Putting Nitrogen Fixation to Work for Smallholder Farmers in Africa

N2Africa

Agro-dealer training course
Zimbabwe
Season 2012-13

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Goal of the N2Africa Project

To link the protein and nitrogen needs of poor African farmers directly to massive atmospheric reserves and providing them with income generating crop production enterprises.

By increasing production of four legumes; beans, soybean, cowpea and groundnuts, the project is helping farmers to practice renewable soil fertility management and adopt profitable new technologies and value-adding enterprises.

The 5 objectives of the N2Africa project:

1. Establish a baseline of the current status of N2-fixation, identify niches for targeting N2-fixing legumes in the impact zones

2. Select multi-purpose legumes (food, fodder, stakes, and soil fertility management) for enhanced BNF and integrate these into farming systems

3. Select superior rhizobia strains for enhanced BNF and develop inoculum production capacity in country, including private sector partners

4. Deliver legume and inoculant technologies to farmers in Zimbabwe

5. Develop and strengthen capacity for BNF research, technology development, and application

Implementation approach

- Work with partners in the 7 districts to reach farmers with legume inputs and technologies

- On-farm research trials generate technologies and best practices

- Results extended through lead farmer demonstration trials and technologies further refined based on feedback

- Larger groups of farmers learn from LF and satellite plots

What do we promote:

- Integration of new ***Biological Nitrogen Fixation Technologies*** into smallholder farming systems

- Improved varieties of 4 crops (***soybean, groundnuts, sugarbeans and cowpea***) together with legume specific inputs, improved production practices and market linkages

- Inputs: **P-based fertilizers**, **gypsum** (as for groundnuts) and soybean **inoculants**

Example of N2Africa demonstration plot: showing effects of SSP and inoculants on yield of soybeans:

	10 meter	*10 meter*
10 meter	**Seed only** **(No fertilizer, no inoculants)**	**Seed** **+ Inoculant** **+ SSP**
10 meter	**Seed** **+ Inoculant**	**Seed** **+ SSP**

Where do you as agro-dealers come in…

- Serve as source of information and guidance on production of legume crops with associated technologies (P, inoculants)
- Become sustainable linkage between sources of legume inputs and farmers
- Extend legume technologies to new farmers beyond life of project
- Increase your revenues by diversifying products and services you have to sell

BIOLOGICAL NITROGEN FIXATION (BNF) AND LEGUME INOCULANTS

From John M. Musyoka (2012) 'Agro-dealers Training: Reference Manual (milestone 5.4.3) www.N2Africa.org, pp49-57, adapted by Isaac Chabata

Biological Nitrogen Fixation

Biological Nitrogen Fixation (BNF) occurs when atmospheric nitrogen is converted to ammonia. BNF is a natural process **BUT** most legume crops do not receive maximal benefit from BNF. Symbiotic nitrogen fixation occurs in plants that harbour nitrogen-fixing bacteria within their tissues. The best-studied example is the association between legumes and bacteria in the genus **Rhizobium**. Each of these is able to survive independently (soil nitrates must then be available to the legume), but life together is clearly beneficial to both. Only together can nitrogen fixation take place. A symbiotic relationship in which both partners benefits is called **mutalism**. Inoculants are inexpensive, low-risk inputs. On many farms, nitrogen from BNF may be the only renewable soil fertility input the farmer can acquire without significant investment.

Legume Inoculants

Legumes convert atmospheric nitrogen to usable ammonia nitrogen for the plant. Inoculation is the process of introducing commercially prepared rhizobia bacteria into the soil. Each legume species requires a specific species of rhizobia to form nodules and fix nitrogen. Store inoculum and pre-inoculated seed in a cool environment without exposure to sunlight. Inoculum packages should be labelled with an expiration date.

Why Inoculate

Affordable compared to inorganic Nitrogen. Inorganic N per Ha costs about USD 87.0/ha while an inoculants sachet costs only **USD 5.0/ha.** Most soils do not have sufficient rhizobia for effective nodulation. It is cheap and easy to transport. It is easy to use, it actually makes sense; 100g for 100 Kg of seed which will help fix 46- 200Kg of N per hectare.

In many soils, the nodule bacteria are not adequate in either number or quality. Under these conditions, it is necessary to inoculate the seed or the soil with highly effective rhizobia. Root nodule bacteria are cultured in the laboratory and combine with a suitable carrier material, such as peat, compost or filter mud, to make an inoculant. In Zimbabwe the carrier material used is bagasse from sugarcanes.

The process of adding this inoculant to the seed is called **inoculation.** Inoculation is often required when new legumes are introduced to an area. Host-specific rhizobia are frequently developed for new varieties of legumes. Many soils are heavily infested with ineffective rhizobia capable of inducing nodulation without benefiting the legume host. Very large inoculant rates of competitive and effective strains may counteract these aggressive native rhizobia.

Types of Inoculants

Legume inoculants are of two general types: those designed for application to seeds or directly to the soil. Seed inoculants are the most common because they are easy to apply and are generally effective under most conditions. Shelf life varies with carrier, handling and storage temperature. It is important that inoculant quality be monitored by an independent laboratory and conservative expiration dates be established to protect the interests of users.

Selecting quality inoculants

Inoculant should contain only rhizobia capable of producing effective nodules. Effective inoculants may consist of one or several elite strains. Inoculant should provide large numbers of viable rhizobia allowing for application of at least 10,000 bacteria per seed. Carrier medium must protect the rhizobia in the package and on the seed. It should be **easy to apply** and **adhere well to the seed**. Inoculant must be free of other bacteria which might be detrimental to rhizobia or to the young legume seedling. Some inoculants contain other beneficial root bacteria. Inoculant must be packaged to protect the rhizobia until it is used. The package should allow exchange of gases and retention of moisture. The package should provide clear instructions and list the legumes that it effectively nodulates and carry an expiry date beyond which the product cannot be considered dependable.

Tangible benefits of Rhizobium legume inoculants

Increased input of N in the system by legumes planted in association or in rotation with non- legume plants hence reducing the need for mineral N fertilizers. There are increased yields of between 20%-50%.

Inoculant labelling and storage requirements

The information required on the legume inoculant package should include:

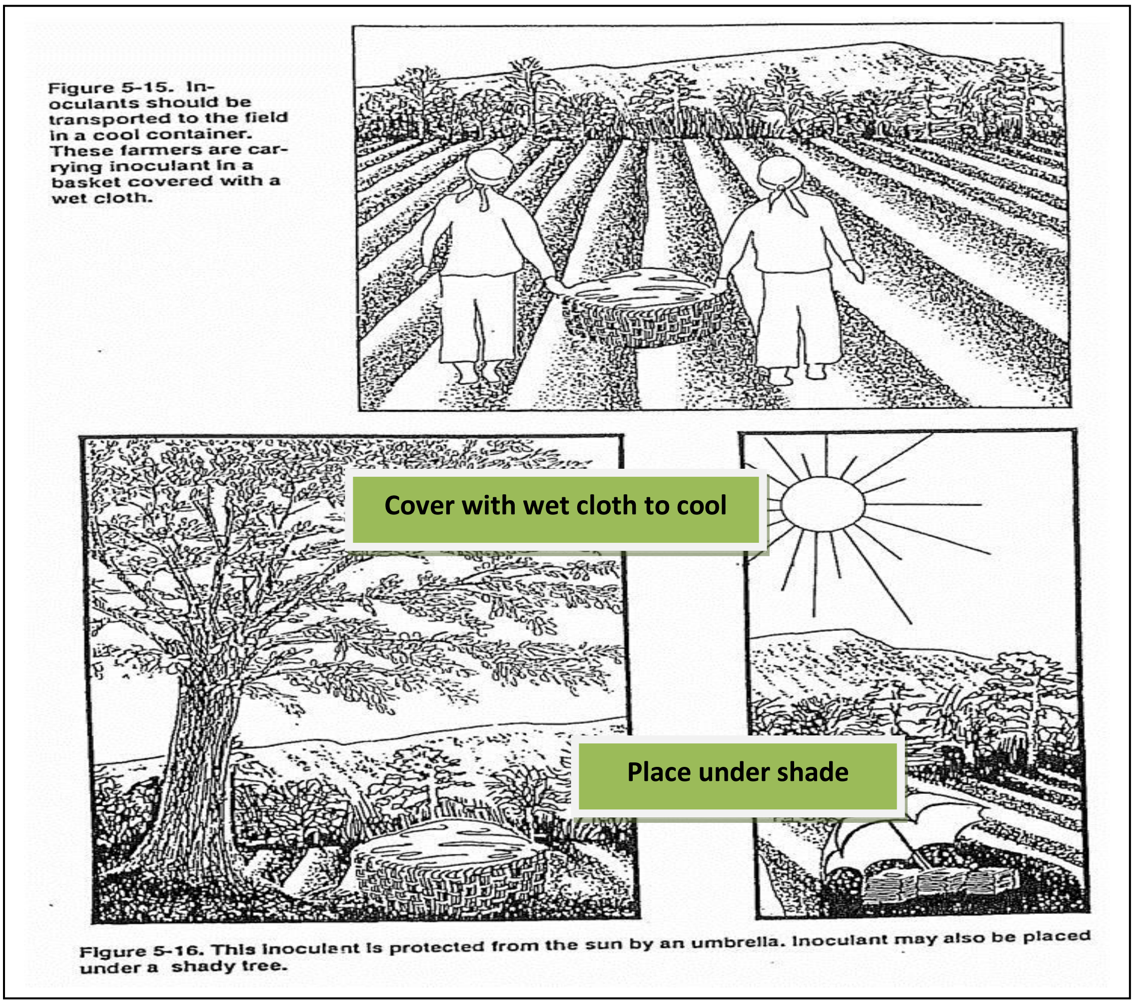
- Name of the crops for which the inoculant is intended
- Scientific name of the Rhizobium species
- Number of live rhizobia per gram
- Expiration date beyond which the product cannot be used
- Lot number for quality control feedback
- Instructions for use
- Net weight of inoculant
- Trade name, manufacturer and address
- Necessary storage conditions


FRONT
BACK
Brand Name
Quantity
Host
Handling
User Instructions
Expiry Date
Manufacturer Contact and
BIOFIX
Legume Inoculant
Manufactured & Distributed by MEA Ltd.
under licence from the University of Nairobi
100g of Legume Inoculant
30g of gum arabic adhesive
For use in SOYBEAN
Store in cool place and protect from Sunlight
DIRECTIONS FOR USE
MAELEZO YA KUTUMIA

Inoculant storage and handling

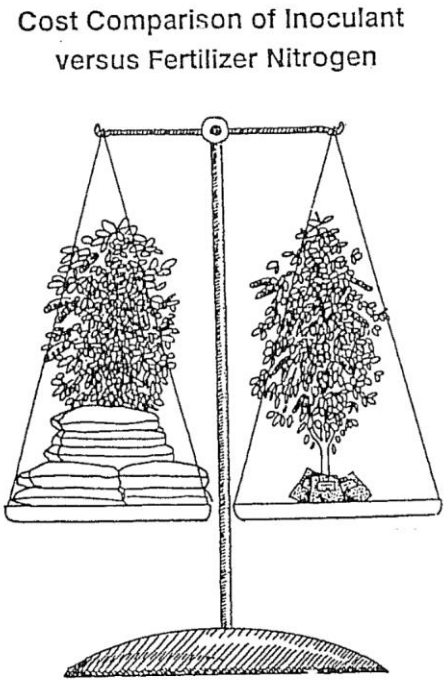
Legume inoculants are perishable and quickly lose their effectiveness when exposed to a temperature of 40^o C or more. Inoculants retain their effectiveness for six months or longer when stored at a temperature around 20^o C. This period can be extended if refrigerated near 4^o C but freezing inoculants damages the product.

Simple precautions prior to inoculant application and planting protects rhizobia



Inoculant versus N Fertilizer

100 gram inoculant has greater net benefits than 150 kg AN in Zimbabwe:



Total BNF = 100 kg N per ha

Cost of inoculants = USD 5.00

Cost of sticker (sugar) = USD 2.50

Total cost = USD7.50

Cost of equivalent fertilizer

100 kg N ≈ 3 bags of AN

1 bag of AN = USD 35

Cost of fertilizer = USD 103.50

Cost Labour 6 hours – USD 6.00

Total cost = USD – 109.50

Benefits from inoculation =

109.50/5 = 22-fold benefits

Sound use of legume inoculants

- Use the correct inoculant for each legume. Check the label for the legume species you are planting.
- Protect inoculant from sun and heat to keep it alive. The ideal storage temperature is between 4^o and 26^o C.
- Store inoculant in tightly closed bags.
- Use a sticker when inoculating seeds.
- Use the recommended amount of inoculant.
- Inoculate seeds just before planting.
- Apply soil inoculant when the soil is moist or just before irrigation.
- Cover the furrows after planting inoculated seeds.

Some common mistakes in inoculant handling and use

- Exposing inoculants to temperatures above 30^oC.
- Using inoculants after their expiration date or after they have been exposed to high temperatures.

- Letting inoculants dry out.
- Mixing fertilizer with inoculated seeds.
- Broadcasting inoculants onto dry soil.
- Appling additional inoculant to the surface when the soil is dry.
- Planting commercially prepared, pre-inoculated seeds.

Group Exercise: Some brainstorming questions (group or plenary)

Q1. A farmer has stored her inoculant in a small shed for over two weeks. You enter the shed and find that the temperature was above 40^{o}C.

What recommendation can you give to the farmer?

Q2. A farmer has told you that in order to save labor and money she is going to apply inoculant to the seed without applying sticker by dusting.

Provide her the alternatives and discuss the advantages in relation to her concerns about the need to save labor and money.

Q3. A farmer asks you to look at his legume crop. He has inoculated the bean crop but after four weeks there are no nodules. The crop looks healthy.

What questions should you ask this farmer to determine why the bean crop is affected by inadequate inoculation?

Q4. A farmer tells you she doesn't think inoculation is necessary because she inoculated cowpeas last year and the yield was not improved. This year, she is planting soybeans this year in the same field.

Provide her with reasons why she did not increase cowpea yield with inoculation last year and why she should inoculate soybeans this season.

Q5. A farmer was unable to plant his legume seed as planned because of delayed rains. He inoculated his seed and has now stored the seed for more than two weeks.

Provide the farmer with some useful advice on how to plant this seed.

Well-managed field N2Africa Delivery and Dissemination plot: soya bean inoculated and fertilized with SSP. Guruve District, Zimbabwe (Picture by Isaac Chabata)

N2Africa contacts

In case you would want to have more information on inoculants, legume fertilizers or the N2Africa project, feel free to contact us:

Isaac Chabata – N2Africa Farm Liaison Officer

12.5 km Peg Mazowe Road

Phone: 0772 262 773

Ms Judith de Wolf – N2Africa Country Coordinator

12.5 km Peg Mazowe Road, Harare

Phone: 0772 572724