Horticulture Collaborative Research Support Program

Annual Report 2010-2011

Horticulture CRSP Annual Report 2011

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Introduction from the Director

Ronald E. Voss

In 2009, the United States Agency for International Development (USAID) initiated and funded Horticulture CRSP as the ninth active Collaborative Research Support Program. Horticulture CRSP is the U.S. Government's response to an internationally conducted Global Horticulture Assessment. Implementation and management of the Horticulture CRSP was awarded to the University of California, Davis, in partnership with Cornell University, University of Hawaii at Manoa and North Carolina State University.

The USAID Collaborative Research Support Programs (CRSPs) are unique in that they have a strong research component and they emphasize human and institutional capacity building. Both are foundational components for communities and countries to become self-sufficient in the development, delivery and implementation of horticulture information and technologies. Thus, all Horticulture CRSP projects conduct adaptive research in local communities with local and national collaboration and leadership. All projects include training of graduate students, scientists, academics, and local leaders. In 2011, Horticulture CRSP aligned all of its projects to fit the Feed the Future focus countries and with USAID Mission focus geographic areas.

The purpose of Horticulture CRSP is to reduce poverty and hunger of the rural poor in developing countries through horticulture. Horticulture has the capability to facilitate a diverse cropping system, provide healthy and nutritious food, and to generate increased opportunity for income to smallholder farmers. Based on the themes of Innovative Technology, Gender Equity, Access to Information, and Building Local Human and Institutional Capacity, the Horticulture CRSP Management Entity designed and developed a program that utilizes existing technologies and expertise throughout the U.S. land-grant university system. Horticulture CRSP also is committed to continuing the development of additional innovative technologies, with the criteria that they are effective, affordable, and sustainable.

Production of horticultural crops can provide several benefits for smallholder farmers, especially for women who are the primary producers of these commodities. Benefits include improved nutrition for children and families, increased income from sale of horticulture products, and improved status and confidence of women farmers. In many cases, horticulture can generate substantial income from smallholdings that would not be profitable if planted only to cereal crop staples. In addition, women typically use the income generated from horticulture to invest in family health and education, which multiplies the benefits by increasing social capital.

Horticulture CRSP has now completed its first two years of addressing hunger and poverty among smallholder farmers in priority developing countries. This marks the transition from 15 one-year Immediate Impact Projects to a broader portfolio of 10 one-year Exploratory Projects, five three-year Pilot Projects, and 10 six-month Trellis Fund Projects. As we enter the third year, Horticulture CRSP has also funded two three-year Comprehensive Projects and will be funding three three-year Focus Projects and two three-year Special Projects, up to 15 Trellis Fund Projects and three Horticulture CRSP Regional Centers of Innovation. All of these projects and centers are aimed at developing and adapting research-based technologies and information that will address income and nutrition issues of smallholder farmers. All of these projects include institutional and human capacity building components so the efforts can be sustained through on-going, locally-led educational programs. Each of these types of projects has unique scopes of program activities, however, and illustrates both the breadth and depth of approaches necessary to effectively and

efficiently address our goals and priorities with limited resources, but with access to the vast U.S. public university and in-country scientific and educational resources.

Through the first two years, Horticulture CRSP has funded 15 U.S. universities and through them, 125 in-country researchers and local collaborators in 34 countries. Collectively, they have tested and implemented a range of novel technologies and interventions, all of which are directly related to reducing the constraints to improved profitability and production of horticultural commodities in Feed the Future countries.

The components of this Horticulture CRSP Annual Report will provide additional information on each of the groups of projects, the linkages between these projects and smallholder farmers, and the most significant outcomes of these projects.

While a large quantity of readily adaptable horticulture research knowledge and technology already exists to solve poverty, nutrition and health issues of the smallholder farmers of the developing world, new technologies and educational methodologies are also needed. Strong, dedicated leadership by many individuals and institutions is also needed to implement the large number of projects, in a large number of countries, and to engage a large number of U.S. researchers and in-country institutions and organizations. The Horticulture CRSP Management Entity at UC Davis consists of several academic horticulturists with a commitment to international horticulture, a strong professional programmatic and administrative staff, an enthusiastic group of undergraduate and graduate students, and strong support from the College of Agricultural and Environmental Sciences and the Plant Sciences Department. Leadership and support has been received from USAID technical representatives in Washington, D.C. Active and supportive guidance has been provided by Horticulture CRSP's International Advisory Board which brings a truly worldwide representation of development, academic, and private sector institutions and organizations. The project Principal Investigators and their in-country Co-Principal Investigators are the true on-the-ground Horticulture CRSP leaders. Each of these individuals and groups has made significant contributions to the success and impact of Horticulture CRSP.

I extend my personal thanks to everyone who is a part of the Horticulture CRSP family, and to those who will become part of the Horticulture CRSP family. I have been honored to be a part of the beginning of an exciting program that is already impacting many small farmers and their communities, and that promises to have much greater impacts in the future. I will be retiring as Director of Horticulture CRSP at the end of 2011 and extend my best wishes to incoming Director, Dr. Elizabeth Mitcham, who has already demonstrated her unique effectiveness by serving as Horticulture CRSP Program Leader and Horticulture CRSP Associate Director since its inception.

HORTICULTURE CRSP IMPACTS

30 projects continued through 2010 and 2011

15 university project partners

- Bridgewater State University
- Colorado State University
- Cornell University
- Michigan State University
- North Carolina State University
- Purdue University
- Rutgers, The State University of New Jersey
- Tennessee State University
- The Ohio State University
- The Pennsylvania State University
- Tuskegee University
- University of California, Davis
- University of Florida
- University of Hawai'i at Manoa
- University of Wisconsin, Madison

34 countries served

Africa: Benin, Democratic Republic of the Congo, Gabon, Ghana, Kenya, Malawi, Nigeria, Rwanda, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe

Latin America: Bolivia, Chile, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, and Peru

South and Southeast Asia: Bangladesh, Cambodia, India, Laos, Nepal, Sri Lanka, Thailand, and Vietnam

2,746 people trained (47% women)
2,547 rural households reached
186 new technologies under research

Program Highlights

- Trained professionals in Sub-Saharan Africa in postharvest practices, so they can serve as regional postharvest experts and trainers
- Developed and tested low-cost pest exclusion nets for small-scale vegetable growers in Benin and Kenya
- Initiated women-led agribusinesses to market disease resistant tomato and pepper seeds in Central America
- Applied participatory market chain analysis to a farmer field school model to produce and market crops in Uganda
- Educated growers in production, postharvest, food safety and marketing in Vietnam and Cambodia
- Established a South Asia consortium on food safety to improve public health, encourage export opportunities, and increase smallholder profits
- Evaluated extension programs and postharvest capacity in Cambodia and Vietnam
- Trained urban and peri-urban growers in cropping systems in Thailand, Cambodia, and Vietnam
- Strengthened indigenous informal seed networks in Southeast Asia
- Used geographic information systems (GIS) to identify horticultural production and market opportunities in Malawi
- Employed a novel gender-based extension model to more effectively train farmers in Kenya
- Educated smallholder vegetable farmers in grafting and microclimate management in Kenya

- Surveyed extension methodology in Central and South America
- Evaluated cell phone enabled agro-advisory services in South Asia
- Evaluated the support structure for production and marketing of tomatoes and paprika in Zimbabwe
- Explored potential for cut flowers export from Honduras using existing fruit exporters and improved storage technology
- Increased consumer awareness of the nutritional and cultural importance of orange-fleshed sweet potato to increase food security, nutrient intake, and incomes in Ghana
- Improved techniques to dry and store seeds where temperature and average relative humidity are problematic in India, Nepal, and Thailand using available resources
- Identified food and plant safety problems in tomato in Nigeria and developed a good agricultural practices (GAPs) education system and transfer to farmers
- Determined the effectiveness of different coatings and essential oils in controlling postharvest disease and maintaining fruit quality of mango and papaya in Sri Lanka
- Increased access to fair trade and other markets for Rooibos tea farmers in South Africa
- Used solar power and improved cooling systems to create storage cool rooms and transport where electricity and infrastructure are limited in India, Uganda, and Honduras
- Deployed rapid diagnostic tools to detect *Phytophthora* disease on horticultural crops in El Salvador, Guatemala, Honduras, Nicaragua, Costa Rica, Panama, and Mexico
- Trained bell pepper farmers in current and best management practices to improve production and postharvest quality in Nicaragua, Haiti, Honduras, Dominican Republic, and Costa Rica
- Introduced and evaluated appropriate and disease resistant vegetable varieties in El Salvador, Honduras, and Nicaragua
- Increased the production base of important indigenous spices, medicinal plants and horticultural crops and provided employment and income to farmers from Ghana
- Helped farmers in Zambia produce consistent vegetable crops to market to hotels and other tourist-serving industries
- Established greater production and use of indigenous vegetables that in the long-term will provide a source of food for economic security and improved nutrition for Kenyans
- Developed a concentrated solar drying unit for mango and tomato in Tanzania

Horticulture CRSP and the Feed the Future Initiative

In 2011, the U.S. Government continued the Feed the Future initiative on global hunger and food security. By targeting regions within 20 focus countries and focusing on women's empowerment, diet quality and diversification, postharvest and infrastructure, high quality inputs and financial services, Feed the Future programing aims to increase agricultural production and incomes of the rural poor.

Horticulture CRSP contributes to the Feed the Future initiative in several ways. In 2011, Horticulture CRSP projects were refocused on the Feed the Future focus countries, especially those that had identified horticultural crops as priority commodities. Horticulture CRSP increased the number of partners in these countries and devoted larger amounts of money to projects in those countries.

In addition, Horticulture CRSP's priorities naturally fall within the Feed the Future initiative because:

- Improving horticultural crop production empowers women by giving them access to increased income.
- Enhancing household horticultural production improves local diets by increasing access to horticultural foods that are rich in micronutrients.
- Decreasing food losses after harvest creates stronger value chains and gives smallholders greater access to markets.
- Building capacity of local agribusinesses, processors, extension educators, and agricultural researchers ensures that horticultural improvements are long-lasting and sustainable.

The work of Horticulture CRSP impacts women and children in 14 of the 20 Feed the Future priority countries. Our work in these countries ranges from enhancing seed systems to developing safe harvest and storage strategies that work in smallholder production situations. By working along the entire horticultural value chain and building capacity through trainings and improved technologies, Horticulture CRSP contributes to the efforts of the U.S. Government.

Leadership and International Advisory Board

Horticulture CRSP is managed by a diverse team of individuals with skills ranging from production to postharvest.

- Ronald E. Voss, Director
- Elizabeth J. Mitcham, Associate Director
- Mark A. Bell, Leader of Communications and Information Transfer
- Michael S. Reid, Leader of Implementation of Innovative Technology and Special Projects
- Amanda Crump, Program Evaluation and Gender Equity Coordinator
- Heather Kawakami, Accounting and Fiscal Management
- James E. Hill, Director of International Programs Office

The management team is supported by:

- Diana Puccetti, Office and Event Planning Assistant
- Sabrina Morgan, Accounting and Fiscal Management
- Rachel Abrenilla, International Programs Office
- Paul Marcotte, International Programs Office
- Peter C. Shapland, Graduate Student - International Agricultural Development
- Elana Peach-Fine, Graduate Student - International Agricultural Development
- Kelsey Barale, Graduate Student - International Agricultural Development
- Dylan Owen, Undergraduate Student - Computer Science

International partners encompass all regions and include numerous farmers and leaders beyond the organizations listed below.

Africa

- A to Z Textile Mills International; Tanzania
- Abomey Calavi University; Benin
- Agribusiness in Sustainable Natural African Plant Products; Ghana, South Africa, and Zambia
- Agribusiness Initiative Trust; Uganda
- Agro Farm Services; Kenya
- Ahmadu Bello University; Nigeria
- Association des Personnes Rénovatrices des Technologies Traditionnelles; Benin
- AVRDC, The World Vegetable Center; Tanzania
- Council for Scientific and Industrial Research; Ghana
- Crops Research Institute; Ghana
- Egerton University; Kenya
- Food Research Institute; Ghana
- Ghana PolyTechnic Institutes; Ghana
- icipe; Kenya
- INRAB; Benin
- International Institute of Tropical Agriculture; Benin
- International Relief and Development; Zimbabwe
- Institut des Sciences Agronomiques du Rwanda; Rwanda
- Institut Gabonais d'Appui au Developpement; Gabon
- Kangai Tisa Horticultural Farmers Group; Kenya
- Kenya Agricultural Research Institute; Kenya
- Kigali Independent University; Rwanda

- Kigali Institute of Science and Technology; Rwanda
- Kwame Nkrumah University of Science and Technology; Ghana
- Makerere University; Uganda
- Ministry of Agriculture, Food Security, and Cooperatives; United Republic of Tanzania
- Moi University; Kenya
- Mukono District Council; Uganda
- Mukono Zonal Agricultural Research and Development Institute; Uganda
- Our Lady Queen of Apostles Nkokonjeru Parish; Uganda
- Reach Your Destiny Consult, Ltd.; Uganda
- Rural Agency for Sustainable Development; Uganda
- Sandra Kruger and Associates; South Africa
- Scheut Tshilomba; Democratic Republic of the Congo
- Selasie Farms and Groceries; Ghana
- South Eastern University College; Kenya
- Stellenbosch University; South Africa
- Uganda Christian University; Uganda
- Umatara PolyTechnic; Rwanda
- University of Cape Coast; Ghana
- University of Ghana; Ghana
- University of the Western Cape; South Africa
- World Relief; Malawi

Europe and United States

- Auburn University; United States
- Bent Creek Institute, The North Carolina Arboretum; United States
- CIRAD; France
- Michigan State University; United States
- NovaFlora, Inc.; United States
- Plant Research International; The Netherlands
- Store It Cold, LLC; United States
- University of Georgia; United States
- World Food Logistics Organization; United States

Latin America

- CARE; El Salvador
- Centro de Investigación Agropecuaria San Antonio; Nicaragua
- City Council Chillan; Chile
- Corporación Dinant; Honduras
- Universidad de la República; Uruguay
- Fundación Hondureña de Investigación Agricola; Honduras
- Instituto Dominicano de Investigaciones Agropecuarias y Forestales; Dominican Republic
- Project Haiti WINNER; Haiti
- Universidad de Costa Rica; Costa Rica
- Universidad de La Molina; Peru
- Universidad de San Carlos; Guatemala
- Universidad Mayor de San Simón; Bolivia
- Universidad Nacional Agraria; Nicaragua

- Universidad Tecnológica América; Ecuador
- University of Concepcion; Chile
- Zamorano University; Honduras

South and Southeast Asia

- Acharya N G Ranga Agricultural University; India
- Asian Institute of Technology; Thailand
- Amity International Centre for Postharvest Technology and Cold Chain management; India
- AVRDC, The World Vegetable Center; Taiwan
- Bangladesh Agriculture Research Institute; Bangladesh
- ECHO Asia Regional Office; Thailand
- Hanoi University for Agriculture; Vietnam
- Industrial Technology Institute; Sri Lanka
- International Horticulture Innovation and Training Center; India
- Kasetsart University; Thailand
- Link Natural Products Pvt. Ltd.; Sri Lanka
- Maejo University; Thailand
- Nepal Agricultural Research Council; Nepal
- Nong Lam University; Vietnam
- Punjab Agricultural University; India
- Rhino Research; Thailand
- Royal University of Agriculture; Cambodia
- Sathguru Management Consultants, Pvt. Ltd.; India
- TATA Consultancy Services; India

The International Advisory Board is the senior advisory council of Horticulture CRSP. The purpose and role of the Horticulture CRSP International Advisory Board are to advise the Management Entity on all major aspects of the program, including setting priorities, evaluating sub-award requests for application, implementing technical and management approaches, allocating budget and ensuring that USAID, Global Horticulture Assessment and Horticulture CRSP objectives are met.

The membership of the International Advisory Board ranges from 8 to 12 and is representative of the major geographical regions, Horticulture CRSP partner universities and other U.S. and international universities, international agriculture research centers, and the private sector. The Horticulture CRSP Management Entity and USAID representatives serve as ex officio members. During the first year of the Horticulture CRSP, eight distinguished members of were appointed. Two additional members were appointed in 2011: Dr. Linus Opara, research professor in postharvest technology at the Postharvest Technology Research Laboratory, University of Stellenbosch, South Africa and Dr. Josette Lewis, Director of Agriculture Development for Arcadia Biosciences, Inc., California. Previously, Dr. Lewis served as the Director of Agriculture for USAID.

<u>Members of the International Advisory Board</u>

L. George Wilson, Ph.D., Chair

George Wilson is Professor of Horticultural Science at North Carolina State University. He was the Senior Advisor for University Relations and Agriculture Research, Training and

Outreach in the Office of Agriculture of USAID/Washington and the North Carolina State University Chief of Party for the USAID Agricultural Technology Transformation Project in Peru.

Lusike A. Wasilwa, Ph.D., Vice Chair

Lusike Wasilwa is Assistant Director in charge of the Horticulture and Industrial Crops Division at the Kenya Agriculture Research Institute.

Deborah Pierson Delmer, Ph.D.

Deborah Delmer is a Private Consultant to foundations and government agencies in the areas of plant biotechnology. She is Professor Emeritus in Plant Biology, University of California, Davis; former Program Director for the BREAD program of U.S. National Science Foundation; former Associate Director for Food Security for The Rockefeller Foundation; and former Chair of Plant Biology, University of California, Davis.

Adel A. Kader, Ph.D.

Adel Kader is Professor Emeritus of Postharvest Physiology in the Department of Plant Sciences, University of California, Davis.

Poonpipope Kasemsap, Ph.D.

Poonpipope Kasemsap is Associate Professor of Crop Eco-Physiology, Chair of the Horticulture Department, and Director of the International Studies Center at Kasetsart University in Bangkok, Thailand.

J.D.H. Keatinge, Ph.D.

Dyno Keatinge is the Director General of AVRDC - The World Vegetable Research and Development Center based in Taiwan and Vice-Chairman of the Global Horticultural Initiative.

Josephine (Josette) Lewis, Ph.D.

Josette Lewis served for sixteen years in various roles at the U.S. Agency for International Development, most recently as Director of the Office of Agriculture at USAID. Dr. Lewis recently joined Arcadia Biosciences to advance the company's business and humanitarian partnerships, with an emphasis on overseas and developing countries. Dr. Lewis' academic training is in genetics and molecular biology

Norman E. Looney, Ph.D.

Norman Looney is President of the International Society for Horticultural Science and is Chair of the Board of Directors of the Global Horticulture Initiative.

Linus Opara, PhD

Linus Opara is a Research Professor and Chair of Postharvest Technology at the University of Stellenbosch, South Africa. He also serves as Chair of the International Society for Horticultural Science Section on Root and Tuber Crops and as Editor in Chief of the International Journal of Postharvest Technology and Innovation.

Howard Yana Shapiro, Ph.D.

Dr. Shapiro is Corporate Staff Officer of Plant Science and External Affairs at Mars, Inc. and an Adjunct Professor in the Department of Plant Sciences at University of California, Davis.

Ex officio members of the International Advisory Board include Jim Yazman and John Bowman, who are also the USAID Administrative Officer's Technical Representatives to Horticulture CRSP.

The board met immediately following the 2011 Horticulture CRSP annual meeting, which was held at UC Davis in April 2011. The board offered critiques and provided suggestions on future directions. Areas of specific interest to the board, with corresponding recommendations, included:

1. Accurate and complete baseline information to facilitate assessment of project impacts,
2. Re-define the Regional Centers of Excellence as demonstration and training centers to showcase successful technologies,
3. Focus on fewer subject matter areas and fewer projects with clear accomplishment goals,
4. Identify the best among the 30 current projects and fund them further,
5. Reserve some funds for discrete technology transfer programs,
6. Create at least one signature project during the next three years,
7. Be an important Feed the Future program by building on new technologies, strengthening partnerships, and developing strong activities around institutional and human capacity building.

The board Chair, George Wilson, and others represented Horticulture CRSP at numerous international events during the year, ranging from attending meetings with USAID Mission staff and workshops organized by FAO, CGIAR, and other international organizations, to making formal presentations at professional society conferences. Chair Wilson has also participated in the Horticulture CRSP Management Entity weekly staff meetings and thus provided a consistent presence of board guidance and experience.

The dedication, experience and guidance provided by the board provides important leadership as a partner with the Horticulture CRSP Management Entity and the Horticulture CRSP team of project collaborators in our collective effort to reduce poverty and hunger among rural smallholder farmers and households. The board’s efforts are greatly valued and appreciated.

Regional Activities and Benefits

Africa

Horticulture CRSP's worldwide efforts included 16 projects with activities in Africa. Projects worked on issues throughout the value chain ranging from greenhouse seedling production in Zambia to developing a Good Agricultural Practices manual for tomato growers in Nigeria. Notable activities included:

1. perfecting the design of an improved solar dryer for use in cloudy climates,
2. training a cohort of African postharvest specialists in advanced postharvest technologies,
3. developing an acceptable weaning food that includes nutrient-rich orange-fleshed sweet potato puree,
4. refining grafting and microclimate management for smallholder fruit and vegetable production,
5. conducting a survey of tomato food safety issues and development of Good Agricultural Practices associated with problems found,
6. training agriculturalists on GIS systems that can improve planting and harvest considerations,
7. increasing market access for Rooibos farmers through alternative and fair trade markets,
8. testing small solar-powered cool rooms ,
9. using a Farmer Field School approach to improve local nutrition,
10. testing nets that modify crop microclimate and exclude insect pests,
11. working with farmers to open export markets for horticultural crops,
12. accessing the tourism industry to open new domestic markets for fruits and vegetables,
13. empowering women's groups through new extension methodologies,
14. engaging players in the entire market chain through Participatory Market Chain Analysis to improve production and market access for remote farmers,
15. promoting the status and production of indigenous African leafy vegetables that are high in nutrition, and
16. evaluating the market potential of fruit and vegetable crops in some of Africa's poorest countries.

Latin America

In Latin America, seven Horticulture CRSP projects expanded production efforts while evaluating new markets, new storage practices, and better extension methods. Horticulture CRSP collaborators were able to:

1. test potential export processes for cut flowers from Honduras to the United States,
2. teach rapid disease detection methods to plant diagnosticians,
3. conduct regional workshops and establish regional networks on using protective structures to improve production of perishable vegetables,
4. evaluate current food safety extension education capabilities,
5. develop women-led agribusinesses that grow improved seed,
6. use innovative technologies to cool crops inexpensively, and
7. test vegetable varieties and encourage the adoption of new varieties and crops.

South and Southeast Asia

Nine Horticulture CRSP projects had activities in Asia. Many of these projects focus on postharvest and food safety. In the past year, Horticulture CRSP added activities in peri-urban gardening and indigenous crop evaluation to our Asian projects portfolio. These projects:

1. used commonly found materials and novel drying techniques to develop better seed drying and storage,
2. evaluated the use of cell phone-based agro-advisory services,
3. created niche markets for vegetables handled and grown under improved food safety practices,
4. catalogued indigenous vegetables and created a system of seed exchange among rural farmers and gatherers,
5. trained urban and peri-urban gardeners on improved practices,
6. assessed the capacity of postharvest specialists,
7. created a consortium on food safety,
8. determined the effectiveness of different coatings in controlling postharvest disease of mango and papaya, and
9. introduced improved cool rooms and cool transport for small-scale farmers.

Section Two - Themes

Information Access

Mark A. Bell, Leader of Communications and Information Transfer
Amanda Crump, Program Evaluation and Gender Equity Coordinator
Peter C. Shapland, Graduate Research Assistant
Elana Peach-Fine, Graduate Research Assistant

The information management group of Horticulture CRSP continually reviews its audiences and its approach to better identify information needs and new, improved avenues to better disseminate that information. One of the growing needs is to highlight the importance of horticulture in terms of its contributions to incomes, health, and nutrition. As a result, Horticulture CRSP developed a number of information sheets highlighting the valuable contributions that horticulture can make to improving diets and nutrition – especially for children and lactating women.

The information strategy remains focused on capitalizing on the power of the Internet. Thus, the Horticulture CRSP website remains the core tool for delivering information. The site continues to have a healthy number of regular and new visitors with 7,000 new visits and over 13,000 total visits in the last year. Horticulture CRSP updated the website to make both searching and navigation more intuitive. For example, projects have been consolidated and technical and related promotional information resources grouped. In 2010, the Horticulture CRSP website won the ASHS Outstanding Website Award.

As mentioned above, the basic questions that information providers need to repeatedly ask themselves are "Who is my audience, and what do they need?" To address this question, at least in part, the Horticulture CRSP Management Entity surveyed participants at the 2011 annual meeting. The results were helpful in identifying what that subset of Horticulture CRSP users saw as information priorities (Table 1). Those surveyed ranked training materials as their highest need, followed by stories on "Horticulture impact and success."

Table 1. Ranking of demand for information on a range of topics. (Survey results from participants of the 2011 Horticulture CRSP Annual Meeting.)

Topic	High	Med.	Low
1. Horticulture training materials	87	13	0
2. Horticulture and Horticulture CRSP success stories	79	21	0
3. Horticulture technologies	77	20	3
4. Extension methodology	74	23	3
5. Global horticulture projects by country database	70	30	0
6. Active groups in different countries	70	24	6
7. Market development strategies	63	32	5
8. Policies required for successful horticulture industry development	29	53	18

Other comments from the surveyed audience included:

- Horticulture CRSP management entity should conduct a call for proposals that would utilize the new Horticulture CRSP centers to develop locally-based, socio-culturally relevant and sustainable/scalable programs.
- Horticulture CRSP should focus more on postharvest issues, innovative technologies, marketing, social economic viability as a key to success.

- The management entity should highlight keys to success and share failures in order to learn from the other projects.
- The Horticulture CRSP should allocate more time to putting more information up on the website.
- The website should include the contact information of the local USAID missions.
- Horticulture CRSP should launch an interactive portal wherein sharing of information can take place, queries can be answered, and issues can be resolved through regular interaction.
- There should be a place to share the existing success and weakness in the implementation and execution of all the Horticulture CRSP projects
- Horticulture CRSP should work on more technology transfer projects--getting innovative technologies developed in one region of the world to new locations.

Training materials
As final reports have come in from the Immediate Impact Projects, all project materials have been consolidated. Training materials have been identified and characterized from each project. A portal for sharing these materials will be developed.

Promotional materials
The information management group had a busy year producing a number of materials in written and video form. All materials are available through the Horticulture CRSP website. Materials are designed to help projects with raising activity awareness, networking and implementing technology and project strategies.

Examples of completed materials include:
- Articles on each of the 15 Immediate Impact projects
- 11 videos (viewed 745 times) on Immediate Impact Projects including videos on:
    - Cold Storage and Transport
    - Building a Honduran Export Industry in Ornamentals
    - Fair Trade and Marketing of Rooibos Tea
- Newsletters
    - October 2011
    - August 2011
    - February 2011
- Summaries of nine completed Immediate Impact Projects including:
    - Orange-Fleshed Sweet Potato Processing in Ghana
    - Protective Structures in Central America
    - Inexpensive Seed Storage Technologies
- Short stories and interviews of project partners including:
    - “Dry Beads Dry Seeds” a snapshot of the zeolite seed drying project
    - Partner Profile: Stephen Weller
- Photographs and slideshows of projects uploaded on Flickr with watermarks, accessible from the Horticulture CRSP project webpages

Networking
The group has engaged graduate students and provided guidance on project implementation through the innovative Horticulture CRSP Trellis Fund project. In particular, Trellis is providing graduate students with important opportunities to gain hands-on experience in horticulture and development.

Horticulture CRSP has also further developed our “Worldwide Horticultural Projects” map. This map enables project creators to identify potential linkages and areas of need. Agencies and project management teams can now easily add their own projects to the map.

Technology
Horticulture CRSP has developed a series of videos and information sheets that highlight technologies being developed and tested through funded projects.

In our continued goal to achieve broader information access, we have invested time in improving our toolkit of Internet-based resources. We have also begun a project to adjust the “Global Horticultural Knowledge Bank” online resource to reflect the needs of partners in several target countries. Initial workshops for this project are planned for the coming year. Horticulture CRSP has also begun work on a collaborative project with the UC Davis International Programs Office to build a website to address the possible uses of Information Communication Technologies along the agricultural supply chain.

Gender Equity

Amanda Crump, Executive Program Coordinator and Gender Specialist

Women are critical players in horticultural production. They participate in the entire value chain as farmers, vendors, and food processors. As such, Horticulture CRSP projects focus on expanding opportunities and providing technologies to women. By including a significant number of women in training programs, our projects ensure that women have access to novel production practices, advanced market opportunities, and the food safety or nutritional information to keep their families healthy.

Horticulture CRSP goes beyond simply ensuring the inclusion of women in our trainings by specifically targeting women with tailored trainings and unique opportunities in many of our projects. On example of this is evident in our Immediate Impact Project in Zambia led by James Simon of Rutgers University. In this past year, Associate Director Beth Mitcham and I traveled to Zambia to visit the project. We visited a group of women farmers who produce vegetables that are directly marketed to regional hotels and restaurants. Every day, tourists flock to view Victoria Falls and during the evening, they dine on healthy vegetables provided by these women and other regional farming groups. Horticulture CRSP's research efforts allowed the regional farmers to expand their operations to include nurseries, thereby giving farmers reliable access to seedlings and subsequently increasing production to 100 metric tons in one year.

The effort led by Dr. Simon and his colleagues is but one example of our successful efforts targeted specifically at improving women's livelihoods. Through our research, we are learning how to distribute food safety information to women in Central America, create jobs for women in postharvest training throughout Africa, provide novel market opportunities for women in South Africa, and increase the price women receive for produce in Southeast Asia.

Innovative Technologies

Michael Reid, Leader of Innovative Technology and Special Projects
Peter C. Shapland, Graduate Research Assistant

Horticulture CRSP encourages projects that explore technologies that provide advanced tools, in an appropriate form, to stimulate and facilitate horticultural development in the developing world. In the 2010-2011 fiscal year, we supported projects that tested novel concentrated solar drying, pest-exclusion nets, drip irrigation, improved cultivars, low-cost cool rooms, and zeolite beads for rapid drying. All of these technologies were tested and developed through a collaborative effort between U.S. researchers and their partners at national research institutes in Feed the Future countries. These technologies were developed on-site, at research stations and in the fields and communities of target farmers. Future emphases of Horticulture CRSP technology development will include testing postharvest innovations, assessing the nutritional value of African indigenous vegetables and developing innovative energy solutions in horticulture, such as off-grid evaporative cooling technologies and the use of photovoltaic cells in pumping, desalination, and other energy-intensive horticultural operations.

Capacity Building

Elizabeth J. Mitcham, Associate Director

Capacity building remains a top priority for Horticulture CRSP. In addition to training more than 2,700 people, Horticulture CRSP expanded its work by engaging new institutional partners throughout the world. Horticulture CRSP funding was provided directly to most of these institutions – enabling them to directly serve those working in the horticulture industry while simultaneously conducting the research that is crucial to Horticulture CRSP priorities. Horticulture CRSP projects also support more than 30 graduate students. These students live and conduct research in 12 countries.

Horticulture CRSP created the Horticulture CRSP Trellis Fund this year. The goal of the Trellis Fund is to link U.S. graduate students to agricultural NGOs and national research institutes in developing countries, and enable these organizations to extend new ideas to rural populations. By providing a small stipend to students and developing world organizations, Horticulture CRSP is encouraging future U.S. professionals to work internationally while improving relationships and trust between developing world organizations and organizations that provide science-based research information. In the last year, we funded 10 Trellis projects. Those projects facilitated 124 training and extension meetings, trained nearly 1,500 female farmers and established 10 demonstration plots.

While every Horticulture CRSP project includes a capacity building component, Horticulture CRSP is specifically focused on building capacity in the areas of postharvest and food safety. We embarked on a three-year effort to train and develop professionals who will research postharvest problems and provide postharvest training throughout Africa. This effort, led by UC Davis, University of Georgia, World Food Logistics Organization, and AVRDC-The World Vegetable Center has identified more than 30 postharvest specialists. Through the next year, these specialists will be trained in postharvest and will establish regional postharvest training and research centers in six countries. Horticulture CRSP funded researchers from The Ohio State University and six Latin American universities to conduct an assessment of extension methods and extension success in Latin America. The information gathered serves as a springboard to deliver better food safety information to farmers in Latin America. Both of these projects are indicative of the commitment Horticulture CRSP has to building capacity throughout the world.

Section Three–Completed Immediate Impact Projects

In 2009, Horticulture CRSP awarded 15 Immediate Impact Projects. Created with the purpose of yielding rapid results and proving concepts, these projects ranged from testing new technologies like zeolite drying beads for improved seed storage to increasing the capacity of Latin American professionals to rapidly diagnose crop disease outbreaks. As a precursor to Horticulture CRSP's longer term research efforts, these short-term projects accomplished substantial activities in a short amount of time and helped identify future research needs.

Project Reports by Priority Issue
Sustainable Crop Production

I. Deployment of Rapid Diagnostic Tools for *Phytophthora* on Horticultural Crops in Central America

Introducing rapid diagnostic tools to detect Phytophthora *diseases on horticultural crops in El Salvador, Guatemala, Honduras, Nicaragua, Costa Rica, and Mexico*
http://hortcrsp.ucdavis.edu/main/10Phytophthora.html

Project completed in July 2011.

Lead Project Investigators:

- Jean Beagle Ristaino, North Carolina State University, USA
- Kelly Ivors, North Carolina State University Mountain Horticultural Crops Research and Extension Center, USA
- Carrie Lepaire Harmon, University of Florida, USA
- Peter Bonants, Plant Research International, The Netherlands
- Monica Blanco Menenses, Universidad de Costa Rica, Costa Rica
- Jose Melgar, Fundación Hondureña de Investigación Agrícola, Honduras

Project Summary

Plant disease is a limiting factor in agricultural production in Latin America. Plant pathogens cause losses estimated to be as high as $30 billion per year in the tropics alone. The risk of new introductions of *Phytophthora* species with trade requires continued monitoring and improved diagnostic capabilities. We have produced a platform of tools needed to detect, identify, and ultimately prevent the spread of species of *Phytophthora* (with a major focus on common and high threat species of *Phytophthora*) on horticultural crops in Central America. In this Immediate Impact Project, we deployed a series of diagnostic technologies to 23 diagnosticians from nine countries at a *Phytophthora* diagnostics workshop held June 2010 in San Jose, Costa Rica. These technologies included a protocols book, a computer-based key to the species of *Phytophthora*, molecular and digital diagnostic systems to identify *Phytophthora* species that can improve the diagnostic capabilities for important plant disease clinics in the region. Our work has had impact in the region and beyond as we trained a network of diagnosticians to survey *Phytophthora* diseases on horticultural crops and expanded the network into South America through the inclusion of participants from Peru and Chile. This workshop also built important connections and relationships as many of the participants had never met one another previously. We plan to continue a survey of *Phytophthora* species on horticultural crops in the region and link diagnosticians via a web-based Latin American *Phytophthora* Diagnostic Network (LAPDN). These funds also allowed us to complete the "Key to the Common *Phytophthora* species" which will be available by the American Phytopathological Society Press (APS Press). We presented a poster and demonstration on the diagnostic tool at the APS meeting in Hawaii in August 2011 and expect the tool to be useful for plant disease clinics around the world.

We have deployed a series of technologies including a protocol book, Lucid key, and molecular tools throughout the region. Also, we have created a regional diagnostic network that supports technicians throughout Central America who impact over 10,000 hectares of vegetable crops annually.

Project Objectives

1. Conduct a regional *Phytophthora* diagnostic workshop at the Universidad de Costa Rica and provide training in traditional morphological and molecular identification of *Phytophthora* species.
2. Deploy field-based detection methods in Central American plant disease clinics for species identification in the genus *Phytophthora*, including a computer-based Lucid key for identification of common species of *Phytophthora*, PCR methodologies and Padlock probes and Clonediag microarrays for common and high threat species of *Phytophthora*.
3. Use the morphological and molecular tools in conducting field surveys at NGOs, industry, and small farms managed by both women and men to identify the major *Phytophthora* species responsible for significant losses on horticultural crops including cacao, potato, root crops, and floricultural crops in Honduras and Costa Rica.
4. Provide digital diagnosis and identification system training (DDIS) for plant disease diagnosis to clinics in Central America and computer access for identification and archiving of data on the International Plant Disease Network (IPDN) and the Southern Plant Disease Network (SPDN).

Project Report Technical Narrative
--Submitted by Jean Beagle Ristaino

The overall objective of this project was to produce a platform of tools needed to detect, identify, and ultimately prevent the spread of species of *Phytophthora* with a major focus on common and high threat species of *Phytophthora* on horticultural crops from Central America. During the second quarter of the project, we held a *Phytophthora* diagnostics workshop and have deployed a series of technologies including: a protocols book, a *Phytophthora* Lucid key and molecular tools for identification for use in the diagnostic labs throughout the region. Two digital diagnostic camera systems were given to the hub laboratories at Laboratorio de Técnicas Moleculares Aplicadas a la Fitoproteccion, Fundación Hondureña de Investigación Agrícola (FHIA) and Centro de Investigaciones en Protección de Cultivos, Escuela de Agronomía, Universidad de Costa Rica (CIPROC-UCR). These cameras will be used to send diseased plant and pathogen images to North Carolina's Plant Disease and Insect Clinic to improve identification of *Phytophthora* species on important crops in Central America.

Workshop participants learn to rapidly detect *Phytophthora* species.

The major activity within this project was to conduct a regional workshop. This workshop on the "Deployment of rapid diagnostic tools for *Phytophthora* on agricultural crops in Central America" was held June 28-July 2. The workshop, organized by Jean Beagle Ristaino and Monica Blanco, was a joint initiative of North Carolina State University, University of Costa Rica, Plant Research International, and FHIA. Centro Agronómico Tropical de Investigación y Enseñanza (CATIE, Wilberth Phillips and Muriela Leandro) assisted with sample collection for the workshop. World Cocoa Foundation, the Global Plant Clinic and CABI provided names of prospective students. Dole Foods also sent an employee who was recently hired to work on *Phytophthora* on pineapples.

The course brought together 24 plant pathologists (14 female and 10 male) from government agencies, private companies, public and private universities in nine countries in Central and South America including El Salvador, Guatemala, Honduras, Nicaragua, Costa Rica, Panama, Mexico, Peru, and Chile. During the week, participants learned a number of "rapid" technologies to analyze and identify species of *Phytophthora* using morphological and molecular methods. In addition, the workshop participants are now part of a diagnostic network in the region called "The Latin American *Phytophthora* Diagnostic Network." Our goal "to improve and build scientific capacity in plant disease diagnostics between the laboratories of Central America and Mexico and improve communications with laboratories in the United States" has been achieved.

The ambitious agenda for the workshop spanned from isolation of *Phytophthora* from plant samples and water samples, to morphological and molecular diagnostics. A detailed protocols workbook was developed and distributed to students. Pairs of students were given an "unknown species" which they ran through the series of experiments during the week to make a correct species identification. Each student was given a USB drive containing resources needed to set up their individual laboratories for *Phytophthora* diagnosis. Many of the students had not met each other prior to the workshop and are working in similar diagnostics clinics in their respective countries.

This project has allowed us to become more familiar with diseases caused by *Phytophthora* in different crops. The project collaborators have collected plant samples throughout the region and are isolating the pathogen for identification. *Phytophthora* was isolated from cacao and potato samples. *P. palmivora* was found on cacao in both Honduras and Costa Rica. A new genotype of *P. infestans* was found in Costa Rica on potato. *Phytophthora* was not identified on pineapple but further sampling is needed to confirm this. We are planning to continue collecting samples to identify *Phytophthora* species in different crops especially those like citrus and ornamentals from which we were not successful in isolating the pathogen during this project. Because of the importance of late blight (*Phytophthora*) on potatoes we will also keep working with this problem.

Project Performance Indicators

4.5.2 Agriculture Sector Productivity	**Project Achievements**
New technologies or management practices under research	5
New technologies or practices made available for transfer	5
New technologies or management practices being field tested	5
Additional hectares under improved technologies or practices	10,000
Female farmers, processors, and others who have adopted new technologies	1
Male farmers, processors, and others who have adopted new technologies	53
Male headed rural households benefiting directly	53
Producers' organizations receiving assistance	12
Trade and business associations receiving assistance	4
Number of trade and business associations who have adopted new technologies or management practices as a result of USG assistance	2
Number of community-based organizations (CBO) who have adopted new technologies or management practices as a result of USG assistance	10
Number of ag. related firms benefiting from USG supported interventions	2
Number of women's associations assisted as a result of USG interventions	2
Number of public-private partnerships formed as a result of USG assistance	13
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	25
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	25
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country organizations in direct cooperation or collaboration	16
Number of workshops conducted for host country institution, agency, and organization personnel	1
Number of host country professionals attending workshops, training conferences, or similar - Female	25
Number of host country professionals attending workshops, training conferences, or similar - Male	22
Number of graduate degrees earned by host country students - Female	2
Number of graduate degrees earned by host country students - Male	2
Number of certificates earned by host country professionals - Female	14
Number of certificates earned by host country professionals - Male	10
Number of U.S. faculty providing instruction in host country - Female	2
Number of U.S. faculty providing instruction in host country - Male	3
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	5
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	12
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	5

II. Improving Fruit Postharvest Quality through Best Management Practices for Perishable Vegetable Production in Protective Structures in Nicaragua, Haiti, Honduras, Dominican Republic and Costa Rica

Implementing technologies to enhance bell pepper yields and quality, while developing an education and research network for agriculture information exchange
http://hortcrsp.ucdavis.edu/main/11Structures.html

Project completed in January 2011.

Lead Project Investigators:

- Bielinski M. Santos, University of Florida, USA
- Teresa Salame, Maricruz Ramirez-Sanchez, Craig D. Stanley, and Jack E. Rechcigl, University of Florida, USA
- Henner A. Obregon-Olivas, Centro de Investigación Agropecuaria San Antonio, Nicaragua
- Jessie E. Inestroza, Corporación Dinant, Honduras
- Maria G. Cuevas, Instituto Dominicano de Investigaciones Agropecuarias y Forestales, Dominican Republic
- Marco V. Sáenz, Laboratorio de Tecnología Poscosecha, CIA, Universidad de Costa Rica, Costa Rica
- Jean-Robert Estime, Project Haiti WINNER, Haiti

Project Summary

Bell pepper production in Central America and the Caribbean has become one of the main agricultural commodities for exporting to the United States and the European Union. To guarantee constant supply and quality, small and medium-size growers use passively ventilated protective structures (i.e. greenhouse and high tunnels) to control the growing environment, reduce pests, and improve fruit quality and yields. One of the main obstacles to sustainability and profitability is managing high temperatures and relative humidity inside the structures. Small- and medium-size growers cannot afford to use electric or diesel fans and cooling systems to lower temperatures and relative humidity, which causes increased sun-scalding, decreased fruit number and size, and thus increased postharvest losses (as high as 35% in some colored peppers). Solving this challenge through the implementation of appropriate agricultural practices (i.e. managing planting densities, irrigation and pruning and using sun protectants) helps secure jobs and timely market supply, while reducing the dependency on fossil fuels.

> We have successfully tested and transferred technologies that were once out of reach to small- and medium-sized growers – giving these growers solutions to production problems and building a network of growers throughout Central America.

The main goal of the project was to implement technologies to enhance bell pepper yields and quality and to develop a comprehensive education, research and market-knowledge network for information exchange. The project is divided into two main components: a) research and validation, and b) education, cooperation, and communication. For the first component, proven production techniques were tested in greenhouses and high tunnels. For the second component, hands-on training workshops and educational meetings were conducted, and the “Protected Agriculture Information Network for Central America and the Caribbean (PAINET)” was created and organized. The implementation of this project impacted: a) current production practices, b) the educational level of the participants and stakeholders, c) further integration of women in

agribusiness, and d) the long-term future of the protected agriculture vegetable industry in the region.

Project Objectives

1. Validate cultural practices leading to improved bell pepper fruit size and value when grown under protective structures in the participating countries.
2. Develop a major research, education and information network throughout the participating countries to exchange experiences and marketing opportunities.
3. Involve innovative stakeholders and growers in the decision-making process for present and future joint projects throughout the region

Project Report Technical Narrative
--Submitted by Bielinski M. Santos
The project "Improving Fruit Postharvest Quality through Best Management Practices for Perishable Vegetable Production in Protective Structures in Nicaragua, Haiti, Honduras, Dominican Republic and Costa Rica" included research, demonstrations, and extension. The philosophy of the project was to design solutions according to each country's needs and creating affordable and practical solutions to have higher yields and increase the postharvest quality of bell peppers grown under protective structures. See below a brief detail of the activities conducted in each country.

Honduras. The institution involved in the research was the Dinant Corporation, and later on for the extension part of the project, the Panamerican Agricultural School, Zamorano University was included as part of the team. Three cultural practices were evaluated: use of sun protectants in bell peppers under protected structures, two plant densities for bell peppers under protective structures, and pruning systems for bell peppers under protective structures. Also a field day to demonstrate the trials was conducted in Comayagua at the Dinant Corporation facilities, and two workshops on protected agriculture were conducted at Zamorano.

Covered structures help small and medium-size growers control the growing environment.

Costa Rica. The University of Costa Rica was the institution that developed the project in Costa Rica and conducted three research trials: use of two sun-protectants for bell pepper production under protected structures, irrigation rates for bell pepper production under protective structures, and effects of plant density and pruning on bell pepper under protective structures. Two field-day workshops were conducted to train students, growers, and technicians on the cultural practices for best results on bell pepper production in protected agriculture.

Dominican Republic. The Instituto Dominicano de Investigaciones Agropecuarias y Forestales (IDIAF) was the institution where the research trials and one irrigation survey were conducted. The effects of plant density and pruning on yield and postharvest quality of bell pepper production under protective structures were studied. Also a survey to characterize the use of fertilization and irrigation in San Jose de Ocoa was implemented. Also one workshop was conducted, on basic cultural practices to grow bell pepper under protective structures, followed by a field day.

Nicaragua. At the facilities of Agropecuaria San Antonio, three research trials were conducted: effects of plant densities, pruning and use of sun protectants on yield and postharvest of bell pepper production under protective structures. Two workshops were conducted to train students, growers and technicians on vegetable production under protective structures and protected agriculture as a new way to produce vegetables. Also the 2011 PAINet Conference was held in Nicaragua to share the results of the trials from all the countries, including the Haitian representative, and organized the future of the network.

El Salvador. This country was not included originally in the project. However, HydroExpo volunteered to conduct one trial on planting densities for bell pepper production under protective structures. Also a workshop was held on protected agriculture topics for technicians of Fomilenio in San Salvador.

PAINet: As part of the project, the Protected Agriculture Network (PAINet) was created with the objective of sharing the information that resulted from the trials in the project, but also to share experiences among members. Newsletters were developed and also a website. As a result of the network, four internships from students from Honduras and the Dominican Republic were offered at the Gulf Coast Research and Education Center (University of Florida), and two Master's degree students were identified.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	107
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	336
Number of individuals who have received USG supported long-term agricultural enabling environment training - Male	3
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance	4
Number of new technologies or management practices made available for transfer as a result of USG assistance	4
Number of new technologies or management practices being field tested as a result of USG assistance	4
Number of additional hectares under improved technologies or management practices as a result of USG assistance	45
Number of male headed rural households benefiting directly	20
Number of agriculture-related firms benefiting directly from interventions	5
Number of public-private partnerships formed as a result of USG assistance	3
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	107
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	336
Number of individuals who have received USG supported long-term agricultural sector productivity or food security training - Male	3
Number of technologies of potential benefit to U.S. horticultural industries	4
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country organizations in direct cooperation or collaboration	7
Number of workshops conducted for host country institution, agency, and organization personnel	8
Number of host country professionals attending workshops, training conferences, or similar - Female	87
Number of host country professionals attending workshops, training conferences, or similar - Male	251
Number of U.S. faculty providing instruction in host country - Male	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	2
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	8
Number of host country professionals directly involved in research - Female	2
Number of host country professionals directly involved in research - Male	7

III. Sustainable Production of Specialty Horticultural Crops in Ghana for Income Generation and Increased Export Value

Providing employment and income to farmers by deepening market access and productivity of sustainable specialty crop production in Ghana
http://hortcrsp.ucdavis.edu/main/13Exports.html

Project completed in April 2011.

Lead Project Investigators:

- James E. Simon; Rutgers, The State University of New Jersey, USA
- Dan Acquaye, Julie Asanta-Dartey, Nana Akua Benewa, Larry Amekuse, S. Boadu, and Prince Manu-Yeboah, ASNAPP, Ghana
- Richard Akromah and Charles Quansah, Kwame Nkrumah University of Science and Technology, Ghana
- Hector Rodolfo Juliani and Ramu Govindasamy, Rutgers, The State University of New Jersey, USA
- Joe-Ann McCoy, North Carolina Arboretum, USA

Project Summary

This project expanded economic opportunities for small-scale farmers in Ghana by enhancing their productivity and deepening market access and participation. This project took place in 10 communities and supported 60 farmers to cultivate additional acres of spices and other non-timber forest products. Direct jobs were created for 350 farmers and collectors (125 women and 225 men) with combined income generated greater than $675,000.

> This project facilitated trade totaling $675,000, more than 4 times the investment from USAID.

Project Objectives

1. Increase the production base of important indigenous spices, medicinal plants and horticultural crops including Grains of Paradise, Griffonia and Voacanga and provide employment and income to selected farmers
2. Implement sustainable collection practices of selected wild harvested non-timber forest products to generate complementary income
3. Increase productivity through applied research, improved quality systems, and technology transfer
4. Increase human and enterprise capacities
5. Provide assistance in trade facilitation and market development for regional and export trade

Project Report Technical Narrative
--Submitted by James E. Simon

At the beginning of this project, we proposed creating direct jobs for 250 farmers and collectors and generating $232,000 in income. In total, this project facilitated trade totaling $675,000, more than four times the initial proposal and directly generated 350 jobs (225 males and 125 females). This project led to the development of public-private sector partnerships, provided strong impetus for countries and communities to examine their own indigenous plants, particularly horticultural crops, for income generation, food security and forest preservation. This project also created opportunities for the rural population to stay on the farm, thus promoting the agribusiness concept among rural communities and instilling the belief that agriculture can generate a living wage.

This project introduced several affordable technologies and addressed key issues across the value chain. While market facilitation and trade were very successful, the key underlying issue that this project was able to achieve was in the use of a market-first approach with strong science and the appropriate partnerships that allowed the entire value chain to be addressed while focusing on sustainable collection and production of high quality natural products. This project is poised to scale-up, yet requires continued technical expertise and support for the rural communities and the buyers, traders, agents, and processors.

Appropriate propagation techniques were investigated and transferred to local farmers.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	122
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	180
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance.	7
Number of new technologies or management practices made available for transfer as a result of USG assistance.	5
Number of rural households benefiting directly from USG interventions - Female Headed Household	50
Number of women's organizations/associations assisted as a result of USG interventions.	1
Number of public-private partnerships formed as a result of USG assistance.	4
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	122
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	180
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	5
Number of workshops conducted for host country institution, agency, and organization personnel	2
Number of host country professionals attending workshops, training conferences, or similar - Female	3
Number of host country professionals attending workshops, training conferences, or similar - Male	8

IV. Sustainable Development of Horticultural Crops in Zambia for Food Security, Income Generation and in Support of the Tourism Industry

Helping farmers in Zambia develop consistent vegetable products to market to hotels and other tourist industries

http://hortcrsp.ucdavis.edu/main/14Tourism.html

Project Completed in April 2011.

Lead Project Investigators:

- James E. Simon, Rutgers, The State University of New Jersey, USA
- Bismarck Diawuo, ASNAPP, Zambia
- Elton Jefthas, ASNAPP, South Africa
- Petrus Lanenhoven, Stellenbosch University, South Africa
- Hector Rodolfo Juliani and Ramu Govindasamy, Rutgers, The State University of New Jersey, USA

Project Summary

Seedling production at Kazuni, near Livingstone, the production of high quality seedling has generated income for almost $170,000 and provided superior germplasm to local farmers.

This project increased food security and generated income for rural farmers through quality production of vegetables. It has also enabled communities to have access to appropriate germplasm and involved community members in the production, postharvest handling, and commercialization of high-value produce to diversify their incomes. Growers were introduced to and trained in greenhouse tunnel construction and systems to produce vegetables in open fields and controlled greenhouse conditions. Access to information was an important component of this project. Farmers were trained not only in production and commercialization of fresh produce, but also on business skills. This project impacted 135 farmers (59% women) from the communities in the Livingstone region to produce more than 100 metric tons of vegetables valued at $170,000. This project used a market-first, science-based approach involving private sector buyers including the Zambezi Sun, Royal Sun, Spar and Shoprite supermarkets, David Livingstone Hotel, Chrismar Hotel, and lodges in Livingstone.

Project Objectives

1. To train farmers in vegetable production.
2. To increase production of high-quality vegetables.
3. To ensure sustainability of the farmers' crop enterprises and assist them to approach horticulture production as an agribusiness.

Project Report Technical Narrative

--Submitted by James E. Simon and Petrus Langenhoven

At the beginning of this project, we had planned that this project would impact 100 farmers (55% women) from the communities in the Livingstone to generate vegetable seedlings valued at

$125,000. At the end of this project, the farmers have generated nearly $170,000. This project impacted more than 135 farmers (55 men and 80 women). Thus, we are pleased to report that this project exceeds our original goals for both total actual trade and number of farmers trained within this short-term project.

> This project exceeds our original goals for both total actual trade and number of farmers trained within this short-term project.

Because of the good quality of seedlings that are being produced, more farmers have ordered seedlings from these communities, thus opening new, longer-term sustainable business opportunities in this region to produce high-quality vegetable transplants, and to offer a big market for the producers. The growers have been trained in due diligence for food safety and marketing of vegetables and fruits, and they recognize that quality (disease-free transplants, produced at the right time, and offered at the correct growth stage) is essential for sales and marketing. Farmers have come to understand that farming needs to be viewed and practiced as an agribusiness enterprise and that the relationships developed and partnerships formed can facilitate trade and increase their own business opportunities.

This project introduced several affordable technologies (high quality seeds and germplasm; plastic tunnels, water management), addressed key issues that were local and regional constraints in production (access to high-quality plant materials and transplants) and led to successful business and income generation in a short time period. The project was based upon the development of strong partnerships, introduction of technologies that overcame current commodity chain constraints, and along the way provided relevant trainings and capacity building. This project is poised to expand and scale up.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	80
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	55
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance.	5
Number of new technologies or management practices made available for transfer as a result of USG assistance.	5
Number of new technologies or management practices being field tested as a result of USG assistance.	10
Number of additional hectares under improved technologies or management practices as a result of USG assistance.	15
Number of rural households benefiting directly from USG interventions - Female Headed Household	40
Number of rural households benefiting directly from USG interventions - Male Headed Household	20
Number of agriculture-related firms benefiting directly from USG supported interventions.	10
Number of public-private partnerships formed as a result of USG assistance.	3
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	80
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	55
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	4
Number of workshops conducted for host country institution, agency, and organization personnel	3
Number of host country professionals attending workshops, training conferences, or similar - Female	10
Number of host country professionals attending workshops, training conferences, or similar - Male	5

V. Indigenous African Leafy Vegetables (ALV) for Enhancing Livelihood Security of Smallholder Farmers in Kenya

Establishing long-term improved nutrition and economic security by increasing production and use of indigenous vegetables
http://hortcrsp.ucdavis.edu/main/15ALVs.html

Project completed in April 2012.

Lead Project Investigators:

- Stephen C. Weller and Maria I. Marshall, Purdue University, USA
- Dharma Pitchay, Tennessee State University, USA
- Mathieu Ngouajio, Michigan State University, USA
- Pamela Obura, Grace Cheserek, Elizabeth Omami, and Julius Ochuodho, Moi University, Kenya
- Christine Ndinya, Kenya Agricultural Research Institute, Kenya
- Chris Ojiewo, AVRDC-The World Vegetable Centre, Tanzania

Project Summary

This project enhanced the potential for production, utilization and marketing of African Leafy Vegetables (ALVs) in Eastern Africa. Project goals were to establish a base of information and experience for greater production and use of indigenous vegetables that in the long term will provide a source of food that improves nutrition, health, and economic security for Africans, especially those afflicted with HIV/AIDs and women farmers. Activities included imparting knowledge on ALV germplasm, establishing/improving local seed banks, providing quality seeds for production, transfer of improved production techniques to stakeholders, organization of self-help groups and market analysis. Participatory approaches were critical in achieving project goals and targeting disadvantaged groups.

This project's household and market surveys revealed that the ALV supply in Western Kenya is low and that production and marketing has numerous challenges and constraints, including competition for land, lack of irrigation, and high postharvest losses.

Project Objectives

1. Assess and enhance genetic resources of ALVs, particularly amaranth, nightshade and spider plant
2. Improve ALV seed availability to stakeholders
3. Develop and disseminate improved horticultural practices and postharvest technologies for ALVs
4. Develop marketing strategies for ALVs.

Project Report Technical Narrative
--Submitted by Stephen Weller

Household food security and nutrition are priority issues on the national planning agenda in many sub-Saharan African countries. Many of these countries' economies are characterized by recurrent food insecurity and high dependence on agricultural production. A majority of the chronically food insecure are smallholder farmers with inadequate resources. Women play a significant role in food production and in income generation to support their households in these countries.

The World Health Organization and the FAO recommend that a person consume 400 grams of vegetables daily, or 146 kg per year. Vegetables provide essential micronutrients, and suboptimal consumption has far-reaching consequences on health and nutritional status. Vegetable consumption in sub-Saharan African countries remains very low, especially among women, children, and people living with HIV/AIDs. This project is working to improve nutrition and reduce micronutrient and vitamin deficiencies through educational and agricultural interventions aimed at increasing indigenous African leafy vegetable (ALV) cultivation.

ALVs are an important part of farming and consumption systems throughout Africa. Many Kenyan ALVs, including spider plant, African nightshades, and amaranths, are important sources of micronutrients including vitamins A and C and iron. In addition, ALVs can be grown with limited inputs; farmers can save their own seed; the species are adapted to local growing conditions; and these vegetables can provide not only vital food, but also income security for poor families in rural areas, especially women.

However, in several areas ALVs are now being replaced by newly introduced "exotic" species including cabbage, kale and mustard greens. Typically, these species have lower nutritional values than ALVs, which has major health consequences particularly among the poor. There is concern over a continued narrowing of the number of food species grown as fewer crops are grown in local farming systems and with this there is a disappearance of local knowledge about traditional crops. The lack of attention by mainstream crop research and development programs has led to under exploitation of ALVs and over-use of exotic vegetables. Consequently, some ALV species are at risk of extinction. This project has taken advantage of conservation strategies that stress the need to maintain the existing diversity and prevent further genetic erosion of suitable traits in many valuable ALV species. These strategies include: multiplication, production, and promotion of the germplasm of popular landraces and improved indigenous vegetable crops.

***Amaranthus* species were among the group of African Leafy Vegetables focused on by this project.**

Major problems affecting smallholder ALV producers in Kenya include poor ALV seed systems, sub-optimal production due to inferior horticultural practices and technologies, poor postharvest handling techniques, inefficient marketing channels, and inadequate market information. Developing appropriate production practices for ALVs will increase the quality and quantity of yields, but also improve nutrition and health of the community. There is high potential for women to earn additional income from selling surplus ALVs since markets for these vegetables already exist in many locales. In addition, production, processing, and preservation of these vegetables could lead to wider markets, thus increasing their commercial value.

Key Activities

The project conducted variety evaluation experiments on 33 cultivars (nine amaranth, nine nightshade and 15 spiderplant) over two seasons in 2010-2011. Farmers participated in variety evaluations during field days, and seed from at least five priority lines of each ALV species most preferred by farmers were given to lead farmers and farmer groups for further evaluation on their farms. Farmer groups received ongoing support through visits by local extension personnel, trainings at the evaluation fields, and visits by project staff.

The most promising approach to improved seed production for indigenous vegetables is the promotion of community-based seed production systems. In order to enable better adoption of the newly introduced ALV varieties, local availability of good quality planting materials (seeds) is important. It was decided by our collaborators that it was necessary to link our activities involving production and marketing of ALVs with an efficient seed system. Participating farmer groups were organized and encouraged to nominate two to three of their members to be trained on both the traditional and modern seed production and management practices for ALVs in order to ensure our client farmers would have access to improved ALV germplasm. The majority of participants in the seed training were women farmers since they are the main producers and marketers of traditional vegetable seeds. Two training sessions and field days were organized and conducted at KARI Kakamega and Moi University Chepkoilel Campus by our collaborating seed scientists. Following the training, we encouraged the farmers to consider the possibility of selling the seeds produced to members of their groups, to neighboring villages, or in local markets.

Extension materials on ALV production previously developed by AVRDC were distributed to farmers and extension personnel. Supplementary extension material developed by and used by AMPATH, Moi University and KARI were also simplified and used during trainings. Additional technical input during training sessions was provided by collaborators from participating U.S. Universities.

Market and household surveys were conducted in five selected AMPATH sites. Overall, both household and market surveys revealed that the ALV supply in Western Kenya is low and that production and marketing has numerous challenges and constraints, including competition for land, lack of irrigation, and high postharvest losses. Surveys also confirmed that women are heavily involved in ALV production, and that ALVs are grown mainly for domestic consumption and local sale. These findings corroborate the basis on which this project was initiated.

Following the surveys, community meetings were arranged with various farmer groups, ALV vendors from local markets, project researchers (Moi University, KARI, and AMPATH), government extension personnel, and other local stakeholders through the local extension personnel prior to the project team's visit. The community meetings provided an opportunity for farmers to discuss and learn more about production and marketing of ALVs and to establish better entrepreneurial skills, as well as build market linkages between women producers and vendors. During these meetings, the participants were taken through the ALV value chain components and there was identification of the main value chain actors and how each component/actor contributes to the success of ALV farming and marketing as a business. Both traders and producers/farmers listed their expectations or what they desired from each other in order to enhance production and market efficiency for ALVs.

Upon completion of the community meetings, a series of workshops and field days were conducted for all the farmers enrolled in the project in the following key areas:

- Land preparation: planting beds, compost manure preparation
- Planting methods: direct seeding and appropriate planting scheduling in order to maximize profits during off-peak seasons when vegetables receive fair prices in the market
- Importance of good quality seeds: where or how to source them with emphasis on community seed bulking since majority of the farmers either save their own seeds from the previous crop or borrow from neighbors or relatives who have saved seed
- Crop management: soil fertility improvement, water supply, pests and disease control, weeding

- Recordkeeping and other entrepreneurial skills: Additional training sessions were organized in each site for the target farmer groups to equip them with relevant agribusiness and entrepreneurial skills such as simple recordkeeping, sales and marketing of the produce, advertisement, market dynamics, and savings and resource mobilization. The concept of diversification of the production system to include other ecologically adaptable and other high-value local market vegetables such as spring onions, carrots, eggplant, tomatoes, cucumbers, crotalaria, cowpeas, jute, pumpkin leaves, and common beans that could be grown for local, regional, and export markets where applicable
- Harvesting techniques and postharvest handling techniques: when to harvest/ frequency of harvesting, parts/how to harvest, and common ALV recipes

The objective of the postharvest handling and value-addition training was to enhance farmers' knowledge on postharvest processing, utilization, and value addition of ALVs. Key topics discussed during the training sessions included: nutrient composition of common ALVs, their importance and comparison with other foods, preservation methods including drying with emphasis on nutrient retention during blanching and actual drying processes. In addition, farmers received ALV recipes that were designed to be nutritious, easy to prepare and locally acceptable. Both male and female farmers learned about cooking vegetables, and also did taste evaluations of all the recipes.

Out of the 285 participating ALV farmers in this project, 73 percent were women, 56 percent of which represented female-headed households. About 81 percent of the participants had attended Horticulture CRSP project training sessions. Many farmers felt that the major benefits obtained were due to the practical training sessions conducted by the project personnel including sessions on land preparation; planting and crop management skills; agribusiness and marketing skills; savings, resource mobilization and banking; recordkeeping; customer relations; produce pricing; seed harvesting, seed processing and storage for future use; and soil testing and fertility management. As a result of these training sessions, the farmers reported that they changed or improved their ALV production. In addition, several group members had already established their own kitchen gardens, apart from their joint group farm planted with assorted ALVs.

Overall, farmers were able to get a larger surplus of ALVs from their farms, and they said they would increase household consumption and explore external markets to increase sales. They were also willing to train neighbors on the importance of ALVs and on methods to produce more seed. In addition to the above community meetings, we acquired 62 manual irrigation pumps (Moneymaker ™) with all the necessary components. This was in response to the extended dry season which severely affected production on most of the farms. Since this was a common challenge experienced by the majority of participating farmers, it was logical to address it as a matter of priority. These pumps will be distributed to farmer groups on the basis of a flexible repayment plan. Once the project recovers the full costs, the funds generated will be used to establish a revolving fund for additional pumps to serve large number of farmers. Hopefully, this will enable ALV farmers to extend the growing period during dry seasons and take advantage of better market prices.

Outcomes and lessons learned

The main achievement of this project was that it provided a sharp focus to the potential of ALVs as a source of income for resource-poor and nutritionally vulnerable households in western

Kenya. Other significant outcomes include:

1. Increased availability of improved indigenous vegetable germplasm that is well adapted to local environments to farmers, extension staff, and participating public research institutions.
2. Participating communities acquired valuable skills on improved production technologies, postharvest handling and utilization of ALVs.
3. The project enhanced the capacity of local extension staff and target communities in the maintenance of germplasm and sustainable community seed systems for their preferred indigenous vegetable varieties.
4. Improved knowledge/awareness, practices, and attitudes among community members and extension staff regarding nutritional and intrinsic value of indigenous vegetables.
5. Integration of agriculture, gender, HIV/AIDS, nutrition and environment components in existing community development programs such as AMPATH.
6. Increased awareness in the community of group dynamics and resource mobilization.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	208
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	79
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research.	6
Number of new technologies or management practices being field tested.	4
Number of additional hectares under improved technologies or management practices as a result of USG assistance.	15
Number of rural households benefiting directly from USG interventions - Female Headed Household	168
Number of rural households benefiting directly from USG interventions - Male Headed Household	125
Number of producers organizations receiving USG assistance.	23
Number of community-based organizations receiving USG assistance.	11
Number of producers organizations who have adopted new technologies or management practices as a result of USG assistance.	23
Number of community-based organizations (CBO) who have adopted new technologies or management practices as a result of USG assistance.	11
Number of agriculture-related firms benefiting directly from interventions.	4
Number of women's organizations assisted as a result of USG interventions.	10
Number of public-private partnerships formed as a result of USG assistance.	5
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	208
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	125
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country organizations in direct cooperation or collaboration.	5
Number of workshops conducted for host country organization personnel	5
Number of host country professionals attending workshops, training conferences, or similar - Female	26
Number of host country professionals attending workshops, training conferences, or similar - Male	30
Number of U.S. faculty providing instruction in host country - Female	2
Number of U.S. faculty providing instruction in host country - Male	3
Number of host country extension workers, university faculty or professionals providing training to other host country professionals - Female	23
Number of host country extension workers, university faculty or professionals providing training to other host country professionals - Male	13
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	6
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	3

Project Reports by Priority Issue
Postharvest Technology

I. Concentrated Solar Drying of Mango and Tomato

Developing a concentrated solar drying unit for mango and tomato for Tanzania to improve off-season food security
http://hortcrsp.ucdavis.edu/main/26pharvest_train.html

Project completed in September 2011.

Lead Project Investigators:

- Diane Barrett, Pieter Stroeve, Jim Thompson, and Kurt Kornbluth, University of California, Davis, USA
- Bertha J. Mjawa, Ministry of Agriculture Food Security and Cooperatives, Tanzania

Project Summary

Women carry out most production of horticultural crops in Tanzania and many other developing countries. Harvest periods are short, but less than 1 percent of the crop is processed for off-season consumption. Previous attempts at establishing solar drying have been unsuccessful due to their expense, low throughput capacity and inability to operate in cloudy environments.

Concentrating solar panels (CSP) utilize reflective surfaces to increase solar heat gain. CSPs are less expensive than glazed solar collectors but have never been applied to food drying. It may also improve texture, color, nutrient retention, and rehydration properties, and therefore will add value to the product and reduce the current 50-80 percent rate of postharvest loss.

This project designed and tested a batch CSP dryer for mangoes and tomatoes in simulated cloudy environments. CSPs were evaluated in terms of drying efficiency, cost, and product quality.

Solar dryers using concentrated solar power were designed and tested for use in cloudy environments. The team was able to dry tomatoes 27 percent faster with the concentrating solar panels.

Project Objectives

1. Design and construct a simple, inexpensive concentrated solar power dryer for horticultural crops dried in cloudy, hazy situations typical of Tanzania and nearby countries.
2. Conduct drying trials on mangoes and tomatoes, evaluating technical performance (heat flux, dryer temperature) and product quality (color, texture, rehydration ratio, nutrient content).
3. Compare the quality of concentrated solar power-dried product to standard solar-dried product.

Project Report Technical Narrative
--Submitted by Diane M. Barrett and Pieter Stroeve

Concentrating solar panels improve the process of solar drying Roma tomatoes. Two mixed-mode solar dryers were identically constructed, though one of the dryers utilized mobile and easily adjustable flat concentrating solar panels (CSPs) to maximize incident solar energy on the dryer. Temperatures inside the dryer with CSPs were approximately 10°C higher than those in the normal dryer during the majority of a sunny day testing period. This increase in temperature led to shorter Roma tomato drying times in the CSP dryer. The CSPs showed a considerable increase in drying rate on sunny days, with a 27 percent decrease in total drying time as compared to the normal dryer to reach the target moisture content. A less significant increase in drying capacity was achieved when the dryer was tested in simulated cloudy conditions. The faster drying rate achieved in the dryer utilizing solar concentrators, under both sunny and simulated cloudy conditions, demonstrates the ability to dry produce to acceptable moisture content in a shortened time, with the objective of reducing postharvest loss and preventing spoilage.

The team tested the concentrated solar panels on many types of solar dryers.

Project Performance Indicators

4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance.	1
Number of new technologies or management practices made available for transfer as a result of USG assistance.	1
Number of new technologies or management practices being field tested as a result of USG assistance.	1

II. Biologically Based Postharvest Quality Maintenance and Disease Control for Mango and Papaya

Researching biologically based controls of diseases to maintain postharvest papaya and mango quality in Sri Lanka
http://hortcrsp.ucdavis.edu/main/7Biological.html

Project completed in June 2011.

Lead Project Investigators:

- Robert E. Paull, University of Hawaii at Manoa, USA
- Nancy Chen, University of Hawaii at Manoa, USA
- Shanthi Wilson Wijeratnam, Ilmi Hewajulige, Chamila Wijesinghe, and Shiranthi Perera, Industrial Technology Institute, Sri Lanka
- Chamari Wickramathilaka, Link Natural Products, Sri Lanka

Project Summary

This project brought together two parallel research programs: the use of natural coating and herbal extracts in Sri Lanka and efforts in Hawaii to use natural epiphytic microorganisms to control postharvest diseases. Essential oils are complex volatile compounds produced in various plant parts such as leaves, flowers, bark, and roots. Volatile compounds from plants can inhibit the growth of fungal pathogens, evaporate without leaving residues, and are considered benign from a health perspective. Epiphytic microorganisms isolated from papaya fruit are being evaluated for their ability to control postharvest disease as antagonistic microorganisms to plant pathogens. This Hawaiian research follows from successful isolation of a yeast for postharvest disease control in pineapple. The project developed and evaluated a biologically based, nontoxic, environmentally suitable approach for postharvest disease control. The output from this project provides an alternative postharvest disease control approach to fungicide in conventional and organic mango and papaya production. The technology developed in this research was introduced to extension officers via workshops held at the Vidhatha collection and distribution centers in Sri Lanka.

> This project provided an alternative postharvest disease control approach to fungicide in conventional and organic mango and papaya production.

Project Objectives

1. Determine the effectiveness of coatings and essential oils in controlling postharvest disease of mangoes and papaya while maintaining fruit quality.
2. Isolate and evaluate epiphytic microbial antagonists in vitro against papaya postharvest pathogens.
3. Evaluate integrated postharvest disease protocol from harvest through storage using coatings, essential oils and selected microorganism in simulated shipping.
4. Transfer the findings of this research via a minimum of two sets of train-the-trainer workshops.

Project Report Technical Narrative
--Submitted by Robert E. Paull

Anthracnose pathogens of mango and papaya as well as stem rot pathogens of mango were isolated from host tissue in accordance with Koch's postulates, and pure cultures maintained. Cultures have been submitted to Gene Tech Ltd., for confirmation of the identification and genetic sequence of the pathogens. Six herbal extracts were obtained from Link Natural Pvt. Ltd.

and screened against the pathogens. Two extracts were selected as being effective in inhibiting growth of the three respective organisms.

Selected herbal extracts were blended with Industrial Technology Institute (ITI) edible wax coatings at different concentrations and tested for in vivo control of growth of the respective pathogens. Determination of the shelf life of the combined wax formulation was completed.

Having secured adequate supplies from our industry partner Link Natural Pvt Ltd. of the selected herbal extracts, we proceeded with the scheduled larger-scale in vivo trials on mango and papaya. Success was achieved with in vivo trials using a new wax formulation where cinemaldehyde was incorporated in place of the herbal extracts into the original ITI wax formulation.

Three yeast isolates that were earlier shown to have potential biological activity were further tested in vivo on papaya fruit obtained from a commercial grower. Half the treated and inoculated fruit were stored at 10°C for 10 days before ripening at ambient temperature. In addition to the

Papaya held for 14 days at 13°C.

Clockwise from upper left: New wax formulation (wax and essential oil), Control (no treatment), Wax formulation alone

yeast isolates, 0.5% thyme oil, 1.5% medium molecular weight chitosan and Sri Lankan wax were also tested for their postharvest disease control activities.

When the biological agents were applied on the same day as the pathogen inoculation, the antagonistic activity was not noticeable in papaya ripened at ambient temperature without cold storage. Neither thyme oil nor yeast isolates reduced the infection of *Collectotrichum*. The yeast isolates #581 and #1061 effectively reduced the Anthracnose development in papaya after cold storage. Initial studies indicated that the application time of the control agent influenced the effectiveness of its antagonist activity. The biocontrol agent was more effective if applied later, if cold storage was not involved. All three yeast isolates tested, #581, #961 and #1061 showed

antagonistic activity against *Collectotrichum* when applied one day after pathogen inoculation in papaya ripened at ambient temperature. However, when the papaya were stored at 10°C before ripening, only yeast isolate #1061 was effective in reducing the *Collectotrichum* infection.

Introductory workshops were conducted in three mango and papaya production areas. The team established links with grower groups Vidhatha Officers in Borrugodawatte, and Thambuthegamma and Palagala in Kallawawe and took this opportunity to introduce the concepts of good postharvest handling procedures. A stakeholder workshop was also held in Colombo to introduce the project objectives to exporters and larger growers of these commodities. The latter program was timed to coincide with the visit of the U.S. collaborators.

Scheduled workshops were conducted to demonstrate the effectiveness of the new cinemaldehyde incorporated formulation to Vidhatha Officers and samples were given to 20 officers to take back to their respective locations for further trials with growers and collection agents. As a consequence of this, a distribution agent/supplier of mangoes and papaya to exporters is interested in manufacturing the new wax formulation and using it in his operations; negotiations are in progress at present.

Two members of the Sri Lankan team participated in the 2010 Postharvest Short Course conducted by the University of California Davis, June 14 – 25. Besides updating their knowledge on current postharvest treatments and procedures, and the experience of visiting large-scale postharvest operations as practiced in developed countries, they also brought back valuable training materials. These materials were used in the train-the-trainers program and the stakeholder workshop held at the Industrial Technology Institute and attended by 40 participants. These materials will be used in future training and stakeholder programs.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	3
Number of individuals who have received USG supported long-term agricultural enabling environment training - Female	2
Number of individuals who have received USG supported long-term agricultural enabling environment training - Male	2
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of rural households benefiting directly from USG interventions - Female Headed Household	35
Number of rural households benefiting directly from USG interventions - Male Headed Household	125
Number of producers organizations receiving USG assistance.	5
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	2
Number of workshops conducted for host country institution, agency, and organization personnel	2
Number of host country professionals attending workshops, training conferences, or similar - Female	16
Number of host country professionals attending workshops, training conferences, or similar - Male	23
Number of certificate training programs conducted	3
Number of U.S. faculty providing training or instruction in host country - Female	1
Number of U.S. faculty providing training or instruction in host country - Male	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	32
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	35
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	1

III. Cool rooms and Cool Transport for Small-Scale Farmers

Using solar power and innovative cooling technology to create storage and transport cool rooms in infrastructure- and electricity-limited areas of India, Uganda, and Honduras
http://hortcrsp.ucdavis.edu/main/9Coolrooms.html

Project completed in August 2011.

Lead Project Investigators:

- Michael Reid and James Thompson, University of California, Davis, USA
- Cecilia Chi-Ham, University of California, Davis, USA
- Neeru Dubey, Amity University, India
- Royce Gloria Androa, Reach Your Destiny Consult, Ltd., Uganda
- Dinie Espinal-Rueda and Julia Gomez, Zamorano University, Honduras
- Ron Khosla, Store It Cold, LLC., USA

Project Summary

The principal achievements of this one-year project were the installation of cool rooms suited to limited-resource farmers in Honduras, India, and Uganda. These rooms are still being evaluated.

Temperature management is the key tool for reducing temperature losses in the developing world. Very few smallholder farmers have access to cooling or cool storage facilities, and refrigerated transportation is a rarity. The unreliability of local electricity supply, the expense of conventional coolers, and the lack of technical expertise for installation and maintenance all have led to the search for alternative solutions such as evaporative cooling systems. Nevertheless, mechanical refrigeration still represents a simple and efficient solution to cooling produce and is usually the only practical means for cooling to temperatures near freezing. For resource-limited farmers in the developing world, cool rooms and transportation systems employing mechanical refrigeration are economically and practically infeasible. We tested an innovative system, the CoolBot system developed and trademarked by Store It Cold, which uses an intelligent thermostat system controlling a standard room air conditioner to create a small-scale cooler out of a well-insulated room. Experiments included testing a range of potential insulating materials that might be used in installing or retrofitting cool rooms, evaluation of the CoolBot/room air conditioner combination, and evaluation of the use of photovoltaic panels to power the system. For short-distance transport to local markets, cool transit can be achieved by placing properly cooled produce in a well-insulated truck or cart. Studies on novel insulating materials will also be applicable to such transportation systems.

Project Objectives

1. Test a range of indigenous and novel materials as possible insulation materials for cool stores and cool transport
2. Test the effectiveness of the CoolBot thermostat/room air conditioner system for refrigerating small-scale cool room
3. Evaluate the possibility of using photovoltaic panels to power the CoolBot and room air conditioner under developing-world conditions

Project Report Technical Narrative
--Submitted by Michael S. Reid

The project was initiated with three collaborators, Dr. Neeru Dubey from Amity University, Noida, India; Gloria Androa from Seek Your Destiny LLC, Uganda; and Julia Gomez from the

Panamerican Agricultural School, Zamorano University, Honduras, who came to Davis, Calif., for a three-week workshop in June 2010.This provided an overview of the biological and technological basis for postharvest procedures, as well as an opportunity to observe a range of postharvest handling strategies under California conditions. In the third week of the workshop, a demonstration of the CoolBot /window air conditioner refrigeration system was installed and operated.

Since insulation is the major cost in installing a cool room and the refrigeration strategy proposed here requires a very well insulated room, we explored the possibility of using locally sourced or innovative insulating materials. Initial experiments were conducted during a week-long workshop of the collaborators at Davis. We determined the insulation value of feathers to be considerably higher than shredded paper and polystyrene “worms.” As an example of a possible construction method for an inexpensive and well-insulated cool room, we built a prototype “straw bale cooler,” using local wheat straw. Given the time that the collaborators were able to spend at Davis, the room was not completed and equipped, but the viability of the straw bale cooler was clearly demonstrated.

A cool room was later completed, however, at Davis and used during summer months by the UC Davis Student Farm to store produce harvested for use in the student dining halls; it operated satisfactorily and without problems. The insulation and fittings of the old cool room used for the installation did not permit temperatures lower than 4^0C to be achieved, and slight heating of the room occurred at peak daytime temperatures.

In Honduras, a small pre-built concrete block room was available on-site, and the product (tropical flowers) required only moderate cooling, so the existing room was retrofitted by insulating the ceiling and existing door with polyurethane foam panels. In Honduras the room was not highly insulated, but the CoolBot-controlled air conditioner was able to cool the flowers and maintain them at the desired temperature, 15^0C.

In India, the cool room was constructed with a double layer of mud-bricks fabricated with a high content of rice hulls in an effort to increase insulation value. The room was painted with four coats of paint to provide protection and a vapor barrier, as well as a clay coating, a cement-based coating called “Putty,” a waterproof coat (FIXIT brand) and a layer of heat reflective paint. A 21,000 Btu/h window air conditioner was installed and was connected to the CoolBot. The room was fitted with a voltage regulator to protect motors and electronics from under- and over-voltage that is common in the power supply. The CoolBot controller and air conditioner maintained satisfactory temperatures in initial experiments.

In Uganda, the cool room was constructed in an innovative fashion with two concentric mud-brick walls separated by a 30 cm cavity that was filled with plastic bags filled with rice hulls. The problem addressed in this situation is that organic insulation materials will quickly be colonized by termites unless protected, hence the plastic bags. We had also tested the possibility of using dried grass treated with a solution of borax to reduce the palatability to insects.

Given that traditional refrigeration systems are very costly, the option explored in this project was to use a modified room air conditioner. The control system of the unit is modified to allow it to produce low air temperatures without building up ice on the evaporator coil. The CoolBot device we tested is easily installed, prevents ice buildup on the evaporator, but does not require modifying the control system of the air conditioner. The highest costs in this system are for electricity, which can be an unreliable resource in many developing countries. Therefore, as part

of the project, we tested the possibility of using photovoltaic electricity to supply CoolBot/window air conditioner cool rooms.

Costs for photovoltaic panels were close to $2 per watt at the inception of the project and have continued to fall; high-quality panels can now be obtained (in quantity) for $1.50 per watt. The total cost of the solar equipment purchased for the Davis installation, on the recommendation of the supplier, was $8,600. This cost, and the costs for the system purchased in Uganda, were substantially more than had been budgeted, and required revision of the budget, reducing the test of the solar system to only two sites (Davis and Uganda). In India a charge controller/battery system was installed to test the value of such a system where electricity is available, but voltage and supply are irregular. At Davis, the PIs, collaborators, and students constructed the panel mounts (from wood), and mounted and assembled the solar and electrical equipment, so this is not included in the costs, but would obviously have added substantially if done on a contract basis. In Uganda, a steel mount was constructed for the solar panels. In Davis, the system was assembled at the UC Davis Student Farm to demonstrate the proof of concept. Security concerns prevented us from leaving it operating unattended, so the cost of a weatherproof enclosure for the electrical equipment and batteries is not included in the Davis cost. An auxiliary shed was constructed to house this equipment in Uganda.

The prototype solar array was completed in time for the annual Horticulture CRSP meeting in Davis, April 2011, and was one of the stops on the field trip for the attendees. Data obtained during operation showed that the system was significantly over-engineered, so that the costs above could be substantially reduced without loss of performance. With four panels installed, the panels generated over 800 W under full sunlight. Startup draw for the cooler was about 1.2 kW, and continuous power when the air conditioner was operating was 625 W. This means that with four panels, the batteries continued to charge even when the cooler was running, indicating that 4 x 210W panels provided sufficient current to maintain the system as configured. Because of the relatively modest start-up current draw, a smaller and less costly inverter could have been installed. Since panels and inverter are the most expensive items in the array, it appears that a competent system could be constructed for much less than what was actually spent on the Davis prototype. A combined inverter/charger unit delivering an ample 2 kW costs $1,500, and panels generating 1.5 kW (5 x 220W) can be purchased at current prices for $1,700. If the cost of the other components remained the same (could be less at the lower current levels required), the cost of a system able to provide power to the air conditioning unit used in the Davis installation would be about $5,000, which is less than what was estimated in the initial project proposal.

Assuming amortization over three years, the costs of the photovoltaic system would therefore be:

- Initial cost: $5,000
- Cost per day: $5 or $0.02 per pound of produce, assuming 250 lbs. of produce per day.

The photovoltaic/battery system is not configured to provide sufficient storage to run the air conditioner during the night. The battery system is intended to provide power for cooling only during sunlight hours, and during the evening only for the Coolbot controller, other control and measurement systems, and needed lighting. Commercial operation of a solar-powered cool room will therefore necessarily be different from conventional cool stores in that product will need to be loaded into the store in the morning to allow maximum opportunity for cooling while solar power is available.

Students in the UC Davis D-Lab conducted a detailed cost-benefit analysis of a solar-powered cool room for Arua, Uganda, with input from collaborator Androa. While this was not part of this

project, it was a valuable exercise for the students, and provided a framework for consideration of options by Androa.

The principal achievements of this one-year project were the installation of cool rooms suited to limited-resource farmers in Honduras, India, and Uganda. The collaborators had the opportunity to become familiar with the concepts of postharvest biology and technology, and will continue to provide this information to their students, colleagues, and community partners. In the one-year span of this project we couldn't evaluate the impact of the project on the livelihoods of the ultimate stakeholders—limited resource farmers—but the expected impacts of the project are increased profits through reduction in postharvest losses and increased sustainability in production and marketing, reduced wastage after harvest, improved product quality, and eventually improved livelihoods.

Project Performance Indicators

4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance.	1
Number of new technologies or management practices made available for transfer as a result of USG assistance.	1
Number of new technologies or management practices being field tested as a result of USG assistance.	1
Number of new technologies or management practices under research as a result of USG assistance.	4
Number of new technologies or management practices being field tested as a result of USG assistance.	50
Number of additional hectares under improved technologies or management practices as a result of USG assistance.	10
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	20
Number of community-based organizations (CBOs) receiving USG assistance.	2
Number of community-based organizations (CBO) who have adopted new technologies or management practices as a result of USG assistance.	2
Number of jobs attributed to FTF implementation (disaggregated by gender, ag vs. non-ag)	2
Number of research projects and/or technologies of potential benefit to U.S. horticultural industries	4
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	3
Number of workshops conducted for host country institution, agency, and organization personnel	2
Number of host country professionals attending workshops, training conferences, or similar - Female	3
Number of certificate training programs conducted	1
Number of certificates earned by host country professionals - Female	3
Number of U.S. faculty providing training or instruction in host country - Male	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	3

Project Reports by Priority Issue
Nutrition

I. Concentrated Nutritional and Economic Enhancement of Ghanaian Diets Using Orange-Fleshed Sweet Potato Products

Building a viable market structure for production, processing and sale of orange-fleshed sweet potato in Ghana to increase food security, nutrient intake, and incomes
http://hortcrsp.ucdavis.edu/main/3Sweetpotato.html

Project completed in January 2012.

Lead Project Investigators:

- Eunice Bonsi, Tuskegee University, USA
- Conrad Bonsi, Robert Zabawa, Prosper Doamekpor, and Ellene Kebede, Tuskegee University, USA
- Curtis M. Jolly, Auburn University, USA
- Kwame Offei, University of Ghana, Ghana
- Felix K. Forfoe, University of Cape Coast, Ghana
- Wisdom A. Plahar, Food Research Institute, Ghana
- Marian Dorcas Quain, CSIR-Ghana
- Fafali Azaglo, Selasie Farms and Groceries, Ghana
- Joseph Apedo, Farmer Leader, Ghana

Project Summary

Orange-fleshed sweet potato flour is rich in Vitamin A and easily incorporated into local bread recipes. This project successfully tested new bread recipes.

Leading forms of malnutrition in developing countries are iron-deficiency anemia and vitamin A deficiency. Additionally rural farmers, specifically women, suffer from combined effects of low incomes and nutritional deficiencies. Combating vitamin A deficiency in developing countries, especially in children, is the World Food Summit's goal to reduce the world's under-nourished population by half by 2015. As an excellent source of vitamin A, the orange-fleshed sweet potato (OFSP) has the potential to address vitamin A deficiency. Varieties of OFSP released in Ghana in 2005 have increased levels of beta-carotene and range from yellow- to orange-flesh color. In previous studies in Ghana, consumers successfully accepted and utilized sweet potato leaves as food through modified and culturally acceptable traditional recipes. Initial results of consumer preference tests in Ghana of incorporating OFSP as an ingredient in local breads showed significant positive response and willingness to pay extra if available. This project built on this study by producing sweet potato puree to be incorporated into traditional bread recipes, flour and chips as nutritional enrichment. The project increased economic activity for farmers, processors, and bakers and increases the availability and consumption of OFSP for health.

Project Objectives

1. Build the technical capacity of OFSP farmers, processors and bakers in good production and postharvest handling practices in the agricultural value chain
2. Develop and package OFSP into puree, flour and dehydrated mini-chips
3. Utilize OFSP puree for local breads, and flour for healthy weaning foods
4. Analyze and pilot potential for OFSP dehydrated mini-chips
5. Conduct economic analysis of OFSP from production to consumption.

Project Report Technical Narrative
--Submitted by E. Bonsi, C. Bonsi, P. Doamekpor, and R. Zabawa

Objective 1: Build the technical capacity of OFSP farmers, processors, and bakers in good postharvest handling practices in the agricultural value chain			
Activities	**Outcomes**	**Measures of Success**	**Documentation of Success**
Recruited and trained farmers in production of clean planting materials; Conducted training for farmers to develop grading indices and weight standardization for market to ensure highest quality of OFSP at time of harvesting and marketing.	Standardized OFSP packing by weight using scales	Producers adopt use of scales to measure OFSP packages	10 – 15 farmers received training in producing clean planting materials
	Producers adopt use of labeled jute bags	Producers now grade OFSP and sell produce in labeled jute bags	Two farmers and one processor received certificate of training and presented at the workshop training in Akatsi and Accra.
Developed and instituted short-term training of individuals involved in OFSP postharvest handling, logistics, storage, safety, good handling and processing practices.	Local farmers and a processor received training on best practices and handling of OFSP at Tuskegee University	Local farmers and a food processor completed two weeks training at Tuskegee University	135 producers comprising 91 males and 44 females participated in a one-day training workshop in Akatsi.
One-on-one training and demonstration on optimum planting methods (mounds vs. ridges) and yield determination	Producers and processors trained in OFSP production and food quality	Farmers trained on how to determine yield on a unit area	Farmers using a limited mixture of ridges along with traditional mounds for planting the crop
	Farmers trained on consistent planting distance and plant pop. to final yield		
Trained farmers on nursery establishment for multiplying planting material for distribution to other farmers	Farmers received training on establishing a nursery to provide clean planting materials.	Farmers desist from taking cuttings from established plots which eventually should increase crop yields.	Farmers agreed to use nonmarketable canner storage roots to establish nursery beds to produce clean planting materials

Objective 2: Develop and package orange sweet potato (OFSP) puree			
Activities	**Outcomes**	**Measures of Success**	**Documentation of Success**
Promoted general awareness and nutritional benefits of the OFSP	Participants identified benefits of OFSP products that can be introduced into local diets	Producers and processors registered and attended training workshops in Akatsi and Accra.	A total of 50 processors comprising 35 females and 15 males attended Accra training workshop
Conducted train-the-trainer workshop and demonstration for community-based women processors	Food processors learned about Vitamin A deficiency and the nutritional value OFSP provides in the traditional diet	Processors adopt standardize methods to prepare, package and label OFSP puree during processing.	Processors formulate weaning foods using proportions of OFSP combined with traditional diets
Conducted one day seminar of integrating existing and new food processing equipment	Processors identify basic equipment and received technical training for producing quality OFSP puree	Processing equipment procured to process OFSP	Manuscript of weaning food product development prepared and ready for submission
Developed appropriate techniques for packaging, and storage of OFSP products for both regional export and local consumption	Processors (bakers) applied knowledge gained to improve their operations	Processors applied knowledge gained to follow standard procedures for safe production, handling and packaging of OFSP products	Extension booklet and fact sheet developed
			Project poster developed and presented

Objective 3: Utilize OFSP puree for local bread production			
Activities	**Outcomes**	**Measures of Success**	**Documentation of Success**
Conducted training and demonstration of preparation of OFSP puree to make local breads	Processors formulated OFSP bread recipe, adapted OFSP recipe to local conditions to produce bread	Processors identified and developed the acceptable amount of OFSP puree to improve quality of bread	Manuscript for product development has been prepared
Conducted workshop on business plan development	Producers and food processors enlightened on steps to follow in basic record keeping to keep track of their business	Business plan template developed to suit individual production and food processing businesses	85 participants received training on how to keep basic information on their business

Objective 4: Analyze/pilot-test other potential OFSP products such as weaning foods for health.			
Activities	**Outcomes**	**Measures of Success**	**Documentation of Success**
Analyzed the nutritional and beneficial properties of OFSP weaning food products	Processors developed an understanding of product development to meet requirements of the Ghana Standards Board and Food and Drug administration	Weaning food products developed and OFSP products formulated and incorporated into traditional recipes	Weaning food formulated and standardized
Assessed viable value-added markets for OFSP, favorable production areas, and suitable processes that facilitate market linkages.	Processors developed an understanding of the OFSP value-chain		Sensory evaluation of developed product accepted

Project Performance Indicators

4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research.	9
Number of new technologies or management practices made available for transfer.	9
Number of new technologies or management practices being field tested.	8
Number of additional hectares under improved technologies or management practices as a result of USG assistance.	10
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	110
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	25
Number of rural households benefiting directly from USG interventions - Female Headed Household	50
Number of rural households benefiting directly from USG interventions - Male Headed Household	200
Number of producers organizations receiving USG assistance.	17
Number of community-based organizations receiving USG assistance.	10
Number of producers organizations who have adopted new technologies or management practices as a result of USG assistance.	5
Number of community-based organizations (CBO) who have adopted new technologies or management practices as a result of USG assistance.	15
Number of ag-related firms benefiting from USG supported interventions.	1
Number of women's organizations assisted as a result of USG interventions.	15
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	50
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training – Male	15
Number of individuals who have received USG supported long-term agricultural sector productivity food security training - Female	5
Number of individuals who have received USG supported long-term agricultural sector productivity food security training – Male	2
Capacity Building (Horticulture CRSP Indicator)	**Project Achievements**
Number of host country institutions in direct cooperation or collaboration.	7
Number of workshops conducted for host country personnel.	4
Number of host country professionals attending training - Female	10
Number of host country professionals attending training - Male	4
Number of U.S. faculty providing instruction in host country - Female	2
Number of U.S. faculty providing instruction in host country - Male	4
Number of host country professionals providing training to other host country professionals - Female	10
Number of host country professionals providing training to other host country professionals – Male	5
Number of host country professionals conducting research - Female	10
Number of host country professionals conducting research– Male	5

Project Reports by Priority Issue
Food Safety

I. Enhancing Trade in Horticultural Crops through Food Safety and Phytosanitary Measures

Increasing tomato production, quality, and safety through the introduction of a good agricultural practices curriculum in Nigeria
http://hortcrsp.ucdavis.edu/main/5Safety.html

Project completed in September 2011.

Lead Project Investigators:

- Sally A. Miller, The Ohio State University, USA
- Jeffrey T. LeJeune and J. Mark Erbaugh, The Ohio State University, USA
- Kenneth C. Shenge, Ladi Lydia Yakubu, Clement M. Z. Whong, and Ajayi Raphael Adeniyi Omolehin, Ahmadu Bello University, Nigeria

Project Summary

This project enhanced regional and international trade in Nigerian tomatoes by developing a science-based good agricultural practices (GAPs) curriculum and training programs to improve production, food safety, and phytosanitary compliance. The team conducted a rapid appraisal with market vendors and a socioeconomic survey with farm households in northwestern Nigeria to determine their knowledge, attitudes, perceptions and practices regarding produce food safety, quality, and plant health. During the farm household survey the team identified the sources and magnitude of microbial contamination of tomatoes. Water and produce were tested for selected human and plant pathogens, and farms were surveyed for major diseases, pests, and other production problems. Information from surveys was used to develop GAP guidelines to fit local market preferences, production systems and capabilities, and training modules for agricultural extension workers for scaling up to producers and other segments of the tomato value chain. Developing this institutional capacity to design and implement GAPs increased tomato production, quality, and safety and laid the foundation for expanded tomato exports and trade. This project increased the incomes of smallholder farmers, including women, and contributed to enhanced food security and economic growth.

> A good agricultural practices manual for tomato producers was prepared so that suggested practices would be practical and achievable within the Nigerian economic, cultural and environmental context. This manual is the first of its kind in Nigeria.

Project Objectives

1. Identify knowledge, perceptions and practices of market vendors and farmers regarding food safety, plant disease, and marketing constraints that affect production and trade.
2. Identify plant health issues limiting tomato productivity and potential for trade on smallholder farms, and sources and magnitude of tomato microbial contamination on farms and in markets in Nigeria.
3. Based on the above analysis of perceptions among horticultural professionals, develop a GAPs program suited for smallholder Nigerian farmers.

Project Report Technical Narrative
--Submitted by Sally A. Miller

A two-staged assessment was conducted with market vendors, wholesalers, and tomato growers in the targeted states of Kaduna, Kano, and Katsina. For this assessment, a subset of market vendors/traders was first sampled in each state using a rapid appraisal approach to assess vendor knowledge and perceptions of price, quality, consumer preferences, food safety, awareness of environmental sanitation, and postharvest marketing practices. Second, a household survey was then conducted among 30 growers to determine grower knowledge, perceptions, and practices regarding sanitary and phytosanitary (SPS) issues, production and management practices and problems, and grower background information that permits differentiation of this knowledge according to socioeconomic and gender criteria. Sample selection and surveying modalities were used to ensure women's participation in both assessments.

Microbial contamination of tomatoes in the markets was also examined. Three field surveys were conducted in November 2010 – February 2011 (early dry season), March – May 2011 (late dry season/early wet season), and July – August 2011 (wet season). The reason for spreading out the surveys is that the economics of tomato production differ widely between the two seasons, as well as the division of labor between men and women. Plant and human pathogen occurrence and population dynamics also differ from one season to the other.

> Tomato growers from our study area will now get better prices for their produce, gain direct access to pesticide companies, explore better market access, and more easily approach their elected representatives to make their voices heard.

A total of 126, 127, and 135 tomato disease samples were collected in the first, second, and third surveys respectively. Samples of whole tomato plants, fruits and leaves were evaluated visually for disease symptoms, packaged, kept cool in transport, and tested for plant pathogens in the laboratory according to standard protocols. Within each tomato farm (45 per state), the incidence of bacterial wilt, canker, bacterial spot, virus, fungal, and other diseases were visually assessed, and diseased plant samples were returned to the laboratory for further analysis by culturing and other appropriate methods. Data on pesticide use and other production practices were collected during the surveys from farmers and other household members.

Tomato fruits from fields and markets, as well as irrigation water samples were collected. The sources were identified, possible contamination points noted, and temperature and pH tested. Samples were then transported to the laboratory to test for pathogens using standard culturing and other analytical procedures (ELISA, Quanti-Trays, culturing). Market tomato fruit samples were handled and tested as described above for field fruit samples. Water sources used for produce washing in markets were noted.

A good agricultural practices manual for tomato producers (T-GAP) was prepared by integrating the microbiological and social science data collected. The recommended guidelines were both practical and achievable within the Nigerian economic, cultural, and environmental context, while building the Nigerian capacity to manage plant disease and phytosanitary risks. This novel approach is the first attempt to develop SPS policies and recommendations in Nigeria, and lays the foundation for future policy recommendations that will promote external trade.

A training workshop, based on our GAPs manual, was conducted on Aug. 3, 2011. Participants included tomato farmers, retailers, wholesalers, irrigation water users, and extension staff from the Agricultural Development Projects (ADPs).

In total, this project:

1. identified grower groups (including women's groups) in the region,
2. assessed knowledge gaps about food safety and SPS issues among value chain actors,
3. identified research and technology transfer priorities,
4. classified tomato diseases that cause production problems and potential trade barriers, as well as human and plant pathogens that contaminate tomato fruit, irrigation and wash water,
5. identified sources of microbial (human and plant pathogens) contamination better, and
6. developed a science-based GAPs document appropriate for Nigerian smallholder farmers/vendors.

As a result of the interactions during our GAPs workshop, tomato growers from our study area are now in the process of forming cooperative associations, which will help them get better prices for their produce through greater bargaining power, gain direct access to pesticide companies, explore better market access, and more easily approach their elected representatives to make their voices heard. In the states targeted by our project, women have indicated that, with the knowledge received through our project, they would more actively participate in tomato value chain activities. Finally, because of this project there is better cooperation between tomato farmers and extension workers in developing strategies for managing sanitary and phytosanitary risks.

Local farmers and farms were surveyed to develop appropriate good agricultural practices curriculum for microbial contamination.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	50
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	300
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance.	7
Number of new technologies or management practices made available for transfer as a result of USG assistance.	5
Number of additional hectares under improved technologies or management practices as a result of USG assistance.	60-90
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	over 300
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	over 900
Number of rural households benefiting directly from USG interventions - Female Headed Household	26
Number of rural households benefiting directly from USG interventions - Male Headed Household	149
Number of producers organizations receiving USG assistance.	24
Number of water users associations receiving USG assistance.	2
Number of trade and business associations receiving USG assistance.	4
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	2
Number of workshops conducted for host country institution, agency, and organization personnel	1
Number of U.S. faculty providing training or instruction in host country - Female	1
Number of U.S. faculty providing training or instruction in host country - Male	2
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	1
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	3

Project Reports by Priority Issue
Enabling Environment

I. Building an Ornamental Plant Industry in Honduras

Expanding the floral export industry in Honduras through improved storage and shipping technology, new breeding programs, trading networks, and grower cooperation
http://hortcrsp.ucdavis.edu/main/2Industry.html

Project completed in July 2012.

Lead Project Investigators:

- Alan B. Bennett, University of California, Davis, USA
- Cecilia Chi-Ham, University of California, Davis, USA
- Michael S. Dobres, NovaFlora, Inc., USA
- Dinie Espinal-Rueda, Zamorano University, Honduras
- David Flemming, NovaFlora, Inc., USA

Project Summary

This project supported the ornamental business in Honduras as a means to drive the development of a local high value industry, increase trade, and develop policy, training, and infrastructure to support the region's agricultural productivity. Expansion of the ornamental industry created new business activities for women and develops local expertise. The project also developed a local market of garden and landscape plants and provided a diversified base from which to establish a sustainable export industry.

This one-year project educated growers and breeders in best horticultural practices, identified and transferred technologies, and improved the logistic infrastructure and policy related to export trade. The team accomplished these goals through collaboration with key partners who have demonstrated expertise in the horticultural industry, agricultural research and outreach, in-country and regional logistics, and developing country technology transfer. The outcome of this project is directly transferable to the development of domestic and export driven horticultural businesses in other developing countries in Central America.

> In the end, the women were managing all aspects of the export including postharvest, quality evaluation, phytosanitary inspection, paperwork, and transportation of the flowers.

Project Objectives

1. Organize and educate growers in best horticultural practices.
2. Identify appropriate and best horticultural technologies for growers.
3. Improve the logistics and infrastructure related to export trade.

Project Report Technical Narrative

--Submitted by Alan B. Bennett and Cecilia Chi-Ham

Central America offers significant advantages in the horticultural and ornamental sector due to the ideal production conditions, low labor costs, and close proximity to local and export markets. However, there is a marked disparity among Central American developing countries' abilities to benefit from this high-value business, mainly due to internal capacity and infrastructure. For example, in 2006, Costa Rica and Guatemala earned more than $184 million and $37 million, respectively, in ornamental exports. In contrast, Honduras only exported about $6 million. The

disparity suggests that there is an opportunity to substantially increase this horticultural sector in Honduras.

The ornamental trade is ideally suited to the development of small businesses by women and other underrepresented groups. A few larger international companies do business in Honduras, but these do little to foster and encourage the growth of home-grown domestic and export driven horticultural businesses in Honduras. Developing the horticultural and ornamental sector in Honduras is of high priority because it offers the opportunity to increase agricultural productivity in a promising and untapped market and to significantly increase small-scale farmers' incomes.

The long-term vision to increase famer income is to develop a flower market in Honduras. We believe that market-driven approaches are critical to implementing sustainable solutions to alleviating poverty in developing countries. The goal of the one-year pilot project was addressing the major constraints that we identified as preventing the growth of Honduras' horticultural sector: 1) educating growers and breeders in best horticultural practices; 2) identifying and transferring technologies; 3) improving the logistic infrastructure and policy related to export trade.

One of the most important aspects of this project was the balanced representation of collaborators from public and private sectors and with local and international expertise. Collaborators included: representatives from U.S. and Honduran universities, UC Davis and Zamorano; a U.S.-based horticultural company NovaFlora with market know-how in the United States and Central America; a non-profit organization, PIPRA, with experience in transferring technologies to developing countries; and several collaborators that provided business and in-country support. In addition, the team recruited an intern who was a recent university graduate with an entrepreneurial spirit and who, unlike most of the partners, was able to dedicate undivided attention to the project.

To initiate the project, we performed a comprehensive survey of all the existing tropical flower producers in Honduras. The choice of grower partners was essential because we had a year to demonstrate feasibility; thus our aim was to identify growers that were committed and who had already grown flowers. We reasoned expansion of a successful pilot project could then focus on training new growers. We identified and invited to the team a group of about 18 female growers who were "associated" –although the association was not working as such. We identified that while the country had expertise in growing many tropical flowers, red ginger was selected for use in this project for market purposes.

We spoke with community leaders to gain their confidence. To our surprise, the growers were a bit wary of working with another international mission. The women growers grew more enthusiastic as we explained our market-driven vision that was not focused on agronomic training, but instead market implementation. Their response was, "We know and can learn how to grow anything you want, the challenge is selling and finding a market." We gained their trust and jointly embarked on addressing each of the challenges in opening a market.

The first objective was educating growers and breeders in best horticultural practices. Here we observed their current agricultural practices and teamed with FINTRAC, who provided biweekly visits and training by a field expert, and with Zamorano University, who donated pest management and fertilizer inputs. To minimize the expenses and efforts from the women, we worked with two demonstration plots or two growers at a time. This way, the growers only had to buy additional inputs and incur labor costs once every few months. The goal, which was achieved

with little difficulty, was to see if the women could grow export-grade flowers. To increase the region's capabilities in breeding, a Zamorano student went for long-term training at NovaFlora in breeding. He returned to Zamorano to share skills and knowledge.

We trained a Honduran intern at UC Davis on postharvest practices, flower industry, and on a transforming technology, the CoolBot, to address cold-storage limitations in the farm-to-market chain. We also partnered with another Horticulture CRSP project that provided *Phytophthora* training to a Zamorano faculty member during a course taught in Costa Rica. The value to the project was that in the future, Hondurans would have the know-how to certify that exports to the United States were free of this threatening pathogen and thus increase value of the commodity. Our project also provided numerous courses to the women growers on various aspects of the value chain. We recognized that the associated women lacked skills on how to operate as an association and how to run a business. Thus we arranged for a local agency to provide free classes on business development and how to operate as an association. The producers also received training on the phytosanitary inspection process. A USDA-representative in Honduras taught the growers how to do their own mock inspection, as the product would be inspected in the U.S. port of entry. This training was very critical to the success of the export trials to the United States, which were conducted during the course of the project.

At the start of the grant, we focused on objectives #2) identifying and transferring technologies and #3) improving the logistic infrastructure and policy related to export trade. Though the country had no prior precedence for exporting tropical flowers, we found that local agencies were willing to work with us. Although procedures for obtaining export and phytosanitary permits in Honduras are not streamlined, we obtained all the proper documentation with relative ease. The main challenge was addressing the lack of infrastructure, particularly with cold-chain and transportation. We learned that the main ports and airports in Honduras lack cold-storage infrastructure. Our solution to the cold-storage limitation was to implement the cold-storage technology from another Horticulture CRSP project called CoolBot. We established cold storage at the farm because that is when it is most critical for the tropical flowers. The cold storage from the farm and at the airport was a pick-up truck with a working air conditioner.

We assessed the possibility of exporting red ginger flowers from Honduras through different modes of transportation, air and sea. Though Honduras has a robust sea port and the flowers are compatible with the conditions necessary for banana fruits, we found that the timeframes for export were too long for a perishable product. Airfreight is really the only option; however, the cost to export by air freight from Honduras is too high, almost the same as production costs. Nevertheless we calculated that at higher sale volumes the cost of transportation may make this a profitable market. Transportation continues to be a bottleneck for flowers and other commodities and could, in itself, be the focus of an international aid project.

Although the project anticipated focusing solely on the export limitations, half-way into the project we felt we were prepared for a test export shipment. The first test export shipment of red gingers was to see if we could merely get the flowers from Honduras to the United States and pass phytosanitary inspection, a considerable challenge! We obtained donated equipment from SENSITECH which allowed us to monitor temperatures during shipment. The flowers arrived to the United States, though the shelf-life was not up to market standards (~6 days). At this point, we did a training workshop in Honduras and decided to implement postharvest practices and the cold-storage technology to increase shelf-life. The postharvest practice consisted of a PVC pipe filled with water, as re-hydration of the flower immediately after cutting is critical. We also converted an office into a cold room with the implementation of the CoolBot.

After numerous vase-life tests, we were able to increase shelf life. The two postharvest changes were tested in a second export shipment. After the changes in postharvest, the lowest quality shelf life (~12 days) was equal or superior to other tropical flowers found in the U.S. market.

Encouraged by the progress of our pilot project, the team decided it was time to get comments from potential distributors in the United States. The industry partner, Novaflora, arranged for demonstration of the Honduran tropical flowers with six distributors in the Philadelphia area. The subsequent four test shipments were used to establish a relationship with potential distributors, obtain input on the product, and test the market. Three of the shipments coincided with major U.S. holidays: Christmas, Valentine's Day, and Halloween. During Halloween we learned that in addition to red ginger, miniature orange birds of paradise had great market potential.

Also an important aspect of the test shipment was to train the women on how to do all aspects of the exports. The team was involved in supervising the first export shipments; however, in later shipments we increasingly transferred this responsibility to the women growers. In the end, the women were managing all aspects of the export including postharvest, quality evaluation, phytosanitary inspection, paperwork, and transportation of the flowers.

Despite the achievement in testing a promising export market, the transportation costs continue to be too high to launch a new industry. Our sustainability strategy was to develop a website portal for resources and to attract future sales by these and new growers, http://www.florhonduras.com and Florhonduras on Facebook.

> We addressed Honduras' limitations to build a flower industry. However, weak transportation and poor cold-storage infrastructures continue to be significant obstacles.

Given the transportation challenges to build an export market, we also focused on considering a local market. Local flowers are sold through street vendors or established, high-end florists. We implemented flower kiosks called "Deconatura" (decorate with nature) at the larger malls in the capital city and project to establish more in other major cities (Facebook: Deconaturas). Each of these businesses is now operated through a local entrepreneur and in this way we hope the market-driven approach may increase the opportunities to increase revenue to the local growers.

In conclusion, we addressed Honduras' limitations to build a flower industry. However, in Honduras the weak transportation and cold-storage infrastructures continue to be significant obstacles. The high costs of transportation prevent the country from developing export markets. Properly addressing these issues will require working with government and implementing policies that are more amenable to export of agricultural commodities.

We exceeded the pilot project's objectives by successfully demonstrating that it is possible to increase income to farmers by developing a promising export business of tropical flowers, just as neighboring countries have been able to do. The pilot project underscored the importance of implementing business and market-driven development projects and forging public/private partnerships. Due to the local uncertainties and realities of developing countries, it is critical to allow for flexible projects that can adapt strategies as the projects advance.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of policies/regulations/administrative procedures analyzed.	4
Number of policy reforms, regulations, administrative procedures approved	4
Number of policy reforms, regulations, administrative procedures drafted and presented for public/stakeholder consultation	5
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	25
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	35
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research.	14
Number of new technologies or management practices made available for transfer as a result of USG assistance.	14
Number of new technologies or management practices being field tested.	14
Number of rural households benefiting directly from USG interventions - Female Headed Household	25
Number of rural households benefiting directly from USG interventions - Male Headed Household	5
Number of producers organizations receiving USG assistance.	1
Number of trade and business associations receiving USG assistance.	1
Number of community-based organizations receiving USG assistance.	2
Number of producers organizations who have adopted new technologies or management practices as a result of USG assistance.	25
Number of trade and business associations who have adopted new technologies or management practices as a result of USG assistance.	1
Number of community-based organizations (CBO) who have adopted new technologies or management practices as a result of USG assistance.	2
Number of agriculture-related firms benefiting directly from USG supported interventions.	5
Number of women's organizations/associations assisted as a result of USG interventions.	1
Number of public-private partnerships formed as a result of USG assistance.	1
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	25
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training – Male	25
Number of individuals who have received USG supported long-term agricultural sector productivity food security training - Female	25
Number of individuals who have received USG supported long-term agricultural sector productivity or food security training - Male	25
Number of jobs attributed to FTF implementation	25
Number of research projects and/or technologies of potential benefit to U.S. horticultural industries	13

Capacity Building (Horticulture CRSP Indicators)	Project Achievements
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	4
Number of workshops conducted for host country institution, agency, and organization personnel	5
Number of host country professionals attending workshops, training conferences, or similar - Female	25
Number of host country professionals attending workshops, training conferences, or similar - Male	25
Number of certificate training programs conducted	1
Number of certificates earned by host country professionals - Female	1
Number of certificates earned by host country professionals - Male	1
Number of U.S. faculty providing training or instruction in host country - Female	2
Number of U.S. faculty providing training or instruction in host country - Male	3
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	7
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	4
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	3

II. Improving Market Access for Emerging South African Rooibos Farmers

Integrating emerging or marginalized Rooibos tea farmers into Fair Trade and other market systems in South Africa
http://hortcrsp.ucdavis.edu/main/8Rooibos.html

Project completed in March 2011.

Lead Project Investigators:

- Laura Raynolds, Colorado State University, USA
- Andries du Toit, University of the Western Cape, Bellville, South Africa
- Douglas Murray, Colorado State University, USA
- Jennifer Keahey, Colorado State University, USA
- Sandra Kruger, Sandra Kruger & Associates, Pniel, South Africa

Project Summary

Fair trade's rapid growth offers the potential for empowering small farmers via access to high-value markets and support for community development and sustainable production. In South Africa, fair trade can help combat acute racial and gender inequalities, building on post-Apartheid policies and NGO initiatives in agriculture. While some smallholder farmers have increased their wellbeing through fair trade, emerging black farmers historically excluded from land and market access have yet to gain entry into these beneficial networks.

This project identified the challenges and opportunities for integrating emerging farmers into fair trade and associated value-added activities. This project focused on Rooibos which can be cultivated in arid soils with little capital investment. The project fostered racial equity and combated poverty in one of South Africa's poorest regions and promoted gender equity, recognizing that women play a key role as farmers and household workers yet are often the most disadvantaged. The team built the organizational capacity of the South African Rooibos Council, established an Emerging Farmer Working Group within the council, including a women's networking group, and provided training in certified and value-added market access, biodiversity preservation, and fiscal management. The project directly benefited more than 500 community members; the project team extended benefits via policy engagement at national and international levels.

> In final project phases, we culminated industry networking activities by hosting a policy seminar at the University of the Western Cape, in which leaders presented research findings to core industry and certification body representatives.

Project Objectives

1. Identify emerging Rooibos farmers' marketing capabilities, opportunities, and constraints.
2. Develop institutional capacity of South African Rooibos Council to provide an enabling environment for emerging farmers through the implementation of training and support services
3. Implement participatory training services to improved market access prospects for emerging farmers
4. Evaluate project outcomes to analyze existing emerging farmer policies and inform ongoing policy development and reform at both the national and international levels

Project Report Technical Narrative
--Submitted by Laura T. Raynolds

This project delivered market access training in South Africa's emerging Rooibos tea sector. To build local scientific and technical capacity, we developed an integrated methodological approach specifically designed to empower emerging farmers, improve producer support, and expand producer-industry networks. This integrated approach incorporated a strong research component in which we identified emerging Rooibos farmers' marketing conditions, constraints, and opportunities. We integrated research with project monitoring and evaluation, and likewise engaged findings to facilitate industry-level policy discussions to improve emerging farmer horticultural trade and export capacity. The project built human and organizational capacity via in-depth training delivery and industry networking development. Our efforts provided an enabling environment to emerging farmers within the Rooibos industry, benefitting approximately 500 Rooibos community members. Industry benefits extended well beyond producer communities as we directly involved numerous industry and certification body representatives as well as additional researchers in project activities. By engaging in this manner, we were able to strengthen industry networking and interdisciplinary collaboration.

Local partners were critical for success. Here, Sandra Kruger leads a workshop.

Our methodological framework is both reflexive and pragmatic. Theoretically, we integrated commodity network analysis with socio-political theories to examine democracy, bureaucracy, and power within the Rooibos commodity network. Methodologically, we incorporated Amartya Sen's human capabilities approach, which engages capabilities as a more holistic measure of socio-economic wellbeing. Participatory action research likewise informed all aspects of project engagement to ensure stakeholder empowerment. In terms of training delivery, we employed outcome-based education to ensure active learning, assessment, and goal achievement. While these conceptual strategies are diverse, they are nevertheless complementary, and synthesis evolved from a process of reflexive application and pragmatic adaptation.

Over the course of the project, we facilitated multiple activities. To begin, the project team identified emerging Rooibos communities and invited project participation. We then held preliminary capabilities workshops within seven participating community groupings, which culminated in gender equitable farmer leader elections for subsequent project engagement. We engaged findings from capabilities workshops to design a series of three multi-day train-the-trainer programs which we held with farmer leaders during the first three project quarters. As part of this process, leaders assisted in developing a modular toolbox of training material and related guide to standards and certification for their use as future trainers. Concurrently, we began leadership industry networking activities, which we continued to expand upon throughout the project. At project mid-term, we conducted in-field research training to enable leaders to actively participate in developing and conducting emerging farmer interviews in their community groupings. At this time, we additionally began theoretical training to secure leader involvement in subsequent data analysis and to help leaders develop the democratic and bureaucratic skills necessary for active industry engagement.

In final project phases, we culminated industry networking activities by hosting a policy seminar at the University of the Western Cape, in which leaders presented research findings to core industry and certification body representatives. These groups then engaged in break-out sessions to discuss producer-industry networking prospects. At project end, farmer leaders designed and facilitated workshops in their community groupings to deliver training in areas identified by their communities as most critical, and they additionally began the process of formally instituting an Emerging Farmer Working Group within the South African Rooibos Council to further enhance producer-industry networking capacity. Consolidating project benefits, the Emerging Farmer Working Group will be fully institutionalized by the end of July 2011. Female farmer leaders have decided to continue to incorporate gender concerns within the main working group where they are equally represented and have become highly effective members, rather than developing a separate women's networking group. This institutional structure will ensure that female farm leaders are able to continue to productively engage with their counterparts and with the industry as a whole.

At project end, we are pleased to announce that farmer leaders have continued to surpass initial expectations. Not only have they actively engaged in all project components, they have continued to develop as a strong group of committed stakeholders.

By integrating assessment with engagement, we incorporated Horticulture CRSP's monitoring and evaluation plan into our overall methodological design. Monitoring and evaluation consisted of initial capabilities assessment, ongoing learner assessment and training evaluations, mid-term community fieldwork, ongoing leader reports, and final project evaluation surveys. Farmer leaders were thus actively involved in project monitoring and evaluation throughout the entirety of the project and findings demonstrate that we created impact beyond research in multiple ways.

Most importantly, male and female farmer leaders were able to develop and transfer capacities. Leaders received training in the following areas: 1) market access, 2) standards and certification, including fair trade, organics, and UTZ certifications, 3) biodiversity, 4) food safety, 5) financial management, 6) effective communication, 7) industry networking, 8) leadership, 9) public speaking, 10) socio-political theories, 11) research methods including interviewing and data analysis, and 12) Afrikaans-English translation. While the diversity of training required us to repeat information in multiple training sessions, pragmatic application enabled leaders to retain much of what they learned. Indeed, final survey findings demonstrate that leaders were able to effectively share what they learned within their communities. For example, 100 percent of community members felt that the farmer leaders had good knowledge of the topics they presented in their community workshops, 82 percent said that their leaders had provided feedback on the training they had received, 78 percent had received feedback on leader industry networking activities, and 65 percent said they would go to leaders for advice before approaching external experts. The successful training of this group of farmer leaders and their demonstrated ability to share their knowledge with men and women throughout the community will strengthen the participation of emerging farmers in high-value markets now and into the future.

At project end, we are pleased to announce that farmer leaders have continued to surpass initial expectations. Not only have they actively engaged in all project components, they have continued to develop as a strong group of committed stakeholders. As the Emerging Farmer Working Group, this leadership group plans to develop strategies for securing ongoing training and funding opportunities. The South African Rooibos Council has likewise expressed an ongoing

commitment to providing leaders with an enabling environment from which to operate. Leaders have established a positive industry presence and numerous actors have expressed interest in further collaborating with this group to capitalize on producer-industry information exchange opportunities.

When we arrived in the Wupperthal communities in early 2010, we found them in disarray due to a number of serious problems and disagreements within the area's Rooibos cooperatives. Many farmers were angry because they had not received payment for their crop in years and did not want to become engaged in any Rooibos-related project as they felt further involvement would be a waste of their time. These challenges appear to at least partially stem from previously implemented top-down projects which failed to invest in appropriate levels of capacity building. Given this backdrop, project outcomes are particularly striking. Not only have leaders united to develop an information sharing network that is focused on opportunity rather than conflict, they have been active in sharing market information with their communities in an effort to clear up misunderstandings. Leaders are now focused on developing potential steps forward. Via their involvement in research and data analysis, they have highlighted the common problems facing farmers and have expressed interest in working with certification bodies to engage bureaucratic solutions to cooperative issues. While we worked hard to achieve project objectives, leaders encouraged us to surpass original goals. They have displayed outstanding levels of enthusiasm, professionalism, and support and as a result, information exchange has advanced in multiple directions.

In summary, this project strove to enhance racial equity and combat poverty to improve the quality of life of emerging farmer households in one of South Africa's poorest regions. We actively promoted gender equity by bolstering the participation of female emerging farmers in all aspects of project engagement. Ongoing attention to these ambitious goals of promoting equity, empowerment, and poverty alleviation ultimately shaped project success. Too often development projects tend to maintain a state of dependency, in which people remain unable to take charge of their own livelihoods. At worst, they may destabilize and/or demoralize already struggling communities. Empowerment through active capacity building can reverse this process, but for this to succeed, historically disadvantaged communities must have access to the enabling environments necessary for ongoing capacity building. This project demonstrates the importance of bringing farmers into projects as participatory stakeholders rather than as beneficiaries who must passively receive pre-determined assistance. Farmer leaders in this project have proven themselves capable of facilitating the transfer of critical local knowledge to diverse groups, including industry and organizational actors, social researchers and scientists, and fellow community members. Their ongoing participation will ultimately enable all interested parties to secure more accurate information and thus more sustainable outcomes. The methodological model that we have outlined above may be applied within diverse commodity sectors and regions as a means of providing efficient yet effective support for producers and industries adapting to 21st Century markets, which increasingly require rapid and coordinated response to emerging trends in standards and certification.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of policies/regulations/administrative procedures analyzed.	6
Number of policy reforms/regulations/administrative procedures passed for which implementation has begun with USG assistance.	1
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	98
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	105
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices being field tested as a result of USG assistance.	3
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	98
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	105
Number of rural households benefiting directly from USG interventions - Female Headed Household	98
Number of rural households benefiting directly from USG interventions - Male Headed Household	105
Number of producers organizations receiving USG assistance.	5
Number of producers organizations who have adopted new technologies or management practices as a result of USG assistance.	5
Number of women's organizations assisted as a result of USG interventions.	3
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	98
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	105
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	11
Number of workshops conducted for host country institution, agency, and organization personnel	3
Number of host country professionals attending workshops - Female	10
Number of host country professionals attending workshops - Male	13
Number of U.S. faculty providing instruction in host country - Female	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	5
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	7
Number of host country professionals directly involved research - Female	20
Number of host country professionals directly involved research - Male	20

III. Promoting Fruit and Vegetable Production to Improve Nutrition

Improving community nutrition in Nkokonjeru, Uganda, by promoting fruit and vegetable production through local university research and partnerships, demonstration gardens, farmer field schools, and nursery expansion
http://hortcrsp.ucdavis.edu/main/12Nutrition.html

Project completed in March 2011.

Lead Project Investigators:

- Kate Scow and Johan Six, University of California, Davis, USA
- Edith Naggenda, Farmer Field School Trainer, Uganda
- Ignitius Bwoogi, Rural Agency for Sustainable Development, Uganda
- Charles Jjemba, Our Lady Queen of Apostles Nkokonjeru Parish, Uganda
- Michael Masanza, Uganda Christian University, Uganda
- Peter Lusembo, ZARDI, Uganda

Project Summary and Objectives

This project facilitates the organization and strengthening of smallholder farmer groups in the Nkokonjeru region of Uganda by providing technical training in fruit and vegetable management and improving farmers' access to simple and innovative production technologies. The specific project objectives are: i) increase vegetable and fruit production through farmer field schools and strengthen farmers' access to local and regional markets for vegetables and fruits; ii) strengthen local farmer group structure and capacity of local partners to support farmer groups; iii) increase participation of women in agricultural activities (research, education, outreach) in Nkokonjeru township and Mukono; and iv) enhance institutional capacity in agriculture at Uganda Christian University (UCU) and promote research and education exchange among UC Davis, UCU, and other collaborating institutions. Project activities are to: i) expand local nursery to serve as information center and source for fruit and vegetable production; ii) use farmer field schools to train farmers and strengthen farmer groups; iii) provide research experience and outreach training to UCU students; iv) engage in participatory research of disruptive technologies within the farmer group framework; v) build capacity of Rural Agency for Sustainable Development (RASD) to support farmers through improved communication and institutional organization.

> It was found that combining organic and inorganic nutrient inputs may be a more cost-effective strategy for managing soil fertility in vegetables by producing higher value products than either nutrient source on its own.

Project Report Technical Narrative
--*Submitted by Kate Scow, Sean Kearney, Abraham Salomon, and Lauren Pincus*

1. Farmer Field Schools (FFS)

Farmer field schools were carried out as a core activity to address the following key problems identified from earlier site visits: 1) lack of access to training and extension, 2) limited land, capital, and bargaining power and high risk, 3) lack of access to technology and information, and 4) low involvement of women in agricultural extension and agricultural income generating activities.

After conducting an initial needs assessment survey and developing a curriculum, the FFS commenced in early May 2010. Tomatoes were identified as the focus crop as nearly every group surveyed identified tomatoes as one of their top three crops of interest.

For many group members, this project was the first time they had access to the inputs provided, especially improved seed varieties and inorganic fertilizers. Additionally, many participants learned new management techniques such as sowing a nursery and transplanting seedlings, using supplemental irrigation to grow vegetables in the dry season, or composting manure. Each farmer group was provided a chart to help identify common pests and diseases in tomatoes and provide control measures.

The techniques introduced in the FFS that were most adopted by individuals include:

- Market research and relationship strengthening with buyers
- Diversification of vegetable production (both indigenous and exotic vegetables)
- Budget and planning training
- Management of group savings and group accounts
- Use of fertilizer and/or manure as a soil amendment

Mid-way through the FFS season, four farmer group exchanges were held between the participating groups. The goal of the exchanges was to encourage flow of ideas and information between groups, build relationships among participating farmers, and encourage pride and recognition for the work done in the FFS. The four exchanges had different rates of success in achieving these objectives, but for the majority of participants, these goals were met. During interviews with farmers and focus groups at completion of the FFS, many farmers noted the exchanges as some of the best parts of the program.

Part of the farmer field school training included nursery production.

At the end of October 2010, the FFS officially concluded with the “Farmer Field Day.” This event was a culmination of the work done by the farmers and proved to be an important part of the FFS experience. The purpose of the event was to bring farmers from all the groups together to realize their common experiences, share information and innovations discovered within their respective FFS groups, link to resources both within the community (such as input dealers) and from outside of it (such as extension agents), demonstrate the work they have done to the broader community, and build self-esteem/empowerment to continue their work in horticulture. The event included a broad mix of stakeholders beyond participating farmers.

Key Outcomes of FFS:

- Formation of eight new farmer groups
- Strengthening and formalization of new and existing farmer groups through development of a constitution, creation of group bank accounts, and election of group leaders and officials
- Intensive agronomic training in various best management practices, principles of farming as a business, marketing, and group development dynamics for more than 350 farmers
- Distribution of fact-sheets for tomato pest management translated into the local language

- Strengthened relationships between farmer groups and local and regional agricultural extension agents – FFS facilitators report that farmer groups still frequently call upon them for continued agronomic advising.
- Eight farmer groups have gone on to develop collectively managed commercial plots
- Increased individual production of, and income from, vegetables
- Modest adoption of best management practices introduced by the FFS

2. Parish Nursery and Demonstration Farm

The main goal of working with the existing Parish nursery and demonstration farm in Nkokonjeru was to expand their nursery production beyond banana and coffee seedlings to include more fruit tree and agroforestry seedling production and sales.

Key Outcomes of Parish Nursery and Demonstration Farm:

- Access to reliable irrigation through the construction of a 10,000 liter water tank connected to a consistent water source
- Increased exposure and community awareness of the Parish Demonstration Farm through multiple farmer visits, new products and participation in the Farmer Field Day
- Expansion of saleable products and demonstrations to include vegetables, agroforestry seedlings, informational materials for use of agroforestry trees and grafted and improved fruit tree seedlings
- Training by MUZARDI staff for proper tomato seed saving techniques
- Awareness of, and potentially long-term access to, a new wilt resistant tomato variety, MT56
- Planting of a mother garden of improved mango and citrus trees for future seedling grafting

3. Rural Agency for Sustainable Development (RASD) Capacity Building

A small but important component of this IIP was to continue to build the capacity of the Rural Agency for Sustainable Development to support future agricultural and community development projects in and around Nkokonjeru. We contracted with Reach Your Destiny Consulting, a capacity building organization, to conduct workshops for RASD.

> For many group members, this project was the first time they had access to many of the inputs provided, especially improved seed varieties and inorganic fertilizers.

Key Outcomes of RASD Capacity Building:

- Repair and subsequent reopening of an internet café, expanded to include printing and scanning services
- Submission of a business case to MTN to construct a new 3G internet tower for the Nkokonjeru community
- Specific training and development workshops for strategic planning for RASD staff and the creation of a detailed and updated Strategic Plan document
- Strengthened linkages and relationships between RASD and key agricultural stakeholders in the region including MUZARDI, Uganda Christian University, the Mukono and Buikwe district offices, individual famers, and farmer groups.

4. Internships for students of Uganda Christian University (UCU)

Two female students from Uganda Christian University (UCU) in Mukono participated in a variety of hands-on learning activities as part of an internship program funded by the project. Funds covered the students' tuition as well as transportation and other costs related to the

internship. Both students shadowed facilitators and attended FFS sessions 2-3 times per week to learn about participatory agricultural extension and gain knowledge in agronomic production of vegetables. The students also received hands-on training in fruit tree grafting techniques from experts at the Kawanda National Agricultural Research Centre, MUZARDI and the nursery manager at the Parish Demonstration Farm in Nkokonjeru. The students also participated in the set-up of a soil fertility experiment practice plot at the Parish Demonstration Farm. This provided an introduction to experimental design and proper soil sampling techniques. The students conducted individual research assignments (one on fruit tree grafting and one on organic pest management) and carried out research through literature review and personal interviews with experts. Both students completed reports on what they learned through the internships as well as on the special topics noted above.

5. Integrated Soil Fertility Management Research

UC Davis conducted an on-farm experiment located at the study plots of eight of the fourteen participating farmer groups. This experiment served to demonstrate the value of controlled experimentation to farmers, as well as develop insight into local soil response to different soil fertility treatments. The fieldwork largely adhered close to its design, and the research plots were harvested mid-November.

Results from the experiment were very encouraging. It was found that combining organic and inorganic nutrient inputs may be a more cost-effective strategy for managing soil fertility in vegetables by producing higher value products than either nutrient source on its own. The study also reinforced to farmers that some sort of fertilizer is required to grow vegetables on soils in the area.

6. Empowerment of Women through Project Activities

Women were included at all levels of project implementation, from leadership to beneficiaries. As a result of these efforts, the majority of FFS facilitators were female, both interns from UCU were women, and the majority of FFS farmer participants (about 75%) were also women. Two of the 14 farmer groups participating in the FFS were women's groups and were formed during project implementation.

We recognize that women's involvement does not necessarily translate directly into empowerment, but we feel that the project did have an impact beyond participation. While evaluation efforts did not attempt to quantify empowerment of women, several anecdotal observations stand out to support that the project did more than just include mostly women: 1) the lead FFS facilitator and several other trainers and project leaders were female, 2) many of the farmer groups elected officials who were women (although chairpersons were often men) and 3) women were often selected as farmer group representatives for many of the farmer group exchange, Farmer Field Day, and participatory evaluation activities.

7. Project Evaluation and Impact Assessment

An extensive project evaluation and impact assessment was conducted and is available from Horticulture CRSP. Below is a list of strategies we feel are essential to further success, as well as mistakes to avoid in future projects.

Important strategies specific to FFS implementation:

- Increased focus on markets and "farming as a business": Nearly all farmers were interested in growing vegetables for markets. Farmers with a ready market in mind were more motivated to engage in the FFS process, and future FFS projects should consider

identifying and linking farmers with markets for the study crop from the outset of the FFS.

- Consider reinforcing FFS concepts with participatory research: The FFS approach can be a great tool for identifying farmers interested in experimentation and experiential learning. On-farm research can maintain rigor to answer specific questions or field-test technologies while complementing the topics explored by FFS participants.
- Devote sufficient time and resources to FFS projects: Achieving significant and lasting impact with the FFS approach in a one-year project may be overly ambitious. The participatory and group nature of this methodology requires patience and resources. It is critical to allow each group to move at its own pace and maintain control over the direction of their efforts. But while the approach may seem resource-intensive compared to traditional extension, the ability to tailor lessons to needs, to cover topics of interest in depth, and for spillover to non-participants help justify these costs.
- Try to maximize opportunities for exchanges between farmer groups: The group exchanges were extremely motivating for participants at both the group and individual level. This gives farmers a chance to learn from others, in addition to fostering pride in their work and the drive to continue experimenting and innovating beyond the FFS. Conversations with farmer groups from other projects around the region illustrated to individuals that success was possible and that they are not the only ones encountering difficulty.

<u>Mistakes to avoid</u>

- Avoid providing inputs directly: Most of the tools and inputs distributed to farmers by the project were purchased by project managers and then given to farmers. In retrospect, we realized that this undermined a potentially valuable opportunity to link farmers directly with input markets, increase their knowledge of prices, options, and availability of supplies, and promoted the “gift aid” mentality that has historically diluted farmer motivations to take risks and innovate.
- Consider hiring independent translators and/or facilitators to minimize conflict of interest: While not a major issue in the project, occasionally complications arose during translating activities. It is tempting to constantly rely on in-country partners for translating services, but when an outside partner needs to directly communicate a message to farmers, it can be useful to have an independent translator to avoid the temptation for partners to push alternate agendas (i.e. for other projects or political reasons).

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	260
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	92
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance.	3
Number of new technologies or management practices made available for transfer as a result of USG assistance.	4
Number of new technologies or management practices being field tested as a result of USG assistance.	3
Number of additional hectares under improved technologies or management practices as a result of USG assistance.	4
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	120
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	40
Number of community-based organizations (CBOs) receiving USG assistance.	2
Number of producers organizations who have adopted new technologies or management practices as a result of USG assistance.	14
Number of women's organizations/associations assisted as a result of USG interventions.	2
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	5
Number of workshops conducted for host country institution, agency, and organization personnel	1
Number of host country professionals attending workshops, training conferences, or similar - Female	9
Number of host country professionals attending workshops, training conferences, or similar - Male	8
Number of certificate training programs conducted	2
Number of certificates earned by host country professionals - Female	2
Number of U.S. faculty providing training or instruction in host country - Female	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	3
Number of host country professionals directly involved in conducting research activities - Female	2
Number of host country professionals directly involved in conducting research activities - Male	3

Project Reports by Priority Issue
Germplasm

I. New Technology for Postharvest Drying and Storage of Horticultural Seeds
Introducing novel, sustainable technologies to dry and store seeds in hot and humid areas of India, Nepal and Thailand
http://hortcrsp.ucdavis.edu/main/4Seeds.html

Project completed in September 2011.

Lead Project Investigators:
- Kent J. Bradford, University of California, Davis, USA
- Peetambar Dahal, University of California, Davis, USA
- Jwala Bajracharya, Nepal Agricultural Research Council, Nepal
- Bhartendu Mishra, Nepal Agricultural Research Council, Nepal
- Keshavulu Kunusoth, Acharya N G Ranga Agricultural University, India
- Johan Van Asbrouck, Rhino Research, Thailand

Project Summary
High-quality seeds of improved varieties are essential to enhance the production of annual horticultural crops. In tropical climates, high temperatures and humidity combine to cause rapid deterioration of seeds in open storage, resulting in loss of value, poor stand establishment, lower productivity, and disincentive to invest in improved seeds. Most horticultural seeds in the targeted locations are locally produced or self-saved and are stored without facilities for drying them to moisture contents that would greatly extend their storage lives. We demonstrated a simple, inexpensive, and widely adaptable method for drying horticultural seeds and maintaining high seed quality during storage. A novel zeolite desiccant, combined with inexpensive hermetic containers, both dried horticultural seeds and maintained them in a dry state during storage, greatly increasing their storage lifetime. As women perform most of the seed production, harvesting, and storage operations for horticultural seeds in these regions, adoption of this system would have direct benefits by enhancing the value of their labor. This simple seed drying and storage system enables the development and distribution of more productive varieties, which can lead to marketing of higher quality products and increases in women's and families' incomes.

> The drying beads were effective in lowering the seed moisture content during storage. After six months, there were marked differences in radicle emergence, final germination, and emergence from soil. Preliminary calculations show cost savings of 35 percent by using beads, which maintain germination at 89 percent over traditional seed-drying with 54 percent germination.

Project Objectives
1. Develop and calibrate a simple, cost-effective method for drying and storing horticultural seeds using a novel water-absorbing polymer/desiccant.
2. Demonstrate the use of desiccant and value of seed drying for enhancing storage life and improving seed quality.
3. Provide information about and access to proper postharvest management to maintain high planting quality (vigor) of stored horticultural seeds.
4. Analyze the economic feasibility of adoption of this method for different scales of application.

Project Report Technical Narrative
--Submitted by Kent J. Bradford
At the beginning of this project, we developed the protocol for reducing seed moisture contents using novel desiccant beads developed for this purpose by Rhino Research. We tested the effectiveness of these zeolite beads for postharvest drying of horticultural seeds. The following crops were used for drying and storage experiments at respective centers in India and Nepal: onion, tomato, cucumber, okra, eggplant, soybean, bottle gourd, watermelon, chilies, sponge gourd and bitter gourd.

By the end of the second quarter of this project, we were able to complete the project sub-contracts to put the funds in the hands of our foreign collaborators. The ovens, beads, and vacuum sealers to be used in the research were purchased and shipped from Thailand to India, Nepal, and the United States. Other activities focused on collecting seeds for the storage studies and initiating the seed drying and storage experiments. Seed samples were collected in India and Nepal for use in the studies. On May 21, 2010, a first workshop was held in cooperation with the Thai agricultural department at the Thai Rice Seed Center in Phitsanuloke. Participants came from the various seed centers throughout Thailand. During this meeting we explained the advantages of working with drying beads and gave some demonstrations thereof.

Co-PI Johan Van Asbrouck initiated drying and storage trials in August and September with AVRDC-The World Vegetable Center in Thailand and followed on scheduled meetings. Seed days and training sessions were held in late August in India to introduce the concept of dry seed storage to farmers and seed companies. Discussions with the Department of Agriculture expanded instruction to include oilseeds, as these crops lose viability quickly during storage due to lack of controlled storage facilities and prevailing climatic conditions.

The second half of the project period took place primarily in Nepal, India, and Thailand. In Nepal, an introductory workshop and training was organized on the novel technology of seed drying and storage on September 2, 2010 at Khumaltar, Kathmandu. About 25 participants were informed about the technology of seed drying with the drying beads. Although we initially planned to have experiments in different climatic zones in Nepal, our collaborator encountered difficulties initiating the experiments in these remote areas. Rather, the seeds were procured from these climatic zones and dried to low moisture content and subsequently stored at the Nepal Agricultural Research Council's Seed Science & Technology Division (SSTD) and the Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED) with or without beads. Hence, the storage conditions did not reflect farm storage as initially envisioned.

The drying beads were effective in lowering the seed moisture content during storage. The initial quality of the seeds varied among the species. The tomato and okra seeds already exhibited relatively low viability (<80%), indicating that the seeds were not fresh and they had already undergone deterioration prior to the start of the experiment, and this continued in the second month (October test). Once seeds have started to lose viability, improved storage conditions cannot always slow deterioration as much as would be expected. For the onion and cucumber seeds that still exhibit high viability, further storage is required to test the effects of lower moisture content. High humidity should have further aggravated loss of seed quality especially in onion. However, we did not notice significant change in the seed quality parameters from experiments at SSTD. A preliminary experiment on drying of fresh maize seeds with beads in 1:1 ratio was carried in the seed testing laboratory in SSTD, Khumaltar. The beads were very

effective as maize seed moisture content was reduced from 31.8 percent to 15.8 percent in just 3 hours of seed incubation without heat.

In India, the drying and storage experiments on onion seeds at the National Horticulture Research and Development Foundation (NHRDF) involved farmers at its different locations. Experimental data here and at the Acharya N G Ranga Agricultural University's (ANGRAU) Department of Seed Science and Technology, in Hyderabad, Andhra Pradesh demonstrates the dramatic extension of seed viability by storing with drying beads in comparison with standard open storage in cloth bags. Co-PI Keshavulu Kunusoth at ANGRAU conducted experiments with chili, tomato, bottle gourd, and watermelon seeds in cooperation with Vibha Seed Company in Hyderabad. It was found that it would be a good practice when using drying beads to rehydrate seeds in high humidity prior to contact with liquid water. Drying and storage studies were conducted with cucurbit seeds at the Indian Institute of Vegetable Research (IIVR) in Varanasi. Storage with drying beads reduced the moisture content of cucumber, sponge gourd, and bitter gourd seeds. As was observed above for watermelon, germination of cucumber seeds was inhibited if the bead-dried seeds were imbibed in water quickly. Bangalore has a moderate climate where temperature and humidity do not fluctuate as much as in Nashik, Maharashtra. There was little change in moisture content of seeds stored in cloth bags for both tomato and okra during six months of storage. Seed germination declined from 97 percent to 77 percent for tomatoes, and 82 percent to 71 percent for okra, in the cloth bags.

In Thailand, experiments on pepper seeds were carried out in collaboration with the AVRDC at Kasetsart University, Kamphangsaen, Thailand. Chili pepper seeds were extracted from fruits and were either sun-dried or stored in mesh bags under ambient conditions, or dried and stored using drying beads. Even though the containers with the beads were apparently not completely hermetic, the difference in seed vigor and emergence was clearly evident. After six months, there were marked differences in radicle emergence, final germination (normal seedlings), and emergence from soil. Preliminary calculations show cost savings of 35 percent by using beads, which maintain germination at 89 percent over traditional seed-drying with 54 percent germination. This after only the first year and repaying the initial investment in beads and containers; due to regeneration and reuse, those costs will be minimal in subsequent years.

One of major educational and outreach activities of the project was the team visit to experimental sites and educational meetings in India and Nepal. We gained insight into the problems faced by the growers, researchers and seed industry. There are grower networks organized by seed companies who can effectively use seed drying beads and minimize seed deterioration immediately after harvest. We became aware of further uses of seed drying beads in the National Germplasm Repository in Nepal where continuous electrical power is not available and dehumidification systems were not operating in their seed storage rooms. Drying beads and sealed containers would reduce dependence upon such unreliable dehumidification systems.

We also had an interaction with a group of 200 farmers in at the premises of Vibha Seed Company in Hyderabad, AP, India, where the farmers were enthusiastic about scaling up use of the beads for cereals and pulses. In another interaction with farmers in Pokhara (Nepal), women farmers pointed to the problems in drying vegetable seeds produced during monsoon periods. The USAID mission in Kathmandu, Nepal has included use of drying beads in its annual program and inquired to us about using the beads in their existing maize production program. This project has received much attention during our visit to India and Nepal, including more than 16 posters, lectures, meetings, and other educational activities in project countries between the third and sixth quarter of this project.

Project Performance Indicators

4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance.	1
Number of new technologies or management practices made available for transfer as a result of USG assistance.	1
Number of new technologies or management practices being field tested as a result of USG assistance.	1
Number of additional hectares under improved technologies or management practices as a result of USG assistance.	5
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	4
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	5
Number of rural households benefiting directly from USG interventions - Female Headed Household	56
Number of rural households benefiting directly from USG interventions - Male Headed Household	175
Number of producers organizations receiving USG assistance.	8
Number of ag. firms benefiting directly from USG supported interventions.	24
Number of public-private partnerships formed as a result of USG assistance.	8
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	101
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	317
Number of research projects and/or technologies of potential benefit to U.S. horticultural industries	1
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	14
Number of workshops conducted for host country institution, agency, and organization personnel	12
Number of host country professionals attending workshops - Female	103
Number of host country professionals attending workshops - Male	155
Number of male U.S. faculty providing training in host country	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	32
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	53
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	19
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	20

II. Sustainable Production and Marketing of Vegetables in Central America

Evaluating locally appropriate disease resistant tomato and chili varieties in El Salvador, Honduras, and Nicaragua and sharing marketing techniques
http://hortcrsp.ucdavis.edu/main/6CAVegetables.html

Project completed in August 2011.

Lead Project Investigators:

- James Nienhuis, University of Wisconsin-Madison, USA
- Peter Hanson and Paul Gniffke, AVRDC - The World Vegetable Center, Taiwan
- Dora Elizabeth Hernandez Centeno, CARE, El Salvador
- Don Breazeale, Fundacion Hundurena de Investigacion Agricola (FHIA), Honduras
- Martha Elizabeth Moraga Quezada, Universidad Nacional Agraria, Nicaragua

Project Summary

We identified tomato lines that are not only virus-resistant, and thus higher yielding, more profitable and more sustainable, but also have quality characteristics that are desirable for marketing.

This project combined the technology and biological capital of the University of Wisconsin-Madison and the AVRDC – The World Vegetable Center, with the managerial and technical skills of three Central American institutions: CARE, El Salvador; Fundación Hondureña de Investigación Agrícola (FHIA) in collaboration with Fintrac, Honduras; and Universidad Nacional Agraria (UNA), Nicaragua. All institutions have hands-on, field-based experience in research, extension, marketing, and organizing growers and small cooperatives run and owned by local women. Advanced breeding lines provided by AVRDC were evaluated in on-farm field trials in collaboration with local community leaders for resistance to two of the most important production constraints in Central America, whitefly-transmitted begomoviruses (tomato) and anthracnose (pepper). Field days were organized at each location with local growers, women's groups, and community leaders. A regional science-based workshop was organized at the University of Zamorano in Honduras with participation of cooperators from each country. To enhance the worldview of regional leaders and to gain hand-on experience in vegetable production and innovative marketing strategies, a workshop was held for project participants in Spanish at University of Wisconsin-Madison.

Project Objectives

1. Development of new technology to identify disease- and virus-resistant germplasm resources in tomato (begomoviruses) and chili peppers (anthracnose) that can be utilized directly as cultivars in sustainable small-scale vegetable production enterprises or, alternatively, serve as parents in short-term plant breeding projects.
2. Development of human and institutional capacity, focusing on women's cooperatives in the region.
3. Increase regional knowledge of best management strategies for sustainable vegetable production.
4. Increase regional knowledge of different market strategies.

Project Report Technical Narrative
--Submitted by James Nienhuis

Viral diseases are the principal limitation to sustainable and profitable production of tomatoes and peppers for most small farmers in Central America. We identified tomato lines that are not only virus-resistant and thus higher yielding, more profitable, and more sustainable, but also have

quality characteristics that are desirable for marketing. These cultivars lower risk for small-scale farmers in Central America. In addition, we organized community field days with women's groups and communities to discuss the vegetable evaluation trials and enable them to choose the cultivar they wanted. We also organized regional participatory workshops in the target countries and international workshops in Wisconsin to discuss the results and to plan, as a group, how best to proceed. Thus, we achieved our goals.

After identifying high-yielding germplasm with virus resistance, we quickly learned that we would have no impact on sustainable production by small-scale farmers and women's groups because no seed was available of the superior cultivars. Moreover, we also quickly learned that importing seed into Central American countries was a very expensive and bureaucratic process, almost impossible. Thus, the logical extension of this Immediate Impact Project is our continuing project "Semillas de Esperanza" in which we propose to produce seed in each target country. Our overall impact will be based on success of the Semillas de Esperanza project.

Partners

The quality and diversity of the partnerships with stakeholders in our target countries was an unexpected benefit to this project. The AVRDC was our technology platform. They were a critical partner. Not only did they have tomatoes and peppers that had been bred for virus resistance, but also the germplasm had been tested in similar tropical production environments in Asia and Africa; thus, we knew beforehand that AVRDC germplasm had a reasonably high probability of success in tropical Central America. In addition, a critical advantage of working with AVRDC was they do not impose intellectual property rights over their germplasm, which directly benefited the women's groups with whom we are working.

The three in-country partners were very diverse, but each brought a unique perspective to our project:

i. CARE is very hands-on, working to alleviate poverty and working with women's groups. The strength of CARE is connection to the community and community organization, especially with women's groups. Our project complemented CARE by providing the one critical aspect that they lacked – access to and knowledge of technology. Evaluating germplasm is completely new to CARE; yet in Morazán, El Salvador, and Tajomulco, Guatemala, CARE is evaluating germplasm in cooperation with rural poor and women's groups. Part of the success of the germplasm evaluation with women's groups was that many of the CARE personnel were in fact agronomists. They had the skills to successfully evaluate germplasm, but they simply had never had access to it.

ii. The Universidad Nacional Agraria (UNA) in Nicaragua had strong professors and students who identified women's groups in Dinamba and Tisma, Nicaragua. In cooperation with the women's groups, they planted germplasm evaluation trials in both locations. I hope we have planted the seeds of a tradition of community outreach that may extend well beyond this project.

iii. Our third partner was the Fundacion Hondureña de Investigacion Agricola (FHIA). They are professional agricultural researchers; their outreach is through a USAID-funded NGO, Fintrac. Fintrac has worked with commercial growers in Honduras, but now has a new project that is focusing on the rural poor, small-scale growers and women's groups. The FHIA-based Fintrac representative, Andrew Medlicott, participated in our regional meeting in Honduras in November of 2010. FHIA did a thorough, careful and professional evaluation of the AVRDC germplasm and provided a detailed report which is available upon request from Horticulture CRSP.

Impact in Costa Rica

Costa Rica was not funded by this project but, due to the interest of Professor Carlos Ramirez of the Instituto Tecnológico de Costa Rica (ITCR) in San Carlos, they did participate. The AVRDC lines are being evaluated at Nadayure and Hojancha, rural areas in which tomato production by small farmers is limited by disease. ITCR and local farmers in the region are cooperating in the evaluation of the lines at no cost to our project. In addition, ITCR sent six students and faculty to participate in our 2010 UW-based workshop on Organic and Sustainable Vegetable Production and Marketing; ITCR students and faculty paid all costs associated with their participation in the UW-based workshop. Professor Ramirez is a widely recognized regional expert on greenhouse design and protected production of tomatoes and peppers; thus, Professor Ramirez has become a critical member of the new “Semillas de Esperanza” project.

Because of ITCR’s interest in our Horticulture CRSP project, I was asked to serve as major professor for Professor Carlos Ramirez for his Ph.D. Thus, at no additional cost to the Horticulture CRSP we will participate in the formation of a new Ph.D.-level regional professional in Central America. In addition, another professor from ITCR, Prof. Xiomara Mata, a plant pathologist, will be coming to UW as a visiting professor in the fall of 2011. The Horticulture CRSP project is not paying any of her expenses. I point out these collaborations with Costa Rica and ITCR only to highlight how this Horticulture CRSP project has leveraged participation and had an impact in high-level training in sister countries who are not paid by Horticulture CRSP. This is a benefit of a regional project.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	50
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	40
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research.	50
Number of new technologies or management practices made available for transfer as a result of USG assistance.	50
Number of new technologies or management practices being field tested as a result of USG assistance.	50
Number of producers organizations receiving USG assistance.	3
Number of community-based organizations receiving USG assistance.	3
Number of community-based organizations who have adopted new technologies or management practices as a result of USG assistance.	3
Number of women's organizations assisted as a result of USG interventions.	3
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	60
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	40
Number of research projects and/or technologies of potential benefit to U.S. horticultural industries	2
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	3
Number of workshops conducted for host country institution, agency, and organization personnel	3
Number of host country professionals attending workshops, training conferences, or similar - Female	14
Number of host country professionals attending workshops, training conferences, or similar - Male	31
Number of certificate training programs conducted	1
Number of certificates earned by host country professionals - Female	9
Number of certificates earned by host country professionals - Male	11
Number of U.S. faculty providing instruction in host country - Female	1
Number of U.S. faculty providing instruction in host country - Male	2
Number of host country extension workers, university faculty or other professionals involved in training other host country professionals - Female	3
Number of host country extension workers, university faculty or other professionals involved in training other host country professionals - Male	1
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	3

Section Four–Exploratory Projects

In 2010, Horticulture CRSP expanded efforts by awarding 10 one-year Exploratory Projects. Horticulture CRSP recognized that many researchers in the United States and in developing countries have the interest and capability to conduct appropriate research and training programs, but have not developed the teams or the background information that would ensure success in an application for a long-term project. The intent of the Horticulture CRSP Exploratory Projects was to provide funding that encouraged the formation of such teams and the acquisition of background or preliminary information that could provide the basis for a competitive long-term project application.

Project Reports by Priority Issue
Sustainable Crop Production

I. Toward increasing Smallholder-Vegetable Farmer Utilization of Grafting and Low and High Tunnel Microclimate Management Tools

Educating smallholder vegetable farmers in grafting and microclimate management techniques in Kenya
http://hortcrsp.ucdavis.edu/main/20grafting.html

Project expected to be completed in January 2012.

Lead Project Investigators

- Matthew D. Kleinhenz, The Ohio State University, USA
- J. Mark Erbaugh, The Ohio State University, USA
- Sally A. Miller, The Ohio State University, USA
- Monicah Waiganjo, Kenya Agricultural Research Institute, Kenya
- Peter N. Kanyuiro, Kangai Tisa Horticultural Farmers, Kenya
- Jeremiah Njuguna, Agro Farm Services, Kenya

Project Summary

This project provides the necessary background information and strategies to improve tomato and pepper production through the increased application of grafting and low/high tunnel technologies among smallholder growers in Kirinyaga District, Kenya. Tomato and peppers are important sources of household income and nutrition. Their production is poised to increase in the region if production systems are made more efficient by minimizing the onset of frequent and highly disruptive crop stresses (e.g., disease, nutrient, and/or water deficiency/excess) and providing greater returns to farmer time and effort. Using grafted plants and low/high tunnels reduces crop stress and eases labor requirements in vegetable production around the globe. Interest in grafting and low/high tunnels is rising in Kenya and the region. However, the availability of regional resources (material and human) is undocumented and guidance for farmers to apply these tools is lacking. We will offset these two deficiencies. We will: 1) document baseline human and material resources available in Kirinyaga District for using grafting and low/high tunnels, 2) develop educational products and programs designed to increase stakeholder success in the use of these tools, and 3) test and evaluate these products and programs as foundational components in larger regional efforts.

We are developing a manual on tomato grafting tailored to Kenya conditions.

Project Objectives

1. Document baseline grafting and low/high tunnel resources in the target area, including stakeholder interest, knowledge and perceptions, and available material inputs.
2. Develop educational programs and products designed to increase stakeholder success in the use of grafting and low/high tunnel management.
3. Test and evaluate these programs and products as potential foundational components in a follow-up regional effort.

Project Report Technical Narrative
--Submitted by Mathew Kleinhenz

First- and second-quarter effort was directed primarily to: a) team formation, b) development of survey instruments (approved by The Ohio State University Office of Responsible Research

Practices (ORRP)), and c) survey implementation. The project team was officially formed and the team immediately set to work developing draft survey instruments. These instruments were reviewed by the ORRP and revised by the project team over the period Dec 2010 – Jan 2011. Project personnel also updated or received Collaborative Institutional Training Initiative (CITI) certification to conduct research involving human subjects during the same period. Survey instruments were categorized as exempt from full Human Subjects Review Board review on January 13, 2011. The farmer-stakeholder survey contained a total of 100 questions and during field testing, required approximately 90 minutes to administer.

During the period Feb 25-March 4, co-PIs Kleinhenz, Erbaugh and Waiganjo organized in-country field pre-tests of the survey instruments in cooperation with Kenya Agricultural Research Institute (KARI) (in-country cooperating institution) and Kangai Tisa Horticultural Farmers (KTHFA) (collaborating stakeholder group) personnel. The project team also met with a second USAID project team led by S. Fennimore and other Kenyan officials during this trip. Co-PI Waiganjo, along with personnel from KARI and KTHFA, executed the survey in full, March 7 – April 8.

A total of 109 farmers (33 female) were surveyed. Data entry and analysis are underway. Preliminary review of the stakeholder feedback suggests that respondents: 1) averaged 46 years of age, 2) averaged 3.7 and 0.7 acres annually of total crop and tomato production, respectively, 3) typically have approx. 11 years of tomato production experience, 4) tend to maintain cropping records, 5) often possessed 12 years of formal education, and 6) have a high level of interest in, but little experience with, vegetable grafting and low or high tunnel use.

Third-quarter effort was directed primarily to: a) survey implementation (final stages), b) survey data entry, c) survey data analysis and summarization, d) workshop agenda development, e) farmer field school agenda development, f) grafting guide development, and g) low/high tunnel guide development. In addition, a high tunnel was constructed at Karikoni in Kirinyaga District in a field provided by a member of the KTHFA. This high tunnel will be used as a teaching/demonstration tool in upcoming educational activities.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	15
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	19
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance.	2
Number of new technologies or management practices made available for transfer as a result of USG assistance.	2
Number of new technologies or management practices being field tested as a result of USG assistance.	2
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	10
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	10
Number of rural households benefiting directly from USG interventions - Female Headed Household	16
Number of rural households benefiting directly from USG interventions - Male Headed Household	18
Number of ag. firms benefiting directly from USG supported interventions.	2
Number of women's organizations assisted as a result of USG interventions.	2
Number of public-private partnerships formed as a result of USG assistance.	4
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	21
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	16
Capacity Building (Horticulture CRSP Indicator)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	4
Number of workshops conducted for host country personnel	2
Number of U.S. faculty providing training in host country - Female	1
Number of U.S. faculty providing training in host country - Male	2
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	5
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	4
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	5
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	4

II. Cell Phone-Enabled, Personalized Agro-Advisory Services for Horticultural Crops in South Asia

Establishing a cell-phone enabled extension center for horticultural farmers in India, Sri Lanka and Nepal
http://hortcrsp.ucdavis.edu/main/22cellphone.html

Project expected to be completed in November 2011.

Lead Project Investigators:

- Mywish Maredia, Michigan State University, USA
- Sangita Ladha, International Horticulture Innovation and Training Center, India
- Karim Maredia, Cholani Weebadde, and Nanda Joshi, Michigan State University, USA
- Rajesh Urkude, Tata Consultancy Services, India

Project Summary

Recent advances in telecommunication technologies and rapid uptake of cellphones by millions of growers provide excellent opportunities for delivering real-time information to growers in rural areas. Taking advantage of these developments, Michigan State University (MSU), in partnership with the International Horticulture Innovation and Training Center (IHITC) in India, proposed to explore and test the cost-effectiveness of a cellphone-mediated, personalized advisory service for growers cultivating horticulture crops in poly-houses and shade-nets. Through public-private partnership, the Tata Consultancy Services will provide technological support for the implementation of the "Mobile Agro Advisory System" (MAAS) through their mKrishi platform, which will allow growers to send queries and to receive real-time information and personalized advice through voice, text, and photographic tools. MSU and IHITC will design and implement this pilot-scale initiative using rigorous methods of impact evaluation. The methodology will consist of assigning eligible farmers into treatment and comparison groups so as to measure and attribute project impacts, analyze program cost-benefits, and explore program sustainability by assessing the demand and willingness to pay for MAAS services. Participatory and gender inclusive training will be integrated in the project. Lessons learned from this exploratory project will help MSU and IHITC expand and scale up the program to other parts of India and South Asia.

Project Report Technical Narrative
--Submitted by Mywish Maredia and Sangita Ladha

Research on the effectiveness of horticultural advisory services is key to understanding information technology

This project was launched in October 2010. A list of 300 greenhouse growers registered with the Rajasthan State Department of Horticulture was obtained to target the implementation of the Mobile Agro Advisory System program. Required hardware and software to run the mKrishi program platform was installed on IHITC computers. A group of nine technical experts of IHITC were trained to implement the MAAS pilot program which included: operating the software to reply to queries, downloading software on the mobile handsets of the growers, and preparation of the technical content to be loaded on the mKrishi platform in English and local languages.

About 50 horticulture growers were trained to use the cellphone-based advisory services by the end of December 2010. To access mKrishi services, mobile handsets required GPRS connection capability, which was found in only 10-15 percent of growers contacted. This turned out to be a major constraint in registering the growers for the MAAS pilot program. To address this

challenge, we decided to extend the program to open field vegetable growers. With the initiative of private input suppliers, especially Monsanto and DCM Shriram Consolidated Ltd (DSCL) Seeds division, open field vegetable growers were identified.

About 60 horticulture growers (protected agriculture and open fields) and 25 extension workers were trained and registered to use the cellphone-based advisory services by the end of March 2011. These numbers of registered farmers are less than the targeted (100 farmers) because of the challenges described above; namely only 10-15 percent of growers had mobile handsets with features required to access mKrishi services.

The impact evaluation design was developed. The plan consisted of evaluating the performance and benefits of three private sector-led, mobile phone-based, agro-advisory programs—mKrishi, Reuters Market Light (RML) and IFFCO-Kisan Sanchar Limited-Value Added Services (KSL-VAS). In addition, opinions and perspectives of horticulture farmers on the Kisan Call Center, which is run by the national government, were also assessed.

The evaluation of the RML and IFFCO KSL-VAS programs involved a one-time survey of horticulture farmers who use these services. The purpose of this one-time survey was to record the experience and assessment of costs and benefits of these two programs from the perspective of the users of these services.

The survey instrument was developed, pre-tested, and translated into Hindi. The survey instrument and methodology was reviewed and approved by MSU's Institutional Review Board in early February. The baseline surveys of the 124 farmers for the mKrishi program were conducted in February and March.

In the third quarter, a "study tour" to IHITC, Jaipur, India was completed for participants from Nepal and Sri Lanka to achieve the following objectives:

- To give an overview of the MSU-IHITC project goals and objectives
- Discuss constraints and information needs of horticulture farmers in India, Nepal and Sri Lanka
- Give an overview of different models of cell-phone based agro-advisory services to meet some of the challenges in Rajasthan and other parts of South Asia
- Explore opportunities to expand the MAAS program adapted to meet the needs of horticulture farmers in Nepal and Sri Lanka.
- Develop plans to explore opportunities to work together beyond the exploratory grant

At of the end of this fiscal year, an additional 30 farmers have been registered in mKrishi bringing the total number to 90.The survey of 132 farmers using RML and IFFCO services has been completed. The survey instruments for the mKrishi follow-up survey were developed and translated into Hindi. Data collection from mKrishi farmers is currently ongoing.

Project Performance Indicators

4.5.2 Agriculture Sector Productivity	Project Achievements
Number of new technologies or management practices made available for transfer as a result of USG assistance.	5
Number of new technologies or management practices being field tested as a result of USG assistance.	1
Number of rural households benefiting directly from USG interventions - Male Headed Household	90
Number of public-private partnerships formed as a result of USG assistance.	1
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	30
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	290
Capacity Building (Horticulture CRSP Indicator)	Project Achievements
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	1
Number of host country professionals attending workshops, training conferences, or similar - Female	2
Number of host country professionals attending workshops, training conferences, or similar - Male	9
Number of U.S. faculty providing training or instruction in host country - Female	2
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	2
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	7

III. Market Oriented Sustainable Peri-Urban and Urban Garden Cropping System: A Model for Women Farmers in Thailand, Cambodia and Vietnam

Training urban and peri-urban horticultural growers in cropping systems, pre and postharvest handling and marketing techniques
http://hortcrsp.ucdavis.edu/main/24periurban.html

Project expected to be completed in July 2012.

Lead Project Investigators:

- Dharma Pitchay, Tennessee State University, USA
- Surendra Singh and Sammy Comer; Tennessee State University, USA
- Juan Carlos Diaz-Perez; University of Georgia, USA
- Robert J. Holmer, AVRDC – The World Vegetable Center, Thailand
- Yingyong Paisooksantivatana and Pariyanuj Chulaka; Kasetsart University, Thailand
- Prabhat Kumar, Asian Institute of Technology, Thailand

Project Summary

The project's long-term goals are to develop strategies to assist and promote a sustainable peri-urban and urban garden cropping enterprise system for small-scale and minority women growers. This project presents a new paradigm in training women growers, with vibrant outreach, training, and demonstration of market-oriented, sustainable peri-urban and urban gardening technology, which includes the production process, pre- and postharvest handling, economic and marketing information, and cropping systems. This training will encourage the peri-urban and urban gardeners to be receptive and willing to adopt new technology. Hands-on workshops will be conducted to train the women trainers and growers on a regular basis on various cultural practices, pre- and postharvest management technology, logistics, marketing, and entrepreneurship. Gardening demonstration plots will be used to demonstrate not only how to grow more and higher quality products, but also how and where to profitably market the products. This empowers women to increase food production, reduce poverty and improve household health. The project is expected to stimulate economic activities by creating employment opportunities for women to improve their incomes in peri-urban and urban areas. It will create opportunities for growers to sell locally grown garden produce and to provide for their own family consumption. Peri-urban and urban gardening will be a significant contributor to overall quality of life for these communities.

Project Objectives

1. Develop cropping system for sustainable peri-urban and urban gardening emphasizing several aspects of crop selection criteria
2. Explore the potentials of plug transplanting and grafting technology for transplants
3. Develop a user-friendly, integrated cropping system-based approach, including nutrient management techniques for decision making in sustainable peri-urban and urban gardening, and using the farmer field school method
4. Evaluate economic costs and benefits, identify risks associated with peri-urban and urban garden farming, and evaluate different marketing channels and strategies to empower women growers with production and marketing knowledge and information.

Project Report Technical Narrative
--Submitted by Dharma Pitchay
Most of our initial work on the project has been done on site. Directly engaging with trainers and growers with hands-on field training in cultural practices was time-saving and effective. We also had the opportunity to learn the strengths, weaknesses, threats, and opportunities of the peri-urban and urban gardening project. The project has created an environment for collaborators, team members, and growers from the host country to get to know and explore the potentials and challenges of vegetable and fruit production in their own backyards. The activities are generally carried out by women, who make up more than 85 percent of all growers. Agrichemical stores act as local extension centers for growers. It is a common practice among the growers to use excessive amounts of several different pesticides to prevent pests and diseases. In some instances, pesticides are used in an attempt to control environmental stress including nutrient deficiencies and over watering.

Some of the informal training that was provided during our field visit included seedling establishment, transplanting, mulching, harvesting, processing, grading and storing, handling and shipping of farm produce. We emphasized pre- and postharvest handling of vegetables using gadgets such as an infra-red thermometer indicating temperature differences between the field, sorting and grading area, and packed vegetables.

We also stressed the importance of crop rotation and multiple cropping systems, which may provide natural shade by selecting climbers (bitter melons, luffa, gourds etc.) for improved cultural practices in areas with limited land size. Poor water management, which includes over watering or using contaminated water, is a common issue in the production system. We also had a discussion and briefing of procedures on minimal processing of vegetables and fruits that may help to minimize losses and provide added value to the crops.

At the end of the visit, the host country collaborators and project team members were able to understand the entire peri-urban and urban supply chain. This has definitely helped us to put together a comprehensive effective training program for the trainers and growers sometime during the month of January 2012.

IV. Evaluating the Support Structure for Production and Marketing of Tomatoes and Paprika among Smallholders in Zimbabwe

Assessing Zimbabwean farmers' potential for producing and marketing fruits and vegetables
http://hortcrsp.ucdavis.edu/main/25zimbabwe.html

Project expected to be completed in December 2011.

Lead Project Investigators:

- Hans Christian Wien, Cornell University, USA
- Edward Mabaya, Beth A. Medvecky, and Ralph D. Christy, Cornell University, USA
- Themos Ntasis and Isatou Jack, International Relief and Development, Zimbabwe

Project Summary

The political unrest and economic turmoil in Zimbabwe in the last 10 years has destroyed agricultural export industries and the beginnings of an emerging smallholder horticulture sector in the country. The adoption of a stable currency and a unity government awakens the hope that small-scale farmers can be stimulated to participate in production of horticultural crops for export and for local markets.

> We are beginning to understand the horticultural constraints in Zimbabwe.

Using the paprika crop grown for export and tomatoes produced for local markets as examples, this exploratory project will determine how smallholders in irrigation schemes in both Manicaland and in peri-urban areas near Harare get information for production and marketing of these horticultural crops. Potential linkages with local institutions that were previously generating research and extension information on horticulture, such as nearby local universities, private agri-businesses and the research and extension arm of the Ministry of Agriculture will be assessed. The potential influence of gender issues on participation, adoption, and household-level impacts of will be assessed. At the end of the exploratory phase of the project, workshops are planned in each of the two production areas to identify the major findings and opportunities for further work.

Project Objectives

1. Using tomato and paprika as examples, assess the potential role of horticulture in improving livelihoods of smallholder farmers in Zimbabwe.
2. Identify the key production, marketing and gender constraints to smallholder horticulture in Zimbabwe and determine how these can be addressed.
3. Map out the principal stakeholders for the smallholder horticulture sub-sector in Zimbabwe, and their capabilities.
4. Assemble an effective team and develop a long-term proposal.

Project Report Technical Narrative
--Submitted by Hans C. Wien

The exploratory project's primary partner in Zimbabwe was the NGO International Relief and Development, who were conducting a USAID-sponsored project in Manicaland Province. They were working with paprika production in irrigation schemes, and thus offered a convenient platform to test the importance of horticulture to smallholders. In the 2010-11 growing season, IRD demonstrated that irrigated paprika could be a lucrative crop for smallholders in two irrigation schemes, with marketing of the product through the private company Capsicum. Farmers were supplied inputs and production and harvesting advice both from Capsicum and from field staff of IRD. Unfortunately, the end of the USAID contract restricted IRD involvement

to only one growing season. Plant scientists from Africa University in Mutare, the University of Zimbabwe, and from the Horticultural Research Center in Marondera participated in exploratory visits to the paprika-producing areas and interviewed growers while being shown the schemes by extension personnel of IRD and the government extension agency Agritex. It was clear from our visit that both genders have leading roles in production and marketing of paprika in the schemes, with leadership responsibilities varying from women to men, depending on the household. The locally based extension staff was sensitive to gender inequalities and had denied payment to unscrupulous males who appeared at payment times, claiming ownership to land they were not working and to crops they had not produced. This sent clear signals that the project would protect the rights of women managers to receive payments for their paprika crop.

A number of issues that require investigation in on-farm and experiment station research were identified during the visits. These included agronomic issues, as well as those related to postharvest and market research. The agronomic research was to focus on increasing crop profitability and productivity by making more efficient and effective use of soil and pest management inputs, and by developing crop management strategies aimed at increasing plant vigor and tolerance to biotic and abiotic stresses. Postharvest research was to assess the effect of drying techniques on crop quality (i.e. grading results) and on handling practices to minimize losses. Market-oriented research was to investigate contract design and enforcement, input diversion and product leakage. During the planning workshop, the group also explored mechanisms that would allow students from the universities and technical workers from the research center to address these. Overall we felt that on the basis of our February 2011 visit, there was a good opportunity to get the universities and the experiment station involved in further work with paprika farmers, if financial support were available.

The situation among tomato producers in the areas near Harare was much less clear. Although they had been growing tomatoes for the Harare market for years, the over-supply of product for that market caused severe hardship. Partly to blame was the influence of medium-scale producers, who flood the markets with tomatoes, and depress prices for smallholders. The small-scale commercial farmers, some of whom are growing tomatoes in greenhouses, often use both urban and rural spot markets to offload lower quality produce that does not meet the requirements of the formal market. Given that local markets are very thin, they are highly sensitive to supply conditions and prices often fall below production costs. While groups of farmers and traders lobby local government officials to stop this dumping, the practice is likely to continue indefinitely.

As a result of discussions in Zimbabwe with our partner institutions in February 2011, we felt confident that a good pilot grant proposal could be prepared that would have a good chance of funding by Horticulture CRSP. To regionalize our efforts, we conferred with Agribusiness in Sustainable Natural African Plant Products (ASNAPP) in Zambia, and vegetable researchers in Tanzania, and were beginning the proposal writing process when we were informed that USAID would not be able to fund government institutions in Zimbabwe. This effectively undermined our potential proposal and terminated our efforts.

Project Reports by Priority Issue
Postharvest Technology

I. Integrated Postharvest Extension Program for Cambodia and Vietnam
Evaluating postharvest capacity and selecting postharvest leaders
http://hortcrsp.ucdavis.edu/main/23postharvest_vietnam.html

Project expected to be completed in August 2012.

Lead Project Investigators:
- Robert E. Paull and Nancy Jung Chen, University of Hawaii at Manoa, USA
- Nguyen Quoc Vong, Hanoi University for Agriculture, Vietnam
- Men Sarom, Royal University of Agriculture, Cambodia

Project Summary
Postharvest losses of fruits and vegetables in Vietnam and Cambodia are very high. In Vietnam, they range from 20 to 25 percent for fruits and more than 30 percent for vegetables. Cambodian vegetable losses have been reported to be higher than those in Vietnam. The most common causes of postharvest losses are quantitative - losses in quality caused by improper handling and microbial and pesticide contamination significantly influence the nutritional value and safety of fresh produces.

Training postharvest specialists in Vietnam and Cambodia is critical to reducing postharvest losses.

The goal of this exploratory project is to evaluate current capacity and needs with respect to postharvest handling and quality, leading to a full proposal whose aim would be to strengthen the capacity of Vietnamese and Cambodian growers and marketers to reduce losses and to improve postharvest quality for fruits and vegetables.

Project Objectives
1. To conduct a site visit to Vietnam to meet with potential university, research institutes and extension partners in North Vietnam (Hanoi), Central Vietnam (Dalat / Lam Dong), and in the South, Mekong river delta (Tien Giang), to determine capacity-building needs that address postharvest losses.
2. To meet with potential commercial Vietnamese partners who handle fresh fruits and vegetables, to determine their current handling practices and possible approaches to assist them in maintaining quality and safety.
3. To evaluate currently available publications on fresh fruit and vegetable postharvest handling and product quality and translate relevant publications.
4. To select up to six postharvest leaders in Vietnam to attend the 2011 UC Davis Postharvest Short Course and return via Hawaii to obtain additional training on postharvest quality evaluation and safe handling training.

Project Report Technical Narrative
--Submitted by Robert E. Paull
During the first and second quarters, a site visit was conducted to Vietnam and Cambodia to meet with potential research and training counterparts to determine capacity-building needs that address postharvest losses. The trip was very successful. The overall conclusion was that Cambodia had an overall priority need for staff capacity building. The academic staff members have B.S. degrees and their skills would be greatly improved by further training and wider

experience. This capacity building would be well served by sending selected students away for course-based M.S degrees connected to research projects. Two areas that continually came up in discussion were integrated crop management that incorporated pest management, as well as integrated harvest, postharvest practices, and marketing that impacted quality and safety.

During the trip, project collaborators also met with potential commercial Vietnamese and Cambodian partners to determine their current handling practices and possible approaches to assist them in maintaining quality and safety. In Vietnam, contacts were made with individual packers and shippers who would be potential partners in any future project. In Cambodia, commercial groups that represent fruit and vegetable growers are less well developed. We think that the best approach would be to collaborate with Fintrac, an organization that is developing a network of farmer cooperators.

Determining which postharvest publications are available in Vietnamese and Khmer on fresh fruit and vegetables is an ongoing effort. In Cambodia, extension publications are few with some translations of English texts. Vietnam has some publications and translation texts.

Selections were made of three Cambodian trainees for short course training in the United States with one from Cambodian Agricultural Research and Development Institute (CARDI), another from the Royal University of Agriculture (RUA) and the third from Prek Leap National School for Agriculture. The three selected from Vietnam included one from Hanoi University of Agriculture and the others from Lam Dong University in Saigon and from the Southern Horticultural Research Institute (SOFRI) in Tien Giang in My Tho. The trainee group was made up of four women and two men. The Vietnamese trainees were able to secure visas at the last moment and travelled as planned to UC Davis for the Postharvest Short Course and the Hawaii workshop and field trips. All three found the trip extremely worthwhile professionally. The Cambodian trainees were unable to secure visas and unable to travel. We have requested an extension of this project to Aug.31, 2012 to allow the trainees to attend next year's Postharvest Short Course and Hawaii workshop.

During the third and fourth quarters, Cambodian and Vietnamese partners sought out what training material is available for their countries for all levels. In both countries, there is a limited amount of material in the local languages dealing with fruits and vegetable postharvest handling. As far as we can determine in Cambodia, except for one book in Khmer for education at the university level, there is little at any other level in Khmer. This book is the UC Davis text: "Small-Scale Postharvest Practices: A Manual for Horticultural Crops." by Lisa Kitinoja and Adel Kader, translated into Khmer and Vietnamese. One book that would be worth translating would be Postharvest Technology of Horticultural Crops.

Project Performance Indicators

4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices made available for transfer as a result of USG assistance.	1
Number of public-private partnerships formed as a result of USG assistance.	2
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	2
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	3
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of certificates earned by host country professionals - Female	2
Number of certificates earned by host country professionals - Male	1
Number of U.S. faculty providing training or instruction in host country - Male	1

Project Reports by Priority Issue
Food Safety

I. A Regional Approach to Food Safety for Fruits and Vegetables in Bangladesh
Establishing a regional consortium on food safety that will improve public health, encourage export opportunities, and increase smallholder profits
http://hortcrsp.ucdavis.edu/main/18safety_consortium.html

Project expected to be completed in December 2012.

Lead Project Investigators:
- Ronnie Coffman, Cornell University, USA
- Glenn M. Young, University of California, Davis, USA
- Vijay Vijayaraghavan, Sathguru Management Consultants Pvt, Ltd., India

Project Summary
Bangladesh horticulture produces 3.2 million metric tons per year, but small-scale farmers suffer economic losses due to lack of high-yielding varieties and hybrids, postharvest technologies, food safety practices, and processing facilities. Among these issues, food safety affects the marketable produce, human health, and food quality, resulting from high chemical and microbial content and due to unhygienic production and storage facilities. Postharvest losses in Bangladesh are 38 percent, which results in significant potential income loss, mostly to small-scale farmers who are largely women. This project establishes the South Asia Consortium on Food Safety that will be a collaboration of Bangladeshi, Indian and U.S. institutions that will be robust and flexible enough to include other South Asian nations later. The consortium will work towards answering research questions, improving technical skills, developing good agricultural practices (GAPs), and building capacity in Bangladesh, with the help of scientific expertise available within U.S. institutions and local expertise available in India. India's involvement as a strategic partner will assist Bangladesh with both research and training.

Project Objectives
1. Identifying the co-PI in Bangladesh (and perhaps India), and identifying other major collaborators in Bangladesh (and maybe India) and in the United States.
2. Conduct an initial workshop in Bangladesh, bringing together the major collaborators, to observe first-hand the situation and facilities available, and to develop an action plan.
3. Develop an initial database to enable determination of how much additional data collection will be required (e.g. sampling of produce for heavy metals, microbial contamination, pesticide residues, other postharvest losses) to determine the extent and distribution of the food safety issues.

Project Report Technical Narrative
--*Submitted by Ronnie Coffman and K. Vijayaraghavan*
In the first quarter, we identified many government and private sector organizations as well as NGOs and international bodies which are working in the areas of food safety in Bangladesh and are capable of becoming potential collaborators for Horticulture CRSP activities.

In the second quarter of this project, a pre-workshop study in Bangladesh for ground level position analysis was conducted from May 25 – June 16, 2011. Meetings were held with government organizations, private sector organizations, NGOs and international bodies in Bangladesh to understand their current engagements in food safety, their strengths, synergies with

our project, and willingness to collaborate with us. Enquiries were also made to understand the availability of data relating to sampling of produce for heavy metals, microbial contamination, pesticide residues, other postharvest losses, etc.

These meetings were organized in and around Dhaka with the help of our regional partners in Bangladesh. A team of four professionals—Glenn Young from UC Davis, Ashok Jha and Rajnish from Sathguru in India, and GP Das, national coordinator of Cornell University at Bangladesh—participated in these meetings.

Based on our findings during the pre-workshop study, a background document is being developed, and it will be further refined in consultation with various stakeholders during the August workshop. Some institutions which were found to be capable of becoming potential collaborators for Horticulture CRSP activities have been invited to participate in this workshop. Most of the planning relating to the August workshop was completed.

In the third quarter of this project, our Bangladeshi partner, the Bangladesh Agricultural Research Institute (BARI), convened a large gathering of important stakeholders with active engagement of the government policy planners, industry, academia, and the NGOs. Stakeholders provided a strategic plan of key elements to be built into the pilot project. This workshop was held August16–18, 2011 at Radisson Blue Water Garden Hotel in Dhaka. The Minister of Agriculture took part in the workshop, marking the importance the Bangladeshi government attributes to the key issue of horticultural safety and postharvest value addition.

The workshop focused on sensitizing potential partners to critical elements of the project, and to collectively developing an action plan for addressing consumption of safe and nutritious horticulture-based food among resource-poor communities in Bangladesh. A major goal of the workshop was to cover food safety in the horticultural value chain from farms through to the markets, and highlighting alarming issues affecting food quality at each step in the value chain. Considering this, various technical sessions were planned for the workshop as part of three major themes: farm-level production issues impacting safety, food safety-related impacts on health, and food safety policy issues which are also in accordance with the country priorities identified by the U.S. government’s Feed the Future initiative.

The technical sessions were planned to comprehensively cover and discuss key food safety issues in the horticultural value chain. Discussions were held following each technical session on ways to effectively deal with alarming food safety issues highlighted in the technical sessions. In addition, focused group discussions with participants were also held for action plan development for the pilot project. For this, all the participants were split into four thematic groups (GAPs, Surveillance, Risk Management and Mitigation, and Policy) with five to seven participants in each group. Participants and faculty together engaged in brainstorming and developing theme-specific action plans for the pilot project. The outcomes of these discussions provided inputs to the pilot project execution plan.

On the last day of the August workshop, a team of 10 scientists from BARI along with partners from Cornell, UC Davis, and Sathguru engaged in making a concrete overall action plan for future projects. The team discussed project location, site selection, farmer group identification, the action plan, and its execution.

Project Performance Indicators

Capacity Building (Horticulture CRSP Indicator)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	4
Number of workshops conducted for host country institution, agency, and organization personnel	1
Number of host country professionals attending workshops, training conferences, or similar - Female	5
Number of host country professionals attending workshops, training conferences, or similar - Male	35
Number of U.S. faculty providing training or instruction in host country - Male	3
Number of U.S. faculty providing training or instruction in host country - Female	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	3

Project Reports by Priority Issue
Enabling Environment

I. Geographic Information Accessibility for Improving Horticultural-Based Income Generation in the Mzimba District of Malawi

Utilizing GIS, and transferring GIS skills to Malawians, to identify horticultural production and market opportunities
http://hortcrsp.ucdavis.edu/main/17gis.html

Project expected to be completed in November 2011.

Lead Project Investigators:
- Darcy Boellstorff, Bridgewater State University, USA
- Gibson Nkanaunena, Moses Jemitale, and Hudson Kaunda, World Relief, Malawi

Project Summary
The focus of this project was to build a Bridgewater State University and World Relief team that acquired needed geographic information (GI) for use in a geographic information system (GIS) for relief work planning in crop cultivation, irrigation, and agribusiness. World Relief Malawi has been actively involved in supporting economic development projects with more than400 poor households in the Mzimba area (northern Malawi) with the focus on enabling farming families to escape poverty through increased agricultural production of high-value crops and higher livestock sales, and value-added processing, with the goal of increased wealth, better food security and improved nutrition. Interventions included promotion of high-value and vegetable crop production, irrigation farming and agribusiness initiatives. The target beneficiaries for projects were orphan support families, caregivers, people living with HIV/AIDS, and ministry team members/caregivers. The main deliverable or outcome of the project was a GI database and training in GIS that enabled farmers and relief workers to identify and prioritize areas for ongoing and new project attention and implementation, and thus improved efficiency and success of relief work in Mzimba.

Project Objectives
1. Develop a GIS base map and database.
2. Train local staff on GIS/GPS.
3. Integrate GI and GIS analyses with current horticulture-related projects and disseminate information.

Project Report Technical Narrative
--Submitted by Darcy Boellstorff
Work during the first quarter was focused on: 1) contractual activities, 2) preliminary data collection, and 3) trip preparation and equipment acquisition (trip for January 2011). This initial trip included: a district trip, area specialist visit training and demonstrations, field data collection protocol and survey design, anemometer installation, and soil texture mapping.

During the second quarter we collected the first anemometer reading data, entered Malawi Survey Office shape files into the GIS, acquired imagery, mapped irrigation views and gathered UMass Amherst Wind Energy Center input on calculation of wind speed efficiency.

During the third quarter, we developed our first GIS analyses with the data collected including village locations using a location-allocation approach. The “maximize coverage” option places

facilities so that as many demand points as possible are allocated to solution facilities within the impedance cutoff. In this case, we used an impedance cutoff of 10 km. The “minimize facilities” option was used so that as many demand points as possible were allocated to solution facilities within the 10 km. In addition, the number of facilities required to cover the village points is minimized. Finally, maximize attendance shows a solution such that as much demand weight as possible is allocated to facilities.

Also in the third quarter, we received the first 100 farmer surveys from the field in April. By mid-May, the total number of farmer surveys collected was 330. The data reveal information on household type, income, land use, and agricultural support services used and needed by the Mzimba farmers. Data were collected from villages in the eastern portion of Mzukuzuku TA and at Kabwandire market GPS locations new GIS data layers were added. The data from the farmer surveys were coded and organized into 13 relational tables which can be joined to their spatial location using a common item called “Survey_ID.” The tables were stored as Excel files and also as .dbf files for joining in Quantum GIS. Metadata attribute tables were written that allow users to look up attribute definition and value codes.

A training manual for using Quantum GIS and the survey database was developed for training World Relief staff in June. The manual exercises are geared to both introduce the user to GIS and to help understand the relationship and utility of the survey data in planning. Each exercise culminated in a finished-product map that was exported to a .pdf format.

Specifications for the solar irrigation pump demonstrated during the April 2011 Horticulture CRSP annual meeting were acquired from Michael Reid. The parts for assembling two of the pumps were purchased to test in Mzimba during the June trip. During the June project trip the first irrigation pump was presented to farmers who were collectively working on an irrigation scheme along a stretch of the Kakoma River. Also during the June trip, the BSU and World Relief team met with potential collaborators.

World Relief staff were trained during the June trip in how to use GIS. The training manuals led participants through the process of using their survey data to answer questions about the location of special demographic groups (e.g. women-headed households with orphans) and to answer questions about spatial relationships between natural and man-made features of interest (e.g. road buffers, proximity to irrigation water, proximity to storage facilities, etc.). After completion of the three-day course, participants were given a certificate of completion.

In September, during the final quarter, Gibson Nkanaunena met the new Head of Horticulture Department at Mzimba District Agricultural Development Office, Harvey Horrea. Their discussion included this project, and the fact that it is winding down September 2011.

Nkanaunena also met with World Relief Malawi staff at Mzimba office (Embangweni). He was informed that data collection is progressing right now with 590 questionnaires done and that the field office can do 140 more by the end of September. He was also told that the weather station was doing OK. The only problem is there is a need for rechargeable batteries since the ones being used run out in two weeks. The possibility of removing the Mzoma station tower was also discussed. The field promoters who were collecting survey data officially completed their duties on September 30, 2011.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of policies/regulations/administrative procedures analyzed as a result of USG assistance.	4
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	10
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research as a result of USG assistance.	5
Capacity Building (Horticulture CRSP Indicator)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	4
Number of workshops conducted for host country institution, agency, and organization personnel	4
Number of host country professionals attending workshops, training conferences, or similar - Male	11
Number of U.S. faculty providing training or instruction in host country - Female	1
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	11

II. Agricultural Technology Transfer in Kenya; A New Approach to Training and Engagement

Using leadership training to improve agricultural production
http://hortcrsp.ucdavis.edu/main/19extension_kenya.html

Project expected to be completed in December 2012.

Lead Project Investigators:

- Steve Fennimore, University of California, Davis, USA
- Jeff Mitchell, University of California, Davis, USA
- Peter Mutua, South Eastern University College, Kenya

Project Summary

Leadership development is key to sustained improvements in agricultural production in developing countries particularly in rural areas. However the rural poor cannot, in isolation, develop complete solutions to deal with the production, market access, and technology challenges they face. Because this group of people are unaccustomed to having their views heard and acted on, this program proposes a way in which urban professionals who are concerned about rural development and food production can use their networks and expertise to develop technical and management capacity among rural farmers in order to generate entrepreneurial solutions to crippling food shortages. The program targets educated urban dwellers with close rural ties and seeks to create intellectual curiosity about this constant struggle with food insecurity. Whereas there is mutual respect as required by local customs, contact between these groups has previously been superficial, i.e. limited to family occasions like weddings and funerals. It seeks to engage those who are motivated to participate in developing a solution to this problem to form networks of like-minded professionals to engage rural farmers and come up with workable solutions.

To encourage stakeholder ownership, it is important that a shift to horticultural crop production – which is one method of increasing incomes and improving nutrition in arid and semi-arid areas – be proposed by the farmers on the ground rather than the program operators. The program will seek to identify other constraints that may not be so obvious and deal with all issues identified in a systematic manner that ensures that local farmers are satisfied that their views are valuable. Farmers in rural Kenya will then take ownership of any proposals that result from these partnerships.

Project Objectives

1. Education of members of 10 rural communities near Kitui Town.
2. Relationship- and capacity-building.

Project Report Technical Narrative

--Submitted by Steven A. Fennimore and Peter M. Mutua

The first quarter was spent identifying key personnel in partner institutions with whom we shall work. Time was spent becoming familiar with the working systems of the South Eastern University College (SEUCO) at its Nairobi and Kitui bases, and those of University of California, Davis. Basic agreements on project accounting and financial records were made as we pursued the fully executed agreement.

During this time, the project also identified individuals and groups in Kitui District with whom the program would be carried out. Due to the distances between them, it was decided that only 10 farmers groups within Kitui District would be involved in the project rather than having groups

spread out in several districts. The local partner organization through which the farmers (both men and women) are organized is the SASOL (Sahel Solutions) Foundation, a locally registered NGO, which specializes in construction of sand dams along rivers in Kitui District.

The fully executed agreement was released in December 2010 following exchange of documents from November 2010. Meanwhile, the PIs in California provided very useful technology tips including soil solarization and designs for weeding apparatuses. These are being implemented or constructed for the March planting season

From February 14 to March 2, Steve Fennimore traveled to Kitui, Kenya to visit project personnel and provide training. He visited SEUCO to meet with faculty to discuss the potential for collaboration. He also conducted several trainings for personnel at Sahel Solutions. On March 3, he attended the Horticulture CRSP partnership meeting at KARI Thika.

Simple drip irrigation systems were introduced to the farmer groups. This system consists of building a 2-meter or higher platform with a 500-liter water tank that supplies water at low pressure to a community garden. Production practices in tomato production, basics of soil fertility, use of urine as a nitrogen source, and irrigation principles were introduced by collaborators from California and are being extended by project personnel in Kenya.

Currently eastern Kenya is in the midst of one of the worst droughts in 60 years. The need for the development of irrigation systems is acute. However, water resources are limited and drip irrigation systems need clean water to prevent plugging. Irrigation systems need to be adapted to the available resources and we are exploring the use of micro-sprinklers rather than fine drip irrigation systems that plug easily.

Later in the year, Steve Fennimore, Jeff Mitchell and Oleg Daugovish of University of California, Davis visited Kitui Kenya to conduct trainings on soil fertility, basic irrigation systems and use of fertilizers, and the basics of tomato and onion production at Sahel Solutions and rural clubs in several different towns. They also conducted meetings and seminars at SEUCO.

Project Performance Indicators

Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country organizations in direct cooperation or collaboration	6
Number of workshops conducted for host country organization personnel	10
Number of host country professionals attending workshops - Female	45
Number of host country professionals attending workshops - Male	45
Number of certificate training programs conducted	2
Number of certificates earned by host country professionals - Female	30
Number of certificates earned by host country professionals - Male	30
Number of U.S. faculty providing training in host country - Male	2
Number of host country professionals involved in training - Female	4
Number of host country professionals involved in training - Male	18
Number of host country professionals conducting research - Female	15
Number of host country professionals conducting research – Male	2

III. Improving extension methods for horticultural outreach among small-stakeholder farmers in Latin American countries

Evaluating extension systems in Chile, Peru, Bolivia, Ecuador, Honduras and Guatemala
http://hortcrsp.ucdavis.edu/main/21Extension_LAmerica.html

Project expected to be completed in January 2012.

Lead Project Investigators:

- Jeffrey LeJeune, The Ohio State University, USA
- Juan Antonio Canumir, Rudi Radrigan, and Maria E. Gonzalez, University of Concepcion, Chile
- Patricia M. Contreras, City Council Chillan, Chile
- Sandra Kruger, Consultancy, South Africa
- Andrés Casas Diaz, Universidad de La Molina, Peru
- Eduardo Mendoza García, Universidad Mayor de San Simón, Bolivia
- Mario Montenegro-Jimenez, Universidad Tecnológica América. (UNITA), Ecuador
- Eduardo Prentzanzin, Universidad de San Carlos, Guatemala
- Gerardo Agresta, Facultad de Ingeniería Universidad de la República, Uruguay

Project Summary

In many Latin American countries, outreach activities have often addressed technical and economic issues specific to small-scale fruit and vegetable farmers. Unfortunately, in most of cases, despite successful delivery of information to the target audiences, long-term adoption of novel practices for enhanced food safety, postharvest handling, and processing techniques of horticultural products is low. The main objective of this proposal is to form an international (from the United States, Chile, Peru, Bolivia, Uruguay, Ecuador, Guatemala, and South Africa) team of researchers and extension experts to gather preliminary information about current extension methodologies used in Latin America and identify barriers to adoption of enhanced practices for these important topics. The results of this exploratory project provide the basis to develop an innovative program that will result in effective technology transfer and sustainable changes in production. Collectively, these changes will improve the income of small-scale, Latin-American horticultural farms.

Project Objectives

1. To form and solidify an international research team (from the United States, Chile, Peru, Bolivia, Uruguay, Ecuador, Guatemala and South Africa) focused on enhancing adoption of food safety and postharvest handling of horticultural products in Latin America. Prepare a full proposal for funding consideration on improved methods of small-scale farmer education in Latin America.
2. Acquire preliminary information concerning current use of extension methodologies used in Latin America (Chile, Peru, Bolivia, Uruguay, Ecuador, and Guatemala).

Project Report Technical Narrative
--Submitted by Jeffrey LeJeune

In the first quarter the interview protocol (in English and Spanish) and planning for an inaugural meeting of co-PIs and collaborators were worked on. The protocol was submitted for approval by the institutional review board at The Ohio State University. Several Skype-based meetings were conducted between co-PIs LeJeune, Canumir, Contreras, and Kruger. Co-PIs prepared summary presentations of describing agricultural extension framework, strengths, and challenges in their home countries.

The inaugural meeting was held January 17-20, 2011 with participants from eight countries participating. Different extension methodologies were reviewed, and presentations were given by each participant attending from the different countries. An observational study tour was attended by the participants to become familiar with Latin American farmers and farms. The interview instrument was reviewed and finalized. Plans were made to visit Guatemala, Honduras, El Salvador, Ecuador, and Peru. Official notification for exempt IRB status was obtained on March 3, 2011 from Ohio State.

Latin American countries were visited in May 1-15, 2011. Guatemala, Honduras, El Salvador, Ecuador, and Peru were the countries identified, and a total of 35 farmers were interviewed in all five countries. Transcription has begun and will continue.

Bolivia was visited September 5-9, 2011. Those visiting this country included Juan Antonio Canumir, Patricia Contreras, Maria Eugenia Gonzalez, Valleria Mellado, Alfredo Rueda, Eduardo Pretzanzin, Jeff LeJeune, Andrea Sosa Cueva, Pam Schlegel, Mario Montenegro, Andres Diaz, and Eduardo Mendoza served as our host. Banana and pineapple farmers were interviewed in the Chimore region. A peach farmer was visited in San Benito Valley. Three days were spent in a classroom setting discussing the identification of the target audience, methods to be used, challenges that will be encountered, and specific aims were discussed for the next project. Coding has been completed in the program NVivo for qualitative analysis.

Project Performance Indicators

4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	120
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	120
Number of rural households benefiting directly from USG interventions - Female Headed Household	6
Number of agriculture-related firms benefiting directly from USG supported interventions.	20
Capacity Building (Horticulture CRSP Indicator)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	6
Number of workshops conducted for host country institution, agency, and organization personnel	2
Number of host country professionals attending workshops, training conferences, or similar - Female	3
Number of host country professionals attending workshops, training conferences, or similar - Male	8
Number of U.S. faculty providing training or instruction in host country - Male	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	3
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	7
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	7

Project Reports by Priority Issue
Germplasm

I. Strengthening Indigenous Informal Seed Systems in Southeast Asia
Building linkages between Northern Thailand hill tribe farmers and their neighbors, a local innovative seed bank, and extension training systems
http://hortcrsp.ucdavis.edu/main/16informal_seeds.html

Project expected to be completed in January 2012.

Lead Project Investigators:
- Ricky M. Bates, The Pennsylvania State University, USA
- Thomas Gill, The Pennsylvania State University, USA
- Rick Burnette, ECHO Asia Regional Office, Thailand
- Abram Bicksler and Laura Meitzner Yoder, International Sustainable Development Studies Institute, Thailand
- Yongyooth Srigiofun, Maejo University, Thailand

Project Summary
Informal seed systems provide access to locally adapted indigenous crops and constitute an essential component of sustainable production for resource-poor farmers. Current efforts to identify, conserve, improve, and disseminate this rich genetic resource are insufficient. Development of these locally valued crops sets the foundation for increased and improved production, marketing and profitability. This project increased the impact and reach of these informal seed systems locally and regionally. Specifically, we formed an effective team that built linkages between Northern Thailand hill tribe farmers, a local innovative seed bank, and extension training systems.

Establishment of this linkage resulted in: 1) surveys of key indigenous crops and collection of local crop knowledge, 2) activities promoting emergence of an effective regional seed bank, including training of key personnel, 3) development of an indigenous seed system conference and seed exchange, and 4) improved human and institutional capacity, strategically focused on entrepreneurial women. This project gave farmers access to new varieties and locally adapted crops, many of which were unavailable from commercial sources, developed value chains around key species, and resulted in regional distribution of important seed resources to less developed neighbor nations such as Bangladesh, Cambodia, Laos, and Vietnam.

Project Report Technical Narrative
--Submitted by Ricky M. Bates
This one-year project demonstrated the value of investing in local, indigenous, informal seed systems. Connecting farmers and farmer associations within the informal seed system to local non-governmental agencies and an NGO-based seed bank is versatile and has certain advantages. Many of the underutilized species revealed in the village surveys have potential and are being evaluated in a regional development context by local actors. The relationship between the local hill tribe seed system and the ECHO seed bank potentially improves system sustainability, offers new economic opportunities for local farmers, and increases distribution of high quality, locally adapted seed to other farmers and development workers in the region.

> Our results indicate that seed produced by local farmers is generally similar in quality to seed from commercial sources.

Our results indicate that seed produced by local farmers is generally similar in quality to seed from commercial sources. As particular species become more visible and gain in popularity, increasing supply to meet demand could be a constraint. However, this scenario does offer new market opportunities—particularly to hill tribe women farmers. Because the seed bank distributes seed to poor farmers, as well as to development workers, the system described here could also facilitate the movement and adoption of improved seed from the formal seed system. It builds upon existing local experience, knowledge and skills. It provides poor farmers who may not be able to afford commercial seed access to high quality, locally adapted varieties. And, it represents a holistic and inherently strong approach, as it relies upon partnerships and networks from all aspects of the informal seed system. It is also important to note that this project was preliminary and limited in scope and duration; weaknesses and bottlenecks identified in this study warrant further testing and modification.

Seed swaps were held as a way to distribute and identify new varieties.

This research outlines practical steps and activities for strengthening indigenous seed systems in northern Thai and Cambodian communities and potentially extends the reach and impact of valuable, locally adapted crop species. The key to success is the adoption of a holistic approach that empowers resource-poor households and communities, fortifies indigenous seed pathways, promotes seed system best practices, and preserves and improves the rich genetic biodiversity of the system. In order to continue the strengthening of informal seed systems within the region, there is the need to expand this research and extend it into other communities and countries. This scale-up is critical to preserving biodiversity, ensuring food security, and facilitating the sustainable development of these rural agro-ecosystems. For maximum impact, it is hoped that this methodological approach to strengthening informal seed systems can be extended into other countries in South and Southeast Asia faced with community food insecurity, including Bangladesh, Cambodia, Laos, and Vietnam.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Achievements**
Females who received short-term agricultural enabling environment training	42
Males who received short-term agricultural enabling environment training	49
4.5.2 Agriculture Sector Productivity	**Achievements**
New technologies or management practices under research.	4
New technologies or management practices made available for transfer.	3
New technologies or management practices being field tested.	7
Number of additional hectares under new technologies or practices.	7
Female farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance	54
Male farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance	49
Number of rural households benefiting directly - Female Headed Household	231
Number of rural households benefiting directly - Male Headed Household	287
Number of producers organizations receiving USG assistance.	1
Number of trade and business associations receiving USG assistance.	2
Number of community-based organizations (CBOs) receiving USG assistance.	8
Number of community-based organizations (CBO) who have adopted new technologies or management practices as a result of USG assistance.	6
Number of agriculture-related firms benefiting directly from interventions.	7
Number of women's organizations assisted as a result of interventions.	8
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	215
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	135
Value of new private sector investment in the agriculture sector or food chain.	$4600
Number of jobs attributed to FTF implementation	4
Number of projects or technologies of potential benefit to U.S. industries	2
Capacity Building (Horticulture CRSP Indicator)	**Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	5
Number of workshops conducted for host country personnel	6
Number of host country professionals attending workshops or similar - Female	204
Number of host country professionals attending workshops or similar - Male	268
Number of U.S. faculty providing training in host country - Female	1
Number of U.S. faculty providing training in host country - Male	2
Number of host country extension workers, university faculty or other professionals involved in training other host country professionals - Female	5
Number of host country extension workers, university faculty or other professionals involved in training other host country professionals - Male	8
Female host country professionals directly involved in research activities	3
Male host country professionals directly involved in research activities	4

Section Five – Long-Term Pilot Projects

In 2010 and 2011, Horticulture CRSP awarded five three-year Pilot Projects. These projects are built on lessons Horticulture CRSP learned through the one-year Immediate Impact Projects, as they were completed in 2010 and 2011, and on priorities identified through the Feed the Future Initiative. The following project reports reflect extensive work to create better seed systems, test and transfer innovative technologies, reduce postharvest losses, deliver information and build capacity, and tackle issues in production and marketing.

I. Extension of Appropriate Postharvest Technology in Sub-Saharan Africa

Opening a regional postharvest training and services center
http://hortcrsp.ucdavis.edu/main/26pharvest_train.html

Project is ongoing until 2013.

Lead Project Investigators:

- Diane M. Barrett, University of California, Davis, USA
- Lisa Kitinoja, World Food Logistics Organization, USA
- Dan MacLean, University of Georgia, USA
- Hilda Vasanthakaalam, Kigali Institute of Science and Technology, Rwanda

Project Summary

Physical losses of horticultural crops during postharvest continue to range from 30-80 percent in Sub-Saharan Africa (SSA), and problems with food quality, safety, and nutritional value are well documented. While past projects have identified appropriate postharvest technologies and recommended a variety of training, capacity-building, and small-scale infrastructure development, no single project has integrated all of this information and offered a locally based solution.

This unique pilot project will combine a wide variety of training programs, adaptive research and demonstrations of postharvest services. It will also provide access to needed tools and supplies in order to reduce postharvest losses and improve market access and incomes for women farmers in Rwanda affiliated with established cooperatives near Kigali.

The project site in Rwanda will serve as a model for postharvest development in five additional SSA countries, whose representatives will participate via collaboration with African partners. By the close of project, 30 postharvest specialists from the six SSA countries involved will be well qualified to implement enhanced postharvest handling techniques. They will be charged to teach these techniques to approximately 1,000 women farmers in their home countries. This will result in increased consumption of higher quality produce and better returns on investment for women farmers.

Project Objectives

1. Train 30 persons (researchers, extension workers, or development workers) from Rwanda, Ghana, Kenya, Tanzania, Benin, and Gabon as postharvest specialists (Year 1).
2. Design and set up a Postharvest Training and Services Center (PTSC) in Kigali, Rwanda (Year 1).
3. Provide demonstrations and training programs, and conduct adaptive research on innovative small-scale appropriate postharvest handling, food safety, and food processing methods at the PTSC in collaboration with trainees and local extension personnel (Years 2 and 3).

Project Report Technical Narrative
--Submitted by Diane M. Barrett

The first step in our project was to identify 30 individuals to be trained as “Master Trainers.” We requested nominations from contacts in six Sub-Saharan African countries in December 2010, and reviewed applications from almost 200 individuals. Approximately 60 were selected for another round of evaluation, in which we asked them to complete a Postharvest Training Needs Assessment. Nominees described their experience with postharvest research and extension

activities, their academic and career backgrounds, and access to the internet. The PIs on the project reviewed and ranked all applications, then chose the best 40 individuals to undergo our one-year Master Trainer program. Approximately half of the individuals chosen are female.

The training agenda, which includes 10assignments over a one-year period, was developed and shared with the trainees. Many of the assignments involve reading information available on websites, and/or on CDs mailed to them, and then completing assigned reports or projects. In February, all of the PIs (Barrett, Kitinoja, MacLean and Vasanthakaalam) met in Rwanda for one week. Following this trip we have written a proposal to the Ministry of Agriculture, requesting a site for the Postharvest Training and Services Center at one of their sites outside of Kigali.

Our co-PI, Dr. Hilda Vasanthakaalam, has successfully obtained permission to build a Postharvest Training and Services Center at the Mulindi Agricultural Fair site from the Ministry of Agriculture. A design has been approved and materials and supplies will be purchased soon so that the in-person training of our 40 Master Trainers can be carried out in February and March 2012.

Project Performance Indicators

Capacity Building (Horticulture CRSP Indicator)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	10
Number of host country professionals attending workshops, training conferences, or similar - Female	20
Number of host country professionals attending workshops, training conferences, or similar - Male	20
Number of certificate training programs conducted	1
Number of U.S. faculty providing training or instruction in host country - Female	2
Number of U.S. faculty providing training or instruction in host country - Male	1

II. Low cost pest exclusion and microclimate modification technologies for small-scale vegetable growers in East and West Africa
Demonstrating nets and floating row covers
http://hortcrsp.ucdavis.edu/main/27pest_exclusion.html

Project is ongoing until 2013.

Lead Project Investigators:
- Mathieu Ngouajio, Michigan State University, USA
- Thibaud Martin, Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), France
- Françoise Komlan, Institut National des Recherches Agricoles du Bénin (INRAB), Benin
- Lusike A. Wasilwa, Kenya Agricultural Research Institute (KARI), Kenya
- Anselme Adégbidi, Abomey Calavi University, Benin
- Damien Ahouangassi, Association des Personnes Rénovatrices des Technologies Traditionnelles' (APRETECTRA), Benin
- Serge Simon, INRAB/CIRAD, Benin
- Mwanarusi Saidi, Egerton University, Kenya
- Pierre Guillet, A-to-Z Textile Mills International, Tanzania
- Laurent Parrot, CIRAD, France

Project Summary
Rapid urbanization in Sub-Saharan Africa (SSA) has resulted in an increase in demand for food. Almost 33 percent of the SSA population, close to 200 million people, are undernourished. Fruit and vegetable consumption in SSA remains 22-82 percent below the intake value threshold of 400 grams per day recommended by the World Health Organization and the Food and Agricultural Organization of the United Nations. This severe malnutrition leads to many chronic diseases among the population. Vegetable growers, mainly smallholders, are poor and have no access to inputs for improved germplasm, pest and disease control tools, and improved crop production techniques. Vegetable farms are routinely devastated by pests and extended drought conditions.

We will harness alternative pest management techniques, micro-climate modifications, and growers' education and training to improve small-scale vegetable production in East and West Africa. A participatory approach will be used to demonstrate efficacy of 1) Eco-Friendly Nets (EFN); insect-barrier netting (either treated or not with insecticides) for protecting vegetables against pests and associated viral diseases and 2) floating row covers for improving crop micro-climate and enhancing yield and produce quality. The project will also assess and address farmer's perception of EFN in order to increase the adoption and use of the technology.

Project Objectives
1. Optimize and adapt EFN and other row cover technologies for year-round production of vegetables under diverse local conditions (climate, crop/cultivar, irrigation, pests and pathogens).
2. Determine the costs, benefits, and socio-economic viability of EFN and row cover technologies.
3. Increase local human capacity, women empowerment, adoption and use of locally adapted eco-friendly nets and other row covers in target communities.

Project Report Technical Narrative
--Submitted by Mathieu Ngouajio
Following the award announcement, two meetings involving MSU, CIRAD, and local partners were held in Kenya (November 2010) and Benin (January 2011) to launch activities in the respective countries. The meetings also served as an opportunity to showcase the project to national and international partners as well as the USAID mission in those countries.

The scientific meetings were followed by multiple meetings with other national and international organizations and a visit to the USAID mission in Benin. At the beginning of the project, more than 1.5 tons of nets with various specifications were donated by the company A-to-Z Textile Mills to Benin, Kenya, and CIRAD for the studies.

During the first six months of the project, studies were conducted at three sites in Kenya (Kabete, Thika, and Egerton) using tomato and cabbage. Nursery experiments are almost complete at some of the sites and preparations for field production were ongoing. Significant amounts of data were collected on a variety of parameters (crop, pest, climate, etc.) and will be analyzed. In Benin, due to the difference in climate, nursery studies were not initiated until the end of March 2011. However, significant progress has been made with on-farm studies. Farmers have already been identified for field trials and will soon receive the nets and instructions.

INRAB, in collaboration with the Faculté des Sciences Agronomiques, Université d'Abomey-Calavi (FSA-UAC) and the Agricultural Extension Services of Mono and Couffo districts (CeRPA), developed survey questionnaires and trained enumerators. FSA-UAC, INRAB, and the Regional Council for Vegetable Production of Mono and Couffo districts (CRM) supervised this survey and approached 160 farmers. A doctoral student (Faustin Vidogbéna) is working on this objective as a dissertation topic.

Two major workshops were conducted in Kenya (November 2010) and Benin (January 2011) to present project goals and strategies to national, local and international partners. These seminars also allowed training of all partners directly involved in the project. A total of 25 people participated in both workshops.

Three separate training sessions with total attendance of 45 people were conducted in Benin between December 2010 and March 2011. The target audiences were extension agents and selected farmers. The training covered the use of nets in vegetable production and survey administration. All trainees on survey administration are currently involved in socio-economic surveys among farmers.

During the second six months of this project, the team in Kenya continued testing cabbages and tomatoes. For each crop, studies were carried out on efficiency of treated and untreated agronets (with temporal net cover changes) targeting pest control. The crops were evaluated both in the nursery and the main field. Temporal differences in placement of EFN, permanent cover with EFN, partial cover with EFN, and open cultivation of the crops were evaluated. Floating row covers were evaluated in the field for favorable micro-climate modification for good seedling and plant growth; insect pest control, and disease incidences as influenced by the micro-climate created by the covers. Field days and open days have been conducted to disseminate the information about the agronets in all the trial sites. Posters and brochures have been developed to provide information about the technology. There have been publications in local daily papers following the field days.

In Benin two series of trials on tomato and cabbage were conducted on INRAB Vegetable Research Program's station at Agonkanmey, from May to September 2011. The objective of the nursery trials was to produce quality seedlings of cabbage and tomato by reducing pest pressure. Four treatments were compared of nets with different sized mesh. The three main production trials on both crops were developed from June to September 2011: Two trials on cabbage and tomato aimed to produce quality cabbage and tomato with untreated EFN. A third trial without nets compared the performance of tomato seedlings produced under EFN. Statistical analysis of the collected data is on course.

The team of Dr. Adegbidi (FSA-UAC) led all activities. A baseline survey has been done in the Mono and Couffo regions where EFN are being tried with farmers by FAFA-NGO. Data collected from this survey have been analyzed, and results presented to stakeholders.

To get a better insight into the peri-urban production systems, a pilot survey was organized for one week along the coastline (Cotonou, Ouidah, Comè, and Grand-Popo) and in the Couffo region. The questionnaire proposed for the survey by the doctoral student, with exhaustive identification of relevant variables, was improved by means of e-mail exchanges between the CIRAD team, Benin team and the four students from FSA-UAC. The students and two experienced surveyors were trained on the use of a pilot survey guideline. In total, 216 farmers participated in the survey, under FSA-UAC's supervision. A statistical datasheet (SPSS) is being completed by the team. The doctoral student will submit his final proposal before the end of next year.

A thesis in environmental economics is conducted by Faustin Vidogbéna, a researcher from INRAB. The thesis covers the socio economic and environmental impacts of EFN on small-scale farming systems in Benin. The thesis is under the supervision of the UAC (Anselme Adegbidi and Professor Rigobert Tossou), and CIRAD (Laurent Parrot). In addition to USAID support, Vidogbéna will be in Montpellier, France in November in order to benefit from the expertise of researchers in the fields of environmental, agronomic, and economic sciences. The French embassy in Benin provided a research grant of 1,500 Euros covering transportation and insurance costs. CIRAD provided an additional research grant of 1,500 Euros covering furniture and materials.

Project Performance Indicators

4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research.	10
Number of new technologies or management practices made available for transfer as a result of USG assistance.	2
Number of new technologies or management practices being field tested.	6
Number of additional hectares under improved technologies or management practices as a result of USG assistance.	0.1
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	3
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	3
Number of rural households benefiting directly from USG interventions - Female Headed Household	14
Number of rural households benefiting directly from USG interventions - Male Headed Household	31
Number of producers organizations receiving USG assistance.	2
Number of community-based organizations receiving USG assistance.	1
Number of ag. firms benefiting directly from USG supported interventions.	1
Number of public-private partnerships formed as a result of USG assistance.	6
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	22
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	48
Number of jobs attributed to FTF implementation	5
Number of research projects and/or technologies of potential benefit to U.S. horticultural industries	3
Capacity Building (Horticulture CRSP Indicator)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	10
Number of workshops conducted for host country personnel	10
Number of host country professionals attending workshops, training conferences, or similar - Female	9
Number of host country professionals attending workshops, training conferences, or similar - Male	20
Number of U.S. faculty providing training in host country - Male	1
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	16
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	18
Number of host country professionals involved in research - Female	12
Number of host country professionals involved in research - Male	18

III. Semillas de Esperanza: Vegetable Seeds for Sustainable Agriculture

Producing local, disease-resistant vegetable seed
http://hortcrsp.ucdavis.edu/main/29seedsofhope.html

Project is ongoing until 2013.

Lead Project Investigators:

- James Nienhuis; University of Wisconsin-Madison, USA
- Suzanne Dove, University of Wisconsin-Madison, USA
- Peter Hanson and Paul Gniffke, AVRDC-The World Vegetable Center, Taiwan
- Doris Hernandez, Claudia Eugenia Flores de Leon, and Edgar Ascensio, CARE, El Salvador and Guatemala
- Martha Moraga, Maria de los Angeles, Francisco Salmeron, and Tomas Laguna, Universidad Nacional Agraria, Nicragua
- Donald Breazeale, Fundacion Hondurena de Investigacion Agricola (FHIA), Honduras

Project Summary

Acute poverty and meager economic opportunities exist in many rural regions of Central America. Vegetable and seed production are technology-driven economic activities that can significantly contribute to economic growth in communities and families and specifically provide new opportunities that contribute to the economic empowerment of women. Factors limiting this horticultural transformation are access to:

- vegetable cultivars with resistance to endemic diseases
- high-quality seed of adapted cultivars
- business know-how, basic management and marketing skills
- connections to regional supply chains that provide stable, predictable markets

Cultivars developed by AVRDC - The World Vegetable Center have demonstrated tolerance to diseases endemic to Central America. Quality seed can be produced in the tropics in screen houses. The University of Wisconsin's Center for International Business Education and Research (CIBER) is a small business incubator. Hortifruti is the dominant regional purchaser, distributor and marketer of vegetables. The supply chain benefits include:

- families and women's groups develop technology-based seed and vegetable production businesses within each country
- access to high-quality seed of adapted cultivars reduces risk, minimizes losses, and increases profitability in sustainable production for growers, cooperatives, and women's groups
- increased consumption of vegetables contributes to a healthier, more diverse diets

Project Objectives

1. Germplasm evaluation - Reduce risk and increase productivity and profitability of sustainable vegetable production by identification of tomato and pepper cultivars with improved adaptation (disease resistance) in Central America. At field days with communities, families, and women's cooperatives, market and distribute seed of selected cultivars plus discuss quality requirements of Hortifruti.
2. Seed production - In cooperation with women's groups, produce, market, and sell seed and selected tomato and pepper cultivars to local spot markets and regional distributors (i.e. Hortifruti). Develop hands-on workshops at UW-Madison on business management and international standards of seed technology.

3. Business management- Cooperatives should develop enhanced management and marketing skills necessary to develop and manage successful businesses.

Project Report Technical Narrative
--Submitted by James Nienhuis
Our goal is to produce and market seeds of advanced tomato and pepper cultivars in four countries. First, we have to identify the cultivars that possess the necessary viral tolerance and desirable horticultural traits, e.g. fruit size, color, flavor, plant size, and yield. We have competed trials of almost 60 genotypes in three of the countries, Honduras, Nicaragua, and El Salvador, and are in the process of evaluating the lines in Guatemala. We have connected to community groups of women in each country and we are either renting our building a greenhouse for seed production. We are providing training in vegetable production and seed processing and cleaning at regional workshops at Madison, Wis., and also scheduled a workshop in Nicaragua. We have not yet produced or marketed seeds; nevertheless, we have identified superior cultivars and now are in a position to begin seed production in 2012.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	4
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	21
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research.	50
Number of new technologies or management practices made available for transfer as a result of USG assistance.	5
Number of new technologies or management practices being field tested.	50
Number of producers organizations receiving USG assistance.	4
Number of trade and business associations receiving USG assistance.	4
Number of community-based organizations receiving USG assistance.	4
Number of producers organizations who have adopted new technologies or management practices as a result of USG assistance.	4
Number of women's organizations assisted as a result of USG interventions.	4
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	4
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	21
Number of individuals who have received USG supported long-term agricultural sector productivity or food security training - Male	1
Number of technologies of potential benefit to U.S. horticultural industries	5
Capacity Building (Horticulture CRSP Indicators)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	4
Number of workshops conducted for host country institution, agency, and organization personnel	1
Number of host country professionals attending workshops, training conferences, or similar - Female	4
Number of host country professionals attending workshops, training conferences, or similar - Male	21
Number of graduate degrees earned by host country - Male	1
Number of certificates earned by host country professionals - Female	4
Number of certificates earned by host country professionals - Male	21
Number of U.S. faculty providing instruction in host country - Male	2
Number of host country professionals providing training to other host country professionals - Female	1
Number of host country professionals involved in providing training to other host country professionals - Male	4
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	20

IV. Increasing the Capacity of Smallholder Farmers to Produce and Market Vegetable Crops in Uganda and Democratic Republic of Congo

Developing a participatory extension model to enhance smallholder production and marketing
http://hortcrsp.ucdavis.edu/main/28prod_uganda.html

Project is ongoing until 2013.

Lead Project Investigators:

- Kate Scow, University of California, Davis, USA
- Johan Six, Mark Van Horn, Heidi Ballard, and Stephen Boucher, University of California, Davis, USA
- Edith Naggenda and Ignitius Bwoogi, Rural Agency for Sustainable Development, Uganda
- Michael Masanza, Uganda Christian University, Uganda
- Beatrice Akello and Peter Lusembo, National Agricultural Research Organization, Uganda
- Harriet Nsubuga Mpanga, Agribusiness Initiative Trust, Uganda
- Prossy Isubikalu, Makerere University, Uganda
- Dennis Yiga, Mukono District Local Government, Uganda
- Karel Van Laer, Scheut Tshilomba, Democratic Republic of Congo

Project Summary

Although the growing market for horticultural products in Uganda offers an opportunity for smallholder farmers to improve their income, their access to these markets is still limited. This project will develop a participatory extension model to rapidly improve smallholder linkages to horticultural markets, which will be achieved by merging and supplementing two agricultural development models - Farmer Field Schools (FFS) with the Participatory Market Chain Approach (PMCA). We will work with farmer groups established in our pilot project in Nkokonjeru, Uganda, and evaluate the potential of our adapted FFS methodology to a pilot community in the Democratic Republic of Congo.

Specific objectives are to strengthen farmer groups' capacity to produce indigenous leafy green vegetables and tomatoes for the market and improve farmers' ability to use their farm as an income generating asset. Research in small plots and on farmers' fields of economically appropriate soil fertility management technologies, including micro-dosing, improved varieties, irrigation, and safe pesticide use, will help identify ways to increase vegetable yields and quality. Curriculum enhancement with a local university (Uganda Christian University) and Uganda's primary agricultural university (Makerere), as well as with governmental and NGO agricultural extension, will strengthen the region's capacity to carry out and sustain research and extension activities for horticultural crops.

Project Objectives

1. Develop a participatory extension model that enhances marketing and production of horticultural crops for small shareholders by linking the Farmer Field School (FFS) method and the Participatory Market Chain Approach (PMCA).
2. Research and develop economically appropriate integrated soil fertility management (ISFM) practices to improve quality and quantity of tomatoes and indigenous leafy green vegetables.
3. Increase the region's capacity to carry out and sustain research, education, and extension activities for horticultural crop production and marketing.

4. Evaluate extension of horticulture-based FFS program to rural Democratic Republic of Congo (DRC).

Project Report Technical Narrative
--Submitted by Kate Scow, Abraham Salomon, Lauren Pincus

Rapid Market Appraisal

A Rapid Market Appraisal (RMA) was conducted in April 2011 to characterize the potential of indigenous leafy greens in the greater Kampala urban area. Staff gathered data on the typical volumes, prices, seasonality, varieties, and standards present in the marketplace. Highlights of the market appraisal on leafy greens included:

1. Leafy greens have a high economic value (up to 5-6 times that of maize, 2-3 times that of cabbage) on a per kilogram basis.
2. Sales of leafy greens are concentrated in 3-4 main Kampala markets with surrounding smaller markets sourcing their vegetables from these main markets.
3. Prices of leafy greens are subject to high seasonality; prices often triple in the dry season.
4. The most popular types of indigenous leafy greens are Nakati (*Solanum macrocarpon, Solanum aethiopicum*), Bbugga (*Amaranthus* spp.), and Ggobe (*Vignaunguiculata*, or cowpea leaves).
5. Leafy greens are often sold in bunches, although there are no standardized measurements for bunch sizes and one seller's bunch size may differ from another seller's bunch size.
6. Commonly referred to quality indicators are large leaves with little or no insect damage. Plants must be freshly picked and are often transported to the market with the roots intact to preserve freshness and prevent wilting.

Farmer Group Formation

Between April and July 2011, farmers were informed of the upcoming project and mobilized into groups. This process consisted of a series of meetings between project staff, farmers, and market vendors.

Project staff initiated contact with local farmers by first inviting guest speakers from one of the major markets identified in the RMA to speak to farmers about the market for vegetables. These meetings provided a forum for the market vendors to present the opportunity for growing vegetables, especially indigenous leafy greens, as a commercial crop. Farmers were able to ask the market vendors questions about leafy greens commercialization during the presentation. Attending farmers were encouraged to talk to members of their respective villages to assess the level of interest in forming indigenous greens production groups. Organizing farmers into functioning groups allows project staff to reach farmers and work with them more effectively.

After these initial meetings, the FFS director visited all the newly formed farmer groups to discuss how the project would operate. This was critically important to level expectations had by farmers, who are accustomed to seeking free inputs from projects. The message given to farmers at these meetings was one of empowerment as well as responsibility, such that farmers would be the leaders in this project, and the role of staff would be to support them in their goals by using a participatory extension approach. This is in contrast to the more typical Training and Visit extension model currently practiced in Uganda. A major goal of these primary meetings with farmers was to separate farmers interested in expanding indigenous greens production through a participatory learning format from those who are not, which is critical for the strength and sustainability of each farmer group.

A next round of meetings was then held in each village to help formalize farmer groups that showed continued interest in the project. Farmer groups were considered formalized when they had established rules of governance and the group objectives, determined leadership and membership responsibilities, and set membership fees. Groups submitted a written constitution that outlined many of these criteria.

This process was coordinated and encouraged by the trainee facilitators (see below). Concurrently, groups elected lead farmers to attend an additional workshop on indigenous leafy greens production and marketing. Objectives of this workshop were to train these lead farmers in Farmer Field School methods and participatory research principles since many local farmers are not familiar with this type of extension approach.

The groups that successfully completed this process were considered eligible for participation in the project.

Facilitator Training

Facilitators for the FFS were selected through a formalized job search, which included both an initial screening and then a final screening after applicants completed a month-long training process.

The position was advertised through various means, including:

1. Postings at Bukalasa Agricultural College
2. Uganda agricultural entrepreneurship forum website (Agri-Pro-Focus)
3. Participatory Ecological Land Use Management (PELUM) notice to member organizations
4. Professional recommendations

Initial interviews were held from April to June. Criteria for advancement to the next round included language skills (fluency in both written and spoken Luganda and English), experience in extension or working with farmers, technical training, and a positive group dynamic. Out of the original 25+ interviewees, 10 were invited to the FFS training-of-trainers (TOT) workshop.

The TOT workshop was held from July 18-July 23, 2011 and consisted of three stages. First, the ten candidates attended a week-long training on the FFS concept, methods, and basic facilitation skills. Main topics of the training included defining FFS, understanding the role of a facilitator, facilitation skills, group management and formalization skills, agro-ecosystem analysis, and basic agronomy of indigenous greens. Guest trainers came from Makerere University (Dr. Prossy Issibikalu), Namulonge Research Center (Phyllis Kasambula), and the USAID LEAD program (Teopista Nakkungu).

After completion of this training, trainee facilitators were given a two-week field assignment to first introduce the FFS concept to farmers and relevant local leaders and then to organize interested farmers into groups. Project staff from RASD and UC Davis monitored their progress and assisted by organizing a mid-assignment meeting to help the facilitators address some of the problems that surfaced. At the end of this assignment the facilitators identified and invited lead farmers from their respective villages to a second TOT workshop to build leadership capacity within the groups. This assignment was an important team building activity between the trainees and project staff.

Trainee facilitators and lead farmers attended a week-long training on agronomic practices for leafy greens. The workshop also focused on the goals of the upcoming project, including creating the curriculum for the FFS and reviewing what a FFS does and does not do. Sessions during the workshop included indigenous leafy greens marketing; management practices for indigenous greens; Agro-Ecosystem analysis; pest and disease management; soil management; the FFS process and goals; and participatory curriculum design for the FFS

During this week, the staff handed over many activities to the facilitator trainees. This built their experiences and skill base while allowing the staff to evaluate how the trainees fared when leading group discussions or activities. The workshop attendees also benefited from having local persons with practical experience growing leafy greens as facilitators. The lead farmers and facilitator candidates all earned official certificates for their contribution and participation at the end of the workshop. An important output of this workshop was the development of a curriculum for the FFS.

After this training, five facilitators were selected to continue with the project based on their demonstrated skills as facilitators. All candidates had made significant progress in their understanding of a FFS and their ability to serve as a facilitator. Selecting five candidates was difficult, but the project staff hopes to support the dismissed trainees through referrals and recommendations to future employment endeavors.

Experimental Design and Baseline Data Collection

In order to determine the effectiveness of an integrated FFS/PMCA program on households involved, each organized farmer group was put into one of four treatments. These treatments were:

1. FFS and PMCA
2. FFS (no PMCA)
3. PMCA (no FFS)
4. Control (no FFS or PMCA)

Household sampling both pre- and post-project will be completed to measure quantitative indicators of the project impact. This data will be combined with qualitative data to give a more complete analysis of the project methods. Before either program officially began, ten members of each farmer group were randomly selected from group membership lists for baseline sampling.

Enumerators were trained in giving a questionnaire that had been designed and field tested by RASD and UC Davis. The enumerators included five undergraduate students from Ugandan Christian University, one Master’s degree student from Makerere, two local volunteers, and RASD's project manager, Sam Mwebe.

Enumerators received three days of training, during which the survey questions were reviewed and discussed and practice interviews were given to nearby farmers. Throughout the enumerators’ training session the survey questions were revised; ongoing training continued during the survey process when mistakes were identified and corrected. The enumerators systematically visited each village containing a treatment group. Data is now being entered into a data input form for analysis.

Farmer Field Schools

FFS sessions for 20 groups in five parishes officially began on Sept. 1, 2011. The five facilitators were posted in their respective villages and facilitated the selection of designated meeting times

and places for each of their groups, though many have been subject to change. Each facilitator is in charge of 3-5 FFS groups. Facilitators will report weekly for a staff meeting with the RASD program manager, the FFS director, and guest attendees (such as Master's students from Makerere and MUZARDI staff). These meetings will be a forum for the ongoing training of facilitators, a chance for facilitators to address problems and receive feedback from other facilitators, and an opportunity to attend to "housekeeping" issues. Facilitators will also share their weekly reports with the project staff.

Additional Farmer Visits
Facilitators who were not selected to continue with the program had organized farmer groups, which are now in the control treatment and not receiving the FFS or PMCA programs. These groups were visited by Dennis Yiga and Sam Mwebe to explain that the project was not continuing, but their groups are still involved in the overall project research as a control group. These groups also benefit from their group formalization through programs offered by the national extension system, NAADS. NAADS works with farmer groups almost exclusively, and it is difficult for individual farmers to access their services. As a formalized group, farmers in these villages have a much better platform to take advantage of these programs.

MUZARDI staff began their PMCA Phase I research by interviewing farmer groups, both in and outside the FFS. They collected data on farmers' indigenous greens production methods and current marketing strategies. They also informed farmers of the upcoming PMCA meetings.

Lead Farmer Workshops
Two workshops were held thus far during the FFS. These workshops are part of a series of capacity building exercises for leaders within the FFS farmer groups. They will also facilitate the transmission of new ideas into the FFS sessions and build group management and planning skills. The first workshop was held on Sept. 23, and covered two main topics: MUZARDI's research on management of indigenous leafy greens and potential seed sources and varieties. The second was held on Sept. 30 and covered group budgeting. Facilitators have commented on the value of these workshops in building group capacity, interest, and leadership among those who attended. On Oct. 28, a workshop will be held on participatory monitoring and evaluation within the FFS producer groups. The goal of this workshop will be to both empower groups to set, monitor, and meet their goals and to come up with participatory methods to monitor the progress of information and innovations discovered during the FFS.

Student Progress
A strike by the faculty at Makerere University in early fall delayed some of the progress on coursework and research formulation, though now things are back to normal.

William Sekamate – Masters student in Soil Science, Makerere University
William Sekamate (Peter Ebanyet's student) began drafting his research proposal, with input from Kate Scow, Johan Six, and Mark Van Horn, and implementing the early stages of his fieldwork. The proposal is focused on investigating the nutrient requirements of nakati, one of the most commonly grown and consumed indigenous greens in Uganda. Research plots at MUZARDI were cleared and planted during September 2011 and germination was recorded on Oct.13. Also, as part of his research, William is monitoring the progress of farmers' trials in the FFS and took nine soil samples to analyze for participating groups.

Nassib Mugwanya – Masters student in Agricultural Extension & Education, Makerere University

Nassib Mugwanya (Prossy Isubikalu's student) began taking courses in his program in February 2011. He has been an active participant/recipient of many of the Horticulture CRSP trainings (focus groups facilitation and the FFS TOT workshop). Nassib has begun his research fieldwork, which consists of participant observation of the farmer groups within the FFS. He also attends many extra-curricular activities related to the project, such as the CRSP directors' meeting in Kampala in July. He was part of the team conducting the baseline survey in August 2011. Finally, he has been developing, with input from Heidi Ballard and Kate Scow, a research proposal for his thesis research.

Students in Bachelors of Agriculture and Entrepreneurship program at Ugandan Christian University (UCU)

Five students from UCU participated in trainings for survey enumeration and conducted baseline data collection. These same five students are also in the process of drafting research proposals for special projects in their program.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	77
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	30
Number of individuals who have received USG supported long-term agricultural enabling environment training - Female	1
Number of individuals who have received USG supported long-term agricultural enabling environment training - Male	2
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of producers organizations receiving USG assistance.	32
Number of community-based organizations (CBOs) receiving USG assistance.	2
Capacity Building (Horticulture CRSP Indicator)	**Project Achievements**
Number of host country institutions, agencies and organizations in direct cooperation or collaboration	5
Number of workshops conducted for host country institution, agency, and organization personnel	3
Number of host country professionals attending workshops, training conferences, or similar - Female	3
Number of host country professionals attending workshops, training conferences, or similar - Male	1
Number of certificates earned by host country professionals - Female	25
Number of certificates earned by host country professionals - Male	31
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Female	4
Number of host country extension workers, university faculty or other host country professionals involved in providing training to other host country professionals - Male	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Female	3
Number of host country professionals directly involved in conduction Horticulture CRSP research activities - Male	6
Number of certificate training programs conducted	3

V. Safe Vegetable Production in Cambodia and Vietnam: Developing the HARE-Network to Enhance Farmer Income, Health, and the Local Environment
Creating a market niche for 'food-safe' vegetables
http://hortcrsp.ucdavis.edu/main/30hare.html

Project is ongoing until 2013.

Lead Project Investigators:

- Cary J. Trexler, University of California, Davis, USA
- Johan Six, Glenn Young, Mark Van Horn, and David Miller, University of California, Davis, USA
- Nguyen Quoc Vong, Nguyen Thi Bich Thuy, Pham Thi Huong, Pham Bao Duong, Pham Van Hung, and Thong Kong, Hanoi University of Agriculture, Vietnam
- Borarin Buntong, Asikin Yoeu, Lyda Hok, and Lor Lytour, Royal University of Agriculture, Cambodia
- Lam Thanh Hien, Phan Thi Giac Tam, Thai Anh Hoa, and Pham Thi Minh Tam, Nong Lam University, Vietnam

Project Summary
The rapid economic and population expansion of Cambodian and Vietnam within the greater Southeast Asian region presents opportunities for impacting the livelihood of many people where horticulture remains an important undeveloped business sector supported by small farmers. Our goal is to empower small-scale farmers (59% of whom are women) with integrated experiential education and training for sustainable vegetable production that limits postharvest losses, increases food safety, increases market access, and, importantly, increases income. We have designed an innovative participatory approach to meet these goals by networking experts in horticulture production through marketing. The inclusiveness as stakeholders of farmer communes, regional universities, local governments, and national communications companies in the network provides continuity needed for continuation of farmer outreach training and education beyond the lifetime of USAID Horticulture CSRP funding. The successful completion of the project in Vietnam will serve as a model for implementation of the participatory action network in other, more challenging, countries like Cambodia and Laos with similar, but less developed, horticulture business sectors. Importantly, completion of this project will address essential capacity-building needs of Cambodia including an assessment of capabilities, research training, outreach development, and promotion of communication between policy makers, universities, and the agribusiness community. A direct impact from this project is that Cambodian and Vietnamese vegetable farmers will gain income.

Project Objectives

1. Build local scientific and technical capacity
2. Apply findings and technical knowledge to increase smallholder participation in markets
3. Facilitate the development of policies that improve local horticultural trade

Project Report Technical Narrative
--Submitted by Cary Trexler
Per the grant timeline, we held a planning meeting in January 2011 for the coordinators of the Vietnamese and Cambodian teams in Davis, California. The meeting was productive and all parties understand their role in the project. We made progress in terms of making connections with various people and organizations in Vietnam and Cambodia. The universities in Vietnam

have made connections and have chosen the four communes located in Hanoi and Ho Chi Minh City.

In Cambodia, we learned from various officials about micro-finance, cooperatives, and other things that are part of our project's design. We made contact with the USAID/Cambodia mission and were told that we are limited to working in four provinces that are of high concern to the mission. We also toured the Royal University of Agriculture (RUA) and signed an agreement of cooperation with the university. Further, we found out that the World Bank does indeed have a competitive grant program for universities. Based in this, we began writing two grant proposals that will support future RUA teaching and research. These grants will be drafted by RUA faculty, and then UC Davis faculty will refine them. In addition, we met with the Chief of Party of Fintrac; a private contractor for the USAID/Cambodia's Feed the Future program. Dennis Lesnick stated that he would support RUA with the development of a demonstration site on campus, t hereby helping to prepare future horticultural extension workers.

PI Trexler traveled to Cambodia and to Vietnam to meet with officials in various ministries. We now understand the requirements for certification of safe vegetables and have determined that our plan for the two universities to certify the commune's vegetables as safe is too costly and cumbersome. Therefore, we will follow a farmer certification program that is more designed for local production and consumption. PI Trexler and David Miller followed up these meetings with additional meetings in June with Hanoi's Department of Agriculture and Viettel. Miller has secured a tentative agreement with CARD, an NGO from the Philippines, to conduct the micro-finance aspects of the project.

The UC Davis team traveled around Phnom Penh and then onto Siem Reap to look at potential field sites. While in Phnom Penh, we met with various NGOs and held a grant-writing workshop at RUA and completed two outlines for proposals to the World Bank grant. PI Trexler and co-PI Glenn Young returned to Cambodia to assist with the writing of the World Bank proposals in July. Trexler returned to Cambodia two more times and held a seminar for students and faculty in August and September 2011. The first grant proposal will be submitted in November 2011.

Production techniques and postharvest techniques are very rudimentary in the Siem Reap area. Because of water issues, the two main vegetables produced when we visited were cucumbers and pole beans. Most of the other vegetables were shipped in from various locations in Cambodia, and the lion's share from Vietnam.

UC Davis team members believe that the RUA team is ready to set up a demonstration site in Year 2, rather than Year 3. Also, the RUA team participated in the planning for Participatory Action Research (PAR) activities in June 2011.

In mid-June the UC Davis team visited both Vietnam and Cambodia to provide university teams with a framework for PAR activities with farmers. We used the Horticulture CRSP project as a basis for the model focus groups. By doing this, we were able to get feedback from the university teams of their thoughts and feelings about the project. Mainly, the groups from HUA and Nong Lam University (NLU) were concerned about communication and their roles in the project. After discussing the weaknesses, we jointly created potential solutions to the weaknesses. At that time we also developed focus group questions for the farmers in the commune in Ho Chi Minh City and Hanoi. The RUA team members observed this process.

After the events of the first days all team members visited two partner communes in the suburban Ho Chi Minh City area. The NLU faculty led the focus groups, while the RUA and HUA team members observed.

After the formal meetings, we headed to the farmers' fields and observed the production, postharvest, and marketing aspects of the smallholder farmers' operations. We repeated this in Hanoi over a two-day period and also visited several NGOs, Viettel, and the Hanoi Department of Agriculture's Crop Production Department.

The team members, except Trexler, left Vietnam on or around June 30. Generally, we felt that our activities and visits were very productive. We have a clear understanding of what farmer field schools and studies can be conducted and what the farmers' needs are. Our biggest problem is not having a provider of farmer field schools and studies to date. We will work earnestly to get a provider. The Vietnamese collaborators would prefer an organization other than themselves to provide the farmer field schools.

The work with farmers and field studies that have begun in Hanoi and Ho Chi Minh City are the result of our Vietnamese collaborators going above and beyond their anticipated duties, as these studies were to be led by the FAO originally.

Project Performance Indicators

4.5.1 Agriculture Enabling Environment	**Project Achievements**
Number of policies/regulations/administrative procedures analyzed.	2
Number of individuals who have received USG supported short-term agricultural enabling environment training - Female	49
Number of individuals who have received USG supported short-term agricultural enabling environment training - Male	67
4.5.2 Agriculture Sector Productivity	**Project Achievements**
Number of new technologies or management practices under research.	2
Number of new technologies or management practices made available for transfer as a result of USG assistance.	3
Number of new technologies or management practices being field tested.	3
Number of additional hectares under improved management practices.	3
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Female	23
Number of farmers, processors, and others who have adopted new technologies or management practices as a result of USG assistance - Male	13
Number of rural households benefiting directly - Female Headed Household	132
Number of rural households benefiting directly - Male Headed Household	111
Number of producers organizations receiving USG assistance.	4
Number of trade and business associations receiving USG assistance.	2
Number of community-based organizations receiving USG assistance.	4
Producers organizations adopting new technologies or management practices	4
Trade associations adopting new technologies or management practices.	2
Community-based orgs. adopting new technologies or mgmt. practices.	4
Number of ag.-related firms benefiting from USG supported interventions.	2
Number of women's organizations assisted as a result of USG interventions.	1
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Female	125
Number of individuals who have received USG supported short-term agricultural sector productivity or food security training - Male	147
Number of individuals who have received USG supported long-term agricultural sector productivity food security training - Female	90
Number of individuals who have received USG supported long-term agricultural sector productivity or food security training - Male	111
Capacity Building (Horticulture CRSP Indicator)	**Project Achievements**
Number of host country organizations in direct cooperation	7
Number of workshops conducted for host country personnel	6
Number of host country professionals attending workshops- Female	9
Number of host country professionals attending workshops - Male	9
Number of U.S. faculty providing instruction in host country - Male	5
Host country professionals providing training to others - Female	5
Host country professionals providing training to others - Male	5
Number of host country professionals conducting research - Female	6
Number of host country professionals conducting research - Male	10

Section Six – Trellis Fund Projects

In an effort to expand capacity building, on both an individual and an institutional level, Horticulture CRSP developed the Trellis Fund. The Trellis Fund provides small-scale, in-country development organizations in Feed the Future countries access to U.S. graduate student expertise, providing benefit to both the student and the institutions. With a focus on impact and expansion of locally proven ideas, the Trellis Fund matches the organizations with students and provides modest funds to support the organization's farmer outreach program.

In the summer of 2011, Horticulture CRSP awarded the following Trellis Projects to students from University of California, Davis:

I. Extension Services for Lake Victoria Wetland Farmers for Improved Horticultural Production

- Partner: Eco Finder
- U.S. Student: Michael Wolff, M.S. in International Ag. Development and Ph.D. student in Soil Science
- Country: Kenya

Project Summary: This project aims to enhance the horticultural productivity of small farms among Lake Victoria's wetland villages. Eco Finder is using local radio and theatre groups to conduct seminars on health and nutrition, and they are training 186 wetland farmers in sustainable organic farming practices. Eco Finder is also promoting the use of their already established eco-sanitation toilets that generate night soil for soil fertility for small farms in the region. The enhanced productivity will increase household consumption and trade in the already existing markets, where demand for horticultural products frequently outstrips supply. Michael Wolff is employing his research skills to examine the benefits and food safety issues of night soil in the wetlands of Kenya.

II. Postharvest Handling and Processing for Pears, Apples, and Apricots

- Partner: Rushnoi
- U.S. Student: Eduardo Gutierrez-Rodriguez, Ph.D. student in Horticulture & Agronomy
- Country: Tajikistan

Project Summary: The majority of farmers in the Rasht Valley sell their crops on the fresh market. During periods of harvest, competition is fierce and the prices are low. When farmers store their harvest, they typically lose 30 percent to spoilage. In this project, Eduardo Gutierrez-Rodriguez is working with local agricultural NGO, Rushnoi, to train local farmers in improved postharvest handling practices. The farmers are learning about new techniques in harvesting, storing, and processing at the household level.

III. Improving Pest Management Practices in Passion Fruit Cultivation

- Partner: Randa United Farmers Group (RUFG).
- U.S. Student: Ariana Rundquist, M.S. student in International Ag. Development
- Country: Uganda

Project Summary: Over 90 percent of the population in the Bududa District lives on less than $1 per day. Severe soil erosion, pests and diseases are the main problems that local farmers face. Passion fruit growers benefit from a strong local demand, but need more training in production, postharvest and marketing in order to increase their profits. RUFG is training farmers and school

children in passion fruit cultivation and organic farming methods. RUFG has experience working in passion fruit production, and has developed new methods for combating pests and diseases. Besides providing supplemental expertise, Ariana Rundquist is assessing, measuring and testing the effectiveness of traditional and novel pest management practices.

IV. Economic Enhancement of the Ethnic Community of KyaminVdc in Tanahu, Nepal

- Partner: Sustainable Agriculture Development Program Nepal (SADP)
- U.S. Student: Allison Ferry, Ph.D. student in Plant Pathology
- Country: Nepal

Project Summary: Agriculture is the mainstay of the Nepalese economy, providing a livelihood for three-quarters of the population and accounting for about one-third of GDP. Off-season tomato cultivation is an important source of income for smallholder farmers. Despite the importance of the industry, tomato growers lack information about improved cultivation practices and management of pests and disease, including insects, powdery mildew, and bacterial wilt. Allison Ferry is working with SADP to extend new pest management techniques to local tomato growers.

V. Promoting Nakati Production in Central Uganda

- Partner: National Agricultural Research Organization (NARO-MUZARDI)
- U.S. Student: Juliet Braslow, M.S. student in International Ag. Development and Horticulture & Agronomy
- Country: Uganda

Project Summary: Nakati (Solanum aethiopicum) is one of the most important vegetable crops in Sub-Saharan Africa. Despite nakati's importance to the African diet, little research has been conducted on its production. One of the main problems that farmers face in growing nakati is its low germination rate. NARO-MUZARDI is promoting nakati production in central Uganda by training smallholder farmers in improved agronomic practices. The farmers are also learning innovative, on-farm nakati seed production and processing techniques. Juliet Braslow is conducting literature reviews on nakati and using her seed propagation expertise to help NARO-MUZARDI create a more informed extension program.

VI. Planting Seeds: Zambia AIDS Clinic Garden Projects

- Partner: Development in Gardening (DIG)
- U.S. Student: Larisa Jacobson, M.S. student in International Ag. Development
- Country: Zambia

Project Summary: DIG's mission is to improve the nutrition and health of HIV-affected and at-risk populations through sustainable gardening. DIG trains people in agriculture and nutrition in order to empower communities to meet their own needs. For individuals that suffer simultaneously from HIV/AIDS, poverty, and malnutrition, more than just antiretroviral therapy is needed. By building community gardens with HIV/AIDS support groups, DIG has created a sustainable model to increase nutrition, improve physical health, increase community capital, and raise involvement in hospital activities. Larisa Jacobson is providing technical agricultural expertise for this project through monthly consultations. Together, they are developing horticultural curricula and a garden manual.

VII. Promoting Orange-Fleshed Sweet Potato in Northwest Ghana

- Partner: Ghana Institute of Horticulturists (GhIH)
- U.S. Student: Kate Fuller, Ph.D. student in Agricultural & Resource Economics
- Country: Ghana

Project Summary: The goal of this project is to develop a cost-effective and sustainable system for continuous multiplication and timely distribution of quality orange-fleshed sweet potato (OFSP) planting material. The project also has a postharvest component that aims to develop small-scale value addition and commercialization systems for OFSP in the northwest regions of Ghana. GhIH is training growers in improved agricultural practices and conducting community meetings to teach members about the nutritional value of OFSP. Kate Fuller is helping GhIH conduct value-chain analyses of OFSP and working to improve the profitability of OFSP farming and the availability of OFSP products in the market.

VIII. Promotion of Improved Tomato Technologies among Smallholder Farmers in Malawi

- Partner: Bvumbwe Agricultural Research Station, Malawi
- U.S. Student: Mark Lundy, M.S. in International Ag. Development and Ph.D. student in Horticulture & Agronomy
- Country: Malawi

Project Summary: Tomato growers in the Thyolo district of Malawi lack access to modern tomato-production technologies. The Bvumbwe Agricultural Research Station is introducing improved varieties and modern production practices to 180 smallholder farmers in the district. Mark Lundy is helping develop educational materials that will be distributed by local agronomists at farmer field days and extension meetings. The organization is also establishing several demonstration plots.

IX. Empowering Rural Women with Drip Irrigation and Modern Agricultural Practices

- Partners: Chepkiolel University, Ministry of Agriculture, and Kenya Plant Health Inspectorate Services (KEPHIS)
- U.S. Student: Jenna Rodriguez, M.S. student in Hydrological Sciences
- Country: Kenya

Project Summary: While horticulture is the fastest growing industry in Kenya's agricultural sector, water resources are becoming more and more limited. Agronomists at Chepkiolel University are promoting drip irrigation among 180 women farmers in order to increase their water-use efficiency and their profits. The project leaders are establishing demonstration plots, conducting farmer field days and drip irrigation training sessions. They are also helping the farmers acquire the necessary capital by facilitating savings and credit cooperatives among the groups of women famers. The goal of the project is for each farmer to install drip irrigation on a quarter acre of her field. Jenna Rodriguez is utilizing her vast experience on California farms to help these women develop low-cost drip irrigation systems.

X. Promotion and Expansion of Organic Tomato Growing in Kira Town Council, Wasiko District, Uganda

- Partner: Environmental Conservation and Agriculture Enhancement Uganda (Eco-Agric)
- U.S. Student: Gina Garland, M.S. student in Horticulture & Agronomy
- Country: Uganda

Project Summary: This project aims to promote farmer adoption of new technologies and facilitate the formation of a marketing association. In the first half of the project, the agronomists at Eco-Agric conducted 15 trainings that were attended by 258 farmers. To promote greater participation, the trainings were conducted in farmers' homes and fields. Their training program included sessions on: tomato nursery establishment and management, improved production practices, pest and disease control, soil fertility management, and postharvest handling. The participant farmers have already established 20 tomato nurseries as a result of this project. Their graduate student partner, Gina Garland, is connecting them to new information on the main diseases affecting the farmers, tomato bacterial wilt and tomato blight.

Section Seven - Activities

Horticultural Centers of Innovation

Michael Reid, Leader of Implementation of Innovative Technology and Special Projects
Mark Bell, Leader of Communications and Information Transfer
Peter Shapland, Graduate Research Assistant

In collaboration with partner institutions, Horticulture CRSP will develop Centers of Innovation in Africa, South Asia and Central America. The centers will connect researchers, serve as repositories for knowledge, provide training programs, evaluate and adapt horticultural technologies, and develop mechanisms for sharing ideas within and across borders. They will be hosted by established institutes in the target regions, and will serve as nodes in the Horticulture CRSP information delivery system. Thus, the Horticulture CRSP Centers of Innovation will have three main goals:

1. Researching, innovating, and disseminating horticultural technologies
2. Training farmers, horticultural stakeholders, extension agents, and researchers
3. Building capacity at partner institutions

Horticulture CRSP laid the groundwork for the centers by hiring a Regional Center Specialist, building relationships with partner institutions, securing the collaboration of principle investigators from Horticulture CRSP projects, and developing strategic plans, budgets, and contracts for the individual centers.

The Centers of Innovation team took the first steps in establishing the centers by building relationships and initiating discussions with potential partners at Kasetsart University in Thailand, the Bangladesh Agricultural Research Institute (BARI), Kenya Agricultural Research Institute (KARI), and Zamorano University in Honduras. In May of 2011, Horticulture CRSP management traveled to Thailand to meet with staff and administrators at Kasetsart's International Programs. They discussed both parties' expectations and goals for a center in Bangkok, established a strategic plan and identified a director for the center – Dr. Poonpipope Kasemsap, director of Kasetsart's International Studies Center. Horticulture CRSP management returned to Thailand in September to meet with Dr. Kasemsap and horticultural faculty members at Kasetsart. Together they created concrete objectives, outputs, and deliverables for the centers; they also developed a contract between Horticulture CRSP and Kasetsart. The Horticulture CRSP team also traveled to Bangladesh to establish contact with officials from BARI and discuss the possibility of establishing a center at the BARI campus.

The Horticulture CRSP also secured collaborative relationships with the principle investigators from completed and ongoing Horticulture CRSP projects. Through synergistic relationships with the Horticulture CRSP projects, the partners at the Centers of Innovation will participate in the projects' training programs, capture their innovative technologies and methodologies, and invite project experts to conduct trainings at the centers. The projects in turn will benefit from collaborating with the Centers of Innovation by:

- delivering their project's message to a wider audience
- capturing results from the adaptive research of horticultural technologies
- participating in and selecting participants for the centers' training programs

The Centers of Innovation team also created strategic plans, information sheets, a list of the technologies that will be established at the centers, and contracts and budgets for the centers.

Sponsored and Co-Sponsored Workshops

Elizabeth J. Mitcham, Associate Director
Mark Bell, Leader, Communications and Information Transfer
Amanda Crump, Coordinator, Program Evaluation and Gender Equity
Diana Puccetti, Office and Event Planning Assistant

Annual Workshop

Following the successful 2010 Inception Workshop in Singapore, an annual workshop was held April 18-20, 2011 in Davis, California, to review lessons learned, scaling-up issues and future directions. Participants joined the Horticulture CRSP management team for two days of lively discussions.

On the first day, each of the 15 immediate impact projects presented on lessons learned (dos and don'ts) considering factors such as technology and scalability, delivery, and cultural/political considerations. Sessions were structured around production, nutrition, pest management, postharvest and marketing.

1. Concentrated Solar Drying - Diane Barrett, PI
2. Seed Drying and Storage - Kent Bradford, PI
3. Cool rooms and Cool Transport - Michael Reid, PI
4. Good Agricultural Practices - Sally Miller, PI
5. Vegetable Marketing and Production - James Nienhuis, PI
6. Use of Protective Structures - Bielinski Santos, PI
7. Participatory Fruit and Vegetable Production - Kate Scow, PI
8. Building an Ornamental Plant Industry in Honduras - Alan Bennett, PI
9. Improving Market Access in South Africa - Laura Raynolds, PI
10. Specialty Crop Production for Export - James Simon, PI
11. Crop Production for the Local Tourism Industry - James Simon, PI
12. Orange-Fleshed Sweet Potato Products - Eunice Bonsi, PI
13. Indigenous African Leafy Vegetables - Stephen Weller, PI
14. Biological-Based Postharvest Disease Control - Robert Paull, PI
15. Rapid Diagnostic Tools for Phytophthora spp. - Jean Ristaino, PI

There were a number of points required for success that were raised repeatedly across multiple projects

1. **Needs-driven and local relevance**. Ensure the project is responding to a "real" local need with a viable solution.
2. **Partners.** Engage good local partners and allow for local cultural and socio-economic conditions.
3. **Communication.** Another major point related to communication and the need for clarity of project goals, outputs, and responsibilities.

Building off the lessons learned the first day, the morning discussion the second day focused on factors required for success and scalability, i.e., how to expand successful technologies to reach more people. The thought for the session was that there have been literally hundreds of projects successful at the village scale (e.g., 1-2 villages), but how can such success be expanded to 20,000 villages or 200,000 villages? As for the lessons learned, discussion focused on:

1. the need to respond to real needs,
2. the requirement to work with committed, capable local partners
3. the need to test and validate technology to ensure a fit with the local socio-economic, physical, and market environments

4. the need for visibility of technology and its impact (“Seeing is believing”)
5. the need for simplicity and clarity of message

The final session the second day saw an exchange of ideas on priorities and next steps for Horticulture CRSP. Dr. Elizabeth Mitcham led the discussion after outlining the initial thinking of the Horticulture CRSP Management Entity. Discussion focused on the need for larger integrated projects that addressed major local “bottlenecks.”

A third day involved a tour of the UC Davis Student Farm and the CoolBot, the Long Term Research on Agricultural Systems (LTRAS) at Russell Ranch Sustainable Agriculture Facility, and Full Belly Farm, a 300-acre certified organic farm located in the beautiful Capay Valley of Northern California.

Participant feedback about the workshop was very positive; comments noted both that the workshop achieved its objectives and that it was well run.

Posters, Presentations, and Publications

Elizabeth J. Mitcham, Associate Director
Mark A. Bell, Leader of Communications and Information Transfer
Elana Peach-Fine, Graduate Research Assistant

During the second year, the Horticulture CRSP Management Entity presented a number of posters and PowerPoint presentations about our program at a variety of venues, including several national and international conferences as well as our Inception Workshop. In addition, numerous brochures and fact sheets focused on the vision of Horticulture CRSP were prepared for sharing with colleagues, Mission personnel, and others interested in development. A list of these posters, presentations and publications are given below and copies of the posters and publications are found online at http://hortcrsp.ucdavis.edu/main/media.html.

Posters

- American Society For Horticultural Science (ASHS) – Horticulture Collaborative Research Support Program, August 2011
- CRSP Directors Meeting – Overview of Horticulture CRSP Projects in Eastern Africa, Uganda, July 2011

Presentations

- Bangladesh Presentation – Horticulture Collaborative Research Support Program, August 2011
- Spring Conference – Horticulture CRSP Program Overview, April 2010
- AVRDC Presentation Tanzania – Horticulture Collaborative Research Support Program, March 2011
- IFPRI Conference New Delhi – Overview of all Collaborative Research Support Programs, February 2011
- IFPRI Conference New Delhi - Overview of Horticulture CRSP Projects, February 2011
- IFPRI Conference New Delhi - Scholarship through Collaborative Research Support Projects, February 2011

Publications

- The Horticulture CRSP Project Portfolio
- Horticulture CRSP Project List
- Feed the Future: Horticulture CRSP's Contribution
- Exploratory Project/Pilot Project Fact Sheet
- Horticulture CRSP Fact Sheet
- Postharvest Technology in the Developing World
- Country/Region Specific Flyers
    - Central America
    - Asia
    - Rwanda
    - Uganda/Rwanda/Tanzania/Zambia
    - Tanzania
    - Kenya

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