Title of Proposal:
Modern Cowpea Breeding to Overcome Critical Production Constraints in Africa and the US

Name(s), institutional affiliation and contact information of Lead U.S. Principal Investigator(s) submitting this proposal:

Philip A. Roberts (PI)
Department of Nematology, University of California, Riverside, CA 92521;
Phone (951) 827-4442; Fax (951) 827-3719; email philip.roberts@ucr.edu

Name(s) and institutional affiliation of all Host Country (HC) and U.S. Co-PIs

Jeffrey D. Ehlers (US Co-PI), Department of Botany and Plant Sciences, University of California, Riverside, CA 92521.

Antonio Chicapa Dovala (HC Co-PI), Instituto de Investigacao Agronomica (IIA), Luanda, Angola.

Issa Drabo (HC Co-PI), Institut de l'Environement des Recherches Agricoles (INERA), Centre Saria, Koudougou, Burkina Faso.

Ndiaga Cisse (HC Co-PI), Institut Senegalais recherches Agricoles (ISRA), Bambey, Senegal.

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<tr>
<th>Proposed Project Period: (30 months maximum, between April 1, 2008 – September 30, 2010)</th>
<th>Total federal funds requested</th>
<th>Total non-federal cost share commitment by U.S. institution(s)</th>
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<td>April 1, 2008 - September 30, 2010</td>
<td>$450,000</td>
<td>$37,081.25</td>
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Proposed HC institutions to be subcontracted (abbreviated name):

Angola,
Burkina Faso,
Senegal

Proposed budget for a sub-contract to a HC institution:

$50,000 to each HC Institution
$132,175 for degree training

Are you requesting the ME (MSU) to manage the Fixed-Price sub-contract for this HC Institution? (Yes/No)

Angola -Yes
Burkina Faso - No
Senegal - No

Authorized lead U.S. institutional representative
(type name, phone number and e-mail): Sylvia Campos: (951) 827-4808; sylvia.campos@ucr.edu

Signature: ___________________________  Date: 3/7/2008
Modern Cowpea Breeding to Overcome Critical Production Constraints in Africa and the US

Philip A. Roberts, University of California, Riverside

Cowpea is a key component of cropping systems and food security in sub-Saharan Africa, but suffers from low productivity due to poor soils, erratic rainfall, pests and diseases, and unimproved germplasm. Improved cowpea varieties with traits that ameliorate these constraints can increase productivity (yield per unit area), with the improved seed-stock requiring little or no change in cultural practices or management level. This project will apply and extend the expertise, experience and technologies extant within the project team for genetic improvement of cowpea under three objectives: 1) Develop improved, pest resistant and drought tolerant cowpea varieties for target regions in sub-Saharan Africa and the US using traditional and modern plant breeding tools and approaches; 2) Strengthen cowpea seed production and delivery systems in Angola, Burkina Faso and Senegal to ensure delivery of improved varieties; and 3) Develop a cowpea breeding program in Angola and strengthen existing breeding programs in Senegal and Burkina Faso through targeted training. At least one improved cowpea variety accepted by farmers and consumers with broad pest and disease resistance will be identified for each host country. In the US, pest and disease resistant varieties with blackeye, all-white, and persistent green grain types will be released. Efforts to deliver improved seed stocks to African farmers will focus on breeder-, foundation-, and certified-seed production in national programs with delivery via cooperating organizations (e.g. Extension Services and NGO networks). Training for capacity building will utilize degree training, plus program-based molecular marker training coupled with practical manual-format and web-based development of cowpea breeding protocols.

### Pulse Crop of Focus

- **Beans**
- **Cowpeas**
- **Other (specify):**

### Topical Areas to Be Addressed By this Project

Select one or more under Global Themes A-C:

- **A.** To reduce bean and cowpea production costs and risks for enhanced profitability and competitiveness.
  - 1. Genetic Improvement
  - 2. Integrated Crop Management
  - 4. Grain Quality
  - 5. Sustainable Seed Systems

- **B.** To increase the utilization of bean and cowpea grain, food products and ingredients so as to expand market opportunities and improve community health and nutrition.
  - 1. Health and Nutritional Attributes
  - 2. Consumer Attitudes and Preferences
  - 3. Influencing Decision Makers
  - 4. Consumer Access to Value-added Pulse Foods

- **C.** To improve the performance and sustainability of bean and cowpea value-chains, especially for the benefit of women.
  - 1. Understanding constraints to smallholder pulse farmer participation in markets and trade
  - 2. Identifying "weak links"/constraints in the functionality of dry grain pulse value-chains
  - 3. Identifying strategic public sector interventions to alleviate constraints or market failures.

Select at least one from Global Theme D: If none selected from A-C, then select at least two:

- **D.** To increase the capacity, effectiveness and sustainability of agriculture research institutions
  - 1. Building and promoting partnerships with key stakeholders
  - 2. Strengthening regional dry grain pulse commodity research networks
  - 3. Training young scientists in the use of modern tools for research, management and outreach

### Summary Checklist

- ✔ Project addresses IEHA objectives (give anticipated level of effort as % of total budget requested): 75%
- ✔ Project devotes at least 30% of project funds on HC capacity building activities (Global Theme D) (give total %
- ✔ Project involves research on biotechnology as defined in the RFP (give % effort on biotechnology)
- ✔ Project involves the use or generation of genetically modified organisms (GMOs)
- ✔ Project involves human subject approval
- ✔ Project involves animal use approval
- ✔ Project involves M.S. or Ph.D. degree training of HC personnel (how many?) at least 2
# Pulse CRSP Proposal – UC Riverside

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4. Technical Approach

a. Problem Statement and Justification

The primary focus of this proposal is to 1) increase the productivity of African and US cowpea producers through the development of improved varieties that possess resistance or tolerance to the major abiotic and biotic stresses impacting cowpea production in these areas; 2) expand grower marketing opportunities by breeding improved cowpea varieties with desirable grain characteristics; 3) help ensure adequate seed of improved cowpea varieties; and 4) provide training and capacity building in modern cowpea breeding to African researchers. This proposal addresses these primary constraints under the Topical Areas of Inquiry for Theme A “reducing cowpea production costs and risks for enhanced profitability and competitiveness”, and Theme B “increasing the utilization of cowpea grain, food products and ingredients so as to expand market opportunities and improve human health." We propose to employ genomics and modern breeding methods to improve cowpea for yield limiting constraints (Timko et al., 2006). By leveraging genomic resource outputs being developed under a complementary cowpea genomics proposal funded by the Generation Challenge Program to UCR, we will be able to implement the first comprehensive application of modern breeding tools and methods for genetic improvement of cowpea under this proposal. Until now, cowpea lacked the genomic resources for modern cowpea breeding even being classified as an 'orphan crop' (Naylor et al., 2004) because of the lack of research attention given to the crop relative to its importance in African agriculture. There is strong expectation that such modern breeding approaches can vastly improve plant breeding progress in developing countries (Delmer, 2005).

Increasing cowpea productivity. Low productivity of agriculture is central to rural and urban poverty in Africa. On-farm cowpea yields in West Africa average 240 kg/ha (Quin, 1997) even though potential yields, as demonstrated in on-station and on-farm trials, are often five to ten times greater (Singh et al., 1997). Most of the loss in yield potential is due to drought, poor soil fertility, and insect pests (Ehlers and Hall, 1997). Cowpea varieties with increased productivity (yield per unit area) without the need for purchased inputs especially benefit poor farmers, many being women who lack access to the most productive lands.

Productivity is key to increasing rural incomes irrespective of changes in cowpea hectarage, because even with constant product demand or sales, less land, labor, and capital are needed to produce the same amount of cowpeas. The resources can then be invested in other activities that help boost total family income. Productivity increases also help reduce prices to urban consumers since some farmer cost-savings can be passed through to consumers. Sustainable increases in cowpea productivity in Africa and the US can be achieved through development of varieties with resistance to insects, nematodes and pathogens, drought tolerance, and the ability to thrive under of low soil fertility.

Increasing Marketing Options with Improved Varieties. To be widely adopted, new cowpea varieties must have features desired by consumers as well as farmers. Grain appearance is especially important (Langyintuo et al., 2004), coupled with desirable
cooking qualities and processing characteristics for specific products (such as akara and moin-moin). Local landraces often have specific grain types preferred in a relatively small region, and if over-produced, prices offered to farmers can be very low because demand for that grain type is limited. Large white grains with rough seed-coat are preferred throughout West Africa. Thus this seed type can be marketed over a wide area, buffering supply (and prices) in the region. Large white grains are also amenable to direct dry milling for use in preparation of value-added foods such as 'akara' and 'moin-moin'. Grains with pigmented seed-coats are not desirable for milling because this results in flour that appears contaminated with dirt or other debris. The University of Georgia and food processors in the US have developed prototype value-added products such as quick cooking, low-fat akara and soy-substitute products that require all-white cowpeas. Development of regionally adapted cowpea varieties with large white grain and resistance to pests would increase the marketing opportunities of cowpea farmers and traders in both West Africa and the US. There is also considerable demand for large rough brown seed type, especially in the large urban centers in Nigeria. The standard rough-brown cultivar 'Ife Brown', is specifically desired in some markets and commands a premium price. Unfortunately, this variety is susceptible to pests and diseases. Other opportunities exist for new cowpea products with the discovery of the 'sweet' trait. Farmers in Cameroon discovered the sweet trait in a participatory breeding program conducted by the Purdue/Cameroon CRSP (Hall et al., 2004). The sweeter and milder taste conferred by this trait could help broaden the number of potential cowpea consumers in the US and Africa and to regions of Latin America and elsewhere, both for consumption of dry grain and value-added products.

**Increasing seed supply of improved cowpea varieties.** Long-term investments in cowpea breeding by the Bean/Cowpea CRSP in Senegal and Burkina Faso, by other national programs in Africa and by IITA in Nigeria have led to the development of improved cowpea varieties and breeding lines that are near release. Despite this progress, only about 5% of the cowpea production area in Africa is planted to improved varieties and their potential positive impacts go largely unrealized. Research with common beans showed that rural African farmers will buy seed when it is available (David and Sperling, 1999), suggesting that there is probably a market for cowpea seed as well.

Recently, effective models for production and dissemination of improved cowpea seed have evolved in Burkina Faso and Senegal, based on collectives (e.g. women farmer organizations) and for-profit seed cooperatives (initially set up by an NGO, but now largely self-sustaining). However, their limited scope reflects insufficient quantities of Breeder and Foundation Seed in Senegal (N. Cisse, pers. com., 2007) and Burkina Faso (I. Drabo, pers. com., 2007). We propose to help support increased production of Breeder Seed and work with several producers of Foundation Seed to strengthen their production and marketing. Strengthening seed production and delivery at the early breeder-involved stages of the seed-system will help ensure that high quality planting seed is available for farmers.

**Training and capacity Building.** The research conducted under these topical areas will provide an excellent framework for training current and new African scientists and capacity building for Host Country Institutions (*Theme D* “increase the capacity, effectiveness and sustainability of agriculture research institutions which serve the cowpea sector in developing countries), as described under Objective 3 and Section 5.
b. Objectives

**Objective 1.** Develop improved, pest resistant and drought tolerant cowpea varieties for target regions in sub Saharan Africa and the US using modern plant breeding tools.

**Objective 2.** Strengthen cowpea seed production and delivery systems in Angola, Burkina Faso and Senegal to ensure delivery of improved varieties.

**Objective 3.** Develop a cowpea breeding program in Angola and strengthen existing breeding programs in Senegal and Burkina Faso through targeted training.

c. Approaches and Methods

**Objective 1.** Development of improved pest resistant and drought tolerant cowpea varieties for target regions in sub-Saharan Africa and the US will be achieved using a combination of traditional breeding protocols coupled with molecular markers for the key traits. The project team has considerable experience in traditional breeding programs to screen for and incorporate the targeted traits (e.g. Muchero et al., 2007a; Omwega et al., 1988). Access to new cowpea genomic resources made available through related research projects such as the Generation Challenge Program Tropical Legumes I (GCP-TL I) project, whose cowpea genomics component is led by UCR, will be utilized for development and application of molecular marker-based selection of the target traits.

In Angola, 50 local landraces recently collected from markets and farmers fields will be put in trials with another 50 improved varieties and breeding lines developed by the Bean/Cowpea CRSP breeding programs and IITA and tested at three main cowpea growing locations in the country. These trials will help identify broadly adapted varieties and parental germplasm that will be used to initiate breeding activities. If one or more varietal candidates are identified from this set of 100 lines, efforts will be initiated to multiply seed under Objective 2. UCR scientists will work with their Angolan counterparts in setting up a complete breeding program. This will include determining breeding program goals, target production environments, most effective trial sites, what breeding methods make the most sense for particular objectives, and integration of marker-assisted selection into the breeding program. Techniques, such as hybridization of parental lines, and screening methods for resistance to flower thrips, pod sucking bugs, Fusarium wilt, root-knot nematodes and cowpea aphids will be incorporated into the program.

In Burkina Faso and Senegal, a collaborative, ‘shuttle breeding’ approach will be used to obtain maximum efficiency and effectiveness. In this model, germplasm is evaluated at the optimum location, in terms of personnel and environment, for effective discrimination of genetic differences among lines for a particular trait. These effective environments provide ‘hot-spot’ screening locations. Collaborative Regional Nurseries will be conducted at regional ‘hot-spots’ for certain major constraints - drought resistance, ability to grow in infertile (low phosphorus) soils, resistance to flower thrips, pod sucking bugs, nematodes, Striga and cowpea aphid. Ten sites in Burkina Faso, Senegal, and California have been identified for this work. This approach allows germplasm from different programs to be screened in the most discriminating environment, without duplication of effort, allows comparative evaluation across...
programs, facilitates evaluations by a scientist with particular expertise to monitor resistance/tolerance at one location, and confirms resistance/tolerance identified in individual HC programs. These nurseries will emphasize a large number of lines using small plots (1-2 rows) with 2-4 replicates and frequent placement of check varieties. Scoring will be trait dependent, but normally obtaining grain yields will not be necessary at this stage.

Early generation nurseries with little or no insecticide protection will avoid selection of lines overly susceptible to insect pests. Three generations per year using greenhouses and off-season nurseries will speed progress. The four breeding programs will maximize progress through collaborative research and germplasm exchanges, and connect with IITA breeders through e-communication, mutual visits and germplasm exchanges. Trials with insect-protected and unprotected plots will assess insect resistance in local varieties and lines from IITA and other sources, providing baseline data on resistance levels, geographical variations, and occurrence of insect biotypes that overcome resistance. Lines with broadly effective resistance will be used in the crossing program.

We propose a two-tiered breeding strategy to meet the immediate and longer term needs of farmers. The **Short-Term Strategy** will use local varieties having both grain quality and agronomic features appreciated by farmers such as appearance, taste, cooking qualities, yield stability, appropriate plant type and maturity. Obvious defects in local varieties will be improved by breeding in resistance to diseases and pests plus other traits, using a rapid recurrent backcrossing approach that will improve productivity and be accepted by farmers. Only minimal performance testing in multilocation trials may be necessary because backcrossing recreates the adaptive performance and grain quality present in the local variety (recurrent parent). Molecular markers for target resistance traits emanating from the EST-derived SNP-marker genotyping effort under the GCP-TL1 cowpea project will be used to select progenies carrying required alleles at each BC generation before flowering. This will allow quick identification of individuals without phenotyping for another round of backcrossing (Ender et al., 2007; Kelly et al., 2003; Ragot and Lee, 2007; Ribaut and Ragot, 2007).

The **Longer Term Strategy** is to pyramid resistance and grain quality factors in varieties desired by farmers. High x high biparental crosses will be made and the populations subjected to marker-assisted recurrent selection (MARS), a strategy commonly used in maize breeding (Bernardo and Charcosset, 2006; Ribaut and Ragot, 2007). Pedigree, bulk, or single seed descent procedures are appropriate, with mating of derived lines to combine characteristics not common to a single set of parental lines. Many excellent multiple pest resistant lines developed at IITA are good choices for parents, in combination with locally adapted varieties. Intensification of cowpea production is virtually assured due to pressure on land resources and population growth. Future varieties will need to be high yielding and responsive to higher management, as in higher density plantings in sole crops.

Attention to agronomic and grain quality characteristics is important so that the eventual varieties are acceptable to farmers and consumers. In period 1, breeders in Senegal and Burkina Faso will choose a set of popular local cowpea varieties for targeted genetic improvement through MAS or MARS. These will be hybridized to sources of known thrips resistance and heat/drought tolerance. Using greenhouse and off-season nurseries, the $F_1$ and $F_2$ generations will be advanced as quickly as possible.
Individuals selected with markers will be evaluated for trait expression to validate the usefulness of the markers in different genetic backgrounds.

Genes for stronger insect resistance and heat/drought tolerance than possible using single traits will be pyramided through indirect selection with SNP-derived markers developed as part of the GCP TLI project. The cowpea gene-space sequences available from a project supported by Kirkhouse Trust (Chen et al., 2007) will be useful in PCR primer design for SNP to CAPs conversions for developing easy-to-use markers. We have identified important QTL and associated candidate genes for cowpea drought tolerance (Muchero et al., 2007a,b) that will be refined with SNP genotyping to generate useful markers for the MARS work. These will be available during the first period of the project and will be used with insect and pathogen resistance markers derived from SNPs as they become available in 2008 and 2009.

**Objective 2.** Cowpea seed production and delivery systems in Angola, Burkina Faso and Senegal will be strengthened to ensure delivery of improved varieties. Adoption of improved varieties is constrained by inadequate supply of Breeder and Foundation Seed, which in turn limits the Certified Seed that can be produced. Insufficient resources limit growing, harvesting and storing Breeder Seed increases, in turn limiting Foundation Seed and Certified Seed for farmers is due to the lack of Foundation seed coupled with the relatively low interest in cowpea by public and governmental organizations and private seed companies. In East and southern Africa several companies carry cowpea seed, including SeedCo, Zimbabwe and Leldet Seed Co., Kenya, suggesting cowpea seed sales can be viable in W. and C. Africa.

We will increase directly amounts of Breeder and Foundation Seed available to Certified Seed producers, help identify new Certified Seed producers, and strengthen and expand proven activities in Senegal and Burkina Faso through leveraged funding from NGOs and USAID Mission funding, if possible. We will work with the national extension services in Senegal (ANCAR), Burkina Faso, and Angola (SENSE) to reach the farmers’ organizations in different communities. We will also seek to strengthen the small private seed producers, some of them already working on cowpea.

A strategy adopted by the newly created GCP/ICRISAT ‘Legumes for Livelihoods’ project that is on-going in Niger, Nigeria, Mali, Tanzania, and Mozambique for cowpea is to improve farmers’ access to seed and enhance widespread adoption of improved cowpea varieties through the development and promotion of community seed production and promotion of local markets for seed. Their well-considered view is that no single agency can produce and provide the required quantities of high quality planting seed. Seed of improved varieties can be disseminated through rural retail networks based on government schools. In Senegal, Burkina Faso, and Angola, schools can act as a seed supply center in each village, with teachers trained on procedures for quality seed production. Several progressive farmers will be selected per village and given guidance in seed production and supplied with quality Foundation Seed for multiplication. They will become the source of improved seed for the entire village. From these efforts, local entrepreneurs may arise to form local seed companies. Strong linkages will be developed with PASS (Program for Africa’s Seed Systems), WASNET (West African Seed Network) and other programs to derive synergy in promoting local seed enterprises.

In Angola two years are needed to identify candidate varieties among local
landraces, and Bean/Cowpea CRSP (in Ghana, Senegal and/or Burkina Faso) and IITA varieties. Candidate lines will be grown in replicated field plots in representative farmer fields in the primary growing zones, and assessed for yield, seed quality and consumer preference/acceptability. We will link with government and NGO institutions and train Angolan nationals in multiplication of high quality seed of selected varieties for farmers. Opportunities to extend seed distribution to Zambia will be explored.

**Objective 3.** A cowpea breeding program in Angola will be developed and the existing cowpea breeding programs in Burkina Faso and Senegal will be strengthened through targeted training of existing and new cowpea program personnel, and the development and provision of user-friendly manual-format and web-based cowpea breeding guidelines. The Host Country partners provide a spectrum of opportunities and needs for developing and strengthening cowpea breeding programs. They are representative of neighboring cowpea producing countries in this sub-Saharan production area. Therefore, training activities and outputs can be ‘regionalized’ to attain broader impact, for example in Ghana, Mali, Niger, Nigeria, and Zambia. We have partnered with Burkina Faso and Senegal cowpea breeding programs for many years. The programs in these countries are relatively mature, particularly in Senegal, and have benefited from staffing with senior cowpea breeders and other scientists working on agronomic, pest and disease problems, coupled with recognition and support from their national institutions (INERA and ISRA). In contrast, Angola represents a cowpea producer with excellent production, marketing and consumption potential, but requiring considerable aid to develop a viable national cowpea breeding program. The Pulse CRSP can make significant positive impact toward this goal, by taking advantage of the interest and experience of key scientific personnel, led by HC PI Dr. Antonio Dovala. Dr. Dovala has longterm experience working with legume crops, with focus on plant pathology problems, and initial exchanges of cowpea germplasm have started with the UC Riverside program. Promising breeding selections in Angola will be extended to neighboring Zambia where we will link with the Legume Program of the Zambian Agriculture Research Institute (ZARI). The targeted training will comprise the following components:

**Degree (PhD level) training** for 2 young African scientists will be undertaken with the goal of developing the next generation of cowpea breeders. The project team is aware of some potential trainee candidates but individuals have not yet been selected. The trainees will be selected from cowpea producing African countries, such as in Ghana where the breeder has re-located, or in Angola or Zambia where a new cowpea breeder would fully complement the plans to develop a new cowpea breeding program. In countries with established senior cowpea breeders such as Burkina Faso, Senegal, and Nigeria, PhD student training now would anticipate gaps arising as senior breeders reach retirement.

Degree training for one PhD student will be conducted at the University of Ghana, Legon, where the WACCI training program ([www.wacci.edu.gh](http://www.wacci.edu.gh)) has been established in conjunction with Cornell University. Research topic and guidance will be overseen by the UCR PIs and encompass Objective 1 activities for marker-assisted cowpea breeding. A second PhD student will be trained in the Plant Biology or Plant Pathology graduate program at UC Riverside.
Training current cowpea breeders in the development and application of DNA-based markers for MAS in the cowpea breeding programs will be embedded in the research effort under Objective 1. Cowpea breeders will be trained in marker application utilizing their own breeding populations generated by the high x high based crosses made within the programs. This will focus on the Senegal and Burkina Faso programs initially. ‘Shuttle’ screening of progenies with trait markers and yield QTL will be done between UC Riverside and the Host Countries, with joint interpretation of data sets and progeny selections as a hands-on MAS and MARS experience.

Development of a practical guide to cowpea breeding will be completed that emphasizes primary target constraints to cowpea yield in Africa and incorporates application of DNA marker technology to breeding. We will produce a full draft of the guidelines by the project midpoint (month 15), which can be ‘field-tested’ by the senior breeders and trainees. The feedback from field-testing will be used to revise the guidelines before issuing in final form. We plan to develop the guidelines in hard-copy manual format that can be taken to the field, greenhouse or lab, and a web-based version of the same document that can have a broad distribution and be easily accessed as a teaching/training resource. The aim is to have the cowpea breeding guide available for all cowpea breeding programs in Africa and elsewhere. The key elements of the guide will cover maintenance and storage of cowpea germplasm, selecting parents, making crosses and selfing for breeding line development, field and greenhouse grow-out and selection, major trait phenotypes (agronomic characters, pest, disease and abiotic stress symptoms and resistance), application of molecular markers for traits for MAS, and requirements for candidate variety testing and new variety release protocols. We expect the postdoctoral scientist to develop the first draft under strong informational and editorial guidance from the US and HC project team.

d. Collaboration with Host Country Institutions

The plan for collaboration and partnership with the Host Country institutions in achievement of the project objectives is structured upon the following framework. The Host Country partners represent the West and Central Africa regions of the sub-Saharan cowpea production zone. Burkina Faso and Senegal in West Africa have relatively mature cowpea breeding and research programs which are led by the project HC PIs, Dr. Issa Drabo in Burkina Faso and Dr. Ndiaga Cisse in Senegal. The US team of Dr. Phil Roberts and Dr. Jeff Ehlers has worked closely with these two HC breeding programs under the previous Bean/Cowpea CRSP and currently under the CGIAR Generation Challenge Program for cowpea breeding and associated research. These relationships provide the platform for the proposed collaboration herein. The proposed partnership with Angola represents a new relationship for collaborative cowpea genetic improvement. The Angola cowpea program requires establishment of a viable breeding program as part of the country’s re-building effort. We have initiated sharing of cowpea germplasms and breeding materials with the Angola PI, Dr. Antonio Dovala, in anticipation of the new collaborative partnership.

Division of responsibilities, coordination of activities, and mutual accountability for success will be achieved through the following process. The US PIs will be responsible for overall project coordination both within the component and with the Management Entity (MSU), including research and training workplans, annual and final technical reports, and project budget planning, allocation and reporting. Under this direction, the
three Host Country PIs will be responsible for planning, coordination and execution of the specific local research and training activities under the objectives within their respective countries. The plans and results of research in the Host Countries will be organized, analyzed and reported in a cooperative team approach among the US and HC project members, based on reciprocal communication among the project team. Most of the distance coordination will be achieved by email including document sharing for results, reports and workplans. Budget coordination within the Host Country will be the responsibility of the HC PI, with support from the US PI. Allocations and advances of funds will be made based on reciprocal communication of plans and needs. Quarterly financial reports to the UC Riverside PI from the HC units will provide an auditable framework for budget management. This system has operated very successfully between UC Riverside and INERA, Burkina Faso and ISRA, Senegal previously under the Bean/Cowpea CRSP, and we plan to operate in a similar process with the new relationship proposed for IIA, Angola. The cost application includes funds budgeted for Host Country visits by the U.S. PIs (Roberts and Ehlers) in at least two of the three funding periods representing three growing seasons. We have found these visits extremely valuable for purposes of both research and training coordination and for addressing administrative issues with the Host Country Institutions.

e. Benchmarks

A benchmarks and milestones table is attached as an annex to provide a detailed timeline of expected specific outputs.

Under Objective 1, we will build on breeding work conducted under the previous Bean/Cowpea CRSP in the U.S., Senegal and Burkina Faso. By month 8, we will complete the release protocols for a new Blackeye-type cowpea variety for the U.S. (breeding line 03Sh-50). We will grow sufficient Breeder Seed of this variety and monitor Foundation Seed production and monitor Certified Seed by contract producers to ensure availability of high quality seed. This new variety has seed 10% larger and brighter white than the standard cv. 'CB46', plus improved resistance to Fusarium wilts and root-knot nematodes. By month 18, we will release persistent-green and all-white cowpea varieties for U.S. growers.

In both Burkina Faso and Senegal by month 18 one or more new varieties will be released. These will be made available for testing by IITA and the NARS of neighboring countries (e.g., Ghana, Mali, Niger, Nigeria). In Angola, evaluation of 100 local and exotic cowpea lines and varieties, identification of 5 prospective varieties and identity of major biotic and abiotic stress constraints will be completed by month 30. The Angola lines will be shared with the ZARI scientists for testing in Zambia. We will establish the first comprehensive breeding effort in cowpea using modern breeding methods and develop 10 improved breeding lines using MAS methods in Burkina Faso, Senegal and the U.S. by month 30.

Under Objective 2, we will support production and seed quality monitoring efforts that will result in 100% increases in the availability of Foundation Seed of 'Melakh' and 'Yacine' in Senegal and of newly released varieties 'Melakh, IT98K-205-8, and KVx421-2J in Burkina Faso by the end of the second growing season (month 20). We will complete Certified Seed Production Manuals for all three host countries by month 12. Large-scale production of Certified Seed of Melakh and Yacine will be occurring in Senegal and large-scale Certified Seed production will be occurring in
Burkina Faso for the newly released varieties 'Melakh, IT98K-205-8 and KVx421-2J by month 30.

**Under Objective 3,** two African PhD students will be midway through a PhD program in plant breeding by month 30. A Cowpea Breeders Manual will be developed and published in hard copy and web-based formats in English, French and Portuguese by month 30. Host country breeders will be trained in modern cowpea breeding methods, including the strategic use of molecular marker assisted selection by month 30.

5. **HC Institutional Capacity Building**

Under Objective 3, we have outlined the planned approaches and methods to Host Country capacity building targeted for cowpea breeding programs. We recognize that the budgetary scope of the Pulse CRSP does not allow for more than very modest improvements to research infrastructure based on minor equipment and facilities inputs. Where such opportunities do exist, for example through re-allocation of unexpended funds in another project area, we will maintain a current list of facility and equipment needs for the cowpea genetic improvement programs in the Host Countries. It is also our expectation that programmatic activities by the Pulse CRSP for cowpea breeding may provide leveraging opportunities in this regard from other funding agencies and sources. Recognizing these limitations, our plan is to build capacity for the HC programs primarily through genetic resources for cowpea breeding, development and application of molecular marker technologies, and through human resource development via training activities.

In Angola a cowpea breeding program will be developed where currently no recognizable breeding program exists. The thrust will be to test new germplasm entries from other countries and regions, the CRSP Core collection and other breeding programs, and field test these for growth and yield potential in comparison with currently preferred Angola local varieties and land-races in representative Angola field production locations. Guidance will be provided on germplasm storage, initial crosses and progeny selections to build a platform for cowpea breeding. The Angola PI Dr. Dovala and his team will benefit by direct training experience in these early steps of the program. Current cowpea breeders and their technical staff in Burkina Faso and Senegal will be trained in application of DNA-based markers for marker assisted selection as part of the Objective 1 research effort. Marker application utilizing local breeding populations within the HC programs will be coupled with screening of progenies with trait markers and yield QTL, followed by joint interpretation of data for hands-on experience. In addition, the African postdoctoral associate hired on the project will gain valuable experience in current marker technology and use of genomic resources applied to cowpea breeding. The three Host Country partners provide a spectrum of opportunities and needs for developing and strengthening cowpea breeding and genetic improvement programs. They are representative of neighboring cowpea producing countries in this sub-Saharan production area. Therefore, training activities and outputs can be ‘regionalized’ to attain broader impact, for example in Ghana, Mali, Niger, Nigeria, and Zambia.

Degree (PhD level) training for 2 young African scientists will be undertaken with the goal of developing the next generation of cowpea breeders. Some potential trainees from cowpea producing countries have been identified but not yet selected. A new breeder in Ghana would be valuable, a country in which a cowpea program exists but
for which the breeder has re-located, either temporarily or permanently. A new cowpea breeder for Angola or Zambia would complement development of a new cowpea breeding program. In Burkina Faso and Senegal established senior cowpea breeders nearing retirement will require PhD trained geneticist/breeders to maintain and advance these programs in the future. We are in planning discussions for degree training through the University of Ghana, Legon, where the West Africa Centre for Crop Improvement (WACCI) (www.wacci.edu.gh) has been established in conjunction with Cornell University. Research topic and guidance will be made with the UC Riverside PIs and encompassing components of the Objective 1 activities for marker-assisted cowpea breeding. A second student will be trained at UC Riverside.

A practical guide to cowpea breeding targeting constraints to yield in Africa and including DNA marker technology will be developed. Draft guidelines will be ‘field-tested’ by senior breeders and trainees and then revised to optimize practical utility of the final form. Hard-copy manual format for field or greenhouse, and web-based format for teaching/training will be developed for broad accessibility in Africa and elsewhere. The key elements of the guide are described under Objective 3 in section 4c.

We will be working with the following Host Country teams:

**Senegal:** Dr. Ndiaga Cisse (cowpea breeder), Moctor Wade (weed scientist-Striga) and Samba Thiaw (agrophysiologist), Centre National Recherches Agronomie, Bambe, Senegal (part of the Institut Senegalais de Recherches Agricole (ISRA). Dr. Cisse has led cowpea improvement activities in Senegal for the past 23 years. He assembled and coordinated a team of scientists that developed the varieties Mouride, Melakh, and Yacine. Collectively, these varieties have resistance to drought, aphids, bacterial blight, cowpea aphid borne mosaic virus and the parasitic weed *Striga gesneroides*.

**Burkina Faso:** Dr. Issa Drabo (cowpea breeder), IN.E.R.A., Ouagadougou, Burkina Faso. Dr. Drabo has led the cowpea breeding effort in Burkina Faso for almost 25 years and has released many varieties. He has assembled a multidisciplinary team of scientists to support the breeding effort. He is supported by Dr. Mme. Clementine Dabire (entomologist) and Dr. A. Sawadogo (nematologist), who have been active research collaborators on the previous Bean/Cowpea CRSP.

**Angola:** Dr. Antonio Chicapa Dovala (cowpea breeder), Instituto Investigacao Agronomica (IIA), Luanda, Angola. Dr Dovala is developing a cowpea genetic improvement program for Angola. He has nearly 30 years experience with legume research and specializes in plant pathogens. His associate Jose Pedro, MSc, is assisting with cowpea germplasm.

### 6. Contribution to IEHA and USAID Objectives and Initiatives

IEHA supports good governance and collaborative relationships to promote conditions that will allow agriculture to flourish in Africa, including support of science and technology driven strategies and partnerships to accelerate advances that will reduce hunger. Our project is the first comprehensive program focused on bringing modern plant breeding tools and strategies that are commonly used in other crops, to cowpea genetic improvement efforts. These tools and strategies will speed up the delivery of improved cowpea varieties to farmers. Modern plant breeding is rapidly evolving as
improvements in molecular marker and other technologies evolve, and the use of modern breeding methods in African breeding programs, as we propose, represents an on-going type of dynamic and highly relevant training for African scientists.

The IEHA program has West and Southern Africa Regional Programs that include Senegal and Angola. USAID-Angola focuses on food security, democratic governance, improved maternal/child health, and economic reform. Our project contributes to food security, an important objective for all of the host countries through the development and dissemination of varieties tolerant to drought and pest attack by harnessing recent advances in plant breeding for the benefit resource-poor farmers.

**Gender equity:** Women produce much of the African cowpea crop, but are also some of the most disadvantaged in terms of access to capital to purchase farm inputs and to ‘good’ land. Our improved varieties will yield better than varieties presently in use in the face of pest attack and do not require purchased inputs of fertilizers and pesticides to add value. Thus the improved varieties are of particular benefit to the majority of women farmers who can not afford inputs.

Women are the main processors of popular value-added cowpea-based food products such as ‘Akara’ that are extensively sold urban centers of West and Central Africa. Hence a large portion the benefits of increased productivity and improved grain quality made possible with improved varieties will flow to women producers of cowpea-based value-added foods in the form of lower prices for the raw product and higher quality of grain available in the marketplace. We will make a special effort, with linkages to Dry Pulse CRSP food quality projects, to develop varieties that are especially attractive to marketers and to producers of value-added foods, such as ‘Akara’, virtually all of them women.

We will hire and train African female students and post-doctoral scholar if possible to conduct pest, drought, and marker screening of germplasm related to the host country breeding programs. This project will also include a large percentage of women in village-level activities, development of seed production manuals targeting women seed producers, and in short-term training and graduate education.

**Biodiversity conservation; and social, political and environmental considerations:** This project will increase farmer yields through the development and dissemination of cowpea varieties with improved yields as a result of improved yield potential and through the possession of resistance to abiotic and biotic stresses. Loss of biodiversity in Africa can be countered by increased rural prosperity through increased yields of crops (Green et al., 2005; Breman, 2002). Increased rural incomes will lessen the pressure on farm families to engage in environmentally destructive practices such as wood harvesting for manufacture and sale of charcoal to generate income, and unsustainable crop rotations. Pesticide use in rural Africa presents an array of human health problems, from re-use of pesticide containers, to lack of proper mixing, application and safety equipment, ignorance of field re-entry periods and food safety issues. The varieties that will be released by this project will be more productive without pesticides, with fewer or ‘softer’ pesticides than existing varieties, reducing the environmental and health hazards associated with insecticides. Increased rural incomes resulting from the improved varieties will allow farmers to purchase soil-improving fertilizers, especially phosphorus, which is currently being unsustainably
mined by present cropping practices in West and Central Africa. The more productive varieties should allow farmers to make money even in the face of reduced cowpea prices. The reduced price will encourage consumption. Increased acreage of cowpea, as a nitrogen-fixing legume, will improve soils for subsequent staple cereal and tuber foods. Thus, the improved varieties can contribute to the start of positive momentum towards more productive and sustainable systems in the targeted host countries.

**Mission Engagement:** Principal investigators will meet with USAID Missions in Angola and Senegal during U.S. Principal Investigator visits to the host country projects. They will inform the Mission about project activities and significant accomplishments and look for opportunities for Mission funding of projects that leverage the goals of our proposal. Similarly, the USAID West African Regional Program, which is responsible for USAID programming in Burkina Faso but located in Ghana, will be contacted about funding opportunities that are consistent with the goals of this proposal.

**7. Strategy for Developmental Impacts**

**Project outputs contributing to development outcomes:** This project is a collaborative effort to 1) develop improved cowpea varieties using modern breeding methods, 2) improve methods of production and delivery of seed to farmers through effective collaboration with HC extension services and committed NGOs, and 3) train HC nationals in cowpea breeding and seed production. Improved varieties can generate higher incomes through increased productivity and improved grain quality.

**Outreach to stake holders, end users, and beneficiaries of cowpea value-chains:** Project Principal Investigators will actively interact with national program extension services, NGOs and community cooperatives and individual seed producers to facilitate delivery of improved seed stocks to farmers. One model we have used successfully in the past to disseminate a new variety is to link with NGOs that have extensive pre-existing networks of villages where they are involved in health-related or other types of projects. Thus, 0.5 kilogram bags of Certified Seed are supplied to farmers in each village through the NGO network, along with information about the variety, and how it is improved compared to local varieties the farmers are currently growing. Particular farmers or village-level organizations (e.g. women’s groups) that are pleased with the new variety are then identified and encouraged to become small-scale commercial seed producers for surrounding villages. These seed producers will have an incentive to promote their product, and its superiority in terms of pest and drought tolerance, yield potential, and grain quality for local food preparations. Our project will not only focus on breeding varieties tolerant of biotic and abiotic stresses, but will carefully consider grain quality characteristics with respect to value-added foods during the breeding process to ensure that the improved varieties produce high quality products. One of our cornerstone principles is that the attractiveness of the grain will help in the adoption and spread (e.g. through farmer-to-farmer diffusion) of the improved, pest resistant varieties that we develop.

**Dissemination of outputs:** Seed of improved cowpea varieties and associated production and varietal characteristic information will be disseminated as discussed
above. A web-based manual on cowpea breeding will be developed, with distribution of multiple hard copies to all African NARS and the website will be linked to websites of interest to African plant breeders. Scientific information will be published in peer reviewed scientific journals and presented at scientific meetings.

8. Annexes

a. Curriculum Vitae of Key Personnel
   (Attached, for Drs. Roberts, Ehlers, Cisse, Dovala, and Drabo)

b. Letters from Collaborating Institutions
   (Attached, for IIA, Angola; INERA, Burkina Faso; and ISRA, Senegal; plus supporting letters from California Dry Bean Advisory Board, Dr. B. Pittendrigh, Purdue Univ., and Dr. S. Mason, Univ Nebraska).

c. Plan for Leveraging Other Resources
   Other resources will be leveraged from current and future funded complementary cowpea research projects. Key among these are the following:
   California Dry Bean Advisory Board and its Blackeye Varietal Council (funds currently and typically set at $18,000 – 20,000 per year) funded for cowpea breeding in California. This is a continuing, longterm research arrangement in support of the UC Riverside cowpea breeding program (see attached letter of support).
   The CGIAR Generation Challenge Program (GCP) Tropical Legumes I Project funded for 3 years (May 2007-April 2010) with expectation for extension of funded research. The cowpea component of this project is lead by UC Riverside (Ehlers, Roberts, and Close) and includes collaborative funded cowpea breeding and research with the cowpea breeding programs in Burkina Faso (with PI I. Drabo), Cameroon (PI O. Boukar) and Senegal (PI N. Cisse), and IITA (PI, C. Fatokun). This project funded at nearly $1.9M is developing cowpea genomic resources, including cDNAs, BACs, ESTs and SNP genotyping for genetic and physical mapping and for development of easy-to-use markers for major traits. Traits targeted are insect resistance, especially flower Thrips, nematode and disease resistance, and drought and heat tolerance. The more upstream genomics and marker work funded under this project provides an excellent leveraging for CRSP resources proposed here to be used for more application (downstream) breeding.
   A second GCP project funded to UC Riverside (Ehlers, Roberts, and Close) for $450,000 starting January 2008 to December 2010, will focus on development of phenotyping protocols for cowpea drought tolerance, with work in the West Africa partner countries, California and Texas. This will provide direct leveraging opportunities for the drought tolerance efforts.
   USDA Germplasm Committee grant to UC Riverside for phenotyping cowpea USDA core collection for nematode and aphid resistance (2007-2008 at $16,000).
   The Pulse CRSP funds proposed herein will also be leveraged with opportunity funds within the Host Countries via NGOs and national sources through presentation of the CRSP effort and the associated opportunities for participatory funding.
d. Literature Cited


David S, Sperling L (1999) Improving technology delivery mechanisms: lessons from bean seed systems research in eastern and southern Africa. Agriculture Human Values 16: 381-388


Delmer D (2005) Agriculture in the developing world: Connecting innovations in plant research to downstream applications. PNAS ww.pnas.org_cgi_doi_10.1073_pnas.0505895102


### e. Benchmarks Table

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#### Objective 1: Develop improved, pest resistant and drought tolerant cowpea varieties for target regions using modern plant breeding tools

1. Release one new blackeye-type cowpea in US
2. Release at least one persistent green cowpea variety in the US
3. Release at least one cowpea variety for value-added foods in US
4. Release at least one cowpea variety in Burkina Faso and Senegal
5. Identify 5 prospective varieties in Angola following evaluation of 100 local and exotic lines
6. Develop 10 improved breeding lines for US and each HC using marker-assisted recurrent selection
7. Identify priority cowpea production constraints for Angola

#### Objective 2: Strengthen cowpea seed production and delivery systems in Angola, Burkina Faso and Senegal to ensure delivery of improved varieties.

8. 100% Increase in availability of Foundation Seed of 'Melakh' and 'Yacine' in Senegal
9. 100% increase in availability of Foundation seed of newly released varieties 'Melakh, IT98K-205-8 and KVx421-2J
10. Certified Seed Production Manuals Published for all three HC
11. Seed of 'Melakh, IT98K-205-8 and KVx421-2J being produced on large-scale by Certified Seed Producers

**Objective 3:** Develop a cowpea breeding program in Angola; strengthen existing breeding programs in Senegal and Burkina Faso; targeted training

**Benchmarks**

12. Training in progress for 2 PhD students from Angola, Zambia, Ghana or other USAID presence countries


14. Breeders trained in modern cowpea breeding
9. **Cost Application**
   
a. Budget Summary (Attached)

b. Budget Tables (Attached)

c. Budget Narrative (Attached)
Curriculum Vitae of
Philip A. Roberts

Education

Ph.D. Plant Biology, University of Birmingham and Rothamsted Experimental Station, United Kingdom. Awarded 1978.

Employment
Assistant and Associate Nematologist and Extension Nematologist, Department of Nematology, University of California, Riverside, stationed at Kearney Agricultural Center, Parlier, California; 1981-1989.

Professor of Nematology and Nematologist, Department of Nematology, University of California, Riverside; 1990-present.

Associate Director, Research, UC Statewide IPM Project, University of California, Riverside; 1993-97.

Chair, Department of Nematology, University of California, Riverside; 1996.

Associate Dean for AES and Cooperative Extension, University of California, Riverside; 1996-2001.

Honors
1994 – CIBA Award from the Society of Nematologists

2001 – Elected Fellow of the American Association for the Advancement of Science

2004 – Elected Fellow of the Society of Nematologists

Selected Publications last 5 years


BIOGRAPHICAL INFORMATION – Jeffrey D. Ehlers

Positions Held

1/92 to present University of California, Riverside. Assistant, then Associate (1996), then Full Research Specialist (2002), Dept. of Botany & Plant Sciences. Genetics and breeding of cowpea

6/88 - 12/91 Nor-Cal Wild Rice Seed Co., Woodland, CA, Plant Breeder. Wild rice breeding

5/85-6/88 International Institute of Tropical Agriculture, Junior Scientist. Cowpea Breeder and Regional coordinator, (Kenya, Uganda, Tanzania, Somalia)

Education

| University of California, Riverside | Plant Science | B.S. | 1979 |
| University of California, Davis    | Vegetable Crops | M.S. | 1980 |
| University of California, Davis    | Genetics       | Ph.D. | 1984 |

Representative Book Chapters and Review Publications


Selected Recent Journal Articles


Name: Cissé  Surname: Ndiaga
Date and place of Birth: February 25 1952; Rufisque, Senegal.
Marital Status: Married; 3 children.
Business Address: ISRA / CNRA Bp 53 Bambey Senegal
                Tel. office (221) 973-63-48;
                Home (221) 973-64-51  Cellular: (221) 580 92 37
E-mail: ncisse@refer.sn;

Field of Specialization: Genetics and Plant Breeding.
Research Achievements: Breeding and release of cowpea varieties:
                        Mouride: (1992); Melakh (1996); Yacine (2004)
Award: 1999 President of Senegal Award for Science and Technology.

           Agronomist, engineer: Sept. 1979. IANB Bucharest, Romania

Employer: Institut Senegalais De Recherches Agricoles (ISRA). 1983-
Responsibility: 2004 - 2006- Co-chair and chair of the West Africa component and
                Technical committee Member of the Bean-Cowpea Collaborative Research Support
                Project (CRSP). Michigan State University.
                • 2003- Member of the Technical Steering Committee for cowpea. African
                  Agriculture Technology Foundation (AATF) : Nairobi, Kenya.

                • 2002 - associate scientist with the Regional Center for the study of
                  Crop Adaptation to Drought (CERAAS)
                • 2001- Chair of Genetics and Plant Breeding group. ISRA.
                • 2001- Coordinator of ISRA-INTSORMIL CRSP (International Sorghum Millet
Collaborative Research Support Project). University of Nebraska – Lincoln.


### CONSULTANCIES

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<td>Assist graduate students</td>
<td>Katy Ibrahima, Ag. Administration Purdue University West Lafayette In.47906, USA. <a href="mailto:kgi@agad.purdue.edu">kgi@agad.purdue.edu</a> (765) 4948462</td>
<td>4/28/2000 - 5/5/2000</td>
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<td>Develop project proposal on cowpea breeding (2002-2007)</td>
<td>Katy Ibrahima, Ag. Administration Purdue University West Lafayette In.47906, USA. <a href="mailto:kgi@agad.purdue.edu">kgi@agad.purdue.edu</a> (765) 4948462</td>
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<td>Design, supervision and analysis of on-farm trials.</td>
<td>ONG : EWA, BP501 RP, Thies, Senegal; <a href="mailto:ewa@sentoo.sn">ewa@sentoo.sn</a> (221) 9517141</td>
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<td>Prepare Seed Production Guide</td>
<td>ONG : EWA, BP501 RP, Thies, Senegal; <a href="mailto:ewa@sentoo.sn">ewa@sentoo.sn</a> (221) 9517141</td>
<td>5/2/2002 - 12/31/2002</td>
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<td>Prepare Regional Catalogue of Varieties</td>
<td>The Mitchell group BP.E. 3670 Bamako, MALI T/F: (223) 23.53.39</td>
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<tr>
<td>Prepare the document Traditional Cowpea Cultivation in Senegal, a Case Study (English and French versions))</td>
<td>FAO, Viale delle terme di Caracalla, 00100-Rome Italia <a href="mailto:Helen.GomezMacpherson@fao.org">Helen.GomezMacpherson@fao.org</a></td>
<td>11/25/02</td>
</tr>
<tr>
<td>Team coordinator: crop irrigation project in the Senegal river basin: project document preparation.</td>
<td>Jordi Comas Angelet Departament d'Enginyeria Agroalimentaria i Biotecnologia Universitat Politècnica de Catalunya Edifici ESAB Campus del Baix Llobregat Avinguda del Canal Olímpic s/n 08860 Castelldefels tel. 93 552 10 88 <a href="mailto:jordi.comas-angelet@upc.es">jordi.comas-angelet@upc.es</a></td>
<td>June/2004</td>
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<td>Evaluation of GEF’s Support to the Cartagena Protocol on Biosafety</td>
<td>Harold Roy-Macauley <a href="mailto:harold.roymacauley@coraf.org">harold.roymacauley@coraf.org</a></td>
<td>June/2005</td>
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**Language proficiency.**

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<td>Romanian</td>
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</table>

**Affiliation:** Agronomy and Crop Sciences Society of America.

**Selected Publications**

**Journal Articles**
Louis K. Prom, Ndiaga Cisse, and Ousmane Ndoye. 2007. Assessing the vulnerability of...
sorghum lines from the United States to long smut (Sporisorium ehrenbergii Vánky)


Crop Science 45: 413-414.

Cissé Ndiaga, G. Ejeta. 2003. Genetic variation and relationship for seedling vigor traits in

Anthony E. Hall, Ndiaga Cisse, Samba Thiaw, Hassan O. A. Elawad, Jeffrey D. Ehlers,
Development of cowpea cultivars and germplasm by the bean/cowpea CRSP. Field crop research.
(82) :103-134.


CISSE NDIAGA 2001. RESISTANCE A LA CHALEUR CHEZ LE NIEBE EN CONDITIONS DE JOURS COURTS.
REVUE SCIENCES ET TECHNIQUE ; SERIE SCIENCES NATURELLES ET AGRONOMIE (BURKINA FASO).

Vol. 25.No2, pp.7-15.
Cissé Ndiaga. 2001. Genotype x Row Spacing and Environment Interaction of Cowpea in

Cissé Ndiaga, Ndiaye Mbaye, Thiaw Samba and Anthony Hall, 1997. Registration of

Cissé Ndiaga, Ndiaye Mbaye, Thiaw Samba and Anthony Hall, 1995. Registration of

Book Chapters
Hall A.E., Ismail, A.M., Ehlers, J.D., Marfo, K.O., Cisse, N., Thiaw, S., Close, T.J.,


**Articles in Proceedings**


Gebisa Ejeta, Peter B. Goldsborough, Mitchell R. Tuinstra, Edwin M. Grote, Abebe Menkir,
Yahia Ibrahim, Ndiaga Cisse, Yohan Weerasuriya, Admasu Melakeberhan, and Coralie

Web Publications
Cissé, N., and A.E. Hall. 2003. Traditional cowpea in Senegal, a case study. FAO [online]. Available at:
(verified 30 January 2005). FAO, Rome

FAO [online]. Available at:
(verified 30 January 2005). FAO, Rome

Extension Publications


THESIS
Cisse Ndiaga, 1995. Heritability estimates, Genetic correlation, and Identification of RAPD
markers linked to seedling vigor and associated agronomic traits in sorghum.

Purdue University. December 1995.
1. DADOS PESSOAIS

Nome: António Chicapa Dovala  
Naturalidade: Andulo, Bié.  
Data de nascimento: 29-07-1956  
Filiação: Chicapa Dovala e Josefina Ganja.  
Bilhete de Identidade: 0007738575BE033  
Passaporte Normal: N0424208, emitido aos 28 de Março de 2005, valido até 28 de Março de 2015  
Morada: Bairro Cassequel, Rua 55, casa nº 28 R/C, Luanda.  
Telemóvel: 00244 923 414259  
Correio electrónico: chicapa29@hotmail.com  
Ocupação actual: Chefe de Departamento Científico-IIA e Chefe do Programa de Investigação de Leguminosas.  
Estado civil: Casado.  
Nacionalidade: Angolana.  

2. FORMAÇÃO ACADÉMICA

2.1. Biografia profissional

1990: Especialidade em Fitopatologia – EAN, Oeiras – Portugal  

2.2. Pós-graduação
1991 Especialidade em Virologia Fitopatológica.
2006: Mestrado em Agronomia e Recursos Naturais "Striga na Cultura do Milho em Angola. Controlo com Desmodium intortum e D. uncinatum".

3. CARREIRA PROFISSIONAL

1979: Admissão no Instituto de Investigação Agronómica (IIA).
1979/81: Estudo e controlo de Cercospora angolensis Carv. & Mend.
1981/92: Identificação e avaliação de doenças de Leguminosas (Feijão, Feijão Macunde/Frade, Amendoim, Soja).
1981/85: Chefe da Divisão de Fitopatologia.
1986/92: Colaborador na docência das práticas de Sanidade Vegetal-I e II, FCA.
1986/94: Chefe do Departamento Científico de Fitossanidade.

4. CURSOS E FORMAÇÃO

1979 – Estágio sobre Doenças dos Citrinos em Angola, 12 meses.
1980 – Estágio sobre Conservação dos Solos e Combate contra a erosão, 3 meses.
1981 – Curso sobre doenças da batata, Gdanski, Polónia, 1 mês.
1983 – Curso sobre nematodes da batateira, 1 mês.
1995 – Curso sobre identificação e implementação de projectos, organizado pela FAO.
1996 - Curso sobre identificação e implementação de projectos de reinserção socio-económica dos desmobilizados, Ministério da Reinserção Social do Governo de Angola e PNUD.
1997 - Treino sobre identificação e implementação de projectos, (FONGA).
2004 - Curso sobre identificação e implementação de projectos, DW-canadiana.
5. APRESENTAÇÃO DE TRABALHOS


6. PARTICIPAÇÃO EM SEMINÁRIOS

1988 – Seminário sobre investigação Agrária em Moçambique, Maputu, Março.
CURRICULUM VITAE

NAME : DRABO
SURNAME : ISSA
DATE OF BIRTH : 20/05/1950
BIRTHPLACE : KOUDOUGOU
SEX : Male
NATIONALITY : Burkinabè

1. GRADUATE STUDIES

<table>
<thead>
<tr>
<th>YEARS</th>
<th>INSTITUTIONS</th>
<th>DEGREE</th>
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<tbody>
<tr>
<td>1987-1992</td>
<td>University Québec (Québec) Canada</td>
<td>PhD Plant Breeding</td>
</tr>
<tr>
<td>1978-1981</td>
<td>Department of Plant Biology and ecology</td>
<td>M Phil Plant breeding</td>
</tr>
<tr>
<td></td>
<td>University of Ibadan Nigeria</td>
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<tr>
<td>1971-1977</td>
<td>Higher School of Tropical Agriculture</td>
<td>Diploma of Rural Development Engineering</td>
</tr>
<tr>
<td></td>
<td>University of Prague Czecoslovakia</td>
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2. ACTUAL JOBS

2007: Cowpea Breeder at the Institute of Environmental and Agricultural Research (INERA) ; National Scientific and Technologic Research Centre (CNRST) and grain legume coordinator of INERA/ CRREA- Centre Saria.

3. JOB EXPERIENCES

1981-2007: Cowpea breeder at Grain Legume Improvement Programme /INERA /CNRST.
2002-2007: PI Bean/ Cowpea CRSP Project
2002-2004: Contribution to the Farmer field School/Fora approach in a joint INERA and farmer organisation in Sahelian (Ouahahigoya) , Central (Donsin and Kombissiri) and Eastern provinces (Koupela) of Burkina Faso; Major: grain and seed production.
1998: Evaluation rural NGO’s and farmers’ associations development programs sponsored by OXFAM/GB:

- Association Songkoadba of Donsin, Oubritenga Province.
- Association of RIGLA villages in Boulkiemdé province.
- Association of RIGLA villages in Kourwéogo Province; Methodology used: DIOBASS

4- TRAINING

Cowpea grain, seed production and storage training courses for:

- Extension and NGO's agents and members of farmer's organisations in Burkina Faso sponsored by LVIA.
- Technicians of national seed service on cowpea seed production and certification
- Technicians of PSAZ of Burkina Faso sponsored by AFRICARE.
- Cowpea farmers of "Durable Agriculture" project at Koupéla