**Biological Nitrogen Fixation (BNF) in Africa**

**Current major multi-partner Project: N2 Africa**

**Project focus: Enhancing inputs from BNF in smallholder farming systems**

**Background**

Maximal rates of BNF recorded in the tropics can reach 5 kg N/ha/day with the green manure Sesbania rostrata. More than 250 kg N/ha of fixed N2 in soybean has been measured in Africa on smallholder farms with associated grain yields of more than 3.5 t/ha. This demonstrates that the potential rates of BNF in legumes are not limited by the efficiency of BNF in the legume-rhizobial symbiosis. But less than 8 kg N/ha/year is often fixed by grain legumes when expressed across the whole area of an African smallholder farm due to a lack of substantial area (<15% of the farm area) planted with legumes and environmental stresses that prevent effective BNF (<35 kg N/ha fixed). Successful BNF by legumes in the field depends on the interaction:

(GL ×GR)×E×M
(Legume genotype × Rhizobium strain) × Environment × Management

Where environment encompasses climate (temperature, rainfall, day length etc to encompass length of growing season) and soils (acidity, aluminum toxicity, limiting nutrients etc). Management includes aspects of agronomic management (use of mineral fertilizers, sowing dates, plant density, weeding). Incidence of diseases and pests are also a function of (GL × GR) × E × M. Thus establishment of effective BNF depends on optimizing all of these components together. They are also allocated less attention in terms of labor for crop management. This means that E and M often override the potential of the legume/rhizobium symbiosis for BNF.

**Project Approach**

A step-wise approach is being used to enhance BNF by grain and forage legumes. As shown in the figure below, substantial increases in BNF can be made based on existing legume and inoculant technologies (for GL × GR × E × M) using current knowledge. Further substantial increases can be gained by increasing the area under legumes and retaining the legume residues in the field, which will be achievable within 4 years in many regions. Selection of rhizobial strains with enhanced BNF efficiency can be selected (including field testing) within 3-5 years. Moving to a longer time scale breeding of legumes for enhanced BNF takes longer, probably 10-15 years before varieties incorporating newly- identified traits can be moved to release. Adaptation to environmental stress in the legume/rhizobial symbiosis is poorly understood and there is a strong need for detailed plant physiology research in this area to support such breeding efforts to enhance BNF. Finally, genetic engineering approaches to enhance BNF hold promise, but may lead to enhanced BNF in farmers' fields only in 30-50 years.

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**Benefits and potential use of Arbuscular Mycorrhizal Fungi (AMF) in banana and plantain (*musa* spp.) systems in Africa**

Crop association with arbuscular mycorrhizal fungi (AMF) often prove beneficial to crop productivity through a number of mechanisms, such as improved access to nutrients and water and pest and disease suppression. Banana and plantain (Musa spp.) are both mycorrhizal plants, with a number of studies demonstrating the strong stimulatory effect of AMF on plant growth in pots. Therefore, application of AMF to newly deflasked tissue culture plants or in nurseries may improve plant growth and possibly provide healthier plants for sale to farmers. Pot trials have also shown that inoculated plants are better able to suppress nematodes. However, how this association benefits banana and plantain plant performance under field conditions remains largely unknown. Studies are currently underway to determine the mycorrhizal associations of banana and plantain cultivars with AMF in East and Central Africa. Greenhouse studies complement field studies for comparison at the different levels. In West Africa, studies have been conducted to assess AMF association and yield impact following inoculation. Data from across Africa increasingly highlights that composition and abundance of AMF species associated with Musa spp. is highly variable. Up to 20 AMF species were found to be associated with banana plantations in East and Central Africa. Spore abundance, the inoculum reservoir that determines colonization, is largely influenced by management practices. The data generated to date increasingly illustrates the importance of AMF in banana systems and its sensitivity to crop and soil management practices. Some AMF species appear to be better than others with regard to their effects on banana growth, nutrient uptake and control of root damage by nematodes. Studies are in progress to screen AMF species and establish trials along different integrated soil fertility management practices.

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