Factsheet

Fighting Drought and Aluminum Toxicity: Integrating Functional Genomics, Phenotypic Screening and Participatory Evaluation with Farmers to Develop Stress-Resistant Common Bean and *Brachiaria* for the Tropics

Centro Internacional de Agricultura Tropical (CIAT)

Country/Region:	Rwanda, Malawi, Colombia, Nicaragua
German participation:	University of Hannover
Leading scientists:	Dr. Idupulapati Rao
Duration:	April 2006 – March 2009

Initial situation

Eighty percent of agriculture worldwide is rainfed with low yields, and droughts as a recurring feature. Approximately 43% of the world's tropical land area is acidic with problems of phosphorus (P) deficiency and aluminum (Al) toxicity. A major component of food security will be new varieties of crops and forages adapted to sub-optimal soil and variable climatic conditions –and acceptable and useful to the resource-poor. Genetic enhancement for drought and Al resistance will increase the rooting depth of crops and forages in Al-toxic subsoils and will increase their water and nutrient use.

A holistic approach integrating genomics, phenotyping based on physiological mechanisms, and participatory product development with women and the poor (diagnosis, testing and evaluation) is needed to address multiple stress factors. This integration will help enable functional genomics to impact directly and positively on agricultural production problems.

Common bean is the most consumed food legume in the world. Nearly 80% of bean is produced on small farms in poor, developing countries. *Brachiaria* grasses are exceptionally resistant to the combination of Al and drought, and have fueled an economic transformation of tropical acid savannas by sustaining crop-livestock systems. CIAT has assembled a multidisciplinary research team to genetically recombine drought and Al resistance with other agronomic characteristics in common bean and *Brachiaria* grasses.

Approach of the project

Maintaining root growth in a drying soil is a prerequisite for drought resistance. Al toxicity affects the root apex and limits root penetration, increasing crop sensitivity to drought. Our hypotheses are: (1) that the ability to maintain root elongation and root integrity in Al-toxic soils contributes to combined resistance for Al toxicity and drought; (2) that distinct genes are expressed in root tips under a combination of Al and drought stress than under individual stresses; and (3) involving women and the small farmers as decision makers and co-researchers in product development contributes to a rural innovation process as well as to products with direct livelihood benefits.

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A strategic partnership among CIAT, the University of Hannover and national programs of Rwanda, Malawi and Nicaragua will contribute to develop farmer-acceptable, drought and Al-resistant bean and *Brachiaria*.

Major results achieved

In Rwanda and Malawi, several stress adapted common bean lines with early maturity and high yield potential were identified and these lines are subjected to participatory varietal selection with farmers, to gain feedback on seed color, seed type and cooking time. A few stress adapted lines were identified and these will pass directly to multi-locational trials in farmers' fields to facilitate rapid release of the most promising bush bean varieties. In Rwanda and Nicaragua, 5 *Brachiaria* hybrids and 3 commercial *Brachiaria* cultivars are being evaluated with farmers, using local check cultivars, and recent results indicate that one of the hybrids has great potential as dry season feed. Research conducted at the University of Hannover demonstrated that the release of organic acid anions, particularly citrate, and the maintenance of high root citrate contents, contribute to Al resistance in common bean. Genotypic variation for Al resistance and response to osmotic stress/drought stress was clearly observed for common bean. At CIAT headquarters, physiological evaluation of recombinant inbred lines (RILs) and advanced lines resulted in the identification of two RILs and three advanced lines that were superior in their adaptation to drought stress conditions.

The superior performance of these lines was associated with a higher pod harvest index and a lower proportion of pod wall biomass, indicating the importance of greater mobilization of photosynthates to pods and seeds under rainfed conditions. Intergene pool crosses offer great potential for improved aluminium and drought resistance in common bean. Forty-two advanced lines of common bean were identified at CIAT headquarters for superior aluminium resistance in the field.

Expected impact

Small farmers and consumers in economically depressed areas of Latin America and Africa will benefit from greater production (at lower per-unit costs) and availability of beans, beef and milk.. The primary target area for common bean and *Brachiaria* grasses is Sub-Saharan Africa (Rwanda and Malawi) and Central America (Nicaragua).

Collaborating institutions: Institut des Sciences Agronomiques du Rwanda, Rwanda; National Department, Ministry of Agriculture, Malawi; Bunda College of Agriculture, Malawi; Instituto Nicaragüense de Tecnología Agropecuaria, Nicaragua; University of Hannover, Germany.

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Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 61 96 79-1435
F +49 61 96 79-7137
E beaf@gtz.de
I www.gtz.de/beaf

Dahlmannstr. 4
53113 Bonn
T +49 228 24934 231
F +49 228 24934 215
E judith.jansen@gtz.de

Pictures by:
Centro Internacional de
Agricultura Tropical (CIAT)

Contact:
Dr. Axel Schmidt: a.schmidt@cgiar.org

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