



Dry Grain Pulses Collaborative Research Support Program

Enhancing productivity, dietary quality
and sustainability of pulse/grain legume
value-chains for improved human welfare

MICHIGAN STATE
UNIVERSITY



WHAT IS A CRSP?

Collaborative Research Support Programs (CRSPs), mandated under Title XII, partner U.S. universities with the United States Agency for International Development (USAID) to achieve poverty alleviation and food and nutritional security goals in strategic developing countries. The CRSPs empower host country institutions to address priority needs and constraints through the creation of new technologies and knowledge while concurrently developing human resource capacity and competencies in strategic areas of agriculture, socio-economics, nutrition and natural resource sciences, thus leading to institutional



A Rwandan farmer proudly shows a recent harvest of a high yielding climbing bean variety, which gives hope for being able to provide for the food needs of his family.

self-reliance and sustainability. CRSP funding is provided by USAID's Bureau of Food Security through the Office of Agriculture Research and Technology. CRSP technologies and expertise are available to USAID Regional and Country Missions, NGOs, IARCs and private sector groups to achieve development objectives consistent with USAID's Feed the

Future Initiative (www.feedthefuture.gov/).

WHAT ARE DRY GRAIN PULSES?

Dry grain pulses represent a diverse group of edible grain legumes including common bean (*Phaseolus vulgaris*), cowpea (*Vigna unguiculata*), lima beans (*Phaseolus lunatus*), pigeon pea (*Cajanus cajan*), chick peas (*Cicer arietinum*), and lentils (*Lens culinaris*). These crops have the unique potential to provide solutions to the health, income creation and agriculture sustainability needs of developing countries in Sub-Saharan Africa, Latin America and Asia. As traditional staple foods, they constitute an important source of affordable protein, complex carbohydrates, essential micro-nutrients, dietary fiber,

vitamin B and anti-oxidants in the nutritionally challenged diets of both rural and urban poor. Due to their adaptability to marginal production agro-ecologies and high market value, pulses are extensively cultivated by resource-poor small-holder farmers for both household food and nutritional security and as cash crops.

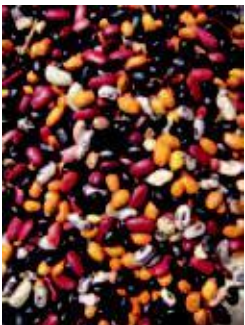
Moreover, pulse crops are valued by farmers for their ability to biologically fix nitrogen and thus contribute to soil fertility and health, and their compatibility with cereal and root crops in farming systems.



Red mottled dry beans are an Andean type large seeded bean grown and consumed commonly in Central and Eastern Africa as well as in South America.



Lablab (*Dolichos lablab*) is a grain legume that is widely grown as a food crop throughout the tropics, especially in Africa, India and Indonesia.



In Africa, small-holder farmers frequently plant mixtures of common bean types as a strategy to reduce risk against abiotic and biotic stresses that may occur during a growing season.

Cover art, top to bottom:

Beans and cowpeas are considered to be a "women's crop" in many regions of Africa and Latin America, providing nutritionally dense food to enhance the dietary quality of households and needed income.

Improved varieties of common bean with resistances to economically important diseases developed by Pulse CRSP breeders for Haiti and Central America enhance the ability of small-holder farmers to achieve up to 50% increases in yield of grain types demanded by domestic markets.

Cowpea, a grain legume indigenous to Africa, is currently produced on >12.5 million hectares worldwide.

Common bean is an important staple crop produced on >8 million and 4 million hectares in Latin America and Africa, respectively.

THE DRY GRAIN PULSES CRSP

The Dry Grain Pulses CRSP, which supports collaborative multi-disciplinary research between U.S. universities and institutions in Africa and Latin America, focuses on edible grain legumes (primarily common bean, cowpeas, lima bean and pigeon pea).

GLOBAL PROGRAM VISION

The Dry Grain Pulse CRSP seeks to contribute to:



Determinate varieties of cowpea which complete their growth cycle and come to harvest in a short period of time are especially important for addressing the food security needs of households during the "hunger period" in the Sahel and Savanna regions of West Africa.

- Economic growth and food and nutritional security through knowledge and technology generation,
- Sustainable growth and competitiveness of pulse value chains utilizing socially and environmentally compatible approaches,
- Empowerment and strengthened capacity of agriculture research institutions in USAID priority countries,
- USAID's Feed the Future and Global Food Security Research Strategy, and
- Achievement of Title XII legislative goals for CRSPs, including the generation of dual benefits to developing country and U.S. agriculture.



Kossai is a value-added cowpea food product which is prepared daily and sold by women street vendors in West African countries. In Niamey, Niger, alone, this industry generates needed income for an estimated 1,300 women and a significant market demand for cowpea grain types with the desired culinary attributes for making Kossai.

TECHNICAL THEMES

The Pulse CRSP achieves its vision by focusing on four technical themes that seek to:

- Reduce production costs and risks for enhanced profitability and competitiveness of bean, cowpea and other grain legumes,
- Increase the utilization of bean and cowpea grain and food products so as to expand market opportunities and improve community health and nutrition,
- Improve the performance and sustainability of bean and cowpea value chains, especially for the benefit of women, and
- Increase the capacity, effectiveness and sustainability of agriculture research institutions which serve the pulse sectors and developing country agriculture in Sub-Saharan Africa and Latin America.

INSTITUTIONAL CAPACITY BUILDING

The Pulse CRSP strengthens institutions by:

- Providing degree and short-term training to address strategic needs and priorities of host country institutions,
- Facilitating regional and international networking with scientists and public and private sector organizations,
- Supporting equipment purchases and training to enhance institutional research and extension program effectiveness, and
- Leveraging resources to assist in strengthening research programs and institutional capacity building objectives.

The Collaborative Research Support Programs support both degree and short term training as a means of building the research capacity of National Agricultural Systems and universities in developing countries. In this photo, Pulse CRSP Principal Investigators are providing training to technicians in Angola on the production and inoculation of bean grain with nitrogen-fixing Rhizobium bacteria.



PROGRAM STRUCTURE

USAID awarded a Leader with Associate-Cooperative Agreement to Michigan State University to serve as the management entity for a five-year program (2007-2012) with the possibility of a five-year extension. Requests for proposals for core projects are announced to address technical themes of the global program. All

proposals are peer reviewed by scientists and development professionals external to the CRSP. USAID is involved in the selection of projects to be awarded. Two- to three-year projects (Phases I, II and III) are contracted for collaborative research, extension and institutional capacity building activities in Africa and Latin America. A Technical Management Advisory Committee assesses technical performance of projects and advises the management office and USAID on technical matters, strategic planning and operational guidelines.

PROJECTS AND OUTPUTS

Theme: Increasing Pulse Productivity through Genetic Improvement

- Improved varieties of bean and cowpea with high yield potential, resistances to economically important diseases and insect pests, and grain quality attributes demanded by markets
- Improved varieties of bean and cowpea with adaptation to drought, high temperatures and low soil fertility, factors associated with climate change



Pulse CRSP research is seeking to improve drought tolerance in cowpea varieties. University of California-Riverside scientists are evaluating lines of cowpea in the field for their adaptation to and productivity under low water input conditions.

Combining Conventional, Molecular and Farmer Participatory Breeding Approaches to Improve Andean Beans for Resistance to Biotic and Abiotic Stresses. PIs: James Kelly and Sieglinda Snapp, Michigan State University; George Abawi, Cornell University; Eduardo Peralta, Instituto

Nacional de Investigacion Agropuecuaria (INIAP), Ecuador; and Louis Butare, Institut des Sciences Agronomiques du Rwanda (ISAR), Rwanda.

Development, Testing and Dissemination of Genetically

Improved Bean Cultivars for Central America, the Caribbean and Angola. PIs: James

Beaver and Consuelo Estevez, University of Puerto Rico; Timothy Porch, USDA-ARS Tropical Agriculture Research Station-Mayaguez, Puerto Rico; Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras; Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti; and António Chicapa Dovala, Instituto de Investigação Agronómica (IIA), Angola.

Modern Cowpea Breeding to Overcome Critical Production Constraints in Africa and the U.S.

PIs: Philip Roberts and Jeff Ehlers, University of California-Riverside; Ndiaga Cisse, Centre National Recherches Agronomie-Bambey, Institut Senegalais de Recherches Agricole (ISRA), Senegal; Issa Drabo, Institut de l'Environnement et des Recherches Agricole (INERA), Burkina Faso; and Antonio Chicapa Dovala, Instituto Investigacao Agronomica (IIA), Angola.



Cowpea (*Vigna unguiculata*) is a staple grain legume ideally adapted to the semi-arid, high temperature, and low fertility agro-ecology of the Sahel and Savanna regions of West Africa. Pulse CRSP research is seeking to generate technologies and knowledge that will enable small holder farmers to increase grain yields from their present average levels of 200-600 Kg/ha to >1000 Kg/ha.

Theme: Increasing Pulse Productivity through Integrated Crop Management (ICM)

- Biological controls for affordable integrated management of insect pests in cowpea
- Improved Rhizobium inoculants and bean varieties with high biological nitrogen-fixing capacity
- Bean genotypes with root architectures more efficient in P uptake and adapted to drought
- ICM technologies to enhance productivity and sustainability of pulse-based cropping systems



Diseases and insect pests contribute to major losses in pulse grain yield and quality. Pulse CRSP scientists are seeking to develop integrated pest management strategies appropriate for research poor small holder farmers, including the use of improved varieties with resistance genes to biotic stress factors.

University and John Ojiem, Kenyan Agriculture Research Institute (KARI), Kenya.

Improving Bean Production in

Drought-Prone, Low Fertility Soils of Africa and Latin America – An Integrated Approach. PIs: Jonathan Lynch and Jill Findeis, Pennsylvania State University; Magalhaes Miguel, Celestina Jochua, and Soares Xerinda, Instituto de Investigação Agrária Moçambique (IIAM), Mozambique; and Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras.

Enhancing Biological Nitrogen Fixation of Leguminous Crops Grown on Degraded Soil in Uganda, Rwanda, and Tanzania. PIs: Mark Westgate, Iowa State University; Mateete Bekunda, Makerere University, Uganda; Susan Mchimbi-Msolla and Hamisi Tindwa, Sokoine University of Agriculture, Tanzania; Augustine

Musoni, Institut des Sciences Agronomiques du Rwanda, Rwanda; Michael Ugen, National Crops Research Institute, Uganda; Henry Kizito Musoke, Volunteer Efforts for Developmental Concerns(VEDCO), Uganda; Lynne Carpenter-Boggs, Washington State University; Karen Cichy, USDA-ARS, Michigan State University; and Eda Reinot, Becker Underwood, Inc., Iowa.



Pulse CRSP scientists are using modern molecular-genetic tools to assist in breeding cowpea cultivars with resistance genes to diverse Striga species (a parasitic weed that attacks cowpea) found in Africa.

Biological Foundations for Management of Field Insect Pests of Cowpea in Africa. PIs: Barry Pittendrigh, University of Illinois at Urbana-Champaign; Clementine Dabire, Institut de l'Environment et des Recherches Agricole (INERA), Burkina Faso; Ibrahim Baoua, l'Institut National de la Recherche Agronomique du Niger (INRAN), Niger; and Mohammad Ishiyaku, Institute for Agricultural Research (IAR), Nigeria; and Mamadou N'Diaye, Institute d'Economie Rurale du Mali(IER), Mali.



Biological controls are being developed and deployed in West Africa utilizing IPM-omics tools to control economically important insect pests on cowpea, such as the larva of Maruca vitrata (see photo). Biological controls present affordable, sustainable and effective means to manage cowpea insect pests in small-holder resource-poor farming systems.

Theme: Increasing Pulse Utilization for Improved Nutrition and Health

- Value added bean grain through appropriate crop management, grain handling and processing
- Bean and cowpea based foods for nutritional rehabilitation of HIV+ children and adolescents
- Knowledge of health promoting attributes of cowpeas in diets

Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value Chain Stakeholders in Uganda and Rwanda. PIs: Robert Mazur, Iowa State University; Dorothy Nakimbugwe, Makerere University, Uganda; Michael Ugen, National Crops Resources Research Institute (NCRRI), Uganda; Hilda Vasanthakaalam, Kigali Institute of Science and Technology (KIST), Rwanda.

Although pulses are recognized by dieticians as being a nutritionally dense food important for dietary quality, a growing domain of knowledge is emerging on their health promoting attributes. Dr. Maurice Bennink focuses his CRSP research on utilizing bean/cowpea based food products to nutritionally rehabilitate HIV+ children in Eastern and Southern Africa.



Improving Nutritional Status and CD4 Counts in HIV-Infected Children through Nutritional Support. PIs: Maurice Bennink, Michigan State University; Theobald Mosha and Henry Laswai, Sokoine University of Agriculture (SUA), Tanzania; and Elizabeth Ryan, Colorado State University.

Increasing Utilization of Cowpeas to Promote Health and Food Security in Africa. PIs: Joseph Awika, Susan Talcott, Lloyd Rooney and Bir Bahadur Singh, Texas A&M University; Chitundu Kasase, John Shindano, and Kalaluka Lwanga Munyinda, University of Zambia (UnZa); Kennedy Muimui, Zambia Agriculture Research Institute

(ZARI), Zambia; Abdul Faraj, Prisca Tuitoek, Egerton University, Kenya; Amanda Minnaar, Gyebi Duodu and Andre Oelofse, University of Pretoria, South Africa.

Theme: Strengthening Pulse Value Chains

- Assessment of bean and cowpea market structures and identification of leverage points in domestic and regional value chains
- Development of policy recommendations to improve bean and cowpea producers' ability to increase the value they receive from supply chain transactions
- Brief on constraints to increasing small-holder participation in domestic markets
- Understanding constraints to adoption of new bean productivity enhancing technologies by households
- Development of production capacity and market linkages for "fair trade" beans from Central America

Expanding Pulse Supply and Demand in Africa and Latin America: Identifying Constraints and New Strategies. PIs: Richard Bernsten and Cynthia Donovan, Michigan State University; David Kiala, Universidade Agostinho Neto, Angola; Feliciano Mazuze, Instituto de Investigação Agrária Moçambique (IIAM), Mozambique; and Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras.

Pulse Value Chain Initiative—Zambia. PIs: Vincent Amanor-Boadu, Tim Dalton. Allen Featherstone and Mahmud Yesuf, Kansas State University; Gelson Tembo, Mukwiti Mwiinga, Rebecca Lubinda, Hamukwala Priscilla, University of Zambia (UnZa), Zambia.



The Legume Program of the Instituto Nacional Autónomo de Investigaciones Agropecuarias del Ecuador (INIAP) released to farmers in Northern Ecuador in 2010 two improved bean varieties (Portilla and Rocha) developed through collaborations with breeders at Michigan State University with support from the Dry Grain Pulses CRSP.

Theme: Impact Assessment

- Ex-post impact assessment of Bean/Cowpea and Dry Grain Pulses CRSP investments in research, institutional capacity building and technology dissemination in Africa, Latin America and the U.S.
- Baseline data collection and impact evaluation integrated into Pulse CRSP projects

Impact Assessment of Bean/Cowpea and Dry Grain Pulses CRSP Investments in Research, Institutional Capacity Building and Technology Dissemination in Africa, Latin America and the U.S. Pls: Mywish Maredia, Richard Bernsten, and Eric Crawford, Michigan State University.



Ing. Eduardo Peralta and Esteban Falconi of the Legume Program of INIAP, a host country partner in the Dry Grain Pulses CRSP, review advanced lines of bean at the Tumbaco Research Center in Ecuador prior to their release for commercial production.

Technology Dissemination Projects

Dissemination of Seed of Improved Black Bean Varieties in Haiti and Guatemala. Pls: James Beaver, University of Puerto Rico; James Beaver, University of Puerto Rico; Juan Carlos Rosas, Escuela Agrícola Panamericana-Zamorano (EAP), Honduras; Emmanuel Prophete, National Seed Program, Ministry of Agriculture, Haiti; Julio Cesar Villatoro, ICTA, Ministry of Agriculture, Guatemala.

Dissemination of Seed of Improved Cowpea Varieties in West Africa. Pls: Phil Roberts, University of California-Riverside; Ndiaga Cisse, ISRA, Senegal; and Issa Drabo, INERA, Burkina Faso.

Implementation of a Comprehensive Bio-Control Program for the Management of Economically Important Insect Pests on Cowpea in West Africa. Pls. Barry Pittendrigh, University of Illinois at Urbana-Champaign; Manu Tamo, International Center for Tropical Agriculture (IITA), Benin; Clementine Dabire, Institut de l'Environnement et des Recherches Agricole (INERA), Burkina Faso; and Ibrahim Baoua, l'Institut National de la Recherche Agronomique du Niger (INRAN), Niger.

New technologies developed through the Dry Grain Pulses CRSP (such as improved varieties of bean and cowpea) must be disseminated to the appropriate stakeholders in order to achieve developmental impact. In Burkina Faso, with support from the Pulse CRSP, associations of small-holder farmers are producing and marketing "quality declared" seed of improved varieties of cowpea with the assistance of the Institut de l'Environnement et des Recherches Agricole (INERA) in Burkina Faso.



Technology Dissemination Associate Award

Strategic Investment in Rapid Technology Dissemination: Commercialization of Disease Resistant Bean Varieties in Guatemala, Nicaragua and Haiti. Participating Institutions: Escuela Agrícola Panamericana-Zamorano, Honduras; Instituto de Ciencia y Tecnología Agrícolas (ICTA), and Agencia de Extensión, Guatemala; Instituto Nicaragüense de Tecnología Agropecuaria (INTA), Nicaragua; Instituto Interamericano de Cooperación para la Agricultura (IICA) and the National Seed Service, Ministry of Agriculture, Haiti; Universidad de Puerto Rico-Mayagüez, Puerto Rico; Michigan State University, Michigan. Project life-October 1, 2010 – September 28, 2013.

Outcome goals

- Disseminate a technology package that includes quality seed of improved bean varieties and Rhizobium inoculants to 120,000 resource-poor farmers in food insecure areas of the four countries
- Increase the availability of highly nutritious bean grain in domestic markets at affordable prices so as to improve the nutritional value of the diets of both rural and urban poor
- Implement sustainable bean seed multiplication systems with local farmer/community involvement so as to ensure long-term availability of quality seed of improved varieties at affordable prices to resource-poor farmers beyond the termination of this three-year project

Feed the Future (FtF)

The Dry Grain Pulses CRSP (Pulse CRSP) contributes to USAID Feed the Future (FtF) priority goals of advancing the productivity frontier and enhancing the nutritional value of diets in USAID focal countries. New technologies, management practices and knowledge generated by CRSP-supported collaborative research has

Rhizobium bacteria have the capacity to biologically fix atmospheric nitrogen (BNF) when in a symbiotic relationship with grain legumes. Pulse CRSP research is seeking to maximize BNF in grain-legume based cropping systems through the use of effective Rhizobium inoculants and the breeding of bean genotypes with high nodulation potential (see photo).



the potential to be of great benefit to stakeholders of pulse value chains in developing countries, especially women entrepreneurs and resource-poor farmers. The Pulse CRSP's management entity, Michigan State University, and its U.S. and host country partner institutions are committed to supporting USAID regional and country mission FtF strategies and are willing to mobilize their capacities to disseminate productivity and value-enhancing technologies and management practices to target beneficiaries in strategic food-insecure countries and regions.



The use of biological controls as part of integrated management strategies shows great promise for the sustainable and effective management of insect pests on cowpeas in West Africa. In this photo, scientists at the Institut de l'Environnement et des Recherches Agricole (INERA) investigate strategies to control bruchid (cowpea weevil) in cowpea grain.

Dry Grain Pulse CRSP Alignment with FtF Research Strategy for Global Food Security:

- Enhancing biological nitrogen fixation in beans and other grain legume crop systems
- Increasing productivity of beans and other grain legumes
- Expand the productivity and adoption of climbing beans in Africa
- Manage insect pests in cowpea in West Africa
- Improve drought and heat tolerance in beans and other grain legumes

Participant Countries in the Dry Grain Pulses CRSP

West Africa—Benin, Burkina Faso, Mali, Niger, Nigeria, Senegal

East and Central Africa—Kenya, Rwanda, Uganda, Tanzania

Southern Africa—Angola, Mozambique, South Africa, Zambia

Latin America—Ecuador, Guatemala, Haiti, Honduras, Nicaragua

Participating U.S. Universities

Cornell University

Iowa State University

Kansas State University

Michigan State University

Pennsylvania State University

Texas A&M University

University of California-Riverside

University of Illinois at Urbana-Champaign

University of Puerto Rico-Mayaguez

Washington State University

Colorado State University

The Dry Grain Pulses CRSP (Pulse CRSP) is a global program which collaborative projects in a total of 18 countries in developing countries, 13 of which are USAID Feed the Future focal countries. Administrative Officer, Ben Hassankhani, presents Pulse CRSP caps to participants in a 2010 global PI conference in Ecuador.



A Technical Management Advisory Committee (TMAC) advised the Management Office on technical and administrative matters regarding the Dry Grain Pulses CRSP. The TMAC is comprised of three elected PIs in the CRSP, two representatives from the IARCs, an external peer scientist, a representative from private industry and the USAID AOTR for the Dry Grain Pulses CRSP.

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Common bean originated and was domesticated in the Americas but was introduced and has become a staple crop and staple food in many countries of Africa. The women in this photo is selling beans in a local market in Rwanda, which is the country with the highest per capita consumption of beans in the world.

Cowpea is a strategic pulse crop for food and nutritional security in Africa. The advantage of cowpea is that the leaves, immature pods, fresh peas and dry grain are highly nutritious and are harvested for household consumption or sale in local markets.



