Dry Grain Pulses CRSP Proposal

COVER PAGE (must print on one page)

Title of Proposal:
Improving Bean Production in Drought-Prone, Low Fertility Soils of Africa and Latin America -- An Integrated Approach

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

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Dr. Jonathan P. Lynch, The Pennsylvania State University
Dr. Juan Carlos Rosas, University of Zamorano, Honduras
Magalhaes Miguel, IIAM, Mozambique

Proposed Project Period: (30 months maximum, between April 1, 2008 – September 30, 2010)	**Total federal funds requested**	**Total non-federal cost share commitment by U.S. institution(s)**
4/1/08 - 9/30/10	**$449,906**	**$114,000**

Proposed HCs where project activities will be implemented:	**Proposed HC institutions to be sub-contracted (abbreviated name):**	**Proposed budget for a sub-contract to a HC institution**	**Are you requesting the ME (MSU) to manage the Fixed-Price sub-contract for this HC Institution? (Yes/No)**
Mozambique; Honduras	**MOZ; EAP**	**$131,750**	**No**

Authorized lead U.S. institutional representative
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Signature: David W. Richardson **Date:** 11/28/07

Dry Grain Pulses CRSP Proposal
SUMMARY PAGE (must print on one page)

Title of Proposal: Improving bean production in drought-prone, low fertility soils of Africa and Latin America - an integrated approach

Name and Institutional Affiliation of the U.S. Principal Investigator:

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Abstract (Limit: 1800 characters including spaces—about 200-250 words):

Drought and poor soil fertility are primary constraints to pulse production in developing countries. Recent developments in our understanding of root biology make it possible to breed crops with greater nutrient efficiency and drought tolerance. Such crops will improve productivity, enhance economic returns to fertility inputs, and may enhance overall soil fertility and system sustainability, without requiring additional inputs. The overall goal of this project is to realize the promise of this opportunity to substantially improve bean production in Africa and Latin America. We propose to 1) Use novel root traits to breed beans with greater tolerance to drought and low soil fertility, 2) Develop technology packages of improved genotypes with local fertilizer sources and soil water conservation, 3) Understand constraints to adoption of new bean technologies, and household and intra-household impacts of adoption on income and nutrition, and 4) Enhance host country capacity to address these issues. Our project capitalizes on previous successful collaboration among Penn State, Zamorano University in Honduras, and IIAM in Mozambique, and successful interdisciplinary collaboration among plant breeding, plant physiology, agroecology, and socioeconomics.

Pulse Crop of Focus ***(select at least one between beans and cowpeas)***

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
- ☒ 3. Mitigating Effects of Low Soil Fertility/Drought
- ☐ 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. Urban 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 ***(select as many as appropriate)***

- ☒ Project addresses IEHA objectives (give anticipated level of effort as % of total budget requested): 90 %
- ☒ Project devotes at least 30% of project funds on HC capacity building activities (Global Theme D) (give total % budgeted): 90%
- ☒ Project involves research on biotechnology as defined in the RFP (give % effort on biotechnology) 10%
- ☐ 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?) 2

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PROBLEM STATEMENT AND JUSTIFICATION

This proposal is premised on four well-established facts:

1) Drought and low soil fertility are principal, pervasive constraints to bean production in Latin America and Africa.

2) The vast majority of bean producers in poor countries cannot afford irrigation and intensive fertilization.

3) Bean genotypes vary substantially for root traits that determine their tolerance to drought and low soil fertility, making it feasible to increase yields in low-input systems through genetic improvement.

4) To exploit the potential of this approach, we need intelligent deployment of root traits in bean breeding programs, and better understanding of the socioeconomic and agroecological factors determining the adoption and impact of stress tolerant crops and cropping systems.

Drought and low soil fertility are primary constraints to crop production throughout the developing world, and this is especially true of common bean, which in poor countries is typically a smallholder crop grown in marginal environments with few inputs [1, 2]. A GIS analyses carried out by CIAT staff (including JP Lynch) to quantify edaphic (i.e. soil-related) constraints to bean production in Latin America [3], as well as a recent CIAT analysis of African bean production [4] amply demonstrate the importance of edaphic stresses:

% total bean production area severely affected by indicated stress

Edaphic stress	Latin America	Central America	Eastern Africa	Southern Africa
Low P	55	62	65	85
Al toxicity	40	19	55	44
Mn toxicity	12	25	50	35
low Ca	36	19	-	-
low K	15	10	55	50
low Mg	23	23	-	-

We do not summarize N limitation here since it is difficult to infer from soil data and since bean can acquire N through symbiotic fixation, but it is important to note that biological N fixation is severely restricted by low P availability [5, 6]. Phosphorus limitation is the most important nutrient constraint to bean production, followed by the acid soil complex of excess Al, excess Mn, and low base supply [2]. The importance of nutritional stress in bean production systems of Latin America and Africa cannot be overstated. It is noteworthy that nutrient stresses persist from year to year over large areas, and are worsening in many regions due to soil erosion and degradation, as well as the disruption of traditional nutrient cycles by population pressures [7]. Approximately 40% of the agricultural land in the world has been significantly degraded by human activity, including over 75% of the agricultural soils of Africa [64]. Decades of low-input agriculture have also resulted in substantial depletion of soil nutrient reserves [8-10]. Fertilizers are not a satisfactory solution to this problem, because of their cost (which has risen substantially in recent years due to increased fuel prices), limited availability [11], the fact that many tropical soils have poor responsiveness to fertilizers [12], and soil degradation from inappropriate fertilizer use. In fact, fertilizer use is negligible in many developing countries, especially in sub-

Saharan Africa, which generally have the poorest soils [13]. What is needed is *integrated nutrient management*, consisting of judicious use of fertility inputs as available, management practices to conserve and enhance soil fertility, and adapted germplasm capable of superior growth and yield in low fertility soil.

The role and value of nutrient-efficient crops is clearly shown by the fact that the single most dramatic breakthrough in world agriculture in the 20th century, the *Green Revolution*, was basically an improvement in the nutrient responsiveness of wheat and rice. Traditional cultivars were adapted to low input conditions, and would lodge when fertilized, thereby reducing yield. The principal advantage of the new dwarf varieties was that they could respond to N fertilization without lodging [14, 15]. Just as genotypes vary in response to high nutrient availability, they vary in response to low nutrient availability. We refer to the ability to grow and yield at suboptimal nutrient supply as 'nutrient efficiency' [16, 17].

Substantial genetic variation for P efficiency in maize was demonstrated 120 years ago [18] and in common bean over 30 years ago [19]. Subsequent studies showed such variation was heritable and was related to root traits [20-22]. We have shown substantial variation in bean P efficiency that is stable across soil environments in Latin America [23, 24]. Analysis of the CIAT germplasm collection identified several sources with outstanding P efficiency [25]- from 100 to 200% better than existent checks such as Carioca. Studies with these genotypes identified a number of distinct root traits that contribute to P acquisition through topsoil foraging [26], including root hair length and density [27, 28], adventitious rooting [29, 30], basal root shallowness [31-33], and traits that reduce the metabolic costs of soil exploration such as root etiolation and root cortical aerenchyma [34, 35]. Genetic variation for these traits is associated with from 30 – 250% variation in growth and P uptake among related genotypes in field studies (references cited above). Several of these traits can be evaluated in rapid screens with young plants, greatly facilitating breeding and selection (http://roots.psu.edu/?q=en/methods).

In collaboration with Chinese colleagues, we employed these root traits as an ideotype to guide the development of P efficient soy genotypes for South China [36], which has resulted (as of this writing in 2007) in the release of 5 new commercial lines with substantially greater yield in low phosphorus soils, currently adopted by 10 million soybean farmers, with 10 more lines in the final stages of release. Several of these traits are also important for phosphorus efficiency in maize [34, 37-42], and we anticipate that they will be useful in many annual crops. Given the successful application of results from common bean to soybean, it is reasonable to expect that results from common bean will also be relevant to cowpea, which share the same subclade [43].

Drought is a primary yield constraint to bean production throughout Latin America and Eastern and Southern Africa [4, 44]. Beans vary substantially in drought tolerance, due primarily to variation in root depth and thereby access to soil water [45, 46], earliness (drought escape) [47], and secondarily to seed filling capacity ([48] – although it is not clear if this is a primary trait or a byproduct of other traits). Drought tolerance has been identified in several races of common bean, but is complex and associated with local adaptation (reviewed in [48]). Utilization of specific traits in drought breeding, through direct phenotypic evaluation or genetic markers (eg QTL) would be useful [48].

Since the majority of bean production environments are faced with drought as well as low soil fertility, it is important that traits selected for drought tolerance and low P tolerance are not mutually antagonistic. Earliness is useful for drought escape but has drawbacks for yield

potential [49] and low P tolerance (unpublished data). Root traits that enhance topsoil foraging are useful for P acquisition since P is more abundant in the topsoil, but are detrimental for water acquisition, since water is typically a deep soil resource. Breeding for drought tolerance in the field resulted in a genotype with deep basal roots (B98311), whereas breeding for P tolerance in the field resulted in a genotype with shallow basal roots (TLP19) [50, 51]. In a field study comparing RILs descended from these two parents, shallow-rooted genotypes had a 40% growth advantage under low P, but deep-rooted genotypes had a 22% growth advantage under drought [52]. This clear trade-off demonstrates why breeding programs should consider drought and low fertility together if they are to make progress in stressful environments. Multilines, or mixtures of genotypes having similar shoot phenotypes but contrasting root phenotypes, show promise in improving yield stability across environments with both drought and low fertility stress (JP Lynch, JC Rosas, J Beaver, unpublished data).

We need a better understanding of how stress tolerant genotypes will affect the performance and sustainability of their cropping systems. One concern is that P-efficient genotypes will 'mine the soil' by removing more nutrients from infertile soils, thereby worsening soil fertility over time. Results from our collaboration with the University of Costa Rica in the Bean/Cowpea CRSP suggest that P-efficient genotypes actually protect soil fertility by reducing erosion. We observed 400% variation in erosion associated with root traits among RILs (unpublished data). These results indicate that root traits can enhance soil conservation as well as yield. Another concern is that more vigorous bean root systems may affect the performance of maize or other intercrops with which beans are often grown in low input systems. In a current project with the McKnight Foundation, we are finding that differential expression of root traits in bean genotypes determines the competitiveness of beans with intercropped maize. These results indicate that targeted breeding for root traits may enhance intercropping performance in stressful systems.

Genotypes that are more responsive to inputs may promote the use of locally available inputs in improved Integrated Crop Management (ICM) systems. Several African countries have reserves of sparingly soluble rock P whose effectiveness may be improved by the use of nutrient-efficient bean genotypes. Beans are superior to maize in their ability to solubilize P in their rhizosphere. The introduction of bean genotypes with superior root systems may enhance the utilization of rock P, thereby improving P availability and N availability (through symbiotic N fixation) in maize/bean systems. Similarly, bean genotypes with deeper root systems may be synergistic with soil management techniques to conserve residual moisture. Our project will test these hypotheses.

We also need a better understanding of socioeconomic factors determining adoption of stress tolerant bean germplasm and the likely effects such adoption may have on household income and nutrition. Socioeconomic research conducted as part of our McKnight project in Mozambique indicates that factors such as family structure may play a large role in determining whether the introduction of more productive germplasm is likely to have positive or even negative effects on household income and nutrition.

This proposal seeks to capitalize on recent advances in root biology, breeding for root traits, and the impacts of root traits in stressful bean agroecosystems. Over the past 20 years we have identified several specific root traits that enhance bean productivity under drought and low fertility stress. In collaboration with colleagues at CIAT we have genetically mapped several of those traits. In our recently completed Bean/Cowpea CRSP project, we collaborated with Juan Carlos Rosas at Zamorano, Jim Beaver at the University of Puerto Rico, and Nestor Chavez at

the University of Costa Rica to begin targeted breeding for root traits for drought and low soil fertility, to understand the effects of P efficient bean genotypes on soil erosion, and to evaluate the yield stability of bean multilines having contrasting root architectures. In an ongoing project in Mozambique funded by the McKnight Foundation, we are working with colleagues at IIAM to identify and validate root traits for P efficiency, evaluate root traits in African germplasm, introgress root traits into elite lines, understand the effects of P efficient lines on soil erosion, intercrops, and symbiotic N fixation, and understand how P-efficient genotypes would affect household income in bean production regions of Mozambique. Both in-service and long-term training is needed to redress a serious shortfall in the capacity of bean researchers to exploit root traits for stress tolerance. This proposal seeks to sustain and expand these efforts.

Drought and poor soil fertility are primary constraints to pulse production in developing countries. Recent developments in our understanding of root biology make it possible to breed crops with greater nutrient efficiency and drought tolerance. Such crops will improve productivity, enhance economic returns to fertility inputs, and may enhance overall soil fertility and system sustainability, without requiring additional inputs [17]. The overall goal of this project is to realize the promise of this opportunity to substantially improve bean production in Africa and Latin America.

Objective 1: Develop bean genotypes with improved tolerance to drought and low P

Approaches and Methods

Bean germplasm will be systematically screened for key root traits including root hair length, root hair density, basal root whorl number (BRWN), basal root growth angle (BRGA), and adventitious rooting. Phenotypic screens will be conducted under controlled conditions where possible and also as field root crown evaluations using a method we have developed. African germplasm to be screened includes lines from the BILFA, lines from CIAT nurseries, a minicore collection assembled at CIAT, and regional landraces. Latin America germplasm to be screened includes improved cultivars, advanced breeding lines and landraces from the Mesoamerican and Andean gene pools of *Phaseolus vulgaris* useful for Central American and the Caribbean, and interespecific lines from *P. vulgaris* x *P. coccineus* crosses developed by the LAC project during the previous Bean/Cowpea CRSP.

In Mozambique bean genotypes will be screened for root traits in the field in Central (Sussundenga) and Northern (Lichinga) Mozambique and in controlled environments (laboratory and greenhouse) in Sussundenga. The genotypes to be screened include local germplasm that will be collect in different bean production regions, regional germplasm and advanced germplasm developed by CIAT, some of which has already been assembled in Mozambique as part of our current McKnight project. We have already identified some genotypes with good root traits that can potentially be used as parents. We also have a series of drought-tolerant genotypes developed by CIAT that can be tested for their performance and adaptation in Mozambique. Since roots are associated with root diseases, we will evaluate the root rot resistance of bean germplasm that we will screen for root traits adapted for low P and drought tolerance.

Introgression of root traits conferring greater drought tolerance and P efficiency will be carried out by developing inbred backcross (IB) populations. These IB populations will be composed of breeding lines which combine key root traits with multiple disease resistance and preferred seed types in the target regions. The initial cross will be made between the recurrent parent (selected elite cultivars and/or advanced lines for CA/C and African target countries) and

the donor parents (selected germplasm with the higher expression of key root traits), followed by two backcrosses to the recurrent parent and three generations of selfing by single seed descent to develop IB populations. In Mozambique breeding activities will involve Andean crosses: AFR298XPVA 773, G14665XSELECTION 63 (progeny G19833), Mesoamerican crosses: SEA5xSXB418, VAX1xSXB418.

Field selection will be based on the average performance of advanced IB lines in replicated drought and low P trials, complemented with field and greenhouse evaluations of root traits. Selected lines will be tested individually or in multiline combinations, to broaden the genetic base required in highly variable soils and environmental conditions such as those frequently present in Latin American and African bean production regions, using previously identified locations in Honduras, Nicaragua, Mozambique, Malawi, Tanzania, and/or Haiti. Selection for disease resistance will be conducted in the field and complemented by marker-assisted selection. In addition, advanced lines and multilines will be introduced to other countries as part of the Central American and Caribbean Bean Network, and the Southern Africa Bean Research Network for testing and evaluation of breeding nurseries and trials. Selected lines, multilines and whole trials will be sent to project collaborators for testing in the African countries which are part of this project or other projects from the Dry Pulses CRSP.

While these new IB populations are developed, the value of drought/low P tolerant multilines will be tested in Honduras and Nicaragua using IB lines already developed by using the cultivar Amadeus 77 (the most widely grown small red improved cultivar in Central America) as recurrent parent and L88 lines (that have different combinations of key root traits) as donor parents. These IB populations were developed at Zamorano during the previous Bean/Cowpea CRSP and are readily available for conducting field trials starting on year one. A similar approach will be employed in Mozambique.

Participatory plant breeding (PPB) approaches will be used in the field trials for evaluation of the performance of the IB lines under drought/low P, as well as for disease resistance, agronomic adaptation and commercial seed types. These trials will be tested in collaboration with NGO technical personnel and farmers from local research committees (CIALs) in Honduras, and with researchers from INTA and farmers groups in Nicaragua. Zamorano and the farmers groups and NGOs to be involved in these participatory field evaluations of IB lines are currently members of the PPB Program for the Mesoamerican Region and have several years of experience in PPB. In Haiti, the field trials will be conducted in collaboration with researchers from the National Bean Research program, NGOs and farmer groups. In Mozambique, we will test the performance of advanced generations in Angonia, Lichinga, Gurue and Chokwe districts, involving farmers associations and NGOs, including WVI, SDAE (District Services for Economic Activities [former District Directorates of Agriculture], Provincial Directorates of Agriculture, Save the Children International, MIA, APLA and CIAT.

Evaluation of consumer and commercialization value of project lines will be conducted in collaboration with members of the bean clusters recently organized in Honduras and Nicaragua (Zamorano and INTA are members of these clusters). Participants in the value chain of common beans (production, processing, commercialization and export) in the target countries will be invited to participate in these evaluations.

Collaboration with Host Country Institutions

In Latin America this activity will be led by Dr. Juan Carlos Rosas at Zamorano (Honduras) in collaboration with INTA (Nicaragua) and Nicaraguan farmers groups, and as part of broader collaboration in bean breeding with the Central American and Caribbean bean networks. In Africa this activity will be led by Celestina Jochua of IIAM (Mozambique), in collaboration with Rose Mongi (Tanzania) and Rowland Chirwa (CIAT- Malawi), as part of the southern African bean research network (SABRN). Genetic studies of trait introgression will be conducted by one of the IIAM students for their MS research at Penn State.

Benchmarks

- Drought and low fertility tolerant lines from the previous Bean/Cowpea CRSP are tested and released in the Central American and Caribbean region, and farmers begin adopting them as cultivars.

- Several hundred lines from the Mesoamerican and Andean gene pools are phenotypically characterized for root traits, and a group of selected lines that have superior expression of key root traits which increase efficiency of bean plants under drought and low fertility is identified and starting to be used as progenitors in crosses with multiple disease resistant germplasm.

- IB lines and multilines from populations developed by using improved lines or cultivars (from the main bean commercial classes of the target countries) as recurrent parents and sources of germplasm for key root traits as donor parents, are being tested in Central America, the Caribbean, Mozambique and other collaborating African countries.

- IB populations are used for genetic and physiological studies to increase the understanding of the role of key root traits in the efficiency of bean plants under drought and low fertility stresses.

- Farmers groups participating in the evaluation of project breeding materials incorporate some of the breeding lines and multilines for commercial testing under their local production systems and potential use as cultivars.

- Breeding lines and multilines are distributed as part of the nurseries and trials distributed by the Bean Networks to Central American ,Caribbean, and Southern African countries, including the target countries.

Objective 2. Develop integrated Crop management systems for stress tolerant bean genotypes

Approaches and Methods

A) Evaluation of the effect of P efficient bean genotypes on soil erosion: Erosion lysimeters will be installed at IIAM station in Lichinga in Mozambique. Using methods we have developed and used successfully in Costa Rica and Ecuador, these 2 by 1.6 m plots allow the measurement of soil and P lost from erosion from specific genotypes. Results will test the hypothesis that P efficient bean genotypes will enhance soil fertility by producing greater shoot biomass, thereby reducing soil erosion.

B) Evaluation of the utility of local rock P with P efficient bean genotypes: Mozambique has local sources of sparingly soluble rock phosphate, but the efficacy of these sources for the soils and crops of Mozambique has not been determined. Preliminary tests have been conducted by IIAM researchers (Drs. Momade and Ecole based in Nampula) in collaboration with CARE

International, but the project was stopped because suitable rock grinding equipment was not available in Mozambique. Better grinders are now being manufactured in Tanzania. In this activity we will evaluate the efficacy of rock phosphate from Monapo and Montepuez provinces for bean genotypes with contrasting root traits in greenhouse and field conditions at Sussundenga and Lichinga. Results will test the hypotheses that more P-efficient bean genotypes will have better utilization of local rock P than traditional genotypes, and that local rock phosphate can be a useful source of both P and Ca in red acid soils of Central and Northern Mozambique.

C) Evaluation of synergy of water conserving soil management with drought tolerant genotypes: Various methods of soil management such as mulching, crop residue management, crop rotations, microcachement systems, and minimum tillage may conserve residual moisture during the dry season and periodic drought. Root traits may have synergy with these methods by for example permitting better exploitation of water deep in the soil profile. These issues have never been investigated. In this activity we will compare traditional and drought-tolerant genotypes under traditional versus moisture-conserving soil management to text the hypothesis that combined packages of novel genotypes and integrated soil management have greater potential impact than either approach in isolation.

D) Evaluation of the effect of root traits in maize/bean intercrops: The effects of BRGA, BRWN, and root hair length on root competition in maize intercrops will be the MS thesis research of one of the IIAM students at Penn State. Closely related bean genotypes contrasting for root traits (RILs of L-88) will be grown in sole crop or intercropped with maize, with and without irrigation and at high and low P fertility, in field studies at the Rock Springs research station at Penn State. Root phenotypes will be confirmed through destructive sampling of root crowns as well as nondestructive root imaging with minirhizotrons. Soil cores at R5-R7 will permit analysis of root length by depth. Plant P acquisition and water status will be assessed over time. Results will test the hypothesis that root traits that benefit bean growth under drought and low P may or may not affect yields of maize intercrops depending on spatial niche segregation. Parallel studies with more genotypes and less intensive physiological sampling will be conducted at the IIAM Sussundenga research station in Mozambique.

Collaboration with Host Country Institutions

Activities 2A and 2B will be the primary responsibility of S Xerinda in Mozambique, with assistance from other IIAM staff (Drs. Momade and Ecole) and JP Lynch. Activity 2C will be the primary responsibility of M Miguel with assistance from S Xerinda and JP Lynch working with a graduate student at Penn State. Activity 2D will be the responsibility of JP Lynch working with a graduate student Penn State, with assistance from M Miguel and S Xerinda.

Benchmarks

Each of the four studies in this activity will be completed within 30 months, resulting in information about the effects of bean root traits on nutrient cycling, efficacy of rock P, synergism with soil moisture management, and performance of bean/maize intercrops. These results will published in theses and scientific journals.

Objective 3: Understand constraints to adoption of new bean technologies, income and nutrition potential, and intra-household effects and impacts.

Approaches and Methods

Farm households in the study areas in Mozambique will participate in identification of a) barriers to widespread adoption, b) constraints to achieving potential income and nutrition impacts, and c) intra-household impacts of introduction of new bean technologies. Use of farm household information expands upon farmer and farm group evaluation and feedback (*Objective 1*), providing depth to understanding of potential for enhanced nutrition and income, and intra-household constraints and impacts.

Proposed work will build on research conducted in China and Mozambique as part of our McKnight Project. Research in South China (Hunan, Guangxi and Guangdong provinces) demonstrates strong effects of working-age labor out-migration leaving a rural elderly population in place (63); new soybean cultivars require low labor intensity (including low input use) consistent with labor capabilities of the remaining elderly population. In Mozambique, research suggests important farm-level constraints created by the HIV/AIDS epidemic, as also demonstrated by others, including Parker *et al.* (2007, reference 60) for Uganda. The results for China and Mozambique are a similar 'hollowing out' of the working age population left in rural villages but with higher incomes in China (remittances) but higher costs and lower incomes in Mozambique (health care, lost wages). Household surveys conducted among men and women in the same households in China also showed differences in farm-household decision-making including decisions related to agricultural technologies. In Africa, gender and intra-household differences in work behaviors, decision-making, and impacts are recognized (53, 54, 55, 59, 61, 62). Qualitative focus group surveys conducted in villages near the Mozambique study sites – with men and women farmers stratified by age – have borne this out.

This proposed project will involve quantitative household face-to-face surveys of men and women in the same households in Mozambique. The questions will be asked in a similar format to that used for China, where 500 face-to-face surveys were conducted, but will be tailored to the Mozambique context. Questions will focus on a) input constraints specifically related to adoption behaviors for new beans, b) intra-household decision-making, and c) functioning of the farm-market value chain. Importantly, questions related to the implications of human disease for production, marketing and health status will be included. A PhD student (L Sevilla) currently in the dual-degree doctoral programs of Agricultural, Environmental and Regional Economics (AEREC) and Demography with interests in human health will conduct research in this phase of the project, in collaboration with the MS student identified for Mozambique and with our IIAM collaborators. A nutritional component will be added to the surveys. J Findeis currently collaborates with Penn State nutrition faculty (e.g. S Krantz, reference 58), and will involve one or more nutrition faculty in survey construction.

Collaboration with Host Country Institutions

This activity will be the primary responsibility of J Findeis, B Demeke (Visiting Professor, Penn State), and L Sevilla, working in collaboration with IIAM.

Benchmarks

- Quantitative survey instrument for Mozambique farm households is developed, translated, verified and clears Penn State Human Participant Review.

- Quantitative surveys are completed in Mozambique at the four study sites.

- Papers drafted on the basis of survey results.

Host Country Institutional Capacity Building

A significant limitation to the improvement of bean production in stressful environments is that very few national program scientists have the required range of expertise. There is a general shortage of trained agricultural scientists in Mozambique, and throughout Africa and Latin America there is a severe shortage of scientists with training in plant nutrition and plant/soil interactions. This is especially true of crop breeders, who typically have training in plant pathology but little expertise in soil fertility and drought physiology. Scientists who may have expertise in soil fertility are often located in soil science units that are disengaged from breeding efforts. The result is that breeding and crop management approaches are poorly integrated and inefficient. An additional problem is that socio-economic expertise is typically lacking in breeding and agronomy programs, which reduces the effectiveness of planned interventions.

This project would directly address this shortcoming by strengthening the capacity of our partner institutions to improve bean production in stressful environments through an integration of breeding, physiology, agroecology, and socioeconomics. This program includes:

Formal M.S. degree training for two IIAM (Mozambique) scientists at Penn State

Two IIAM researchers have been identified by Dr. Calisto Bias (Director, IIAM) for degree training in breeding and plant nutrition. These trainees are current employees of IIAM and will retain their positions at IIAM while they conduct their studies at Penn State. In the summer of 2008 these trainees will conduct an internship with Dr. Juan Carlos Rosas at Zamorano University in Honduras. This will give them invaluable experience working with a highly successful bean breeding program, and will also provide an opportunity to begin their thesis research programs by conducting crosses and fieldwork with Dr. Rosas, utilizing low P/drought fields that we have established at Zamorano and on nearby farms during the course of our previous CRSP project. In the Fall of 2008 the trainees will begin their studies at Penn State, which include coursework in breeding, soil science, plant nutrition, plant physiology, and statistics, and field work in drought and low P environments we have established at the Penn State field research facility. Thesis research projects will be directly addressing the objectives of the CRSP project and the needs of IIAM, with approval from Dr. Bias. This component of our project is important for IIAM, which has very few researchers with advanced training, especially in plant nutrition.

Short-term training for two INTA (Nicaragua) agronomists at Penn State

In our past CRSP project we had a very productive training partnership with INTA, whereby each year an agronomist selected by INTA would spend 6 months at Penn State as a short-term trainee. During the internship the trainees work directly on research projects with graduate students, including experimental design, execution, and analysis. Our goal is to empower INTA agronomists to conduct research on root traits and stress adaptation with precise methods that are more meaningful than simple yield trials. Trainees benefit from the training without prior knowledge of English, since virtually everyone in the Lynch lab speaks Spanish. The internship also includes guided study of Spanish language materials in plant nutrition. This is an important activity, much appreciated by INTA, because Nicaragua is the largest producer of beans in Central America and the Caribbean, it has many stressful production environments with both drought and low soil fertility, and training in plant nutrition/stress physiology is scarce among INTA staff.

Strengthening research infrastructure at IIAM

Many IIAM researchers are posted in regional research centers, which encourages interaction with farmers in production zones, but limits research possibilities, since the zonal centers do not have internet access or lab facilities. In our current Penn State-IIAM project funded by the McKnight Foundation we have invested in strengthening research infrastructure at the Sussundenga research center, which is the base of Magalhaes Miguel and is located near a main bean production zone. We installed a satellite dish for direct internet access and constructed a lab for soil and plant analysis. Internet access has been critical in maintaining communication between Mozambique and the USA, and in the ability of IIAM scientists to access research literature and other internet resources. The soil and plant analysis lab will be an important resource for the entire central region of Mozambique. Our proposed Pulse CRSP project would expand this effort by providing internet access for the Chokwe research station, the base of Celestina Jochua and Soares Xerinda, and adding additional capacity to the analytical lab at Sussundenga.

Strengthening research and training capacity of Zamorano

Zamorano serves undergraduate students from most Latin American countries. Dr. Rosas offers courses in Genetics, Plant Breeding and Crop Production, and guides thesis research projects utilizing field plots, greenhouse and laboratory facilities of the Bean Research Program. Traditionally, some Zamorano graduates become research assistants in the Bean Program; this experience has helped more than 20 graduates go to graduate school in the USA and abroad. The Bean Program at Zamorano has trained many researchers from the national bean programs of Central America, the Caribbean and Ecuador, as part of the previous Bean/Cowpea CRSP. Training in the Bean Program is offered in areas such as breeding and selection, field plot management, techniques for managing bean pathogens in the field and laboratory, marker assisted selection, and Rhizobium and mycorrhiza production technologies. Also, several graduate students from U.S. universities involved in CRSP collaborations with Zamorano have conducted their M.S. and doctoral field research in Honduras. Recently, the program has developed capability for root phenotyping to characterize and select genotypes with superior root traits associated with tolerance to drought and low soil fertility. Capabilities in this area will be upgraded as part of this project. In the proposed project, Bean Program facilities and expertise at Zamorano will be used in formal training of undergraduate students; in-service training of technical personnel from Central America, Caribbean and African; graduate research of doctoral and master science candidates from collaborating countries and the U.S.; and to organize and conduct short courses, workshops and project related events. In addition, the project would have access for conducting on site studies and research trials with CIAL and other farmer organizations which are involved in participatory plant breeding and seed production.

Multilingual web-based delivery of research methods for root traits

We have established a web site that describes research methods for root traits in English, Spanish, French, and Portuguese (http://roots.psu.edu). This site has been widely used, having received 8,500 visits and over 27,000 pages viewed in the most recent month (October 2007). Continued support for this web site in the proposed project will be a resource for agricultural researchers throughout Africa and Latin America.

Contribution to USAID Objectives and Initiatives

Contributions to IEHA objectives

Our project would directly address IEHA objectives. Mozambique has been formally part of the IEHA program since 2004. According to the IEHA (http://www.usaid.gov/locations/sub-saharan_africa/initiatives/ieha.html) "*The essence of the IEHA science and technology strategy is to encourage partnerships among U.S. universities, international researchers, and African researchers that invest in agricultural research, institutions, networking, and training.*". Our project is a partnership between a US university, international researchers in Latin America and Africa, and African scientists that would include focused research on urgent farmer problems, strengthening of IIAM research capability, strengthening of the regional research networks, and training. Our project fits squarely within the IEHA science and technology strategy.

Our project would also *"address linkage of producers and markets"*, another IEHA goal, in socioeconomic analyses of constraints to adoption of improved germplasm, access to appropriate fertility inputs, and potential impacts of technology adoption - coupled with access to markets for beans - on household income. An understanding of intra-household dynamics is expected to shed light on the balance between use of the improved germplasm to directly improve farm household nutrition as compared to marketing of newly-developed beans to enhance income.

A third IEHA objective that our project would address is *"Reaching out to the vulnerable"* - an objective that specifically mentions drought as a threat to the food security of vulnerable groups. By directly addressing the problem of food production under drought, our project would contribute to this IEHA objective.

Contributions to USAID policy framework for bilateral foreign aid in Mozambique, Central America/Caribbean

The general strategy for USAID in Mozambique is "*transformational development*", including capacity building, country ownership of initiatives, and complementation of work of other donors. In particular, USAID states that *"Government institutions… suffer from a shortage of skilled personnel due to low salaries and the country's extreme shortage of trained citizens."* (http://www.usaid.gov/mz/development_challenge.htm). Poverty reduction is another USAID goal in Mozambique, as well as early childhood health and HIV. Our project would directly contribute to these goals by enhancing training of IIAM staff, enhancing production of a valuable source of farm income (beans have high market value), enhancing availability of a nutrient-dense food (bean) that has value in the nutritional support of HIV sufferers, and by complementing work by other donors (McKnight Foundation). Our project would therefore directly contribute to USAID/Mozambique policy goals.

Our project would support the bean breeding program of Juan Carlos Rosas, the most important bean breeder in Central America, which generates new cultivars used throughout the region. USAIDs "Central America and Mexico Regional Strategy", supported by country plans for Honduras and Nicaragua, notes that alleviation of poverty and malnutrition, as well as promotion of export markets, are important regional goals, and in Nicaragua in particular USAID has invested in a program on "*Sustainable Growth in Small Producer Employment and Income*". Beans are an important source of income and nutrients for small farmers in the region, and are an important export crop for Nicaragua. By enhancing yield and yield stability of beans, this project would contribute to USAID policy goals in Central America.

Strategy for integration of gender equity in project design and implementation

Two of the three Penn State faculty involved are female, as are two of the four African researchers. One of the two IIAM researchers identified as potential MS trainees is female, and one of the two INTA interns trained in our previous CRSP project was female - we anticipate that future INTA interns will include women. In Africa bean production is largely a feminine enterprise, so our direct beneficiaries would be largely female. Our socioeconomic component would specifically consider gender equity, by evaluating women's needs and priorities, and impacts of interventions on families, women, and children. We will specifically address marketing and women's involvement in it. We are sensitive to gender equity issues and have structured our project so that research and training activities will benefit women as well as men.

Strategy for integration of biodiversity conservation in project design and implementation

Our project would include evaluation of local bean landraces and would introgress traits from those landraces into elite germplasm, thereby enhancing the conservation and utilization of crop genetic resources. By improving and stabilizing bean production, our project would reduce the environmental degradation of soils, forests, and landscapes in Africa and Central America. Small farmers with greater and more stable yields are less likely to clear forested lands to plant new plots, which is a major source of biodiversity loss in Honduras, Nicaragua, and Mozambique.

Strategy for integration of social, political, and environmental considerations in project design and implementation

Our project would directly address social issues by analyzing a) household access to new technologies and constraints to adoption, b) intra-household dynamics that can hinder the realization of benefits accruing to specific types of individuals in the household (e.g., women, children) or to the overall household, and c) product marketing and intra-household engagement in marketing to secure income. Lack of access represents an important social – and often political – issue. As noted above, our project should have favorable environmental impacts by reducing pressure on forests and uncultivated lands. Our project would also include studies of how improved genotypes may reduce soil erosion, which is a major threat to agricultural productivity. Our project would also evaluate the efficacy of local fertilizer sources, which would cause less soil degradation than conventional fertilizer application.

Mission engagement

The USAID Mission in Honduras has been very supportive of Bean/Cowpea CRSP research activities conducted by Zamorano over the last 18 years. They are aware of the impact of the cultivars released by the program in bean production in Honduras. Even though the Mission has not provided any direct funding for bean research, it has supported several emergency relief projects after Hurricane Mitch that included seed production and distribution to more than 20,000 small farmers. The participation of researchers from the Zamorano bean program in the design and implementation of these projects as well as the training of extensionists and farmers involved, were crucial. In Mozambique the USAID mission funded the MS training of the three principal IIAM participants. USAID was concerned with research infrastructure and acquired some research equipment for IIAM trainees upon their return. The USAID mission in Mozambique is supportive of this project, as documented by a letter from the mission in the appendix.

Strategy for achieving developmental impacts

Outreach/Impact in Honduras:

The project will work in collaboration with several of the nearly 100 farmer local agricultural research committees (CIALs) (56, 57) which are currently active in Honduras. These CIALs are composed of men and women interested in the introduction and testing of technological alternatives to improve the productivity and sustainability of the cropping systems in their communities. Although most CIAL members are male, it is quite common to find CIALs led by women and others composed only of women; also, many young farmers are members of several CIALs. Zamorano is currently collaborating with CIALs in three regions of Honduras, as part of participatory plant breeding activities started in 2000, to improve local landraces of beans and maize with specific agro-ecological adaptation and consumer preferences. So far, eight bean and four maize cultivars have been released through these partnerships for conducting participatory plant breeding (PPB) activities with CIALs of Honduras. Several other breeding lines are under validation in communities of the regions of Yorito, Yojoa Lake and the Yeguare river basin, and some will be released as cultivars by 2008.

The project will also collaborate with the main NGOs of Honduras, especially those organizations that have been collaborating with Zamorano for more than 10 years (FIPAH, PRR, etc.), as well as with the National Bean Research programs from Honduras, Nicaragua and other Central American and Caribbean countries members of the Bean Research Network. This regional bean research network will be the mechanism to be used for the testing, validation and dissemination of novel bean lines and multilines developed by our project. The regional bean network has been coordinated by Zamorano since 1996; and has been recently reorganized under the Red SICTA and the leadership of Zamorano has been confirmed. The bean network has facilitated the testing of breeding lines and germplasm for nearly 20 years, and its members (the national bean programs) have been involved in the release of improved bean cultivars developed by Zamorano which are currently the main cultivars used by farmers in the region.

Foundation seed of released cultivars will be produced by Zamorano to assist certified and artisanal seed production and distribution projects supported by governmental and NGO organizations, such as the technological bonus in Honduras, which is reaching over 20,000 farmers every year with high quality seed of improved bean cultivars. Similar seed production and distribution projects have been implemented in Nicaragua and El Salvador in recent years, to assist small farmers with seed and fertilizer, as part of a policy for food security in rural areas and urban low-income sectors. These seed production and distribution projects will be assisted with foundation seed of improved cultivars developed by the project through our collaborators from the national bean programs and NGOs who are also involved in these seed projects.

The Zamorano bean program has been involved in training courses and in-service training in several aspects of bean research and seed production. The program has the required field, greenhouse and laboratory facilities to train technical personnel of our Central American and Africa collaborators in germplasm evaluation, breeding and selection, field plot management, marker assisted selection, participatory plant breeding and seed production. Also, in collaboration with CIALs and NGOs, we can train technical personnel and farmers in on-farm

innovation, participatory plant breeding and artisan seed production, focusing it from the perspective and needs of the small farmers.

Outreach/Impact in Mozambique:

In Mozambique we will be working with NGOs, namely World Vision International (WVI), Care International and the Cooperative League of the United States (CLUSA), with involvement of small scale farmers in several regions in Nampula, Zambezia and Niassa provinces in central and northern Mozambique. The proposed project will continue our collaborative work with World Vision International, which has been conducting activities in agricultural extension, variety testing, human nutrition and on-job training, involving thousands of farmers in Gurue, and Milange districts in Zambezia province; Malema and Mutuali, in Nampula province.

The project will also encourage farmers to organize themselves in organizations formed by several farmers associations and work with them in plant variety testing and evaluation. Currently, in almost all village communities in Mozambique farmers are organized in associations and sometimes, a number of farmers associations in a community form a cooperative, ending up with an organization with a large number of farmers. This is being encouraged by the CLUSA in Lioma, Gurue, which enables them to empower the farmers for acquisition of more expensive farming facilities and equipment, such as animal traction, tractors, implements, warehouses, etc., and better market access for their produce. We will be working with CLUSA to ensure that innovative technologies generated by the project can reach a large number of farmers capable of selling their increased production.

A major focus of WVI is the training of extensionists and then of the farmers in a community. Currently, extensionists lack training materials and useful information to deliver. In this project, we will, in parallel with the research activities, conducting training of extensionists, both from the public sector and NGOs, in relevant subjects like diagnosis of nutritional disorders, soil water conservation and techniques in participatory technology testing and dissemination. Since the farming systems vary among the regions where the project is going to be implemented, we will be developing training materials appropriate to each of the sites. For example, in Angonia farmers use ridges during land preparation, while in Gurue, and Sussundenga, farmers use flat red soils and/or in declined terrain susceptible to erosion, for planting, and as a result water and nutrient status of the soils in these locations vary. Our project will develop technologies (plant materials and soil management techniques) adequate to these specific crop systems across targeted research and technology delivery sites.

Under this project we will be working with the above mentioned NGOs, and farmers associations in Sussundenga, Manica province, Angonia, Tete province, Gurue, Lioma, Milange in Zambazia province, and Malela, Molocue and Mutuali, Nampula province, reaching several thousand small-scale farmers growing beans in the region. The planned activities can be summarized as: a) genotype evaluation and testing using participatory approach, b) technology dissemination for adoption, and c) training for extensionists in relevant subjects such as diagnosis for nutritional disorders and techniques for soil water use conservation.

Leveraging Plan

This project will benefit from substantial leveraging of resources from several sources:

Penn State

Penn State is contributing to this project through faculty time and through direct support for the tuition of one MS student for one year. In addition, graduate students in the Findeis lab at Penn State will participate in the project without stipend support.

Federal/private sector grants in Lynch/Brown labs

The project will directly and indirectly benefit from related projects in the Lynch/Brown labs funded by public and private sources, including the Monsanto Corporation, the National Research Initiative of the United States Department of Agriculture, the National Science Foundation, and graduate fellowships. These projects focus on root traits related to water and nutrient acquisition, from genetic, physiological, and agroecological perspectives, and have substantial relevance to the current project. At the time of our external project review conducted in 2006 as part of the Bean/Cowpea CRSP, CRSP funds were leveraged 20- fold, i.e. of resources directed to CRSP goals, only about 5% were supported directly by USAID. We anticipate continued substantial leveraging for the current project, most notably from the McKnight Foundation (see below).

McKnight Foundation CCRP

The Penn State and IIAM participants of this project are current recipients (along with the South China Agricultural University) of a 4-year $800,000 grant from the CCRP (Collaborative Crop Research Program) of the McKnight Foundation entitled "Increasing Phosphorus Efficiency and Productivity of Grain Legumes in China and Africa". The Mozambican portion of this project includes selection of beans with greater P efficiency, socioeconomic analysis of constraints to bean cultivar adoption, and analysis of potential agroecological impacts of the cultivation of P efficient bean genotypes. In the McKnight project we purchased a vehicle for transport in Mozambique, established a lab for plant and soil analysis at the Sussundenga research station, established direct (satellite) internet access at Sussundenga, established field sites for low P screening in Manica province, established field sites for agroecological research in several locations in Northern Mozambique, hired support staff in Mozambique, and are supporting the Ph.D. training of Magalhaes Miguel, Soares Xerinda, and Celestina Jochua. The research we propose in this CRSP project does not directly duplicate efforts in the McKnight project but has substantial synergy with them and will allow them to be enhanced and expanded. The infrastructure and research team we have established in the McKnight project will be invaluable in the execution of our proposed CRSP project, especially considering its short time frame (30 months) and the difficulty in purchasing supplies, importing seed, setting up field sites, communication, transport, etc that inevitably confront complex projects in remote, undeveloped locations such as the bean production regions of Mozambique.

Leveraged resources in Honduras

- The project will only be charged with 10% overhead and Zamorano will assume the other 20% (Zamorano normally applies a 30% overhead rate).
- Zamorano will provide office, field, greenhouse and laboratory space and equipment for research and training activities.
- The project will have access to a pickup truck at a very low cost for field trials in Honduras and for some visits to Nicaragua.
- Zamorano will finance the time of J.C. Rosas (20%), two lab technicians (30% each), one field technician (30%) and two field labor (30% each) involved in project activities.

In addition, the following projects of J.C. Rosas will be providing resources to bean research during the period of the project:

- Biofortification of common beans for Central America, in collaboration with CIAT (S. Beebe) and Central America National Bean Programs (funded by CIAD/Canada).
- Drought and low fertility tolerant varieties for Central America, in collaboration with CIAT, INTA/Nicaragua and DICTA/Honduras (funded by Red SICTA/IICA-COSUDE).
- Participatory plant breeding in common beans and maize, in collaboration with the PPB Program for Mesoamerica (funded by the Norwegian Development Fund).
- Drought tolerant beans and maize varieties, in collaboration with four universities (2 Mexico and 2 Spain) and CIAT (I. Rao) (funded by CYTED Program-EU).

Momentum

An important asset for this project is the fact that all of the participants have worked successfully together doing exactly the sorts of things proposed here in the context of the previous Bean/Cowpea CRSP (in which Lynch and Brown collaborated with Rosas, and Miguel did his MS training with Lynch) and the McKnight project described above. Momentum from previous work is especially important for breeding activities, since breeding and genetic studies typically require multiple seasons or years to complete. Dr. Rosas has begun introgressing specific root traits into commercially important bean genotypes for Central America, and Celestina Jochua (in collaboration with CIAT breeders Steve Beebe, Matthew Blair, and Rowland Chirwa) is advancing several crosses for possible P efficiency in African bean germplasm. Lynch and Rosas, in collaboration with Jim Beaver at the University of Puerto Rico, have already begun evaluation of promising bean multilines with contrasting root traits. The expertise, methods, and genetic resources from previous and ongoing efforts will be a tremendous aid to the proposed work and represents a form of ‘leveraging’ capitalizing on previous investments.

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63. Zhang, L., and J. Findeis. 2007. Agent-based Modeling on Household Migration and Land Use Decisions in South China. Paper presented at the Transatlantic Land Use Change Conference, Washington, DC.
64. UNEP; http://maps.grida.no/go/graphic/global_soil_degradation

Biographical Sketch

Kathleen M. Brown

Professional Preparation

State University of New York, Potsdam	Biology	B.A.	1974
University of New Hampshire	Genetics	M.S.	1976
University of Florida	Horticulture	Ph.D.	1978

Appointments

Assistant/ Associate/ Full Professor, Department of Horticulture, Penn State University. 1980-present. 75% research and 25% teaching in physiology of horticultural crops.

Visiting Scientist, Department of Biology, Royal Holloway and Bedford New College, University of London, 1990. Research on anatomy and molecular biology of flower abscission.

Postdoctoral Research Associate, Department of Agronomy, University of Missouri. 1979-1980. Research on hormone activity of *Rhizobium* strains.

Current Teaching and Administrative Responsibilities

Hort 412w, Postharvest Physiology. Undergraduate/graduate writing-intensive course, 3 cr.

Hort 390, Junior Seminar. Undergraduate issues course, 1 cr.

PLBIOL 512, Resource Acquisition and Utilization (course coordinator), 3 cr.

Coordinator, Graduate Program in Horticulture.

Steering committee & other service for the Intercollege Program in Plant Biology

Graduate Student Mentoring

Number of graduates successfully mentored: 12 Ph.D. and 2 M.S.
Past four years:
Nuwan Sella Kapu Umatha, M.S. 2002 Plant Physiology. Subsequently completed Ph.D. in Plant Biology at Penn State and currently working as postdoctoral research associate
Hye-Ji Kim, Ph.D. Horticulture, 2004. Presently Research Associate, Dept. Horticulture, Cornell University. Research in flowerbulb physiology.
Ivan Ochoa, Ph.D. Horticulture, 2006 (coadvised with J. Lynch). Presently Research Associate, Germplasm Resource and Biotechnology Unit, CORPOICA, Columbia, SA. Breeding and germplasm evaluation of tropical crops.
Paramita Basu, Ph.D. 2006, Plant Physiology. Presently Research Associate, Indian Institute of Technology, Kanpur. Research on root architecture and adaptation to edaphic stress of chickpea.

Publications past four years (Total 56 refereed journal articles)

Basu, P, Zhang, YJ, JP Lynch, and KM Brown. 2007. Ethylene modulates genetic, positional, and nutritional regulation of root plagiogravitropism. Functional Plant Biology 34:41-51.

Kim, H-J, R Craig, and KM Brown. Ethylene resistance of Regal Pelargonium is complemented but not replaced by 1-MCP. Postharvest Biology and Technology 45:66-72

Tanaka, M, R Snyder, JK Boateng, WJ Lamont, MD Orzolek, KM Brown, and JP Lynch. 2006. Utility of alumina-buffered phosphorus fertilizer for vegetable production. HortScience 41:775-779.

Lynch, JP, KM Brown. 2006. Whole plant adaptations to low phosphorus availability. *In:* Plant-Environment Interactions, 3rd Ed, B. Huang, editor. Taylor & Francis, Boca Raton, pp 209-242.

Kim, H-J, R Craig, and KM Brown. 2005. Genetic variation in ethylene sensitivity of regal pelargonium. Journal of the American Society for Horticultural Science 131:122-126.

Ho, MD, JC Rosas, KM Brown, JP Lynch. 2005. Root architectural tradeoffs for water and phosphorus acquisition. Functional Plant Biology 32: 1-12

He, ZX, Z Ma, KM Brown, JP Lynch. 2005. Assessment of inequality of root hair density in *Arabidopsis thaliana* using the Gini coefficient: a close look at the effect of phosphorus and its interaction with ethylene. Annals of Botany 95:2887-293.

Zhang, YJ, JP Lynch, and KM Brown. 2003. Ethylene and phosphorus availability have interacting yet distinct effects on root hair development. Journal of Experimental Botany 54:2351-2361.

Fan, M, J Zhu, C. Richards, KM Brown, JP Lynch. 2003. Physiological roles for aerenchyma in phosphorus stressed roots. Functional Plant Biology 30:493-506

Ma, Z, TI Baskin, KM Brown, JP Lynch. 2003. Regulation of root elongation under phosphorus stress involves changes in ethylene responsiveness. Plant Physiology 131:1381-1390

Borch, K, C Miller, KM Brown, JP Lynch. 2003. Improved drought tolerance in marigold by manipulation of root growth with buffered-phosphorus nutrition. HortScience 38:212-216.

Brown, KM, YJ Zhang, HJ Kim and JP Lynch. 2003. The ethylene underground. Acta Horticulturae (ISHS) 618:193-198.

Zhang, YJ, L Kuhns, JP Lynch, and KM Brown. 2002. Buffered phosphorus fertilizer improves growth and drought tolerance of woody landscape plants. Journal of Environmental Horticulture 20:214-219.

Brown, KM, R Snyder, MD Orzolek, L Otjen, CS Vavrina, JP Lynch. 2002. Production of high quality tomato transplants with a novel buffered fertilizer. HortTechnology 12:662-669.

Other relevant publications

Liao, H, G Rubio, X Yan, A Cao, KM Brown, JP Lynch. 2001. Effect of phosphorus availability on basal root shallowness in common bean. Plant and Soil 232:69-79.

Lynch, JP and KM Brown. 2000. Topsoil foraging – an architectural adaptation to low phosphorus availability. Plant and Soil 237: 225-237. (review)

Borch, K, T Bouma, JP Lynch , KM Brown. 1999. Interactions of ethylene and phosphorus nutrition on root growth. Plant, Cell and Environment 22:425-431.

Lynch, JP and KM Brown. 1997. Ethylene and plant responses to nutritional stress. Physiologia Plantarum 100: 613-619 (invited review).

RESUME
ROWLAND M CHIRWA

KEY QUALIFICATIONS:
Dr. Rowland M Chirwa is a scientist, manager and plant breeder with substantial experience in many parts of southern Africa. He has worked extensively in the public sector, the Department of Agricultural Research in Malawi, as an Agricultural Research Scientists – focusing on plant breeding in a number of crops including common bean. Currently he serves as Coordinator for the Southern Africa Bean Research Network (SABRN) as well as a Regional Bean Breeder supporting 10 countries with bean germplasm in the network.

EDUCATION:

Ph.D. University of Nebraska; Lincoln, Nebraska, Department of Agronomy. Institute of Plant Sciences, 1991.

M.Sc. University College of Wales; Department of Plant Science, Aberystwyth, United kingdom, 1983.

B.Sc. University of Malawi; Bunda College of Agriculture, Lilongwe, Malawi. ,1980

RELEVANT EXPERIENCE:

2001-Present As a Network Coordinator and CIAT bean breeder for the Southern Africa Development Community (SADC) member states, I lead NARS scientists and collaborating government and NGO partners to develop and release improved bean technologies (including varieties) and to implement strategies of making seed of improved bean varieties and other technologies available to as many farmers as possible in various SADC countries.

1998-2000 As a Chief Research Scientist in the Department of Agricultural Research in Malawi, but also a Germplasm Coordinator for the SADC Bean Research Network, I assisted various countries within the SADC region with bean germplasm either through the network nurseries and trials or through special requests. The countries that have benefited most from the bean germplasm network exchange are:Malawi, Zambia, Tanzania, Mozambique, Angola, south D R Congo, Zimbabwe and Swaziland.

1994-98 As a Principal Bean Breeder, Commodity Team Leader for beans and Project Manager for a bilateral project between Malawi-UK (DFID) – "the Bean Improvement Programme", I led the team to release six improved bean varieties (CAL 143 (Napirila), DRK 57 (Sapatsika), A 197 (Nagaga), CAL 113 (Maluwa), A 286 (Kambidzi) and A 344 (Mkhalira) in 1995 to help small-scale bean farmers, most of whom are women, to produce, eat and sell more beans.

Representative Publications:

2006. Chirwa, R. M., V.D Aggarwal, M. A. R. Phiri, and A. R. E. Mwenda. Experiences in Implementing the bean seed Strategy in Malawi. Journal of Sustainable Agriculture. (29) 2, 43-69.

2006. Hillocks, R. J., C. S. Madata, R. M. Chirwa, E. M. Minja and S. Msolla. Phaseolus Bean Improvement in Tanzania 1959-2005. Euphytica. 150, 215-231

2005. Kang M. S., V. D. Aggarwal and R. M. Chirwa. Adaptability and Stability of Bean Cultivars as Determined via Kang's Yield-Stability Statistic and GGE Biplot Analysis. Journal of Crop Improvement. (15) 1, 97-120

2003. Aggarwal, Vas D., Marcial A. Pastor-Corrales, Rowland M. Chirwa, & Robin A. Buruchara. Identification of resistance to the angular leaf spot pathogen (*Phaeoisariopsis griseola)* in Andean beans in Malawi. Euphytica. 136:201-210

2000. Chirwa, R. M. and V. D. Aggarwal. Bean Seed Dissemination Systems in Malawi: a Strategy. Journal of Sustainable Agriculture. Vol. 15(4): 5-24.

1998. Snapp, S., V. D. Aggarwal and R. M. Chirwa. Note on phosphorus and cultivar enhancement of biological nitrogen fixation and productivity of maize-bean intercrops in Malawi. Field Crops Research. 3702. pp. 1-8.

1997. Aggarwal, V. D., S. K. Mughogho, R. M. Chirwa and S. Snapp. Field-Based Screening Methodology to Improve Tolerance of Common Bean to Low-P Soils. Communications in Soil Science and Plant Analysis. 28. pp. 1623-1632.

Jill L. Findeis
Professor of Agricultural, Environmental and Regional Economics & Demography
Department of Agricultural Economics and Rural Sociology
Population Research Institute

112 Armsby Building	Phone:	814-863-8246
The Pennsylvania State University	Fax:	814-865-3746
University Park, PA	E-mail:	fa2@psu.edu

EDUCATION

1982	Ph.D., Agricultural Economics, 1982 (Fields: Public Policy, Quantitative Methods, Production Economics)
1978	M.S., Agricultural Economics, University of Idaho (Fields: Resource Economics, Applied Statistics)
1974	B.S., Natural Resource Economics, Cornell University

ACADEMIC POSITIONS

2007	Professor, School of International Affairs
2001 - 07	Professor, Department of Agricultural Economics and Rural Sociology, & Population Research Institute (PRI)
1995 - 96	ESCOP/ACOP Leadership Development Fellow
1988 - 01	Associate Professor, Department of Agricultural Economics and Rural Sociology, & Population Research Institute (PRI)
1982 - 88	Assistant Professor, Department of Agricultural Economics and Rural Sociology, & Population Research Institute (PRI)
1981 - 82	Research Associate and Contract Monitor, Office of Applied Energy Studies, Washington State University & University of Washington
1981	Lecturer, Quantitative Methods, College of Business and Economics, University of Idaho
1977 - 80	Research Assistant, Agricultural Economics, Washington State University
1974 - 77	Computer Programmer, University of Idaho
1973 - 74	Research Assistant, Population Studies Program, Cornell University

VISITING POSITIONS

2005 - 07	Joint Faculty Scholar, Farm and Nonfarm Well-being Branch, Resource Economics Division, Economic Research Service, Washington, DC
1998	Visiting Scholar, International Trypanotolerance Center, Banjul, The Gambia
1986	Visiting Professor, Centre for Human Research Development (CHRD, now INSPARC), Kalyani, West Bengal and the Indian Statistical Institute (ISI), Calcutta, India

DISTINCTIONS

2006 - 08	Harbaugh Scholar
2005	Vice President's Award for Learning and Community (Group Award)
2000	Milton S. Eisenhower Award for Distinguished Teaching
2000	Who's Who in the World; Directory of American Scholars
1995 - 97	President, American Agricultural Economics Association Foundation Governing Board
1994	U.S. Department of Agriculture Excellence in College and University Teaching Award
1994	The George W. Atherton Award
1989	American Agricultural Economics Association Outstanding Teaching Award
1989	Gamma Sigma Delta Honor Society Teaching Award of Merit
1989	Outstanding Professor, Pennsylvania Governor's School
1986	Sigma Xi; Alpha Zeta
1982	Washington State University, American Agricultural Economics Association Outstanding Dissertation Award Nomination
1979	Western Agricultural Economics Association Outstanding Thesis Award
1976	Gamma Sigma Delta

AFFILIATIONS

School for International Affairs
Operations Research Faculty
Demography Program Faculty
Social Science Research Institute
Population Research Institute

GRANTS/CONTRACTS RECEIVED FROM:

Mellon Financial Foundation (for Mellon Community Bridge Project)
NIH/NICHD
OECD
Rural Policy Research Institute (RUPRI)
Penn State Outreach Partnership Fund
U.S. Department of Agriculture, National Research Initiative Competitive Grant Program
U.S. Department of Agriculture, Cooperative Agreement(s)
American Agricultural Economics Association
Northeast Regional Center for Rural Development
Aspen Institute/Ford Foundation
Pennsylvania Department of Agriculture
U.S. Department of Agriculture/Office of Personnel Management (Research Associate)
Symposium funded by Farm Foundation and the Regional Rural Development Centers
Center for Rural Pennsylvania
The National Endowment for the Arts (with Rural Opportunities, Inc.)

PROFESSIONAL ORGANIZATIONS AND OFFICES HELD

International Association of Agricultural Economists (IAAE), Organizing Committee, XXIII IAAE Congress (1995-97)
American Agricultural Economics Association (AAEA)
- American Agricultural Economics Assoc. Foundation Governing Board, Board President (elected 1994-96); Program Chair (elected 1993-94)
- Committee on Women in Agricultural Economics (CWAE), Board of Directors (elected 1992-94); Research Committee (1990-92; Chair 1991-92)
- Selected Papers Committee (multiple years; topic leader, multiple years); *Choices* Editorial Review Board

Population Association of America (PAA)
Northeastern Agricultural and Resource Economics Association
- Board of Directors (elected 1992-94)

GRADUATE-LEVEL TEACHING

Quantitative and Survey Research Methods:

AEREC 527	Quantitative Methods (Operations Research)
CEDEV 575	Methods and Techniques for Economic and Community Development
DEMOG 596	Demographic Methods
R SOC 597A	Discrete choice method module in summer workshop course

Field Courses:

AEREC 501	Production Economics
AEREC 597A	Rural Labor and Labor Markets (Economic Demography)
AG EC 542	Advanced Topics in Rural Development (co-taught)
AEREC 590	Graduate Seminar (co-taught)
AG EC 596	Research In Labor Economics

GLOBAL SEMINAR GRADUATE EXPERIENCE (experimental).

Celestina N. Jochua, M.Sc.
PhD Candidate
Horticulture – Plant Breeding

Education

MSc, Biological Sciences - Plant Pathology, University of Nebraska, Lincoln, USA, 2004.
Thesis: Phenotypic and genetic variability of the bean rust pathogen.

BSc (Licenciatura), Agronomy - Plant Production and Protection, Universidade Eduardo Mondlane, Mozambique, 1997.
Licenciatura thesis: Alternative hosts of pests of the main crops in Sábie-Incomáti irrigation Scheme, Maputo.

Professional Experience

1998 to Present: Work as researcher in the Agrarian Research Institute of Mozambique - IIAM, Chokwe research station, Chokwe, Gaza.

1998 to 2002: Worked in the National rice program at IIAM, Chokwe Research Station.

2003 to Present: Work in the National Legume program and plant protection at IIAM, Chokwe Research Station.

Research interest

Common bean (*Phaseolus vulgaris L.*) is a main source of dietary protein and micronutrients for people in developing countries of Latin America and Africa. One of the major constraints to common bean production in these regions is low soil fertility, particularly low phosphorus (P) availability. My PhD research focuses mainly in the improvement of root traits in common bean for higher phosphorus acquisition and development of P efficient genotypes adapted to Mozambique. Development of P efficient common bean genotypes through genetic improvement of root traits will potentially increase bean production since most farmers in developing countries cannot afford fertilizers. Bean genotypes with shallower basal roots, multiple basal and adventitious roots, and long and dense root hairs have been found to perform better under low P availability. Most of my PhD research for development of P efficient genotypes will be conducted in Mozambique.

Awards

American Phytopathological Society (APS) award. Poster awarded in the first place in the student's poster competition in the APS North-Central division meeting, Minnesota, 2004. Title: Pathogenic variability of the bean rust pathogen within individual bean fields".

Publications

Jochua, C. 1997. Hospedeiros alternativos de pragas das principais culturas no regadio de Sábie-Incomáti, Maputo. Tese de licenciatuta. FAEF, Universidade Eduardo Mondlane, Maputo, Mozambique.

Jochua, C. N., J. R. Steadman, M. I. V. Amane and J. G. Fenton. 2004. Pathogenic variability and Sources of Resistance to the Common Bean Rust Pathogen in Southern Mozambique. Ann. Rep. Bean Improv. Coop. **47**: 113-114.

Jochua, C. N., J.R. Steadman, M. Amane and J. Fenton. 2004. Pathogen phenotypes used to identify sources of resistance to rust from a specific common bean gene pool in southern Mozambique. Abstract. Phytopathology 94:S4. Publication no. P-2004-0316-AMA.

Jochua, C.N. 2004. Pathogenic variability of populations of the bean rust pathogen, *Uromyces appendiculatus*, and identification of resistance to bean rust in southern Mozambique. MS thesis. University of Nebraska-Lincoln, USA.

Steadman, J.R., M. Acevedo, C. Jochua, C. Araya, and J. C. Rosas. 2005. Rust of common bean: origin of pathogen virulence diversity and disease resistance gene deployment. Abstract. 1st IELC. p. 39. Durban, South Africa.

Jochua, C., J.R. Steadman and K. M. Eskridge and M.I. Amane. 2005. Pathogenic variability of populations of the bean rust pathogen within individual bean fields. Abstract. Abstract. 1st IELC. p. 12. Durban, South Africa.

Jochua, C., J.R. Steadman, X. Xue, K.M. Eskridge and M.I. V. Amane. Pathogenic variability of the common bean rust pathogen and development of sampling strategies. Paper submitted to Plant Disease Journal for publication.

Jonathan P. Lynch

Professional Preparation

University of California, Berkeley	B.S. (honors)	Soils & Plant Nutrition	1980
University of California, Davis	M.S.	Plant Physiology	1982
University of California, Davis	Ph.D.	Plant Physiology	1987

Appointments

Asst./Assoc./Full Prof. of Plant Nutrition,
Dept. Horticulture, Penn State University, 1-91 to present.
Senior Staff
International Center for Tropical Agriculture (CIAT), Colombia, 10-88 to 1-91.
Postdoctoral Fellow
CIAT, Colombia, 8-87 to 10-88.
Postgraduate Researcher
University of California, Davis, 9-84 to 8-87.

Honors and Awards

Alex and Jessie C. Black Award for Excellence in Agricultural Research, College of Agricultural Sciences, Penn State University, 2005.

Fellow, Crop Science Society of America 2004

China Friendship Award, the highest recognition awarded foreigners by the government of China, received from Premier Zhu Rongji, Beijing 1999.

Excellent Educational Work Prize, Guangdong Province, China, 1996

Distinguished Professor, Mexican Academy of Sciences

Editorial Boards: Plant, Cell and Environment, Functional Plant Biology, Plant and Soil, Annals of Botany.

Synergistic Activities

1) Collaborative research and training activities with Chinese colleagues on the genetic and physiological basis of phosphorus efficiency in crops has had significant impact. New varieties of soybean (*Glycine max*) with greater phosphorus acquisition efficiency are being bred and released in collaboration with Dr. Xiaolong Yan at South China Agricultural University. It is projected that these new varieties will be adopted by 10 million soybean farmers in 2007.

2) New varieties of common bean (*Phaseolus vulgaris*) are being bred and released in Africa and Latin America that carry root traits identified and genetically tagged through research on the architectural basis of phosphorus acquisition efficiency, in collaboration with bean breeders at CIAT and in national agricultural research institutes, funded by USAID.

3) An integrated program to develop new bean varieties with superior adaptation to drought and low soil fertility has been initiated in Mozambique with funding from the McKnight Foundation, including breeding, trait physiology, agroecology, socioeconomics, and nutrition.

4) Formation of ideotypes for drought tolerance and nitrogen use efficiency in maize.

Publications (last five years)

Basu, P, A Pal, JP Lynch, KM Brown. A novel image analysis technique for kinematic study of growth and curvature. Plant Physiology, in press

StClair, S, W Sharp, JP Lynch. Key interactions between nutrient limitation and climate change in temperate forests: a synthesis of the sugar maple literature. Can J For Res, in press

Lynch, JP. 2007. Rhizoeconomics: the roots of shoot growth limitation. HortScience 42: 1107-1109.

Lynch, JP. 2007. Roots of the second green revolution. Australian Journal of Botany, 55, 493–512.

Basu P, Y-J Zhang, JP Lynch, KM Brown. 2007. Ethylene modulates genetic, positional, and nutritional regulation of root plagiogravitropism. Functional Plant Biology, 34:41-51.

Lynch JP, RE Jaramillo. 2006. Book review- Soil Fertility Decline in the Tropics, with Case studies on Plantations. Field Crops Research 96:481-483.

Lynch, JP. 2006. Book Review: Plant Roots: their Growth, Activity, and Interaction with Soils, by Peter Gregory, Soil Science Society of America Journal,71:253.

Rubio G, JP Lynch. 2007. Functional compensation among root classes. Plant and Soil, 290:307-321.

Walk, TC, R Jaramillo, JP Lynch. 2006. Architectural tradeoffs between adventitious and basal roots for phosphorus acquisition. Plant and Soil 279:347-366.

Beebe SE, M Rojas-Pierce, X Yan, M Blair, F Pedraza, F Muñoz, J Tohme, JP Lynch. 2006. Quantitative trait loci for root architecture traits correlated with phosphorus acquisition in common bean. Crop Science 46: 413-423.

Zhu J, SM Mickelson, SM Kaeppler, JP Lynch. 2006. Detection of quantitative trait loci for seminal root traits in maize (Zea mays L.) seedlings grown under differential phosphorus levels. Theoretical and Applied Genetics 113:1-10.

Lynch, JP, KM Brown. 2006. Whole plant adaptations to low phosphorus availability. *In:* Plant-Environment Interactions, 3rd Ed, B. Huang, editor. Taylor & Francis, Boca Raton, pp 209-242.

Tanaka, M, R Snyder, JK Boateng, WJ Lamont, MD Orzolek, KM Brown, and JP Lynch. 2006. Utility of alumina-buffered phosphorus fertilizer for vegetable production. HortScience 41:775-779.

Ochoa, IE, MW Blair, JP Lynch. 2006. QTL Analysis of adventitious root formation in common bean (Phaseolus vulgaris L.) under contrasting phosphorus availability. Crop Science 46:1609-1621.

St.Clair, SB, JP Lynch. 2005. Differences in the success of sugar maple and red maple seedlings on acid soils are influenced by nutrient dynamics and light environment. Plant, Cell & Environment 28:874-885.

Riseman, A, R Craig, JP Lynch. 2005. Zinc uptake and shoot partitioning between zinc efficient and inefficient exacum genotypes. Journal of the American Society of Horticultural Science 130:674-679.

Zhu, J, SM Kaeppler, JP Lynch. 2005. Topsoil foraging and phosphorus acquisition efficiency in maize (Zea mays L.). Functional Plant Biology 32:749-762.

Ho, MD, JC Rosas, KM Brown, JP Lynch. 2005. Root architectural tradeoffs for water and phosphorus acquisition. Functional Plant Biology 32:737-748.

Zhu, J, SM Kaeppler, JP Lynch. 2005. Mapping of QTL for lateral root branching and length in maize (Zea mays L.) under differential phosphorus supply. Theoretical and Applied Genetics

111:688-695.
St.Clair, SB, JE Carlson, JP Lynch. 2005. Evidence for oxidative stress in sugar maple stands growing on acidic, nutrient imbalanced forest soils. Oecologia 145:257-268.
Lynch, JP. Root architecture and nutrient acquisition. 2005. in Nutrient acquisition by plants: an ecological perspective, H. Bassirirad (Ed.), Ecological Studies Volume 181. pp 147-183. Springer-Verlag, Berlin, FRG.
Lynch, JP, MD Ho. 2005. Rhizoeconomics: carbon costs of phosphorus acquisition. Plant and Soil 269:45-56.
St.Clair, SB, JP Lynch. 2005. Element accumulation patterns of deciduous and evergreen tree seedlings on acid soils and its implications for sensitivity to manganese toxicity. Tree Physiology 25:85-92.
St.Clair, SB, JP Lynch. 2005. Base cation stimulation of mycorrhization and photosynthesis of sugar maple on acid soils are coupled by foliar nutrient dynamics. New Phytologist 165:581-590.
He, ZX, Z Ma, KM Brown, JP Lynch. 2005. Assessment of inequality of root hair density in Arabidopsis thaliana using the Gini coefficient: a close look at the effect of phosphorus and its interaction with ethylene. Annals of Botany 95:287-293.
Zhu, J, S Kaeppler, JP Lynch. 2004. Mapping of QTL controlling root hair length in maize (Zea mays L.) under phosphorus deficiency. Plant and Soil 270:299-310.
Yan, X, H Liao, SE Beebe, MW Blair, JP Lynch. 2004. QTL mapping of root hair and acid exudation traits and their relationship to phosphorus uptake in common bean. Plant and Soil 265:17-29.
Zhu, J, JP Lynch. 2004. The contribution of lateral rooting to phosphorus acquisition efficiency in maize (Zea mays L.) seedlings. Functional Plant Biology 31:949-958.
St.Clair, SB, JP Lynch. 2004. Photosynthetic and antioxidant enzyme responses of sugar maple and red maple seedlings to excess manganese in contrasting light environments. Functional Plant Biology 31:1005-1014.
Liao, H, X Yan, G Rubio, SE Beebe, MW Blair, JP Lynch. 2004. Genetic mapping of basal root gravitropism and phosphorus acquisition efficiency in common bean. Functional Plant Biology 31, 959-970.
Rubio, G, A Sorgona, JP Lynch. 2004. Spatial mapping of phosphorus influx in bean root systems using digital autoradiography. Journal of Experimental Botany 55(406):2269-2280.
Lynch, JP, S StClair. 2004. Mineral stress: the missing link in understanding how global climate change will affect plants in real world soils. Field Crops Research 90: 101-115.
Walk, TC, E van Erp, JP Lynch. 2004. Modelling applicability of fractal analysis to efficiency of soil exploration by roots. Annals of Botany 94:119-128.
Tomscha, JL, MC Trull, J Deikman, JP Lynch and MJ Guiltinan. 2004. Phosphatase under-producing mutants have altered phosphorus relations. Plant Physiology 135:334-345.
Ho, MD, BC McCannon, JP Lynch. 2004. Optimization modeling of plant root architecture for water and phosphorus acquisition. Journal of Theoretical Biology 226(3):331-340.
Brown, KM, YJ Zhang, HJ Kim and JP Lynch. 2003. The ethylene underground. Acta Horticulturae (ISHS) 618:193-198.
Halperin, S, JP Lynch. 2003. Effects of salinity on cytosolic Na+ and K+ in root hairs of Arabidopsis thaliana: in vivo measurements using the fluorescent dyes SBFI and PBFI. Journal of Experimental Botany 54(390):2035-2043.
Zhang, Y-J, JP Lynch, KM Brown. 2003. Ethylene and phosphorus availability have interacting

yet distinct effects on root hair development. Journal of Experimental Botany 54(391):2351-2361.

Miller, CR, I Ochoa, KL Nielsen, D Beck, JP Lynch. 2003. Genetic variation for adventitious rooting in response to low phosphorus availability: potential utility for phosphorus acquisition from stratified soils. Functional Plant Biology 30:973-985.

Rubio, G, J Zhu, JP Lynch. 2003. A critical test of two prevailing theories of plant response to nutrient availability. American Journal of Botany 90(1):143-152.

Borch, K, C Miller, KM Brown, JP Lynch. 2003. Improved drought tolerance in marigold by manipulation of root growth with buffered-phosphorus nutrition. HortScience 38:212-216.

Halperin S, S Gilroy, JP Lynch. 2003. Sodium chloride reduces growth and cytosolic calcium, but does not affect cytosolic pH, in root hairs of Arabidopsis thaliana L. Journal of Experimental Botany 54:1269-1280.

Fan, M, J Zhu, C Richards, KM Brown, JP Lynch. 2003. Physiological roles for aerenchyma in phosphorus-stressed roots. Functional Plant Biology, 30:493-506.

Bayuelo-Jiménez, JS, DG Debouck, JP Lynch. 2003. Growth, gas exchange, water relations, and ion composition of wild and cultivated Phaseolus species grown under saline conditions. Field Crops Research, 80:207-222.

Ma, Z, TI Baskin, KM Brown, JP Lynch. 2003. Regulation of root elongation under phosphorus stress involves changes in ethylene responsiveness. Plant Physiology 131:1381-1390.

Rubio, G, H Liao, X Yan, JP Lynch. 2003. Topsoil foraging and its role in plant competitiveness for phosphorus in common bean. Crop Science 43:598-607.

Zhang, YJ, L Kuhns, JP Lynch, KM Brown. 2002. Buffered Phosphorus Fertilizer Improves Growth and Drought Tolerance of Woody Landscape Plants. Journal of Environmental Horticulture. 20(4):214-219.

Brown, KM, R Snyder, MD Orzolek, L Otjen, CS Vavrina, JP Lynch. 2002. Production of high quality tomato transplants with a novel buffered fertilizer. HortTechnology 12:662-669.

Bayuelo-JimÃ©nez, JS, R Craig, JP Lynch. 2002. Salinity tolerance of Phaseolus species during germination and early seedling growth. Crop Science 42:1584-1594.

Bayuelo-JimÃ©nez, JS, DG Debouck, JP Lynch. 2002. Salinity tolerance in Phaseolus species during early vegetative growth. Crop Science 42:2184-2192.

Fisher, MCT, DM Eissenstat, JP Lynch. 2002. Lack of evidence for programmed root senescence in common bean (Phaseolus vulgaris) grown at different levels of phosphorus supply. New Phytologist 153:63-71.

Bielenberg, DG, JP Lynch, EJ Pell. 2002. Nitrogen dynamics during O3-induced accelerated senescence in hybrid poplar. Plant Cell & Environment 25:501-512.

Curriculum Vitae for Magalhaes Miguel

Personal Identification

Full Name: **Magalhaes Amade Miguel**
Date of birth: January 1st, 1970
Place of birth: Nampula city, Nampula
Nationality: Mozambican
Marital status: Single

Current Position and Address

Researcher, Agricultural Research Institute of Mozambique. Central Zone Research Center (CZC) - Sussundenga. a/c DPA-Manica, P. O. Box. 42, Pigivide Avenue, 678, Chimoio, Manica, Mozambique.
Telephone: +258 51 23356, Fax: +258 51 23356
Mobile: +258 825140313
E-mail: <mam1041@psu.edu>, <magalhaes_amade@hotmail.com>

Academic Titles

Member of National Farming System team, IIAM, 1997-2001
Member of American Society of Agronomy, 2002
Member of American Society of Plant Biologists, 2003.

Education

MSc. in Plant Nutritional Physiology, Horticulture Department, Pennsylvania State University. (Supported by International Sorghum and Millet Research Support Program – INTSORMIL CRSP & Bean/Cowpea CRSP), 2004, USA.
Advisors: Jonathan P. LYNCH (Principal Advisor, PSU), Kathleen BROWN (PSU), Roger KOIDE (PSU).

BSc in Plant Breeding, Kazakh State Agrarian University, 1996, Alma-Ata, Kazakhstan.
Advisor: Nurgasin NURGASINOV, Professor of Plant Breeding.

Language proficiency:

Portuguese – fluent
English – fluent
Russian -fluent
Spanish – good
Mother thong: Macua (fluent), sena (good).

Working Experience

- Research Assistant at Agricultural Research Institute of Mozambique (IIAM), 1997-present.

- Visiting Scholar, Brazilian Agricultural Research Company (EMBRAPA), 1997-1998;
- Visiting Researcher (for MSc. thesis Research), University of Costa Rica, San Jose, Costa Rica, 2003.
-Visiting scholar, Centro Internacional de Agricultura Tropical – CIAT, Cali, Colombia, August, 2006

- Current Principal Investigator (PI) of PSU/SCAU/IIAM joint research project entitled "Increasing Phosphorus Efficiency and Production of Grain Legumes in China and Africa" supported by the Collaborative Crop Research Program of the McKnight Foundation, USA - an $800,000 Research & Training grant.

- Current Principal Investigator (PI) of the research project entitled "Evaluation and Selection of Legume Genotypes for Root Traits Conferring Phosphorus (P) acquisition Efficiency in Low-P soils of Central and Western Mozambique" supported by International Atomic Energy Agency, UN – an 9,000 USD/Year research grant.

- PhD Candidate at Pennsylvania State University, USA.

Research Areas:

Plant nutritional physiology, plant root traits conferring phosphorus efficiency for low fertility soils. Root hair morphology.

Role of mycorhizal associations in nutrient uptake, especially P-uptake in plants.

QTL genetic mapping.

Water resources, plant water relations.

Publications

Miguel, M. A., Nurgasenov, N. (1996). Development and selection of early maturing Maize *(Zea Mays L.)* genotypes for northern Kazakhstan. (BS thesis work).

Miguel, M.A., Mutaliano, J.A. (1998). The effect of different levels of fertilizer application in Maize *(Zea Mays L.)* Yields in Manica Province. INIA Annual Report, 1998.

Miguel, M.A., and Lynch, J. (2004). Genotypic variation of root hairs and phosphorus efficiency in Common bean *(Phaseolus vulgaris L.)* – Pennsylvania State University. (MS thesis research work).

CARRICULUM VITAE

Name: Rose Mongi-Henday

Host Institution: The Uyole Agricultural Research Institute

Postal Address: ARI-Uyole, P.O. Box 400, Mbeya, Tanzania

Physical Address: Kilimo-Uyole, Mbeya. Tanzania

E-mail: rhmongi@yahoo.com

Fax: 255-25-2510065

EDUCATION

University of Idaho, Moscow- Idaho, USA
Master's of Science degree in Plant science (January 1994 – May 1996)
Thesis title: Allelic variation of high molecular weight glutenin protein subunits and their effect on soft white wheat end-use quality.

University of Missouri-Columbia, USA
Bachelor of Science degree in Agronomy (June 1991 – December, 1993)
Relevant course work included: Grain crops, theory and concepts of plant pathology, statistical analysis, crop physiology and plant genetics

International Maize and Wheat Improvement Center (CIMMYT), MEXICO
Diploma in Wheat breeding and pathology (Feb 1988 – October 1988)

The Uyole Agricultural College, Mbeya-TANZANIA
Diploma in crop production (July 1983 – June 1985)
Relevant course work included: Crop improvement and physiology, Plant pathology, farm machinery management and principals of field experimentation

Certificates

International community development: May-September, 1993. University of Missouri-Columbia, USA

Farming System Approach: February-August, 2002, Tanga, Tanzania

HIV/AIDS in Agriculture: February, 2003. Arusha. Tanzania

WORK EXPERIENCE (In reverse chronological order)

The Uyole Agricultural Research Institute, Mbeya – TANZANIA
Agricultural technician (July 1985 – June 1991)
Worked as full time employee in wheat breeding program. Involved in field plan preparations, experiment layouts, planting, seed selection, trial management, data collection, data processing, harvesting and supervision of 20+ part time employees

University of Missouri-Columbia, USA
Worked as part time student employee, department wheat breeding program. May 1993 to December 1993. Involved in data collection, harvesting and seed processing

The Uyole Agricultural Research Institute, Mbeya – TANZANIA - June1996 to date.
Working as Plant breeder. Involved in developing new varieties through hybridization, selecting desirable genotypes from segregating populations and evaluate them. Transfer the developed environmentally sound technologies to farmers in the country.

Regional Representative for Eastern and Southern Africa:
Legumes community of practice, under the McKnight Foundation:
(2007 to date)

International research collaborations
LinKS –FAO. 2003 – 2005. Project title: Local indigenous knowledge on agro-biodiversity and seed management in relation to food security in the Southern Highlands of Tanzania. Have a detailed study on bean seed landraces.

Grant won

Programs for green revolution in Africa (ProGRA) – 2007
Donor: Rockefeller /Bill and Melinda Gates Foundations. Team leader: Grant no. 005 Addressing Rural poverty in the Southern Highlands of Tanzania through improvement of angular leaf spot and anthracnose disease resistance in common beans.

Awards

Best Zonal Research Team – 2005: Awarded by the Ministry of Agriculture, Food and cooperatives.

Gender and Diversity/ Rockefeller Foundation: 2005 – 2006.
First round: Improving career of Eastern Africa women in science.

PROFESSIONAL MEMBERSHIP

Active member of African Crop Science Society
Active member of AMMANET (African molecular marker application network)
Used to be a member of American Society of Agronomy, but due to financial difficulties my membership was freezed.

RELEVANT PUBLICATIONS

1. **Mongi-Henday, R**. 2002. Genetic diversity among local wheat cultivars in the Southern Highlands of Tanzania. *In* The second national workshop on plant genetic resources and biotechnology: Arusha, Tanzania.

2. **Mongi-Henday, R** and A. M. Elanga. 2002. Grain yield potential stability and agronomic perfomance of some wheat genotypes in the Southern Highlands of Tanzania. *In* Collaborative Workshop between Directorate of research in the Ministry of agriculture and Food security and the Sokoine University of Agriculture. Morogoro, Tanzania

3. **Mongi-Henday, R**. and A. M. Elanga 2005. Verification of advanced lines of wheat and farmers preferences in the informal seed system, Southern Highlands of Tanzania. *In* Seventh African Crop science society. Entebbe, Uganda

4. Elanga A. M, F.N. Mwalyego, and **Rose Mongi –Henday.** 2002. The effect of time of planting and fungicide application in control of wheat diseases under small scale farming in Mbeya district. – Proceedings of workshop on collaborative research for food security organized jointly by Sokoine university and the ministry of Agriculture and food security 28 – 30 May 2002, Morogoro, Tanzania.

5. Mussei, A.J.Mwanga,W. Mwangi, H.Verkuijl, **R. Mongi** and A. Elanga. 2001. Adoption of improved wheat technologies by small-scale farmers in Mbeya district, Southern highlands, Tanzania. Mexico, D.F.: International Maize and Wheat Improvement Center (CIMMYT) and the United Republic of Tanzania

6. Plant Anatomy, Physiology and breeding Training Manual for diploma and Certificate courses. Instructional Material Development unit/ASPS. Ministry of Agriculture and Food Security, Technical handbook 12 of 2003. (Yongolo, S and **R. Mongi-Henday**)

7. Katunzi, A. L. and **Mongi. R**. 1987. Adaptation and breeding studies in bread wheat for the southern highlands of Tanzania. *In* The sixth regional wheat workshop for eastern and central Africa (D.G. Tanner, M. Van Ginkel and W. Mwangi eds)

Reports

Mongi-Henday, Rose, A. M. Elanga, F. Shao-Mwalyego. 1996-2005 Wheat variety Development for medium and high altitude in Tanzania. Annual progress reports.

Variety Released

SIFA - **Mongi-Henday, R,** A. M. Elanga, F. Shao-Mwalyego. 2005. Bread wheat variety for high and medium altitude in Tanzania.

REFERENCES

Dr. Mohamed M. Msabaha,
Assistance Director
Ministry of Agric.
P.O.Box 2066 .
Dar es Salaam
TANZANIA

Freda Mwalyego
Plant Pathologist
ARI-Uyole
P.O.Box 400.
Mbeya, TANZANIA

Rymond Mghogo, breeder
Head of Crops Department
ARI -Uyole
P.O.Box 400.
Mbeya, TANZANIA

CURRICULUM VITAE

Name:	*JUAN CARLOS ROSAS*
Date/Place of birth:	January 12, 1945. Lima, Peru (Peruvian citizenship)
Family:	Romeri (wife); Carlos, Juan and Alejandra (Children)
Address:	Escuela Agrícola Panamericana/Zamorano, P.O. Box 93, Tegucigalpa, Honduras.
Phones/Fax/Email:	011 (504) 776-6140/ 776-6150 Ext. 2314; Fax: (504) 776-6242
E-Mail:	jcrosas@zamorano.edu

Education (graduate and undergraduate):

Ph.D. (1983) and M.Sc. (1982) degrees in Plant Breeding and Plant Genetics, University of Wisconsin, Madison, U.S.A.

B.S. and I.A. undergraduate degrees (1969) in Agronomy, National Agrarian University, Lima, Peru.

Professional positions held:

1999- To date	Professor, Agricultural Science and Production, Escuela Agricola Panamericana (EAP), Zamorano, Honduras.
1992- 1999	Head, Agronomy Department, EAP, Zamorano, Honduras.
1996-1997	Visiting Professor, Department of Plant Pathology, University of Wisconsin, Madison.
1988-1992	Assistant Head, Department of Agronomy, EAP/Zamorano.
1985-1988	Associate Professor, Department of Agronomy, EAP/Zamorano.
1983-1985	Research Associate, Department of Horticulture, University of Wisconsin.
1979-1983	Research Assistant, Department of Horticulture, University of Wisconsin.
1975-1978	Research Assistant, Soil Microbiology, Bean Program, CIAT, Cali, Colombia.
1972-1973	research Assistant, Agronomy and Physiology, Cassava Program, CIAT, Cali, Colombia.
1970-72; 74	Specialist, Cassava and Sweet Potatoes Program, Research Division, Ministry of Agriculture, Peru.

Teaching experience:

Courses: Plant Breeding (15 years); Agronomy I (8 years); Basic Grain and Industrial Crops (15 years); Applied Biotechnology (5 years); Genetics (5 years).

Textbooks published (in spanish): Principios y Prácticas para la Producción de Cultivos (1991); Principios y Prácticas para el Mejoramiento de Plantas (1992); El Cultivo de la Soya (1993; 1998); El Cultivo del Frijol Común en América Tropical (1998); Principios de Genética y Mejoramiento de Plantas (2002; 2005).

Student advisory: more 60 students at the B.S. degree level (as main advisor on thesis research and on in-service training).

Research experience:

International Projects: Leader of more than 20 research projects funded by the Bean/Cowpea CRSP-USAID, PSTC/USAID, National Academy of Sciences, Profrijol/Swiss Corporation, PRIAG/European Economic Community; Norwegian Development Agency, CIAT, IPGRI, CGIAR and others. Collaborations with more than 15 U.S. and Latin American universities, international centers, and research programs from Central America and the Caribbean.

Societies Membership:

American Society of Agronomy; Crop Science Society of America; Bean Improvement Cooperative Group; Latin American Society of Rhizobiology; Central American Cooperative Improvement of Crops and Animals; and Gamma Sigma Delta.

Common bean cultivar and germplasm releases:

"Tio Canela-75" in Honduras (1996), El Salvador, Nicaragua and Panamá (2000), and Haití (2003); "Bribri" in Costa Rica (2000); "Amadeus 77" in Nicaragua, El Salvador, Honduras and Costa Rica (2003); "Carrizalito" in Honduras and Costa Rica (2003); "Macuzalito" in Honduras (2004); "Palmichal 1" and "Nueva Esperanza 01" in Honduras (2005); "INTA Precoz" in Nicaragua (2005); "CENTA Pipil" in El Salvador (2005); "Gibre", "Curre" and "Tongibe" in Costa Rica (2006); "Cardenal" , DEORHO", "Victoria" and "Don Cristóbal" in Honduras (2007).

Professional Awards:

Certificate of membership in recognition of high scholarship, outstanding achievement or service to Agricultural Science by The Honor Society of Agriculture Gamma Sigma Delta on October 1989.

Distinguished achievement award in recognition of outstanding accomplishments related to bean (*Phaseolus vulgaris*) improvement by the Bean Improvement Cooperative on November 2001.

Language Skills:

Spanish: native; English: excellent; and Portuguese: read and understand well.

Recent publications:

Beaver, J.S., **J.C. Rosas**, J. Myers, J. Acosta, J.D. Kelly, S. Nchimbi-Msolla, R. Misangu, S. Temple, E. Arnaud- Santana and D. P. Coyne. 2003. Contributions of the Bean/Cowpea CRSP to cultivar and germplasm development in common bean. Field Crops Research 82: 87-102.

Graham, P.H., **J.C. Rosas**, C. Estévez de Jensen, E. Peralta, B. Tlusty and J.A. Acosta-Gallegos. 2003. Addressing edaphic constraints to bean production: Bean/Cowpea CRSP perspective. Field Crops Research 82: 179-192.

Frahm, M.A., **J.C. Rosas**, N. Mayek-Pérez, E. López –Salinas, J. A. Acosta-Gallegos and J.D. Kelly. 2003. Resistencia a sequía terminal en frijol negro tropical. Agronomía Mesoamericana 14 (2):143-150.

Frahm, M.A**., J.C. Rosas** and J.D. Kelly. 2003. Drought resistance of black bean evaluated in a lowland tropical environment. Ann. Rep. of the Bean Improv. Coop. 45: 56-57.

Frahm, M.A**., J.C. Rosas** and J. D. Kelly. 2003. Field resistance to *Macrophomina phaseolina* in black bean populations. Ann. Rep. of the Bean Improv. Coop. 45: 148-149.

Rosas, J.C., J.C. Hernández and R. Araya. 2003. Registration of 'Bribri' small red bean (race Mesoamerica). Crop Science 43 (1): 430-431.

Mather, D.L., R. Bernsten, **J.C. Rosas**, A. Viana and D. Escoto. 2003. The economic impact of disease- resistant beans in Honduras. Agricultural Economics 29:343-352.

Mather, D.L., R. Bernsten, **J.C. Rosas**, A. Viana, D. Escoto and J. Martínez. 2003. The impact of bean research in Honduras. Staff paper, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, 34 p.

Rosas, J.C. 2003. Management recommendations for bean crop production. Litocom Press, Tegucigalpa, Honduras, 33 p., 45 illust. (in spanish).

Rosas, J.C., O. Gallardo and J. Jimenez. 2003. Genetic improvement of common beans using participatory approaches in Honduras. Agronomía Mesoamericana 14 (1):1-9. (in spanish).

Rosas, J.C. 2003. Bean Crop in Tropical America. Pan-American Agricultural School, Zamorano, 2nd. edition, Litocom Press, Tegucigalpa, Honduras, 57 p. (in spanish).

Rosas, J.C. 2003. Soybean Crop. Pan-American Agricultural School, Zamorano, 2nd. edition, Litocom Press, Tegucigalpa, Honduras, 56 p. (in spanish).

Frahm, M.A., **J.C. Rosas**, N. Mayek-Pérez, E. López –Salinas, J.A. Acosta-Gallegos and J.D. Kelly. 2004. Breeding beans for resistance to terminal drought in the lowland tropics. Euphytica 136:223-232.

Rosas, J.C., J. S. Beaver, S. Beebe and A. Viana. 2004. Names of bean varieties released in Central America and the Caribbean. Ann. Rep. of the Bean Improv. Coop. 47:329-330.

Rosas, J.C., J. S. Beaver, S. Beebe and A. Viana. 2004. Nomenclature of bean varieties released in Central America and the Caribbean. Agronomia Mesoamericana 15 (2): 221-224 (in Spanish).

Rosas J.C., J. S. Beaver, D. Escoto, C.A. Perez, A. Llano, J.C. Hernandez and R. Araya. 2004. Registration of "Amadeus 77" small red common bean. Crop Sci. 44:1867-1868.

Rosas, J.C. 2004. Genetic Resources of the Genus *Phaseolus* in Honduras. Litocom Press, Tegucigalpa, Honduras, 40 p (in spanish).

Rosas, J.C. 2004. Macuzalito: small red bean variety developed by participatory plant breeding. Tech. Bull., Litocom Press, Tegucigalpa, Honduras, 4p. (in spanish).

Zamora, M. and R. Bernsten. 2004. Evaluation of the demand of beans from El Salvador, Guatemala Honduras and Nicaragua in ethnic communities of the U.S.A. Agronomía Mesoamericana 15 (2): 131-143 (spanish translation by **J.C. Rosas**)

Martinez L., R. Bernsten and M. Zamora. 2004. Market strategies for Central American beans. 2004. Agronomía Mesoamericana 15(2): 121-130 (spanish translation by **J. C. Rosas**).

Ho M. D., **J.C. Rosas**, K.M. Brown and J.P. Lynch. 2005. Root architectural tradeoff for water and phosphorus adquisition. Functional Plant Biology 32:737-748.

Acevedo M., J.R. Steadman, **J.C. Rosas** and J. Venegas. 2005. Characterization of virulence diversity of the bean rust pathogen *Uromyces appendiculatus* in wild bean populations as a tool for effective resistance gene deployment. Ann. Rep. of the Bean Improv. Coop. 48:132-133.

Gonzalez-Martinez N., F.H. Fewerda, M. Alameda, **J.C. Rosas** and J.S Beaver. 2005. Identification of new sources of resistance to web blight of common bean. . Ann. Rep. of the Bean Improv. Coop. 48: 130-131.

Rosas J.C., O. Gallardo and J. Jiménez. 2006. Mejoramiento de maíces criollos de Honduras utilizando metodologías de fitomejoramiento participativo. Agron. Mesoamericana 17(3):375-383.

Porch, T., R. Bernsten, **J.C. Rosas** and M. Jahn. 2007. Climatic change and common bean production on the North Coast of Honduras. J. Agric. Univ. Puerto Rico (accepted for publication).

Porch, T., R. Bernsten, **J.C. Rosas** and M. Jahn. 2007. Cost benefit analysis of the introduction of heat tolerant bean varieties in Atlantida, Honduras. Ann. Rep. of the Bean Improv. Coop. 50: 199-200.

CURICULUM VITAE
of
Soares Almeida Xerinda

June, 2007

1. Identidade

1.1. Date of birth	August 15, 1966
1.2. Place of birth	Manhiça - Maputo
1.3. Nationality	Mozambican
1.4. Marital status	Maried
1.5. Identification Document	090009124G, Maputo, 30/01/2006

2. Contacts

Soares Almeida Xerinda
Centro Zonal Sul – Estação Agrária de Chókwe, Postal Box Nr. 26. Chókwe-Gaza.
Celular: 82-3030757; E-mails: sax100@psu.edu, or soaxer@hotmail.com

3. Formal Academic Education

2006: Finalized all course requerements and passed Candidacy Examination for PhD at Pennsylvania State University (U.S.A), now in Mozambique doing two years field research work. Plan to present the PhD Seminar and graduate in 2009. The title of the dissertation is 'The impact of Phosphorus efficient common bean genotypes on agro-ecosystem productivity and sustainability'. The research work has 3 projects, evaluating P efficients genotypes impact on nutrient cycling and erosion, biological nitrogen fixation and how the P efficient common bean genotypes affect intercropped crops like maize. Contributor at roots.psu.edu where posted a method for root crown sampling, processing and evaluation, developed as part of methodologies for the PhD research projects.

2004: Graduated as *Master of Science in Soil and Water Management at the Department of Agronomy and Horticulture at the University of Nebraska-Lincoln* (E.U.A). The main course work subjects included soil fertility evaluation and management, Irrigation Systems Management, microclimate and biological environment, microclimates establishment, GIS – Geografic Information Systems for different utilities including land use planning, route analysis, fire plans and management, urbanization, and others. The MSc thesis was 'Stater fertilizer efects on maize and sorghum in the eastern Nebraska' under rainfed and irrigated conditions (USA). The work consisted of 22 on-farm trials and was conducted in 2002 and 2003.

1997: Graduated as BSc. with thesis on '*Rural Engeneering and Mechanization' at the Department of Agronomy at 'Universidade Eduardo Mondlane' (Mozambique)*. The main subjects were: irrigation and drainage, Hydraulic, topography, Soil Science, management of machinery, agriculture mecanization, agriculture economics, rural constructions, management and planning.

1995: Graduated at High School (11ª classe) at 'Escola Secundária Francisco Manyanga' in Maputo - Mozambique.

5. Professional Experience

1997-2007: Employee – Researcher in Soil and Water Management and Consevation, based at Estação Agrária do Chókwe of IIAM – Institute of Agriculture Research of Mozambique. Planned and implemented various research trials and specialized studies; is team member for technology transfer to beneficiaries and extension officers at irrigation systems built by SSIP – Small Scale Irrigation Project, and participated in elaboration of technology packages for irrigated/intensive farming, training of extensionists in subjects of water management, operation and maintenance of irrigation infra-structure and equipment, installed water management on-farm demonstrations for water and soils management for commercial crops. Was trainer/facilitator of extension officers working with SSIP beneficiaries for the topic of Water Management and Conservation, also elaborated a take-home manual for the trainees.

2005 e 2007: 'Team Leader' for field implementation of CP1 Project 'CP1 = Challenge Program Water for Food' for increased water productivity in grain crops through better crops/varieties, water/moisture conservation, and soil fertility best bet technologies. This project is taking place in Mozambique, South África and Zimbabwe. The Mozambican component has field trials at the districts of Bilene, Mabalane and Chókwe.

2007: Evaluated the performance of 12 Irrigation Systems built by SSIP (Small Scale Irrigation Project) in Maputo, Sofala and Zambézia provinces; based on the results of the evaluation as well as on consultation with beneficiaries, will determine the training needs for extension officers and direct beneficiaries of SSIP to ensure sustainability.

2001: Designed, did field work (topography and implantation) of small irrigation system in Macarretane, funded by Help Age International for the 'Associação Ucocha - Chókwe'. Aditionally, the contract included the planning of intensive agriculture production of horticulture crops and banana, and was established a demo banana field with a plot for plant multiplication to feed the gradual expansion of banana plantation.

1995-1996: Worked for Intermon Project (Spanish NGO) funded by Spanish Cooperation which had development activities in Matutuine. I was responsible for Agriculture and Livestock Development, and Credits Unit. Designed and implemented, including procurement, five (5) small irrigation systems for farmers' Associations to produce horticulture crops. The equipment were pumping stations and inputs which were supplied to farmers on credit basis, in sustainable fashion and credit service we developed is still operating successfully, now (12 years after the end of Intermon Project) with more than 2000 beneficiaries.

1994-1995: Worked for former-INDER (Institute for Rural Development of Mozambique) as Mozambican conterpart in 'Projecto Francês' for Intensification of Agriculture production in Chókwe Irrigation Schem with emphasis on reinforcement

capacity of farmers Association in Chókwe Irrigation Scheme (~30.000 ha). The project was funded by French Cooperation Agency.

4. Courses attended, on-job training

2000 (Israel, 1 month): Water and Soil management and conservation, and Crops productivity in Semi-Arid and Arid Zones.
2001 (Brasil-Embrapa Semiárido, 1 month): Water Management for crop production in Semi-Arid Environments, with design of rain water caption, colection, and storage sistems; alternatives for exploring the potential of natural resources, conservation of pasture for animals and crops adapted to semi-arid areas.
2003 (Nebraska, USA - University of Lincoln Nebraska, 3 days): Sucessful Grants Writing.
2005 (Ghana 2 times, 2 weeks): (1) Crop modeling using DSSAT model to simulate the impact variables on water availability and soil fertility gradients on biomas and grain yield;
(2) Participatory integrated soils management using the NUTMON Model – simple package modifiable on Excel, to evaluate the impact of different soil management strategies on crop yield.
2007 (Maputo, IIAM): Writting of 'Concept Notes' in Grant Project Proposals.

6. Recent publications

Xerinda, S. 2005. Avaliação e Mapeamento Aptidão de Solos da Província de Gaza para Agricultura de Sequeiro. Estação Agrária de Chókwe.

Wortmann, C., S. Xerinda, and C. Shapiro. 2006. Starter fertilizer efect on no-till corn (*Zea mays*) under rainfed and irrigated conditions in Eastern Nebraska. American Society of Agronomy.

Wortmann, C., S. Xerinda, and M. Mamo. 2006. Starter fertilizer efect on no-till grain sorghum (*Sorghum bicolor*) under rainfed and irrigated conditions in Eastern Nebraska. American Society of Agronomy
Wortmann, C., S. Xerinda, and M. Mamo. 2006. Sorghum Atlas for 5 Eastern Africa Countries. (http://supersorghum.org)

Xerinda, S. 2006. Root crowns sampling and evaluation. Published in roots.psu.edu

7. Informátic/computers and softwares knowledge for research

- Windows e Mcintosh: Microsoft Word, Microsoft Excel e powerpoint
- Statistical Packages: SAS, MSTATC e STATISTIX
- Have used Cropwat and AUTOCAD for irrigation systems design

8. Languages

Portuguse: read, write and speak fluently.
English: read, write and speak fluently.
Changana e Ronga: read, write and speak fluently.
Espanhol: read fluently, and understand when spoken.
Xitswa: understand when spoken, and speak sufficient for communication.

REPUBLICA DE MOItAMBIQUE

MINISTERIODA AGRICULTURA

INSTITUTO DE INVESTIGAcAO AGRARIA DE MOQAMBIQUE (IIAM)
GABINETE DO DIRECTOR GERAL
Tel: 21 462 241 Faz: 21 461 581

Date: November 22, 2007

To: Dr. Irvin E. Widders, Director
Dry Grain Pulses CRSP
321 Agriculture Hall
Michigan State University
East Lansing, Michigan USA 48824

Subject: Letter of Willingness for Collaborative Research and Training

This letter is to confirm the willingness of the Agricultural Research Institute of Mozambique, to collaborate in the proposed research, capacity building and/or outreach project entitled: "Improving bean production in the drought-prone, low fertility soils of Africa and Latin America - an integrated approach" that is being submitted as a proposal by Dr. Jonathan Lynch of the Pennsylvania State University for consideration for funding through the Dry Grain Pulses CRSP.

The focus of the activities in this proposal is an area of priority for our institution. The proposed research/outreach approach and training needs have been adequately discussed with several colleagues at HAM and Mr. Magalhaes Miguel, plant physiologist, who will serve as the Host Country (HC) Principal Investigator (PI) on the subcontract project if funded.

Therefore, the proposed project represents a high priority of our institution, since it will contribute to the fulfillment of research and training programs of the institution.

HC-institution: Instituto de InvestigagAo Agraria de Mocambique, IIAMMozambique.

Best Regards,

Dr. Calisto Bias

I Director General

ZAMORANO

November 16, 2007

Dr. Irvin E. Widders, Director
Dry Grain Pulses CRSP
321 Agriculture Hall
Michigan State University
East Lansing, Michigan USA 48824

Dear Dr. Widders:

This letter is to confirm the willingness of the Escuela Agricola Panamericana/Zamorano to collaborate in the proposed research, capacity building and/or outreach project entitled "Improving bean production in drought-prone, low fertility soils of Africa and Latin America- an integrated approach" that is being submitted as a proposal by Dr. Jonathan P. Lynch of the Pennsylvania State University for consideration for funding through the Dry Grain Pulses CRSP.

The focus of the activities in this proposal is an area of priority for our institution. The proposed research/outreach approach and training needs have been adequately discussed and approved by Dr. Juan Carlos Rosas who has agreed to serve as the Host Country (HC) Principal Investigator (PI) on the subcontracted project if funded.

Respectfully,

ESCUELA AGRICOLA PANAMERICANA LABOR OMNIA VINCIT TEGUCIGALPA, HONDURAS, C. A. COORDINATURA ACADEMICA

Raúl Espinal, Academic Dean

Juan Carlos Rosas, HC-PI

HC- Institution: Escuela Agrícola Panamericana/Zamorano, Honduras

Apartado postal 93 Tegucigalpa, Honduras, América Central
PBX: (504) 776-6140 / 50

ESCUELA AGRÍCOLA PANAMERICANA
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Fax:(703) 991-8101

USAID MISSI ɔN-MOZAMBIQUE

To: Dr. Irvin E. Widders, Director Dry G ain Pulses CRSP
321 Agriculture Hall Michigan State Univ ersity
East Lansing, Michigan USA 48824

From: Elsa Mapilele
Rural enterprise Advisor
USAD Mission-Mozambique
Email: emapilele@usaid.org
Maputo,
Mozambique

DATE: November 28, 2007

Subject: Letter ɔf Endorsement/Support

This letter is to support the collaborative re earch project entitled: "Improving bean production in the drought-prone, low fertility soils of Afr ca and Latin America - an integrated approach" that is being submitted as a proposal by Dr. Jon than Lynch of the Pennsylvania State University for consideration for funding through the Dry (rain Pulses CRSP.

In Mozambique, this project will be in plemented by researchers at Agricultural Research Institute of Mozambique, IIAM, who rece ıtly completed their MS training in the USA funded by USAID through Intsormil CRSP, and they returned to their positions after the completion of the training program. This collaborative r search proposal is an opportunity to continuing USAID/Mozambique effort for capacity b ilding, and an opportunity for application of acquired knowledge for the benefit of the country through applied agricultural research and technology generation and dissemination to the smal scale farmers, who is in need to increase their crop production and productivity, and represent the majority of the population in Mozambique.

We believe that by having this project ap roved and implemented, it will represent an extension of the USAID Mission effort behind the training of IIAM scientists, bringing more beneficial impact from the investment made by US AID/Mozambique in training these young agricultural scientists.

Therefore, we fully support and endorse t ıe research and training project being submitted by Dr. Jonathan Lynch, from Penn State, and we look forward to working together through our ongoing COMPETE grant research projects.

Best Regards,

Elsa Mapilele

Elsa Mapilele

Gobierno de Reconciliación
y Unidad Nacional

El Pueblo, Presidente!

NICARAGUA TRIUNFA!

Instituto Nicaragüense de Tecnología Agropecuaria INTA

Managua, 26 de Noviembre del 2007.

Doctor
Jonathan Lynch
Penn State
102 Tyson Building
University Park, PA, 16802
814-863-2256

Estimado Dr. Lynch:

El Instituto Nicaraguense de Tecnología Agropecuaria INTA de Nicaragua, esta de acuerdo en participar en conjunto con PSU en el proyecto "Improving bean production in drought-prone, low fertility soils of Africa and Latin America - an integrated approach", para seguir estas actividades bajo el nuevo 'Dry Grain Pulse CRSP' que comenzara en 2008. Como parte de este proyecto, INTA considera importante y esta de acuerdo con incluir actividades de capacitación de agrónomos de INTA en las áreas de fitonutrición y tolerancia a sequía en fríjol común, uno en el 2009 y uno en el 2010, siempre que todos los gastos estén cubiertos por PSU, incluyendo los boletos aéreos.

Atentamente

Dirección General
Instituto Nicaragüense de Tecnología Agropecuaria
"INTA"

Marta J. Matus López
Directora General en Funciones

SOUTHERN AFRICA BEAN RESEARCH NETWORK (SABRN)
Chitedze Agricultural Research Station
P.O. Box 158, Lilongwe, Malawi.
Tel. (265) 9-962851; Fax. (265) 1-707278; email: rchirwa@malawi.net **or** r.chirwa@cgiar.org

November 19, 2007

Dr. Irvin E. Widders, Director
Dry Grain Pulses CRSP
321 Agriculture Hall
Michigan State University
East Lansing, Michigan USA 48824

Dear Dr. Widders,

HOST COUNTRY INSTITUTIONAL WILLINGNESS TO PARTNER IN A DRY GRAIN PULSES CRSP PROJECT

This letter is to confirm the willingness of Dr. Rowland M Chirwa to collaborate in the proposed research, capacity building and/or outreach project entitled (Dry Grain Pulses CRSP Project) that is being submitted as a Proposal by Dr. Jonathan Lynch of Penn State University for consideration for funding through the Dry Grain Pulses CRSP. The focus of the activities in this proposal is an area of priority for our institution. The proposed research/outreach approach and training needs have been adequately discussed and approved by Dr Rowland M Chirwa who has agreed to serve as the Host Country (HC) Principal Investigator (PI) on the subcontracted project if funded.

Respectfully,

___Mrs Ella Ngondo_____
(*Typed Name of Authorized Administrator of Host Country Institution*)

_____
(*Signature of HC Administrator*)

_Dr. Rowland M Chirwa_____
(*Typed Name of Host Country PI*)

_____
(*Signature of HC PI*)

CIAT-Southern Africa Bean Research Network

_____
(*Name of Host Country Institution*)

World Vision

OVATA
Av.da República
Talhão N° 90
Telefone n° 04910218
Fax n° 04910214
Gurúè-Sede

ZAMBÉZIA

Date: November 27, 2007

To: Dr. Irvin E. Widders, Director
Dry Grain Pulses CRSP
321 Agriculture Hall
Michigan State University
East Lansing, Michigan USA 48824

Subject: Letter of Willingness for Collaborative Research and Training

This letter is to confirm the willingness of the Agricultural Research Institute of Mozambique, to collaborate in the proposed research, capacity building and/or outreach project entitled: "Improving bean production in the drought-prone, low fertility soils of Africa and Latin America - an integrated approach" that is being submitted as a proposal by Dr. Jonathan Lynch of the Pennsylvania State University for consideration for funding through the Dry Grain Pulses CRSP.

The focus of the activities in this proposal is an area of priority for our agricultural development program especially in the bean producing districts of Upper Zambezia. World Vision is therefore willing to be a field collaborator in this respect, in a similar manner as we have been doing with IIAM. Our Mozambican district coordinators, who are experienced agronomists, will be available to work directly with the project through IIAM. Since we have limited budget (USAID), WV can not guarantee additional expenditures for the collaborative activities in the project. The proposed research/outreach approach and training needs have been discussed with my colleague at the provincial level.

The identification of drought and low P bean varieties is a timely scientific activity in our areas, as it presents a hope for numerous farmers who can benefit through increased yields at low costs from their traditional cash crop. We hope we can contribute more to the project during its implementation through this proposed collaboration.

Best Regards,

Patricio Agustin
WV-Ovata Project Northern Area Coordinator,
Gurue, Zambezia

World Vision
OVATA-NORTE
AGRICULTURA

USAID | MOZAMBIQUE
FROM THE AMERICAN PEOPLE

November 27, 2007

Dr. Irvin E. Widders, Director
Dry Grain Pulses CRSP
321 Agriculture Hall
Michigan State University
East Lansing, Michigan USA 48824

Subject: Letter of Endorsement/Support

Dear Dr. Widders,

The purpose of this letter is to express USAID/Mozambique's support for the collaborative research project entitled: "**Improving bean production in the drought-prone, low fertility soils of Africa and Latin America - an integrated approach"** that is being submitted as a proposal by Dr. Jonathan Lynch of the Pennsylvania State University for consideration for funding through the Dry Grain Pulses CRSP.

In Mozambique, this project will be implemented by researchers at Agricultural Research Institute of Mozambique, IIAM, who recently completed their MS training in the USA funded by USAID through Intsormil CRSP. These scientists returned to the research institute after the completion of the training programs and are engage on the Mozambican portion of this proposal. This collaborative research proposal is an opportunity to continue USAID/Mozambique's capacity building efforts as well as to apply agricultural research and technology generation and dissemination methodologies to the small scale farmers who represent the majority of the agricultural producers in Mozambique and who desperately need to increase their crop production and productivity.

We believe that approval and implementation of this project proposal will enhance the pay off of USAID/Mozambique's investments in training and bring beneficial impacts to agricultural sector development in Mozambique. As such, we fully support and endorse the research and training project being submitted by Dr. Jonathan Lynch, from Penn State. In addition, we believe that this CRSP-funded research is an important complement to the USAID-funded applied research being conducted under the COMPETE grant research program.

Sincerely,

Christine de Voest
Private Enterprise Officer
Rural Incomes Team

U.S. Agency for International Development
JAT Complex
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P.O.Box 783
Maputo, Mozambique

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