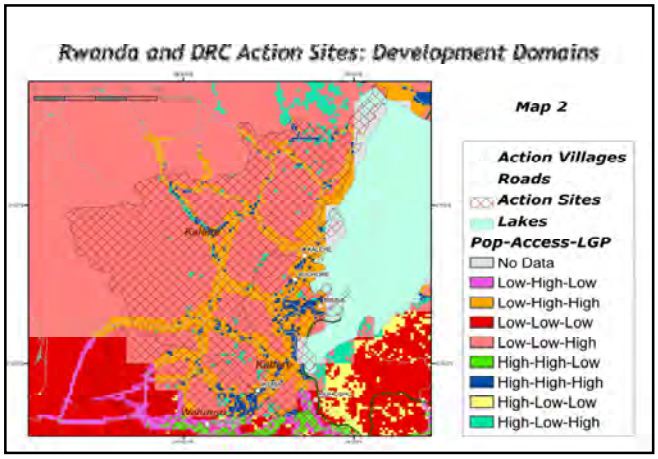
East & Central Africa
- Common bean, groundnut, soybean

Southern Africa
- Common bean, groundnut, soybean

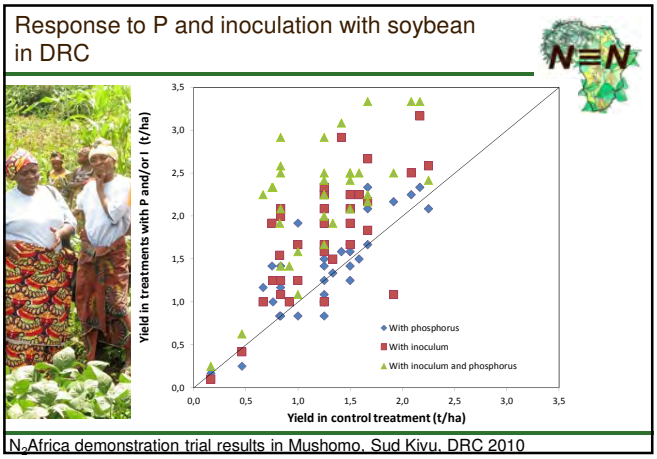
Throughout all regions
- Legume forages



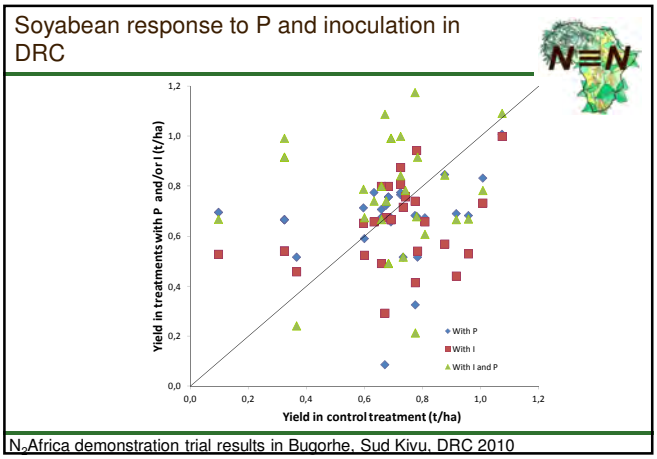



Rwanda and DRC Action Sites: Development Domains
Map 2
Action Villages
Roads
Action Sites
Lakes
Pop-Access-LGP
No Data
Low-High-Low
Low-High-High
Low-Low-Low
Low-Low-High
High-High-Low
High-High-High
High-Low-Low
High-Low-High

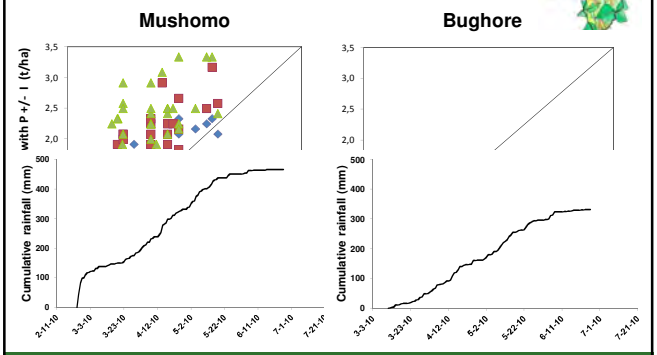

control
+Pfert
+ino
+Pfert+ino


Response to P and inoculation with soybean in DRC
N≡N
Yield in treatments with P and/or I (t/ha)
Yield in control treatment (t/ha)
With phosphorus
With inoculum
With inoculum and phosphorus
N2Africa demonstration trial results in Mushomo, Sud Kivu, DRC 2010


Potassium deficiency


Soyabean response to P and inoculation in DRC
N≡N
Yield in treatments with P and/or I (t/ha)
Yield in control treatment (t/ha)
With P
With I
With I and P
N2Africa demonstration trial results in Bugorhe, Sud Kivu, DRC 2010

Response to P and inoculation with soybean in DRC



N_2Africa demonstration trial results in Sud Kivu, DRC 2010

Drought problems …
Differential germination: some plants at podding (dark green) while others s
flowering (pale green); many missing stands; very few or no nodules obser

Climbing beans in Rwanda

Farm type		Stake density (no. ha^{-1})	Dry grain yield (Mg ha^{-1})
1	Very resource poor	18 200	1.18
2	Resource poor	18 900	1.14
3	Resource rich	24 800	2.02
4	Very resource rich	22 000	2.27

Climbing bean yields depend on the length, number and quality of stakes
The poorer farmers have fewer, shorter stakes of inferior quality

Putting nitrogen fixation to work for smallholder farmers in Africa
Reckling MSc thesis 2011, Klapwijk MSc thesis 2011

Climbing beans in DRC

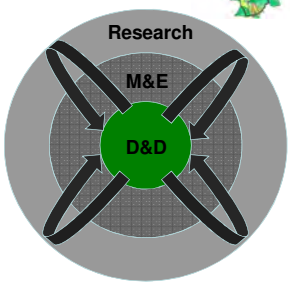
Long rains season 2010 in Sud Kivu, DRC

Successes after two years

- $(G_L \times G_R) \times E \times M$ is key to significant yield increase and benefits on farms across all regions
- Often doubling or more of yields with groundnut, cowpea and common bean with small amounts of *P*
- With soybean strong $P \times I$ interactions in the field – neither *P* or *I* alone is enough

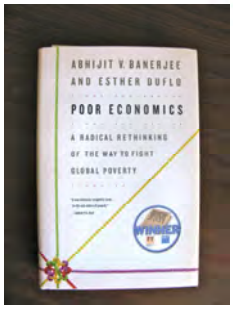
N_2Africa is a development to research project

- Dissemination and development are the core
- M&E is provides the learning
- Research analyses and feeds back



N2Africa is a large experiment

- Baseline information
- Use randomised control trials
- Monitoring and Evaluation
- Analysis within and across countries

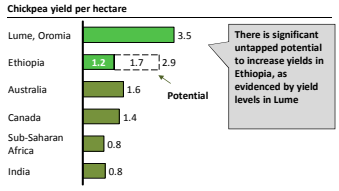


B6. There are limited extension services covering chickpea, that lead to poor farming practices which in turn, reduces yields

ATA

Current extension services provided to farmers are inadequate

- Designed for pulses in general and fail to address specific essential components for chickpea farming
- Neglect important agronomic factors such as
  - Optimum tillage required
  - Critical weeding time
  - Initial fertilizer application
  - Optimum plant population
  - Seed quality requirement (health, soundness and germination capacity)
  - Optimum planting date
- In addition, there is a lack of knowledge in scouting pests and skill in pesticide application



As a result of limited extension services, farmers have limited knowledge on modern practices and cannot achieve chickpea yield potential

Note: Lume productivity is above the national average in Ethiopia due to improved agricultural practices in the area
Source: FAO, Pulse Canada, IFPRI, field interviews, Team analysis

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Questions not conclusions!

1. Is there a role for N2Ethiopia?
2. With which legumes we can make a difference? (soyabean, chickpea, common bean - others?)
3. Is there farmers' demand for legume forages?
4. Do you have other advice and suggestions?

For updates see

www.N2Africa.org

Lots of video resource materials

N_2Africa Podcaster - Monthly Newsletter

Putting nitrogen fixation to work for smallholder farmers in Africa

Planning Workshop for N2Africa Project in Ethiopia from April 30- May 2, 2012 ILRI Campus, Addis Ababa

Ethiopian Institute of Agricultural Research
Pawe Agricultural Research Center
National Soybean Research Coordination

Opportunities for Increasing Benefits from Biological Nitrogen Fixation in Soybean and Research Efforts in Ethiopia

Zinaw Dilnesaw
April 2012

Contents

EIAR

Ethiopian Institute of Agricultural Research

- In the past EARO has a national mandate to conduct and coordinate Agricultural research.
- Established in 1966
- A public organization.
- It is a principal plant breeding institution in Ethiopia
- undertaking responsibilities for
  - Cereals . Legumes
  - Oil seeds . Fibers
  - Horticultural and . Forage crops.

EIAR cont'd

EIAR

- has 14 main research centers and
- 29 sub centers located in various agro ecological zones of the country.
- has a strong collaborative research with international agricultural research centers such as
  - CIAT
  - CIMMYT
  - ICARDA
  - ICRISAT
  - IITA and others

Introduction

Ethiopia is home to about a dozen species of tropical grain legumes.

An estimated 1.5 million ha of land is planted to grain legumes in this country and

more than 1.9 million metric tons (MT) of grain produced each year

Touching the lives of about 10 million households

Source of cheap protein

Ethiopian farmers are also cognizant of the role of legumes in

- improving soil health and
- widely use them in rotation and inter cropping with cereals.

Introduction cont'd

Soybean [*Glycine max* (L. Merrill)] is an important legume crop of the world occupying a premier position among other crops due its versatile uses as a human food, animal feed and in soil improvement.

It is an important source of human dietary protein and vegetable oil.

Among grain legume, soybean has the highest protein and oil content, nearly 40 and 20%, respectively.

Introduction cont'd

Based on the government five year's Growth and Transformation Plan

Main focus is given for

- Increasing Production by 100%
- export promotion
- import substitution and
- production of raw materials for local industries.

So that, The Ethiopia Agricultural Research Institute prioritise research activities based on the growing demand and the national Policy and strategy

Introduction cont'd

From lowland pulses highest priority is given to common bean followed by soybean and cowpea because of their importance for

- export market
- raw material for agro-industries and
- contribution to food security in drought prone areas of the country.

The national Agricultural Research Strategy developed various Agricultural Research Activities on different commodities in commodity based research projects.

Soybean Production Potential and Research Efforts in Ethiopia

Soybean (Glycine max)
common name for an annual leguminous plant
belongs to the subfamily Papilionoideae and family Fabaceae.

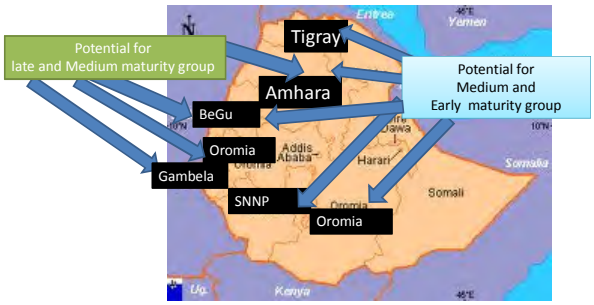
Soybean grows well

- Depending on the varieties the crop grows in
- Rain fall 450-1500mm/annum rainfall suitable for soybean production.
- Temperature range from 23-25°C .
- Altitude range 700-1800 m.a.s.l,
- It can grow in light fertile sandy, clay and alluvial soil.

Soybean Potential Areas of Ethiopia
Maturity group

No	Region	Zone/Area	Maturity Group	Production Potential
1	Amhara	Awi, E & W Gojam	Medium and late	**Major**
		N & S welo	Early	Minor
		N Gonder	Medium	Major
2	SNNP	Sidama, N&S Omo, Gamogofa	Early & Medium	Major
3	BeGu	Metekel, Assosa and Kamashi	Medium and late	**Major**
4	Oromia	Jimma, E & W Shewa	Medium and late	Major
5	Gambela	Abobo	Medium and late	Major
6	Afar	Tendaho	Early	-
7	Tigray	North West zones	Early & Medium	-

Soybean Growing Potential Areas of Ethiopia



Soybean Production Constraints

Biotic

- Disease caused by pathogens
- Pests and
- Weed

Abiotic Factors

- Climatic change
- Drought
- Soil acidity
- Low NP
- Water logging

Production Constraints cont'd

Socio-Economic Problems

- Lack of organized marketing system
- Lack of local food preparation experience
- Lack of awareness on use of Soybean

Criteria used to identify and prioritize Soybean research activities include

- Immediate impact of outputs
- Inputs accessibility for experimentation
- Acceptance and adaptability of technologies

Criteria used to identify and prioritize Soybean research activities include

Frequency and intensity of occurrence for constraints
- Biotic
- Abiotic
- socio-economic

Direct contribution to address problematic soils such as
- Acidity
- water-logging and low N&P

level of participation of partners
- Farmers
- Agro-processors
- Commercial farmers and other stakeholders

Research Efforts

In Ethiopia Various Soybean Technology Generating Research Activities have been made for different Agro ecologies for few decades.

There are many improved soybean varieties released for cultivation in Ethiopia from different research centers for their yield and disease resistance.

Research Efforts

The varieties which have been developed are classified as
- **Early**
- **Medium** and
- **Late**

Based on their maturity period and water requirements
- high and stable yield
- disease resistance
- good crude protein content and
- high calorie for poultry feed have been taken as variety selection criteria

Released Soybean Varieties

No	Maturity Group	Number of Varieties	Maturity period	Remark
1	Early Maturing	4	**90-120 days**	
2	Medium Maturing	7	**121-149 days**	
3	Late Maturing	3	**>150 days**	
	Total	14		

Two newly released and Registered Varieties in 2012 are

-Nova:- mature in 88 days

-Ags7-1:- Mature in 95 days

Research Efforts

Table. **Early set maturity group**

Characteristics	Variety			
	Williams	Crawford	Clark 63K	Awassa-95
Days to maturity	90-120	90-120	90 -120	90-120
Growth habit*	D	D	ÍD	ID
General adaptability	Short rain fall areas	Short rain fall areas	Short rainfall areas	Short rainfall areas
Seed rate (kg/ha)	60	60	60	60
Spacing (cm)	40 x 5	40 x 5	40 x 5	40 x 5
Yield (kg/ha)	15 - 20	15- 20	15 - 20	17 – 26

* D = Determinate, ID = Indeterminate

Research Efforts

Table. 2 **Medium set maturity group**

Characteristics	Variety						
	Cocker 240	Davis	Jalale	Cheri	Gizo	Gishama	AFGAT
Days to maturity	121 - 150	121-150	120 - 133	135 120-145	120-145	120-140	
Growth habit*	ID	ID	ID	ID ID	ID	ID	
General adaptability	Intermediate and long rainfall areas	Intermediate and long rainfall areas	Intermediate and long rainfall areas	Intermediate Intermediate and long long rainfall areas areas	Intermediate and long rainfall areas	Intermediate and long rainfall areas	and rainfall
Seed rate (kg/ha)	60	60	60	60	60	60	60
Spacing (cm)	60 x5	60 x 5	60 x 5	60 x 5 x 5	60 x 5	60 x 5	60
Yield (kg/ha)	15 - 25	15 - 25	16 - 21	24	20	18	14-25

Research Efforts

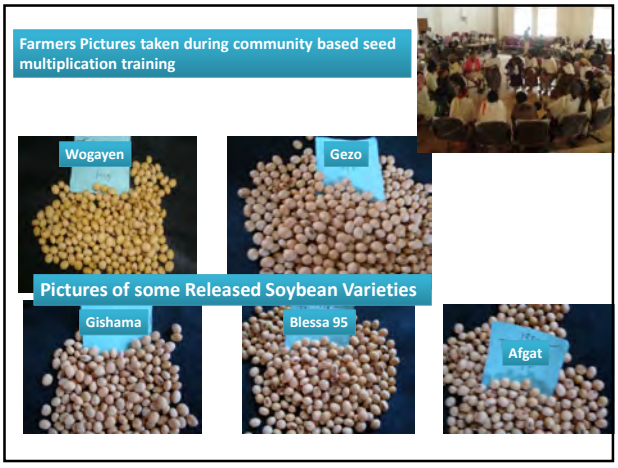
Table 3. Late set maturity group

Characteristics	Variety		
	Belesa-95	TGX-13-3-2644	Wegayen
Days to maturity	> 150	> 150	> 150
Growth habit*	ID	ID	ÍD
General adaptability	Long rainfall areas	Long rainfall areas	Long rainfall areas
Seed rate (kg/ha)	60	60	60
Spacing (cm)	60 x 5	60 x 5	60 x 5
Yield (kg/ha)	17 - 29	20 - 25	20.75

Research Efforts

Table 4. The quality analysis data of some of the released soybean varieties

	Unit	Williams	Clark-63k	Crowford	Davis	G - 2261	Cocker-240
Moisture	%	9.31	9.07	9.44	7.97	8.09	8.26
Crude Protein	%	30.60	27.86	33.51	28.25	32.95	29.07
Ether Extract	%	20.70	20.67	19.48	21.55	19.60	21.06
Crude Fiber	%	5.25	6.43	5.11	5.44	5.26	5.58
Ash	%	5.50	5.50	5.55	5.44	5.26	5.58
Salt as Nacl	%	0.38	0.38	0.36	0.36	0.33	0.33
Me for Poultry	Real/kg	3504	3499	3436	3583	3508	3552
T.carbohydrate	%	28.64	30.47	26.91	31.11	29.17	30.47
Aspartic	%	3.63	3.40	4.18	3.44	4.04	3.42
Threonine	%	1.26	1.16	1.37	1.21	1.36	1.17
Serine	%	1.64	1.54	1.83	1.60	1.80	1.56
Glutamic	%	6.77	6.15	7.86	6.34	7.44	6.25
Glycine	%	1.28	1.30	1.38	0.91	1.13	1.18
Alanine	%	1.38	1.27	1.62	1.57	1.71	1.36
Valine	%	1.38	1.24	1.54	1.33	1.51	1.29
Methionine	%	0.43	0.45	0.51	0.45	0.46	0.43
Isoleucine	%	1.27	1.14	1.41	1.22	1.37	1.18
Leucine	%	2.31	2.12	2.60	2.22	2.50	2.16
Tyrocine	%	1.12	1.05	1.27	1.09	1.22	1.04
Phenylalanine	%	1.43	1.33	1.61	1.40	1.29	1.32
Ustidine	%	0.83	0.76	0.92	0.77	0.92	0.74
Lysine	%	1.72	1.83	2.18	1.93	2.14	1.78
Arginine	%	2.07	1.94	2.59	2.03	2.58	1.99
Cysteine	%	0.26	0.26	0.24	0.21	0.26	0.27
Tryptophan	%	0.49	0.42	0.39	0.41	0.39	0.40



Future Works on Soybean Research in Ethiopia

Though, the agro ecology for soybean production is excellent, Most of Soybean Varieties under cultivation in Ethiopia are

- Low oil and protein content
- Poor potential in fixing nitrogen
- poor in disease resistance
- Poor resistance/ tolerance for climatic variability
- Poor in their yield potential compared to varieties in other countries

Future Works on Soybean Research in Ethiopia

Soybean Research focus will be on

- Developing/adoption of multi-purpose(Higher yield, protein, oil content and resistance for disease, climatic variability, etc) Soybean varieties for food and animal feed
- Developing/adoption Soybean technologies that improve soil fertility
- Developing/adoption of soybean inoculants technologies (to higher yield and soil fertility)

Soybean Research focus will be on

- Promotion, Demonstration and intensification of improved soybean production technologies.
- Developing Soybean Seed supply system
- Developing and promoting soybean production, marketing and utilization technologies for small holders, commercial farmers etc.

PROGRESSES OF HIGHLAND PULSES RESEARCH AND DEVELOPMENT IN ETHIOPIA: Opportunities for Biological Nitrogen Fixation

PRESENTED TO N2AFRICA WORKSHOP IN ETHIOPIA

BY

GEMECHU KENENI

30 APRIL – 2 MAY, 2012 | Addis Ababa, Eth

INTRODUCTION

- Highland pulses: faba bean, chickpea, field pea and lentil
- Economically and ecologically important
  - Food and feed
  - Cash and export earnings
  - Soil fertility restoration (N and P)
  - "Break" crops to diseases and pest
- Temporal and spatial intensification (product diversification, resource optimization and yield maximization)
  - Intercropping
  - Double cropping
  - Relay cropping
- Theme – bird's eye view of efforts made so far and opportunities for new R&D initiatives

PRODUCTION STATISTICS

Area under Production (ha, all crops)

Crop category	2005/06	2006/07	2007/08	2008/09	2009/10
Cereals	8,072,561	8,453,080	8,730,001	8,770,118	9,233,025
Pulses	1,292,663	1,378,936	1,517,892	1,585,236	1,486,308
Oil crops	796,397	740,847	707,059	855,147	780,916
Vegetables	117,578	95,194	119,091	162,125	138,393
Root crops	168,836	188,917	184,329	145,742	212,208
Other temporary	77,554	97,677	84,977	69,103	63,418
Permanent crops	767,582	823,121	1,038,313	906,518	53,086
Total	11,292,571	11,787,775	12,382,432	12,493,989	11,970,354

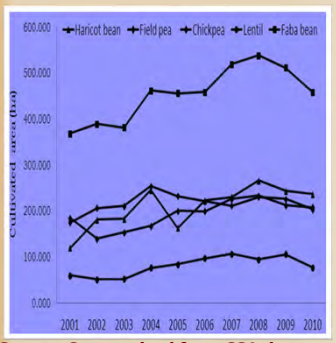
Source: CSA Annual Reports

FOUR POINTS:

- Area of pulses is steadily increasing
- Area increase are not at the expense of cereals
- Some additional lands coming under production
- Dominance of cereal-cereal monoculture

PRODUCTION STATISTICS (Continued)

Area under Production (ha, pulses)



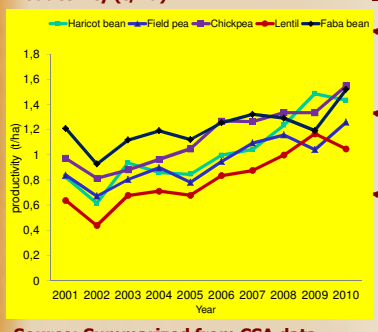
Source: Summarized from CSA data

ONE POINT:

- The position of faba bean in pulses economy of Ethiopia
- All highland pulses put together would make the almost same area as faba bean!

PRODUCTION STATISTICS (Continued)

Productivity (t/ha)



Source: Summarized from CSA data

THREE POINTS:

- Productivity of all pulses is increasing with time
- Productivity is generally low (0.5-1.5 t/ha)
- The productivity of haricot bean followed by chickpea is increasing at higher rates (why?)

PRODUCTION CONSTRAINTS

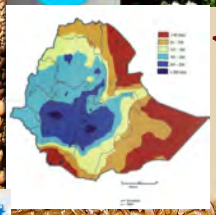
- Biological limitations (e.g. flower shedding in faba bean, grass pea)
- Diseases (foliar and root)
- Insects (field and storage)
- Weeds (parasitic and non-parasitic)
- Market quality (seed size & colour)
- Abiotic stresses (poor management, drought, waterlogging, frost, soil acidity)

PULSES RESEARCH IN ETHIOPIA

- **History:** Started in 1950's by the HLIs, strengthened with the establishment of IAR after mid 1960's and re-strengthened through international collaborations after the mid 1980's (e.g. ICARDA, ICRISAT, CIAT, IITA)
- **Objectives:** to improve productivity of the crops through developing and transferring of improved varieties suitable for different agro-ecologies and production systems with appropriate crop management and protection practices
- **Sources of germplasm:** introduction, local collection and hybridization (mutation , ?)
- **Selection of varieties for diseases resistance:** hotspot, artificial inoculation, sick plot
- **Evaluation:** multiple locations and production domains

PULSE BREEDING APPROACHES

- Exploiting Genetic Potential – fitting the environment to the cultivars (environmental manipulation) and selection of genotypes that effectively exploit the environment provided (genetic manipulation)



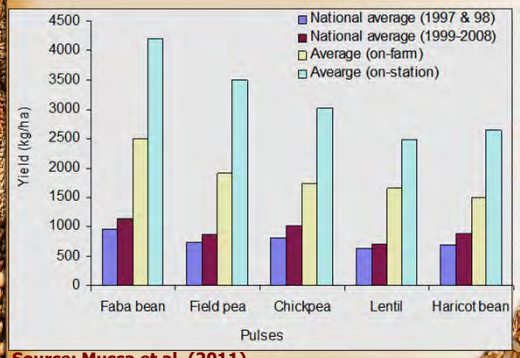
- Fitting cultivars to the environment not to exploit genetic potential but to enhance suitability under limited resource base with reasonable yields (e.g. moisture regime and length of growing period)

RESEARCH ACHIEVEMENTS

	Crop	No. of varieties released
	Faba bean	24
	Field pea	31
	Chickpea	18
	Lentil	9
	Haricot bean	38
	Total	120

Source: MOA (2010)

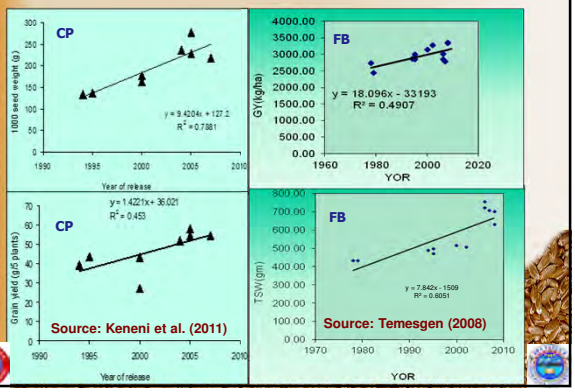
RESEARCH ACHIEVEMENTS (Continued)



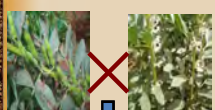
Source: Mussa et al. (2011)

RESEARCH ACHIEVEMENTS (Breeding progress, e.g.)

Breeding progress: Grain yield, an evolution; seed size, a revolution!

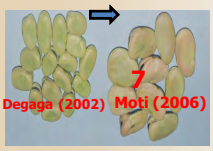


RESEACH ACHIEVEMENTS(continued)



- Crossing of adapted and resistant/ tolerant parents resulted in new recombination – for diseases resistance and seed size
- Hitherto research efforts resulted in improved seed quality (size and colour)

Obse (2007)



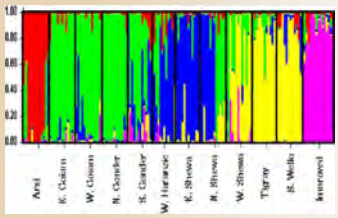
RESEARCH ACHIEVEMENTS (Continued)

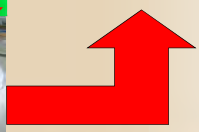
Agronomic and crop protection packages	Achievements/recommendations
Diseases	•Resistant varieties developed •Chemicals indentified
Weeds	•Hand weeding •Herbicides identified
Insects	•Insecticides identified •Partial resistance observed in many cases
Agronomic practices	•Sowing date •Seed rate and spacing •Ploughing frequency •Fertilizer requirements and rates
Symbiotic studies • Not well coordinated •No clear procedure for strain registration and release	•Strain diversity (extensive studies done but information partially not accessible) •Host diversity (limited information available) •Strains developed (faba bean, haricot bean, lentil, chickpea, soybean and field pea) •Strains mass production and popularization (at infancy and limited scale)

AN EXAMPLE OF ONLY PARTIAL RESISTANCE TO INSECTS/FROST

- Lack of sources of complete resistance/tolerance to some biotic stresses (e.g. field and storage insects)
- Tendency that breeding for better seed quality inadvertently increased susceptibility to storage insects (Keneni et al., 2011)
- Lack of sources of tolerance to abiotic stresses (e.g. frost)

AN EXAMPLE OF HOST DIVERSITY FOR SSR MARKERS IN CHICKPEA





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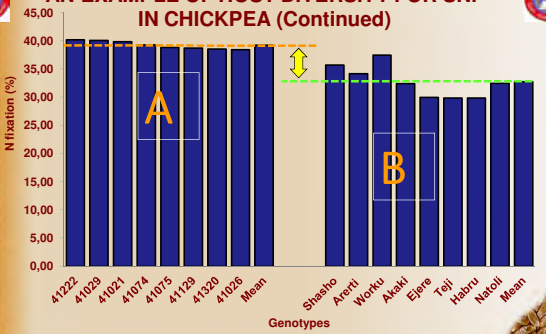
AN EXAMPLE OF HOST DIVERSITY FOR SNF IN CHICKPEA

AN EXAMPLE OF HOST DIVERSITY FOR SNF IN CHICKPEA (Continued)



Comparison of N fixation between (A) the top 5% best performing accessions and (B) the released chickpea varieties

Mean performances of 155 genotypes for attributes of symbiotic nitrogen fixation (with and without P)

	Range		Mean		
Character	With P	Without P	With P	Without P	RR
NI	0.335-4.033	0.243-3.562	1.559	1.306	0.16
NN	5.50-44.75	2.75-33.75	15.974	10.413	0.35
NDW	105.06-1643.71	65.04-955.80	484.41	355.97	0.27
SPC	4.89-11.43	5.00-9.43	7.68	7.03	0.08
GPC	15.53-26.22	14.46-25.16	22.27	21.64	0.03
SNF	13.76-56.94	9.27-45.27	33.68	26.26	0.22
GNF	26.72-45.73	28.40-45.63	35.55	36.35	-0.02
BNF	26.33-42.20	24.48-41.60	33.36	33.12	0.01
FNAE	63.06-93.66	64.43-92.56	78.89	81.67	-0.04
GNY	0.830-2.873	0.667-2.310	2.057	1.640	0.20
SNY	0.582-2.590	0.508-1.700	1.443	1.058	0.27
BNY	1.412-4.935	1.175-3.963	3.500	2.699	0.22
NHI	0.475-0.692	0.475-0.700	0.591	0.610	-0.03

TRANSFER OF IMPROVED TECHNOLOGIES

- Seeds of improved varieties increased
- Knowledge dissemination, producers training and scaling up of technologies started
- Superiority of technologies revealed to farmers and development workers
- **Complaints:** no more "lack of proper varieties " but "**shortage of improved seeds**"

A FEW GOOD EXAMPLES OF INFORMAL AND FORMAL SEED PRODUCTION WITH FARMERS

AREA COVERED BY IMPROVED SEEDS

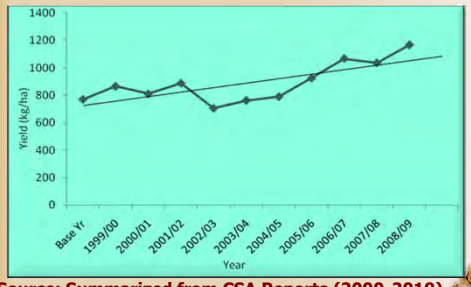
Crop	Cropping season				
	2005/06	2006/07	2007/08	2008/09	2009/10
Cereals	428,536	335,369	412,629	430,937	322,819
Pulses	5,224	5,025	6,309	14,918	12,912
Oil crops	1,833	4,056	2,273	2,328	9,139
Vegetables	779	559	501	1,899	2,788
Root crops	813	2,114	2,251	799	3,721
Other annuals	70	102	-	-	-
Permanent	9,681	11,742	5,828	13,120	9,852
Total	447,936	358,967	429,791	464,001	361,231

TWO POINTS:

- Use of improved seeds very low
- Increment with time (pulses, oilcrops and root crops)

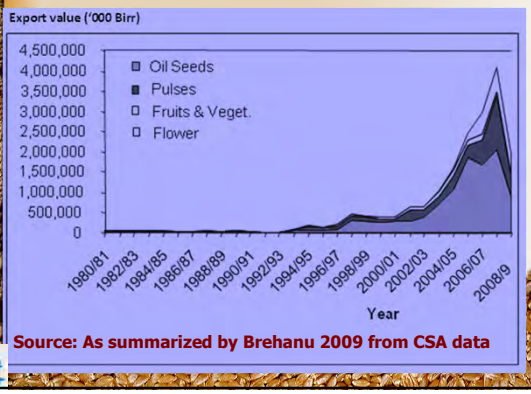
Source: CSA Reports (2006-2010)

PAST R&D EFFORTS RESULTED IN INCREASED PRODUCTIVITY AT THE NATIONAL LEVEL



Source: Summarized from CSA Reports (2000-2019)

INCREASED REVENUE FROM EXPORT



Source: As summarized by Brehanu 2009 from CSA data

THE DEMAND FOR IMPROVED SEEDS IS FAR FROM SATISFACTION

Crop category	Demand (t)	Supply (t)	% supply
Cereal crops	2,056,469	638,856	31.07
Pulse crops	312,155	33,159	10.62
Oil crops	34,341	3,435	10.00
Total	2,402,965	675,450	28.11

Source: MoARD, 2010

THREE POINTS:

- Seed is a critical problem in all crops but more critical in pulses and oil crops
- More relative priority given to cereals by the seed sectors
- A call for private seed producers?

APPEARANCE OF "NEW" THREATS

- Pea weevil (*B. pisorum*) in field pea
- Broomrape (*O. crenata*) in faba bean
- Dodder (*Cuscuta species*) in chickpea

OPPORTUNITIES FOR N2AFRICA

- Hitherto research efforts resulted in a number of improved production technologies – a matter of building on success!
- Nation-wide scaling up of "high value" crops production technologies already underway – a suitable ground!
- Nation-wide amelioration of acid soil with lime expected to be launched soon – pulses are more sensitive to soil acidity than many other crops (with the exception of maybe soybean)
- This is a time when risks of cereal-cereal monoculture in some potential production areas is already considered a national threat (at technical and policy levels)
- Ethiopia has huge diversity for strain, host, climatic and edaphic factors
- Positive output:input price ratio with good local and export markets

LESSONS TO BE TAKEN

- Disregarding faba bean in any R&D initiatives on pulses would definitely undermine the expected success and impact at least because of two reasons:
  - Ethiopia is the second largest producer of faba bean in the world
  - Faba bean is one of the most suitable crops for rotation with cereals in areas where cereal-cereal monocroppinng is already considered a national threat
- It is pertinent to integrate the seed system as part-and-parcel of any R&D initiatives that target the promotion of pulses in Ethiopia

Research and development on forage legumes in Ethiopia: The DZARC Experience

Solomon Mengistu

N2 AFRICA WORKSHOP
Wageningen University & ILRI
30 April – 02 May, 2012
Addis Ababa, Ethiopia

INTRODUCTION

LEGUMES include:
Grain legumes: chickpea, lentils, faba bean
Forage legumes: medics, vetches & clovers

ROLES
- Intensify agricultural systems by acting as:-
  - -soil fertility restorers through fixed N2
  - -pest and disease cycle breakers
  - -as a cheap source of protein for man & animals
- Forage legumes used as cut-and-carry help to implement tethered feeding system

INTRODUCTION

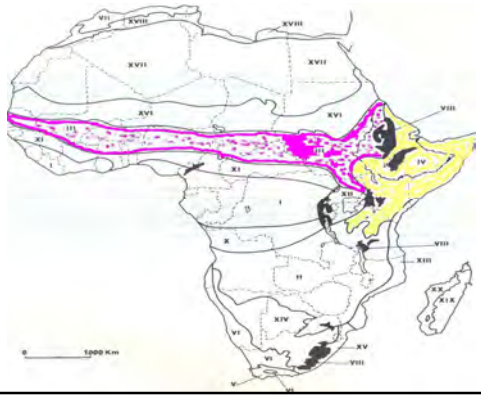
Legumes role specific to the pasture system:

a. **Legumes have high protein content.** They improve the palatability & Digestibility of roughages by keeping the CP level above the critical level
b. **Legumes insure high quality feed supply over the dry season** since Legumes become fibrous at a later stage of maturity as compared to grasses; DM digestibility and VI of legumes is generally higher than the grasses
c. **Legumes have high Ca, S, and P contents**, thus they provide stock with more balanced diet.
d. **Legumes fix atmospheric N_2** , insuring the cycling of this N in to the pasture system

Forage genetic resources of Ethiopia

- Ethiopia has diverse physiographic features which give rise to enormous diversity of vegetation types.
- These vegetation types contain valuable plant genetic resources including wild crop relatives, medicinal plants, condiments, forages and industrial plants.
- 3 of the 18 vegetation types are important centers of genetic diversity: the Afroalpine and Afromontane; the sudanian, and the Somali-Masai floristic regions (Figure 1).

Forage genetic resources in 3 *PHYTOCHORIA*



Forage genetic resources of Ethiopia (cont'd)

1. Temperate legumes & grasses

Two sources:
a. The Afroalpine grassland (climax type)
b. Afromontane grassland (biotic type)

Grass tribes: Festuceae, Aveneae, and Agrosteae (higher alt), which are Afromontane / Afroalpine endemics & Andropogoneae and Paniceae (at lower altitudes)

Legume tribes: Trifoleae dominate the secondary grassland in the lower altitude of these zones

Forage genetic resources - Afroalpine & Afromontane

S.N	Species	Characteristics
	LEGUMES	
1	Trifolium spp	Herbaceous legume
2	Medicago polymorpha	Herbaceous legume
3	Medicago lupulina	Herbaceous legume
4	Lotus schoeleri	Herbaceous legume
5	Lotus	Herbaceous legume
6	Scorpurus muricatus	Herbaceous legume
7	Argyrolobium rupestri	Herbaceous legume
8	Sesbania sesban	Tree/shrub legume
9	Aeschynomene abyssinica	Tree/shrub legume
10	Erythrina brucei	Tree legume
	GRASSES	
1	*Setaria sphaceleta*	Perennial grass
2	*Setaria chevalieri*	Perennial grass
3	*Pennisetum clandestinum*	Perennial grass
4	*Andropogon distachys*	Perennial grass
5	*Pennisetum reparium*	Perennial grass
6	*Avena abyssinica*	annual grass

Forage genetic resources of Ethiopia-Afroalpine & Afromontane (cont'd)

Diversity of the genus *Trifolium* in the Afromontane and Afroalpine regions

- About 35 – 40 *Trifolium* species have been recorded in Eastern Africa.
- Ethiopia, with its huge highland mass is home to 28 *Trifolium* species (9 of them endemic)
- Therefore, it is considered as the secondary center of origin of the genus *Trifolium*.

Diversity of Trifolium in Africa (Cont'd)

Ethiopia: Dega Damot (Agewmidir); Dejen-Gozamin plateau/ Mount Choke and Mount Mekerakir:	T. quartinianum; T. simense; T. decorum; T. billiniatum, T. burchellianum, T. rueppellianum, T. usambarense, T. pichisermole, T. semipilosum; T mattirolianum; T. polystachyon
N. Gondar: Debark, Gaynt and Estie	T. campestri, T. arvense; T mattirolianum
Arsi-Bale Highlands-Mount Chilalo (3500 m), Dinsho Massif (4000 m),	T. burchellianum var Johnstonii and var oblongum; T. semipilosum var bruneli
Sidamo Highlands-Amaro Mountain massif- Mount Dello (4000 m);	T. burchellianum var oblongum
Eastern Wollega Highlands- Horo Gudru; Shamboo	T. billiniatum, T. burchellianum, T. rueppellianum,
Kibre Mengist plateau	T. somalense; T. semipilosum
Wollo, Kutaber	T. polystachium

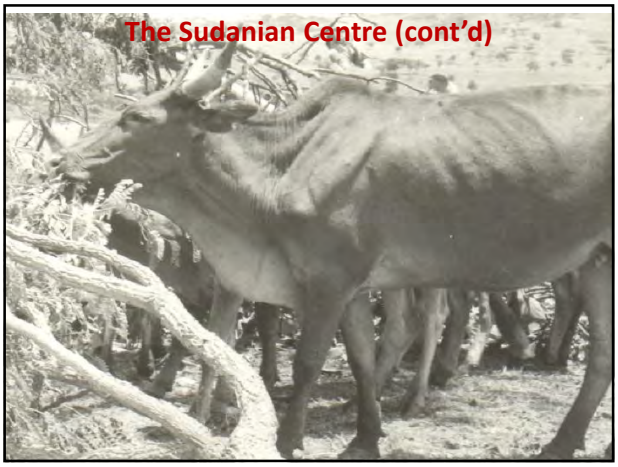
Diversity of Trifolium in Africa (Cont'd)

Diversity of Trifolium in Africa (Cont'd)

Legume Genetic Resources: the Sudanian Vegetation Zone

	Herbaceous legumes	
1	Macrotyloma axillare	Forage
2	Stylosanthes fruitcosa	Forage
3	Clitoria ternatea	Forage
4	Neonotonia wightii	Forage
5	Vigna membranacea	Forage
6	Teramnus labialis	Forage
7	Zornia setosa	Forage
8	Zornia glochydiata	Forage
9	Psophocarpus grandiflora	Forage & wild crop relative
	Browse trees	
1	Acacia albida	Browse legume tree
2	Acacia nilotica	Browse legume tree
3	Acacia polycantha	Browse legume tree
4	Albizia malacophylla	Browse legume tree
5	Aeschyomene ruspoliana	Browse legume tree

The Sudanian Centre (cont'd)



Legume genetic resources: the Somali-Masai Floristic Region

	Browse trees	
1	Cordeuxia edulis	Browse legume tree
2	Dichrostachys cenerea	Browse legume tree
3	Acacia albida	Browse legume tree
4	Acacia nilotica	Browse legume tree
5	Acacia polycantha	Browse legume tree
6	Acacia sieberiana	Browse legume tree
7	Aeschyomene elaphroxylon	Browse legume tree
8	Sesbania sesban	Browse legume tree
9	Sesbania quadrata	Browse legume tree
10	Erythrina burana	Browse legume tree
11	Parkinsonia aculeate	Browse legume tree

Achievements in Forage Legume Research in Selected Strategies

1. Integration of Forage and Grain Legumes

Why we integrate forages ??

Poor capacity of the smallholder to adopt conventional pastures

1.1. Cereal / forage crop rotation

- Involves cropping sequence with or without a fallow period.
- The main feature of crop rotation is that a given combination of crops is grown in a particular sequence on the same piece of land for several years without loss of soil fertility or significant reduction in yields.
  - Fig. 1

Forage Legumes in Crop Rotations

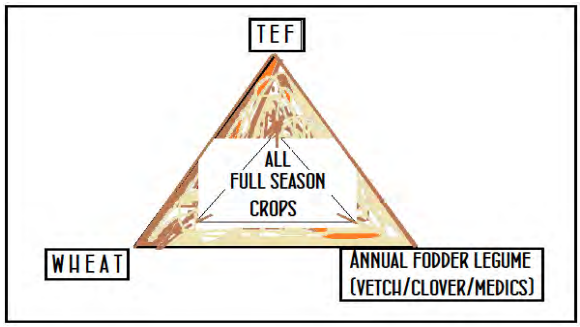


Fig 1. Modified cropping cycle with a replacement of the pulse phase with annual fodder legumes grown as full-season crop

Cereal/forage crop rotation (contd.)

Table 1. Herbage yield of different annual forage legumes grown in mixture with an oats variety on Vertisols at Debre Zeit and Akaki

Oats-legume mixture (treatments)	Herbage yield (t/ha)			
	Debre Zeit		Akaki	
	Fresh	Dry	Fresh	Dry
Oats (pure stand)	25.75 b*	6.10 a	22.42	6.46 a
Oats + *Vicia dasycarpa*	28.00 ab	6.03 a	23.42	5.23 b
Oats + *Trifolium quartinianum*	31.67 a	6.22 a	25.00	5.98 ab
Oats + *T. steudneri*	24.67 bc	5.52 ab	26.42	6.26 a
Oats + *T. rueppellianum*	26.58 b	5.86 a	23.50	5.83 ab
Oats + *T. decorum*	21.17 c	4.86 b	23.17	5.20 b
LSD (0.05)	4.31	0.87	NS	0.79
SEM	1.48	0.30	1.19	0.27
CV (%)	13.78	12.68	12.16	11.41

*Means followed by similar letters are not significantly different at P<0.05.

Table 2. Grain yield of durum wheat grown with different fertilizer levels subsequent to mixtures of oats with annual legume species on Vertisols at Debre Zeit

Precursor crop of Oats-legume Mixture	Nitrogen fertilizer level on wheat crop				
	Optimum	Sub-optimum	Low	None	Mean
Oats + *Vicia dasycarpa*	1744.0	1643.3	1263.0	1135.3	1446.4 a*
Oats + *T. quartinianum*	1777.0	1604.3	1319.7	1098.3	1449.9 a
Fallow	1552.0	1520.0	755.0	906.0	1283.4 bc
Oats + *T. steudneri*	1745.3	1659.7	1264.3	1235.3	1476.2 a
Oats + *T. rueppellianum*	1683.3	1519.0	1419.7	1218.3	1460.1 a
Oats (pure)	1522.7	1429.7	1058.7	1011.3	1255.6 c
Oats + *T. decorum*	1733.7	1595.7	1211.3	1057.3	1399.5 ab
LSD (0.01)		NS			122.0
SEM		64.32			32.16
Mean (Fertilizer)	1679.8 a	1567.4 a	1241.8 b	1094.6 b	
LSD (0.01)		207.6			
SEM		39.59			
CV (%)			7.98		

*Means followed by similar letters are not significantly different at P≤0.01. NS = none significant

Integration of fodder and food crops (CONT'D)

1.2. Sequential cropping of Forage & Grain Legumes

- Two crops are grown during the season, one after the other.
- The two crops do not overlap, the second being sown only after the harvest of the first. .
- This cropping sequence does not affect the traditional crop cycle.

– **Fig. 2**

Sequential cropping of Forage & Grain Legumes

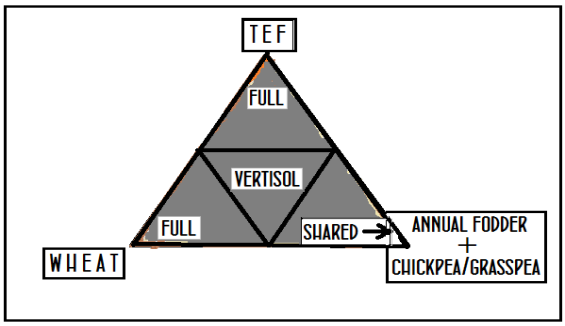


Fig 2. Modified cropping cycle with a replacement of the pulse phase with annual fodder legumes grown as full-season crop

Table 3. Dry herbage yield of forages legumes and grain yield of a sequentially sown chickpea on a *Vertisol* at Debre Zeit.

Phase I		Phase II
Annual forage legumes (June-Mid-Sept)	DM yield (kg/ha) (June-mid-Sept.)	Chickpea grain yield (kg/ha) mid-Sept.-Dec.
Medicago scutellata	4925	2649
Fallow (partial) + Chickpea	-	2553
Trifolium steudneri	2645	2468
Fallow (full season)	-	-
Vicia dasycarpa	2549	2384
Trifolium quartinianum	3585	2530
C.V. %	12.69	9.18

Table 4. Grain yield of durum wheat (var. Kilinto) grown under four nitrogen fertilizer levels subsequent to sequentially grown double crops of forage legumes and chickpea on a *Vertisol* at Debre Zeit.

Phase I Annual forage legumes (June-Mid-Sept.)	Phase II (June-Sept.)	Phase III. Wheat yield (kg/ha) at different N levels*				
		Optim level	sub-optim level	Low level	None	Mean
Medicago scutellata	Chickpea	1911	1765	1569	1230	*1619*
Fallow + Chickpea	Chickpea	2065	1215	1119	631	*1258*
Trifolium steudneri	Chickpea	2603	2451	1617	1550	*2055*
Fallow (full season)	-	2116	1023	769	653	*1140*
Vicia dasycarpa	Chickpea	2267	1720	1360	1158	*1626*
Trifolium quartinianum	Chickpea	3476	2258	1599	1498	*2208*
Fertilizer means		*2406*	*1738*	*1339*	*1120*	
C.V. %				12.72		

*optimum (64 kg N/ha), sub-optimum (32 kg N/ha), low level (18 kg N/ha), and zero (without N fertilizer).

T. quartinianum "Fitting native clovers in croping cycles"

Fig. 1. Fodder is harvested Chickpea is planted

Fig. 2. Oats/Vetch mixed fodder displayed

Fig. 3. I like this cropping technique !! (Ato Alitah)

Precursor crop (oats + vetch)

Subsequent crop (chickpea)

Integration of fodder and food crops (cont'd)

1.3. Intensive fodder crops (Backyard / fodder bank)

- Fast growing
- High biomass yielding
- Profuse nodulaters even without inoculation

E.g. *S. macrantha*:- Well adapted to light soils producing high yields (in 105 days) of:

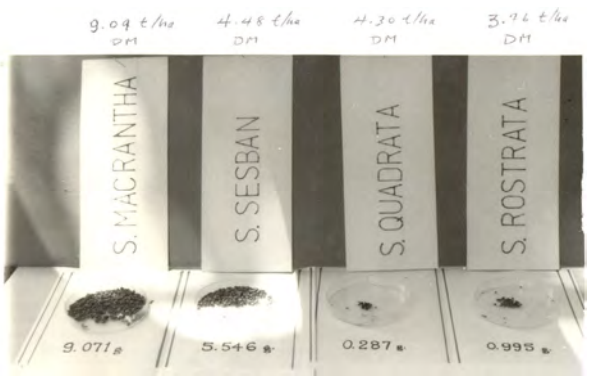
- Leaf, 2.8 t/ha
- Stem, 6.3 t/ha
- Total DM, 9.1 t/ha

Integration of fodder and food crops production

Browse

Easy to store/ to Feed

Integration of fodder and food crops (cont'd)



CONCLUSION & WAY FOREWARD

- Legumes have been integral components of the farming systems for ages and will continue to play pivotal roles in both the smallholder and commercial agriculture in the future.
- Critical issues need to be addressed to enhance and sustain the use of grain and forage legumes in Ethiopia.

→

CONCLUSION & WAY FOREWARD

- Critical issues: (Ethiopia):

1. There is a need to devise ways and means of improving availability of forage **seed and inocula**.
2. Build the capacity of research institutions and national laboratories that work on legume microbiology such as isolation of Rhizobia strains & devmt of inocula; quantification of fixed N2
3. Need for regulations towards limiting free grazing so that wider use of forage legumes can be successful.

~END~

GOD BLESS YOU !

An Overview of IFDC Activities under the AGP-AMDe

By
ABEY MEHERKA

N2 Africa Workshop
April 30 – May 2, 2012
Addis Ababa

Introduction to IFDC

- Established in 1974 during the world food crisis
- Suggested by U.S. Secretary of State Dr. Henry Kissinger
- U.S. President Jimmy Carter, by Executive Order, accorded IFDC immunities and privileges of an International Organization in 1977
- Initial purpose to help developing countries solve food-deficit problems by focusing on development of fertilizers and fertilizer practices to meet special needs of tropical and subtropical climates and soils
- Evolved into multi-faceted center with broadened focus

IFDC

- International, multidisciplinary staff and physical facilities uniquely suited for conducting broad range of R&D activities in sustainable food system.
- Specialized research laboratories, greenhouses, growth chambers, specialized instruments essential for laboratory research, bench-scale and pilot-plant units, training facilities, technical library, scientific information services, and word processing center.
- Assisted 130 countries and has current presence in 22 countries

Goal and Focus of AMDe

AMDe Goal

Transform Ethiopian Agriculture from subsidy based to commercial, incentive driven industry

AMDe Focus Interventions

- Strengthen farmer-market linkages for introduction of improved inputs and outputs
- Boost supply chains through improving quality and standards to enhance marketable agriculture products

Interventions cont'd

- Create incentive schemes for key value chain actors (cooperatives, unions, women and the private sector) to engage in value addition activities such as improvements in post-harvest management and agro-processing – on cost sharing bases
- Build the capacity of these value chain stakeholders through business and entrepreneurship skills training as well as facilitating access to credit

Overview of IFDC's Intervention in the project

- IFDC will focus on strengthening the input supply chain in the project area
- Special attention will be paid to increase the number of farmers buying inputs in VC areas by Increasing the availability of fertilizers, and improved seeds
- Increasing the production and quality of wheat, maize, coffee, sesame and chickpeas and Improving the product knowledge and business skills of cooperatives

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Overview

- Efforts will also be made to attract participation and investment of the private sector in the production and marketing of improved seeds and fertilizer products.
- Special attention will be paid to local capacity building, through training and linkage development
- IFDC will collaborate with other subcontractors particularly JMA, on Policy enabling issues, Crown Agents on logistics planning and input delivery and Gender issues
- IFDC will use its wealth of experience in agri input market development in Africa, Asia and other parts of the world to achieve the performance targets of AGP-AMDE Ethiopia

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2012 Priority Activities

- Assistance in production and marketing of improved seeds of wheat and maize
- Field demonstrations on the merits of multi- nutrients fertilizers and improved seed varieties on wheat, maize ,Sesame and chick peas through integrated soil fertility management (ISFM) Technologies

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2012 priority Cont'd

- Technical assistance on up gradation of fertilizer recommendations
- Credit mobilization through training and business net working of credit providers, and input supply enterprises
- Training of Trainers on product Knowledge and Business Management

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2012 priority Cont'd

- Training of Coop Unions, Pvt dealers and extension Agents on Inputs Product Knowledge, Business management and technologies
- Mobilize business credit among wholesale and retail dealers through trust building and of business linkages
- Review of existing fertilizer & seed Laws and quality regulatory mechanisms
- Business Development Model for the expansion of rural sale points in selected Woredas on pilot basis
- Market study on the scope of marketing the multi -nutrient fertilizers (NPK Grades) in Ethiopia

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Potential Areas of partnership with N2 Africa

- Capacity building of farmers cooperatives and groups engaged in legume crops production.
- In the supply and efficient distribution of Agricultural inputs.
- Cooperation in relevant research activities.
- Areas to be identified by this workshop.

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IFDC
THANK YOU!
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Soybean Value Chain Project

Brief Presentation to N2Africa Workshop: May 1st, 2012

Monika Sopov & Yared Sertse

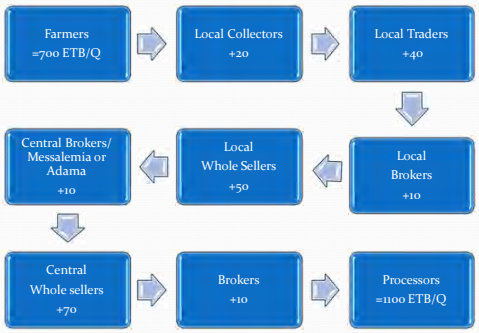
What is covered in this Presentation

- Soybean Value Project Highlights
- Soybean Value Chain Mapping
- Soybean Production and Market Projection.
- Key challenges and concerns in developing the soybean value chain.
- Potential intervention for N2Africa.

Soybean Value Chain Project Highlights:

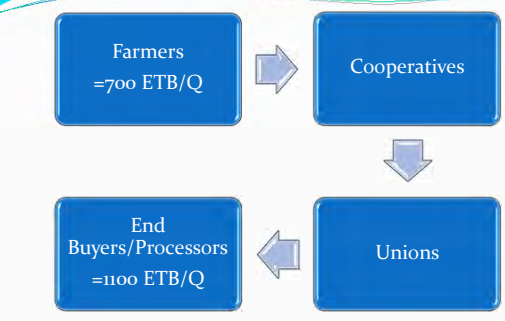
- **Commissioned by the RNE and Implemented by WUR-CDI and local partners in two phases.**
- **Phase 1: Feasibility Analysis for Value Chain Selection**
  - Soybean Production as value chain commodity is economically feasible.
  - Production exists but is fragmented & small to cater commercial demand.
  - Markets are underdeveloped but emerging faster and stronger.
- **Phase 2: Developing the Chains: 2011**
  - Stakeholders identification and engagement.
  - Chain Formation-Nutritious Food (CBS), Animal Feed, Edible Oil and Soymilk + Others.
  - Understanding challenges and developing strategies.
  - Series of Facilitation for market linkage between upstream and downstream actors.
- **Phase 2: Developing the Sector + Chains-2012**
  - Contract Farming.
  - Commercial vs Household Value Chain
  - Soy processing technology development
  - Sector Association and Information Platform

A typical Soybean Value Chain without the supporting services



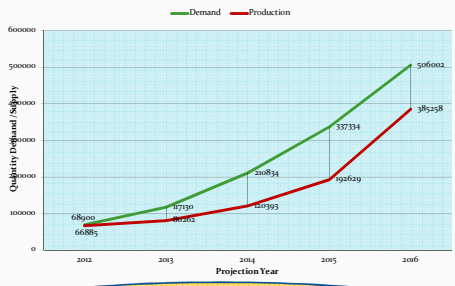
Complex and Long Chain → Market Volatility + Transaction Cost+ Adulteration+ Hording.

Emerging value chain in high production and commercially orieneted areas



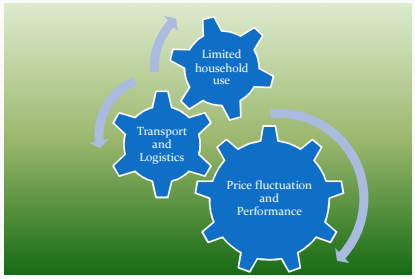
This model works in areas where farmers are well organized and soybean is one of the main cash crop.

Projected Demand and Supply (1012-2016): increasing supply gap.

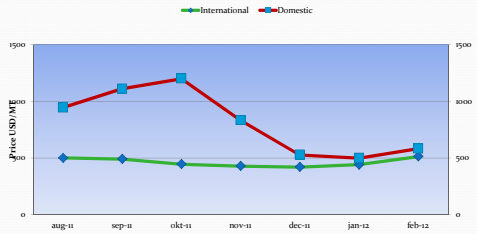


- *Demand is growing faster than supply → up to 75% gap in the coming three years.*
- *Demand doesn't include export and household level use.*

Key challenges and concerns in developing soybean value chain

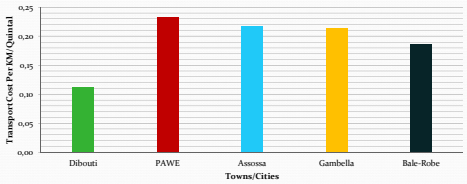


Price are unpredictable and higher than international market



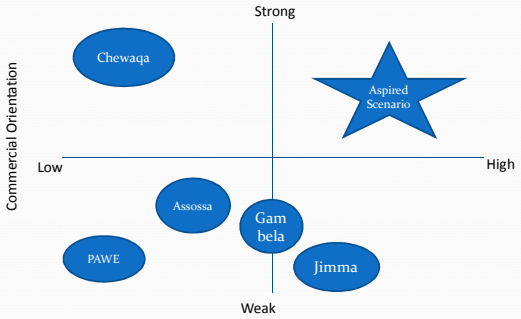
Economic Return from Soybean is better than most competing crops including sesame but lesser than that of maize, pepper and cotton.

In areas where soy is popular inland Transport cost is more than double to that of Djibouti Corridor.

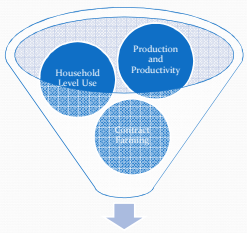


Availability in space and time plus compatibility with product volume are also big challenges.

Limited household use → limited options when market fails



Potential intervention for N2Africa.



Focus on upstream technologies and lessons

Potential intervention for N2Africa.

- Household Level Use:
  - Soybean Menu and Home economics
  - Small Scale Soybean Processing Technologies
  - Small Scale Feed Processing Technology from Soy byproducts.
- Production and Productivity:
  - Make soy economically better or as attractive as competing crops
    - Inoculation
    - Improved Varieties
    - Agronomic Practices

Improved Productivity + Production → Low Unit Cost from Economies of Scale → High Profitability → More Soy Farming → Improved Soil Fertility.

- Contract Farming:
  - Experience of other countries; Best Models


IN THE END=
THANK YOU FOR LISTENING

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 soybeans, common beans, cowpeas and groundnuts varieties with proven high BNF potential and sufficient seed availability in target impact zones of N2Africa Project
10. Project launch and workshop report
11. Advancing technical skills in rhizobiology: training report
12. Characterisation of the impact zones and mandate areas in the N2Africa project
13. Production and use of Rhizobial inoculants in Africa
18. Adaptive research in N2Africa impact zones: Principles, guidelines and implemented research campaigns
19. Quality assurance (QA) protocols based on African capacities and international existing standards developed
20. Collection and maintenance of elite rhizobial strains
21. MSc and PhD status report
22. Production of seed for local distribution by farming communities engaged in the project
23. A report documenting the involvement of women in at least 50% of all farmer-related activities
24. Participatory development of indicators for monitoring and evaluating progress with project activities and their impact
25. Suitable multi-purpose forage and tree legumes for intensive smallholder meat and dairy industries in East and Central Africa N2Africa mandate areas
26. A revised manual for rhizobium methods and standard protocols available on the project website
27. Update on Inoculant production by cooperating laboratories
28. Legume Seed Acquired for Dissemination in the Project Impact Zones
29. Advanced technical skills in rhizobiology: East and Central African, West African and South African Hub
30. Memoranda of Understanding are formalized with key partners along the legume value chains in the impact zones
31. Existing rhizobiology laboratories upgraded
32. N2Africa Baseline report
33. N2Africa Annual country reports 2011

34. Facilitating large-scale dissemination of Biological Nitrogen Fixation
35. Dissemination tools produced
36. Linking legume farmers to markets
37. The role of AGRA and other partners in the project defined and co-funding/financing options for scale-up of inoculum (banks, AGRA, industry) identified
38. Progress Towards Achieving the Vision of Success of N2Africa
39. Quantifying the impact of the N2Africa project on Biological Nitrogen Fixation
40. Training agro-dealers in accessing, managing and distributing information on inoculant use
41. Opportunities for N2Africa in Ethiopia

Partners involved in the N2Africa project

Caritas Rwanda

Diobass

Eglise Presbyterienne Rwanda

Nairobi University

Resource Projects-Kenya

Université Catholique de Bukavu

University of Zimbabwe