Horticulture Collaborative Research Support Program

Annual Report 2011-2012

Horticulture CRSP Annual Report 2012

Edited by Amanda Crump and Elizabeth Hohenberger

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Section One - Introduction and Program Overview

Horticulture CRSP Introduction and Impacts

The cultivation and marketing of high-value fruit, vegetable and flower crops—horticulture—offers the promise of increased incomes and enriched diets for both growers and consumers in developing countries. To that end, the Horticulture Collaborative Research Support Program builds international partnerships for fruit and vegetable research that improves livelihoods in developing countries. Successful horticulture is heavily knowledge-dependent, so Horticulture CRSP partners with organizations in three different ways to build capacity while supporting research outcomes. First, Horticulture CRSP supports research projects led by top U.S. public university scientists with international collaborators that solve horticultural problems along the value chain. In addition to our research projects, Horticulture CRSP has established three Regional Centers of Innovation—one in Thailand, one in Honduras and one in Kenya—each of which supports horticulture at existing international research centers with a multi-country reach. Horticulture CRSP is also building capacity among smaller organizations in the developing world and U.S. graduate students, through projects that pair the two together for projects that benefit both. In the past year, our projects altogether have supported more than 30 university students while training more than 13,000 producers.

Horticulture CRSP's extensive research portfolio addresses a variety of horticultural problems specific to developing countries, including boosting yields, reducing postharvest losses and improving market access. With the success of 15 Immediate Impact Projects, Horticulture CRSP has continued support of seven long-term "Pilot and Comprehensive Projects" and five "Focus and Continuation Projects." These broader projects have established a postharvest training and services center in Tanzania, developed protocols for use of nets and floating row covers for pest exclusion in Africa, produced local seeds of disease-resistant vegetables in Central America, developed a participatory extension model to enhance smallholder production and marketing in Uganda, created a market niche for "food-safe" vegetables, introduced new technologies for seed drying and storage, engineered alternative energy solutions for horticulture, and improved production and marketing of indigenous African leafy vegetables. Thanks to these projects, nearly 3,000 farmers have applied 40 new technologies and management practices. Horticulture CRSP project leaders and their 78 partners worked with more than 40 women's groups, 100 private enterprises, and 40 community-based organizations. Thirty percent of the more than 1300 targeted are impacted by HIV/AIDS, extreme poverty, or other factors. Women in particular are beneficiaries for Horticulture CRSP's work because vegetables and small-scale horticulture have been considered "women's crops" in many developing regions. From Horticulture CRSP's work, 75 percent of the farmers who have adopted new practices and 61 percent of the farmers trained have been women.

Horticulture CRSP and the Feed the Future Initiative

USAID's Horticulture Collaborative Research Support Program (HortCRSP), funded in 2009, and managed by the University of California at Davis, uses research within the horticulture value chain to improve incomes, nutrition, health, and economic wellbeing for the rural poor, particularly women. HortCRSP's first call for projects was issued in November 2009 before the first Feed the Future (FTF)

document was published and focus countries were identified. The focus and emphasis of HortCRSP was to address poverty and hunger, through horticulture, among rural smallholder farmers. As emphasized in USAID's 2005 Global Horticulture Assessment, we had a strong focus on women and nutrition, given the importance of horticultural crops for women farmers and their nutritional value. This aligns well with FTF. The most recent call for projects, issued in May 2011, reiterates a commitment to conduct research to develop new technologies, improve nutrition, and enable women but now requires that projects are conducted only in FTF focus countries with an emphasis those whose Missions have identified horticulture as a focus commodity such as Kenya, Mozambique, Tanzania, Zambia, Cambodia, Nepal, Guatemala, Haiti, Honduras, and Nicaragua.

Geography. HortCRSP supports 15 research projects in 26 countries including 12 FTF countries[1]. Projects are located in Bangladesh, Benin*, Bolivia, Cambodia*, Chile, Democratic Republic of the Congo*, Ecuador, El Salvador*, Gabon*, Ghana*, Guatemala*, Honduras*, India, Kenya*, Laos, Malawi, Nepal, Nicaragua*, Peru, Rwanda*, Sri Lanka, Tanzania*, Thailand, Uganda*, Vietnam*, and Zimbabwe.

Research Strategy. The HortCRSP management entity has read the strategic plans for every FTF focus country except Tajikistan. Horticulture (not including coffee) is explicitly mentioned as a value chain in ten of the countries and nutritious foods are mentioned throughout most strategic plans. Our research is focused on 1) empowering women with access to income by improving horticultural production and marketing, 2) increasing household production and quality of nutritious foods, 3) dissemination of technical assistance for increased production, postharvest quality and market access, 4) increased capacity in pre- and postharvest handling, and 5) creating an enabling policy environment for agribusiness growth. These match the FTF strategies to accelerate agriculture sector growth through improved agricultural productivity and expanded markets and improve nutritional status by increasing access to diverse and quality foods.

Production Systems. HortCRSP focuses on the bottlenecks in the production to consumption horticultural value chain. As such, it is relevant to all the major geographic groupings within FTF. HortCRSP emphasizes research where horticulture can complement and diversify staple crops, extend cropping and marketing seasons, impact the entire horticulture value chain, and increase the production and consumption of nutritious horticultural products. HortCRSP supports five long-term research projects in the following areas: postharvest, pest exclusion technologies, sustainable production, seed systems, and food safety. HortCRSP will fund long-term projects in the 2 or 3 of the following areas: postharvest, seed systems, African indigenous vegetables, and orange fleshed sweetpotato. Improvement in seed systems and postharvest will impact horticulture value chains, as will the increase in production and consumption of more crops.

Research Focus. HortCRSP program themes are gender equity, innovative technologies, and information accessibility. Research priorities are 1) postharvest and seed systems for all horticultural crops, 2) nutritious crops such as leafy vegetables and orange fleshed sweetpotato, 3) increasing women's opportunities in horticultural markets and production, and 4) adapting and improving technologies.

[1] Countries where the five long-term projects will be continuing in 2012 are marked with an asterisk (*).

Alignment with Other USAID Partners. HortCRSP projects rely on 47 different partners including host country universities, government agencies, NGOs, and USAID supported AVR

Leadership and International Advisory Board

Leadership

Elizabeth Mitcham, Director
Dr. Elizabeth (Beth) Mitcham is a postharvest biologist and extension specialist with the Department of Plant Sciences at UC Davis. Her research program is focused on maintaining the quality of fruit after harvest, mechanisms of calcium deficiency in fruit, and postharvest insect control.

Amanda Crump, Associate Director
Amanda Crump leads the gender equity and monitoring and evaluation programs. Her research interests include the development of novel agricultural extension education practices that impact farmers, particularly women.

Michael Reid, Leader of Implementation of Innovative Technology and Special Projects
Dr. Michael Reid is a professor and postharvest extension specialist emeritus in the Department of Plant Sciences. Specializing in postharvest handling of ornamentals, he has worked with flower growers in Africa, Latin America and Asia.

Mark Bell, Leader of Communications and Information Transfer
Dr. Mark Bell is also the director of the UC Davis International Learning Center. Before joining UC Davis, he was head of both International Programs and the Training Center at the International Rice Research Institute (IRRI) in the Philippines.
Accounting and fiscal management

Heather Kawakami, Budget Analyst
Heather Kawakami is also the business unit manager for the Department of Plant Sciences.

Programmatic and administrative support

Britta Hansen, Regional Centers of Innovation Specialist
Britta Lilley Hansen holds a master's degree in Development Practice. She previously worked in nutrition research at the University of Minnesota and has served with the Peace Corps in Liberia and Bolivia.

Diana Puccetti, Office and Event Planning Assistant
Diana Puccetti is a Certified Government Meeting Planner (CGMP). She is currently pursuing a B.S. in Technical Management and has previously worked in municipal government.

Brenda Dawson, Communications Coordinator
Brenda Dawson has communicated on behalf of the UC Small Farm Program, UC Division of Agriculture and Natural Resources, and UC Davis University Communications. She previously worked as a newspaper editor.

International Programs Office

Jim Hill, Associate Dean

Dr. Jim Hill is the associate dean of the UC Davis College of Agricultural and Environmental Sciences.

Chelo Abrenilla, Analyst / Supervisor

Rachel (Chelo) Abrenilla provides support to Horticulture CRSP as an analyst and supervisor in the International Program Office.

Members of the International Advisory Board

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 John Bowman, Jim Hill, Elizabeth Mitcham and Amanda Crump.

List of countries where Horticulture CRSP works

In 2012-13, Horticulture CRSP supported projects in the following countries.

Bangladesh
Cambodia
Ethiopia
Ghana
Guatemala
Honduras
Haiti
Kenya
Malawi
Nepal
Rwanda
Tanzania
Tajikistan
Uganda
Vietnam
Zambia

List of Program Partners

U.S. Universities

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

International Partners

Bangladesh
- Bangladesh Agriculture Research Institute
- International Development Enterprises (iDE)
- International Potato Center (CIP)
- AVRDC-The World Vegetable Center

Cambodia
- Royal University of Agriculture

Ethiopia
- Haramaya University
- World Food Logistics Organization

Ghana
- Agribusiness in Sustainable Natural African Plant Products (ASNAPP)
- Council for Scientific and Industrial Research
- Crops Research Institute
- Food Research Institute
- Ghana PolyTechnic Institutes
- Kwame Nkrumah University of Science and Technology
- Selasie Farms and Groceries
- University of Cape Coast
- University of Ghana
- Ghana Institute of Horticulturalists
- Methodist University College
- Quin Organics
- University for Development Studies
- Kwame Nkrumah University of Science and Technology
- Awfarm Consulting
- Bomarts Farms, Ltd.

Guatamala
- Universidad de San Carlos
- CARE

Haiti
- Project Haiti WINNER

Honduras
- Zamorano University
- Corporación Dinant
- FHIA

Kenya
- Agro Farm Services
- Egerton University
- Kangai Tisa Horticultural Farmers Group
- Kenya Agricultural Research Institute
- Moi University
- Eldoret Region Company-Christian Community Services
- South Eastern University College
- Eco Finder
- Chepkiolel University
- Kenya Plant Health Inspectorate Services
- CIRAD

Malawi
- World Relief
- Bvumbwe Agricultural Research Station

Nepal
- International Development Enterprises (iDE)
- Nepal Agricultural Research Council (NARC)
- Center for Agricultural Policy Research, Extension and Development (CEAPRED)
- Sustainable Agriculture Development Program Nepal
- Ecological Services Centre (ECOSCENTRE)

Rwanda
- Umatara PolyTechnic
- Kigali Institute of Science and Technology
- Kigali Independent University
- Institut des Sciences Agronomiques du Rwanda
- Sustaining Rwanda Youth Organization
- Gardens for Health International
- National Agricultural Export Development Board
- Adventist Development and Relief Agency

Tajikistan
- Rushnoi

Tanzania
- A to Z Textile Mills International
- AVRDC-The World Vegetable Center
- Ministry of Agriculture, Food Security, and Cooperatives
- Sapporo Mobi-Vet
- Selian Agricultural Research Institute
- Balton, Ltd.
- Small Industries Development Organisation

Uganda
- Agribusiness Initiative Trust
- Makerere University
- Mukono District Council
- Mukono Zonal Agricultural Research and Development Institute
- Our Lady Queen of Apostles Nkokonjeru Parish
- Reach Your Destiny Consult, Ltd.
- Rural Agency for Sustainable Development
- Uganda Christian University
- Uganda Environmental Education Foundation
- Eco-Agric Uganda

National Semi Arid Resources Research Institute
Teso Women Development Enterprise
Uganda Network for Community Empowerment
Randa United Farmers Group

Zambia

Agribusiness in Sustainable Natural African Plant Products (ASNAPP)
Development in Gardening (DIG)

Public-Private Partnerships

Since 2009, the program has collaborated with 18 U.S. universities and more than 200 organizations—including at least 12 public-private partnerships in 2011-12. Here are some highlights from these public-private partnerships:

Safe vegetables in Vietnam: One such formalized public-private partnership is between the private company Hapro's safe vegetable handling unit and Hanoi University of Agriculture (HUA), a public university in Vietnam. Together, they will conduct field studies on off-season tomatoes to improve production and handling procedures so that local farmers can deliver a safe product that meets both Vietnam's and the international community's food safety standards. In a related effort, a new partnership has developed between HUA and My Way Seeds, a private seed company. The private seed company supported farmers as they transitioned from trellising plants to field plantings of a small honeydew melon, increasing both melon yield and the length of time a field is productive.

Using locally produced nets in African fields: In Benin and Kenya, Horticulture CRSP has partnered with the Tanzanian company A to Z textiles to develop pest exclusion nets. Similar to mosquito bed nets, these nets limit pest infestations in vegetable fields while modifying the environment around the crop. A to Z textiles is partnering with public research institutions in Kenya and Benin including Abomey Calavi University, Kenya Agriculture Research Institute, and Egerton University as well as RCPA (Head of District Agriculture Extension Services) and local authorities in Benin. Helping farmers reduce pest damage to their vegetables while supporting market opportunities for local textiles helps make this public-private partnership thrive.

Innovation that can help horticulture farmers throughout the world: Through Horticulture CRSP researcher Kent Bradford's efforts, the private company Rhino Research and its zeolite-based drying beads have been connected to many public institutions including Kasetsart University in Thailand, the Centre for Agricultural Bioscience International in Kenya (CABI Africa), the Center for Agricultural Policy Research, Extension and Development in Nepal and Acharya N G Ranga Agricultural University in India. Together this team has been testing how to use drying beads to improve high-value horticultural seed and formulating a marketing strategy to disseminate this technology throughout the developing world.

Partnership with small New York company cools vegetables around the world: Another public private partnership that has its roots in Horticulture CRSP is that between Store It Cold, LLC., of New York and several public institutions including Rutgers University, Kenya Agricultural Research Institute, and AVRDC-The World Vegetable Center. Store It Cold produces the CoolBot, a device which creates a small-scale commercial cooler out of a standard room air conditioner and a well-insulated

room. Cooling fruits, vegetables and flowers is a critical step in extending the quality and marketability during postharvest stages, and using a CoolBot can substantially reduce the cost of cool storage for horticultural produce. Horticulture CRSP has deployed CoolBots in Honduras, Zambia, Uganda, Bangladesh and India. Developed by an American farmer in New York, the CoolBot makes cold storage a viable option for developing-world farmers, cooperatives and market groups to increase their competitiveness.

Guiding Policies

The main policies that guide our decisions are the University of California, Davis policies, USAID policies, and especially the USAID Feed the Future initiative.

The Horticulture CRSP adheres to the University of California, Davis mission of national and global engagement and public. Our work draws on the combination of horticultural and allied expertise and international connections of the faculty in the UC Davis College of Agricultural and Environmental Sciences (CA&ES).

Horticulture CRSP is also guided by the overarching goals of USAID and the priorities identified in the 2005 USAID Global Horticulture Assessment. The most important initiative that guides our activities is the USAID Feed the Future plan. In May 2010, the USAID announced a $3.5 billion, three-year Presidential Initiative called Feed the Future. 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 program aims to increase agricultural production and incomes of the rural poor.

Horticulture CRSP contributes to the Feed the Future Initiative in several ways. As soon as the initiative was announced, Horticulture CRSP projects were refocused on the Feed the Future priority countries, especially those that had identified horticultural crops as priority commodities. Horticulture CRSP has continued to increase 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:

- 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 16 of the 19 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 United States Government.

Section Two - Themes and Collaborations

The Horticulture CRSP has 4 major themes that are addressed by our projects in different ways: Information accessibility, Innovative Technology, Gender Equity, and Building Local Human and Institutional Capacity.

Information accessibility

The Global Horticulture Assessment (2005) notes the desperate need in rural communities for information – on marketable crops and varieties, on production techniques, postharvest handling, and market requirements and access. Information access is addressed through our individual projects in different ways including: websites, permanent demonstration plots, and written materials. The Horticulture CRSP Management entity also comprises an information management team. Our information strategy focuses on:

1. Understanding existing dissemination practices and help partners develop enhanced dissemination strategies (including use of emerging information communication technologies)
2. Improving access to information on horticultural technologies and how they can best be applied

We address these specific objectives by capturing information from projects, developing and distributing technical information through our Centers of Innovation, capturing information and feedback during our Horticulture CRSP meeting and through a series of information access activities. Through the information access activities the information management team is working to answer the following questions through workshops, and project, PI and collaborator interviews and surveys:

1. Needs - How are audiences and their needs identified?
2. Source - Where do people (organizations) get their (credible) information?
3. Delivery
    a. What is their approach to information dissemination?
    b. What are the greatest challenges and opportunities (including new tools)
4. Feedback - how do they collect feedback

Innovative technologies

Horticulture CRSP encourages projects that explore ‘disruptive’ or ‘leapfrog’ technologies providing advanced tools, in an appropriate form, to stimulate and facilitate horticultural development in the developing world. Such technologies have the potential to directly benefit farmers by decreasing costs and increasing efficiency. Technologies addressed through Horticulture CRSP projects so far include solar drying, pest-exclusion nets and drip irrigation, improved cultivars, electronic controllers that use window air conditioners to provide low-cost coolrooms, and Zeolite beads for rapid drying of seeds and other horticultural products. 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. Future emphases of Horticulture CRSP technology development will include postharvest, improving nutritional value of African Indigenous vegetables and innovative energy solutions in horticulture, such as off-grid evaporative cooling technologies and the use of photovoltaics in pumping, desalination, and other energy-intensive horticultural operations.

Gender equity

In the developing world, women can provide as much as 90% of the labor for the production of horticultural crops. Although they represent a reservoir of production and marketing knowledge of what are often termed 'women's crops' they usually are compensated with lower wages and less permanent positions than those available to men. Lacking knowledge of how finance works and where to get it, as well as collateral to insure it, women have unequal access to technology and production inputs and therefore reduced opportunities for economic advancement. As such, Horticulture CRSP projects focus on expanding opportunities and providing technologies to women. By training nearly 50% women, 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.

Capacity Building

Building local scientific and technical capacity is a theme and a top priority for Horticulture CRSP. In addition to training farmers, Horticulture CRSP engages new institutional partners throughout the world each year. Horticulture CRSP funding is 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 over dozens of graduate students. These students live and conduct research in the United States as well as most of our Feed the Future project countries. 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. A variety of projects focus on this topic in particular.

Section Three - Horticulture CRSP Research Project Reports

The detailed technical reports include research data and are distilled from annual project reports required of each project. For more detailed technical reports, please contact Horticulture CRSP. For projects that were previously funded by Horticulture CRSP prior to October 2012, please visit http://horticulture.ucdavis.edu/main/projects.htm.

Reports are provided for the following projects:

- Seed Systems – Improving Seed Quality for Smallholders
- Semillas de Esperanza: Vegetable Seeds for Sustainable Agriculture
- Low cost pest exclusion and microclimate modification technologies for small-scale vegetable growers in East and West Africa
- Extension of Appropriate Postharvest Technology in Sub-Saharan Africa: A Postharvest Training and Services Center
- Sustainable Development of Horticultural Crops in Zambia by Introducing Postharvest Technologies and Practices for Food Security, Income Generation and in Support of the Tourism Industry
- Delivering Vegetable Safety Education through Established Social Networks in Latin America
- Sustainable African Indigenous Vegetable Production and Market-Chain Development for Improved Health and Nutrition and Income Generation by Smallholder Farmers
- Safe Vegetable Production in Cambodia and Vietnam: Developing the HARE-Network to Enhance Farmer Income, Health, and the Local Environment
- Sustainable Technology for Orange and Purple Sweetpotato (STOPS) in Ghana
- Increasing the Capacity of Smallholder Farmers to Produce and Market Vegetable Crops in Uganda and Democratic Republic of Congo

Seed Systems – Improving Seed Quality for Smallholders

Target Country: Nepal, Bangladesh, Kenya, Tanzania, Uganda and Rwanda

Principal Investigator: Kent J. Bradford, University of California, Davis

Collaborators:
Luke Colavito, International Development Enterprises (iDE), Nepal
Jwala Bajracharya, Nepal Agricultural Research Council (NARC), Nepal
Indra Raj Pandey, Center for Agricultural Policy Research, Extension and Development (CEAPRED), Nepal
Roger Day, CABI Africa (Centre for Agricultural Bioscience International), Kenya
Keshavulu Kunusoth, Acharya N G Ranga Agricultural University, India
Johan Van Asbrouck, Rhino Research, Thailand
Ganesh Shivakoti, Asian Institute of Technology (AIT), Thailand
Project Description
This project builds on a completed Immediate Impact Project.

Improving the ability of smallholders to access high-quality seeds of improved varieties of horticultural crops is fundamental to increasing productivity and incomes. Traditional seed production and storage methods in humid tropical regions without temperature and moisture control result in rapid deterioration of seed quality.

With collaborating institutions and partners, this project will demonstrate and implement a novel seed drying and storage technology (desiccant drying beads) that can dramatically improve seed quality and longevity for smallholders in tropical climates. The project will:

Organize international workshops, in collaboration with Horticulture CRSP's Regional Centers of Innovation, to publicize the availability of drying beads, to solicit additional local cooperators and to explore additional applications in germplasm conservation and dried horticultural products;
Conduct socio-economic and technical analyses of horticultural seed production, distribution and marketing value chain in focus countries to identify critical points where seed quality is at risk;
Provide technology support and on-site advice to assist cooperators in establishing improved seed production, storage and utilization procedures in their own operations or among their stakeholders;
Establish sustainable, market-based systems for enabling local adoption of improved seed production, handling, storage and distribution procedures;
Build local technical capacity through extension educational programs focusing on producing and maintaining high seed quality; and
Enhance economic opportunities for women, who represent the majority of workers engaged in horticultural seed production, preservation and utilization.
This comprehensive project will disseminate a novel, economical and appropriate technology to improve seed quality and enhance the horticultural value chain, particularly in humid climates.

1st Report

UC Davis
Press release (October 2011):
The press release on the award of 34-months HortCRSP Seed System and AIV projects is attached.

Establishing Co-PI subaccounts:
We worked with HortCRSP staff, particularly Heather Kawakami, to set up subaccounts for all of our Co-PIs and initiate them into the invoicing procedure used. This went much faster than in the IIP and helped us get started quickly on this project.

Master calendar:
A master calendar for proposed activities in Seed System Project was prepared by PD and KB and shared with the collaborators. This calendar served as a guideline to initiate, target and schedule proposed activities. (Attached).

Technology Support Package:
An early objective of the project is to develop a website containing information about the application of Drying Beads to drying of seeds and other horticultural products. We are developing that information and starting to populate the website (www.dryingbeads.com). One frequently asked question is the bead quantity needed to dry seeds to specific final moisture content (MC). If initial seed MC is known, this calculation is straightforward and we previously developed tables that give quantity of beads to dry seeds from initial MC to targeted final MC. However, farmers seldom know the actual seed MC, so it would be more useful to use the actual temperature (T) and relative humidity (RH) and known relationships between these and seed MC to estimate initial MC. We found cheap hygrometers (US$8.00 each) that display T and RH when placed inside a moisture-proof container with seeds. We developed a spreadsheet that can use this information and the known seed oil content to calculate the actual seed MC and also the amount of beads (bead:seed ratio) required to achieve a user-defined final MC. We compiled information on a large number of species using both common and botanical names. The user can modify T, RH and target MC and bead capacity parameters. We have shared this spreadsheet with our collaborators for their use and improvement (Attached). We will modify the spreadsheet for different levels of users, i.e., general grower, extension worker or researcher at the resource center, and post these versions (or simple instructions based on them) on our website.

Refining seed drying parameters:
Experiments with rice indicated that seeds did not achieve the theoretical MC predicted, assuming that the Drying Beads are capable of removing all water from the seeds. However, as seeds dry, the remaining moisture is held more and more tightly, so that the calculation of final MC needs to be modified. We are conducting experiments on seeds of tomato, chili pepper, lettuce, onion and cucumber to determine the modifications needed. In addition, there is possibility of accidental over-drying of seed if the farmer uses excess beads. The seeds in this experiment that have been dried to low MC using high bead:seed ratios will be imbibed and germinated to test for their susceptibility to imbibition damage when hydrated from very low MC. We will also allow the seeds to rehydrate in ambient RH for 7 days prior to imbibition to determine whether this will prevent imbibition damage,

assuming it is of concern for a given species. Information gained from these experiments will be incorporated into our Technology Package recommendations.

Use of zeolite beads in DNA extraction:
Drying Beads have been successfully used to dry grape leaves for extracting DNA. The yield of DNA was comparable with the standard method of collecting and grinding tissues in liquid nitrogen (LN). The quality of DNA samples was comparable with existing protocols as checked by both gel electrophoresis and sequencing as reported by Mark Walter Szczerba at PIPRA, UC Davis. Drying Beads would simplify collecting and drying tissues for molecular or pathogen assays from remote areas without using LN.

Technical support
During communication with CABI and based on prior experience in delivering the technology to new collaborators, we realized that a visit to CABI collaborators in Nairobi, Kenya would be helpful before organizing the Training and Demonstration Workshop in February, 2012. Hence, PD visited CABI collaborators and USAID missions in Kenya and Tanzania (Picture: CABI collaborators-0288). The visit was planned to coincide with USAID official John Bowman's trip to Kenya on Nov 21, 2011. PD presented the technology to CABI collaborators Roger Day, Noah Phiri (NP), Daniel Karanja, Richard Musebe, Chacha Duncan and had a discussion regarding the project Master Calendar on Nov 17, 2011. The date for the Workshop was set for February 14-15, 2012. A visit to local shopping mall with NP revealed that moisture-proof plastic and glass containers with seals were readily available in Nairobi, Kenya. (Picture: Moisture proof container-0294).

PD and NP visited East Africa Regional USAID Mission in Nairobi, Kenya on Nov 21, 2011 and PD presented the desiccant seed drying technology to Naren Chanmugam (nchanmugam@usaid.gov) Agri Team leader, Regional Economic Growth and Integration office; Corey J. Fortin (cfortin@usaid.gov); Agri Development Officer; Matthew Rees (Regional Trade Advisor: mrees@usaid.gov): Steven Humphrey/COMPETE program, Staple Food Specialist (USAID Contractor) (shumphreys@competeafrica.org); John Bowman (Senior International Affairs Specialist, USAID Bureau for Food Security, Office of Agricultural Research & Policy (jobowman@usaid.gov); Harrigan Mukhongo (hmukhongo@usaid.gov); and Samson Okumu, Food Aid and Devlopment Specialist (sokumu@usaid.gov). Data on bimodal rainfall pattern of Kenya was also presented to assert that seeds could deteriorate rapidly under high RH conditions in Kenya. Questions were raised on the economic feasibility of bead use by individual growers. Since smallholders cannot afford de-humidified cold stores, Drying Beads would be a cheaper alternative to maintain seed quality in humid regions. It was also clarified that seeds should be sun dried initially and beads should be used to dry further to safe target MC in moisture proof containers, which also protect seeds and commodities from insects and rodents. With respect to why seed companies were not already using this technology, it was clarified that this new technology was enabled by the HortCRSP/Immediate Impact Project in 2010, and extension efforts are ongoing around the world. Based on survey data available, intervention is needed to improve the quality of horticultural seeds available in humid regions of Africa, including Kenya.

PD and NP also visited Dr. Lusike Wasilwa at Kenya Agriculture Research Institute (KARI). Dr. Wasilwa suggested holding the upcoming Workshop in Thika where the HortCRSP Innovation Center

potentially would be launched. NP visited Thika Training Center with John Bowman and Dr. Wasilwa on November 25, 2011. A decision was made to organize the Workshop on February 14-15, 2012 at the World Agroforestry Center (ICRAF) where CABI is housed as well. NP further consulted with Dr. Desterio Ondieki Nyamongo, National Coordinator, Genetic Resources conservation, Kenya Agricultural Research Institute, National Genebank of Kenya, P.O. Box 30148 00100, NAIROBI KENYA, Tel: 0725 234249 (dnyamongo@yahoo.co.uk) who eventually attended the Workshop on Feb 14-15, 2012.

PD visited USAID Mission in Tanzania on November 23, 2011 and presented bead technology to Kevin McCowan (kmccowan@usaid.gov) and Mark Henderson (mahenderson@usaid.gov), Agriculture officers, Feed the Future. Mark is UC Davis graduate who knows HortCRSP directors. PD had detailed discussion about the bead use table with Mark in Dar es Salaam. The price of the beads will be an issue in adoption. Both officers agreed to discuss further with John Bowman in Arusha during weeklong FTF meeting. It was pointed out that weather in Dar es Salaam (30°C and 80% RH) would result into high seed MC which favors rapid seed deterioration in open storage.

Kent Bradford (KB) participated in the HortCRSP Annual Meeting in Bangkok, February 8-10, and presented an overview of the project to HortCRSP Management Entity and Co-PIs. KB explored collaboration with PIs of AIV (Stephen Weller) and the Central American variety testing and seed production project (Jim Nienhuis). Jim Nienhuis will purchase Drying Beads starter technology packages for all of his collaborators in Central America and KB will deliver a workshop on Drying Beads at Madison, Wisconsin in August 2012 for collaborators in this project. KB also presented in the Demonstration and Training Workshops in Bangkok (Feb. 7) and Nairobi (Feb. 14-15), as described below.

Presentation at monthly PRB seminar at UC Davis:
PD presented an overview of the HortCRSP Comprehensive Project at the monthly Plant Reproductive Biology seminar, Department of Plant Sciences, University of California, Davis on March 5, 2012 (PRB flyer March 5). There were about 50 researchers including Xingping Zhang (xingping.zhang@syngenta.com) from Syngenta, Sagay Mary from Nunhems (Bayer CropScience vegetable seed business) and Peter Shapland from HortCRSP management. Dr. Zhang pointed out that prevention of fungal and microbial development on seeds by drying would be highly valuable in their seed production operations in humid regions, while also preventing production of mycotoxins.

India
Graduate students from Tanzania and Nepal are being trained about seed quality testing and seed processing at Nuziveedu Seeds Ltd. and SGS Technologies, Hyderabad. A Tanzanian student is continuing MS thesis research on tomato seed drying and storage using Drying Beads.
Co-PI Keshavulu Kunusoth (KK) attended USAID and IITA inception workshop at Dar Es Salaam, Tanzania, during February 6-8, 2012. His participation contributed to inclusion of seed production and seed systems in the 'AFRICA RISING' program. KK made a presentation on the Drying Bead technology at the Tanzania Official Seed Certification Institute (TOSCI) at Morogoro and strategies were discussed to initiate storage trials in the next season. In addition, the staff of TOSCI at Arusha were briefed about the use of Drying Bead technology for seed drying and storage enabling them to demonstrate the technology to seed companies and farmers and to initiate the storage experiments.

Strategies to initiate storage trials in the next season were discussed at Arusha, Tanzania. KK visited Tengeru and Alpha vegetable seed unit and informed them about the need for immediate post-harvest drying before storage. A visit to the Asian Vegetable Research and Development Center (AVRDC) regional center has influenced the breeders/genetic resource division to conduct storage trials using Drying Bead technology for seed drying. Following communication by CABI and visit by KK, Chris Ojiewo, Vegetable breeder and Marilyn Belarmino, Genetic Resources Scientist at AVRDC subsequently attended the Workshop in Nairobi, Kenya.

KK also participated in the international Workshop in Nairobi. Strategies were developed to deliver seed drying technology in East African countries. KK also contributed to the Training/Demonstration on Drying Bead technology held at Kathmandu, Nepal on March 6, 2012, where he stressed the need for immediate postharvest drying and storage of seeds. In his laboratory, seed quality tests and storage studies are being conducted in onion, mung bean, soybean and sunflower.

Non-pesticide bruchid control in stored seeds using Drying Beads: KK conducted a new experiment at ANGRAU, Hyderabad, to determine whether Drying Beads can control bruchid insects in stored mung beans. Ten pairs of bruchids were inoculated into one kg of mung bean seeds. The samples were put either in porous bags or moisture-proof plastic containers. Equal quantities of beads and seeds were used in the bead treatment. Initial seed MC was 11.8% which was reduced to 4.2 %. After six months, germination had declined from 97% to 30% in the porous bags, but not at all in the bead-dried treatments. In open bags, heavy bruchid infestation occurred resulting in physical damage and the drastic decline in germination. However, bruchids were not active at low humidity and high seed germination (95%) and integrity were maintained. (See pictures below)

Bruchid control in mung bean at ambient storage without using pesticide: ANGRAU, Hyderabad, India

Initial Seed MC -11.8%

Germination – 30%

Final MC with beads- 4.2%

Germination – 95%

Bead-dried seeds were not consumed by bruchids:
ANGRAU, Hyderabad, India

CABI-Africa:

A Training and Demonstration Workshop was held in Nairobi, Kenya during February 14-15, 2012. (Attached announcement flyer; see picture below). KB, JVA and PT delivered the Workshop to an enthusiastic audience of 42 participants (13 female) from Kenya, Tanzania, Zambia, Uganda representing a range of government, research and farm organizations. CABI collaborators advertised the event to stakeholders and attracted notable researchers like Dr. Nyamongo Desterio, National Coordinator, Genetic Resources Conservation, National Gene Bank, Kenya Agriculture Research Institute (KARI); Dr. Chris Ojiewo, Vegetable Breeder, The World Vegetable Center, Arusha, Tanzania, Dr. Steven Humphreys, Staple Foods Team Leader; USAID-COMPETE, P.O. Box 1555, 00606, Nairobi and Dr. Moses Onim, Managing Director, LAGROTECH Seed Company & Consultants, P.O. Box 1244-40100 Kisumu, Kenya, onim@lagrotech.org; cell:+254 722739583). Other participants included Dr Fina Opio, Executive Director of Association for Strengthening Agricultural Research in Eastern and Central Africa; Professor Mary Onyango of Jomo Kenyatta University of Agriculture, Dr Evans Sikinyi, Executive Officer, Seed Traders Association of Kenya (STAK), Mr Kalipochi Chazyoka Kaonga, Coordinator, Southern Africa Development Coperation (SADC) Seed Centre, Mr. Patrick Ochieng, Director of Extension in the Ministry of Agriculture, Kenya. Different stakeholders in seed systems in Africa were represented such as seed companies East West Seeds, Tanzania and Kenya; Tanseed International, Tanzania; FICA Seeds, Uganda; Lagrotech, Kenya; Real IPM, Kenya; Savana Seeds, Kenya; Freshco Seeds, Kenya. Similarly, National Research Organizations like Kenya Agriculture Research Institute (KARI), Kenya; National Crops Resources Research Institute of National Agriculture Research Organization, Uganda; Rwanda Agriculture Board (RAB), Rwanda; and Hort Tengeru, Tanzania attended the workshop. Representatives from academic institutions like Jomo Kenyatta University of Agriculture and Technology, Kenya; Seed Regulators (Tanzania Official Seed Certification Institute (TOSCI), NGO (Catholic Relief Services, Kenya); Agribusiness in Sustainable Natural African Plant Products, Zambia; Farmer Organization (Technology Adoption through Research Organizations, Kenya); Ministries of Agriculture in Kenya and Tanzania, and international organizations (CABI and Asian Vegetable Research and Development Center (AVRDC) . (Detail list attached).

This conference at the World Agroforestry Center in Nairobi created considerable interest amongst USAID Mission officials and stakeholders. Some stakeholders even wanted to try the technology for drying horticulture produce such as fruits, in addition to horticultural seed drying. Group discussions identified four main levels of the seed chain where Drying Bead technology could be used: 1. Seed source (basic seed producers such as researchers, gene banks, seed companies, AVRDC); 2. Seed bulkers (producers of certified seed (seed companies and contract seed producers); 3. Open market (seed traders and distributers); and 4. Farmer level (large scale and smallholder farmers after a system for recuperating the beads has been worked out). Three researchers (Chris Ojiewo, Newton Phiri and Christine Ndinya) from the HortCRSP AIV project also attended the workshop.

IDE-Bangladesh

IDE operates in both Nepal and Bangladesh. We were aware of the Nepalese horticulture seed situation after a visit to the country in the IIP project during December 2010. JVA, PT, GS, and Luke Colavito (LC) of IDE-Nepal (Co-PI) communicated with IDE-Bangladesh and organized a visit during Nov 19-21, 2011. Initial contact with Rajiv Pradhan (RP), IDE-Bangladesh, revealed his enthusiasm towards implementing Drying Bead technology and he was formally included as a Co-PI in the project. GS recruited one student for PhD studies from BARI from this first visit. However, the student received a permanent job offer and decided not to continue further. GS is looking to recruit another student to carry out baseline survey and socio-economic analysis of bead use in Bangladesh. Further consultations between IDE-Bangladesh and Rhino Research resulted in a Training and Demonstration Workshop in Dhaka on January 30, 2012.

Through the partnership of the USAID HortCRSP, IDE-Bangladesh and Rhino Research Group (Thailand), a one-day training on Seed Drying and Storage Technology was held in the IDE Tech Center in Savar, Dhaka on January 30, 2012. The training was given by the Managing Director of the Rhino Research Group JVA and his team. The participants (17 in total) were district program officers from IDE-Bangladesh, members of the District Agriculture Extension office as well as Bangladesh Agricultural Research Institute (BARI). The aim of this training was to bring awareness of the Drying

Beads technology and to brainstorm on whether this technology would be sustainable and if so how can the beads reach the hands of the retailers and farmers.

Members of BARI and District Agri. Extension testing the seeds after drying with beads for 4 hours.

The morning session included a demonstration on Drying Beads by putting 100 grams of onion seed (surface dry) with 250 grams of Drying Beads. There was 30 percent weight loss after 4 hours of drying with beads. This drying method can prevent seeds from deterioration in humid climate and can reduce loss of shelf life as well as preserve the higher percentage of germination. The afternoon session was an interactive session where the participants gave their views on whether this technology, if implemented, would really help Bangladeshi farmers or would it create an inconvenience where things like high cost of investment, recuperating of the beads, etc., would discourage farmers from trying the new technology. After much discussion, the biggest concern was the affordability factor and

how IDE could play an important role along with USAID HortCRSP to find private investors to distribute the beads to local farmers as well as seed retailers. IDE reiterated that they will help in implementing the business model for Drying Beads in Bangladesh. RR Group has agreed to send free samples of beads to Bangladesh for testing in the field in selective districts.

In the meantime IDE will also ensure that relevant data are communicated to RR Group to prepare a table and literature that is easily understood by farmers. Drying Bead technology could transform the seed drying business in Bangladesh. At the end of the day, most participants agreed to go out to their districts and labs to test the Drying Bead technology. HortCRSP/RR Group is fully committed to give assistance through its Technology Support Package. (List of participants and additional pictures attached)

IDE-Nepal:
Nepal Agricultural Research Council (NARC)
In continuation of IIP work on use of Drying Beads in other commodities, communication between Jwala Bajracharya (JB) and G. Ortiz-Ferrara, Principal Scientist, Leader-HMRP, CIMMYT-Nepal developed further. Drying Beads were used in different ratios to dry three corn varieties supplied by CIMMYT at ambient temperature. Drying Beads reduced corn grain MC from 12-16% to 8-10% in just 5 days without heat. After learning this result, Dr. G. Ortiz-Ferrara and Dr. B.M. Prasanna of Global Maize Program at Nairobi invited JB to present a poster at the 11th Asian Maize Conference in Naning, China during Nov 7-12, 2011. JB is seen below attending and explaining the technology to the researchers. (Poster and additional pictures attached). Following visit by JVA, PT and GS to IDE, NARC, CEAPRED and CIMMYT/Nepal during November 23-28, 2011, Dr. G. Ortiz-Ferrara has ordered 125 kilograms beads for corn seed drying from Rhino Research.

JB, who is also associated with World Bank program on cereal seed production, notes that there is a plan to use beads to dry and store wheat breeder seed. JB attended IPM CRSP regional meeting held

in Kathmandu, Nepal during February 1-3, 2012. John Bowman and Luke Colavito and other delegates from partner countries in USA, India, Bangladesh and Nepal also participated in the same meeting. John Bowman organized a short discussion among the Nepalese collaborators. There is need to find the stakeholder willing to sell/distribute the beads and provide services to the farmers. JB opined to provide bead technology to the network of vegetable growers with the IPMCRSP package although vegetable production and vegetable seed production are quite distinct enterprises. JB notes that there is increasing bulk trade of hybrid seeds in addition to open-pollinated vegetable varieties. Hybrid seeds are usually repacked into different sizes based on local market needs. In such conditions, the technology could help in maintaining the quality of seed both during transportation, repacking and safe storage of carry over seeds for future use.

IDE/Training of Trainers Workshop:

IDE Nepal/Rhino Research organized a Training of Trainers workshop in Nepal at Nepal Agricultural Research Council (NARC) in Khumaltar, Lalitpur on March 6, 2012. There were 29 participants (five females) including three instructors from NARC, CEAPRED, IDE Nepal and private sector (List of participants attached). JB introduced the concept of seed drying and gave an overview of traditional drying methods and seed storage in Nepal. Given the climatic conditions in Nepal, it is very hard to get the seeds to the correct MC for storage. Many smallholders struggle with drying their seeds that end up losing almost 60 to 70 percent of germination. Drying Beads will absorb the seed moisture and maintain low SMC in the storage environment that will help the seed germinate better. Keshavulu Kunusoth (KK) from ANGRAU, Hyderabad, India presented the background of Drying Beads and its composition and performed various tests like mixing the beads with seeds, separation which was then followed by going into the lab to see how the beads were recuperated. In the afternoon session, the group brainstormed on how to disseminate the bead technology in Nepal. One of the first concerns was to develop a supply chain system. Participants highlighted that by identifying the major vegetable seeds (onion, cucumber, tomato, okra and legume) for pilot testing in two locations in the south (Terai) and 2 locations in the hills would be the first step. CEAPRED will also conduct experiments with the Drying Beads in Kavre district with the mentioned vegetable crops. In the pilot testing period the Drying Beads will focus mainly on vegetable crops and then in the later years focus on cereal crops.

One main discussion was based on how to develop a supply chain system where small farmers could rent the beads and then bring them back to a distributor for the recuperation process. It is challenging in Nepal to have ovens in small households and proper training is required in order to set up these facilities. It was suggested that the farmers' cooperatives handle this issue and set up Drying Beads stations where the farmers can come to get the beads and then return the beads for recuperation. A well-implemented business plan would be able to reduce the cost of renting the beads for small farmers especially in the Hills. As the pilot testing goes on, the business plan should be initiated along with the testing to see what factors into the feasibility of the technology and what the leverages in the process are.

The private sector representatives were very enthused with the Drying Beads technology but concerned about their affordability. Rhino Research Group believes that the initial cost of investment may be high but the return would be much greater due to the reusability of the beads as long as the beads are handled and proper training is given to all individuals involved in the process. We believe that training is vital and that this workshop has helped the trainers understand the Drying Beads technology and it will have a huge impact on smallholders who will get better yields to compensate for the cost.

Drying Beads technology was also showcased in the IDE booth at the 5th National Agro Expo during March 9-11, 2012. (See picture below). About 30, 000 people were expected to visit the event at Bhrikuti Mandap, Kathmandu.

Center for Agricultural Policy Research, Extension and Development (CEAPRED)
There is a very large network of vegetable seed growers organized by CEAPRED covering different districts in Nepal. A meeting between IDE, NARC and CEAPRED prepared a 6-month work plan for the project and proposed to send Indra Raj Pandey, former USAID trainee (IP) (Team Leader, Vegetable Seed Program) to attend the Training and Demonstration Workshop and the Annual HortCRSP meeting in Bangkok. IP notes, "The workshop on seed drying using zeolite beads was very informative and useful. There were both theoretical and practical exercises at the workshop. MC of the seed is determined by the RH of the storage environment." After returning from Bangkok, IP encouraged CEAPRED laboratory staff to attend ToT workshop or March 6, 2012 at NARC, Khumaltar, Nepal. Furthermore, CEAPRED has assembled required materials to start the pilot research projects. CEAPRED is in a position to demonstrate the seed drying technology to the seed growers.

Thailand:
Rhino Research (RR):
RR has provided significant leadership in implementing the project in Bangladesh, Nepal and African countries. RR personnel visited Bangladesh and Nepal and organized Training and Demonstration Workshops in Dhaka, Bangkok, Kathmandu and Nairobi (Picture below) . The communications initiated with Dr. G. Oritz-Ferrara, Project Leader, CIMMYT/Nepal during previous IIP flourished further. JVA, GS, PT and Nepal team visited CIMMYT/Nepal during Nov 23-28, 2011. Dr. G. Oritz-Ferrara has ordered 125 kg of Drying Beads which will be delivered during mid-May, 2012. RR will send 125 kg of beads each to Bangladesh, Kenya, Nepal (IDE/CEAPRED/NARC). Stover Seed Co. and UC Davis will get 50 kg and 150 kg beads, respectively. RR has also provided 250 g free samples to all participants that attended the Workshops. RR has also prepared a Starter Package of essential equipment and beads that was shared with interested stakeholders at the Workshops (Attached). RR has recruited Aziz Shrestha (AS) who will also help to establish the marketing chain in HortCRSP targeted FtF countries.

Johan van Asbrouck and Ganesh Shivakoti visited hybrid tomato seed production farm of Dr. Kedar Buthathoki in Kathmandu, Nepal.

Drying Beads Training Workshop at Kasetsart University, Bangkok

A Drying Beads training/workshop was held at at Kasetsart University in Bangkok, Thailand on February 7, 2012 (flyer attached). This event was a prelude to the technologies that were unveiled in the opening of the new HortCRSP Regional Center of Innovation in Kasetsart University on February 8, 2012. The one-day training involved practical sessions where the participants could conduct the tests themselves. There were 81 participants that attended this workshop. Dr. John Bowman, Sr. Int'l Affairs Specialist USAID Bureau for Food Security, and Elizabeth Mitcham, Director of HortCRSP, were among the distinguished participants.

(L: KB and his team conducting practical sessions. R: JVA presenting the Drying Beads Technology)

The Associate dean of the Faculty of Agriculture gave the opening remarks and mentioned how Kasetsart University has been the pioneer in Agricultural Education in Thailand and how the

university is honored to host the event as well as have the HortCRSP Center of Innovation on its campus. Dr. Kent Bradford from UC Davis then gave the introduction to the Drying Beads, which was followed by more analysis and practical tests that were conducted by Rhino Research Group Managing Director Mr. Johan van Asbrouck. The participants got the opportunity to test the beads themselves and at the end of the day the results they witnessed made them more interested with using the Drying Beads. Each participant was given a small sample of the drying beads to use in their own tests.

Rhino Research Group also set up an information booth the following day on the Opening of the HortCRSP Center of Innovation. During the open house flyers were handed out with 2 page report on the recently conducted IDE training of Drying Beads in Bangladesh.

(L: Drying Beads on display for the open house event. R: JVA explaining the Drying Beads Technology)

The Drying Beads, being new in the agricultural industry, generated major interest during workshop and exhibition. Our partnership with RR group will further help to spread the technology to smallholders in Feed the Future countries. Many participants commented that the Drying Beads will revolutionize the drying and storage of seeds in the future and were glad that they had this opportunity to learn about them. RR Group is also looking forward to getting these beads to small farmers and seed companies in Thailand to resolve their drying and storage problems. They are confident to achieve this goal with the help of the HortCRSP Innovation Center at Kasetsart University, Thailand.

Asian Institute of Technology (AIT):
Ganesh Shivakoti (GS) has extensive experience in conducting agricultural socio-economic analyses in Nepal and other Southeast Asian countries. He is in charge of designing, coordinating and conducting the baseline and socio-economic analyses of the seed systems in Nepal and Bangladesh. GS visited Bangladesh and Nepal with JVA and PT during November 19-28, 2011. During these visits, GS initially recruited two PhD students from NARC, Nepal and Bangladesh Agriculture Research Institute (BARI). However, the student from BARI has discontinued the program. Krishna Timsina from NARC is new PhD student who has contacted several researchers in developing the attached questions for baseline survey. He was involved in Team visit by GPS, JVA and PT to Nepal and also participated at the ToT workshop on March 6, 2012. The questionnaire/survey developed by

Timsina and Shivakoti was shared with Richard Musebe of CABI-Africa to coordinate with his socio-economic surveys in Africa as well.

Other users:
John McShane, President, Stover Seed Company, 800-621-0315, FAX: 213-626-4920 (stoverseed.com) communicated with KB on Nov 3, 2011 about using beads to dry Zoysia seeds destined for the humid Hawaiian climate. They needed seed MC to be less than 6% such that MC does not exceed 6% during packing. We sent 2 kg of Drying Beads to Stover Seed Co. Previously, they used 4 parts silica gel (8 oz cloth bags) to 3 parts seed and sealed for 28 days which reduced the moisture content from 10-13% to 5.9%. In their initial test with the Drying Beads at 1 part beads (8 oz cloth bags) to 2 parts seed for 7 days, seed MC was reduced from 10% to 5.2%, a 75% time saving over silica gel. Stover Seed Co has ordered 50 kg beads from Rhino Research and has expressed interest to be a dealer for North America.

Anne Marie Welten, PhD, Enza Zaden Postharvest Research, 525 Lucy Brown Lane, P.O. Box 866, San Juan Bautista, CA 95045, USA, Phone +1 831 623 4644' Cell +1 408-427-4628, Fax +1 831 623 1746
(anne.welten@enzausa.com, www.enzazaden.com) got information on Drying Beads from Dr. Allen van Deynze, UC Davis. Dr. Welten visited PD at UC Davis on Feb 14, 2012 and received information on different uses of beads. One kilogram of beads was mailed to Dr. Welten who reports, "After some quality/analysis problems with (larger quantities of) oven leaf dried material last year, we will use the beads this coming season for drying material that we do not want to dry using heat (no access to a freeze-dryer). No new applications or data collection foreseen. If we need more (also for the other Enza labs that might be interested), we will definitely contact rhino-research."

2nd report
UC Davis:
Technology Support Package:
There were two main research activities to generate information to simplify the use of Drying Beads. A simple spreadsheet was developed which provides information to calculate bead quantity needed to dry seeds from current moisture content (MC) to desired final MC.This spreadsheet used the following equation from Cromarty *et. al*. (1982) to estimate current seed equilibrium MC (M_e) of diverse seeds based primarily on their oil content. We also found simple and cheaper T-RH meters that can predict T and RH for seeds when enclosed inside moisture-proof containers with seeds for 24 h.

Cromarty *et. al.*, 1982→ $$M_e = \frac{\left((1-D_o)\times\sqrt{(-440\times\ln(1-R))}\right)}{1.1+\left(T/90\right)}$$

The oil content for seeds of interest was compiled from Seed Information Database (http://data.kew.org/sid/viability/mc1.jsp?oil=47.30&drytemp=25&equib=80&constid=2083) and is searchable by either common or scientific name.This spreadsheet, Bead Calculator, was designed such that the users could enter current T, RH for the seed and find out current seed MC (A001). Then, the user has to decide final storage MC or equilibrium RH. For long-term storage, seeds should be in equilibrium with 20%-30% RH. Most crop seeds will remain viable for several years at such low MC at ambient T. When the user enters desired final equilibrium RH, the spreadsheet yields the quantity of bead (g), needed to dry 1 kg seed. Users also need to know current MC (bead capacity). For now, we are recommending to put 50-100 g beads inside porous bags over water for 24 hours at ambient T such that the beads and bags do not touch water and calculate the % change in weight for triplicate samples. Studies are ongoing to estimate drying capacity of Drying Beads under varying environmental conditions more accurately.

Seed drying time courses
The second part of research was to validate the assumptions of the Bead Calculator using several vegetable seeds including tomato, chili, lettuce, onion and cucumber. Bead quantities to reduce seed MC from about 80% RH to 20% RH were calculated as described above for 65 species (Fig. 1). Bead quantities in excess of 1:1 and 1:2 seed:bead ratios were also used to find possible adverse effects of over-drying. Seed MC were measured at 1, 3, 7, 14, 28, 56 and 84 days by oven method. The predictions of Bead Calculator matched observed MC after drying very well (A002). These MC reduction studies indicate that in general, 1:0.5 seed:bead ratio will dry seeds from ~80% RH to 20% RH, which results in a safe seed MC to store for several years at ambient conditions.

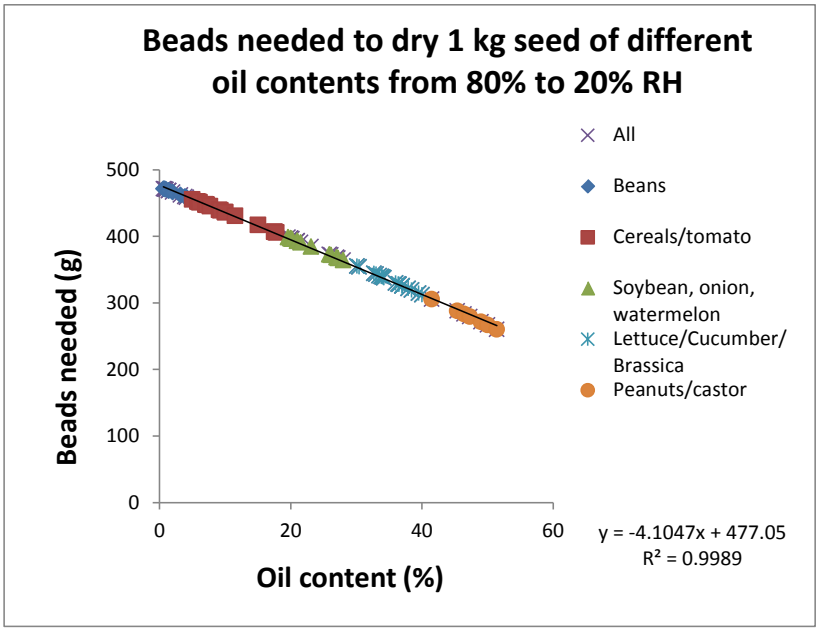

Figure 1. Amounts of drying beads needed to dry 1 kg of seeds of different oil content from equilibrium with 80% to 20% RH. As the seed oil content increases, the amount of beads required decreases linearly. This relationship is used in the Bead Calculator to determine the amount of beads needed to dry seeds of a specific species from an initial RH (MC) to a final RH (MC).

No harmful effects of excess drying were found for cucumber seeds. On the other hand, larger seeds like beans and corn at less than 4-6 % MC could be damaged if imbibed rapidly. Although advanced bead users can check MC by using simple T-RH meters and avoid such damage, it is recommended that large seeds be exposed to ambient humidity for about 5 days before planting. Another salient feature of the Bead Calculator is that one can decide to use a number of sequential drying steps when bead quantities are limiting. These procedures have been shared with collaborators during recent Training and Demonstrations on Drying Beads in Bangladesh and Nepal and through SKYPE conference with CABI, Kenya. We have further simplified Bead Calculator which warns users regarding unsafe storage RH graphically. (A003). The Bead Calculator will be available at www.dryingbeads.com.

UC Davis receives a royal visit from Thailand

Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand visited UC Davis during May 14-15, 2012. The Princess of Thailand and senior Thai academic scientists accompanying her showed high interest in the newest developments in agricultural and nutritional research presented to them by UC Davis faculty. HRH the Princess is a knowledgeable and dedicated patron of several charitable organizations that are active in agriculture, nutrition and community development in Thailand and other countries of Southeast Asia.

At the UC Davis workshop, Allen Van Deynze and Kent Bradford of the UC Davis Seed Biotechnology Center (SBC) had the honor to present a summary of recent SBC activities (Fig. 2). Allen described a new SBC educational program, the Asian Plant Breeding Academy that will begin in November 2012 in Thailand in collaboration with the Asian & Pacific Seed Association. Kent Bradford updated HRH the Princess on a novel technology (desiccant drying beads) that is being implemented to address the challenge of safely drying and storing seeds under humid conditions. This project, supported by a USAID-funded HortCRSP grant, is based on technology developed by a Thai company (Rhino Research Group, Phitchit) and is being implemented in Thailand, Nepal, Bangladesh,

India, Kenya and other countries. Such expertise and methods will be instrumental for adoption of advanced seed technologies in Thailand's agricultural industry.

Figure 2. Visit of Highness Princess Maha Chakri Sirindhorn (center) with Dr. Kent J. Bradford (left) and Dr. Allen Van Deynze (right) of the UC Davis Seed Biotechnology Center.

University Outreach and International Programs:
Drying beads was featured as Seed Storage for Small Farms in newsletter for Spring /Summer 2012; vol 12 p 5:
KB presented "Of Seeds and Beads: Genetic and Technological Approaches to Improve Seed Quality" on Wednesday, June 6, 2012 at noon in 242 Asmundson Hall (Big Hanna Room) in Plants Sciences Departmental Seminar at UC Davis.
PD presented a short talk on bead technology at the POSTHARVEST SHORT COURSE held at UC Davis during June 18-22, 2012. Of 93 participants, 16 were UCD PLS 196 Students and 23 instructors. The audience was interested in postharvest issues of horticulture crops where maintaining low T is critical for maintaining quality. PD talked about Drying Bead technology that maintains low humidity in closed containers and provides safe storage environment for seeds for several years in humid regions.The use of beads to dry and maintain phytonutrients of fresh produce like chillies and nuts without using heat was informative to the audience.

KB was approached by Mark L. Roest (marklroest@gmail.com), Imagine Rural Development Initiative which has conservation project in Zambia (http://imaginezambia.org/). KB suggested potential use of drying beads for seed conservation and commodity storage projects. KB shared basic information and suggested to check further information at website (www.dryingbeads.com) which is being populated. KB introduced Mark with Rhino, CABI of HORTCRSP project and to Howard Shapiro and Jason Clay of African Orphan Crops Initiative.

Collaboration with other HORTCRSP projects:
James Nienhuis (JN), PI of another HORTCRSP seed project in Central America, communicated with KB to hold the workshop on drying beads for cooperators in 5 Central American countries on August 19-20, 2013 at Madison, WI, USA. KB and JVA have agreed to participate. JN expects each participating country will participate in the workshop and then will take the starter package home with them for their use in storing vegetable seeds being produced in that project.

FAO

KB discussed Drying Bead technology with Thomas Osborn (TO), Senior Agricultural Officer (Seed Policy) (thomas.osborn@fao.org) for the FAO at the International Seed Testing Association (ISTA) meeting in Venlo, The Netherlands, where KK was also present. TO was quite interested in the Drying Beads and offered to help make further contacts. He also encouraged KB to pursue the collaboration with the PICS group at Purdue as storage of legumes in Africa is a big problem and with Catholic Relief Services. KB shared that Technology Support Package for using Drying beads would be available at www.dryingbeads.com.

Communications with International Rice Research Institute (IRRI)
Communications started with Robert Zeigler, Director, IRRI during his seminar at UC Davis, "Research and Development on Rice: Food Security and Livelihoods for More than Three Billion People." Bob was receptive to the Drying Bead technology during question answer session and shared contact information with PD for A. Schmidley at IRRI. PD shared the following information with Bob and A. Schmidley at IRRI.

There are on-going communications with IRRI to use Drying Beads in rice. Extensive discussions were held with Dr. Fiona Hay, director of IRRI seed conservation, in relation to her experiments with Drying Beads for drying and storing rice seeds. These discussions resulted in a better understanding of the physical characteristics of Drying Beads. Further experiments are in progress in Davis to follow up on these insights to improve predictions of the Bead Calculator to estimate required seed:bead ratios.

Thailand:
Rhino Research Group, Thailand:
Several SKYPE and email communications between RR and UC Davis took place to facilitate delivery of Drying Beads to collaborators and to work on contents for website. RR has shipped beads to Africa, Bangladesh and Nepal. RR is gaining experience about how to effectively deliver Drying Beads to different countries. There were some difficulties in receiving the beads, especially in Nepal. One lot of beads donated by RR to CIMMYT Nepal is about to move from Calcutta, after being held

in customs there for about two months. On another front, Selvan Selvakumaran at Rhino has taken the lead on website design. The contents for the web were collected from collaborators. The web navigation tree was discussed between RR and UC Davis. Finally, a version including several tools to use the technology has been posted at www.dryingbeads.com.

Repeated inquiries have been made about a bead dealership in India. Rhino Research Group is working to establish dealers in target countries when demand for beads will increase after seeing results from current demonstrations. The recent experience of shipping beads to Nepal and Kenya indicates that users will face difficulties to import beads directly from Thailand. Discussions will also need to be conducted with governmental officials to identify mechanisms to facilitate import of beads.

CABI-Africa:
Following communications with Dr. Larry Murdoch and Dr. Klein E. Ileleji at Purdue University, KB asked NP to attend Purdue Improved Cowpea Storage (PICS) workshop from April 10-12, 2012 in Accra, Ghana. The PICS program is promoting distribution of hermetic and oxygen-tight bags for cowpea storage to prevent development of bruchids that damage stored seeds. One major objective was to learn experiences in implementing PICS in African countries. Another objective was to share the desiccant bead seed drying technology which is very appropriate in humid and semi-humid areas of Africa. NP attended the PICS workshop from April 10-12, 2012 in Accra, Ghana with a poster entitled "New Desiccant Technology Enables Efficient Post-harvest Drying and Storage of Seeds in Humid Climates". The poster attracted a lot of interest from the workshop delegates. For example, Dr Tom Remington of Catholic Relief Service in East Africa who also attended the workshop requested to test drying beads with drying and storing of bean seed in Burundi. It was apparent from the workshop that the PICS technology has had a huge impact on storage of cowpeas, especially in reducing use of storage pesticides. It is important however to mention that the technology has some challenges too, such as stored product going moldy if not dried properly in humid conditions. Additionally, some unscrupulous people are making substandard counterfeits that do not work well. The use of PICS bags could be a great complementary technology with the addition of desiccant seed drying technology. (A7, A8)

Socioeconomic surveys to obtain baseline information on seed systems in Kenya and Tanzania
To effectively promote the desiccant beads for purposes of drying and storage of vegetable seeds it is important to obtain a better understanding of the existing production, distribution and marketing systems so as to identify critical points where seed quality is at risk. A socioeconomic survey was instituted as a baseline study to pave the way for appropriate and cost effective introduction of desiccant drying beads in areas with best impact. The study targeted key horticultural crops in Kenya and Tanzania especially grown by the smallholder farmers, in areas where these horticultural crops are grown in the two countries. The interest is in commercially important commodities. Particular vegetable crops targeted in both Kenya and Tanzania included kale, onions, beans, tomatoes, amaranths, spider plant, black night shade, African eggplant and ground nuts. The study covered all key stakeholders in the horticultural sector. These are the ministries of Agriculture, seed companies, NGOs, Universities (e.g. the Seed Enterprise Management Institute at the University of Nairobi), individual farmers, seed grower networks/cooperatives, distributors of seed, marketing agents, seed microenterprises, seed regulators, researchers and extension agents, national gene banks and seed traders.

The survey had the following objectives: assess the level of availability of quality seeds, document incomes of the seed producers, identify the constraints to improving horticultural seed quality, highlight where the most cost effective interventions should be made, quantify the benefits to be expected throughout the horticultural value chain, identify the key points where the quality of both farm-saved and commercial seeds can be improved (is at risk), assess the level of local knowledge and capacity for production, storage and distribution of high quality seeds, assess the roles of women in the existing seed systems to identify strategies to increase their participation in management and entrepreneurial activities, document existing drying and storage technologies specific to local conditions, identify opportunities and approaches for introducing improved seed drying and storage technologies specific to the local conditions. The study was conducted in the key vegetable growing areas of Kenya and Tanzania, including the key vegetable seed producing areas. The areas covered are in Western and Rift Valley Provinces in Kenya as well as complementary data from other areas involved in vegetable seed production. Arusha and Dodoma Regions were covered in Tanzania. These areas also have seed companies and locations of the offices of key stakeholders in the vegetable seed industry. The choice of the study areas is also based on their suitability for the production of vegetables with regard to the agro-ecological zones. There also exists potential for increasing seed production in these areas.

Data are being analysed. Preliminary findings indicate that the education level of most vegetable growers is up to primary level. This means that to improve adoption of specific technology, it will be necessary to use participatory and demonstration approaches (see Table below).

Table: Highest education level attained by the vegetable seed producers

Education	Percent (%)
Non-formal/ none	24.34
Primary	51.77
Secondary	19.91
Post-secondary	3.98
Total	100

The key constraints in vegetable seed production are lack of certified seeds, prevalence of pests and diseases, and high costs of inputs, as well as lack of drying materials and equipment. Lack of certified seeds is due to unreliable markets and seed sources. Some seeds are diseased while others are mixed with other seed which lowers the quality of seeds. Only 39.8% of the farmers interviewed had training in vegetable seed production, drying, storage, packaging or marketing. This indicates a shortage of knowledge in seed husbandry practices and marketing. The farmers who conduct tests of seed germination constitute only 28.3%, implying that some of the seeds seen as physically good may not be as good as depicted by their appearance. The key problems in seed storage are lack of storage facilities and equipment to protect from pests and rodents. Marketing problems are also a key impediment to vegetable seed production. These can be disaggregated as transportation, prices and limited infrastructure and delayed payments for the growers under contracts with different companies. Most of the vegetable growers (64.2%) do not know the safe moisture content (MC) that the seeds should be dried to for safe storage and longevity. Provision of knowledge and technical know-how in

this line is essential to assure good seed quality. Additionally only 4.4% know about air tight (sealed) storage of seeds.

Demonstration trials on use of desiccant beads for drying and storing seed

A lot of preparations have been completed for this important activity in Africa. Desiccant beads were shipped from Rhino Research in Thailand to CABI, Kenya. Although a shipment of 125 kg beads left Thailand on time, the beads arrived on August 29, 2012 at CABI, Kenya, thus providing important lesson for future. Discussions were held with partners on types of seed/crops to be tested using the desiccant bead technology. Set up of demonstration trials outlined below are in progress after consulting UC Davis. There is possibility to test initial seed quality at ANGRAU, Hyderabad, India but options are being explored to test in Kenya as well. The following organizations are participating in trials:

Kenya

- TATRO farmer group in Kisumu, West Kenya; Kenya Agriculture Research Gene Bank, Central Kenya; CABI; Caritas farmer group under Catholic farmers in Embu, Eastern Kenya; Seed companies – the Association of Seed Traders of Kenya (STAK) and Kenya Plant Health Inspectorate Service (KEPHIS), Nakuru who will help in testing for seed quality.

Tanzania

- Tanzania Horticulture Research Institute (Hort Tengeru) in Tengeru, Arusha; East West Seed Company in Moshi; AVRDC Africa office in Arusha requested to be included early next year because they do not have staff, but are currently recruiting a gene bank scientist and others; INADES farmers group being facilitated by the District Horticultural Officer in Morogoro; Tanzania Official Seed Testing and Certification Institute (TOSCI) in Morogoro – will participate mostly by testing for germination of seed from trials

Rwanda

- Rwanda Agriculture Board

Uganda

- National Crops Resources Research Institute (NaCRRI) of the National Research Organization (NARO) – will work in collaboration with FICA Seeds Ltd of Uganda.

Seed of the following crops will be included in demonstration trials:

Kenya – Amaranths, green gram, spider plant, night shade (seed not available this season), ground nuts, and kale.

Tanzania – Tomato, onion, amaranths, African egg plants, and green gram (mung bean)

Uganda and Rwanda – crops not confirmed yet

India:

KK was invited to present the Drying Bead technology at "The XXVII Annual Group Meeting of All India Coordinated Research Project –National Seed Project (Crops)" organized by ICAR at AAU, Anand, Gujarat, India during 14-16, April 2012. The delegates comprised scientists from different ICAR institutes and State Agricultural Universities, senior officials and scientist from ICAR headquarters, Directorate of Seed Research. Researchers from 35 Breeder Seed Production Units, 23 Seed Technology Research Centers, 16 centers of Annual Oilseed Scheme, Project Coordinators of AICRP (Crop Sciences), seed industries both public and private and representatives from NSC, Seed Certification Agencies actively participated in this Annual Group Meeting. After presentation and discussion by KK, they recommended that pilot studies on application of zeolite beads should be taken

up at selected Seed Technology Research Centers in sunflower and rice. Another center of Jabalpur Agricultural University (JNKVV), Madya Pradesh would like to take up studies of soybean. There were many enquiries about the technology and availability of beads. The representatives from National Seed Association of India (NASI) actively participated in the discussion and requested to organize a training/demonstration on the technology.
In response to the presentation by KK atThe XXVII Annual Group Meeting of All India Coordinated Research Project, Project Director, Directorate of Seed Research, ICAR, Mau, UP, India asked for 25 kg in 1 kg sealed packs to distribute to different researchers in different centers in India. Invoice for the beads to be sent to "Project Director, Directorate of Seed Research (DSR), ICAR, Mau, UP, India", with copies to pd_dsr2005@yahoo.co.in for approval and to Dr. S N Sharma (sns_str2001@yahoo.com).

Publication:
Dr. N. K. Dadlani, National Seed Association of India (NSAI), an active participant at The XXVII Annual Group Meeting of National Seed Project (Crops) at Anand, Gujarat communicated with KK. After consulting KB at UC Davis, KK agreed to publish research results from India in Seed Times, a NASI magazine. Manuscript was submitted, accepted and published.
Keshavulu K, Dahal P, Asbrouck JV and Bradford KJ. 2012. New technology for post harvest drying and storage of seeds. Seed Times. The National Seed Association of India, New Delhi 5(2):32-38. (A02)

KK honored by Chief Minister of Andhra Pradesh, India on July 23, 2012:
KK was chosen for The Federation of Andhra Pradesh state Chambers of Commerce and Industry (FAPCII) Outstanding Scientist Award for the Year 2010-11 in recognition of his significant contributions in seed technology especially on Drying Bead technology. The award was presented by the Chief Minister of Andhra Pradesh on July 23, 2012. KK had an exclusive award winning interview with one of the leading local newspapers, namasthetelangaana on May 8, 2012. (www.namasthetelangaana.com/News/article.asp?category=1&subCategory=2&ContentId=136257).

Research
There has been agreement to work with ICRISAT on the effect of Drying Beads in reducing aflatoxin in groundnut. Similarly, studies to find the threshold humidity to control bruchids in mung bean are in progress. In addition, seed samples have been received from Bangladesh and seed testing is ongoing.

Graduate student training_technology transfer to Africa:
Pete Jackson from Tanzania Official Seed Testing Institute (TOSCI) completed MS thesis research on tomato seed drying and storage using Desiccant beads and is interested to continue collaboration with CABI in Arusha, Tanzania.

Bangladesh:
Market systems development and value-chain approaches are being used in IDE's programs. With the Seed System project, iDE Bangladesh is focusing on strategic portfolios which include the commercialization of the technologies. iDE will also focus on developing the Drying Bead supply chain by identifying the various business models. The field activities are mostly incorporated into the

various projects of iDE in Bangladesh. iDE is exploring different service providers to strengthen the bead services to the farmers.

In the end, HortCRSP will deliver practical, field-tested business models for the up-scaling of drying bead technology by generating consumer demand through demonstrations of drying and storage while building supply-side awareness and capacity to deliver these services. This strategy relies on four key steps:

- Demonstrations of Drying Beads in field tests to identify potential for smallholders;
- Identify business models for the delivery of improved drying and storage from engaged service providers and retailers to smallholders;
- Facilitate commercial distribution and sales networks for drying and storage services based on identified business models;
- Promote the usage of drying and storage products/services amongst smallholders through the resulting channels

iDE has developed research methodology for supply chain analysis by preparing questionnaire and sample size. A total of 23 stakeholders were interviewed in south Bangladesh including 6 seed users, 9 seed producing farmers, 4 seed retailers and 4 local seed companies/dealers. The data collection and report for north Bangladesh will be complete by the next quarter.

In order to implement the Drying Bead technology, 131 service providers (SPs) were selected including 26 local seed companies, 25 seed retailers and 80 seed producing farmers and MoU signed. In the meantime, 125 kg Drying Beads and two data loggers were received from Rhino Reseach Group. Drying Beads were transferred into moisture proof containers. The training program for SPs was communicated with UC Davis. It was realized during email and SKYPE communications that a visit to iDE Bangladesh would be effective to initiate field demonstrations. Hence, PD planned a visit to Bangladesh and Nepal starting July 23, 2012 and carried cheaper T-RH units for iDE Bangladesh.

iDE planned two day-long re-orientation programs for its staff. PD attended the first “Re-Orientation on Seed Drying and Storage Technology” for iDE staff on July 26, 2012 at Barishal, Bangladesh. The orientation sessions were focused on project interventions, implementation strategy, bead capacity measurements, seed:bead ratio calculation using spread sheet for different seed types and operation plans. After the training, iDE staff are now more confident to use the beads in user demonstrations and implement the pilot interventions. (see attendance list below).

Re-Orientation on Seed Drying and Storage Technology

26 July 2012
Barishal, Bangladesh

Participants Attendance Sheet

Name	Designation	Project/Dept	Organization	E-Mail	Remarks
Md. Asaduzzaman	Manager Business Development	Rural Enterprise Development (RED) MIDPCR	iDE, Bhola	asaduzzaman@ide-bangladesh.org	Implementer in Charfashon, Bhola
Md. Mahmud Kabir	Manager Business Development	Rural Enterprise Development (RED) MIDPCR	iDE, Patuakhali	mahmud.kabir@ide-bangladesh.org	Implementer in Dashmina, Patuakhali
Susanta Kumar Saha	Manager Business Development	Rural Enterprise Development (RED) MIDPCR	iDE, Barisal	susanta.saha@ide-bangladesh.org	Implementer in Bakergonj, Barisal
Bablu Kumar Barua	Coordinator- Program	Nobo Jibon (NJ), Save the Children International	iDE Barisal	bablu.barua@ide-bangladesh.org	Observer
B M Asadul Haque	Specialist Training & Enterprise Development	Nobo Jibon (NJ), Save the Children International	iDE Barisal	asadul.haque@ide-bangladesh.org	Field Coordinator
Kanai Lal Das	Manager Business Development	Nobo Jibon (NJ), Save the Children International	iDE Barisal	kanai.das@ide-bangladesh.org	Implementer in Barisal Sadar, Barisal
Md. Nazrul Islam	Manager Business Development	Nobo Jibon (NJ), Save the Children International	iDE, Barguna	nazrul.islam@ide-bangladesh.org	Implementer in Amtoli, Borguna
Satyajit Roy	Manager Business Development	Nobo Jibon (NJ), Save the Children International	iDE, Patuakhali	satyajit.roy@ide-bangladesh.org	Implementer in Kalapara, Patuakhali
Md. Nur Alam	Officer-Training	WOTSHAB	iDE, Barisal	nur.alam@ide-bangladesh.org	Observer
Shyam Sundar Saha	Director- Programs		iDE	shyam.saha@ide-bangladesh.org	Contact Person of HortCRSP
Peetambar Dahal	Project Coordinator,	HORTCRSP Seed System Project	University of California, Davis, CA	pdahal@ucdavis.edu	Researcher, UC Davis
Syed Mahmudul Huq	Coordinator- Training		iDE	mahmudul.huq@ide-bangladesh.org	Training & Technical Support
Kazi Mozammel Hossen	Officer-Training	ANEP	iDE	mozammel.hossen@aneproject-bd.org	Observer

One additional day-long staff orientation session was organized for the following staff on Aug 6, 2012 at Rangpur Regional Office, iDE.

SN	Name	Designation	Project /Dept	Organization	E-Mail	Remarks
1	Md/.Mustafa Kamal Milon	Officer ABD	ISEM	iDE-Bangladesh	mustafa.milon@ide-bangladesh.org	Nilphamari
2	Hiren Chandra Ray	Officer ABD	ISEM	iDE-Bangladesh	hiren.ray@ide-bangladesh.org	Rangpur
3	Abhijit Kumar Roy	Officer ABD	ISEM	iDE-Bangladesh	Abhijit.roy@ide-bagladesh.org	Dinajpur
4	Chandan Kumar Sarker	Team Leader	CMDI	iDE-Bangladesh	Chandan.sarker@ide-bangladesh.org	Observer & technical back up
5	Rezwan Haque Lohani	Officer BD	CMDI	iDE-Bangladesh	rezwan96@yahoo.com	Observer & technical back up
6	Md.Motiur Rahman	Officer BD	CMDI	iDE-Bangladesh	motiurrahman03@gmail.com	Observer & technical back up
7	Md.Mahbubur Rahman	Officer BD	CMDI	iDE-Bangladesh	mahbub_niba@yahoo.com	Observer & technical back up

The objective of these re-orientations was to provide practical training to iDE staff to use Drying Beads which had arrived a week earlier. An oven was purchased locally after communication with UC Davis. Similarly other supplies required for the bead re-activation were also procured. iDE staff practiced bead re-activation, bead MC determination using T-RH meters and step-wise seed drying using Bead Calculator. Apparently, the seeds were harvested in March/April and already subjected to the summer RH. Knowledge of initial seed quality would be essential to know the effect of desiccant beads during storage. Each trainee was provided with one T-RH meter and 7 kg of beads in moisture proof plastic box. One iDE trainee would cover 20 farmers. Once the lab studies show a difference in seed quality, the agents will plant both bead-treated and controls and share the results with the farmers in their command area. (A9-12)

PD, SS and iDE staff visited two agrovets and leader farmer on July 27, 2012. SM Jakir Hussain, Agrovet, owner of Bakergunj Seed Store # 19. Mr. Hussain has good contacts with local iDE staff. He opened the store for us even though it was Saturday and Muslim Holiday, Ramadan. He sold different vegetable seeds in packets, some self-packed after procuring from growers while seeds for Amaranth, Indian spinach and okra were in open sacks. He was aware that he needed to sell seeds by expiry date. He had to sell rice seeds at lower price as germination was lower and he could not store for the next season. Mr. Hussain had observed that seeds inside the aluminum packets sweated when placed under sunlight. He became quickly aware that high RH resulted into high seed MC and observed decline in seed quality. He would like to take part in the technology which could increase seed shelf life for several years. He said other dealers could challenge him if used longer expiry date than being currently used. He was curious about the technology and will come to the scheduled next day training on July 28, 2012. (A13, A14)

Mr. Shahid: leader vegetable seed producer, Boalia, Bakergunj; It rained heavily while going to his relative's house. Local tomato seed produces about 10 kg per plant. Gourd seeds would be dried in the next sunny day. Ms. Shahid will come to the training on July 28, 2012. Village level staff of District Agriculture office was also present in this interaction.

Aziz Jalal. Newmarket, Bakergunj. Agro vet dealer sells seeds, fertilizers, pesticides (including pheromones to kill insects). He purchased urea pelleting equipment by paying 25% of the total price; rest was provided by USAID/IFDC (www.ifdcbangladesh@ifdc.org). He has medium and big plastic barrels for fertilizer which seem suitable for bead seed drying. (A15, A16)

An interaction with representatives of three local seed companies was also held on July 27, 2012. We found that one seed company dealt with bitter gourd, pumpkin, sweet gourd, bottle gourd, watermelon, radish, tomato, eggplant, chilli, carrot, cabbage, cauliflower, kohlrabi, onion, jute, maize, rice, soybean, sunflower, potato, flowers. Another Mittal seed company had the same list except sunflower and soybean. They had complaints about germination in papaya, chilli, jute, maize, onion. Radish and watermelon seeds fared well up to 3 years. A suggestion whether a seed lot with 50% germination can be made to 100% germination by drying also came during discussion [no, it cannot]. The seed companies were curious whether other countries are using this technology. A question by iDE staff

revolved about the original inventor of beads. PD explained several uses of beads and that use in agriculture drying is invented by Rhino Research.

Practical session with iDE staff. Beads baked and cooled inside oven on July 26, 2012 were allowed to imbibe at ambient conditions (RH 82%). Bead MC was closer to 22% for 2 samples. Cowpea, indian spinach and chili seeds were allowed to equilibrate with T-RH meter for 24 hours inside moisture-proof containers. Displayed seed parameters on T-RH meter were used to calculate initial MC. Using bead capacity as 20%, beads required to dry these seeds to final RH between 15-25% were calculated. The beads were put in a muslin cloth over seeds and sealed. PD emphasized that mixing beads with seeds is best way but beads could be placed separately inside the moisture proof containers for ease of handling like for hot chilli seeds.

Training Service Providers. Following enabling orientation, iDE staff organized 3 one-day training sessions for 59 SPs in north and 5 day-long sessions for 82 SPs in south. The primary objective of the training was to orient SPs about effectiveness of Drying Beads on seed drying and storage, bead handling and re-activation and field demonstrations. Nine crops were selected in the project area for drying and storage using beads, each crop selected for each sub-district based on availability and service providers' interest. Below is a summary of the training organized for SPs in different locations including crops and assigned iDE staff.

SN		District	Sub-district	Training date and venue	SPs	Crop	Facilitator
1	North	Rangpur	Mithapukur	August 7, 2012 at Hotel Caspia, Rangpur	10	Bitter Gourd	Hiren Roy
			Badargonj	August 7, 2012 at Hotel Caspia, Rangpur	10	Eggplant	Hiren Roy
2		Dinajpur	Sadar	August 9, 2012 at Pallishree training center, Dinajpur	10	Tomato	Abhijit Roy
			Birgonj	August 9, 2012 at Pallishree training center, Dinajpur	9	Radish	Abhijit Roy
3		Nilphamari	Jaldhaka	August 8, 2012 at RDRS training center, Jaldhaka	10	Eggplant	Mustafa Kamal
			Domar	August 8, 2012 at RDRS training center, Jaldhaka	10	Chili	Mustafa Kamal
4	South	Barisal	Sador	July 28, 2012 at AVAS Training Center, Barisal	10	Okra	Kanai Das

5		Barisal	Bakergonj	July 28, 2012 at AVAS Training Center, Barisal	10	Tomato	Susanta
6		Bhola	Chaarfassion	August 5, 2012 at CharfassionZinnahgor UP	10	Chili	Asaduzzaman
7		Patuakhali	Kolapara	August 7, 2012at Destiny Training center, Amtoli	10	Okra	Sattyajit Das
8		Patuakhali	Doshmina	August 6, 2012 at iDE Office, Patuakhali	12	Mung bean	Mahmud Kabir
9		Borguna	Amtoli	August 7, 2012at Destiny Training center, Amtoli	10	Snake gourd	Nazrul Islam
10		Noakhali	Sador	August 11, 2012 at BRDB training center	10	Soybean	Delowar Hossain

Detail list of SPs who attended training sessions is presented below.

Training participant List (Service Providers) on Seed Drying and Strorage Technology
South Region
Training Date: July 28, 2012
Area: Barisal Sador, Bakergonj
Total Participants: 20; Male 17, Female 3

SN	Name of Participant	Category of Participant
1	Gobindo Saha	SEED COMPANY
2	S.M Jakir Hossain	SEED COMPANY
3	Md. Kamal Talukder	SEED RETAILER
4	Md Atikur Rahaman	SEED RETAILER
5	Md. Sabuj Gazi	SEED PRODUCER
6	Md. Ferdouse Gazi	SEED PRODUCER
7	Md. Samim Fakir	SEED PRODUCER
8	Md. Salam Soial	SEED PRODUCER
9	Md, Aliazgar (Leda majhi),	SEED PRODUCER
10	Md. Salam Howladar	SEED

		PRODUCER
11	Hazi Md Jalal	SEED COMPANY
12	Mowlana Sayed Khalilur Rahman	SEED RETAILER
13	Md. Harunar Rashid Khan	SEED RETAILER
14	Md. Shahid	SEED PRODUCER
15	Gita Rani	SEED PRODUCER
16	Polash Mitra /Pobitra Mitra	SEED PRODUCER
17	Laxmi Rani	SEED PRODUCER
18	Balai Singh	SEED PRODUCER
19	Rekha Rani Das	SEED PRODUCER
20	Kalachan Das	SEED RETAILERT

Training Date: August 5, 2012
Area: Charfasson, Bhola
Total Participants: 10; Male 10

SN	Name of the Participant	Category of Participants
1	Md.Torikul Islam	SEED PRODUCER
2	Md.Belal Hossian	SEED PRODUCER
3	Md.Abdus Sattar Faruk	SEED PRODUCER
4	Md.Alauddin	SEED RETAILERT
5	Md.Lockman	SEED PRODUCER
6	Md.Soleman	SEED PRODUCER
7	MD.Ab.Ali	SEED RETAILER
8	MD.Billal	SEED RETAILER
9	Md.Amir Hossian	SEED PRODUCER
10	Md.Aktaruzzaman	SEED RETAILER

Training Date: August 6, 2012
Area: Doshmina, Patuakhali
Total Participants: 12; Male 12

SN	Name of Participant	Category of Participant
1	Md. Zahid Hasan (Titu)	SEED COMPANY
2	Md. Mujibor Rahman	SEED COMPANY
3	Amol Shaha	SEED COMPANY
4	Md. Saiful Islam (Nasir)	SEED RETAILER
5	Md. Saiful Islam	SEED RETAILER
6	Seed retaileree Amol sha	SEED COMPANY
7	Md. Anisur Rahman	SEED PRODUCER
8	Md. Razaul Karim	SEED PRODUCER
9	Md. Bosir Uddin	SEED PRODUCER
10	Seed retaileree Sumboo chandro	SEED PRODUCER
11	Seed retaileree Kattik chandro	SEED PRODUCER
12	Md. Sultan Halder	SEED PRODUCER

Training Date: August 7, 2012
Area: Kolapara & Amtoli
Total Participants: 20; Male 19, Female 1

SN	Name of Participant	Category of Participant
1	Gawthom Hawlader	SEED COMPANY
2	Sarower Bapari	SEED COMPANY
3	Masud Bapari	SEED RETAILER

4	Shahid Mussulli	SEED RETAILER
5	Shanker Biswash	SEED PRODUCER
6	Bimol Gorami	SEED PRODUCER
7	Dulal Khan	SEED PRODUCER
8	Masumbillah	SEED PRODUCER
9	Md. Jashimuddin	SEED PRODUCER
10	Md. Kabir	SEED PRODUCER
11	Md. Abdul Jobbar Sardar	SEED COMPANY
12	Harun Ur Rasid	SEED COMPANY
13	Nuruzzaman	SEED RETAILER
14	Roton Gazi	SEED RETAILER
15	Shohidul Islam	SEED PRODUCER
16	Md. Abdul Motaleb Haolader	SEED PRODUCER
17	Nazma Begum	SEED PRODUCER
18	Hanif Mridha	SEED PRODUCER
19	Amena Begum	SEED PRODUCER
20	Abdul Latif	SEED PRODUCER

Training Date: August 11, 2012
Area: Noakhali Sador
Total Participants: 10, Male 10

SN	Name of Participant	Category of Participant
1	Amirul Jamin Faisal	SEED COMPANY
2	Md. Nurul Amin Babul	SEED COMPANY
3	Md. Nur Nabi Chowdhury Shapon	SEED RETAILER

4	Md. Golam Sarwar	SEED RETAILER
5	Ahammod Ullah	SEED PRODUCER
6	Md. Nur Nabi	SEED PRODUCER
7	Abdur Rahim Nizam	SEED PRODUCER
8	Nur Ahmed Tonu	SEED PRODUCER
9	Akhter Hossen Masud	SEED PRODUCER
10	Md. Abul Kashem	SEED PRODUCER

Training participant List (Service Providers) on Seed Drying and Strorage Technology
North Region
Training Date: August 7, 2012
Venue:Hotel Kaspia, Rangpur

SN	Name	Category	Village	Union	Sub-district	District
1	Md. Anamul Hoq	Seed company	Badargonj Bazar,	Badargonj Pourasava	Badargonjk	Rangpur
2	Md.Alamgir Hossain	Seed company	Poura Bazar	Jummapara	Badargonjk	Rangpur
3	Md.Rasel Miah	Seed Retailer	Shibpur	Gopalpur	Badargonjk	Rangpur
4	Md. ASeed retaileraful Islam	Seed Retailer	Arunannacha	Kutubpur	Badargonjk	Rangpur
5	Abdul Wahad	Seed Producer	Gopalpur	Gopalpur	Badargonjk	Rangpur
6	Moksedul Islam Biplob	Seed Producer	Gopalpur	Gopalpur	Badargonjk	Rangpur
7	Abu Tahar Miah	Seed Producer	Thataripara	Gopalpur	Badargonjk	Rangpur
8	Nazir Hossan	Seed Producer	Stationpara	Gopalpur	Badargonjk	Rangpur
9	ASeed retaileraful Islam	Seed Producer	Bashpara	Kutubpur	Badargonjk	Rangpur
10	Shahadat Hossain	Seed Producer	Bashpara	Kutubpur	Badargonjk	Rangpur
11	Md. Mejanur Rahman	Seed company	ASeed retaileratpur	Dorsona	Mithapukur	Rangpur
12	Md.Deldar Hossain	Seed company	Mithapukur Bazar	Durgapur	Mithapukur	Rangpur
13	Md, Lovlu Miah	Seed Retailer	Moyenpur Digolpara	Moyenpur	Mithapukur	Rangpur
14	Md. Edrish Ali	Seed Retailer	Ranipukur	Ranipukur	Mithapukur	Rangpur
15	Md. Naya Miah	Seed Producer	Akhirahat	,Moyenpur	Mithapukur	Rangpur
16	Md. Fattarul Islam	Seed Producer	Ranipukur	Ranipukur	Mithapukur	Rangpur
17	Monjurul Alam	Seed Producer	Ranipukur	Ranipukur	Mithapukur	Rangpur
18	Md. Biplob Miah	Seed Producer	Ranipukur	Ranipukur	Mithapukur	Rangpur
19	Md. Mostafizur	Seed Producer	Ranipukur	Ranipukur	Mithapukur	Rangpur

	Rahman					
20	Md. Asab Uddin	Seed Producer	Ranipukur	Ranipukur	Mithapukur	Rangpur

Training Date August 8, 2012
Venue :RDRS,Jaldhaka, Nilphamari

SN	Name	Category	Village	Union	Sub-district	District
1	Mahababur Rahman	Seed company	Domar	Domar	Domar	Nilphamari
2	Md.Jewel Hassan	Seed company	Domar	Domar	Domar	Nilphamari
3	Anisul	Seed retailer	Basunia	Sonaray	Domar	Nilphamari
4	Ibrahim	Seed retailer	Basunia	Sonaray	Domar	Nilphamari
5	Rubel	Seed Producer	Khaturia	Sonaray	Domar	Nilphamari
6	Bellal	Seed Producer	Khaturia	Sonaray	Domar	Nilphamari
7	Jakirul	Seed Producer	Khaturia	Sonaray	Domar	Nilphamari
8	Rezaul	Seed Producer	Khaturia	Sonaray	Domar	Nilphamari
9	Mukta	Seed Producer	Bororata	Sonaray	Domar	Nilphamari
10	Dilip	Seed Producer	Deverdanga	Sonaray	Domar	Nilphamari
11	Jahangir Alam	Seed company	Rangpur	Rangpur	Jaldhaka	Nilphamari
12	Alauddin Ahmed	Seed company	Rangpur	Rangpur	Jaldhaka	Nilphamari
13	Sobadul	Seed Producer	Jaldhaka	Jaldhaka	Jaldhaka	Nilphamari
14	Abdul Gaffer	Seed Producer	Jaldhaka	Jaldhaka	Jaldhaka	Nilphamari
15	Sahidul	Seed Producer	Kalcaute	Mirgonj	Jaldhaka	Nilphamari
16	Poresh	Seed Producer	Singra	Soilmari	Jaldhaka	Nilphamari
17	Babul	Seed Producer	Singra	Soilmari	Jaldhaka	Nilphamari
18	Sosibuson	Seed Producer	Singra	Soilmari	Jaldhaka	Nilphamari
19	Laxmikanta	Seed Producer	Singra	Soilmari	Jaldhaka	Nilphamari
20	Nirananda	Seed Producer	Singra	Soilmari	Jaldhaka	Nilphamari

Training Date: August, 9, 2012
Venue: Polli Seed retailer Training Centre, Balubari, Dianjpur

SN	Name	Category	Village	Union	Sub-district	District
1.	Md. Shahriar	Seed company	Station road	Pouroshava	Sadar	Dinajpur
2	Md. Rezaul	Seed company	Station road	Pouroshava	Sadar	Dinajpur
3	Md. Al Amin	Seed retailer	Station road	Pouroshava	Sadar	Dinajpur
4	Md. Razzak	Seed retailer	Station road	Pouroshava	Sadar	Dinajpur
5	Md. Khalil	Seed producer	Jote para	Fazilpur	Sadar	Dinajpur
6	Jober Ali	Seed producer	Guriapara	Fazilpur	Sadar	Dinajpur

7	Md. Rezaul	Seed producer	chadgonj	Chahelgazi	Sadar	Dinajpur
8	Md. Khalil	Seed producer	Puliapara	Chahelgazi	Sadar	Dinajpur
9	Raton chandra	Seed producer	Purbo Ramnagar	Sheakpura	Sadar	Dinajpur
10	Sammesshar Roy	Seed producer	Gopalpur	Sheakpura	Sadar	Dinajpur
11	Md. Sabuj	Seed company	25 mile	Sator	Birgonj	Dinajpur
12	Md. Golam Mustofa	Seed retailer	25 mile	Sator	Birgonj	Dinajpur
13	Assadulla Badsha	Seed retailer	Khanshama road	Birgonj	Birgonj	Dinajpur
14	Md Imdad	Seed producer	25 mile	Sator	Birgonj	Dinajpur
15	Md. Anisur Rahaman	Seed producer	Chakpatla	Sator	Birgonj	Dinajpur
16	Md. Ahatasham ul Haque	Seed producer	Sator	Sator	Birgonj	Dinajpur
17	Md Tazul	Seed producer	Dalua	Sator	Birgonj	Dinajpur
18	Md. Ibrahim	Seed producer	Prannagar	Sator	Birgonj	Dinajpur
19	Md. Anawar	Seed producer	Chakpatla	Sator	Birgonj	Dinajpur

After completing the service providers training, the service providers are storing the seeds available with them at their condition with air-tight containers. A common bead rate was used for selected crops calculated considering the temperature, humidity, bead capacity (20%) to get the optimum seed moisture in storage condition. The project staff has assisted SPs to calculate beads required, storage container selection & use. All SPs have stored seeds with beads and sample seeds without beads to compare the results and disseminate to other clients. A total of 91 kg beads were distributed which included 42 kg for north and 49 kg for south region. Many service providers are reusing beads to dry and store other seeds as well. A total of 37 kg Drying Beads were used for 135 kg seeds.

During demonstrations at Barishal on July 28, 2012 and at Rangpur on August 6, 2012, studies were also set up using following seeds. Bead amount was calculated using Bead Calculator and seed parameters from T-RH meter (Table below). Following experience on bead MC measurement during training at Barishal and similar handling procedures followed for beads into moisture-proof containers, bead capacity (MC) was assumed at 20%. Curious iDE staff monitored effectiveness of Drying Beads to lower RH after week. Predicted seed parameters after a week are also shown below.

	Seed parameters							
Location: Barishal	Initial					After a week		
Name of Seed	Seed (g)	RH (%)	T (ºC)	MC (% FW)	Beads (g)	RH (%)	T (ºC)	MC (% FW)
Chilli	46	77	26.7	11.9	16	30	29.2	6.1
Indian Spinach (*Beta vulgaris*)	170	85	27	16.3	80	20	28.7	8
Bean	150	79	27.5	15.3	60	20	29	8.4
Location: Rangpur								
Bitter Gourd	112	73	28.3	9.7	21	10	25.6	5.6

Red Amaranth	98	69	28.4	13.1	31	20	25.4	7.5
Radish	160	72	28.8	9.1	27	25	25.5	4.7
Brinjal/Egg Plant	90	74	28.2	11.1	21	28	24.7	5.4

Monitoring initial seed quality:

It was realized that checking initial seed quality in local seed laboratories would be expensive as iDE did not have its own seed testing laboratory. iDE developed seed germination guideline and circulated among staff. Initial germination test was conducted in each sub-district at farmer/SP level. The main objective of the germination test is to keep data which will compare over the time period (this sowing season, next sowing season as well). PD suggested sending seed samples to KK at ANGRAU, Hyderabad, India for reliable information on initial seed quality in Bangladesh. Samples were properly coded and sent to ANGRAU, Hyderabad, India, for testing initial seed quality and germination. It proved difficult to send seed samples outside Bangladesh. Certification is needed to satisfy seed quarantine and it is costly as well. Alternatives for seed testing locally will be investigated.

Baseline survey in Bangladesh:

Ms. Soma Mallick, SSO, BARI is working with this project and conducting her PhD degree on socioeconomic analyses at AIT, Bangkok. Ms. Mallick has some experience working with seed storage pests. iDE Bangladesh is assisting her in study design and primary data collection both in south and north. She has done a baseline survey in iDE working areas and conducted interviews with farmers, seed producers, seed retailers and companies with the help of iDE's field team in August 2012. She was suggested that her baseline study samples would cover the seed users/service providers where iDE is planning to demonstrate drying beads technology. Attached is detailed report. (A17)

During visit and subsequent communications, Rajiv Pradhan and Shyam Sah have expressed interest to commercialize the technology. Furthermore, they want to increase their capacity by developing a Technology Commercialization Center for which they are looking for additional resources. (A17-1)

Nepal:

International Development Enterprises (iDE) Nepal leads HORTCRSP program in Nepal which has two implementing partners, National Agriculture Research Council (NARC) and Center for Agricultural Policy Research, Extension and Development (CEAPRED).

Identification of project sites/beneficiaries such as seed producer farmers, agro-vets and community level farmers: On March 2012, the project sites in Kavre and Rukum were identified asd well as 600 seed growers in Kavre and 200 in Rukum.

Project field office setup: iDE/HortCRSP has established offices in districts. The activities of districts are regulated from regional and central offices. Necessary project staff members have been hired at central office, regional offices and districts offices. IDE and implementing partners have followed their standard policy guidelines and procedures in staff recruitment.

Agreement with implementing partners. Due to initial delay on the part of iDE to sign a MOU with UC Davis, iDE signed an agreement with CEAPRED in June 2012. Despite the delay in signing the MOU, planned activities continued uninterrrupted. It took some more time to sign MOU with NARC. A new NARC policy required new projects to be presented for review by NARC management. A presentation was organized on August 24, 2012 where Komal Pradhan outlined the project objectives and detailed budget for 3 years. PD explained the technical properties of drying beads. Jwala Bajracharya (JB) shared her involvement with HortCRSP from the beginning including visits to Singapore and UC Davis. Executive Director (ED) DB Gurung and JB were in Naning, China at 11th Asian Maize conference where JB presented poster on desiccant technology. ED was chief of the national maize program where CIMMYT is planning to use Drying Beads to store foundation seed. During the meeting, Bharat Upadhyaya (Executive Director of CEAPRED) gave a broad overview of USAID CRSP programs. It was opined that the technology could be appropriate for collection, transport and conservation of duplicate indigenous germplasm as well. ED was satisfied with the budgetary transparency and supported the technology following minor changes pointed out by his staff. There is budget allocated for Genebank and Malepatan and Dailekh farms. At the end, ED Gurung approved the use of Drying Bead technology for NARC and the MOU was signed subsequently.

Baseline Survey:
Krishna Timsina associated with NARC and PhD student with Ganesh Shivakoti at AIT, Thailand, conducted a baseline survey for economic analysis of existing seed production, storage and distribution systems. The study aimed to assess the current status of vegetable seed production and distribution systems including seed harvest, storage and marketing. Rukum, Kavre, Rupandehi and Palpa districts of Nepal were selected after consultation with IDE, CEAPRED, NARC and AIT based on the intervention of different horticulture related programs by CEAPRED (a national level NGO in Nepal) and iDE Nepal. The selection of these sites was based on the occurrence of vegetable seed production and availability of different end users for vegetable seed.
Altogether 350 samples and 175 vegetable seed growers (55 onion growers from Rukum and 120 from Kavre, 30 each of tomato, cucumber, okra and bean seed growers); 100 vegetable seed end users (60 from Rupandehi and 40 from Palpa) and 75 supply chain actors and service providers were selected for the baseline study. (A18 “Baseline Survey-Vegetable Seed Production and Distribution in Nepal”)

Prepare Detailed Implementation Plan (DIP) for year-1:
After starting demonstrations in several districts, a one-day detailed implementation planning workshop was organized at iDE Nepal on August 26, 2012. The team planned activities for year one and allocated budgets for each activity. In addition to central level staff of iDE, CEAPRED and NARC, staff from Bhairahawa area, Kavre and Rukum also attended this meeting. Participants listed below shared ongoing activities on the HortCRSP project. The following 18 members participated in the meeting, including 5 women. In the meeting, PD, Hort CRSP Project Coordinator, UC Davis also participated and explained the Performance Indicator Table.

B. K. Gyawali, IPMCRSP Team Leader(bkgyawali@idenepal.org); Bimala Rai Colavito, Volunteer (brcolavito@idenepal.org); Binod Sharma, Government Program Development Specialist, (bsharma@idenepal.org); Dev Bahadur Gurung, Scientist, SSTD/NARC (devug@hotmail.com); Indra Raj Pandey, HortCRSP Focal Person/ Team Leader-VSP, CEAPRED (indra.pandey@ceapred.org.np);

Jwala Bajracharya, Sr. Seed Technologist, SSTD/NARC (seedtech@wlink.com.np); Komal Pradhan, National Program Director, HortCRSP/iDE, (kpradhan@idenepal.org); Laxmi Khadka, Seed Analyst, CEAPRED (laxmi.khadka@ceapred.org.np); Luke A Colavito, Country Director, iDE (lcolavito@idenepal.org); Peetambar Dahal, Project Coordinator, University of California, Davis, USA (pdahal@ucdavis.edu); Prativa K.C., District Coordinator, Kavre, CEAPRED (vsp.kavre@ceapred.org.np); Pratima PandeyScientist; SSTD/NARC (pratimaanu@gmail.com); Purna Bahadur Shakya, Sr. Seed Technologist, CEAPRED (purna.shakya@ceapred.org.np); Rakesh Kothari, M & E / GIS Officer, IDE (rkothari@idenepal.org)
Ram Bhakta Neupane, Cluster Coordinator, Rukum, CEAPRED; Rudra Thapa, Program Officer, iDE (rthapa@idenepal.org); Shailendra Shrestha, Marketing and Planning Coordinator, iDE (skshrestha@idenepal.org); Shiva Shankar Bhattarai, Agriculture Officer, CEAPRED (cvabhattarai@gmail.com). (A19, A20)

Luke Colavito (LC) stressed that the broad goal is to make quality vegetable seed available to consumers by commercializing the desiccant bead technology in Nepal. Planning should: (i) create product demand; and (ii) develop a private sector supply chain. He further noted that both USAID missions in Washington DC and in Nepal consider this project very important. LC further pointed out that there should be more demonstrations as the beads can be taken out and used for the next seed type. This will help to create demand and market for the beads. PD opined that a demand can be created effectively by holding more demonstration studies at more places in addition to growers included in the baseline survey.

Purna Bahadur Shakya (CEAPRED) presented some initial seed quality data from recent demonstrations set up in Kavre district.

Komal Pradhan (iDE) outlined sharing of 125 kg beads received from Rhino Research Group, Thailand as follows: Kavre and Rukum, 20 kg each; Palpa, 20 kg including 5 kg to Palpa Hort farm; Bhairahawa, Rupandehi district, 15 kg; NARC, 20 kg; seed companies, 25 kg (SEAN 10 kg, CG Seeds 10 kg and Gorkha Seed 5 kg); Methinkot Coop in Kavre for chillies, 5 kg.

Trainings and Demonstrations:
NARC
Experiments on onion seeds and breeder seeds of wheat and maize were designed using the seed:bead ratio predicted based on the relative humidity (RH) and temperature (T) of the seed store. Based on previous experience at SSTD, Khumaltar, the beads generally have 20% capacity (i.e., will absorb about 20% of their initial dry weight). Target safe MC for onion seed storage is 6% and for wheat and maize seed is 8%. The initial quality attributes in terms of MC, germination and vigour were tested before laying out the following experiments.

1. Onion seed, Seed Grower's Groups, ARS, Dailekh on September 17, 2012.
Treatments: 4; Replications: 3 (Farmer groups), one group as one replicate

a. Control, without beads in porous bag
b. 200 g seed + 72 g bead (continuous)
c. 200 g seed + 72 g bead, beads taken out at 6% MC
d. 200 g seed + 72 g bead + indicator silica gel

- Initial germination (91%), MC (10.8%); Initial T/RH: 28^{o}C/82%

JD Neupane, SSTD, NARC with farmers at ARS Farm, Dailekh

2. Onion seed, ARS Station, Dailekhon September 17, 2012

- Treatments: 4; Replications: 3

a. Control, without beads in porous bag
b. 200 g seed + 72 g bead (continuous)
c. 200 g seed + 72 g bead, beads taken out at 6% MC
d. 200 g seed in traditional plastic bag

- Initial germination (91%), MC (10.8%); Initial T/RH: 28^{o}C/82%

A training and demonstration program was carried at ARS, Dailekh by JD Neupane, SSTD, NARC on September 17, 2012. Onion seed growers listed below from 5 VDCs (Danda Parajul, Gauri, Mallika, Pusakot and Barah) participated in the program and the program was coordinated by the local seed cooperative named *Hatemalo tarkari Biu Prabadhan Sahakari sanstha,* Barah 5, Siyakot, Dailekh. Three seed producing groups namely *Nawajyoti Makai Biu Utpadan samuha, Nawa jagaran makai Biu Utpadan samuha* and *Jan Sahayogi Makai Biu Utpadan Samuha* were identified for desiccant seed drying and storage demonstrations.

Attendance list:

- Krishna Bahadur Shahi – Mallika VDC ward 6
- Bhakta Bahadur Shahi – Mallika VDC, ward 6
- Tikaram Bahadur Shahi – Mallika VDC, ward 5
- Krishna Budha – Mallika VDC, ward 7
- Krishna Shahi – Mallika VDC, ward 6
- Kaushila Shahi – Mallika VDC, ward 7
- Bisna Shahi – Mallika VDC, ward 6
- Sita Shahi – Danda Parajul VDC, ward 6
- Dhana Shahi – Mallika VDC, ward 6
- Bam Bahadur Shahi – Gauri VDC, ward 6
- Samsher Shahi – Mallika VDC, ward 5
- Jagat Bahadur – Pusakot VDC, ward 3
- Min kumari Shahi – Barah VDC, ward 6
- Rup bahadur Budha, Mallika VDC, ward 6
- Min Bahadur Shahi – Mallika VDC, ward 6
- Ram Bahadur Budha – Mallika VDC, Ward 6

3. Onion seed, SSTD, Khumaltar on Aug 10, 2012.

- Treatments: 4; Replications: 3

a. Control, without beads in porous bag
b. 200 g seed + 72 g bead (continuous)
c. 200 g seed + 72 g bead, beads taken out at 6% MC
d. 200 g seed in traditional plastic bag

- Initial germination (91%), MC (10.8%); initial T/RH: 27^{o}C/66%

4. Wheat Breeder Seed (BS), Agricultural Botany Division, Khumaltar on Aug 10, 2012.

- Treatments: 5; Replications: 4;

a. Control, without beads in porous bag
b. 2.5 kg seed + 488 g bead, present throughout storage
c. 2.5 kg seed + 488 g bead, beads taken out at 8% MC
d. 2.5 kg seed + 10% beads, throughout storage
e. 2.5 kg seed+ 20% beads, throughout storage

- Initial germination (91%), MC (12.3%); initial T/RH: 22^{o}C/86%

5. Maize BS seed, Agricultural Botany Division, Khumaltar on Aug September 24, 2012.

- Treatments: 4; Replications: 3;

a. Control, without beads in porous bag
b. 5 kg seed + 1.1 kg beads
c. 5 kg seed + 1.1 kg beads, beads taken out at 8% MC
d. 5 kg seed + 1.1 kg beads +indicator silica gel

- Initial germination (98%), MC (12%); initial T/RH: 25^{o}C/60%

6. Wheat BS seed, NWRP, Bhairahawa on September 30, 2012.

- Treatments: 4; Replications: 3
- Control, without bead in porous bag
- 5 kg seed + 976 g bead
- 5 kg seed + 976 g bead, beads taken out at 8% MC
- 5 kg seed + 976 g bead+ indicator silica gel
- Initial germination (ongoing), MC 12%; initial T/RH: 35^{o}C/67%

Jwala Bajracharya (center) with Janmeyjai Tripathi, wheat coordinator (left) and Dayanidhi Pokhrel, seed production officer at NWRP (right), Bhairahawa, Rupandehi.

7. National Agricultural Genetic Resource Centre (NAGRC), Khumaltar on September 26, 2012 on different crops. Studies have been initiated in cauliflower, rice, and nacked barley. Research-demonstrations were preceded by orientation of respective farms staff to Drying Beads technology. These research/demonstration programs have been possible following several rounds of consultation with national program directors. A meeting of NARC management gave a final approval to the project on August 24, 2012. However, the activities were already initiated quite earlier.

8. Training on drying and storage of plant germplasm resources using Zeolite in community seed banks. Training for farmers on Community Seed Bank Management was organized during June 28-29, 2012. The program was sponsored by NAGRC, NARC at its premises under the Genetic Resources Policy Initiatives (GRPI), NARC, Nepal/Bioversity International, Italy. Altogether 24 farmers from 15 districts ranging from Jumla to Shankhuwasabha and Kanchanpur to Jhapa participated in the Community Seed Bank Management Training. Participant farmers are involved in PGR conservation activities at local level. The major objectives were to expose CSB members in PGR exploration with needed passport data, regeneration and characterization, seed processing, seed drying and storage activities. They were also exposed to some other aspects such as access to PGR from Mid- and Long term Storage, policy issues, PGR interdependency at global and individual country level and the importance of PGRFA conservation at farmers, community, national and international level and also exposed to importance of safety duplication at different level.

An introduction was presented of applications of zeolite technology for drying and storage of seeds of valuable germplasm in community seed banks. The group was given simple know-how about zeolite desiccant and its applications in drying seeds. All participants except one farmer from Nawalparasi had no knowledge about zeolite. They thought beads to be useful to handle the seeds in adverse conditions. However, they were very concerned regarding availability and high initial cost. These are the only limitations we normally encountered in every kind of training on Drying Beads. These farmers were excited to have preliminary research on use of Drying Beads in their respective seed

banks. One farmer from Solukhumbu district, where Mt. Everest is located, was especially interested and requested samples of the product.

Outcome of the training: Community Seed Bank survey: *Dallchowki Samudayik Biu Bank* (CSB) in Lalitpur district was surveyed. The survey team included Chief of NAGRC MR Bhatta, BK Joshi and JB from SSTD. It is expected that the practice of seed regeneration to replace stored samples will be reduced and it will save time, effort of local farmers.

Pilot research on zeolite seed drying and storage on few minor but endangered crop species will be designed in few selected community seed banks at Dallchowki VDC, Lalitpur and Dandapakhar VDC, Sidhupalchowk. Drying and storage experiment on local maize, soybean and beans have been set up in CSB at Dallchowki VDC, Lalitpur.

Dr Bharat Paudyal, Directorate of Horticulture Seed production, Khumaltar and Horticulture Seed production Farm, Dadeldhura with Department of Agriculture have consulted with NARC to set up demonstrations, a positive extension of technology.

During initial interaction with on July 31, 2012, PD met Luke Colavito (LC) and Komal Pradhan (KP) at iDE. At CEAPRED, Indra Raj Pandey (IP, Co-PI); Bharat Upadhyaya, Executive Director, Purna B. Shakya (PBS); Krishna Kumar Shrestha and Laxmi Khadka (LK) also held discussions regarding achieving the objectives of the Seed Systems project. PD demonstrated to LK how to use step-wise drying using the Bead Calculator. CEAPRED had observed that cucumber seed was not hurt when dried to 2-3% MC but beans were hurt at 4% MC. Instructions in the Bead Calculator suggested to dry big seeds like beans, corn only to about 8% MC. Hence, LK and others appreciated the Bead Calculator where one can dry seed to desired MC level. Discussions were held with CEAPRED team to get data similar to that generated using onion seed by ANGRAU, Hyderabad, India. A visit to CEAPRED seed laboratory revealed a local source of both oven (220 °C) and T-RH meter and other supplies. (A21). IDE, CEAPRED and NARC team members discussed further and organized following training and demonstration programs with PD during August, 2012.

9. Vegetable Seed project (VSP) District Office, Dhulikhel, Kavre on August 8, 2012. CEAPRED has been leading vegetable seed production in many distrcts in Nepal, including Kavre (http://www.ekantipur.com/the-kathmandu-post/2012/06/10/money/production-of-veggie-seeds-swells/235907.html), http://www.ekantipur.com/the-kathmandu-post/2011/01/02/money/profits-lure-farmers-away-from-cereals-to-veggies/216789/). Indra Raj Pandey (CEAPRED) suggested to offer demonstrations using Drying Beads in Kavre. A total of 21 participants took part in this demonstration and training, including 4 females. Among the participants, one participant was from Jorsalla Cooperative, two from Subhprabhat Cooperative, one from Kanchanjanga Seed Company and one from Kishan Agro-vet (see attendance list below). PD presented the technology to district level staff of CEAPRED in Kavre together with IR, LK and PBS. IR Pandey explained the importance desiccant seed drying and use of proper controls (A22). LK demonstrated using the bead calculator to estimate bead quantity needed for 500 g each of onion, cucumber, okra and beans (A23).

Although there are suggestions to dry seeds to low MC in literature, it had not been convenient to determine the seed MC. The participants could see value of the T-RH meter to determine seed MC after 24 h equilibration with a seed sample inside a moisture-proof container. For now, the seed growers can call local CEAPRED/NARC/iDE offices to access the Bead Calculator to find out required bead quantity.

A noteworthy discussion here involved a seed dealer, Mr. Subash Dhital, who was curious to find out MC of cucumber seeds which he purchased from seed growers (A24). The farmers had asked Mr. Dhital to pay Rs. 1400/kg, Rs 200 above the contract price. In return, Mr. Dhital demanded seeds at 12% MC. However, there were no convenient means to check seed MC at the village level. Mr. Dhital knew about the seed drying project through CEAPRED and was curious about the demonstration. LK estimated cucumber seed MC at 10.3 % using the Bead Calculator and T-RH meter. Mr. Dhital was happy about what he purchased but got concerned when he heard that seeds begin to deteriorate at weather conditions prevalent in Kavre district. Mr. Dhital argued that he could buy low MC seed directly from the farmers, bypassing the co-operatives. On the other hand, representatives of co-operatives thought that they could store the seeds longer and could get higher price and avoid middle man like Mr. Dhital. At the end, both seed dealer and co-operative representatives realized that quality seeds could be made available by proper drying.

One participant shared that he put cucumber seeds in plastic bags for a year and tested germination with seeds kept in porous bag. The seeds inside plastic bags did not germinate. Since we were proposing to use plastic container to store seeds, he asked the different effects of two types of plastic. It was clarified that Drying beads are used with seeds inside moisture proof containers and the desiccants hold water very tightly and do not release moisture until heated at > 200 ^{o}C. The desiccants can be taken out after 3 days when the seeds reach safe storage MC at ambient conditions, and seeds should then be safe to store in plastic containers. Storing high MC seeds in hermetic containers is not advised, as it creates an opportunity for high RH, which encourages mold growth and rapid seed deterioration.

Based on room T = 26.9^{o}C, RH = 75% displayed by T-RH meter and Bead Capacity = 20%, bead quantities required for drying were estimated using the Bead Calculator. Three replications of onion cv. Red Creole, cucumber cv. Bhaktapur Local, okra cv. Arka Anamika and bean cv. Chaumase were

either incubated with beads in moisture-proof plastic containers or stored in cloth bags (without beads, control). LK, PBS, Rita, Ruma set up the demonstrations. Prativa KC, in charge of VSP district office in Kavre, was asked to send seed samples at the beginning and at 4-month intervals. Controls need to be protected from the rats by hanging the porous cloth bag from the roof ceiling. Seed samples were tested for initial seed quality at Seed Testing Laboratory, CEAPRED (see below).

Initial seed parameters and Drying Beads for safe storage

Seed	Initial MC %	Target MC %	Target RH %	Drying Bead (g)/ 500 g seed
Onion	12.4	5.4	20	206
Cucumber	10.6	5.7	30	145
Okra	12.2	7.8	40	130
Bean	14.8	8.1	30	200

T = 26.9°C, RH = 75%

IR briefed the local news representative about the new technology being introduced in Kavre (A25). Chairman of co-operative at Jorsalla, Methinikot Rudra Bahadur Bishunkhe said, “We learned to produce seeds, now we have to compete for the seed quality”. (A26-0-, A26-1, A27-28).

Attendance list			
S.N	Name	Organisation	Address
1	Rudra Bahadur Bishunkhe	Jorshalla seed cooperative	Methinkot
2	Baburam Koirala	Subhaprabhat seed cooperative	Kanpur
3	Shiva Pandey	Subhaprabhat seed cooperative	Kanpur
4	Komal Pradhan	IDE	Kathmandu
5	Bishnu Gyawali	IDE	Kathmandu
6	Gambar singh Thapa	IDE	Kathmandu
7	Indra Raj Pandey	CEAPRED	Kathmandu
8	Purna Bahadur shakya	CEAPRED	Kathmandu
9	Laxmi Khadka	CEAPRED	Kathmandu
10	Dr. Peetambar Dahal	UCDAVIS	USA
11	Janaki Dutta Neupane	NARC	Kathmandu
12	Subash Dhital	Kanchanjunga Seed Company	Banepa
13	Keshab Panday	CEAPRED	Kavre
14	Madhusudan Guragain	Nagarik Daily	Kathmandu
15	Manoj Silwal	CEAPRED	Sipali
16	Prativa K.C.	CEAPRED	Kavre
17	Kali Prasad Pandey	CEAPRED	Sarsyukharka
18	Rita Thapaliya	CEAPRED	Kavre

19	Ruma Pandey	CEAPRED	Daapcha
20	Ram Deu Shah	CEAPRED	Methinkot
21	Madhab Pokhrel	Kishan Agro	Dhulikhel

10. Jorsalla Seed Cooperative in Methinkot, Kavre on August 9, 2012.

While the seed growers were assembling gradually even on a national holiday to celebrate the birthday of Lord Krishna, iDE/CEAPRED/NARC/UC Davis team members visited two farmers who were producing hybrid tomato seeds inside plastic houses. CEAPRED representative Ram Deu Sah is supervising tomato hybrid seed production in this area. (A29-30) A light rain had created high humidity which would pose problem to dry high value hybrid seed. A large crowd of about 65 people gathered at the primary school building in Methinkot by 11 AM. (A31) There were 16 women despite most women devotees staying home to prepare for festive holiday celebration. Mostly, IR, LK, PBS, Prativa KC presented the technology (A32). LK raised one important point regarding the need to follow other normal seed production and management practices. Seed growers should not think that Drying Beads can preserve seed quality and harvest seeds from immature fruits. LK even wrote down Cromarty equation and asked people to use hand calculator to plug in T, RH for determining equilibrium seed MC. During the discussion, the seed growers realized that they needed T-RH meter to know MC of their seed. PD made personal arrangement for delivery of 15 T-RH units to CEAPRED and JB kindly carried these units to Nepal. Weather parameters displayed by T-RH units were T = 25.4^{o}C and RH = 75%. Bead Calculator was used to estimate beads required to dry the seeds. The demonstration was set up by PBS, LK, Prativa, Rita, Ram Deu Sah with help from the audience. Ram Deu Saha was asked by IR to take care of the set up including taking out samples. Initial seed quality was tested at CEAPRED headquarters. (A33)

Initial seed parameters and Drying Beads for safe target storage

Seed	Initial MC %	Target MC %	Target RH %	Drying Bead (g)/ 500 g seed
Cucumber	10.4	5.7	30	117
Okra	15.0	6.6	30	170
Bean	12.2	8.2	30	142

T= 25.4^{o}C and RH=75%.

Jorshalla Seed Cooperative, Methinkot, Kavre			
Attendance list on Aug 9, 2012			
S.N	Name	Organization	Address
1	Dev Raj Khakurel	Subhaprabhat Seed Cooperative	Kanpur
2	Sambhu Bahadur koirala	Subhaprabhat Seed Cooperative	Kanpur
3	Baburam Koirala	Subhaprabhat Seed Cooperative	Kanpur
4	Budhhiman Tamang	Subhaprabhat Seed Cooperative	Kanpur
5	Narayan Neupane	VDC Secretary	Methinkot
6	Pasang Dorje Tamang	Subhaprabhat Seed Cooperative	Kanpur
7	Chandra Prasad Pandey	Subhaprabhat Seed Cooperative	Kanpur

8	Krishna Prasad Bhurtel	Subhaprabhat Seed Cooperative	Kanpur
9	Ram Prasad Pandey	Subhaprabhat Seed Cooperative	Kanpur
10	Pramod Raj Koirala	Subhaprabhat Seed Cooperative	Kanpur
11	Gopali Sorali	Subhaprabhat Seed Cooperative	Kanpur
12	Ram Chandra Shrestha	Deurali Seed production group	Kanpur
13	Ram Kumar Shrestha	Deurali Seed production group	Kanpur
14	Ram Chandra Shrestha	Deurali Seed production group	Kanpur
15	Surya Lal Shrestha	Deurali Seed production group	Kanpur
16	Kamal Bahadur Lama	Deurali Seed production group	Kanpur
17	Ashuni Maya Tamang	Subhaprabhat Seed Cooperative	Kanpur
18	Ambika Koirala	Subhaprabhat Seed Cooperative	Kanpur
19	Tej Bahadur Silwal	Tikeshwor seed production group	Kanpur
20	Kaji Bahadur Shrestha	Tikeshwor seed production group	Kanpur
21	Janak Prasad Dhital	Tikeshwor seed production group	Kanpur
22	Ram Bahadur Silwal	Tikeshwor seed production group	Kanpur
23	Laxmi Neupane	Seed Production group	Methinkot
24	Ram Bahadur Bhujel	Seed Production group	Methinkot
25	ChetPrasad Silwal	Seed Production group	Methinkot
26	Kamala Chimoriya	Seed Production group	Methinkot
27	Ishwari Bhandari	Seed Production group	Methinkot
28	Raju Chimoriya	Seed Production group	Methinkot
29	Ram Sharan Adhikari	Seed Production group	Kanpur
30	Bishnu Bahadur Shrestha	Jorshalla seed cooperative	Methinkot
31	Bimala Mijar	Jorshalla seed cooperative	Methinkot
32	Shalina Shrestha	Jorshalla seed cooperative	Methinkot
33	Chari Mijar	Jorshalla seed cooperative	Methinkot
34	Ratan Bahadur B.K	Jorshalla seed cooperative	Methinkot
35	Punya Prasad Pakwaal	Jorshalla seed cooperative	Methinkot
36	Thula Kancha Mijar	Jorshalla seed cooperative	Methinkot
37	Ramesh Mainali	Jorshalla seed cooperative	Methinkot
38	Sharada Regmi	Jorshalla seed cooperative	Methinkot
39	Teknath Regmi	Jorshalla seed cooperative	Methinkot
40	Keshar Lal Shrestha	Jorshalla seed cooperative	Methinkot
41	Govinda Chimoriya	Jorshalla seed cooperative	Methinkot
42	Rudra Bhdr. Bishunkhe	Jorshalla seed cooperative	Methinkot
43	Sher Bahadur Mijar	Jorshalla seed cooperative	Methinkot
44	Kumari Mijar	Jorshalla seed cooperative	Methinkot
45	Maiya Mijar	Jorshalla seed cooperative	Methinkot
46	Goma Mijar	Jorshalla seed cooperative	Methinkot
47	Kedar Regmi	Jorshalla seed cooperative	Methinkot
48	Masini Bhdr. Mijar	Jorshalla seed cooperative	Methinkot
49	Krishna Bhdr. Mijar	Jorshalla seed cooperative	Methinkot
50	Lok Bhdr. Shrestha	Jorshalla seed cooperative	Methinkot

51	Komal Pradhan	IDE	Kathmandu
52	Bishnu Gyawali	IDE	Kathmandu
53	Gambar singh Thapa	IDE	Kathmandu
54	Indra Raj Pandey	CEAPRED	Kathmandu
55	Purna Bahadur shakya	CEAPRED	Kathmandu
56	Laxmi Khadka	CEAPRED	Kathmandu
57	Peetambar Dahal	UCDAVIS	USA
58	Janaki Dutta Neupane	NARC	Kathmandu
59	Keshab Panday	CEAPRED	Kavre
60	Prativa K.C.	CEAPRED	Kavre
61	Rita Thapaliya	CEAPRED	Kavre
62	Ram Deu Shah	CEAPRED	Methinkot
63	Pancha lal Tamang	Subhaprabhat Seed Cooperative	Kanpur
64	Mohan Shrestha	Jorshalla seed cooperative	Methinkot
65	Ram Sharan Shrestha	Deurali Seed production group	Kanpur

11. Phulbari Seed Cooperative at Amaltari, Kavre on August 10, 2012.
Going through rough trails, the team reached Amaltari after about 2 hours from Dhulikhel. (A34) iDE and NARC members had returned to Kathmandu. A total of 38 participants took part in this demonstration at Amaltari, including 7 females. There was one retired NARC fellow at the interaction. (A35) The activities and vegetable crops were the same as for Jorsalla Seed Cooperative, Methinkot. IR, LK, PBS, Prativa KC, Rita Thapaliya and Keshab Pandey made the presentation. PD also shared additional advantages of Drying Beads in preventing mold and insects. When picture of experiments with mung bean stored with and without beads at Hyderabad, India was shown in a computer screen, only one female could identify bruchid infestation in the control treatment. (A36) LK, PKC and Rita Thapaliya assembled the following demonstration in cucumber, okra and bean similar to one set a day earlier at Methinkot, Jorsalla. (A37) Co-operative members were asked to save the experiments even during political unrests that often lead to street protests and destruction of properties. Controls also need to be saved from the rats by hanging in the ceiling. Seed samples were tested for initial seed quality at Seed Testing Laboratory, CEAPRED (see below). (A 38)

Initial seed parameters and Drying beads for safe target storage

Seed	Initial MC %	Target MC %	Target RH %	Drying Bead (g)/500 g seed
Cucumber	11.6	5.0	30	170
Okra	13.4	6.4	30	175
Bean	16.2	7.9	30	210

T= 31^{o}C and RH=84%.

Initial seed quality data for seeds used in these demonstrations in Kavre was tested at CEAPRED seed laboratory in Kathmandu. The results below show that most vegetable seeds had relatively satisfactory

quality despite being exposed to the humidity of rainy season. It should be noted that the seeds are at the site of production, i.e., in the beginning of seed value chain.

Initial seed quality for cucumber, okra, bean, onion at different locations in Kavre

Seed	Germination (%)		
	VSP Dhulikhel	Cooperative, Methinkot	Cooperative, Amaltari
Cucumber	97	97	96
Okra	83	83	80
Bean	90	88	89
Onion	85		

Training and Demonstration on Drying Beads on Aug 9, 2012 at Phulbari Co-operative, Amaltari, Kavre on Aug 10, 2012			
S.N	Name	Organisation	Address
1	Muktinath Thapaliya	Phulbari seed cooperative	Amaltari
2	Netra Raj Thapaliya	Phulbari seed cooperative	Amaltari
3	Ratna Bhandari	Phulbari seed cooperative	Amaltari
4	Hom Narayan Shrestha	Phulbari seed cooperative	Amaltari
5	Netra Bahadur Bhandari	Phulbari seed cooperative	Amaltari
6	Ram Prasad Pandey	Phulbari seed cooperative	Amaltari
7	Raj Kumar Bhandari	Phulbari seed cooperative	Amaltari
8	Sanchabir Tamang	Phulbari seed cooperative	Amaltari
9	Nar Bahadur thapa Magar	Phulbari seed cooperative	Amaltari
10	Shyam Thapaliya	Phulbari seed cooperative	Amaltari
11	Keshab Prasad Pandey	Phulbari seed cooperative	Amaltari
12	Tank Prasad Tripathi	Phulbari seed cooperative	Amaltari
13	Pingal Das Shrestha	Phulbari seed cooperative	Amaltari
14	Gyan Bahadur Bhandari	Phulbari seed cooperative	Amaltari
15	Navaraj Bhandari	Phulbari seed cooperative	Amaltari
16	Sunita Bhandari	Phulbari seed cooperative	Amaltari
17	Saraswati Tripathi	Phulbari seed cooperative	Amaltari
18	Kamal prasad Baskota	Phulbari seed cooperative	Amaltari
19	Bhakta Bahdur Pandey	Phulbari seed cooperative	Amaltari
20	Ram Krishana Thapaliya	Phulbari seed cooperative	Amaltari
21	Krishna Bahadur Bhandari	Phulbari seed cooperative	Amaltari
22	Sworna Bahadur Panta	Phulbari seed cooperative	Amaltari
23	Manoj tripathi	Phulbari seed cooperative	Amaltari

24	Sundar Bhandari	Phulbari seed cooperative	Amaltari
25	Govinda Bahadur Pandey	Phulbari seed cooperative	Amaltari
26	Radhika Panta	Phulbari seed cooperative	Amaltari
27	Yasodha Bhandari	Phulbari seed cooperative	Amaltari
28	Ram Krishna Thapaliya	Phulbari seed cooperative	Amaltari
29	Dan Raj Pathak	Phulbari seed cooperative	Amaltari
30	Ambar Dhwoj Tamang	Phulbari seed cooperative	Amaltari
31	Indra Raj Pandey	CEAPRED	Kathmandu
32	Purna Bahadur shakya	CEAPRED	Kathmandu
33	Laxmi Khadka	CEAPRED	Kathmandu
34	Dr. Peetambar Dahal	UCDAVIS	USA
35	Keshab Panday	CEAPRED	Kavre
36	Prativa K.C.	CEAPRED	Kavre
37	Rita Thapaliya	CEAPRED	Kavre
38	Kali Prasad Pandey	CEAPRED	Amaltari

12. Department of Agriculture officers, seed companies, seed professionalsat iDE, Kupondol. During initial interaction at iDE, LC advised PD to pay courtesy visits to Director General of Department of Agriculture, Dr. Suroj Pokhrel (SP), Program Director, Crop Development Directorate (CDD) (surojpokhrel@yahoo.com; cropdev@vianet.com.np) and Dila Ram Bhandari (DRB), Chief Seed Development Officer (Joint Secretary); Seed Quality Control Center (SQCC) (sqcc@vianet.com.np; dilarambhandari@yahoo.com; tel: 977-1-5521359; cell: 9849594130). PD visited these two officers 2-3 times with BS and BKG. SP works on big seed projects funded by USAID/EU along with Bhartendu Mishra, former ED, NARC in MOAC. All commercial wheat seed produced in the Terai region could not be sold. So, they transport hundreds of metric tons of unused wheat seed to the hills to store at relatively cooler T. They hope that the seed will still be at ~80% germination for the next season. SP immediately realized the potential of Drying Bead technology and agreed to come to the interaction with seed companies and government officials. He further pointed out that there are "Field Seed Schools" at the village level where the Drying Bead technology could be used to conserve seeds. PD also followed with DRB whose office building has a sign, "Seeds protect and Sustain Life –Victor, 1960". DRB pointed out that beads could be used to dry wheat in Jumla and other hilly regions when the crop matures during onset of rainy season. Apparently, there is sprouting of grain due to lack of post-harvest drying causing food loss. Food security is of continuous concern in Far Western Nepal. DRB agreed to come to the interaction/demonstration with representatives of seed companies on Aug 13, 2012. PD suggested to both SP and DRB that beads should get import tax-free status similar to other agriculture inputs like fertilizer. DRB, Chief of SQCC is a member of Seed Advisory Board.

In yet another interaction PD presented drying Bead technology to a joint meeting of CDD and SQCC at SQCC conference hall where 10 officials participated including SP and DRB. Others present were Madan Thapa, SQCC; (madanthapa78@gmail.com); Deepak Pandey, Seed Development Officer, SQCC, (dpandey5@yahoo.com); Chandra Bdr. Budha cell: 9741053890; Basu Dev Regmi, Senior Seed Technologist, SQCC, (regmibd@yahoo.com); Mahendra Khanal, Senior Seed Technologist,

SQCC, (khanal.mp@gmail.com); Ramesh Pd. Koirala, CDD, (ramesh523833@hotmail.com). PD shared that Project leader of CIMMYT/Nepal Dr. G. Oritz-Ferrara will use beads at National Maize Improvement Center, Chitwan in maize foundation seed and at Tuki Seed Company at Sindhupalchowk. Still, concerns on bead reactivation and availability of beads for upscale use in cereals were raised. PD followed up these contacts after learning that there are existing USAID funded seed projects in cereals. So, PD aimed to convince CDD to use beads at the village level in their existing Field Seed Schools.However, the chiefs of CDD and SQCC opined on August 26, 2012 that NARC should recommend the technology before they could use it. (A39)

Other major players who deal with seeds are private seed companies. One Demonstration-Interaction was organized for representatives from major seed companies and government officials at iDE in Kathmandu on Aug 13, 2012. The following invitees were based on suggestions from LC and Krishna Timsina, PhD student at AIT, Thailand, supported by HORTCRSP.
Durga Prasad Adhikari, Managing Director, SEAN Seed Service Centre Ltd. <ssscseed@gmail.com>; Krishna Kumar Gyawali, Chairman, Nepal seed Co. Pvt. Ltd. <kkgyawali@gmail.com>; Ganesh Baniya, Managing Director, Kathmandu Agro Concern <kathmanduseed@ntc.net.np>; Shyam Krishna Pant,Chief Agriculturist, Chaudhary Group (CG) CG seed <production@cgns.com>; Dr. Kedar Budathoki, Tech Director, Gorkha Seed Company <kedar_budathoki@yahoo.com>; Ms. Rasmila Maharajan, Executive officer, National Agriculture and Forestry (P) Ltd. <natseeds@gmail.com>; Dr. Madan Rai, Chairperson, Khotang Vikash manch, Lalitpur rafanchha@hotmail.com>; Purna Bahadur Shakya, Sr. Seed Technologist, HortCRSP/CEAPRED <purna.shakya@ceapred.org.np>; Dr. Luke A Colavito, Country Director, iDE <lcolavito@idenepal.org>; Komal Pradhan, National Program Director, HortCRSP/ iDE <kpradhan@idenepal.org>; Dr. Madan Pariyar, Program/Monitoring & Evaluation Director, iDE <mpariyar@idenepal.org>; Dr. Binod Sharma (BS), Government Program Develop. Specialist, iDE Nepal <bsharma@idenepal.org>; Dr. Bishnu K. Gyawali (BKG), Leader, IPMCRSP/Team, iDE <bkgyawali@idenepal.org>; Vijay Sthapit, NTFP Cordinator iDE <vsthapit@idenepal.org>; Gambar Singh Thapa, Program Officer, iDE <gthapa@idenepal.org>; Arjun Khanal, Agri. Officer, iDE <sandeshkhanel@yahoo.com>; Rakesh Kothari, M. & E. /GIS Officer, iDE <rkothari@idenepal.org>; Bimala Rai Colavito, Volunteer, iDE <brcolavito@idenepal.org>; Neha Thapa, Intern, iDE <chetana_neha@yahoo.com>.

This meeting was organized to apprise seed companies and government officials on the use of Drying Beads. If convinced, these organizations could use the beads in their programs and eventually increase awareness about seed quality and improve the seed value chain. At first, a vigorous discussion followed after presentation by PD who included information on recent demonstrations in Kavre. Two biggest seed companies, Chaudhary Group and and Seed Enterpreneur Association of Nepal (SEAN), questioned the utility of these demonstrations at farmer or co-operative level. However, Dr. K. Budhathoki (KBu) of Gurkha seeds and developer of hybrid Srijana tomato countered that other seed companies are adopting Drying Beads and supported our approach to help maintain seed quality starting from harvest time. PD and Komal Pradhan (KP) appreciated deep interest of seed companies who play important roles in seed value chain. During the discussion, it was learnt that CG disposed about 1.5 to 2.0 MT onion seeds annually due to loss of viability. Economic analysis would be useful to convince seed companies to use the technology and they asked us to set up demonstrations in their backyard where their seed technicians could be trained as well. KP, iDE agreed to organize such

demonstration with 10 kg beads on onion seeds each with SEAN and CG and 5 kg on hybrid Srijana tomato seeds at Gurkha seeds. (A40-42)

13. Agrovets at Bhairahawa, Rupandehi on August 14, 2012.
iDE team members including KP and BKG travelled to Bhairahawa, Rupandehi, the birth place of Buddha. BKG is team leader for IPMCRSP which has been launched in Rupandehi to reduce pesticide usage in eggplant and bitter gourd. PD, BKG, D.C. Lopchan, S.S. Bhattarai, Khadga Gurung visited IPMCRSP fields of brinjal and bitter gourd in the morning. One female interpreter working for Agriculture Nutrition Extension Project (ANEP) was invited to attend the demonstration meeting with Agrovets at 10 AM at the District Agriculture Office (A43-46). Two other iDE groups were visiting this site. The regional leader in-charge Shailendra Shrestha joined during second half of the presentation on Drying Beads. Bhairahawa had has a very hot and humid climate but low rainfall. PD, KP and BKG presented the technology at District Agriculture Development Office (DADO). Guddu Mishra, iDE staff for Bhairhawa for Rupandehi moderated the program. One agrovet dealer had tested storing seeds in the refrigerator to maintain seed quality. Apparently, the seeds did not last longer and developed mold. Another agrovet shared that hybrid seeds from Japan and other European countries germinated well even after 4-8 years. However, non-hybrid seeds in packets from other suppliers did not perform well even if planted within declared expiry date. The dealer was curious whether he could puncture holes in the packets and maintain viability as he has seen moisture condensation while opening these seed packet. PD linked these observations to the need to maintaining low seed moisture. Drying Bead technology enables seed producers/dealer/consumers to maintain low seed MC and maintain seed quality for several years without the need of de-humidified cold stores. S.S. Bhattarai, Khadga Gurung, BKG, Shailendra Shrestha and Guddu Mishra set up demonstration using 300 g onion seed CV Nashik Red. iDE asked Lala P. Lodh of Siddhartha Agro Center to save and house the demonstration set-up. Shiv Shankar Bhattarai was asked to take samples in presence of the agrovets. Seed samples were tested for initial seed quality at Seed Testing Laboratory, CEAPRED (see below). (A47-49)

Seeds (g)	Beads (g)	Temp (^{0}C)	RH (%)	Germination	Abnormal Seedlings	Dead Seed
300	150	33.7	85.7	81%	5%	14%

After 5 days, curious iDE staff (Shailendra Shrestha, Guddu Mishra, SS Bhattari, Rudra Thapa, Khadga Gurung) removed the beads and T-RH meter from the boxes and noted the following seed and bead parameters. Bead MC increased by 21-24% and RH inside the containers remained below 20%, a clear demonstration of onion seed drying by beads as the latter increased in weight by absorbing water from the seeds.

Wt. of Beads	Temp (^{0}C)	R.H. (%)	Bead MC %
R1=186 g R2=183 gm R3=181 gm	31.32	Below 20%	R1=24 R2=22 R3=21

Venue: District Agriculture Development Office, Bhairahawa on Aug 14, 2012			
SN	Name of paricipants	Name of Organization	Address
1	Om Prakash Thakur	Om Agrovet	Dhakdhai-4, Rupandehi
2	Ram Bhd. Chai		Asuraina-8, Rupandehi
3	Keshav Tiwari	Nirbhav Krishak Shakari Collection Centre	Raypur-8, Rupandehi
4	Surendra P. Chaudhary	Siddharth Agrovet	Jamuniya-4, Nawalparasi
5	Madhusudan Paudel	Dynemic Agrovet	Ramgram-5, Nawalparasi
6	Dilip Chand Murraw	Morya Agrovet	Asuraina-4, Rupandehi
7	Jay Ram Morya	Pradip Agrovet	Raypur-8, Rupandehi
8	Achal Nath Tharu		Madhuri-6, Rupandehi
9	Ramsewak kewat		Asuraina-3, Rupandehi
10	Bramhanand Chaudhary		Asuraina-3, Rupandehi
11	Sukai Kurmi		Bogadi-4, Rupandehi
12	Ramji Yadav	Kalika seed company	Siddharthanagar-7
13	Ramsagar Chaurasiya	Krishna seed store	Siddharthanagar-5
14	Dharmaraj sahani		Raypur-5, Rupandehi
15	Rambriksha Morya		Raypur-5, Rupandehi
16	Ram kothari Kurmi		Bogadi-4, Rupandehi
17	Ashok Kumar Yadav	Yadav Agrovet	Majhouli, Rupandehi
18	Jyoti Prasad Poudel	Siddharth Agrovet	Siddharthangar
19	Ram Narayan Chaudhary	DADO Rupandehi	Bhairahawa
20	Gobind Krishna Tharu	Kapilvastu Ag. Centre	S.N.P.-9
21	Ram Milan Yadav	R.G.	S.N.P.-9
22	Birendra Yadav	Universal seed company	Bhairahawa-8
23	Lala Prasad Lodh	Siddhartha Agro Concern	Bhairahawa
24	Den C. Lopchan	IDE/Butwal	Butwal
25	Komal Pradhan	IDE	Kathmandu
26	Peetambar Dahal	UC, Davis, USA	USA
27	Bishnu K. Gyawali	TL/IPM CRSP	IDE NEPAL
28	Khadga Gurung	PC, IDE Butwal	Butwal
29	Shailendra Shrestha	IDE Butwal	Butwal
30	Shiva Shankar Bhattrai	AO/IPM CRSP	Bhairahawa
31	Prinkala Chaudhary	Bes Nepal	Bes Nepal
32	Sulochana Pariyar	ANEP, CEAPRED	CEAPRED
33	Tulsi Prasad Chaudhary	ANEP, CEAPRED	Rupandehi
34	Guddu Mishra	IDE/Nepal	Nawalparasi

14. Co-operative and Horticultural Farm at Tansen, Palpa on Aug 15, 2012.

Chandibhanjyang Co-operative: iDE team members consisting Rudra Thapa, Shailendra Shrestha, KP, BKG, DC Lopchan and PD had to walk uphill for 15 minutes to reach the co-operative at Chandibhanjyang in Tansen. Rudra Thapa, Shailendra Shrestha, KP, BKG added to the presentation by PD. Seed producers and members of Marketing and Planning Committee (MPC) attended this meeting where women had visible presence. One of the highlights of this meeting was that a young boy came with a memory stick and asked for the Bead Calculator spread sheet. Otherwise, the general suggestion for the users was to call local/regional resource centers for bead quantity needed to dry seeds. Drying the vegetable seeds at the co-operative could also be preferred in this seed producing area. Currently, the farmers are selling the produce through the co-operative. They pay charges for the use of balance and the facility. So, they should be willing to pay for re-activation of drying of the beads. (A50-53)

Training on Drying Beads , HORTCRSP/iDE Nepal		
Venue : Chandika Agri-Cooperative , Chandibhanjyang, Tansen on Aug 15, 2012		
Attendance list		
S. N.	Participants	Address
1	Ms. Lok Kumari Rana	Baugha Pokharathok -4
2	Ms. Gomati Lungeli	Baugha Pokharathok -3
3	Ms. Harikala KC	Baugha Pokharathok -1
4	Ms. Bishnu Karki	Bandi Pokhara - 6
5	Ms. Champa Ghimire	Baugha Pokharathok -2
6	Mr. Prem Nath Ghimire	Baugha Gumha -6
7	Mr. Khum Bahadur Saru	Baugha Gumha -4
8	Mr. Man Bahadur Rana	Baugha Pokharathok -1
9	Mr. Man Bahadur Aairuni	Baugha Pokharathok -2
10	Mr. Juddhabir Somere	Baugha Pokharathok -2
11	Mr. Chabilal Rana -2	Baugha Pokharathok -2
12	Mr. Dhan Bahadur Thapa	Bagdha Gumha -7
13	Mr. Khim Bahadur Rana	Baugha Gumha -7
14	Mr. Rukbir Reshami	Baugha Pokharathok -2
15	Mr. Devi Bahadur Rana	Baugha Pokharathok -2
16	Mr. Bishnu K. Gyawali	TL/IPM CRSP/IDE
17	Mr. Komal Pradhan	IDE-Nepal
18	Mr. Shailendra Srhestha	IDE-Nepal
19	Mr. Rudra Thapa	IDE-Nepal
20	Ms. Jitisara Rana	Baugha Pokharathok -2
21	Dr. Peetambar Dahal	UC-DAVIS
22	Ms. Rawati Rana	Baugha Pokharathok -2
23	Ms. Khema Rana	Baugha Pokharathok -2
24	Mr. Bhanubhakta Basyal	Karese -2 , Palpa

25	Mr. Bimal Raj Ghimire	Masyam -6, Palpa

Horticulture Farm, Department of Agriculture: The meeting venue had to be changed from Citrus Development Center, Horticulture Farm to Veterinary Center due to load shedding. The meeting was attended by several farm staff including Chief Horticulturist Ganapati Pandey and Asst. Horticulturist, Dist. Agriculture Development officer and his assistant agronomist, agrovets and farmers. Two important points were raised here. One agrovet said that a dealer might just sell the saturated beads without the farmer knowing it. PD argued that it would be unethical to sell saturated bead knowingly. The horticulture farm under Department of Agriculture produces onion and radish seed. Chief Horticulturist asked whether all seeds could be dried by beads or the Drying Bead technology is suitable only for orthodox seed. After realizing the utility of the beads, assistant horticulturist asked 5 kg beads to dry and store onion and radish. This interaction revealed that local iDE staff Rudra Thapa had cordial and direct links with local agriculture government offices. Both District Agriculture Office and Horticulture Farm in this hilly town were eager to host Drying Bead demonstration. Interestingly, assistant agronomist Tharka Bahadur GC at the District Agriculture office returned to Tansen from Kathmandu after learning that PD was in town with iDE staffs to demonstrate a new seed drying technology. PD knew his brother as both studied BS Agriculture under USAID scholarship in India. (A54-58).

Initial seed quality parameters of onion seed at Tansen, Palpa
Variety: Red Creole, local agrovet in Tansen, produced in Rukum
Germination = 68%; Dead Seed = 30%; Abnormal Seedling= 2%.

This initial seed quality check revealed that the seed used in this demonstration was of poor quality. The seed was produced in Rukum and purchased from local agrovet in Tansen, Palpa. This test is also an eye opener for everyone regarding the utility of initial quality check. It has been suggested that once the seed quality starts declining, it becomes difficult to stop further decline in seed quality. Local iDE staff has been advised to use better seed for another demonstration and continue this demonstration also.

Training on Drying Beads , HORTCRSP/iDE Nepal		
Venue : Veterinary Farm, Tansen on Aug 15, 2012		
Attendance list		
SN	Paricipants	Address
1	Rajesh Kumar Bhattrai	Bhattrai Agrovet, Palpa
2	Radha Nepal	Krishak Khasauli
3	Surendra Raimajhi	Tansen N.P.
4	Samjhana Malego	Srijana Agrovet
5	Madan Kumar Shrestha	DADO, Palpa
6	Khima Nanda Pokharel	Harthok, Palpa
7	Jeevan gyawali	DRSP, Palpa
8	Dhurba Raj Bhandari	Madanpokhara, Palpa
9	Komal Pradhan	IDE NEPAL

10	Tharkman Bahadur Karki	DADO, Palpa
11	Ganapati Pandey	Chief Horticulturist
12	Tara Chandra Chaudhary	Citrus Farm
13	Debilal Lamichhane	JBPK, Sahalkot, Palpa
14	Krishna Kaphle	Tansen N.P.
15	Baikuntha nath Khanal	DADO, Palpa
16	Mahendra Raj Kaudal	DADO, Palpa
17	Panda Bhd. GC	DADO, Palpa
18	Ram Prasad Bhandari	Bhandari, Agrovet
19	Bimal Raj Ghimire	Krishak Samaj Kendra
20	Bhanubhakta Basyal	Bashyal Agrovet, Kharda
21	Bishnu K. Gyawali	TL/IPM CRSP IDE NEPAL
22	Den C. Lopchan	IDE/Butwal
23	Peetambar Dahal	UC, Davis, USA
24	Rudra Thapa	IDE NEPAL, Palpa
25	Shailendra Shrestha	IDE/Butwal

Interaction with chairman of local news media: KP, PD, Shailendra Shrestha, Rudra Thapa interacted with chairman of local news media during breakfast on August 16, 2012. Chairman of news media raised one important question on disappearance of local cultivars like beans and cucumbers. He was of the opinion that foreign companies especially from America were flooding mid hills of Nepal with foreign cultivars. PD suggested that seed companies from different countries are active in Nepal but the USAID/HortCRSP project on beads would enable to preserve local cultivars at ambient conditions without need of cold stores. The chairman seemed satisfied and subsequently published news report on use of Drying Beads. (A59-60).

15. Agrovets, Butwal on Aug 16, 2012.

Butwal is a hub that has connections to 18 districts in west Nepal. Sixteen participants were present in this interaction including several agrovets, Dr. Mina Devkota, CIMMYT and local iDE staff. The agrovets asked that the meeting be brief as their business could suffer. However, they stayed for longer period due to interesting interaction. One agrovet strongly opined that the beads would be useful for big seed companies who sell seeds to retailers as agrovets just buy enough seeds based on local demand and do not stock. They were advised to sell high quality seed by maintaining low storage RH inside containers. Komal Pradhan shared that Chowdhury Group loses about 1.5-2.0 MT of onion seed in Kathmandu (A61). Another agrovet suggested that the technology could be used by seed producers to ensure good seed quality from the beginning. Dr. Mina Devkota from CIMMYT also participated in the discussion and was apprised that Project leader of CIMMYT/Nepal G. Oritz Ferrara is deeply interested to use Drying Beads in foundation seed of maize. At the end, agrovets realized the utility of the technology and asked to set up one demonstration at Butwal too. (A62-63) Subsequently, Shailendra Shrestha, in charge of both Rupendehi and Palpa area, has set up one demonstration with Tinau Agrovet in Butwal using onion seed on September 19, 2012.

Training on Drying Beads , HORTCRSP/iDE Nepal
Venue: IDE-Butwal

Attendance list		
S.N.	Paricipant	Address
1	Dhaneshwor Pokharel	Pashchimanchal Agrovet
2	Manoj prasad Basyal	Sristi Agrovet Butwal
3	Suraj Pakhrin	Save the Children
4	Peetambar Dahal	UC, Davis, USA
5	Dr. Mina Devkota	CIMMYT
6	Huma Kant Kafle	Tinau vet Center, Butwal
7	Tirtha Udaya	IDE Butwal
8	Chitra Gautam	Jay Kishan Agrovet
9	Lok Pd. Subedi	Annapurna Agrovet
10	B. K. Gyawali	IDE-Bakhundole
11	Prakash Shrestha	Prakash Agrovet, Butwal
12	Shiva Shankar Bhattarai	IPM CRSP, Butwal
13	Den C. Lopchan	IDE/Butwal
14	Khadga Gurung	IDE/Butwal
15	Komal Pradhan	iDE, Lalitpur
16	Shailendra Shrestha	IDE, Butwal
17	Man Dhoj Khatri	IDE, Butwal

Team members briefly attended a Training of Trainers meeting for ANEP project on the way to the airport on August 16, 2012 where iDE was also involved. Young female participants were discussing in small groups before making presentations. (A64-65)

16. Seed companies, SEAN Service on August 27, 2012.
After initial agreement between Durga Adhikari (SEAN), Dr. Kedar Budhathoki (Gorkha Seeds) and Laxmi Panta (Chaudhary Group) on August 13, 2012 and several follow up communications by KP, another follow up interaction was organized to disseminate the Drying Bead technology to more members of SEAN on August 27, 2012 at 1 PM at SEAN Service, Thankot. As seen from attendance list below, many participants from seed companies attended the interaction. JB made the technical presentation and shared that she was involved with HortCRSP project since 2010. LK from CEAPRED demonstrated use of the Drying bead calculator and showed the use of T-RH meter to monitor seed MC of onion seed using locally available containers. There were two representatives from Superbags as well. PD pointed out that the first suggested requirement before putting seeds inside Superbag is to dry the seeds. However, seeds cannot be dried to safe storage MC at ambient humidity in humid climates. Improperly dried seeds inside plastic bags provide suitable environment for mold growth. Besides, seed quality declines rapidly at high T and RH conditions inside bags which are not rodent-proof either. (A66-70)

Venue: SEAN Seed Service Centre Ltd.				
S.N.	Name	Designation	Organization	Email Address
1	Arjun Khanal	Agriculture Officer	IDE Nepal	sandeshkhanel@yahoo.com

2	Atish Tulsyan	Director	Jay Kisan Seed Centre	jaykisan@wlink.com.np
3	B. K. Gyawali	IPM CRSP Team Leader	IDE Nepal	bkgyawali@idenepal.org
4	Basanta Marahatta	Managing Director	Gorkha Seed	basantacmarahatta@yahoo.com
5	Bal Krishna Upadhya	Finance Manager	SEAN Seed Service Centre Ltd	ssscseed@gmail.com
6	Binod Sharma	Government Program Development Specialist	IDE Nepal	bsharma@idenepal.org
7	D. K. Neupane	Production Manager	SEAN Seed Service Centre Ltd	ssscseed@gmail.com
8	Damodar Poudyal	R&D Manager	SEAN Seed Service Centre Ltd	ssscseed@gmail.com
9	Dharma Raj Adhikari	Marketing Manager	SEAN Seed Service Centre Ltd	ssscseed@gmail.com
10	Durga Prasad Adhikari	Managing Director	SEAN Seed Service Centre Ltd	ssscseed@gmail.com
11	Durga Dahal	Proprietor	Dahal Trading Concern	agro.nepal@hotmail.com; agro_nepal@yahoo.com
12	Gajendra Maharjan	Director	NAF Enterprises	mikhabahal@gmail.com
13	Mr. Ganesh Baniya	Managing Director	Kathamandu Agro Concern	kathmanduseed@ntc.net.np
14	Gopal K Sangat	Director	Mero Agro	sangatgopal@yahoo.com
15	Jagannath Adhikari	Program Coordinator	SEAN Seed Service Centre Ltd	ssscseed@gmail.com
16	Kedar Budathoki	Tech Dir.	Gorkha Seed Company	kedar_budathoki@yahoo.com
17	Komal Pradhan	National Program Director	HortCRSP/ IDE Nepal	kpradhan@idenepal.org
18	Laxmi Khadka	Seed Analyst	CEAPRED	laxmi.khadka@ceapred.org.np
19	Mahendra Bisht	Tech Manager	Mero Agro	N/A
20	Mani Bahadur Bhattarai	Manager	NEMBLOL	N/A
21	Neha Thapa	IDE Intern	IDE Nepal	chetana_neha@yahoo.com
22	Peetambar Dahal	Project Coordinator	HortCRSP - Seed sector, UC Davis, USA	pdahal@ucdavis.edu
23	Rakesh Kothar	M & E / GIS Officer	IDE Nepal	rkothari@idenepal.org
24	Ram Prasad Poudyal	Field Tech	SEAN Seed Service Centre Ltd	ssscseed@gmail.com
25	Sushil Singh	Director	Sunaulo Krishi Multi Purpose Cooperative	nasseeds@gmail.com
26	Urmila Pradhan	Lab Technician	SEAN Seed Service Centre Ltd	ssscseed@gmail.com

27	Jwala Bajracharya	Chief, SSTD	NARC	seedtech@wlink.com.np

Seed companies had hoped that demonstration experiments would be set up during interaction on August 27, 2012. KP followed up subsequently and organized demonstration experiments at the premises of Gurkha Seeds, SEAN Service and Chaudhary Group as detailed below.

17. Gurkha Seed Company, Lalitpur on September 11, 2012.
There are five participants in the demonstration. First, bead bead capacity was calculated by keeping 100 g beads in cloth bag for 24 h; it was estimated as 24%. Initial hybrid tomato cv. Srijana seed MC was at 10% MC as calculated by keeping thermo-hygrometer inside moisture-proof container with seed for 24 h. Three replicates of 100 g seeds were placed inside moisture-proof containers with T-RH meter and 18.6 g of beads were added to each container and sealed quickly. Similarly, three control treatments were kept inside cloth bags without beads. Beads lowered RH to 24% in 2 days. Finally, T-RH meter and beads were removed from moisture-proof container. Initial seed quality test is in progress.

18. SEAN Seed Service, Thankot on September 13, 2012

Demonstration of Drying Bead efficacy to dry onion and pea seed at SEAN SEED SERVICE, Thankot, Kathmandu on September 13, 2012

There are seven participants in the demonstration. Bead capacity was calculated at 25% by noting increase in weight of 100 g beads in cloth bag. Initial onion seed MC was calculated as 9.31%. Three replicates of 500 g onion cv. Red Creole seed were placed inside moisture proof container with T-RH meter and 87 g of beads was added and sealed quickly. Three cloth bags each with 500 g seed without bead served as controls. RH was lowered to 18% by 3 days. Finally T-RH meter and beads were removed from container. Initial seed quality test is in progress.

Initial moisture of pea seed was 12.75% after 24 h equilibration. Three replications of 1 kg pea seed were dried by adding 231 g of beads inside containers and sealed quickly with T/RH meter. The controls in cloth bags did not get beads. The beads were removed after 2 days when RH was at 22%. Initial seed quality tests are in progress.

19. Chaudhary Group Seed Company at Satdobato, Lalitpur on September 25, 2012.

There are six participants in this demonstration. Bead capacity was calculated as 25% (DW) by keeping 100 g beads in cloth bag. Initial seed MC was calculated as 9.86%, FW. Three replicates of 200 g onion cv. Red Creole seeds were placed inside moisture-proof containers and 48 g of beads were added to each container and T/RH meter. Similarly, three control treatments were kept inside cloth bags without beads. RH decreased from 57% to 18% in 24 h, when the hygrometer and beads have been removed from the container. Initial seed quality test is in progress

Training and Demonstration at Chaudhary Group (CG), Satdobato, Lalitpur, (L-R, Sarbojeet Yadav, Arjun Khanal (iDE), Shyam Krishna Pant, Dr. Binod Kumar Sharma (iDE)

Chaudhary group is the largest seed company in Nepal. Shyam Krishna Panta had attended the demonstration-interaction at iDE on August 13, 2012. These follow-up demonstration experiments with seed companies are vivid examples that it takes time to persuade people to use a new technology. Clearly, big seed companies wanted to see the results by placing a demonstration in their backyard before making further investments. Now, seed companies can estimate seed MC from environmental parameters like T and RH displayed in simple and inexpensive T-RH meters. It is expected that seed companies will take up the technology at a larger scale and save their storage losses and supply quality seed to the dealers/retailers and consumers.

20. Ranagaun, Lele, Lalitpur on September 26, 2012.
(davisprojectsforpeace.org/media/view/1922/original/)

There were nine participants at the demonstration. Bead MC was similar to that observed at Chaudhary Group on August 25, 2012. Pea MC was at 13.82%, FW. Pea seed called Sikkim local was purchased from Kisan Agrovet in Chapagaun. Three replicates of 400 g of pea seed were placed inside moisture-proof containers and 121 g beads were added to each container with T-RH meter and closed quickly. Three cloth bags each with 400 g seed without beads served as control. RH was reduced to 28% in two days. Initial seed quality test is in progress.

21. Rukum District in September, 2012. (districtmaps/rukum_district.htm; un.org.np/sites/default/files/Rukum.pdf)

PB Shakya (CEAPRED) traveled to Rukum on September 21, 2012. Rukum is the oldest and major onion seed producing area in Nepal. There are rough and difficult roads to villages in Rukum (right).

The demonstration and training on Drying Bead technology to the government officials, cooperative members and seed growers of Vegetable Seed Project (VSP) in Musikot, Rukum, was jointly organized by

CEAPRED and iDE and delivered by PB Shakya (below) on September 25, 2012. While preparing for the event, PBS attended a marketing workshop as well.

Three Trainings and Demonstrations were carried out in three locations on onion cv. Red Creole procured from local seed growers. First demonstration was held at Sub-tropical Vegetable Seed Production Center, Musikot, Chapa on September 25, 2012. Use of the Bead Calculator was demonstrated to calculate bead quantity required to dry onion seed. Control and bead treatments were set up in three replications. Initial seed MC was calculated from ambient T and RH. Two sets of seed samples were taken for initial germination tests. One set was sent to Seed Testing Laboratory (STL), CEAPRED, and another set was kept in Musikot Farm, Rukum. Twenty participants took part in the training including six females. (A71).

Attendance list

S. No.	Name	Address	Designation
1.	Mr. Krishna Prasad Paudel	VSPC	Sr. Vegetable Development Officer
2.	Mr. Peetambar Basnet	Dist. Agri. Dev. Office	Plant Protection Officer
3.	Mr. Dil Bahadur Singh	VSPC	Horticulture Development Officer
4.	Ms. Nirma Khadka	VSPC, Rukum	Junior Technical Assistant
5.	Mr. Kamal Gyawali	Gyawali Agro-vet	Proprietor
6.	Mr. Man Bahadur Khatri	VSPC	Junior Technical Assistant
7.	Mr. Mahendra Pun	VSPC	Technical Assistant
8.	Mr. Ram Bhakta Neupane	VSP	Cluster Coordinator
9.	Mr. Laxman Singh Karki	CEAPRED	Junior Officer
10.	Mr. Kalak Bahadur Rokaya	VSP	Seed Technician
11.	Ms. Meena Bohara	VSP	Seed Techinician
12.	Ms. Bijaya Sharma	VSP	Seed Facilitator
13.	Ms. Laxmi Pariyar	VSP	Seed Technician
14.	Mr. Purna Bahadur Shakya	VSP, CEAPRED	Senior Seed Technologist
15.	Mr. Tika Nath Yogi	VSP	Marketing Cooperative Assistant
16.	Ms. Sita Chaudhary	VSP	Seed Technician
17.	Mr. Nav Raj Oli	Shahi Kumari Agro-vet	Proprietor
18.	Mr. Bishnu Oli	Milan Agro-vet	Proprietor
19.	Mr. Gopal Malla	Malla Agro-vet	Proprietor
20.	Ms. Sita Oli	VSPC	Office Asistant

On September 26, 2012, the experiment set up in Musikot Farm was replicated at Multi-crop and Fresh Vegetable Seed Production Cooperative in Machhimi. Seed samples from this location were sent to CEAPRED. A total of 31 participants took part in that training including 8 women. (A72-75).

Attendance list

S. No.	Name	Address	Designation
1.	Mr. Mohan Khadka	Khalanga-5, Machhimi	Farmer
2.	Mr. Nar Bahadur Khatri	Khalanga-5, Machhimi	President of the cooperative
3.	Mr. Khusal Khadka	Khalanga-5, Machhimi	Member of the cooperative
4.	Mr. Nand Ram Khatri	Khalanga-5, Machhimi	Secretary of the cooperative
5.	Mr. Parsu ram Oli	Khalanga-5, Machhimi	Member of the cooperative
6.	Mr. Tul Ram Khadka	Khalanga-5, Machhimi	Member of the cooperative
7.	Mr. Nabin Malla	Khalanga-5, Machhimi	Member of the cooperative
8.	Mr. Prithvi Bahadur Khatri	Khalanga-5, Machhimi	Member of the cooperative
9.	Mr. Amar Khadka	Khalanga-5, Machhimi	Member of the cooperative
10.	im bahadur Khadka	Chhiwang-2, Caulichaur	Farmer
11.	Mr. Kubir Khadka	Khalanga-5, Machhimi	Farmer
12.	Mr. Lok Bahadur Khadka	Khalanga-5, Machhimi	Member of the cooperative
13.	Mr. Dhan Bahadur Oli	Khalanga-5, Machhimi	Member of the cooperative
14.	Ms. Sabita K.C. (Khadka)	Khalanga-5, Machhimi	Farmer
15.	Ms. Lila Khadka	Khalanga-5, Machhimi	Farmer
16.	Ms. Champa Khatri	Khalanga-5, Machhimi	Farmer
17.	Ms. Dhan Maya Khadka	Khalanga-5, Machhimi	Member of the cooperative
18.	Ms. Khima Khadka	Khalanga-5, Machhimi	Member of the cooperative

On September 27, 2012, third set up was also replicated at Rukumeli Agriculture Cooperative, Saankh, Jhinja. There were 28 participants in the training of which included 7 women. (A76-77).

Attendance list

S. No.	Name	Address	Designation
1.	Mr. Bhadra Bahadur Bohara	Saankh-8, Jhinja	Member of the cooperative
2.	Mr. Bal Bahadur Pandey	Saankh-3, Gotaniwang	Member of the cooperative
3.	Mr. Kiran malla	Saankh-8, Jhinja	Treasurer of the cooperative
4.	Mr. Bijay Pandey	Saankh-3, Langsiwang	Member of the cooperative
5.	Mr. Hukum Bahadur Pandey	Saankh-3, Gotaniwang	Member of the cooperative
6.	Mr. Amar Bahadur Pandey	Saankh-3, Gotaniwang	Secretary of the cooperative
7.	Mr. Gambhar Singh Bohora	Saankh-8,Ghaidara	Member of the cooperative
8.	adan Mall	Saankh-8, Jhinja	Member of the cooperative
9.	Ms. Amarika Rawal	Saankh-8, Jhinja	Member of the cooperative
10.	m Bahadur Mahat	Saankh-8, Jhinja	Member of the cooperative
11.	Ms. Kavita Giri	Saankh-8, Jhinja	Member of the cooperative
12.	Ms. Kalpana Giri	Saankh-8, Jhinja	Member of the cooperative
13.	Ms. Khima Pun Magar	Saankh-8, Jhinja	Member of the cooperative
14.	Mr. Kamal Rawal	Saankh-8, Jhinja	Member of the cooperative
15.	Ms. Kamala Mahat	Saankh-8, Jhinja	Member of the cooperative
16.	Mr. Lokendra Oli	Dist. Agri. Dev. Office, Rukum	Junior Technical Assistant
17.	Ms. Sushila Pandey	Saankh-8, Jhinja	Member of the cooperative

18.	Mr. Hira Mani rawal	Saankh-8, Jhinja	Member of the cooperative
19.	Mr. Ganesh Bohora	Saankh-8, Jhinja	Member of the cooperative
20.	Ms. Bina Pun	Saankh-8, Jhinja	Member of the cooperative
21.	Mr. Bhuvan Pandey	Saankh-8, Jhinja	Member of the cooperative
22.	Mr. Amar Bahadur Pandey	Sanjh Besi Seed Prodn. Agri. Coop.	President of the cooperative
23.	Mr. Prabil Pandey	Sanjh Besi Seed Prodn. Agri. Coop.	Vice-president of the cooperative
24.	Mr. Purna Bahadur Shakya	VSP, CEAPRED	Senior Seed Technologist
25.	Mr. Ram Bhakta Neupane	VSP, Rukum	Cluster Coordinator
26.	Mr. Tika nath Yogi	VSP, Rukum	Marketing and cooperative Assistant
27.	Mr. Kalak Bahadur Rokaya	VSP, Rukum	Seed Technician
28.	Mr. Min Lal Ale	VSP, Rukum	Runner

Measuring and controlling these seed parameters at the site of seed production open new avenues to the seed growers to maintain seed quality. The seed growers become aware that their seed will have a higher value if they maintain low seed MC right after harvest. Furthermore, they can get simple T-RH meter and monitor seed quality by themselves. They can hold and decide the time to sell their seed for a fair price. But, they will have to invest in Drying Beads and moisture-proof storage containers to take advantage of this opportunity.

22. Training Governmental Staff

Governmental Staff of DADO were trained on September 12, 2012 in Palpa and September17, 2012 in Rupandehi. DADO staff provided valuable suggestions about the amount of beads required calculated from temperature, relative humidity and moisture percentage. If this information is in as booklet, it can be used anywhere (even if there is no computer facility) and by anybody (even by farmers who don't know to use computers). They wanted the Drying Bead technology in simple Nepali language.

23. Marketing Planning Committee (MPC)and community members

Training on Drying Beads for MPC and community members was held at 5 different villages namely Rayapur-5 on September 9, 2012, Asuraina-8 on September 10, 2012, Asuraina-3 on September 11, 2012, Basantapur-5 and Basantapur-6 on September 12, 2012 in Rupandehi district. Similar trainings were also organized at Pipaldanda on September 8, 2012; at Chidipani on September 11, 2012; at Baugapokharathok and Harthok on September 14, 2012 and at Baugagumba on September 16, 2012 in Palpa district. MPC and community members were very much excited about the new technology and were ready to apply it when it will be very cheap for them at either agrovet or Service provider where they have to pay for the price of bead or seed drying.

24. Project implementing partners' meeting at district level

An initial meeting with the district related stakeholders was held on September 12 and 16, 2012 in Palpa and Rupandehi, respectively. There were 13 participants at Tansen in Palpa and 14 participants at Bhairahawa in Rupandehi district. It was very effective and fruitful as Abdul Mahboob Khan of the seed company Rastriya Biu Bijan Company LTD., Rupandehi (formerly Agri Input Corporation), is interested to test Bead technology on radish and wheat.

25. Distribution/Sharing of beads.

IDE Nepal has received 125 kg of beads from RR Group on August 26, 2012. Beads were distributed to partners as follows.

CEAPRED	45 kg (20 kg each for Kavre and Rukum districts and 5 kg for Methinkot cooperative)
NARC	20 kg
IDE Palpa	20 kg (15 kg for bead training and demo and 5 kg for Horticulture farm, Tanseen)
IDE Rupandehi	15 kg
Seed Companies	25 kg (10 kg SEAN Seed Service Center Ltd., 5 kg Chaudhary Group Seeds, 5 kg Gorkha Seeds)

25. CIMMYT/Nepal on August 1, 2012.

PD visited Dr. G. (Memo) Oritz-Ferrara, Project leader of CIMMYT, Nepal on August 1, 2012. Memo has been interested in Drying Beads for a long time. He enabled JB to present a poster on Drying Beads at 11th Asian Maize Conference in Naning, China during November 2011. In addition, Memo has contributed to the poster presented at PICs conference held in Accra, Ghana during April 10-12, 2012. CIMMYT/Nepal is entering into 5th phase where CIMMYT wants to introduce 4 new technologies in corn, including Drying Beads. Other technologies include use of hybrid corn, use of cheaper, small farm equipment (mini tillers) to help women and Quality Protein Maize from commercial white corn to yellow corn. About 20 MT of this cultivar will be produced during the 5th phase. Currently there is 11 MT of corn foundation seed which will need about 2.75 MT at 1:0.25 seed:bead ratio. Since this was a big quantity of bead, Memo wanted to use bead in Foundation seed stocks in limited locations. Memo wanted to use in Foundation seeds at different NARC centers, at National Maize Improvement Center, Rampur and with Tuki Seed Co. in Sindhuplachowk district. Memo also wanted to use the beads with rice and wheat after corn. Memo was quite impressed to see stepwise drying in the Bead Calculator. PD re-visited Memo and his associates Nirmal Gadal and Dilli KC again on August 23, 2012 before they left for Bhutan. PD and JB shared stepwise MC reduction using Bead Calculator. PD and JB shared recent demonstration and trainings organized in Kavre, Rupandehi and Palpa districts with CIMMYT team.

Rhino Group donated 140 kg beads to CIMMYT, Nepal after seeing deep interest of Memo in Drying Beads. The beads were shipped on May 2012 and are about to move out of Calcutta port and reach Nepal by Nov 20, 2012. Memo had a deep interest to use beads during harvest of corn seed. He has paid about $1500 to release the shipment from Calcutta. (A78-79)

Semillas de Esperanza: Vegetable Seeds for Sustainable Agriculture

Target Countries: El Salvador, Guatemala, Honduras, and Nicaragua

Principal Investigator: James Nienhuis; University of Wisconsin-Madison

Collaborators:

Suzanne Dove, University of Wisconsin-Madison
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
Donald Breazeale, Fundacion Hondurena de Investigacion Agricola
Project Description (Project builds on completed Immediate Impact Project)

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. The factors limiting this horticultural transformation are access to:
vegetable cultivars with resistance to endemic diseases,
high quality seed of adapted cultivars,
business know-how and basic management and marketing skills, and
connections to regional supply chains that provide stable, predictable markets.
Cultivars developed by the World Vegetable Center (AVRDC) have demonstrated tolerance to diseases endemic to Central America. Quality seed can be produced in the tropics in screen houses. The UW 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, and
increased consumption of vegetables contributes to a healthier, more diverse diet.

1st Report

Each country, El Salvador, Nicaragua, Guatemala and Honduras is working with a Women's cooperative. In addition, each collaborating institution, e.g. the Univ. Nacional Agraria, Nicarauga, CARE – Guatemala, CARE – El Salvador and FHIA in Honduras has completed field trials of the 80 AVRDC tomato and pepper advanced breeding lines. We reviewed the results of the regional trails and we have identified the 10 tomato lines with the best quality characteristics and resistance to virus. We have deleived seeds of the 10 varieties to Nicaragua; the other cooperating countries are expected to get seeds from Nicaragua (Univ. Nac. Agraria). WE are now moving into seed production phase in each country. We held a hands-on workshop in Nicaragua in November to provide cooperators with hands-on experience in seed production and processing. Jim will visit each country this summer to review progress on greenhouses for seed production in cooperation with women's groups. At the workshop in Nicaragua, Janette Gutierrez (Nicaragua) and Victor Cabrera (Univ. of Wisconsin-Madison) presented a one-day intensive course in small business management. Carlos Ramierz of the Institutio Tecnologico de Costa Rica gave a ½ day presentation on construction and management of greenhouses for seed production. The conclusion of the group was to focus on the AVRDC tomato cultivars and to focus on greenhouse based seed production.

At the HortCRSP meeting Jim Nienhuis and Javier Diaz (FHIA) were able to connect (CRISPing) to Adel Kader (UC-Davis) and we are actively developing a complementary new component of post-harvest physiology and a new regional workshop on Post-harvest Physiology to be added to our existing project.

In addition Jim Nienhuis and Javier Diaz (FHIA) were able to connect (CRISPING) to Kent Bradford (UC-Davis) and Johan Von Asbrock (Rhino Research) to develop a 2-3 day hands-on workshop on vegetable seed processing and storage. We are in the process of more detailed dates and objectives of this workshop. This would be very very timely, as our in-country cooperators should have produced some seed within the next season (year) and will therefore need critical hands-on information on vegetable seed drying and storage.

At our seed production and business management workshop in Nicaragua, It was very nice to connect with a very sincere, young AID professional, Ira Frydman. He actively participated in our 3-day workshop. If this young man represents the quality of AID personnel, then I have faith in our future.

2nd report

This is a very complex project involving four countries; thus, regional and international meetings are critical to foster communication among the participants. An unexpected benefit of this multi-country project has been awareness of individuals in each country of the regional resources available to them. A good example is Carlos Ramirez of the Instituto Tecnológico de Costa Rica who is not supported by the HortCRSP but who has emerged as the regional expert on construction and management of greenhouses for vegetable and seed production. Also the increased awareness among our three principal partners, CARE, the Univ. Nacional Agrícola and the Fundación Hondureña de Investigación Agrícola of the resources and activities of each institution. This is an unexpected but critical outcome of this project – regional awareness and cooperation.

The regional meetings in Madison, Wisconsin are not only surprisingly cost-effective, but also provide a unique opportunity for focused high-level training of the cooperators and community leaders involved in our project (see pictures 7-27 in addendum). We can draw upon expertise within or near the university community for specific training. This was exemplified in our recent UW-Madison based workshop on Production, Marketing and Business Management, in which Elana Peach-Fine and Britta Hansen of HortCRSP central and John Bowman of USAID was able to complement our program with specific presentations on Information management and provide an overview of the 'Feed the Future' initiative in USAID (see pages 11-15 in addendum). I'm pleasantly surprised at how effective these UW-Madison based programs are. That is not to say that they are easy to organize, they are very complex and require an enormous effort by my whole research lab (10 people), and involve Jim being a driver of the bus not to mention issues with visas, etc; regardless, the results and impacts are worth the effort.

The objective of this project is to evaluate germplasm resources on a regional level and identify lines that had potential to be open-pollinated cultivars, the seed of which would be produced and marketed by women's groups. On a regional level we have evaluated several hundred tomato and pepper genotypes provided by the World Vegetable Center in Taiwan and have identified 10 tomato lines that combine virus resistance with desirable fruit and plant quality characteristics and that have potential as regional cultivars. Women's groups in several of the countries, notably El Salvador and Guatemala, have produced crops using our cultivars that they then sold for a significant profit and also have begun to produce seed of the selected lines (Pictures 1-6 in addendum). Interestingly, the sustainable business that has emerged for the women's group in Morazán, El Salvador is not for seeds, but rather for seedlings. They are now producing seeds of the selected lines, but they grow the plants in the greenhouse and are selling the seedlings to other growers. Thus, in El Salvador our project is not 'Semillas de Esperanza' but rather 'Plántulas de Esperanza'.

In short, we are achieving our objectives of introducing and validating new and valuable germplasm (technology) into the region and, through a rigorous process of evaluation involving cooperation among our partners in each country, we have identified ten tomato lines as potential cultivars. Moreover, the women's groups are beginning to gain knowledge and experience in production in protected environments (greenhouses); thus, we have provided access to knowledge and technology.. This combination of knowledge, confidence, germplasm and technology is resulting in the development of small businesses managed by women's cooperatives that produce tomatoes for sale in local markets and is increasingly shifting towards value-added production of seed and seedlings.

Our project is beginning to achieve some success in all four countries; nevertheless our project must adapt to a changing environment of challenges and opportunities and make adjustments in objectives, activities and budgets. We must also be agile and aware enough to take advantage of opportunities. One of the opportunities available to us is to combine our hard-earned expertise in germplasm and vegetable production and marketing with expertise in post-harvest physiology of crops and seeds. This is the unexpected benefit of the HortCRSP network and the meetings in Singapore and Bangkok, aka, CRISPing. We recognize that our partners and the women's groups in Central America can benefit from knowledge and experience of other HortCRSP projects. Because our current project has shifted emphasis to actual production and marketing of BOTH tomatoes and tomato seeds (and seedlings) – for the longer-term success of our project and enhance quality of tomatoes in the marketplace, we need technology and expertise in post harvest physiology. Therefore, we are proposing changes in objectives, activities and budgets. All changes take advantage of validated technology and knowledge acquired from other CRSPs.

The suggested changes are in two major shifts in activities to:

i) Post-harvest evaluation of our selected tomato cultivars, and
ii) Post-harvest physiology of seeds.

To facilitate a more complete understanding of these new activities, I have outlined details in a separate document for your evaluation that I have sent as a word document [see separate add-on document sent to Amanda Crump]. These changes most significantly alter our needs for hands-on training in post harvest technology. The post harvest evaluation of tomato cultivars will combine International experts Profs. Adel Kader and Marita Cantwell of UC-Davis with regional experts, Héctor Aguilar of the Fundación Hondureña de Investigación Agrícola and Sergio Torres of the Instituto Tecnológico de Costa Rica. We are proposing field-based post-harvest evaluations as well as a new regional workshop specifically focused on post-harvest physiology of vegetables. This workshop also offers unique opportunities to connect to regional markets, e.g. Wal-Mart Centroamérica. The regional workshop is tentatively scheduled for November 2013 in Honduras, and has commitments from all regional and International experts to participate. All that is needed is approval for activities and funding.

The other proposed change in activity involves the need for technology and training in post-harvest seed physiology. It is critical that the women's groups who make a huge investment in time and resources in seed production don't lose that investment due to lack of knowledge and technology in seed cleaning, processing and storage. This project also takes advantage of a sister HortCRSP project directed by Kent Bradford of UC-Davis and Ing. Johan Van Asbrouck of Rhino Research. Both Kent and Johan have agreed to participate in a hands-on workshop in cooperation with UW-Madison. One of the critical features is that each Central Amrican country is provided the technology package provided by Rhino Research. The objective is that cooperators in each of our four partner countries will receive training in post-harvest physiology of seeds and a Drying Beads kit (clay beads) that they can bring back to their countries in their suitcases, as each individual is legally allowed $500 value to import when they travel overseas, [in order to avoid the bureaucratic process of import permits if we ship the four packages]. Thus, we are proposing funding a workshop specifically focusing on post Harvest seed processing and post-harvest physiology to be held on the campus of UW-Madison in

August of 2013. This will require additional funding. The cost for the Drying Beads is $5,000 (see addendum page 24 – quote from Rhino Research for six Drying Beads kits).

Details of the two proposed changes in activities are provided in a separate document sent to Amanda Crump as an addendum to this report.

Participatory Tomato Breeding for Virus Resistance in Central America

A. Raul Guerra[1], James Nienhuis[1], Javier Diaz[2], Francisco Salmeron[3], Doris Hernandez[4], & Caludia Flores[5]

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Tomato Culture in Central America

Although the cultivated tomato (*Lycopersicum esculentum*) originates from Mexico (Jenkins, 1948; Rick, 1958), most of the tomato seeds planted in Central America are imported, mainly from USA, Israel, Holland, and Italy (MIFIC, 2007; FHIA, 2006). In Nicaragua, the importation of seeds is used as an indicator of agricultural activity (USAID, 2000). Long-term investments required for breeding programs often preclude public efforts in Central America to provide high-quality, low-cost seeds to small-scale farmers. Central America accounted for 0.4 % of the global agricultural research and development (Stads et al., 2009). Multinational seed companies have stepped in (James, 1997) to provide pepper and tomato seeds with a focus, however, on large-scale, high-input farmers (Jones, 2005). Their success permits novel introgressions from wild varieties that contain resistance to devastating pathogens and, thus, the establishment of a dependence on foreign seeds.

In tropical countries around the world, production suffers losses up to 100% due to geminiviruses transmitted by the white fly *Bemisia tabaci* in a persistent, circulative manner (Agrios, 2005; Lapidot et al., 2002; Polston and Anderson, 1997; Morales). This threatening vector encourages large applications of insecticides that may reduce the population size but increase costs and selective pressure for resistance, worsened by continuous sowing cycles. Moderate to high resistance to insecticides in *B. tabaci* has been noted (Ahmad et al., 2002; Cahill et al., 1996). In Central America, this disease was exacerbated by the introduction of the whitefly type B in the late 1980s (Polston and Anderson, 1997; Morales). Although the presence of geminiviruses were reported since the mid 1950s, the new whitefly biotype "avidly fed and reproduced more successfully on tomato than most of the local biotypes" (Polston and Anderson, 1997).

The average yield of tomatoes in Central America is very low, far from the genetic potential. In addition to the high-stress caused from the viruses, the main plant pathogens affecting tomato in the region include *Pseudomonas* (Bacterial wilt), *Phytophtora* (late blight), and *Alternaria* (early blight).

They all contribute to the excessive application of agrochemicals, affecting the health and safety of farmers and consumers. The mean yield in metric tons per hectare for Guatemala, El Salvador, Honduras, and Nicaragua are 30.0, 36.2, 22.0, and 14.8, respectively (FA0STAT).

The majority of the tomato produced in this region is destined to export within Central America. El Salvador consumes three times the per capita average of the other Central American countries. Exporting to El Salvador has two major implications for producers in the region: 1) planting of cultivars desired by El Salvador and 2) on-land transportation through less than optimal road conditions.

El Salvador´s national consumption of tomato is mainly for the elaboration of fresh paste as dressing for their local cuisine. Their tomato preference demands an elongated-saladette for fresh market processing. Tomato imports to El Salvador have steadily increased and exports remained near zero since 1994. Guatemala, Nicaragua, and Honduras export 8, 43%, and 47%, respectively, of their national production to El Salvador (FAOSTAT).

The national consumption for Guatemala, Nicaragua, and Honduras also creates differences among the types of tomatoes grown, which determines the breeding effort and market presence of seed companies. The most popular hybrids grown are Pony (Harris Moran), an elongated- saladette, Silverado (Harris Moran), a large plum, Retana (Vilmorin), elongated-saladette, and Shanty (Hazera), with an oblong shape. For OP varieties, Butte (Ferry Morse) captures this segment of the market.

Materials and Methods

The World Vegetable Center (AVRDC) based in Taiwan is one of the few public institutions who develops cultivars with resistance to virus and adaptation to the tropics.

A regional collaboration among community-based groups of farmers and women's groups has facilitated the selection of 10 adapted AVRDC lines of tomatoes for the region of Central America. Organized in a participatory fashion through a Hort-CRSP grant funded by USAID, the process provides hope for a sustainable implementation of cultivars into the region. Each country selects the germplasm best suited to their markets, national and international. The dissimilar preferences, although with the common criteria of virus-resistance and high yields, complicates the reduction to only one cultivar.

Although each country performed replicated trials, the bulk of the statistical data recorded came from the Honduran Foundation for Agricultural Research (FHIA), the National Agrarian University-Managua, Nicaragua (UNA), and from the University of Wisconsin-Madison. The data from El Salvador and Guatemala was obtained in collaboration with CARE during field days. Women's groups of local communities selected and saved seeds of the lines that satisfied their cultural criteria, as well as high yield and resistance to virus.

All experiments were conducted under a Randomized Complete Block Design (RCBD) with three repetitions. Having differing environments according to the input intensity, soil properties, and dates planted, the main variables measured were yield and virus resistance. Moreover, each institution included other variables of interest.

For example, FHIA, with the most variables measured, obtained data on: percentage of survival, height of plant and virus incidence at 15 days, emergence of flowers, time to first harvest, total and commercial yields, equatorial and longitudinal diameter, weight, and an analysis of unacceptable fruits. UNA recorded data on total yield, number of locules, degrees Brix, fruit weight, equatorial and longitudinal diameter, and virus resistance. The data recorded at UW Madison included an earliness scale (1-5), weight of fruit, pH level and degrees Brix.

Results

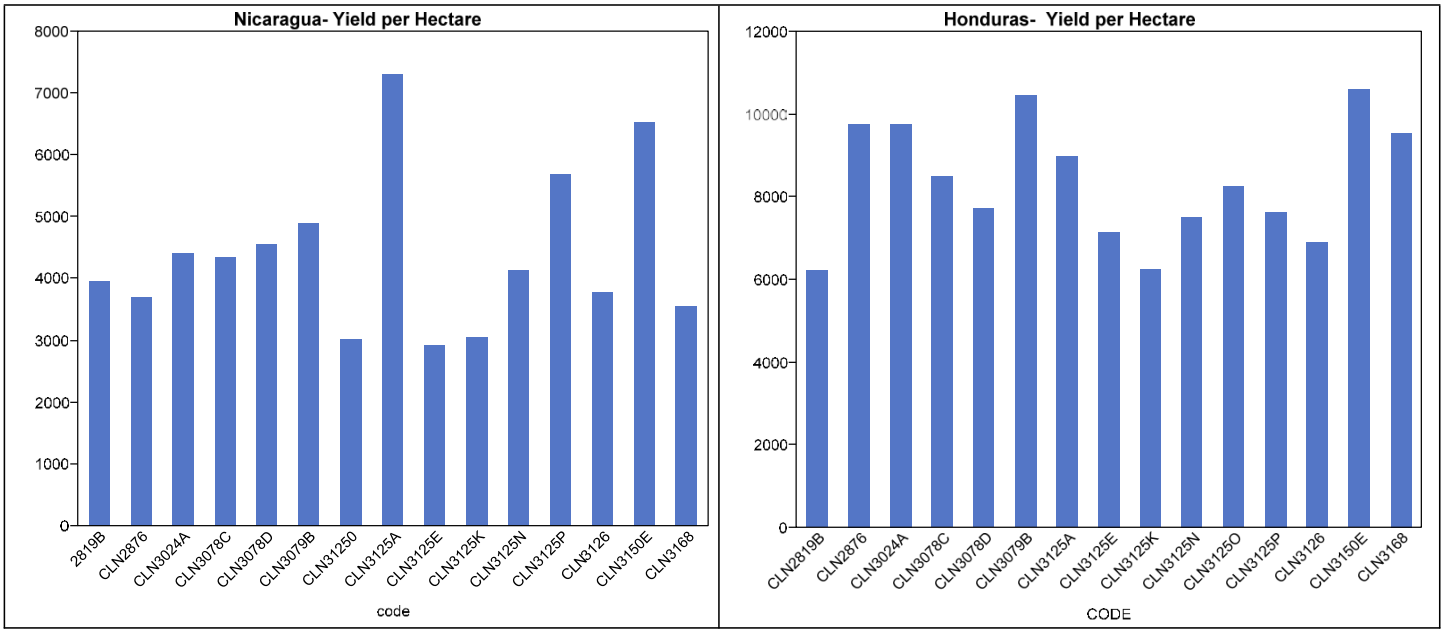
The ANOVA table below shows a significant difference for yield and maturity among lines, the latter measured in days after transplant (ddt for Spanish acronym).

Effect Tests

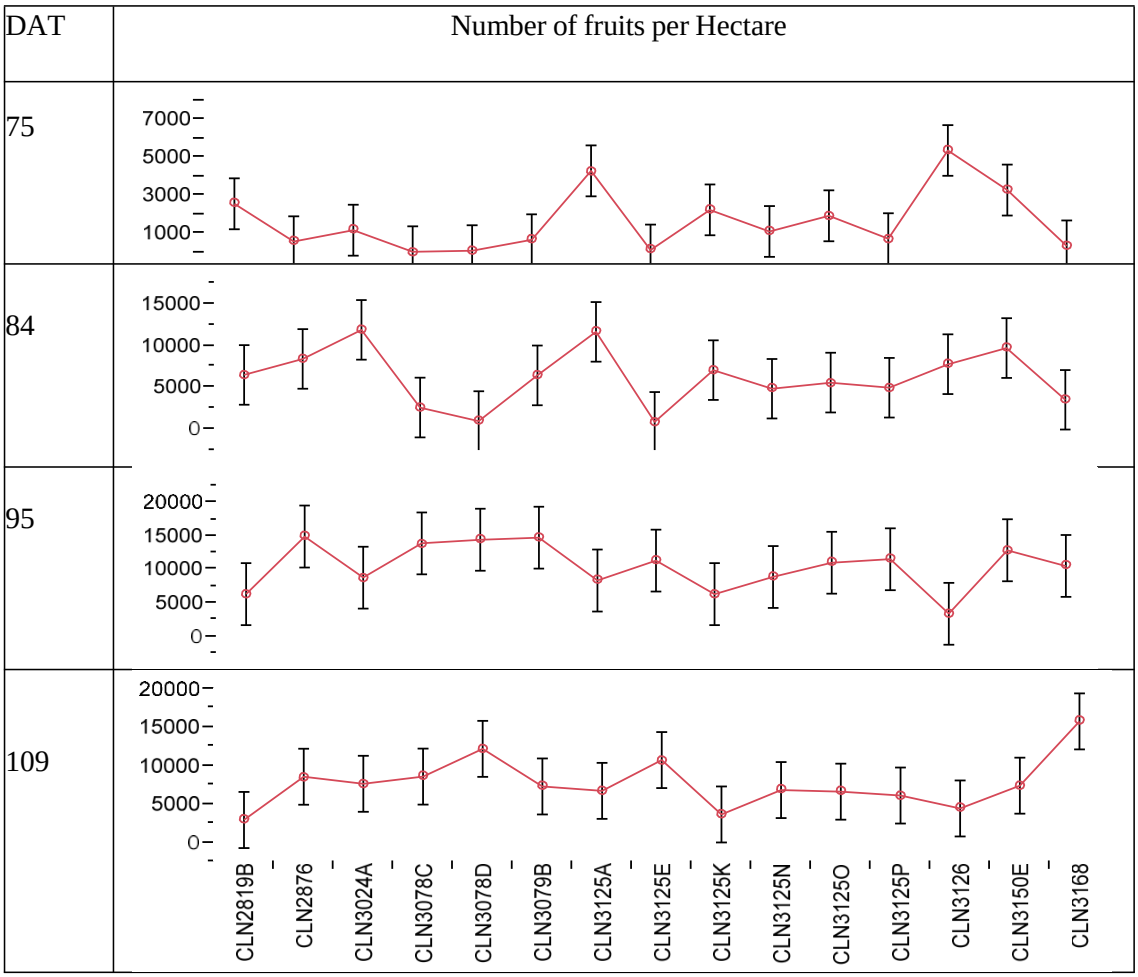
Source	DF	Mean Square	F Ratio	Prob > F
CODE	14	5.6e+7	6.69	<.0001*
Rep.	2	1.4e+8	17.22	<.0001*
Rep.*CODE	28	4.8e+7	5.75	<.0001*
ddt	8	5.3e+8	63.56	<.0001*
ddt*CODE	112	3.2e+7	3.85	<.0001*

Genotype X environment interaction

Yield graphs (below) of Honduras and Nicaragua demonstrate a shift in ranks between selected lines. Line CLN3150E performs well on both environments.

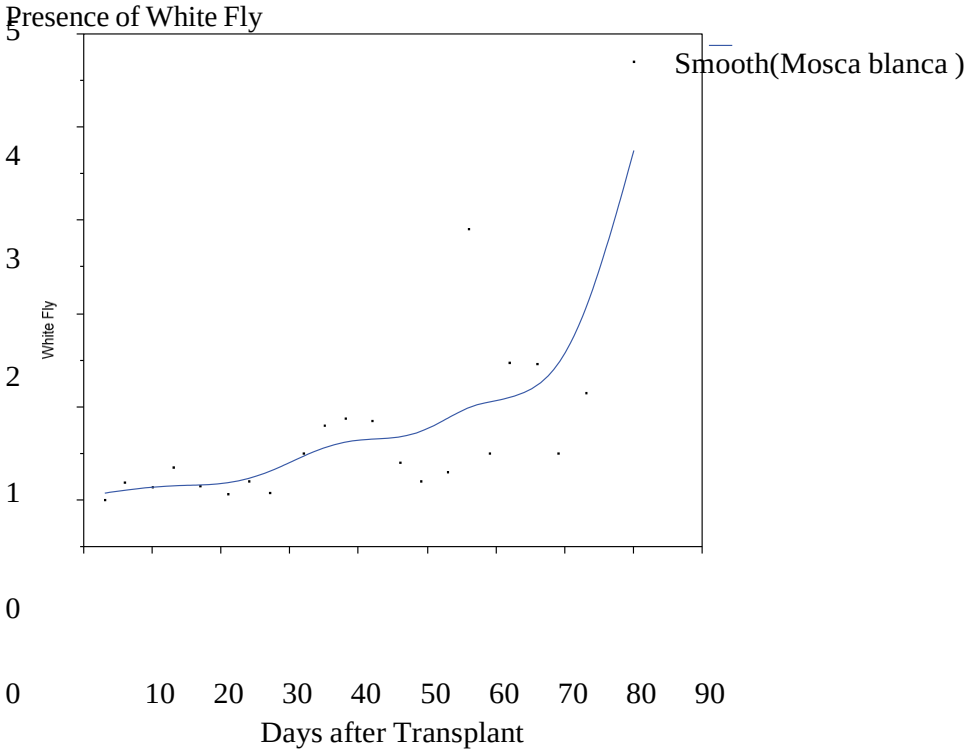


The graphs below show the number of harvestable fruits at differing times, measured in days after transplant (DAT). Lines CLN3125A, CLN3126, and CLN3150E demonstrate earliness over the rest. However, only CLN3125A and CLN3150E maintain consistency throughout (data from FHIA at Comayagua, Hondruas, 2011).



Virus Screening

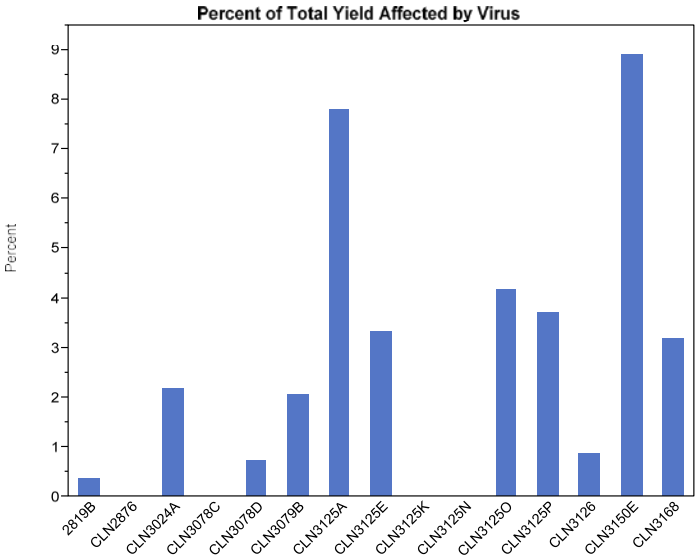
Usually a good indicator of *Begomovirus*, the presence of white fly per plant increases with plant maturity (data from FHIA at Comayagua, Hondruas, 2011).

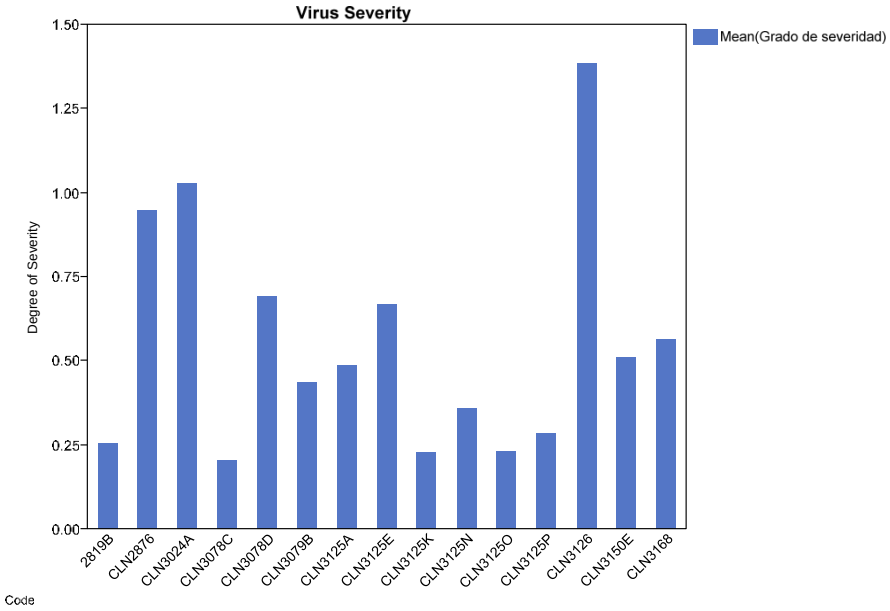


This ANOVA table indicates no difference between lines affected by virus. The same source of resistance explains the lack of difference.

Source	DF	Mean Square	F Ratio	Prob > F
Trat.	14	4621.53	1.4635	0.1256
Rep.	2	8079.28	2.5585	0.0795
Trat.*Rep.	28	5127.84	1.6239	0.0288*
ddt	8	12484.25	3.9535	0.0002*
Trat.*ddt	112	2329.66	0.7377	0.9656

The percentage of total yield affected by virus is very low. The severity, in a scale from 1 to 5, is also low for all lines.





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Low cost pest exclusion and microclimate modification technologies for small-scale vegetable growers in East and West Africa

Target Countries: Benin and Kenya

Principal Investigator: Mathieu Ngouajio, Michigan State University and William Vance Baird, Michigan State University

Collaborators:

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Françoise Komlan, INRAB, Benin
Lusike A. Wasilwa, 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, AtoZ Textile Mills International, Tanzania
Laurent Parrot, CIRAD, France
Project Description

Rapid urbanization in Sub-Saharan Africa (SSA) has resulted in an increase in demand for food. Almost 33% of the SSA population, close to 200 million people, is undernourished (FAO, 2006). Fruit and vegetable consumption in SSA remains 22-82% below the intake value threshold of 400 g/day recommended by the World Health Organization and Food and Agricultural Organization. This severe malnutrition leads to many chronic diseases among the populations. Vegetable growers, mainly small holders 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 propose to 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 nettings (either treated or not with insecticides) at protecting vegetables against pests and associated viral diseases 2) floating row covers at improving crop micro-climate and enhancing yield and produce quality, 3) Assess and address farmer's perception of EFN in order to increase the adoption and use of the technology.

1st report

Project team adjustment

Dr. Muo Kasina (Kenya) and Mr. Leonce Adjaito (Benin) were officially added to the team. All PIs maintained their responsibilities on the team.

Project Activities by objective

Objective 1: Optimize and adapt EFN for vegetable tunnel house and other row cover technologies for year-round production of vegetables under diverse local conditions (climate, crop/cultivar, irrigation, pests and pathogens)

Overall, all activities planned for this reporting session were carried out successfully. In Benin activities were conducted at research stations and on-farm. In Kenya, however, most of the activities were carried out at the research station as planned. Below are some of highlights of activities in each country.

Kenya

Second season trials on cabbages (Var Gloria F1) and tomato (var Rio Grande) were conducted at Egerton University, Njoro from October 2011 to March 2012. For each crop, studies were carried out on efficiency of treated and untreated (with temporal net cover changes) EFN and row covers targeting pest control and microclimate modification around the immediate crop environment. Crop and pest response to the technologies were evaluated both in the nursery and the main field. Treatments entailed temporal differences in placement of EFN and row covers with permanent cover or partial cover with EFN or row covers and open cultivation of the crops. Production of seedlings under EFN improved seedling growth rate and quality leading to early maturity of seedlings in readiness for transplanting. In the field experiments, cabbage yield and quality was best under 0.9 mm pore diameter mesh used permanently. Floating row covers, which were only used in the tomato experiment proved to be better than 0.4 mm, 0.9mm opened or used permanently. Microclimate conditions were improved both in the floating row covers and EFN. Pest counts were generally lower under nets and lowest in the treated nets.

At KARI, the Thika year one experiments were at final stage and harvesting was done in October 2011.

At Kabete, new experiment was set to study the effects of EFN architecture size and the EFN twine density on the pests of cabbages. The treatments were: 1.) Height from the ground: 30 cm, 45 cm, and 60 cm an 2.) Density of the nets: 80 denier and 120 denier.

Benin

Data from the rainy season trials have been analyzed and reports produced by the research team in Benin.

A new series of six (6) trials were implemented during the dry season, from December 2011 to March 2012. An impregnated (treated) net with alphacypermethrin (ANet 0.9 α) was tested in the dry season both cabbage and tomato. Additionally tomato was permanently covered in the new trials to limit pest introduction inside the nets.

Preliminary results confirmed the efficacy of the EFN in controlling *Hellula undalis* on cabbage. Populations of other caterpillars were very low. However, aphids *(Lipaphis erysimi)* control with EFN was poor aphid population exploded in plots covered permanently with net. In tomato, the population of whiteflies was generally higher compared to that observed in the rainy season. Meanwhile, the infestation was lower under nets (bot treated or untreated) which acted as a physical barrier. Nevertheless, Tomato

Yellow Leaf Curl (TYLC) disease developed under the nets despite the low population of whiteflies. Thus, there was no yield for the dry season trials.
A similar protocol has been implemented on tomato at Bohicon station. In addition to the impact of EFN on TYLC disease development, the microclimate under EFN has been documented. However, the infestation by whiteflies was low at the time of experiment.
Finally, a drip irrigation system was developed at Agonkanmey station for the tomato trial. In addition to water economy during the dry season, this irrigation system is well adapted to protected crops under insect net because of the homogeneous distribution of water. The profitability of the technology (EFN combined with the drip irrigation) will be investigated in subsequent studies.

Objective 2. Determine the costs, benefits, and socio-economic viability of EFN and row cover technologies

In Kenya, field production data and cost of activities were recorded and will be used in cost-benefit assessment of the project. A fellowship application was submitted to the French government for a PhD student who will conduct the analyses in Kenya.
Most of the activities for this objective were conducted in Benin. These include the following activities and actions:

- Internship of the PhD student (Faustin Vidogbèna) at CIRAD, Montpellier. This was supported by a new fellowship offered by CIRAD.
- Presentation of the PhD proposal to CIRAD team involved in the HortCRSP/USAID project at Montpellier. The presentation was followed by a literature review on Agronet acceptation by farmers, and factors affecting its adoption.
- Supervision of four graduate students on various socio-economic topics related EFN technology.
- Completion and defense of the four theses (BS student with project). Results of these theses have been presented to BioNetAgro partners and the PhD dissertation committee of Mr. Faustin Vidogbèna.
- Mr. Faustin Vidogbèna defended his PhD proposal at FSA.
- The experimental protocols and survey question for follow up surveys were developed.
- One abstract was submitted to the International Symposium on Horticulture in Europe for 2012 (ISHE2012), which will be held in Angers from 1-5 July.

Objective 3. Increase local human capacity, adoption and use of locally adapted eco-friendly nets and other row covers in target communities

Human capacity building is an important component of this project and significant efforts were carried out during the reporting to achieve that goal. Training and extension activities were carried out in all project countries targeting scientists, extension educators, farmers, and students at all levels. In Kenya for example 234 BSc and 138 Egerton Diploma Horticulture students (202 male & 170 female) were trained on use of and 114 visiting high school students (27 male & 87 female) sensitized on use of EFN between October 2011 – March 2012 in the Njoro trial. In Benin 40 farmers were selected and trained on the use of agronets. Below are more details on human capacity building activities during this reporting period.

Kenya
Multiple field days were conducted to disseminate the information about the EFN in all trial sites in Kenya. Poster and brochures were also developed to provide information about the technology. Three

female and 2 male MSc students have completed their experiments and are now analyzing data collected at Egerton University, Njoro and KARI. One female KARI MSc student submitted her thesis to Moi University for examination. One female MSc student from Kenya Methodist University was recruited at KARI and One female MSc Student from JKUAT recruited at *icipe*. A field day was conducted in October 2011 and was attended by 15 male and 20 female in Egerton University. In March a field day at Kikuyu District was attended by 21 male and 22 female farmers and extension officers. Training on the use of the EFNs was conducted at EAST College, Embu and was attended by 20 males and 12 female extension officers. Similar training was conducted at FTC Busia and was attended by 14 male and 13 female extension officers and farmer group leaders.

Benin

At INRAB, one researcher, one technician and one laborer were trained on the establishment and monitoring of EFN trials and data collection. Two students (one MSc. and one BSc.) were actively involved in the studies as a component of their degree research projects.

Mr. Armel Mensah, staff of PCM/INRAB participated in an internship at CIRAD Montpellier from September 12 to October 7, 2011. He participated in ongoing activities on EFNs at the laboratory of Dr. Thibaud Martin.

At FSA, Mr. Faustin Vodogbena had an internship at CIRAD Montpellier (November 7 to 25, 2011) where he worked with Dr. Laurent Parrot on the socio-economic aspects of EFN technology.

APRETECTRA (NGO) conducted most of the hands-on training activities in Benin during the reporting period. The demonstration sessions on the use of EFN started with farmers: cabbage nurseries were established from September 14 to November 18 2011 at Pahou, Seme-Podji, Ouidah, Grand Popo and Comè. In total, 21 farmers (13 females and 8 males) have experimented with the technology on two cabbage varieties (KK Cross and Royal Oxylus). For various unpredictable circumstances (unavailability of the producer, motor pump failure, etc.), only 15 farmers transplanted their nurseries. Farmers using EFN reported an important reduction in the quantities and frequencies of pesticide used EFN compare to the traditional production system. Crops were harvested in January and February 2012 and data are being analyzed.

As part of farmers' capacity building, three training sessions were organized, from 3 to 7 January 2012. In total, 40 farmers were trained in Seme-Podji, Ouidah, Grand Popo and Come on the protection of cabbage, tomato and pepper nursery and crop plots. Also, 14 awareness campaigns were held with project beneficiaries. In addition, four farmers' organizations have directly or indirectly sensitized their peers. These organizations are: the District Association of Farmers (UCP) of Comé and Ouidah, members of the District Association of Vegetable Growers (UCM) and the Regional Council of Vegetable Growers (CRM) of Mono-Couffo.

In addition, 21 farmers of which 7 agricultural households headed by women were directly supported by the project. At the end of this first series of on-farm demonstration, two interns at APRETECTRA NGO and 26 farmers from Sèmè-Podji, Grand-Popo and Comé were trained on the EFN technology.

Objective 4 Communication and knowledge management

A semester report was submitted in October 2011 and photos provided for uploading to the project website. Financial agreements were signed between MSU and the Kenyan partners and an image database created for the project. One manuscript was submitted and accepted for publication in the June volume of HortTechnology Journal by Egerton University and a second manuscript was developed and is currently under peer review before submission to HortScience journal. Multiple brochures were also developed on the project and short videos recorded during field days.

Student research topics (*See more details on students in the Table below: Part V*)

Name	Gender	Level	Research topic
Elisha Otieno Gogo	M	M.Sc. (Kenya)	Influence of Ecofriendly nets and floating row covers on microclimate modification, pest infestation, growth, and yield of tomato (*Solanum lycopersium* L.), Dept of Crops, Horticulture and Soils, Egerton University (Thesis writing)
Everlyne M'mbone Muleke	F	M.Sc. (Kenya)	Evaluation of Bioagronets on microclimate modification, pest control and cabbage (*Brassica oleracea* var. *capitata*.) performance, Dept of Crops, Horticulture and Soils, Egerton University (Thesis writing)
Jane Gateri	F	M.Sc. (Kenya)	Effects of agronet placement on aphids and diamondback moth pests infesting cabbage (B. oleracea) at Kabete, Kenya, Dept. Agriculture and Natural Resources, Kenya Methodist University (Data collection)
Judith Kiptoo	F	M.Phil. (Kenya)	Use of insecticide-impregnated nets to manage pests of cabbage (Brassica oleracea var. capitata l.) in Kenya, Department of Zoology, Moi University (Thesis submitted for examination)
Catherine Gatheri	F	M.Sc. (Kenya)	Effects of mesh size and cover duration of low cover nets on cabbage pests and their natural enemies in Kenya, Dept Zoological Sciences, Kenyatta University (Thesis writing)
Caroylne Achieng'	F	M.Sc. (Kenya)	Efficacy of low cost insect exclusion covers for sustainable smallholder tomato (*Lycopersicon esculentum* Mill) production in Kenya, Dept Zoological Sciences, Kenyatta University (Thesis writing)
Victor Juma	M	M.Sc. (Kenya)	Efficacy of insecticide treated insect proof nets in management of tomato (*Lycopersicon esculentum* Mill) pests in Kenya, Dept Zoological Sciences, Kenyatta University (Thesis writing)
Agohoundjè Victor	M	B.Sc. (Benin)	EFN in the control of cabbage pests in Southern Benin. Ecole Polytechnique d'Abomey Calavi (EPAC). (Dissertation writing) *"Les filets anti-insectes dans la lutte contre les ravageurs de chou au sud du Bénin Ecole Polytechnique d'Abomey Calavi (EPAC). (Rédaction du mémoire en cours)"*
Agonsè Hilaire	M	M.Sc. (Benin)	EFN use in the dry season in Southern Benin: impact on growth, pests and diseases of tomato crop. Dept of Crop Production, UATM/ GASA Formation (Université Africaine de Technologie et de Management du Groupe AHIY et S.A.) (Dissertation writing) *"Filet anti-insectes : impact sur le développement des ravageurs et des maladies de la culture de tomate en période de contre saison au Sud du Bénin. Session Agronomie : Option Production Végétale, UATM/ GASA Formation (Université Africaine de Technologhie et de Management du Groupe AHYI et SARL) (Rédaction de la thèse en cours)"*

Faustin Vidogbena	M	PhD (Benin)	Use of EFN in controlling crop pests: Adoption and environmental impacts in vegetable farming systems in Southern Benin. Dept of Economics, Faculty of Agricultural Sciences, University of Abomey- Calavi (Collecting data) *"Adoption et impact environnemental du contrôle des ravageurs par le filet anti-insectes (Agro-Net) dans les exploitations maraîchères du sud-Bénin. Département d'Economie, Faculté des Sciences agronomiques, Université d'Abomey- Calavi (Collecte des données en cours)"*
Gildas M. Adjovi	M	B.Sc. (Benin) Engineer, Agricultural Economist	Farmers' perceptions and willingness to use EFN in vegetable farming systems in the Mono and Couffo regions. Dept of Economics, Faculty of Agricultural Sciences, University of Abomey- Calavi (Dissertation defended in December 2011) *Perceptions paysannes et consentement à utiliser les filets anti-insectes dans les exploitations maraîchères des départements du Mono et du Couffo. Département d'Economie, Faculté des Sciences agronomiques, Université d'Abomey- Calavi (mémoire soutenu en décembre 2011)*
Rustique J. G. Akodogbo	M	B.Sc. (Benin) Engineer, Agricultural Economist	Determinants of farmers' preferences for the features of EFN introduced in vegetable farming systems in the Mono and Couffo regions. Dept of Economics, Faculty of Agricultural Sciences, University of Abomey- Calavi (Dissertation defended in December 2011) *"Analyse des déterminants des préférences paysannes au sujet des attributs des filets moustiquaires introduits dans les exploitations maraîchères des départements du Mono et du Couffo. Département d'Economie, Faculté des Sciences agronomiques, Université d'Abomey- Calavi (mémoire soutenu en décembre 2011)"*
Sandrine S. S. L. Segla	F	B.Sc. (Benin) Engineer, Agricultural Economist	Actors, communication system and adoption of EFN technology in vegetable farming systems in the Mono and Couffo regions. Dept of Economics, Faculty of Agricultural Sciences, University of Abomey- Calavi (Dissertation defended in December 2011) *"Acteurs, systèmes de communication et adoption du filet anti-insectes dans la production maraîchère dans les départements du Mono et du Couffo. Département d'Economie, Faculté des Sciences agronomiques, Université d'Abomey- Calavi (mémoire soutenu en décembre 2011)"*
Lauriane Yehouenou	F	B.Sc. (Benin) Engineer, Agricultural Economist	Effect of the financial profitability of EFN on its adoption by farmers: case of cabbage (Brassica oleracea) and pepper (Capsicum frutescens) production in the Mono and Couffo regions. Dept of Economics, Faculty of Agricultural Sciences, University of Abomey- Calavi (Dissertation defended in

			December 2011) *"Influence de la rentabilité financière sur l'adoption du filet anti-insectes pour la protection des cultures de chou pommé (Brassica oleracea) et de piment (Capsicum frutescens) dans les départements Mono et Couffo. Département d'Economie, Faculté des Sciences agronomiques, Université d'Abomey-Calavi (mémoire soutenu en décembre 2011) "*

2nd Report

Project team adjustment

Dr Thibaud Martin from Cirad is now working as a visiting scientist in icipe since August 1st 2012. Dr Thibaud Martin will coordinate the scientific activities of the project from Kenya in partnership with Pr Mathieu Ngouajio. Dr Thibaud Martin will work closely with Dr Subramanian Sevgan (icipe) in partnership with Dr. Komi Fiaboe to implement research and extension activities in icipe, KARI (team led by Dr Lusike Wasilwa) and Egerton University (team led by Dr Mwanarusi Saidi). One Masters and one Ph.D students will be trained at icipe in partnership with CIRAD.

With approval of HortCRSP (UC Davis), MSU established direct sub-contracts with KARI, and Egerton University. This was in response to a request from those institutions to streamline movement of funds and implementation of activities.

Project Activities

Overall, all activities planned for this reporting period were carried out successfully. In addition to intensive research and extension activities, we trained a group of five researchers from Benin and Kenya at Michigan State University. The training was followed by a project workshop at Michigan State University. Below are some of highlights of activities by objectives in each country.

Objective 1: Optimize and adapt EFN for vegetable tunnel house and other row cover technologies for year-round production of vegetables under diverse local conditions (climate, crop/cultivar, irrigation, pests and pathogens)

Kenya

The third season of on-station trials was conducted at Egerton University, Njoro from June to September 2012. Cabbages (Gloria F1 and Copen Hagen market), tomato (var Rio Grande), Onion (Red creole) and French beans (Monel) varieties were tested in the open and under treated and untreated nets. The EFN technology was also tested on-farm with 5 farmers within the Egerton University neighborhood. Only cabbage (Gloria F1 and Copen Hagen market) was included in the on-farm trials. In both the on-station and on-farm trials, crop and pest response to the technologies were evaluated in the nursery and the main field. Like on the on-station trials, production of seedlings under EFN improved seedling growth rate and quality leading to early maturity of seedlings in readiness for transplanting in the on-farm trials. Cabbage yield and quality was also better under net protection than in unprotected plots. Even though, the onion and French been crop is yet to be harvested, growth of both crops is better under net protection than in open fields. Pest counts were generally lower under nets and lowest in the treated nets.

At KARI, the experiment to study the effects of EFN architecture size and the EFN twine density on the pests of cabbages was repeated in the second season. The treatments were the same: 1) Height from the ground: 30 cm, 45 cm, and 60 cm and 2) Density of the nets: 80 denier and 130 denier. The experiment ended during this period. New experiments were established on-station at Kabete to investigate at 1) disease development on tomatoes, 2) pests and pollination management using Agronets for melon and

French beans. During the same period, on-farm trials were conducted at Limuru using cabbages as the target crop.

Benin

INRAB: Three trials were conducted from June to September 2012. A new treatment was introduced in the dry season. This is the use of insecticide-treated nets. Under Benin conditions, insecticide impregnation did not improve efficacy of the nets at protecting the crops against targeted pests (aphids and whiteflies), neither at nursery nor in open field.

The pressure of aphids and whiteflies in the wet season is lower than that in the dry season and the two seasons have very contrasting climatic conditions. Permanent protection of cabbage with nets reduced infestations by aphids in the rainy season (2011 trial) and increased their development in the dry season (2012).

The fine mesh Net (0.4 mm) had the greatest effect at reducing whiteflies populations on tomato at Agonkanmey station. However, the level of protection was not satisfactory since the small number of whiteflies that penetrated the nets was sufficient to transmit TYLC virus to all tomato plants in the plot. Thus, the entire crop was lost and no harvest in the infested plots.

At Bohicon's research tomato plants were taller under nets (71 to 78 cm) than in control plots (53 cm), in spite of the increase of temperature under nets (+3 ˚C). Pressure by whiteflies was also lower on crop protected with nets (less than two whiteflies per plant) than that on the control (nine whiteflies par plant). The low infestation by whiteflies at this site allowed for the harvest however, no differences were found among treatments.

So far, three new trials were conducted on cabbage since June 2012. They investigated the effects of color of nets, insect repellent properties of *Ocimum gratissimum* and organic fertilization. The first trial compared the effect of new and old nets with 0.9 mm size, containing black and white fibers (SilverNet). The second experiment aimed at investigating whether the use of net with mesh ANet 0.9 mm would enhance the insect repellent properties of *O. gratissimum*. The third trial investigated the effect of microclimate under nets with mesh ANet 0.9 mm on mineralization of organic matter.

Additionally, a greenhouse was installed at Agonkanmey research station using local materials and covered with ANet 0.4 mm. A first experiment is comparing different production practices on tomato, as an intensification of vegetable production using net technologies. In September a field visit was conducted.

Three members of INRAB team participated in the Course organized by Michigan State University (MSU) on Agroecology, Integrated Pest Management (IPM), and Sustainable Agriculture.

After the course the team attended a seminar organized by the PI of BioNetAgro project. The team exchanged on project activities with the PI and the Kenyan team. During this seminar, participants visited laboratory and field activities with the PI at MSU.

Objective 2. Determine the costs, benefits, and socio-economic viability of EFN and row cover technologies

Kenya

A male Ph.D student in socio-economics was recruited at Egerton University to explore this objective. The broad objective of his dissertation is to contribute towards improved livelihoods and environmental safety by use of Eco-friendly nets in vegetable production in Kenya. The specific objectives are to:

a. Compare the costs and benefits of using eco-Friendly Nets against pesticide use in vegetable crops
b. Assess the potential positive impacts of eco-friendly nets on the capabilities of farmers.
c. Estimate the determinants of adoption among producers and consumer's perceptions and willingness to pay for quality vegetables.
d. Estimate the externalities generated by eco-friendly nets.

Benin (FSA)

Activities completed during the semester include:

- Design and presentation of a poster at the 2nd Symposium on Horticulture in Europe held on July 1-5, 2012 at Angers, FRANCE. The poster is entitled "Farmer's perceptions of Eco-friendly nets adapted to vegetable production in Benin"
- Writing of a working paper out of the poster to be included in the proceedings of Angers' Symposium
- Design of two data collection tools, one on technology choice analysis and the other on perception analysis
- Training of three surveyors on the use of choice experiment tool
- Implementation of two surveys: one on choice experiment and the other on perception
- Drafting of two research problems and methodologies, respectively on preference and information asymmetry and use of eco-friendly net
- Initiation of data analysis on farmers' perceptions on and preferences for eco-friendly net

In the coming months, our team plans to:

- Continue with data analysis on farmers' perceptions and preferences for eco-friendly net
- Write the report on perceptions, preferences and information asymmetry
- Collect data for cost-benefit analysis
- Collect data on consumers' perceptions
- Analyze data on cost-benefit and consumers' perceptions
- Write reports

Objective 3. Increase local human capacity, adoption and use of locally adapted eco-friendly nets and other row covers in target communities

Human capacity building is a critical component of this project and significant efforts were carried out during the reporting to achieve that goal. Training and extension activities were carried out in all project countries targeting scientists, extension educators, farmers, and students at all levels. IPM training at MSU was completed during this reporting period. Below are some of the details on human capacity building activities during this reporting period.

Kenya

Two of the Kenyan project team members (Drs. Kasina and Saidi) received a 10-day training on integrated pest management and sustainable agriculture in Michigan State University in June 2012. Field demonstrations were conducted at Egerton University to show farmers how to apply the technology in production of cabbage seedlings and actual crop their farms. On-station show cases of the technology were also made to farmers groups, primary and secondary school pupils, and middle level college and

university students to demonstrate its potential benefits. A demonstration of the project was also done at Egerton University stand in the Nakuru National Agricultural Show held in July 2012. One male MSc. student at Egerton University has submitted his thesis for examination while the female student is finalizing her thesis draft for submission. A male Ph.D student was recruited by Egerton University in Kenya and Université d'Auvergne in France to investigate the socio-economic aspect of the project.

Farmers and extension officers were trained on the use of Agronet to manage pests and microclimate at Limuru, Central Kenya. Farmers established a trial to compare effects of treated and untreated Agronets on cabbage pests and microclimate conditions, compared with the cabbages that are not protected with Agronets. The trial ended and a new one set of trials was started. Farmer groups and students from different parts of the country were trained on the use of Agronets in crop management. Some farmers acquired Agronets from A to Z for their farm use, utilizing at least 2000m^2 nets. New students at KARI were recruited (2 male and 1 female) to work on tomato diseases, pests of melon and French beans. Two training workshops were held in July and August at KARI to train students and technical assistants on the publication, and, evaluate progress on thesis writing.

Benin

After harvest of the first round of on-farm trials in February 2012, APRETECTRA assessed data with beneficiaries and INRAB. In this respect, three participative reflection sessions were held with farmers at different project sites on March 7, 12 and 19th 2012. Another meeting was held between APRETECTRA and INRAB teams on March 21st 2012. These meetings allowed in-depth analysis of progress and lessons were drawn by all the stakeholders.

In order to better plan for the second round of on-farm trials, three awareness campaigns were organized involving farmers at each of the four project sites (Sèmé-Podji, Ouidah, Grand-Popo and Comé). The first awareness campaign which covered the period from 6 to 18 April 2012 was on the theme "pesticides and human health". This was once again an opportunity to draw attention on the risks involved with abusive use of chemical pesticides in vegetable farming and the opportunities offered by BioNetAgro technology to reduce synthetic chemical pesticides inputs in vegetable production. The second awareness campaign was on "management plan for vegetable production sites". This was organized from April 25th to Mai 4th 2012 and was focused on production planning and management of a vegetable production site. Here the emphasis was on crop rotation and soil fertility management. The last campaign was organized from Mai 9th to 21st 2012 on "maintenance of trial equipment". The focus was on adequate conditions for maintaining equipment (nets and hoops). It was necessary to train farmer on appropriate ways to keep netting materials out of adverse weather conditions and animals, for longer use.

Due to seasonality the second round of on-farm trials was launched on June 2nd 2012. In this regard, farmers' registry was updated. Thus, 21 farmers out of whom three are new installed cabbage nurseries (K-K cross variety) between June and September 2012. Due to seedling losses only 18 farmers have transplanted the crop and monitoring activities are ongoing.

Further meetings were initiated with the RCPA (Head of District Agriculture Extension Services) and local authorities to discuss the introduction of BioNetAgro technologies into current farming systems.

Objective 4 Communication and knowledge management

A semester report was submitted in April 2012 and photos provided for uploading to the project website. One peer reviewed scientific publication was published on the project and additional manuscripts are at various levels of the publication process. Multiple presentations were made at scientific meeting throughout the world.

Kenya: A semester report was submitted in April 2012 and photos provided for uploading to the project website. One manuscript was publication in HortTechnology 22, (3): 292-298 and a second manuscript was submitted to Agronomy Journal by Egerton University. Three articles are also in preparation for submission to journals by the Egerton University team. Each of the two 2 MSc. students at Egerton University submitted and made a presentation at the Egerton University 7th International Conference held in September 2012. Multiple brochures were also developed on the project and short videos recorded during field days. At KARI, three (2 female and 1 male) MSc students continued writing their Thesis and are expected to graduate in 2013. One female student is waiting for oral defense of her thesis.

Benin: Below are some of the activities from the Benin team

- In april the French Ambassador in Benin paid a visit at INRAB's research Station. A poster on HortCRSP project was presented
- INRAB research team completed monitoring visits at Semé, Pahou and Grand-Popo and Bohicon sites
- The third financial report was sent to MSU in July 2012.
- 1 poster was submitted for SCAC's competition
- 1 technical sheet was developed on *efficient use of EFN to protect cabbage*
- 1 advisory sheet elaborated was developed on *threshold control of pests on cabbage*
- A group of 25 farmers and extension workers from two vegetables sites at Cotonou and Togba visited INRAB research station to learn more about net technologies and other Agroecology practices to reduce the use of pesticides
- Second semester report is being finalized for October 2012.

MSU:

- The project was presented at the regular seminar series of the African Studies Center at Michigan State University. Title of the presentation: *From Malaria Control to Crop Protection: The Use of Eco-friendly Nets for Vegetable Production in Benin and Kenya*.
- A presentation on the project was delivered at the annual conference of the American Society for Horticultural Sciences. Title of the presentation: *Improved Small-scale Vegetable Production and Productivity in Africa with the Use of Agricultural Nets.*

Student research topics (*See more details on students in the Table below: Part V*)

Name	Gender	Level	Research topic
Elisha Otieno Gogo	M	M.Sc. (Kenya)	Influence of Ecofriendly nets and floating row covers on microclimate modification, pest infestation, growth, and yield of tomato (*Solanum lycopersium* L.), Dept of Crops, Horticulture and Soils, Egerton University (Thesis submitted)
Everlyne M'mbone Muleke	F	M.Sc. (Kenya)	Evaluation of Bioagronets on microclimate modification, pest control and cabbage (*Brassica oleracea* var. *capitata*.) performance, Dept of Crops, Horticulture and Soils, Egerton University (Thesis writing)
Jane Gateri	F	M.Sc. (Kenya)	Effects of agronet placement on aphids and diamondback moth pests infesting cabbage (B. oleracea) at Kabete, Kenya, Dept. Agriculture and Natural Resources, Kenya Methodist University (Thesis writing)
Judith Kiptoo	F	M.Phil. (Kenya)	Use of insecticide-impregnated nets to manage pests of cabbage (Brassica oleracea var. capitata l.) in Kenya, Department of Zoology, Moi University (Awaiting oral defense of thesis)
Catherine Gatheri	F	M.Sc. (Kenya)	Effects of mesh size and cover duration of low cover nets on cabbage pests and their natural enemies in Kenya, Dept Zoological Sciences, Kenyatta University (Thesis writing)
Caroylne Achieng'	F	M.Sc. (Kenya)	Efficacy of low cost insect exclusion covers for sustainable smallholder tomato (*Lycopersicon esculentum* Mill) production in Kenya, Dept Zoological Sciences, Kenyatta University (Thesis writing)
Victor Juma	M	M.Sc. (Kenya)	Efficacy of insecticide treated insect proof nets in management of tomato (*Lycopersicon esculentum* Mill) pests in Kenya, Dept Zoological Sciences, Kenyatta University (Thesis writing)
Samuel Machuki	M	M.SC. (Kenya)	Integration of Agronet technology in the management of pests and pollination of sweet melon (*Cucumis melo* L.) in Kenya. Department of Plant Science and Crop Protection University of Nairobi (On-going research)
Rebecka Sakwa	F	M.SC. (Kenya)	Efficiency of Agronet technology in managing pests and pollination of French bean (Phaseolus vulgaris L.) in Kenya. Department of Plant Science and Crop Protection University of Nairobi (On-going research)
Abel Too	M	M.SC. (Kenya)	Disease development and management on *Lycopersicon esculentum* (tomato) protected from crop pests using agro-nets in Kenya. Department of Biological Sciences Chepkoilel University College (On-going research)
Miriam Kungu	F	M.SC. (Kenya)	Influence of circadian migration behaviour of *Tetranychus evansi* and its predator, *Phytoseiulus longipes* on the efficacy of acaricide treated net in the management of the red spider mite

			(On-going research)
Ginette Azandeme	F	PhD (Kenya & France)	Development of an original technique to fight against phytophagous mites. Environmental impact and complementarity with other methods in protecting horticultural crops (On-going research)
Patrick Muthee	M	PhD (Kenya & France)	Determinants of innovation adoption in agriculture: the case of Eco-Friendly Nets applied to vegetable production in Kenya Dept Agriculture Economic and Agribusiness Management, Egerton University (On-going research)
Agohoundjè Victor	M	B.Sc. (Benin)	EFN in the control of cabbage pests in Southern Benin. Ecole Polytechnique d'Abomey Calavi (EPAC). (Defended) *"Les filets anti-insectes dans la lutte contre les ravageurs de chou au sud du Bénin Ecole Polytechnique d'Abomey Calavi (EPAC). (Rédaction du mémoire en cours)"*
Agonsè Hilaire	M	M.Sc. (Benin)	EFN use in the dry season in Southern Benin: impact on growth, pests and diseases of tomato crop. Dept of Crop Production, UATM/ GASA Formation (Université Africaine de Technologie et de Management du Groupe AHIY et S.A.) (Defended) *"Filet anti-insectes : impact sur le développement des ravageurs et des maladies de la culture de tomate en période de contre saison au Sud du Bénin. Session Agronomie : Option Production Végétale, UATM/ GASA Formation (Université Africaine de Technologhie et de Management du Groupe AHYI et SARL) (Rédaction de la thèse en cours)"*
Faustin Vidogbena	M	PhD (Benin)	Use of EFN in controlling crop pests: Adoption and environmental impacts in vegetable farming systems in Southern Benin. Dept of Economics, Faculty of Agricultural Sciences, University of Abomey- Calavi (Collecting data) *"Adoption et impact environnemental du contrôle des ravageurs par le filet anti-insectes (Agro-Net) dans les exploitations maraîchères du sud-Bénin. Département d'Economie, Faculté des Sciences agronomiques, Université d'Abomey- Calavi (Collecte des données en cours)"*

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

Principal Investigator: Dharma Pitchay; Tennessee State University

Collaborators:

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

The project's long term goals are to develop strategies to assist/promote a sustainable peri-urban and urban garden cropping enterprise system for small and minority women growers. 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 system will be a new paradigm in training of women growers. This will encourage the peri-urban and urban gardeners to be receptive and willing to adopt the 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 as to not only how to grow more and better quality product but also how and where to market the product with profit. 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 income in peri-urban and urban areas. It will create opportunities for local growers to supply locally grown garden produce as well for their own consumption family. Peri-urban and urban gardening will be significant contributor to overall quality of life for the communities.

Directly engaged with trainers and growers and provided hands-on field training on the cultural practices which was time saving and effective method of outreach activities. During the interaction, we also had the opportunity to learn the strengths, weaknesses, threats and opportunities of the peri-urban and urban gardening project. In fact, as an eye opener, the project created an environment for collaborators, team members and growers of the host country members to get to know well and explore the potentials and challenges of vegetable and fruit production in their own backyard. The activities are generally carried out by women growers. More than 85% of them are women. Agrochemical vendors and shops act as local Extension Centers for growers in acquiring any cultural techniques. Therefore, most of the answers to growers' issues and challenges in growing crops result in the use of agrochemicals as a solution. The outcome is: Application and use of excessive amount of several different pesticides/agrochemical cocktail to control pest and diseases. In some instances, pesticides are used to overcome fertility and abiotic stresses including nutrient deficiencies and over watering.

Several informal training that were provided in the actual field conditions include the seedling establishment, transplanting, mulching , harvesting techniques, minimal processing, grading and storing, handling and shipping of farm produce to minimize losses and increase quality. We certainly emphasized on pre and postharvest handling of vegetables using simple gadgets such as thermometer indicating the field, sorting and grading area, and packed vegetable temperature differences and the perishability of oriental vegetables. The growers trainers and growers convinced and willing to make necessary changes to their practices.
We also had the opportunity to stress the importance of crop rotation, multiple cropping systems, which may provide natural shade by selecting climbers (bitter melons, luffa, gourds, cucumber etc.) for improved cultural practices in areas with limited land size. Water management, which includes over and under watering or contaminated water, is a common issue in the production system. Several options were provided to with the inputs from the stakeholders on harvesting rain water etc. for growing the leafy greens during drought season.
We 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 this point, the host country collaborators, project team members, trainers understand the entire peri-urban and urban market gardening food supply chain challenges, weaknesses, threats and opportunities. The training part itself definitely helped us to put together a comprehensive effective training program for the trainers and growers in coming months and achieve the goals of the project.

Extension of Appropriate Postharvest Technology in Sub-Saharan Africa: A Postharvest Training and Services Center

Target Countries: Rwanda, Ghana, Kenya, Tanzania, Benin, Gabon

Principal Investigators:
Diane M. Barrett, University of California, Davis
Lisa Kitinoja, World Food Logistics Organization
Rob Shewfelt, University of Georgia
Victor Afari-Sefa, AVRDC-The World Vegetable Center, Tanzania
Project Description
Physical losses of horticultural crops postharvest continue to range from 30-80 percent in Sub-Saharan Africa, 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 small women farmers in Tanzania.

The project site in Tanzania, at the World Vegetable Center's regional office in Arusha, will serve as a model for postharvest development in five additional Sub-Saharan countries, whose representatives will participate via collaboration with African partners. By the close of project, 30 postharvest specialists from the six countries involved in Sub-Saharan Africa 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 to women farmers.

Objective 1: Build local scientific and technical capacity						
Activities / Tasks	Indicators			Measure of Success	Documentation of Success	Progress to Date
	Outputs	Key Outcomes	Definitions and notes			
1.1 Train Africans as postharvest specialists	Design and implement a six-month long Training of Master Trainers program	30 Persons with horticulture oriented jobs trained as postharvest specialists	horticulture oriented jobs = researchers, extension workers or development workers	34 persons enroll and complete training assignments and turn in final reports	196 applications for training were received from 12 SSA countries. A self-administered written training needs assessment was utilized to identify those applicants who were most ready and able to participate in the ToT program. The top 40 trainees from seven SS Africa countries were selected ToT program (consisting of 10 assignments, CD of training materials) was designed and launched in February 2011 Trainees have completed assignment #5 and are presently working on Assignment #6. They submitted reports on a commodity of interest	Implementation is on-going. Trainees on now on assignment #9 out of a total of 10.

					in their country, and identified the current problem, potential solutions and future training, research and advocacy needs. Trainees are linked via internet websites (linkedin.com discussion group "Postharvest Training" and the blog http://postharvest.tumblr.com) and are actively engaged in sharing their ideas and experiences. The linkedin.com site also includes over 100 others who are interested in the topics of training and many postharvest experts who answer their questions. Seven additional trainees were invited in April to participate on the recommendation of our Rwanda and Tanzania collaborators Seven trainees have dropped out due to work, travel or health related issues. Currently (Sept 2011)	

					we have 40 active ToT participants (20 men and 20 women).	
1.2 Identify local Farmer's Marketing Associations or Women's cooperatives in Rwanda	Farmer marketing Associations or Women's cooperatives identified as project beneficiaries	5 or more women's cooperatives agree to work with the project		Each association will have at least 100 active members –at least 50% women	Several large farmers coops and locally active groups were identified during a field visit to Rwanda in March 2011, including CODEPRAG (700+ members) and local womens' groups near the future site of the PTSC in Mulinde (near Kigali).	Completed
1.3 Build the capacity of farmer's associations and women's cooperatives in Rwanda	Design and deliver management training and marketing strategies training for the leaders using lessons learned from various models of horticultural development	20 Lead farmers, village women and members involved in farmer group management trained in management and marketing strategies	Models of horticultural development include: Egyptian organic horticultural products company SEKEM; MCC Cape Verde Postharvest Trainin	20 leaders participate in capacity bldg training activities	A marketing options workshop has been designed and is scheduled to be offered in November 2011 (PY2) for local farmers group and cooperative leaders. This workshop will be managed by our partners at KIST.	KIST marketing options workshop held in Dec. 2011, with 29 participants from Rwanda.

			g and Services Center; Kenya, Zambian and HEIA Egyptian export marketing associations			
Activities	Indicators			Measure of Success		
	Outputs	Key Outcomes	Definitions and notes			
2.1 Design and set up a postharvest training and services center (PTSC)	One postharvest PTSC established in Kigali, Rwanda	Local PTSC established	Includes: Assessment, design, Structure, equipment, supplies for demos, shop, training venue	Design completed, one structure constructed, stocked with postharvest supplies and equipment for demos and services	The site for the PTSC has been allocated by MINAGRI, and the design has been approved. A materials/supplies list has been developed and procurements will begin in PY2. This process will be managed by our partners at KIST. Demonstrations and facility features (cold storage room, shop, ZECC, solar driers, etc) are scheduled to be ready for the ToT workshops to be	PTSC set-up progress -- we have a new site in Arusha with AVRDC as our local partner. I will visit in May to assist with

					offered at the PTSC in Feb/March 2012.	procurement planning and organizing some volunteer help from our TZ trainees to set up postharvest demos, training, site preparations for our launch on Oct. 2012.
2.2 Identify an African and train him/her to be PTSC manager	Criteria for selection established. Candidates will be recruited from among junior staff members of KIST or ISAR.	PTSC manager identified; trained	Criteria may include: English skills, experience Fees from PTSC services will	Training provided in postharvest technology, center management, marketing, inventory control, staff supervision skills, fee setting, recordkeeping, etc.		

			support this position once project ends.			
Objective 2: Apply research findings and technical knowledge to increase small producers' participation in markets						
Activities	Indicators			Measure of Success		
	Outputs	Key Outcomes	Definitions and notes			
1. Provide innovative training programs	50-60 innovative training programs and postharvest supplies and services to the local community in and around Kigali, Rwanda	Reduced PH waste and improved market value	innovative small-scale appropriate postharvest handling to reduce postharvest losses of horticultural crops	Minimum of 25 training programs per year (2 per month over 2 years) for audiences of 30 persons each	Will take place in Oct 2011 – Oct 2013	
2. Conduct adaptive research, demonstrations and commercial operations in the PTSC	10 topics investigated	Reduced PH waste and improved market value	Adaptive research on pest control, plastic-free packages, low cost cool chambers, improved solar drying and/or other	Reports on results of research studies on minimum of 10 topics	Will take place December 2011 – October 2013	

			topics	submitted to PIs		
Activities	Indicators			Measure of Success		
	Outputs	Key Outcomes	Definitions and notes			
3. Ongoing technical support to PTSC by visiting project scientists	12 Training workshops and demonstrations of appropriate interventions by scientists and trainers from UC PTC, UGA, WFLO and Africa	Increased technical capacity of Project staff and association members involved in day to day operation and management of PTSC	Visiting scientists will be from many established African organizations with postharvest expertise (may include STTA from KIST, ISAR, ILK, and Umatara Polytechnic in Rwanda; KARI and Moi Univeristy in Kenya; MAFS in Tanzania; and Tamale PolyTechnic and CSIR in Ghana)	Minimum of 6 per year (12 visits over 2 years) provided for PTSC clients	Will take place October 2012-September 2013	
4. Local African trainees prepare to repeat training in their own	PH Specialist Trainees participate in one program at the PTSC	50% of each group trained will be women		Trainees prepare reports on a	Upon completion of visit to PTSC	

locales	during the course of their training,			program designed for their home country		
5. PTSC will work toward generating its own income	PTSC will charge fees for services, sale of tools and supplies, and rent-to-own or leasing agreements	Earned funds to cover personnel costs, utilities, and additional training as needed		Income grows over time from zero to self-supporting (set goal during initial assessment and design phase)	Monthly	
6. Linkages to current and planned USAID and MCC projects	The PTSC will link to the Beans/Cowpeas CRSP; RHESI; PFID-F&V; RAISE; KHDP; MiDA projects	PTSC project will serve as a successful model for future large scale projects in Africa		Partners identified and proposal developed for submission to BMGF for expanded funding	On-going	

Part III. Narrative. Please supply a narrative on your progress to date.

Our project was significantly delayed due to a number of reasons, and finally we had to stop our collaboration with KIST in Rwanda and seek a new partner. At the Hort CRSP Annual meeting in February, held in Thailand, Diane Barrett spoke with Dino Keating and he agreed on behalf of AVRDC to host the PTSC in Arusha, Tanzania. Between February and end of April, budget was recalculated and has been approved by AVRDC. Dr. Beth Mitcham recently approved the budget and we are awaiting Heather Kawakami's approval before we can proceed.

1) ToT program progress (we are now on assignment 9 out of a total of 10) and we have 34 postharvest trainees actively engaged.

2) PTSC set-up progress -- we have a new site in Arusha with AVRDC as our local partner. I will visit in May to assist with procurement planning and organizing some volunteer help from our TZ trainees to set up postharvest demos, training, site preparations for our launch on Oct.

3) Completed trainings for farmers -- the KIST marketing options workshop, held in December 2011, with 29 participants from Rwanda.

2nd report

1. Training of Trainers program. Our 36 trainees have will have completed all 10 assignments following their 'in-person' training at AVRDC in October 2012. This activity took approx. 18 months to complete, due to delays with our initial collaborator, KIST in Rwanda.
2. Marketing Workshop. KIST held a Marketing Workshop in December 2011, with 29 Rwandan participants. (Reports were provided previously.)
3. February 2012. One of our Master Trainers, Ms. Odette Ngulu, was invited to attend the Annual Hort CRSP meeting in Bangkok, Thailand. Ms. Ngulu worked with Dr. Barrett on a join presentation describing the progress of the project. She engaged in active discussions, met with other Hort CRSP project leaders and discussed her specific postharvest interests with Dr. Barrett.
4. Change in Collaborator. Our project was significantly delayed due to a number of reasons, and finally we had to stop our collaboration with KIST in Rwanda and seek a new partner. At the Hort CRSP Annual meeting in February 2012, held in Thailand, Diane Barrett spoke with Dyno Keatinge and he agreed on behalf of AVRDC to host the PTSC in Arusha, Tanzania. Between February and end of April 2012, the budget was recalculated and was approved by AVRDC. Funds were re-allocated to AVRDC in May 2012.
5. Dr. Kitinoja visits AVRDC in Tanzania in May 2012. Dr. Kitinoja visited and met with Dr. Victor Afari-Sefa, the new PI from AVRDC. They evaluated a number of possible sites for the PTSC, discussed costs of building the facility and specifications for size and construction. They also discussed staff requirements, materials and supplies required prior to opening the PTSC in October 2012 and training our 36 Master Trainers.
6. AVRDC successfully requested additional funds from the Tanzanian USAID mission to hire a Postharvest Specialist, Mr. Ngoni Nenguwo, using Feed the Future funds. Mr. Nenguwo was hired on a 4 year project to provide additional oversight on postharvest research activities in Sub-Saharan Africa, Bangladesh and Cambodia. He will begin his position in early October 2012 prior to our launch of the PTSC.

Sustainable Development of Horticultural Crops in Zambia by Introducing Postharvest Technologies and Practices for Food Security, Income Generation and in Support of the Tourism Industry

Target Country: Zambia

Principal Investigator: James E. Simon, Rutgers, The State University of New Jersey

Co-PIs:

Rodolfo Juliani, Rutgers University, USA
Petrus Langenhoven, Agribusiness in Sustainable Natural African Plant Products (ASNAPP), South Africa
Newton Phiri, ASNAPP, Zambia
Elke Crouch, Stellenbosch University, South Africa
Collaborators:

Bill Sciarappa, Ramu Govindasamy, Albert Ayeni, Rick VanVranken, Rutgers University
Stephen C. Weller, Purdue University
Richard Tracy, Global Cold Chain Alliance, USA
Lisa Kitinoja, World Food Logistics Organization, USA
Project Description
The goal of this project is to build on gains made in the Livingstone, Zambia, horticulture program and the related Immediate Impact Project, and further extend economic opportunities to small-scale farmers in Zambia.

This project seeks to strengthen the value chain for fresh market vegetables with a focus on postharvest handling. Building upon our successful introduction of locally produced commercial vegetables into southern Zambia's Livingstone region, this proposal will expand local production of fresh vegetables for the tourism and supermarket industries and reduce postharvest losses by 40 percent. As local production displaced more expensive imported vegetables, significant economic opportunities for small-scale farmers were achieved.

This proposal will strengthen the value chain and scale up production to supply markets in the Livingstone area. As the major constraint to scaling up is the lack of cold-chain systems, this project focuses on introducing a strong postharvest and cold-chain program to reduce postharvest losses and increase profitability along the value chain, ensuring food security and promoting rural livelihoods and diversified income streams.

Using an innovative, market-first, science-driven approach with a focus on applied postharvest technologies, farmers will be trained in good agricultural management practices, postharvest and storage systems, and entrepreneurship; they will also be linked to sustainable markets. Innovative technologies including low-cost coolers, quality control in postharvest technology and appropriate cold storage systems

at the farm. Our private sector partners include Sun International Hotels, David Livingstone Hotel, Freshmark/Shoprite and SPAR supermarkets. Many secondary micro-enterprises to support the farmers will be created.

This report covers our activities from January 1, 2012 to September 31, 2012. During the reporting period, on farm training on the production of vegetable seedlings using greenhouse technology was conducted and 145,500 seedlings were produced and sold to the value of $26,000.

One permanent full time staff was employed to focus on this project. He has been working closely with the Communities and the Market. He has been making sure that the communities produce good quality product according to the market specification through on farm trainings using the lead farmers that in turn were able to train the groups the lead on crop production and postharvest handling (due diligence in food safety). Because of these measures, the markets (Sun International, Protea Hotel, Chrisma Hotel, Lodges and Supermarkets) are very satisfied and are requesting additional fresh product from the farmers that are working and have been trained with ASNAPP under this programme, which has quality assurance measures in place. Dr. Langenhoven and Mr. Newton Phiri made a number of trips to Livingstone to give support to the programme and also to the Staff. Drs. Simon and Weller made one trip in April to this site to provide additional technical back-up.

The following crops were grown under the reporting period: Cabbage, Okra, Carrot, Sweet corn, Egg plant, Baby marrow, Butternuts, Green beans, Gem squash, Sweet melon spanspek, Water melon, Patty pan, Bulb Onion, Celery, Pumpkin, English cucumber, Zambian cucumber, Big tomato, Cherry tomato, Sweet pepper –green, Sweet pepper -red & yellow, Spinach, Oranges, Irish Potato, Chinese Cabbage, Rape, Pumpkin Leaves, Sweet potato Leaves, Cauliflower, Broccoli, Lettuce, Garlic, Strawberries, Basil, Bean sprout, Bokchoy, Chives, Green maize, Ginger, African Eggplant, Lemon grass, Red onion, Parsley, Magetout, Spring onion, Amaranthus, Pawpaw, Banana, Oyster Mushroom.

A number of field visits were made and 15 farmer groups with a total number of 267 (female 152, male 115) growers were reached for technical back stopping in the area of improved production techniques. Crops sold to the Livingstone market reach 458 tons to the value of $679,417.

During Q1 and Q2, we wrote initial draft for two planned training modules (1) on food safety and postharvest handling for small-growers in Zambia. Draft module now being reviewed by Zambian partners; and (2) a draft production guide for small growers, with focus on organic production. Draft manual/module new being reviewed by Zambian partners. Aiming for the text of both of the above training modules to be completed by February 01, 2013. The capture of appropriate photos may take longer as we want to use photos from the growers and Zambian farmers with whom we are working to be used in the final modules (copies available upon request)

On the Oyster mushroom, we have two partners, that is Chief Mukuni of Livingstone and Kazungula districts of Southern province of Zambia and another Non profit making organization called LeadLoad have come on board to help increase the production capacity of the communities through the provision of finance to the community to enable them construct more production units under the CRSP supervision. The mushroom that is being produced at the moment under the CRSP project is only less than 5% of the market demand.

During the same reporting period, we introduced HK 51 Oyster mushroom in Livingstone at the Maramba HBC group. This group has since produce 419kg of oyster mushroom that was sold to Royal Livingstone Hotel, which is the five star Resort for Sun International to a value of $1,634.10.

Packhouse- From the meetings that we have had with Sun Hotel and Development Bank of Zambia, the two entities have agreed to fund the construction of Packhouse that will be used as a product consolidating centre for fresh fruit and veg on the CRSP programme in Livingstone. This packhouse will be supervised by the CRSP programme. Apart from serving as a central place for the product, this center will also do the value addition to the product according to the market specification, it will also help in the management of the cold chain that will in turn increase the product shelf life which has been a challenge at times. This deliverable has been slower than anticipated and relies on the progress and continued movement of the private sector. We hope and anticipate this will proceed satisfactorily and be done by end of Y2.

The following number of students were trained (in-service training) during their industrial attachment; 2 from Natural Resource Development College, 3 (2 female, 1 male) from Zambia Cooperative College, 2 (Female 1, Male 1) from Mulungushi University and 1 female from Lusangu University. These students received practical training in the production of fruit and vegetables, postharvest treatment of fruit and vegetables and marketing of fruit and vegetables.

During March 2012 the group worked on developing and finalizing the baseline data survey. The survey will now be completed during September 2012.

Frost- The programme suffered a setback during the reporting period due to black frost that Livingstone and Kazungula districts experienced this year. Frost hit the area 4 times in a month beginning May, June, July and early August. This resulted in lower production as some farmers could not replant their fields after frost burnt their crops. Production and sales from the farmers only increased after the second week of August.

Because of the importance of this CRSP programme, DFID is waiting for our recommendations on the introduction of Greenhouse in the area as a way of mitigating frost problems during winter period.

PostHarvest- Visit by Simon and Weller to Zambia in April, 2012 to Zambia lead to meetings with University of Zambia faculty and staff; two of which are enrolled in the Postharvest Foundation education on-line postharvest course (and received tuition scholarship for this class). Simon purchased five CoolBots and brought them to Zambia for use in Lusaka area (1), Livingstone area (2) and for Stellenbosch University (1), and for the University of Zambia (1), postharvest collaborating partner. A 6th CoolBot and AC unit was purchased for set-up and use at Rutgers as well. The CoolBots will be installed in Q3 and Q4 of Y1. Plans to introduce postharvest and cold rooms into this continuation project were set to begin in Y2 with the CoolBots and affordable coolers first being built in latter half of Y1 and after staff begins training in postharvest handling.

A formal cold chain analysis was completed by the Global Cold Chain Alliance (GCCA). Visit by Richard Tracy and Nikki Duncan in July 2012 from the World Food Logistics Organization (WFLO), a core partner of the GCCA led the cold chain analysis study in Zambia. Our work will now build upon their insights and recommendations (copy available upon request)

Currently, we have Newton Phiri who is doing his B.Sc. in Agricultural Sciences on the CRSP programme who will be leading the on-site cold chain studies using the CoolBot and other low cost affordable coolers, including a planned cold storage units as a root cellar and built under the ground. This will be compared to the above ground CoolBot in Zambia and geared for low respiring produce (potato, onions, squash, pumpkins, cabbage). The root cellar approach will be field tested in Q1 and Q2 of Y2.

In concert with the postharvest education foundation, we constructed in Q1 and Q2, a survey on plastic recycle containers and a cost calculator. The survey will allow us to really figure out how best to use plastic containers in Zambia in support of small-farmers (a copy of this survey and cost calculator is available upon request).

A total number of 11 extension Officers from the Ministry of Agriculture and livestock were trained in both production and postharvest technologies.

More trainings will follow.

IDENTIFICATION OF SMALLHOLDERS - Lusaka
This process is an ongoing program. Certain organizations and farming groups were contacted and informed about the ASNAPP exhibit at this 86th agriculture and commercial show. This is to give them opportunity to visit ASNAPP stand and get more information about the CRSP and CASH project. This will also give an opportunity to meet and arrange for formal visitations to these areas. Below are some of the contacted groups.

FARMING GROUP	AREA	CONTACT PERSON	TITLE	CONTACT	REMARKS
Luminary Foundation	Kabanana-Lusaka	Mrs. Mukusulo	Director	097763575	Horticulture production
Shimulayi cooperative	Chibombo	Mr.A.Mawite	Chairperson	0978172693	Mushrooms & horticulture
Mapalo group	Chazanga-Lusaka	Mrs. R.K.Kasanya	Director	0977610360	Horticulture & community school
Messiah women ministry	Kafue	Mrs. Judith Gupingu	Director	0977616629	Horticulture &community school
Ministry of agriculture	Lusaka	Mrs. Pricilla Phiri	Agriculture assistant	0977851230	Extension to smallholders
Bauleni street kid	Bauleni-Lusaka	Mr.C.Mulenga	Accountant	0978677060	Horticulture & community school

World vision	Chongwe	Mr.R.Kaulule		097731587	Support to community based organizations
Ministry of agriculture	Mumbwa	Mr.Lukubi	District marketing officer	0977932777	Extension to smallholders
Kanakantapa women association group	Kanakantapa	Mrs. Chisangamo	Director	0977720935	Conservation farming
Mapepe multipurpose society	Mapepe	Mr. Zulu	Board secretary	0977366666	Horticulture production

The above table was done in collaboration with the CASH- GDA programme

POTATO FIELD DAY

www.hzpc.com

HZPC Companies core business is breeding, growing and marketing of potatoes. HZPC is based in Holland and many other countries in Europe and America. HZPC is one of the largest private seed potato companies in the world. HZPC in partnership with Enviro flor, Hygrotech and MRI organized a field day held at enviro flor on the 27th of July 2012.The main topic was on the new varieties of potatoes being tested within Zambian climate and conditions. Ten (10) different varieties such as; VDW 01-69, Evora, Sylvama, Compass, Caesar, HZ 01-899 and Sifra are planted and subjected to local conditions . To meet the customer needs in different market sectors, HZPC operates a modern breeding station. Suitable varieties are developed for specific market segments traditional, retail fresh, French fries and peeled. The extensive breeding program combines quality, yield, disease resistances and sustainable characteristics.

Above is VDW 01-69 among the varieties currently planted at Enviro Flor Farm

This field day was officially opened by Mr. Watson the Managing Director for Enviro Flor who introduced a Mr. Aryan representing HZPC based in Holland. About 60 Farmers and representatives from different organizations attended the field day.

Dr. Petrus Langenhoven (ASNAPP-Zambia) and Dr. Ramu Govindasamy (Rutgers) attended the Hort CRSP Annual Conference in Bangkok, Thailand, during 7-12 February 2012.

During the period of July 2012, ASNAPP received representatives from World Food Logistics Organizations based in Alexandria USA on 9th of July 2012.WFLO is an international organization which supports effective use of cold chain management systems in perishable goods. Different institutions which play key role in cold chain management systems were visited during this period.

MEETINGS
Representatives from WFLO, Dr. Richard Tracy – Director of international programs and Miss Nikki Duncan-international programs manager accompanied by members from ASNAPP to visit these institutions bellow.

INSTITUTION	CONTACT PERSON	POSITION	DATE

ZEGA	Mr. Luke C.Mbewe	Chief executive	10th July 2012
ENVIRO FLOR	Mr. Watson	Director	10th July 2012
MATATU FARM	Mr.S.Clever	Farm manager	11th July 2012
HOTEL INTERCONTINATAL	Mr.Jere	Head Procurement	11th July 2012
PAMODZI HOTEL	Mr.Ndalama	Head supply & stores	13th July 2012
FRESH MARK	Mr. Graeme	General manager	12th July 2012
SPAR ARCADES	Mr.D.Kaluba	Head Fruit & vegetables	13th July 2012
KANGO FISHERIES	Mr.A.Mwenya	Director-operations	12th July 2012
YORK FARMS	Mr. Alias	Assistant pack house	13th July 2012

ABOVE COLD CHAIN MANAGEMENT SYSTEMS AT YORK FARMS FOR HORTICULTURE PRODUCTS

LESSONS LEARNT/CHALLENGES

These visits to different stake holders involved in the support of cold chain managements were very successful. It has been noted that cold chain management systems plays key role in horticulture fresh products industry. The following have been learnt from the visitations done;

1. Cold chain management systems plays key role in reduction to post-harvest losses especially in perishable products and also in export industry.
2. Demand for horticultural products for local industry and export markets is currently very high in Zambia.
3. High quality, hygiene standards and consistence in production and supply are key areas for one to supply local and export markets.
4. High value crops are on high demand that above 80% is imported from other countries; hence need to introduce locally produced exotic crops among small holders.

The biggest noted challenge in this cold chain industry is the high cost involved to procure and maintenances of these facilities. There is also lack of local trained work force to repair and maintain these equipment's.

The draft report on this survey is out for comments (See attached).

We received five CoolBots for our partners during the reporting period. The CoolBots are meant to help on the management of cold room temperature.

We had a successful meeting at UNZA were we looked at the involvement of the institution in the area of postharvest and involve students as part of their studies particularly on the use of the Coolbots. The meeting was attended by Prof Weller, Prof Simon, Dr. Langenhoven, Mr. Newton Phiri from the CRSP programme and two departmental head from UNZA under the food science department.

Delivering Vegetable Safety Education through Established Social Networks in Latin America

Target Country: Guatemala, Honduras and Nicaragua

Principal Investigator: Jeffrey LeJeune, The Ohio State University

Collaborators:
Alfredo Rueda, Zamorano University, Honduras
Julio Lopez, PROMIPAC, Nicaragua
Eduardo Pretzanzin, Universidad de San Carlos, Guatemala
Yordana Valenzuela, extension specialist, Nicaragua and Honduras
Project Description
Contamination of vegetables with foodborne pathogens and spoilage organisms results in foodborne illness and economic losses. This problem is worldwide, but is particularly serious in Central American countries that are already fighting problems due to poor nutrition and poverty. Despite the potential magnitude of the problem, small-scale Latin American farmers are generally unaware of these hazards and losses and how these risks can be prevented. The lack of awareness of these risks (and potential benefits realized by their control) complicates communication efforts on the subject and hinders the sustained adoption of safe agricultural practices in horticultural production.

This project hypothesizes that established social networks will provide an effective and efficient venue to communicate vegetable microbial contamination information and promote management changes to improve produce safety and quality. We will test this hypothesis using several social networks (greenhouse associations, organic production associations, health clinics, schools, and traditional extension outreach programing) to communicate food safety and quality messages. These networks are particularly relevant as they are expected to include a large proportion of female farmers. Increases in awareness among farming communities in Honduras, Guatemala, and Nicaragua will be measured. Successful pathways of communication will be expanded and adoption of food safety practices assessed.

At the completion of these participatory research and outreach activities, several tangible goals will be accomplished:

food contamination will decrease;
farmer health and produce quality will be improved among participants;
new opportunities for sale and trade of produce will be opened, increasing economic viability for farmers; and
a model system for effective delivery of agricultural assistance in Central American countries will be validated.
These methods can then be applied to communicate other important information to enhance crop production, microfinance, or additional nutritional education.

1st report

Activities to date have included the Annual Meeting in Bangkok, Thailand, preparation of curricula materials, and completion of materials for the Institutional Review Board dealing with human subjects. An important, exciting and timely aspect of this project is the new partnerships being formed with Drs. Francoise Fontannaz (World Health Organization) and Marjorie Davidson and Enrique Perez (PanAmerican Health Organization). Dr. Fontannaz (WHO) developed the manual "Five keys to growing safer fruits and vegetables: promoting health by decreasing microbial contamination" available in both English and Spanish (uploaded). This manual has been pilot tested with Drs. Davidson and Perez in El Salvador. All three of these individuals are highly interested in this project and are encouraging us to use their materials and are willing to work with us. Through this collaboration, newly expanded partnerships have developed. Collectively, we have submitted a proposal complementary to this current HortCRSP project to USAID to fund a project to adapt the manual to the African context and culture.

2nd report

Our research has not started as we are still waiting on the IRB approval from Ohio State. Since our other universities we are collaborating with do not have an internal IRB review board, all responsibility for ensuring safety to the participants falls on our own (Ohio State) review board. We take this very seriously and it has been determined that the instrument tool we are using to educate participants is not exempted research. We are expediting the process, but it is taking a long time to complete and obtain the necessary guidelines and signatures. We feel confident that those should be in place very soon, at least for the research that will be conducted in Honduras/El Salvador and Nicaragua in conjunction with Zamorano University. For the research that will be conducted in Guatemala, we are in the process of approving an individual investigator (Dr. Pretzanzin). There are certain criteria he needs to complete (namely CITI training) before he can be approved to begin research.

Sustainable African Indigenous Vegetable Production and Market-Chain Development for Improved Health and Nutrition and Income Generation by Smallholder Farmers

Target Country: Kenya, Tanzania and Zambia

Principal Investigators:

Stephen C. Weller, Purdue University
Maria Marshall, Purdue University
James Simon, Rutgers University
Co-PIs:

Pamela Obura, USAID/AMPATH Project, Moi University, Kenya
Chris Ojiewo, AVRDC-The World Vegetable Center, Tanzania
Petrus Langenhoven, Agribusiness in Sustainable Natural African Plant Products (ASNAPP), Zambia
Project Description
This research project seeks to support and strengthen the African indigenous vegetable (AIV) industry using a market-first approach to overcoming constraints along the value chain, leading to improved production practices, supply, postharvest handling, distribution and consumer acceptance of AIVs in Kenya, Tanzania and Zambia.

Key pieces of the project are development of strong public-private sector partnerships that ensure activities support the needs of consumers and markets. These partnerships will involve germplasm evaluation, development of sustainable production techniques, seed production/saving techniques, improved market access and building stakeholder capacity through outreach programs at all levels of the AIV value chain.

This project will both characterize nutritional attributes of AIVs as well as create awareness of health and nutritional benefits of AIVs through household and market surveys and educational programs about nutrition. The project will bridge information gaps through research and promotional activities cooperating with private sector, farmer groups, government, research and non-governmental organizations to build confidence in AIV production and enhance farmer adoption. Project activities will build capacity of African universities and institutions involved in research and training of extension personnel who serve the farm community. Improved indigenous vegetables will provide nutritional complements to diets.

The approach promotes biodiversity and sound environmental management while providing affordable, edible foods that can be grown/processed locally and are tailored to local dietary needs. Activities will result in improved income generation, new microenterprises across the value chain, improved availability of nutritious AIVs for consumption and overall improved quality of life.

This project builds on two previous projects, one in Kenya and one in Zambia.

1st report

This report covers our activities from October 1, 2011 to March 31, 2012. The report does not contain many direct activities with our target clients in the agriculture sector other than getting our collaborating partners organized. The reason for this is that we did not get the final Hort CRSP contract signed with University of California, Davis until the first of March, 2012 and then it took most of the month of March to send out sub-contracts to our collaborators in the US and Africa. These sub-contracts were not were finished until the end of March. Unfortunately, with these delays, our activities were limited due to lack of funds for our African collaborators. However, we did have several activities that included an inception meeting of key our collaborators in mid-October of 2011. This meeting with us to discuss, plan and establish duties and responsibilities of all collaborators on this project. This inceprtion meeting was held in Arusha, Tanzania from October 14 -17, 2012 and involved key collaborators from Kenya, Tanzania, Zambia and the US and results and plans are expanded on in the l. Monitoring and Evaluation Plan above under Part II of this report. Our Second activity involved sending 2 of our collaborators, Nancy Kaaya from the Horticulture Research Institute in Tengeru,Tanzania and Naman Nyabinda from AMPATH/FPI in Eldoret, Kenya to a Post-Harvest and Technology of Horticulture Crops workshop held in Lusaca, Zambia on Novemebr 8-10, 2011. This meeting was conducted by ASNAPP who is a partner with us on this Hort CRSP project. The meeting is described in more detail under trip reports of Nancy Kaaya and Naman Nyabinda. A third activity was the annual Hort CRSP Managing Entity meeting of all Hort CRSP collaborators that was held in Bangkok, Thailand from February 8 -11, 2012 and was attended by 3 of our collaborators, Steve Weller, Pam Obura and Petrus Langenhoven. Also during this period, Steve Weller and Pam Obura attended the Drying Beads workshop held on February 7 at Kasetsart University sponsored by the Hort CRSP project Seed Systems – Improving Seed Quality for Smallholders (see trip report for details).. ,. We sent 3 project collaborators, Christine Ndinya, Chris Ojiewo and Newton Phiri to the Drying Beads workshop held the week of February 12 sponsored by the Hort CRSP project Seed Systems – Improving Seed Quality for Smallholders (see trip reports for details. Other activities included design and human subjects approval of our initial project producer survey that will be conducted in Kenya and Zambia and also design and approval of our post-harvest survey in Tanzania that will be conducted in the next 6 months. . Naman Nyabinda is a student in the post-harvest, on-line course conducted by Lisa Kitinoja and Diane Barrett which is underway in Africa and includes course work and a final workshop at the conclusion of the course. This course will provide Naman with expertise in postharvest necessary in our project and the ability to properly construct the planned coolbot refrigeration unit in Kenya. I have also leveraged a 3 year Andrews Fellowship for a new Ph.D. student in the amount of $15,750 per year. The student will start at Purdue University in the fall semester of 2012 and will work on the Hort CRSP AIV project. This student will spend the summer in Kenya funded partially on funds outside of the Hort CRSP in the amount of $5,000. The lack of full funding until March, 2012 has slowed our progress to date but we are now ready to finish our survey work early this quarter and begin our field studies and other planned activities including as outlined in Part II of this report.

2nd report
Zambia. The following are the activities that were undertaken during the reporting period:

Field trials

We received seed for Amaranth, African Nightshade and spider plant from the AVRDC - World Vegetable Centre in Kenya. Of each product line, Zambia received five varieties of each product line and these were: Amaranth (AM-45, Madiira 1(EX Zim), Madiira 2(AM-38), UG –AM -40 and EX Mwanga). African Night Shade (Nduruma (BG 16), Olevolosi(SS 49), EX Hai, SS 52 and SS 04.2). Spider plant (ML-SF -29, UG –SF -15, PS, UG- SF – 23 and ML – Sf -17. For each variety, we received 1.65g for Amaranth, 1.65 African Nightshade and 1.95kg for Spider plant. Field trials for these varieties have been established in both Lusaka (Mrs. Mwananshiku, plot 25 Chamba Valley) and Livingstone (Nsongwe Women Group). We are using a Lima (50m x 50m) for each site. We are conducting both agronomic (influence of soil fertility on production) and variety influence of variety on production) trials in Zambia.

From each site, soil samples were taken and we are just waiting for the results from the laboratory. We have since requested climatic data from the metrological department in each area. The results will be shared as soon as we receive them.

Trials will be planted during Q1, year 2

Baseline Household Survey

Under the reporting period, we carried out one baseline survey for Lusaka and Livingstone to mark the current status and practices before the implementation of the project. We had a total of 100 respondents in Livingstone of which 29 were female and 71 were male. In Livingstone were had 100 respondents also with 39 being female and male 61. The results will be sent out after analysis which is currently underway.

Partnership

We have the full support of Sun International, Silva Catering on the Market side, Ministry of Agriculture and Livestock on the extension side. These major partners are very excited about this project and have pledged to give this project the full support.

Kenya

Field Experiment Establishment.
Experiment 1: Variety and fertilizer evaluation trial – Kakamega, Kenya
Seven varieties of African nightshade, spider plant and Amaranth were planted on 12th and 13th September 2012 with three fertilizer treatments using a Split-Split plot randomized complete block design with three replications.
The main plot was the varieties and the sub plots the fertilizer treatments. Plot sizes were 1.8 m by 4m and the spacing of 40 cm by 60 cm for nightshade and 25 by 60 cm for amaranth and spider plant. The total numbers of plots in the trial are 189. The rates of fertilizer applied were 125 kg /ha for the artificial fertilizer and 6 MT/ha for Farm Yard Manure (FYM).

The varieties were:-
Nightshade
1. BG-16
2. SS-49
3. EX-HAI
4. SS-52
5. SS0 4.2
6. Local commercial source (Kenya Seed Company)
7. Available market seed

Amaranth
1. AC-45
2. Ex-Zim
3. AC-38
4. UG-AM-40
5. Ex Mwanga
6. Local commercial (Kenya Seed company)

7. Available market seed

Spider plant
1. ML-SF 29
2. UG-SF-15
3. PS
4. UG-SF-23
5. ML-SF-17
6. Local Commercial (Kenya Seed Company)
7. Available Market Seed

Similar variety trials were established at Chepkoilel (Eldoret) and Kitale the week of October !4, 2012. These later plots were delayed because of constant rains during our September target planting date.

Field Lay Out for Variety Evaluation and Fertilizer Trials: Split – Split Plot Design
Rep 3

	S2				S1				S3		
V2	F1	F3	F2 147	*V1*	F2	F1	F3 168	*V5*	F3	F2	F1 189
V7	F2	F3	F1	*V6*	F3	F1	F2	*V6*	F3	F1	F2
V3	F2	F3	F1	*V5*	F2	F1	F3	*V3*	F2	F3	F1
V6	F1	F2	F3	*V2*	F3	F2	F1	*V2*	F3	F2	F1
V5	F1	F3	F2	*V4*	F1	F3	F2	*V4*	F3	F2	F1
V1	F3	F1	F2	*V3*	F3	F2	F1	*V7*	F1	F3	F2
V4	F1 127	F2	F3	*V7*	F2 148	F1	F3	*V1*	F3 169	F1	F2

Rep 2

	S1				S3				S2		
V2	F1	F2	F3 84	*V2*	F3	F2	F1 105	*V2*	F3	F1	F2 126
V7	F2	F1	F3	*V1*	F3	F1	F2	*V4*	F1	F3	F2
V1	F3	F1	F2	*V6*	F3	F2	F1	*V7*	F1	F2	F3
V6	F1	F2	F3	*V7*	F2	F1	F3	*V3*	F3	F1	F2
V3	F3	F3	F2	*V4*	F3	F1	F2	*V6*	F2	F1	F3
V5	F2	F3	F1	*V3*	F2	F3	F1	*V5*	F3	F2	F1
V4	F1 64	F2	F3	*V5*	F2 85	F3	F1	*V1*	F1 106	F3	F2

Rep 1

	S2						S3						S1					
V1	F1	19	F2	20	F3	21	*V5*	F3	40	F2	41	F1	42	*V7*	F3	61	F2	62	F1	63
V4	F3	18	F1	17	F2	16	*V4*	F1	39	F3	38	F2	37	*V6*	F2	60	F3	59	F1	58
V2	F2	13	F3	14	F1	15	*V3*	F2	34	F1	35	F3	36	*V5*	F3	55	F2	56	F1	57
V3	F1	12	F2	11	F3	10	*V1*	F3	33	F2	32	F1	31	*V4*	F1	54	F2	53	F3	52
V5	F1	7	F3	8	F2	9	*V7*	F1	28	F3	29	F2	30	*V3*	F3	49	F1	50	F2	51
V7	F2	6	F1	5	F3	4	*V6*	F2	27	F3	26	F1	25	*V1*	F2	48	F1	47	F3	46
V6	F2	1	F3	2	F1	3	*V2*	F2	22	F3	23	F1	24	*V2*	F1	43	F2	44	F3	45

Note: Main plot = Species (S1=Nightshade: 1=BG 16, 2=SS 49, 3=EX Hai, 4=SS 52, 5= SS 05-2, 6= Kenya Seed and 7=Market. S2 = Amaranthus: 1=AC 45, 2=XZim, 3=AC38, 4=UGAM40, 5=XMwanga, 6= Kenya Seed and 7=Market. S3=Spider Plant: 1=MLSF29, 2=UGSF15, 3=PS, 4=UGSF23, 5=MLSF17, 6= Kenya Seed and 7=Market).

Sub plot = Varieties (5 improved varieties, a commercial variety and a popular local variety – see above)

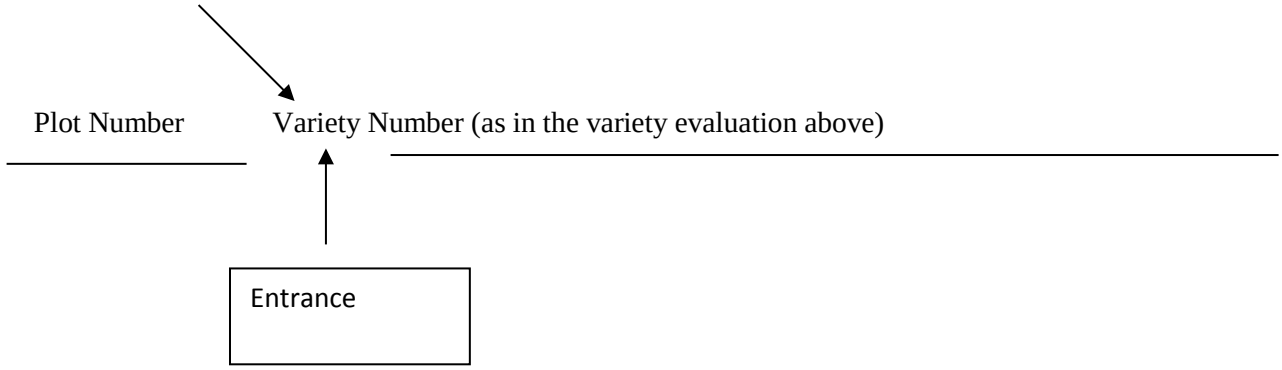
Sub-Sub plot = Fertilizers (F1 = No fertilizer, F2 = Manure and F3= Commercial fertilizer-DAP)

Experiment 2: Seed Evaluation Trial

Seven varieties of night shade, Amaranth and spider plant were planted on 14th September 2012 using a randomized complete block design replicated three times. The experiment was planted using DAP fertilizer at the rate of 125 kg/ha.

Seed Evaluation Trial

	S2 (Amaranthus)						S1 (Nightshade)						S3 (Spider plant)					
	Rep 1		Rep 2		Rep 3			Rep 1		Rep 2		Rep 3			Rep 1		Rep 2		Rep 3	
	V4	7	V1	8	V1	21		V2	22	V3	35	V6	36		V6	49	V3	50	V3	63
	V1	6	V5	9	V3	20		V6	23	V7	34	V4	37		V2	48	V1	51	V1	62
	V6	5	V3	10	V4	19		V1	24	V4	33	V1	38		V3	47	V7	52	V7	61
	V2	4	V6	11	V7	18		V4	25	V5	32	V2	39		V5	46	V4	53	V6	60
	V3	3	V2	12	V6	17		V7	26	V2	31	V5	40		V4	45	V5	54	V3	59
	V7	2	V7	13	V5	16		V5	27	V6	30	V7	41		V1	44	V2	55	V5	58
	V5	1	V4	14	V2	15		V3	28	V1	29	V3	42		V7	43	V6	56	V2	57


Plot Number
Variety Number (as in the variety evaluation above)
Entrance

Other activities.
Kenya: US student activities. From May 24 through August 6, 2012 we had 4 US students (Marcia Croft, Aaron Crow , Caitlin Grady and Hannahjoy Pheasant) in residence in Eldoret, Kenya, working on various aspects of the AIV project. These students were supported by non-Hort CRSP funds. Their activities included evaluating markets, both local open markets and grocery stores related to AIV sales, gathering data on our client farmer groups use, farmer access to irrigation and types used, preparing AIV production manuals for use in our framer training activities and visiting AMPATH clinics, villages and learning more about land use issues, access to finance. The training materials, Appendix 1 were prepared in both English and Swahili. A report of on the markets and quality of AIVs is included in appendix 2. The students took Swahili lessons and 2 of the students Marcia and Caitlin were able to participate in farmer training at the village level speaking Swahili.

Evaluation of nutrient composition of dried AIV leaves. This activity involved analyzing dried and packaged leaves from a local company for their nutrient composition. A summary of the report is below but is not for distribution due to an agreement that all data would be kept confidential with our private partner until an agreed upon completion of all studies.
Summary. The purpose of this initial study was to begin to nutritionally examine the value of African Indigenous Leafy Vegetables (AIVs). Dried leaves of the Spider plant (*Gynandropis gynandra*) also known locally as Saga; black nightshade (*Solanum nigrum*) also known as Managu; Common amaranth (*Amaranthus retroflexus*), also known as Dodo; Cowpea leaves (*Vigna unguiculata*), also known as kunde and Kale (*Brassica oleraceae* var. *acephala*), localled called Sukuma Wiki were analyzed to obtain a nutritional profiled. Commercial African indigenous leafy vegetables grown in western Kenya and processed/prepared/packaged were provided to Rutgers, The State University where the moisture, total ash, and acid insoluble ash analysis as important parameters in quality control were measured. Results showed that the products were dried to a proper moisture and stored properly. The samples were visually desirable, had good color and quality but the sampled products exhibited higher than desirable ash and insoluble ash contents. These two latter parameters are suggestive of the cleanliness of botanical and food products; and levels from the amaranth, cowpea and kale were high. An elemental analysis to provided quantitative information on the mineral content of each plant. Nutritional analysis demonstrated Amaranth had a relatively high mineral content among of the AIVs examined. We then conducted total phenol and antioxidant assays on the AIVs. *Solanum nigrum* demonstrated the highest antioxidant capacity (1.21g TE/ 100 g DW) among all the AIVs sampled. Information generated in this study could be used by a private company for labeling their dried AIVs and in providing such nutritional information to their consumers and placement on the product packages. Additionally, these results can used to provide baseline data and in comparing to field-grown fresh leafy AIVs. Furtherwork will next examine total carotenoid content (for vitamin A assessment), vitamin E, fat, protein, sugar, fat, fiber (soluble and insoluble) contents. We also recommend that such periodic sampling of dried products be evaluated throughout the year to ascertain whether there are seasonal differences. Modified/improved drying systems will be examined in the next months by the Hort CRSP and these techniques may modify the end product as such, will be examined for nutrient composition by similar testing.

Postharvest training. Mr. Naman Nyabinda is a student in the UC Davis sponsored on line postharvest class being coordinated by Lisa Kitinoja and Diane Barrett. Naman is half-way through with this class.

Tanzania. Three activities were addressed in this reporting period, training, postharvest survey and development of a review copy of and AIV cookbook (appendix 3).

1. Seed Fair and the Amaranth Stakeholders' Workshop.
Seed fair 2012 at AVRDC-RCA. A seed fair held at AVRDC's Madiira Farm on June 15, 2012 was and attended by more than 300 farmers and 6 seed companies and agro dealers (including East African Seed Company, Rijk Zwaan Afrisem, Kibo Seed Company, Alpha Seed Company, Multiflower and Balton East Africa) displaying various inputs in tented booths. The guest of honor was the Arumeru District Commissioner. The national television ITV covered the event. The seed fair offered a good platform for interaction between various players along the AIV value chain from policy makers to input dealers, producers, researchers, seed system actors and most importantly farmers and consumers. It was an excellent awareness creation platform, a tool that will go a long way in knowledge and technology transfer during and after the project period. Participants of the seed fair were particularly amazed at the very tall growing amaranthus varieties Madiira 1 and Madiira 2 developed for continuous harvesting. Farmers in Tanzania traditionally harvest amaranth by uprooting. The traditional varieties are small-leaved, early flowering and low yielding (about 5 t/ha), especially given the single clear harvest. After the onset of flowering and seed-set, the reproductive function seems to suppress vegetative growth. Thus the farmers have no choice but to clear harvest the crop and plant a fresh one. The practice of clear harvesting by uprooting and replanting every couple of weeks is not only labor-intensive, but also costly in terms of farm inputs. The practice results in continuous disturbance of the soil, leading to rapid degradation. In addition, most small-scale commercial farmers practice crop specialization and mono-cropping without crop rotation, thereby accumulating soil borne pathogens. 'Madiira 1' (narrow leaved, many leaves) and 'Madiira 2' (broad-leaved) have leaves that have been described by farmers during participatory evaluation in various localities as softer, sweeter and cooking in a much shorter time than local landraces. The new varieties grow tall and can be harvested continually with a cumulative leaf yield potential of about 40 t/ha after 4-6 harvests. Continuous harvesting leaves the soil intact, involves less labor in land preparation and is less costly in terms of farm inputs. Furthermore, it can be practiced sustainably on a small piece of land. If the farmers opt for clear harvesting, the new varieties mature in just 21-28 days.

Figure 1: Two leaf amaranth varieties developed for continuous harvesting and officially released and registered in Tanzania. *A. cruentus* Madiira 1 (left) and *A. cruentus* Madiira 2 (right).

- Demonstration of amaranth products: The seed fair participants had an opportunity to taste different grain amaranth products from a small scale processing company, Kubana Foods and from AVRDC nutrition unit. Some of the products included amaranth cake, amaranth flour used to make instant porridge, amaranth buns fondly referred to as 'kokoto' among others.

Figure 2. Various amaranth products displayed at the seed fair at AVRDC on 14th and 15th June, respectively.

Kenya. The Amaranth Stakeholders' Workshop was held on the 14th June 2012 at Snow Crest Hotel. The Amaranth project funded by the Australian Government (AusAID) and led by Dr. Daniel Sila of the Department of Food Science and Technology of Jomo Kenyatta University of Agriculture (JKUAT) in Kenya, in collaboration with researchers drawn from four other international organizations namely; Tanzania based AVRDC- World Vegetable Centre and Sokoine University of Agriculture (SUA), Kenya's Bioscience east and central Africa Hub under International Livestock Research Institute (BecA-ILRI Hub) and Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO). This project team is expected to explore possible opportunities for value addition for the production of suitable local foodstuffs from the vegetable and grain amaranth. The Hort CRSP participated in this workshop.

The 23 participants included the amaranth project scientists from Kenya, Tanzania and Australia with a wide range of expertise. In addition, representatives from Farm Concern International which is a non-governmental organization, Kibo Seed Company and a representative from the farmers' cooperative were in attendance. Some of the highlights of the presentations and discussions from different stakeholders include the following aspects:

- Importance of amaranth in nutrition, health and as a potential cash crop to target communities. Despite the nutrient dense characteristic of amaranth, it was noted that nutrient content varies depending on geographic location and varieties.
- Role of research in selection for nutrient dense varieties and improvement on agronomic aspects.
- Need for capacity building both for local scientists and institutions e.g. strengthening capacity of local institutions to conduct reliable nutritional analysis; and among other stakeholders including farmers and food processors and handlers. These include value addition using local processing techniques to improve and retain nutritional value and self life.
- Need to stimulate linkages in the entire value chain comprising of farmers, seed merchants, and leaf and grain processors).

Some of the challenges that were noted during these presentations and discussions included:

- Uncertainty about bioavailability of these nutrients – lack of information and documentation on specific nutrient bioavailability. Further research needs to be done to shed more light on this. Also of concern is the presence of anti nutritional factors such as oxalates in some AIV species including amaranth.
- Only small portions are normally consumed in meals. There is therefore need for diversification of diets to ensure sufficient nutrient intake by the vulnerable populations including children under 5 years and pregnant women.
- Need to use improved methods of meal preparation to ensure high retention of nutrients and hence intake
- Promotion and familiarization with amaranth among the target communities
- Food safety concerns both at production stages, during marketing and post harvest handling.
- Need to improve market access through stimulation of both formal and informal market development processes. This can be achieved through conducting market research and value chain analysis, small holder commercialization interventions, strategic partnerships, market information exchange among others

2. AIV cookbook draft. A draft version of an AIV cookbook is in review and it is anticipated to be ready for publication in Year 2 of the project.

3. Seeds produced for our field experiments in Kenya, Tanzania and Zambia.

   Nightshade – Line BG-16 – 26,100, SS-49 – 18,700, EX-HAI – 11,900, SS-52 – 27800, SSO4.2 – 8,700.

   Amaranthus – AC-45 – 24,000, EX ZIM – 15,700, AC-38- 24,300, UG-AM-40 – 7,900, Ex-Mwanga – 5,600

Spiderplant – ML-SF29, - 8,600, UG-SF-15 – 18,200, PS – 8,800, UG-SF-23 – 17,900, ML-SF17 – 6,300

4. Postharvest survey. A postharvest survey was conducted with 182 AIV producers in Dodoma, Arusha, Morogoro and Iringa, Tanzania. Data are being processed and will be completed in the first half of year 2 of the project.

Safe Vegetable Production in Cambodia and Vietnam: Developing the HARE-Network to Enhance Farmer Income, Health, and the Local Environment

Target Countres: Cambodia and Vietnam

Principal Investigator: Cary J. Trexler, University of California, Davis

Collaborators:

Johan Six, Glenn Young, Mark Van Horn, and David Miller, University of California, Davis
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 Description

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 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 farmers 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 Horticulture CRSP 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.

One extension of this project will work with savings groups in Cambodia that will be trained in financial literacy and cell phone-related savings technology. The savings and lending groups will also be introduced to improved horticultural technologies investigated by Horticulture CRSP projects and provided with the opportunity to invest in these technologies. We will collect data on the demand and use of these technologies in rural farming systems. Those groups which are interested in saving for a new technology will be connected to Horticulture CRSP partners who are best able to deliver the technology and training. This model will enable information to flow in two directions, as farmers and

savings groups gain access to “leapfrog technologies,” and Horticulture CRSP partners learn how rural farmers in Cambodia reinvent new technologies to accommodate on-the-ground realities. This project will also help determine which horticulture technologies are in demand among Cambodian farmers, and what specific conditions create demand for these technologies.

1st report

Listed below is a narrative from three sources. First, from the UC Davis perspective, second from the Hanoi University of Agriculture (HUA) perspective and finally from Nong Lam University (NLU). The project is progressing along, but has been delayed because the foreign universities are somewhat reluctant to work when they do not have project funds within their university accounts. We are meet many of the objectives set forth in the original grant application.

Highlights:
All universities are now working in the communes they selected. HUA and NLU have been working in their communes for about 1 year now and have conducted Farmer Field Schools (FFS) and Farmer Field Studies. The Royal University of Agriculture (RUA) conducted participatory action research focus groups with farmers, traders, and local authorities in March 2012. Using data from the farmers' self-identified needs (see trip report from C. Trexler), RUA will design FFS and Studies to help farmers and traders increase income and decrease inputs and costs.

Hanoi University of Agriculture has conducted several FFS in the area of production and, like NLU, will soon be conducting studies related to microbiology.

There has been some concern relative to the Photo-voice and Savings group aspects of the project. Basically, the Vietnamese and Cambodians need to be trained on the use of Photo-Voice techniques and want to get started, but the UC Davis team has been unable to provide training yet. We plan on conducting a workshop on Photo-Voice in June 2012.

Another change to the project is that now the universities will be conducting all the FFS and Studies. This change happened because UC Davis and FAO did not come to terms on a contract. The HortCRSP administration approved this change and we really think it is much more cost effective and provides the partner universities with more buy-in with the project. An additional change to the original project is that Cambodia will be working with farmer groups for two years rather than one. We used cost savings from the FAO contract to fund RUA for two years rather than just one.

The UC Davis team is really excited about working longer with the RUA because there is such a strong need to upgrade our collaborators' skills. The RUA faculty are also very eager to work on this type of project and with Americans because this is there first interaction with an American university. Also we are excited about the fact that the call for the World Bank Higher Education Grant Program will come out in May 2012. Last summer we (the UC Davis team) spent a lot of time helping the Cambodian's learn to write a grant. And now they will be applying. The $200,000 RUA grant will build upon this Hort CRSP grant and hopefully fund a post-harvest facility on the RUA campus.

Challenges
The biggest challenge to date has been funding the sub-awards in a timely manner. The partner universities do not have the same type of working capital that a large US universities has, therefore work sometimes stops by the sub-awardees until funds are in the university accounts. For various

reasons, sub-awards have gone out way to late to the partner universities. We will work in the future to ensure that sub-awards get out faster.

At our next group meeting with all collaborators, we will focus on strengthening the research aspect of the project. Presently, we are somewhat uncoordinated in our research protocols and have now only one potential publication. We believe that a vital aspect of out project is helping our Vietnamese and Cambodian collaborators become proficient in research and publishing.

We see from reviewing our objectives and activities that we need to concentrate more effort on Occupational Health outcomes and will focus on this aspect of the project in the coming term. Also, we need to figure out a way to either have signage for the project designed and built in Vietnam and Cambodia, or figure out a way to ship it overseas.

Below are highlights of the project in narrative form from both HUA and NLU.

Hanoi- HUA's progress to date (from October 1, 2011 to March 30, 2012

Activities	Participants	Documentation	Outcomes
October 3, 2011	All project members [1)]	Monthly meeting	Report: Minutes of Meeting
October 8, 2011	Project coordinator 4 team leaders	Design Baseline survey	Drafting of 147 questions from 4 teams
From mid-October 2011	Production / Environmental team	To organize an experimental trial in Dong Xuan on Grafting tomato	Tomato trial organized in Dong Xuan commune
November 5, 2011	All project members	Monthly meeting	Report: Minutes of Meeting
November 7, 2011	Project coordinator and 4 team leaders	Progress Report of Year 1 – Report 2	Sending to UCD Progress Report of Year 1 – Report 2
November 10, 2011	Project coordinator and Project members	To discuss with Van Noi commune's People Committee for establishing "un-safe grower group"	A list of 15 "un-safe vegetable" growers was formed
November 25, 2011	All project members	To finalize the Questionnaires for Baseline survey	166 Questionnaires for Baseline survey were finalized ready for interviewing
December 6, 2011	Team members and Baseline Survey assistants	Baseline survey was organized in Van Noi commune	20 householders were interviewed

December 10, 2011	Team members and Baseline Survey assistants	Baseline survey was organized in Dong Xuan commune	30 householders were interviewed
December 16, 2011	Team members and Baseline Survey assistants	Baseline survey was again organized in Van Noi commune	10 householders were interviewed
December 29, 2011	All project members	Monthly meeting	Report: Minutes of Meeting
January 17, 2012	1. Production/ Environmental Team 2. Postharvest/Safety/ Health Team 3. Economic/Community Team 4. Education/Marketing Team	FFS 2 on Cabbage production, postharvest treatment, concept of crediting and marketing for Dong Xuan commune, Soc Son District, Hanoi	Report on FFS on January 17, 2012
February 14, 2012	All project members	New Year meeting: Evaluation of 2011 activities and Planning for 2012	Report: Minutes of Meeting February 14, 2012
February 27, 2012	Project coordinator	Working with Project's PI – Dr Cary Trexler on Year 2's Project Planning and its Budget	Report to project members re. Planning 2012 and team's budgets
March 06, 2012	Production/ Environmental Team	FFS3 on composting with EM in Van Noi commune, Dong Anh District	Report on FFS3 in Van Noi commune, Dong Anh District
March 07, 2012	Production/ Environmental Team	New variety exp. trial: 2 new kohlrabi varieties (heat resistant) for off-season production have been tested in Dong xuan commune for household income improvement.	Expecting to have off-season and safe products at higher market price. Preparing 3 pilot plots for next FFS4 in Dong Xuan
March 26, 2012	All project members	Monthly meeting for further discussion on research activities and detailed budgets	Report: Minutes of Meeting March 26, 2012

HCMC- NLU

October, 2011

- Oct. 12: NLU team routine meeting, see meeting minute;
- Oct. 18: Sending NLU invoice of Y1 quarter 3 to UCD;
- Oct. 26, 2011: NLU team routine meeting, see meeting minutes;

- Farm experiments on cucumber to be developed at Nga Ba Giong Cooperative starting in October 2012.

November, 2011

- Nov. 2: Trip of NLU team to Xuan Thoi Thuong commune to meet with a commune representative to discuss of the project implementation and the purpose of farmers' survey, see meeting minutes.
- Nov. 30: Trip of NLU team to Phuoc An Cooperative to meet with Phuoc An Cooperative Board of Management, see meeting minutes
- UCD informed the advance process for the 3rd and 4th quarter budget of year 1 is delayed due to the amendment procedures.

December, 2011

- Farm experiments on cucumber at Nga Ba Giong coop to be in progress

January, 2012

- Visiting the 2 coops before the Tet holidays
- Farm experiments on cucumber at Nga Ba Giong coop to be in progress

February, 2012

- Feb, 1: NLU team routine meeting to discuss of FFSs and plan for Dr. John E. Bowman's trip, see meeting minutes
- Feb. 13 – 15: NLU's team join the field trip with Dr. John E. Bownman in Ho Chi Minh City, see trip report
- Feb. 22 and 29: Meeting of NLU's team with Dr. Glenn Young to discuss of the project progress, see meeting report.

March, 2012

- March 8: Receiving information from UCD regarding wiring transfer for Y1 Q3 Q4 and Y2 Q1 Q2
- March 9: NLU's team routine meeting, see meeting minutes
- March 21: NLU's team routine meeting, see meeting minutes

2nd report

Listed below is a narrative from three sources. First, from the UC Davis perspective, second from the Hanoi University of Agriculture (HUA) perspective and finally from Nong Lam University (NLU). The project is progressing along, but has been delayed because the foreign universities are somewhat reluctant to work when they do not have project funds within their university accounts. We are meet many of the objectives set forth in the original grant application. RUA coordinator was in Bangkok for a HortCRSP sponsored training by ARVDC, so was unable to provide a report at this time.

Highlights:

All university teams are up and running. HUA and NLU are collaborating on their FFS and are providing similar subject matter and skills development techniques. RUA has benefitted from visiting the sites in Hanoi and HCMC. RUA faculty are now able to envision what the potential of the project.

HANOI

Hanoi has conducted the most FFS and is making strong progress. Trexler was asked by the cooperatives to figure out how we can get additional funds to continue the project into a fourth year because the gains that are being made in terms of production and farmer health are noteworthy. Farmers are using bio-pesticides and fertilizers and are reducing input costs and many women mentioned that they no longer get headaches from spraying pesticides. As far as production increases, a PPT will be provided at a later date that documents the benefits achieved in the field sites in Hanoi. One very noteworthy impact of the Hanoi project is that the acreage using the new techniques has increased more than was projected. Women in Hanoi are writing poems and songs about the new techniques so that they can be easily passed onto others. In addition, a new partnership developed between HUA and My Way Seeds. The private company supported farmers as they transitioned from trellis plants to field plantings of a small honeydew mellow. This has increased both yield and the length of time a field is productive. (This is documented in the video, which was sent to HortCRSP in September 2012.

The marketing team are HUA has introduced farmers to the Ho Tay (West Lake) farmers market. This will be a venue where the Hanoi farmers can sell directly to the westerners in Hanoi. We believe this will be successful because, we plan to show the Photo-voice PPTs at the market, so the the consumers will understand that the vegetable and fruits are now grown in a safe manner, without inorganic pesticides and fertilizers.

Some of the early adopters in Hanoi have expressed interest in starting small businesses to sell inputs needed to make bio inputs; they also have said that may consult for other farmers. These same farmers used Photo-Voice techniques to very clearly show all teams what they perceive as benefits of the project

HCMC

HCMC has been somewhat slow to start. Efforts have mainly focused on production and post-harvest aspects of the project. Plans are to help the Community Development (CD) and Marketing teams set a clearer course of action. During the 2nd Annual meeting, the UC Davis team members focused the agenda on research. Now both the CD and Marketing teams at all the universities have a clearer Idea of where they should be headed in terms of research.

After a visit by J. Bowman, NLU got the idea of providing a small amount of funds to each of the coops we are working with. So, the UC Davis team plans on taking money that we had held in reserve to fund small improvements that we can research. At one coop, we plan to use funds to look into the CoolBot technology. This will be coupled with insulation of the cool room. In Vietnam, no one uses insulation, so we plan to research what kind of energy savings can be made by combining these technologies. In another coop, we will help, with assistance of the local government, to upgrade a packing shed to comply with VietGAP standards (now all post harvest functions occur on the concrete floor. (We seek approval for the $5000 for each commune). Also, we wonder that since, Bowman suggested these activities, if it would be possible to get additional funding from Hort CRSP because he made the suggestion.

In terms of production gains, we have seen less in HCMC. The issue is that the communes that we are working with are locked into production of leafy vegetables. They harvest about 10 crops per year and use very intensive techniques. The farmers have said that the composting is helping to reduce costs, but that the bio-pesticides are not working as well as they had anticipated. J. Six and M. Van Horn said last year that the production techniques are even more intensive than in the USA. Therefore, we want to suggest crop rotation, but the farmers are locked into contracts with local supermarkets and are unwilling to try anything else.

RUA

In Cambodia, we work with a great group of faculty who are not yet tainted by governmental aid. They were slow to get going as we had not planned to work with them intensively until year 3. But since we received additional funding from Hort CRSP we started working with farmers in year 2. It was not until C. Trexler went to Cambodia in March that focus groups were conducted with farmers. FFS began in May, so RUA is about one year behind the other universities. There is also a concern that most of the RUA faculty have only BS or MS degrees, as a result, many are leaving our project for fully funded advanced degrees sponsored by Asian governments, particularly Japan.

D. Miller's project was not funded until Sept 2012. Even though the start date says differently. Therefore C. Trexler provided start up funds from the larger grant for the two IAD graduates to begin their residency in late August 2012. Fred and Neda have become a great asset in Cambodia as they travel to the field sites around Phnom Penh with the RUA faculty. They have made contacts with OXFAM to start up farmer savings groups and have also developed a research plan to determine whether famers are willing to pay for technologies that have been generated as a result of investments by HortCRSP. We still have not heard about the outcome of the World Bank grants. We helped write two: Teaching through Problem Solving and Integrated Research in Vegetable Production. This has been delayed for about 1 year.

Challenges

Unlike last year, funding no longer is an issue. Now, the biggest challenge is to keep the teams on task. We need to focus them on following the research design that each team (Production, Post-Harvest, Community Development, and Marketing) developed at the 2nd Annual meeting.

We also suffer from a loss of J. Six, who will be leaving UC Davis in December 2012. Further, M. Van Horn did not travel with us to Vietnam this year. As a result, we have lost expertise in the production side of the project. Many times when we visited Cambodia and Vietnam in June and September, we wished that they were with us as we have a designed this project to be interdisciplinary. We may seek the assistance in the future from one of C. Trexler's former graduate students who is now a faculty member at UC Santa Cruz.

In sum, we can show that our project, particularly in Hanoi, is making a difference in the lives of farmers. We are certain that once the Cambodia and HCMC teams come to full steam that we will show similar successes. It will take time, and 3 years (which is really like 2 because of funding delays and start-up time) is probably not enough for an interdisciplinary project.

One area of assistance needed:

G. Young and C. Trexler have proposed that all teams hold a meeting for Cambodian and Vietnamese stakeholders in March 2013. The purpose of the meeting would be to show the progress we have made up to this point using Photo-Voice techniques so that we might garner additional support from other funders. We would invite in-country representatives from USAID, USDA, Embassies; Vietnamese and Cambodian governmental representatives, private industry, NGOs, American chambers of commerce (AMCHAM), and local restaurants who serve Westerners. We believe this will garner much publicity about the efforts of HortCRSP in our two partner countries.

Budget revisions sought:

$5000- CoolBot and insulation research
$5000- Post harvest packing shed in HCMC
$10000- to assist with Savings Group trainings in HCMC and Hanoi
$4000- marketing research about consumer preferences, HUA, NLU and RUA
$5000- Photo-Voice materials; HUA, RUA, and NLU
$9000- additional student support to increase capacity for Horticulture at RUA. Horticulture is not yet an academic discipline in Cambodia. There is a Cambodian student (he was granted a scholarship by the Vietnamese government) who will graduate in Feb 2013from HUA and he can support RUA in horticulture specific activities. Presently, RIA only has agronomy (rice mainly) production experts.

All these funds will come from unencumbered funds from UC Davis. We held these funds in reserve until we knew how that could be used more effectively.

Below are highlights of the project in narrative form from both HUA and NLU.

Hanoi- HUA's progress to date (from April 1, 2012 to September 31, 2012

March 06, 2012 Farmer Field School FFS 5	Participant number: 20 Production/ Environmental Team	FFS 5 on composting with EM in Van Noi commune, Dong Anh District	Report on FFS5 in Van Noi commune, Dong Anh District
April 22 , 2012 Farmer Field School FFS 6	Participant number: 42 Production/ Environmental Team	FFS 6 on Introduction of new varieties and VietGAP in safe vegetable production in Dong xuan commune, Soc son district, Hanoi	Report on FFS6 on April 22 , 2012
May 16, 2012	All project members	Monthly meeting for further discussion on research activities and detailed budgets	Report: Minutes of Meeting May 16, 2012
June 20 , 2012	All project members,	Monthly meeting, meeting with Dr Cary Trexler and Dr. Glenn Young for further discussion on research activities and detailed budgets, and the 2nd Annual Meeting	Report: Minutes of Meeting June 20 , 2012
June 24, 2012 Farmer Field School FFS 7	Participant number: 30 Economic/Community Team	FFS 7 on Introduction and instruction of camera use in safe vegetable production	Report on FFS on June 24, 2012
June 28 , 2012 Farmer Field School FFS 8 FFS 9	Participant number: 60 1. Production/ Environmental Team 2. Participant number: 45 Postharvest/Safety/ Health Team	FFS 8 on Exchanging farmers' expriencens and introduction to innovative techniques in intensive production of safe supersweet muskmelons, FFS 9 on Food safety for farmers in safe vegetable production	1. Report on the FFS on June 28, 2012, Production/ Environmental Team 2. Report on the FFS on June 28, 2012, Postharvest/ Food SafetyTeam
August 6, 2012	All project members	Monthly meeting for further discussion on research activities and the 2nd Annual Meeting	Report: Minutes of Meeting August 6, 2012
September 12	30 participants + 45	Visit rock melon comparision	Report on the 2nd HORT

FFS 10	farmers + 15 local officers to visited Dong Xuan's 3 rock melon trials and their expanded farms FFS 10 PhotoVoice presentation from Dong Xuan farmers.	trial: Trial organised on 360m^2 X 3 farmers on variety Ngan Huy. The trial expanded to 38.2 ha including: -Thôn Bến = 12.3ha -Thôn Đình = 6 ha -Thôn Đồng Dành = 10 ha -Thôn Yêm = 10 ha FFS 10 on PhotoVoice presentation from Dong Xuan farmers	CRSP Annual Meeting in Hanoi, Vietnam Report on the 2nd HORT CRSP Annual Meeting in Hanoi, Vietnam
September 12	30 participants visited Hoai Duc's VietGAP's implemented vegetable farm	VietGAP for the Fresh fruit and vegetable production	Report on the 2nd HORT CRSP Annual Meeting in Hanoi, Vietnam
September 13 - 15	30 participants from UCD, RUA, NLU and HUA	The 2nd HORT CRSP Annual Meeting was held in Ha Long Bay	Report on the 2nd HORT CRSP Annual Meeting in Hanoi, Vietnam

HCMC- NLU

April, 2012

- April 12: NLU team routine meeting, see meeting minutes;
- April 25: NLU team routine meeting, see meeting minutes;
- Production team conducting farm experiments on leafy vegetables at Phuoc An coop.

May, 2012

- May 15: NLU team routine meeting, see meeting minutes;
- May 19: The first farmer field school, conducted by production team. Topic 'Using bio-fertilizer of HTD for safe vegetable production'. Venue: Phuoc An Cooperative. Number of participants: 38; male: 27; female: 11.

  May 24: The second farmer field school, conducted by post-harvest team. Topic 'postharvest skills on production of safe vegetables'. Venue: Phuoc An Cooperative. Number of participants: 36; male: 25; female: 11.

June – July, 2012

- June 5: NLU team routine meeting, see meeting minutes;
- June 29 – 30: Dr. Cary J. Trexler, Dr. Glenn M. Young and NLU's team going to Nga Ba Giong and Phuoc An's to discuss of providing support for Phuoc An's coolroom with CoolBot technology, and for Nga Ba Giong's packing house upgrade.

Aug., 2012

- Aug. 27: NLU team routine meeting, see meeting minutes.

- Every team
  Sept., 2012
- Sept. 9 – 10: Dr. Cary J. Trexler, Dr. Glenn M. Young, Dr. David G. Miller, Ms. Nikola Teutscherove (Czech Republic), and NLU's team having the field trips to Nga Ba Giong's and Phuoc An's cooperatives to discuss more about financial support possibility for packing houses of the 2 coops.
- Sept. 12 – 15: all participants of UCD, HUA, RUA, and NLU attending the second annual meeting held in Ha Noi and Ha Long bay.

Sustainable Technology for Orange and Purple Sweetpotato (STOPS) in Ghana

Target Country: Ghana

Principal Investigator: Eunice Bonsi, Tuskegee University

Collaborators:
Conrad Bonsi, Prosper Doamekpor, Desmond Mortley, Robert Zabawa, Tuskegee University
Thomas Gill, Leland Glenna, Janelle B. Larson, Sjoerd W. Duiker, Pennsylvania State University
Kwame Offei, University of Ghana
Wisdom A. Plahar, Food Research Institute, Ghana
Hans Adu-Dapaah, Crop Research Institute, Ghana
Stephen Nutsugah, Savanna Agricultural Research Institute, Ghana
Fafali Azaglo, Selasie Farms and Groceries, Ghana
Joseph Apedo, farmer leader, Ghana
Hawa Musah, Ministry of Food and Agriculture, Ghana
Nana Ayim Poakwah, Hunger Alliance of Ghana (HAG), Ghana
Project Description
This project builds on a completed Immediate Impact Project.

In Ghana, the prevalence of vitamin A deficiency is high among children and pregnant women. Vitamin A deficiency (VAD) affects 72 percent of the country's children younger than 5 years and contributes to one of three of child deaths between the ages of 6 to 59 months. The projected number of childhood deaths attributed to VAD is 104,300 between 2005 and 2014.

Sweet potato is considered an excellent food security crop in sub-Saharan Africa. Although high in carbohydrates, white sweet potatoes mostly consumed are very low in beta-carotene, a precursor to vitamin A. Widespread production and consumption of the vitamin A-rich orange and purple sweet potatoes in Ghana remains limited due to lack of awareness, limited availability of clean-planting materials and limited inclusion in the diet for diversity.

Using the gap and decision analysis tools, this project proposes to strengthen the value chain in three sweet potato growing regions in Ghana to improve food security, agricultural productivity and economic value. This aligns with the themes and related strategic emphases of the Horticulture CRSP and USAID's Feed the Future initiatives in Ghana as a focus country. Throughout the value chain analysis, gender and the status of children will be given elevated consideration to ensure the participation and benefit to women and children from project services and outcomes. By working with most of the actors along the value chain, this research has the potential to enhance the economic opportunities especially among resource-poor sections of the rural population.

After several teleconferences with Penn State, Dr. Prosper Doamekpor traveled to Ghana on the project to meet with Ghanaian partners and briefed them on the STOPS project. Several attempts to meet with a representative from the Ghana USAID Mission proved unsuccessful due to prior engagement by the mission staff. Dr. Doamekpor proceeded to Tamale and Bawku to meet with SARI and UDS partners. He and a technician from SARI research station at Manga in Bawku visited a few sweetpotato-growing communities to assess current interests, capacity and involvement of potential project participants in sweetpotato production.

Dr. Doamekpor met with several sweetpotato producers, marketers and consumers to promote the interest and nutritional benefits of the orange and purple sweetpotatoes that will be introduced for production along with local varieties already under cultivation in the region.

Dr. Doamekpor also contacted and held meetings with potential community partners, schools, and individual families who will be involved in the STOPS project. Private processing business owners and community processing groups in Tamale and producer and produce-marketing groups in Bawku were also contacted. At these meetings, producers, processors and marketers were briefed on the benefits and varied uses of the orange and purple sweetpotato varieties.

A seminar was held for producers where attendees shared information on some cultural and post-harvest handling practices with the project team. Dr. Doamekpor visited a few selected farms and was shown samples of sweetpotato varieties predominately grown in the Bawku area.

The project team held meetings with the district director of Ministry of Food and Agriculture (MOFA) and a representative of the Women in Agricultural Development (WIAD) for the Northern region. A meeting was also arranged with the proprietor of a food processing facility in Tamale.

Two vine multiplication sites were selected to start the production of clean orange and purple sweetpotato planting materials in northern Ghana under the STOPS project. Multiplication of vines is currently underway at the SARI nursery at Nyankpala. A second vine multiplication site has been established at Anloga in the Volta region to expand and sustain the production of clean orange and purple sweetpotato vines. Anloga is strategically positioned and we are looking into the use of the irrigation farming system in that area to set up a clean vine multiplication nursery. A comparison will be made between the rain-fed cultivation practices (Akatsi) and the irrigation cultivation practices (Anloga) for the orange and purple sweetpotato varieties.

Recognizing the need for ensuring that the sweet potato vines are properly managed and handled, the Tuskegee project management team identified two individuals to coordinate project activities in the south (Volta region) and in the north (Northern and Upper East regions) for the STOPS project. These individuals will work closely with the potential project participants (producers, processors and produce marketers) and the research scientists at SARI, FRI, and UG.

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

Target Country: Uganda, Democratic Republic of Congo

Principal Investigator: Kate Scow, University of California, Davis

Collaborators:

Johan Six, Mark Van Horn, Heidi Ballard, and Stephen Boucher, University of California, Davis
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 Description (Project builds on completed Immediate Impact Project)

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) 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.

1st report

Summary of FFS Activities (Oct 1 - March 30)

Eighteen farmer groups in the project area were engaged in a Farmer Field School (FFS) supporting production and marketing of indigenous leafy greens (ILGs). Each farmer group has now completed seven months of participatory training on these topics. This training is non-traditional adult education, in which participants share their own knowledge under the guidance of an extension worker (facilitator) who helps guide them to practicable, enhanced production and marketing practices. Each group has been meeting routinely (every 1-3 weeks) for the past seven months to share information, discuss topics related to ILG production, conduct trials on important production issues (e.g. pest control, soil fertility), and plan group activities (e.g. marketing, setting up new gardens). As a result, farmers are adopting new practices in both their home gardens and their group plots. Monthly reports from facilitators indicate that on average, at least 50-80% of active members have adopted some form of improved practices on their own plots.

In addition to their weekly meetings with facilitators, each farmer group was given a small grant to set up a commercial plot where trials, discussion, and analysis take place. These small grants allowed farmer groups to purchase supplies such as seeds, fertilizers, and watering cans. The commercial plots also serve as an income-generating activity for the group, which encourages group sustainability and gives members a reason to continue meeting after the formal program has ended. Most farmer groups spent the grant money on start-up costs such as land rental and input purchases, and business costs such as establishing market connections and transporting their harvest to market. The size of the established commercial plots are between ¼-1 acre and are planted in staggered stages to keep harvests and income regular.

During Jan 2012 a series of exchange visits were organized for clusters of 3-4 closely situated farmer groups. These visits were organized through the joint work of the lead farmers and their local facilitator and took place at a central group plot within the cluster. All members of the FFS from the cluster were encouraged to attend to meet other participating farmers, share information on the practices/business of leafy greens, and show their accomplishments thus far to local leaders, guests, and farmers. During these exchanges, local leaders proclaimed the value of having these groups in their localities and committed to supporting their efforts.

During the course of the FFS, it became clear that farmers' activities were greatly impeded by the lack of irrigation facilities available to them. It also became clear that there is a great lack of knowledge among farmers on the resources, requirements and opportunities existing within the irrigation sector present in the region. In response, the RASD and UC Davis team conducted research to assess the feasibility of irrigation for farmer groups in the area, and a package was developed and offered to participating groups to pilot an irrigation scheme. This scheme was constructed as a business opportunity for interested farmer groups or individuals. A willing individual or famer group could invest in a small, mobile engine pump with a limited amount of tubing to irrigate high-value crops (notably vegetables) through an asset lease designed in partnership with a local Savings and Credit Cooperative (SACCO). The opportunity would allow the farmer or farmer group to not only

irrigate their own crops and receive higher dry-season prices, but also operate a small business as a water seller to nearby farmers. This irrigation package is scheduled for testing in two sub-counties, one spearheaded by a FFS farmer group and the other by an individual employed by the program. We will then assess the operational aspects of the package and determine its scalability. We also hope to have ongoing communication with other FFS farmer groups on the progress of the irrigation scheme to spread awareness of the opportunity and increase eventual uptake. The business plan of the package is attached as Appendix A.

A series of fact sheets have been developed and distributed to extension agents and farmers on key information needs identified throughout the course of the program. These have covered 1) seed saving and storage, 2) post-harvest handling and preservation, and 3) preparation of greens for better nutrition. The project also provided simple business plan templates to extension staff and farmers to help learn the main considerations needed to begin commercial production. These were distributed after workshops on these topics to reinforce existing knowledge on a familiar topic. They are attached in Appendix B.

Capacity Building within FFS

The FFS has encouraged capacity building at many levels, from the participating farmers to local staff involved in implementing the program.

1. Farmer Leaders – Expertise in Production, Marketing, and Support Activities
   In each farmer group, 1-3 leaders have been elected to receive training from HortCRSP activities and bring this knowledge into the group. A main goal is to strengthen leaders' ability to drive their group's activities forward as a business enterprise, on the assumption that the additional earned income will keep members engaged in the venture. Farmer leaders will also act as the primary links to other stakeholders in the project—including researchers, market-actors, and farmer support organizations—to build and strengthen the farmer group's network. Project partners have organized trainings and workshops for lead farmers on the topics of:

- Seed selection, processing, storage, and marketing
- Good agronomic practices
- Post-harvest handling
- Business planning
- Participatory Monitoring and Evaluation
- Budgeting and Financial Management

2. Extension Staff – Expertise in Participatory Extension and Project Innovations
   RASD has trained and managed five facilitators working with the FFS groups to enhance their skills as agricultural extension agents through participatory approaches. These staff members underwent an initial one-month training after which they have spent the following seven months in the field, helping build the capacity of farmer groups in production and marketing. The facilitators have received ongoing trainings throughout the program on topics such as reporting & monitoring, agronomic practices, post-harvest handling, agricultural enterprise development, group leadership training, group facilitation skills, village savings and loans development, on-farm agricultural trials,

and soil fertility management. In addition, the facilitators have gained much local expertise as a result of working closely with their communities as a local leader.

3. RASD – Enhancing Extension Expertise and Project Management Skills

RASD has been coordinating the extension activities of the FFS under the directorship of Dennis Yiga, an experienced practitioner of FFS. This experience has allowed RASD to expand their work in the agricultural sector and gain experience in new methods of extension and management of agricultural extension projects. Mr. Yiga has been personally mentoring a senior staff member, Sam Mwebe, of RASD to lead FFS programs. Furthermore, RASD has closely worked with UC Davis on issues of budget accounting and project planning. Staff and volunteers from RASD have been in close contact with other project partners to increase learning on issues such as technical assistance to extension staff, accounting & budgeting, reporting, and monitoring & evaluation. Further, as key participants in the PMCA process, senior RASD staff have gained a broad exposure to local agricultural issues, especially related to horticultural development and marketing systems. Finally, RASD's professional network in the agricultural sector has been strengthened through routine communication with other project partners engaged in agricultural research and education.

PMCA Activities

The Participatory Market Chain Approach (PMCA) is a methodology that brings market chain actors together during a series of participatory meetings intended to open up new communication lines and build trust among market chain actors. Phase I of the PMCA began with a Rapid Market Appraisal that assessed supply and demand chains for indigenous leafy greens in major markets within the region. This report was presented to representative market chain actors at the PMCA kick-off event, the Phase I Final Event, on the 29th of November. Different market chain actors in vegetable production, marketing and processing attended the event. They included HortCRSP farmers, traders (wholesalers and retails), researchers, extension officers, processors, seed companies, existing commercial farmers within and outside the project area, credit institutions (SACCO) and potential transporters. A total of 73 participants turned up, 48% of whom were female. The participants decided to focus on three promising areas for further research: packaging and processing of ILGs, sale of fresh ILG vegetables, and ILG seed production and processing. During and after the meeting, participants were interviewed with two different surveys: one to establish any changes in social networks that are formed as a result of the PMCA meetings and one to document the participants' learning and level of involvement during the meeting.

Phase II of the PMCA consists of refining and exploring the potential market opportunities identified in Phase I. MUZARDI first conducted a series of Rapid Market Appraisal activities and then held a number of Phase II meetings with targeted market chain actors to determine the relevance and feasibility of these market opportunities (MO). A thematic group consisting of interested market chain actors was formed around each of the three areas to be pursued.

Thematic Group I: *Seed Production and Processing*

MO 1: Seed production and multiplication with proper packaging and branding at farmer level

After a series of meetings with three seed companies in Uganda it was determined that the companies had their ILG breeding conducted outside of Uganda (Kenya and Tanzania). The reason for this is that the companies thought that the seed system for vegetables in Uganda was not well streamlined to produce quality seed. They mentioned that the quality of the existing seed for indigenous leafy vegetables on the market is poor; an assessment of the available seed found a germination level of 10%. The market opportunity will therefore focus on empowering the farmer groups to produce and market seed for selected indigenous leafy vegetables at community level.

Thematic Group II: *Leafy Vegetable Production*
MO1: Supplying vegetables to specific markets like export markets or tender markets (hotels and schools)
MO 2: Supplying existing markets by increasing production through contract farming

The group evaluating fresh market vegetable supply looked at food markets, hotels and restaurants. A major challenge for Nkokonjeru farmer groups accustomed to subsistence-level production is the level of production required to meet the demands of these markets. In addition, urban market traders have already established suppliers from Wakiso, a district that is closer to them than Nkokonjeru. The option of dry season production and supply might be the most suitable for the target farmers and should be explored. However, this implies the need for training of farmers in, and availability of, small scale irrigation technologies.

Thematic Group III: *Leafy Vegetable Processing (value addition)*
MO1: Processing vegetable paste with groundnuts
MO2: Processing flour from leafy vegetable seed
MO3: Processing Nakati Bagiya

Discussion with officials at Makerere University- Food Technology Business Incubation Center and NARL-FOOD Biosciences Research Centre confirmed that Nakati leaves can be blanched, dried and grounded. The product can be blended with groundnut paste to make snacks, breadspread and sauce. In case of MO 3, Nakati powder can be mixed with cassava flour and other spicing ingredients to add flavor. For all processed product market opportunities, different ratios need to be determined; issues of color, aroma and flavor need to be critically assessed and evaluated. Consumer acceptability tests as well as nutritional assessments need to be conducted to ensure that the products attract market. The team was informed that processing equipment for grinding was estimated at Ushs. 70,000 while the Bagiya processing machine was estimated at about 850,000.

During the three Phase II meetings that were held with market chain actors during this time period, MUZARDI worked with the meeting participants to further analyze and refine the identified potential market opportunities. At the end of Phase II, specific work plans will be drafted that detail how the stakeholders will achieve the most promising of market opportunities.

Uganda Christian University Activities

Four UCU students successfully completed their 4th year capstone special projects with the Hort CRSP Uganda team. These students are the pioneer cohort of UCU's agricultural degree program and have helped the faculty develop learning points from the special project assignment. The special project is designed as a chance for students to do a self-driven research project related to agricultural production or extension. Due to the involvement of the four participating students in other HortCRSP activities, all the sponsored projects relate to marketing and production of indigenous vegetables and tomatoes. The titles are as follows:

- DETERMINATION OF OPTIMUM APPLICATION RATE OF "PLANT TEA" FOR LEAFY VEGETABLE GROWING (Jones Muhindo)
- ANALYSIS OF FACTORS THAT AFFECT TOMATO PRODUCTION IN NKOKONJERU TOWN COUNCIL, BUIKWE DISTRICT (Stella Kukunda)
- THE EXTENT TO WHICH INDIGENOUS VEGETABLES HAVE BEEN ABANDONED IN BUIKWE. (Peter Niwagaba)
- CONSTRAINTS TO INDIGENOUS LEAFY VEGETABLE MARKETING BY FARMERS (Sebastian Walugembe)

A few major themes appear in the students' analyses and reflections on their special projects:

- They appreciated the help they received in research design and methods
- They appreciated receiving guidance on and reviews of their proposals
- Their fieldwork activities were made easier by being able to partner with the project's farmer groups.
- They benefited from access to other program activities (eg focus groups, trainings, questionnaires)

Agricultural Systems Research Activities

1. UC Davis - PhD Research

Lauren Pincus, the Graduate Student Researcher assigned to the project, has begun investigations into the production of nakati, which emerged as the most promising indigenous leafy vegetable. She arrived in Uganda in March 2012 to conduct a field diagnostic survey assessing the impact of farmers' management strategies and their agroecological settings on nakati yield losses. It is expected that this field diagnostic survey will identify some of the major sources of yield loss in nakati production, as well as bring forward some fundamental information on the socio-economic impact of this crop for smallholder farmers. For this research she is partnering with the International Institute of Tropical Agriculture (IITA), a CG Center with an office in Kampala, and the staff at RASD. To assist with her field work she has trained five local post-high school students who will be attending university in the fall of 2012.

2. Makerere University Masters' Research

William Sekamate is completing data analysis after the first season of his on-station field experiment at MUZARDI, "Integrated Soil Fertility Management for Increased Nakati Production in the Lake Victoria Crescent." His second season trial was planted but failed to germinate due to a lack of rain.

William has also been heavily involved in designing and establishing on-farm trials of his research (described below), which he will analyze as part of his Master's thesis.

Nassib Mugwanya has been engaged in coursework for his Masters, as well as research activities documenting the FFS and PMCA process. His research focuses on the two participatory approaches used by the project (FFS & PMCA) and how farmers respond to the two approaches when they are combined. He will focus on the learning process that occurs in the FFS-PMCA groups to determine the strengths and weaknesses of integrating a PMCA approach into a FFS. The study will largely employ a qualitative design using a case study of farmer groups under the FFS-PMCA program to gain an in-depth understanding of the implementation of FFS-PMCA activities.

3. Social Network Research

RASD, UC Davis, and MUZARDI have collected two separate sets of data which will be used to analyze changes in social networks among participating farmers. Social network research is a method of understanding links between entities, under the assumption that it is not only attributes of entities (as is often measured by traditional social research), but also links between entities that matter. The first set of data was collected among farmer groups participating in the program. All four treatment groups ((1) FFS and PMCA, (2) PMCA only, (3) FFS only, and (4) Control) were surveyed to understand the role of social links within groups participating in different treatment arms. The survey looked into different types of relationships and levels of trust found within the groups relating to sharing of market information, production information, benefits of cooperation, and risk aversion. These will serve as case studies in understanding adoption rates or success factors for small scale horticultural commercialization.

The second dataset looks within the PMCA groups. A baseline intake survey conducted at the first PMCA meeting measured participants' connection to other market chain actors. At each subsequent meeting participants have been indicating during a survey who they have been doing business with or collaborating with since the last meeting. The results of this analysis will help evaluate the success of the PMCA in achieving its goal of increasing cohesion in the market chain as well as explain the observed patterns of adoption of desired practices in the marketing sector (e.g. directly linking with farmers, adopting better post-harvest techniques, collaborating on new markets). If successful, it could become a regular tool for assessing market interventions such as PMCA in Uganda.

4. On-Farm Soil fertility Trials

Makerere researchers partnered with RASD to develop a participatory research trial that was implemented during the FFS. The trials were developed as a result of the overwhelming reports of soil fertility challenges in relation to vegetable production by Sekamate, the soils science Masters student funded through the HortCRSP grant. Sekamate conducted on-station field trials to determine optimal nakati fertilization rates from organic and inorganic sources. The results of his on-station research informed a simplified fertility trial replicated among eighteen of the FFS farmer groups. The farmer groups established their plots under his supervision and were trained in plot management and data collection. The experimental plots were set up next to the groups' commercial plots to stimulate comparisons and learning from the results. These participatory trials address a widespread challenge to smallscale farmers; farmers have inadequate access to organic fertilizer resources, yet lack

knowledge on how to use inorganic fertilizers. This field trial has already demonstrated proper inorganic fertilizer application to farmers and could encourage better fertility management through the use of both inorganic and organic fertility sources.

List of Appendices

Appendix A
Irrigation Business Scheme (uploaded at website)
Appendix B
Fact Sheets (1-Seed saving and storage, 2-Post-harvest handling and preservation 3-Preparation of greens for better nutrition) and Business Plan Template provided to extension workers and farmers. (uploaded at website)

2nd report

Summary of FFS Activities (April 1, 2012 to Sept 30, 2012)

The FFS ended on April 30th 2012, with a Farmer Field Day held at RASD's resource center. During the Farmer Field Day, each farmer group had a stall to exhibit their produce, seed, tools, and other relevant items. In addition, most of the groups presented or demonstrated on a topic important to them during the FFS. These topics included seed saving and preparation, site selection, savings, marketing, planting methods, pest control, fertility management, and post-harvest preparation of greens. Some of these were standard demonstrations of various techniques, but many took the form of role-plays or song and dance, which provided topical take-home messages for the attendees and also created an entertaining and energized atmosphere. The event was attended by many important local leaders who became aware of the farmer groups' work and expressed interest in the results of the research project. A few traders from major markets also attended and saw that farmers in the project area were beginning to produce crops they frequently buy. It was reported that these traders shared their contact information with a few attending farmers. Farmers had the chance to receive small gifts through a raffle and "quiz" about the topics that were presented. Many farmers reported the importance of this event in elevating their work and encouraging them to proceed with the learning points from the FFS. For more information on this event, please refer to Appendix A.

The five FFS facilitators were recognized at a general partners' meeting for their contribution to the process and will be awarded certificates of successful completion of their role in the farmer field school. FFS participants were later interviewed about their perceptions of key learning points in the FFS, including the field day. These responses will be categorized and included in endline randomized surveys in the attempt to learn the learning pathways that result in adoption of new practices.

PMCA Activities

In May, MUZARDI held the fourth and final participatory meeting on Phase II of the PMCA. During this meeting, each thematic group (centered around different value chains) prepared a work plan. The work plans took the form of a "to do" list, in which specific tasks were assigned. The list was constructed in a participatory manner ensuring that the thematic group members contributed and agreed upon its content. MUZARDI has had trouble in the past with recruiting vegetable traders to attend the meetings, but at this meeting more traders from Lugazi and Nakawa markets were available to interact with farmers and participate in designing business ideas.

In June, MUZARDI held the Final Event of Phase II of the PMCA. Seventy participants were recorded at the event. The Final Event reached out to all market chain actors, including farmers, traders, wholesalers, seed suppliers, and food development representatives with the goal of presenting the work completed by core group members during the smaller Thematic Group meetings, such as that reported on above. Each of the three Thematic Groups chose a representative who presented their work plans to the plenary. The presentations included a demonstration of each group's progress, including the market opportunities identified during previous group meetings and a presentation of their work plans for Phase III of the project. Groups were also asked to address missing actors not currently within their networks and the additional support needed during Phase III. Various actors from each of the thematic groups were asked to share their achievements as a result of participating in the PMCA thus far. To demonstrate innovations resulting from PMCA activities, a mini exhibition was organized and participants presented their ideas and product prototypes. Products in the works include a paste made out of nakati which can be packaged and then added to food when cooking and a dried nakati powder which can be incorporated into a common cracker snack-food consumed in Uganda, known as *bagiya*. The thematic group responsible for developing these products (Leafy Greens Vegetable Processing Group) was able to take advantage of the event to carry out a simple product evaluation on the color, taste and preference of their products. Organizers

also took the opportunity to demonstrate a treadle pump to participants, many of whom are looking for solutions to unreliable water supplies for their crops. One issue that came out of this event was the mistrust between producers and traders as far as payment for the nakati product. Farmers complained that they reach an agreement with traders early in the season to be paid for the yield from a particular plot, yet they frequently underestimate how much yield is actually contained in the field. When traders go to harvest the nakati to take to market, they do not pay farmers for the produce that was unaccounted for by farmers. Through the PMCA platform, farmers were able to express their discontentment with this system. In response to this issue, MUZARDI organized a facilitated follow-up meeting with certain traders to agree on terms of payment for farmers' produce.

MUZARDI and RASD joined together to hold a series of visits with PMCA farmers' groups (18 total) to share the results of the Phase II thematic meetings (business opportunities, work plans, and factors critical for success) and facilitate information flow between farmers' groups and the representatives of each thematic group.

The team also invited a trader who is a member of the Fresh Vegetable thematic group to speak at these meetings. He discussed the market requirements of fresh vegetables, the type of variety preferred, standardized market measurements, and market changes due to commodity demand and supply with farmers. He encouraged farmers to practice off-season production of vegetables and stagger their plantings to take advantage of higher prices during non-peak times. Post-harvest procedures to protect vegetable quality were also discussed. He demonstrated to farmers a low grass-thatched shade with a protected floor where vegetables are placed and water is poured through the grass-thatched roof to keep the vegetables fresh and provide cool conditions.

As a result of the meetings, farmers expressed an interest to be involved in more than one thematic group. Farmer group members will work together to develop a large communal plot for fresh vegetables, with some plants set aside for seed production or to be used for processing.

Undergraduate Student Trainings

Two interns from UCU worked with the project between June and August 2012. Both interns were female students from the Agricultural Science and Entrepreneurship B.S. program at Uganda Christian University. These interns each took a lead role in two projects that they helped design and were exposed to other components of the Hort CRSP project as opportunities arose. The internship process helped these students gain experience working with rural people, which is an opportunity not possible through the school's classroom environment. They received a broader insight into the research to adoption spectrum through their agronomic trials, on-farm research, and experience with extension activities.

To facilitate the interns' work experience, the interns were paired with the project's two M.S. students. This relationship provided the interns with a ready supervisor and mentor and offered the graduate students field support and experience as a supervisor. The graduate students were able to assist the interns by guiding them through the research process, explaining their own research and how the interns were assisting with these endeavors, and facilitating the intern's outreach to local farmers. Topics covered included soil fertility and soil amendments, agricultural research, and data collection and analysis techniques.

One of the interns managed 8 on-farm trials that were identified as promising soil amendments from the on-station research conducted. The treatments on each trial plot were:

- Chicken Litter (2.5 T/Ha)
- + NPK (180 kg/Acre)
- + NPK (180 kg/Acre) + Chicken Litter (2.5 T/Ha)
- Control

Farmers that participated in the FFS were asked if they would host the trial plots, and a total of 11 volunteered their land. However, some plots were not prepared in time or suffered from poor post-seeding rainfall which destroyed the crop. A summary of the plots is as follows:

- Nyemerwa Village, William and Joyce Samsa
- Kanga Village, Mark Kisomba
- Katente Village, Nalongo Sekinguse (not germinated)
- Buzu Village, Alice Nakanyike
- Kiyoola Village, Cissy Luyiga
- Nampanyi Village, Rebecca Nandera
- Lukunyu Village, Bernard and Regina Olowo (Not prepared in time)
- Nakawali Village, Nalongo Kharimu (not germinated)
- Nassaka Village, Zamu Nandudu
- Lugala Village, Ester Ndagire
- Butooke Village, Henry Sekinguse

This work required the intern to help farmers determine the appropriate place for a research site, set up the trial plots, plant the crop, measure the inputs, apply manures and fertilizers, measure crop growth, harvest and weigh output, collect soil and plant tissue samples, and conduct a farmer evaluation of the trial. In addition, this student collected data on diseases of the most important indigenous leafy green in the area (Nakati, *Solanaceum Aethiopicum Shum)* to determine whether there are common diseases that are prevalent or damaging enough to warrant control. She worked with the local Global Plant Clinic to learn how to diagnose, take samples, and relate findings to possible causes.

The second intern managed a soil fertility experiment looking into the residual effect of charcoal by-products on leafy green production. This was chosen because the local practice is to only produce leafy greens in places where charcoal has been recently burnt. The experiment was targeted at seeing whether any improvement in growth occurred as a result of the presence of by-products versus the presence of a more complex interaction or simply a heat/sterilization effect. The treatments were

- Crushed Charcoal (2.5 T/Acre)
- Ash (5 T/Acre)
- Crushed Charcoal (2.5 T/A) + Ash (5 T/Acre)
- Crushed Charcoal (2.5 T/A) + NPK (180 kg/Acre)
- Ash (5 T/A) + NPK (180 kg/Acre)
- Control

The initial results seemed to show an effect of both the ash and charcoal, and yields improved by combining the two. A UC Davis soil chemistry lab will test the chemical and physical properties of the materials to discover possible explanations for how these materials function as a soil amendment. However, as a one-site, one-season experiment, this research only opens the possibility of more in depth and rigorous trials on the subject.

The student helped lead a farmer evaluation of the results and learned important skills in managing the crop and taking measurements and samples. As a second project, this student also worked with a local fish farmer to improve his aquaculture production system and was able greatly enhance her knowledge of aquaculture from her meetings with commercial aquaculture farmers, national researchers, and UCU faculty. In the process, she developed an integrated vegetable/aquaculture/animal industry plan for one commercial farmer and helped another improve his production of fish by implementing proper stocking, feeding, and water fertility management practices.

Both students helped the extension M.S. candidate pre-test and enumerate an open ended survey designed with staff of UC Davis. This survey is important to understanding impact pathways from participants' perspective. They were trained to conduct open ended questionnaires and practiced

on over 75 respondents. This data will be used for both his masters' research and the broader program evaluation. This experience helped the students learn more about the constraints to farming experienced by local farmers and offered them a better understanding of what it is like to work with smallholders.

Finally, these students were able to participate in and assist MUZARDI staff during PMCA stakeholder platform meetings. This exposed them to the broader leafy vegetable market chain and enriched their understanding of local agricultural systems.

Graduate Student Research

M.S. student in Soil Science – William started his second season of data collection for his on-station experiment analyzing various combinations of organic and inorganic fertilizer. He also began his on-farm experiments anew since many plots were began with farmers, but were abandoned when the FFS ended and did not have adequate maintenance and data collection done by farmers. He is working together with two undergraduate students from UCU to monitor his on-farm fields and properly collect the necessary data. He is on track to graduate after having successfully defended his research proposal to his committee members.

M.S. student in Extension Science – Nassib defended his research proposal to his departmental committee and was able to incorporate feedback regarding his theoretical framework. In August Nassib completed the bulk of his data collection on what aspects of the FFS-PMCA integration enhance the production and marketing of indigenous leafy greens. He conducted six focus group interviews between 31st July and 4th August as part of his data collection. The objective of the interviews was to find out what production and marketing challenges farmers faced in the FFS and FFS-PMCA. He also asked farmers what they learned from participating in the project and what or who they feel was most instrumental in this learning. Heidi Ballard was able to assist him in structuring this interview protocol and also guide him in developing his analysis framework to develop the major themes and sub-themes of his data. He has begun his data cleaning, entry, and analysis as of late August.

Ph.D. student in Horticulture and Agronomy – Lauren was in Uganda from March – June 2012 to begin data collection for her Ph.D dissertation in Horticulture and Agronomy. Her first study will be an exploratory survey into the management practices and agronomic characteristics of nakati. She worked with a field staff of six recently graduated high school students to collect information from 75 farmers growing nakati within Buikwe and Mukono districts. Together they visited each farmer three times to collect soil and leaf samples, yield measurements, management information, and attitudes towards production, marketing, and consumption of nakati. Dr. Peter Ebanyat of Makerere University and Dr. Piet Van Asten of the International Institute of Tropical Agriculture assisted her in this process. Since returning to Davis she has been entering and analyzing her data and making arrangements for her upcoming qualifying exam.

Research and Evaluation Data

At the end of the FFS, data was collected on some initial results of participation in the program. This was done through facilitators' reports, open ended participant questionnaires, and focus groups. Some initial findings are discussed here, but the majority is to be used for qualitative analysis and narrowing down the important learning points for more accurate endline data collection tools.

Adoption of Leafy Greens Production

Summary data was collected by facilitators on adoption of leafy greens production at the end of the FFS. These reports showed that roughly 40% of farmers that participated until the end of the FFS adopted the enterprise of growing and selling leafy greens. Out of the adopters, 71% were women and more than 58% of them had already made sales from their own produce (i.e. not group

commercial plots) by the end of the FFS. The income participants have earned from greens has been reported to be spent almost entirely on:

- Investment in production inputs (renting better land, seed, pesticides)
- Savings (personal and group accounts)
- Consumption (household necessities, e.g. soap, salt, sugar)

When discussing community impacts, six groups attracted new members who saw the potential of the enterprise, ten groups reported "overcoming" their previous lack of access to seed, and ten groups reported "overcoming" their lack of knowledge about how to access markets. Finally, all but one group made sure part of their commercial grant (which was self-managed by each group) was used to purchase fertility amendments for their commercial plots. The data collected by facilitators during the final FFS meeting showed that a total of five hectares of nakati had been planted by the participants that season: 1.5 ha on FFS groups' commercial plots and 3.5 ha on member's individual plots.

Open Ended Questionnaire

An open ended questionnaire was conducted by the project's undergraduate interns at the end of the FFS. Seventy-five farmers were interviewed to assess their overall reaction to the program and to better understand what aspects of the program were most important in contributing to their learning process. This data will be used to pinpoint elements in the program that led to adoption during the FFS, as well as more broadly define the key aspects of a participatory extension system in Uganda. A copy of the questionnaire is included in Appendix B. Participants indicated which barriers they face in growing and selling indigenous leafy greens and how the project helped them reduce these barriers.

Focus Groups

A series of six focus groups were held with groups that participated in the FFS. During the discussions the groups discussed the following issues:

- Most important things learned about farming by meeting with this group
- Most important things learned about working with other people
- Changes in farming practices as a result of this program
- Changes in others' behavior in farming practices as a result of this program
- Major production challenges faced by the group
- Solutions to Production challenges
- Marketing Challenges
- What keeps the group together?
- Why others left the group

The results are to be coded and used for both the master's thesis on extension and program evaluation.

Group Empowerment

An impromptu event spearheaded by an active FFS farmer group demonstrates the power of a farmer-led, participatory process. The Lugala farmer group decided to hold an event of their own in their village in response to a local leader encouraging them to share their success stories and reach out to their locality. Over 70 FFS and non-FFS farmers, local leaders, and school children attended the exhibition organized and led by the Lugala FFS members. The members had speeches, song and dance, an auction for their produce, and a catered lunch. This event was attended by the area's community development officer, who promised the group that they were eligible and highly competitive to receive a business development grant for the enterprise of growing leafy greens. Three FFS groups and two individual participants have already been approved for either a production loans, irrigation asset-lease (see Q3 report), or motorcycle loan arrangement offered through the local

Savings and Community Cooperative Organization (SACCO). These groups plan to use their loans to produce in the dry season and take their goods to market. This is a notable development in an area where farmers are extremely risk-adverse and are rarely willing to take out loans or engage with financial institutions.

List of Appendices

Appendix A

Summary of Farmer Field Day (uploaded at website)

Appendix B

FFS Barriers to Adoption Mid-term Survey (uploaded to website)

Innovative Energy Solutions in Horticulture
Target Country: Thailand, Honduras, Kenya

Principal Investigators:
Kurt Kornbluth, D-Lab, Program for International Energy Technologies, UC Davis
James Thompson, University of California, Davis
Michael Reid, UC Davis
Collaborators:

Horticulture CRSP Regional Centers of Innovation in Thailand and Honduras
Project Description:
Among the most promising disruptive technologies for application to horticulture are those that address the uses of energy in the production, marketing, and processing of horticultural crops. This project proposes to test a range of sustainable energy solutions, and to deploy the most promising at Horticulture CRSP's Regional Centers of Innovation.

Technologies that will be discussed for possible testing include:

Direct-current split air-conditioner with CoolBot for a solar-powered cool room
In-village solar panel construction to reduce the cost of photovoltaic supply
Inexpensive photovoltaic pumping based on R.V. water pumps
Adsorption refrigeration using zeolite beads
High-intensity LED lights for a solar-powered germination cabinet
Vacuum-sealed straw bales for building inexpensive insulated rooms
Aerogel panels for high-quality insulation
Peltier-effect cooling for small-scale transport
Low-cost air suspension for small-scale transport
Simple solar dryer for fruits, vegetables and grains
Facilitated solarization for weed- and soil-borne disease control
As part of a larger capacity-building effort, this project will integrate activities at the Horticulture CRSP Regional Centers of Innovation in Thailand and Kenya into ongoing work at the UC Davis D-Lab. UC Davis D-Lab faculty mentors and graduate student teams will collaborate with the Regional Centers of Innovation partners through a structured approach for performing feasibility studies, technical and market assessments, and design development on innovative horticulture-focused energy technologies. Through this process, the centers will gain new methods for evaluating and developing horticulture innovations, better enabling them to attract investment and initiate dissemination of these technologies.

Michael and Jim's part

Among the most promising disruptive technologies for application to horticulture are those that address the uses of energy in the production, marketing, and processing of horticultural crops. In this project we are testing a range of sustainable energy solutions, particularly focused on photovoltaics, with the goal of deploying the most promising at the HortCRSP Centers of Innovation. Technologies that are under consideration for possible testing include:

- D.C. split air conditioner/CoolBot for a solar-powered cool room
- In-village solar panel construction to reduce the cost of photovoltaic supply
- Inexpensive photovoltaic pumping based on R.V. water pumps
- Adsorption refrigeration using Zeolite beads
- High intensity LEDS for a solar-powered germination cabinet
- Vacuum-sealed straw bales for building inexpensive insulated rooms
- Aerogel vacuum panels for high-quality insulation
- Peltier-effect cooling for small-scale transport
- Low-cost air suspension for small-scale transport
- Simple solar dryer for fruits, vegetables, and grains
- Facilitated solarization for weed and soil-borne disease control

Progress to date:

To date our work has been on the following technologies:

1. Stack solar dryer

We have designed the improved solar dryer for fruits and vegetables shown in the photograph. The key features of the unit are that it incorporates a 2m stack to induce relatively high airflow in the dryer and it is built on an earth berm. It serves to increase solar energy collection when the sun is low in the sky in the morning and evening and it concentrates the air flow around the drying trays to provide high air velocity past the product to speed drying.

The stack dryer design has been demonstrated at our Centers in Thailand and Honduras. In addition, the tunnel dryer was a finalist in an international competition for a low-cost, low-input dryer for breadfruit, and was demonstrated at the National Tropical Botanical Gardens in Kauai.

In Davis, we compared the effectiveness of the stack dryer with that of a traditional cabinet dryer. Mature tomatoes were sliced longitudinally with a maximum dimension of about 1 – 1.5 cm and placed on 0.6 x 0.6m plastic mesh trays. Each tray held 0.45 kg of fresh sliced fruit. Ten trays were placed, two high, in the stack dryer and five trays were loaded into the cabinet dryer. Samples of fruit were placed on small sections of plastic mesh and were weighed approximately every two hours to monitor tomato moisture content. Inlet air and exhaust air temperatures were recorded for both dryers.

	Stack Dryer	Cabinet Dryer
Capital cost ($)	38.93	58.84
Fruit capacity, fresh weight (kg)	4.5	2.25
Time to dry fruit to 10% MC (11h days)	2.0	5.5
Cost per drying capacity ($/kg-day)	7.33	26.66
Average air temperature leaving dryer – ambient (°C)	15.2	9.3
Air velocity past fruit (m/s)	0.63	0.11

The test showed that the stack dryer required only 2 days to drop the tomato moisture content to 10% (wet basis) compared with 5.5 days for the cabinet dryer. This was a result of the stack dryer heating the air to a higher temperature and causing higher air speed past the fruit.

The stack dryer was much more cost effective than the cabinet dryer, with a cost of only $7.33 per kg-day of drying capacity compared with $26.66 per kg-day for the cabinet dryer.

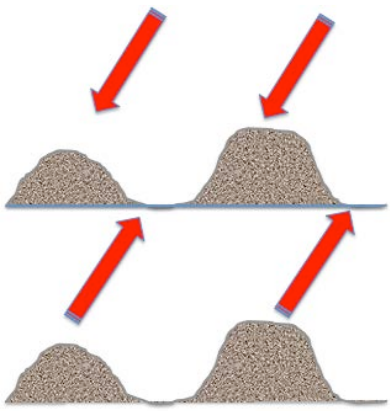
Both dryers caused blackening of some of the dried fruit. Perhaps because if its higher drying temperature the blackening was greater in the stack dryer. However the drying air temperatures in both dryers were within the typical operating range of small-scale fruit and vegetable dryers.

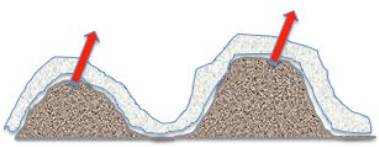
2. Photovoltaic pumping

The simple system that we developed combining a small solar panel (50W) with a simple irrigation filter, and an inexpensive yet reliable pump designed for use in RVs, proved very effective in testing in California. A cooperator has implemented the system on a small scale in Malawi, and the cooperators there are now evaluating ways to scale-up implementation. Photovoltaic pumping is also being demonstrated at the Innovation Centers in Thailand and Honduras, using other pumping systems, and it is our intent to provide them with our filter/pump module for comparison with these much more expensive units.

3. Facilitated solarization

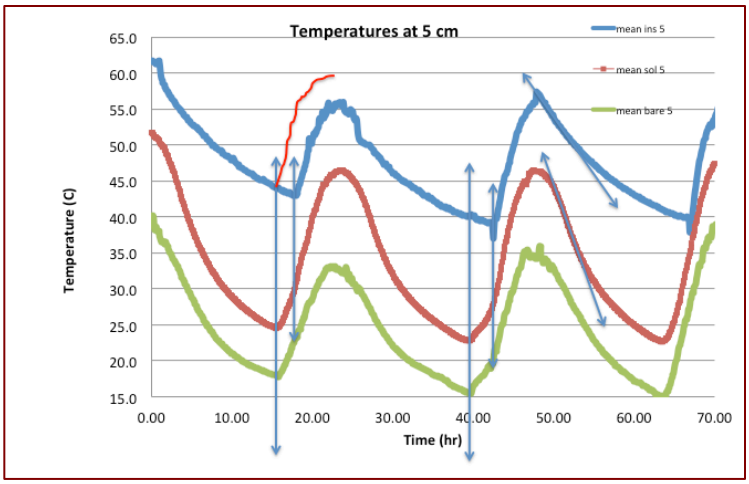
A major part of the labor required for crop production is devoted to weed control. In small-scale and sustainable production systems, herbicides are not an attractive option. Solarization, in which a clear plastic sheet is placed over prepared and irrigated beds is effective, but only after several weeks





of exposure to daily solar cycles. The high temperatures generated in the upper layers of the soil during the day are sufficient to kill weeds and some thermosensitive pathogens (e.g. Verticillium), but re-radiation during the night means that temperatures in the lower soil profiles rise only slowly. We proposed to test a system in which an insulating layer is placed over the clear plastic film in the late afternoon. In preliminary testing, this strategy was able to maintain high temperatures in the soil profile resulting in kill temperatures at 30 cm within a few days. Although not suited to broadscale agriculture, this technique is well-suited to small-scale horticulture.

The facilitated solarization technique has been tested at Davis, and preliminary results, shown below, indicate the potential value of the insulation step in accelerating the solarization process.

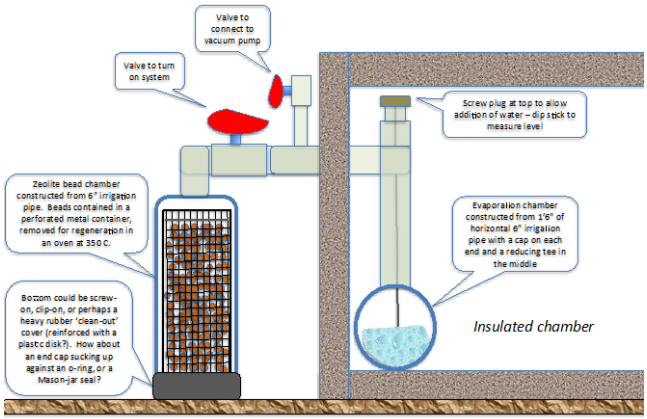


This graph is very illustrative. At 5 cm. depth, the temperature maxima of the soil in the 'insulated' beds (blue curves) are 10 C higher than those in the solarized beds (tan curves), which are 15 C higher than those in bare ground (green curves). The temperature minima for the three treatments are 40, 23, and 15, respectively. The rate of cooling (slope of the lines) is much higher in the bed that was solarized but not insulated, even though the insulated bed is at a higher temperature (which would normally increase cooling rate – Newton's law). Note that the soil in the non-insulated beds starts warming before that in the insulated beds, because we didn't take the insulation off until several hours after solar heating started. The red line shows a possible result of taking the insulation off as soon as the soil starts warming (as determined by temperatures in the control or non-insulated bed).

This technique was demonstrated in Honduras during the inauguration of the Innovation Center at Zamorano, and we are writing a proposal to the Gates Foundation Millenium Challenge to conduct further testing in-country to evaluate the possible use of this simple technique for reducing the labor for weed control of women smallholder famers.

Adsorption refrigeration using Zeolite beads

Adsorption refrigeration uses the latent heat of vaporization for cooling, and the adsorption capability of an adsorber to remove the vaporized



refrigerant, permitting cooling to continue. One intriguing system uses water as the refrigerant and zeolite beads as the adsorbant. At 0.4 mm Hg, water boils at 0^0C, and the large latent heat of vaporization of water makes this system attractive for cooling small-scale transportation chambers. Others have constructed small- and large-scale coolers based on this principle, but failed in attempting to market their expensive prototype in the developing world. We have been working on building a demonstration system using this principle, and designed to be easily constructed in the developing world using local materials. The figure shows a schematic of such a device.
Working with students from the UC Davis D-lab, we put together a prototype using simple irrigation piping. With an inexpensive two-stage rotary vacuum pump, we were able to achieve the desired vacuum, but the system didn't work as we had hoped, primarily because we were unable to maintain the vacuum if the pump was disconnected, and because the water vapor contaminated the oil in the vacuum pump. We have redesigned the system to deal with these problems and will continue to pursue this interesting concept.

U.C. Davis Design Lab

Project Description and Spring 2012 At a Glance:
D-Lab student teams researched, evaluated, and developed the following 3 energy technologies with Kasetsart University in Thailand and Zamorano University in Honduras in Spring 2012.

- Evaporative cooling system in a mobile, truck-mounted horticultural cooler
- Zeolite drying bead cooling system in a horticultural cooler
- Farm-scale off-grid biochar processing using a modified blender, hammer press, and extruder

Detailed summaries are below and full reports available online at http://piet1.ucdavis.edu/projects.

Project Narrative:
D-Lab student teams collaborated with Innovation Center partners to conduct feasibility assessments, technology reviews, and market analyses and design, build, test, and evaluate innovative and appropriate energy technologies. The D-Lab student teams utilized D-Lab evaluation and design methodologies in their technology analyses to ensure the technology is market-driven. Collaboration with in-country partners was used to give context to the UC Davis teams.

D-Lab student teams designed and built prototypes for each of the above technologies and completed reports evaluated by international partners, local mentors, and HortCRSP and D-Lab staff members and shared with international partners.

During the first 5 weeks of the academic quarter, D-Lab student teams communicated with Innovation Center staff and local mentors (in person and/or virtually), performed background research in order to frame the problem and evaluate design concepts. The last 5 weeks, D-Lab student teams prototyped their designs, evaluated the prototype, revised the design as necessary, documented

their findings, and lastly presented their prototypes before a panel and submitted a report to the partnered Innovation Center.

Capacity building
D-Lab has planned site visits to Zamorano University in November 2012 and Kasetsart University in January 2013 with the purpose of networking students and faculty, capacity building, and knowledge exchange. At this time, both institutions (D-Lab and the partner) will give presentations and/or hold technical workshops (i.e. post harvest, irrigation, renewable energy) as well as collaboratively develop future D-Lab projects and shared curriculum.

Future work
D-Lab aims to improve upon the existing communication methods between D-Lab and the Innovation Centers. D-Lab will analyze and share the survey results with the Innovation Centers and develop appropriate measures with the Innovation Center to ensure better communication exists between the partners and greater project ownership is adopted by the Innovation Centers.

D-Lab will visit the Innovation Centers at both Zamorano and Kasetsart universities within the next 3 months to fulfill its technological development and capacity building objectives through various trainings, workshops, and meetings.

Using lessons learned, D-Lab will engage the innovation center partners in feasibility studies for 2-3 horticulture technologies. This will be from January-March 2013.

Appendix: Spring 2012 D-Lab I Project Overviews

Project title	Appropriate Biochar Processing in Small Farm Setting
International Partner	Zamorano University, Honduras Contact: Tim Longwell (tlongwell@zamorano.edu
Local (USA) mentor	Peter Shapland
UC Davis Student Team	Bradley Eagleson, Majid Khan, Jasmine Nazari

Project Background:
Biochar is charcoal created by pyrolysis (burning with minimal oxygen) of biomass (e.g. agriculture and forest wastes) and is considered as an effective way to remove carbon dioxide from the atmosphere. Biochar is an almost pure carbon, at least 50% of the carbon dioxide a plant or tree absorbed from the atmosphere during its lifetime is trapped through the charring process. Biochar has been promoted as an option for soil improvement to increase yields. Generally, micro-gasifiers are utilized for the production of biochar in developing countries. However during this production process, numerous issues need to be resolved.

Problem Statement:
Develop a formula and process to reduce large pieces of biomass (ie. switchgrass, pine needles) into smaller pieces for use in domestic-sized combustion chambers, combine with a binding agent, and densely compact into briquettes.

Design Brief:
Design improved biochar process to reduce mature switchgrass and pine needs into small particles 2-3 mm in diameter. This material must then be compressed into a dense mass 1 g/cm^3. Prototype must cost less than $2000, be able to operate without electricity, and be safe and easy to use.

Results:
The D-Lab team experimented with several biochar processing techniques, including a hammer press and oil press extrusion. A modified blender was developed to grind the biomass. The most successful compacting technology was a hammer press with paper as a binding agent. D-Lab team was successful in building a prototype safe and easy to use and capable of grinding biomass to desired particle size. D-Lab team was unable to produce a dense briquette and fast process rate.

Future work:
Develop better formulation (ie. binding agents) and pressing technique. The modified blender should be larger and equipped with better seals with a hopper for improved processing rate and grinding efficiency. Consider combining grinder and extruder into a single process. Consider bike power to eliminate the need for electricity to power the modified blender.

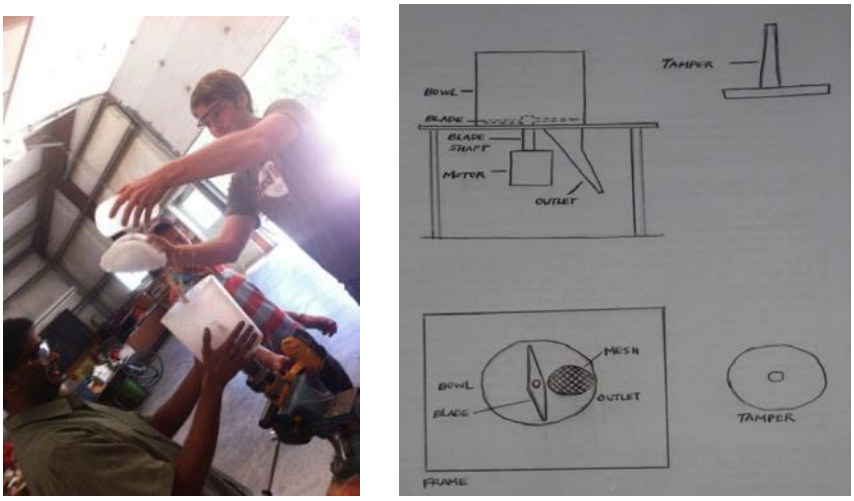


Fig. 1 An illustration of the first prototype and its test set up. The tamper held by the user and placed in the bowl to force grass down towards the blades.

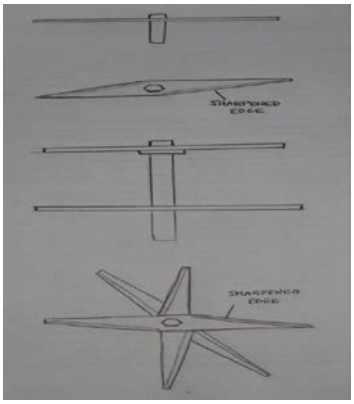


Fig. 2: An illustration of the two blades designs: Prototype One on the top and Prototype Two on the bottom. Prototype One was far more successful with a good process rate and no tangling. Prototype Two did not improve the process rate and resulted in more tangling.

Project title	Off-grid cool room using drying beads
International Partner	Zamorano University, Honduras Contact: Arie Sanders (asanders@zamorano.edu)
Local (USA) mentor	Michael Reid, James F. Thompson, Ephrem Rukundo
UC Davis Student Team	Natalie Pueyo Svoboda, Mattan Shrager, Christine Tao

Project Background:
In villages without access to electricity, there are no affordable ways to cool agricultural produce during transport and storage. Providing a non-electric cooling system to those remote communities is one way to increase their income by reducing postharvest losses. This cooling system will use water as the refrigerant and zeolite beads as the adsorbent. We are proposing to build an adsorption

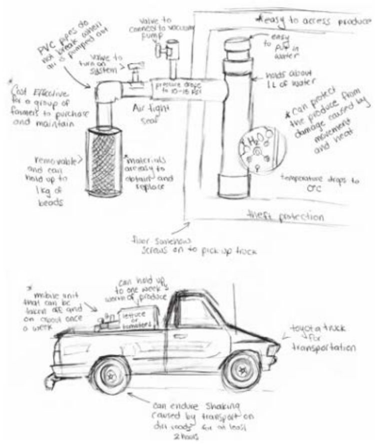
refrigeration which uses the latent heat of vaporization for cooling, and the adsorption capability of an adsorber to remove the vaporized refrigerant, permitting cooling to continue.

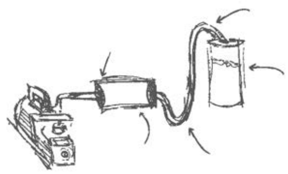
Problem Statement:
Design a mobile cooling device that uses zeolite bead technology to preserve agriculture produce in rural areas of Honduras. Evaluate zeolite technology to see if the zeolite beads can be used to freeze water in order to create a cooling device that can preserve agricultural produce in rural areas of Honduras.

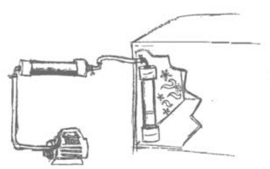
Design Brief:
Three prototypes were developed, one with separate water and zeolite bead white and black PVC and ABS pipe chambers in an airtight system, the second with separate water and zeolite chambers but this time in transparent glass dessicator vessels so that the water-zeolite interactions could be monitored and evaluated, and the third with a similar design to prototype #1 but with ABS and transparent PVC pipes. All prototypes separated the water from the zeolite beads and utilized a vacuum to create an airtight system.

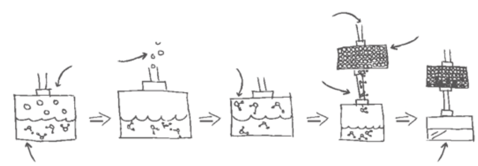
Results:
The third prototype proved that ice could be created using zeolite beads and a vacuum pump. However, the system was inefficient and failed to produce enough ice for the specified needs.

Future Work:
Consider a design that increases the water surface area and decreases the water depth (water surface freezes first and rate declines significantly at deeper depths). Consider increasing the surface area of the zeolite beads that can absorb water so there is an even distribution between the water vapor and the beads. The D-Lab team believes the water vapor cannot reach the beads furthers from the vapor which is slowing the freezing rate. Consider a design that allows closer monitoring and measuring of water temperature and air pressure for more effective analysis. Improved seals to eliminate air leaks would also increase the system efficiency. Appropriate vacuum technology needs to be explored.


PVC pipes do not break when air is pumped out
Valve to connect to vacuum pump
Valve to turn on system
easy to access produce
easy to put in water
holds about 1L of water
Cost Effective for a group of farmers to purchase and maintain
pressure drops to 10-15 PSI
Air tight seal
can protect the produce from damage caused by movement and heat
removable and can hold up to 1kg of beads
materials are easy to obtain and replace
temperature drops to 0°C
theft protection
floor somehow screws on to pick up truck
mobile unit that can be taken off and on about once a week
can hold up to one week's worth of produce
lettuce or tomatoes
toyota truck for transportation
can endure shaking caused by transport on dirt roads for at least 2 hours







Project title	Truck-mounted horticultural cooler for smallholder farmers
International Partner	Kasetsart University, Thailand Contact: Dr. Jate Sathornkich (jate_s@yahoo.com), Dr. Poonpipope Kasemsap (agrppk@ku.ac.th),
Local (USA) mentor	Peter Shapland
UC Davis Student Team	Hermes Huang, Garry Negroni, Thomas Stein

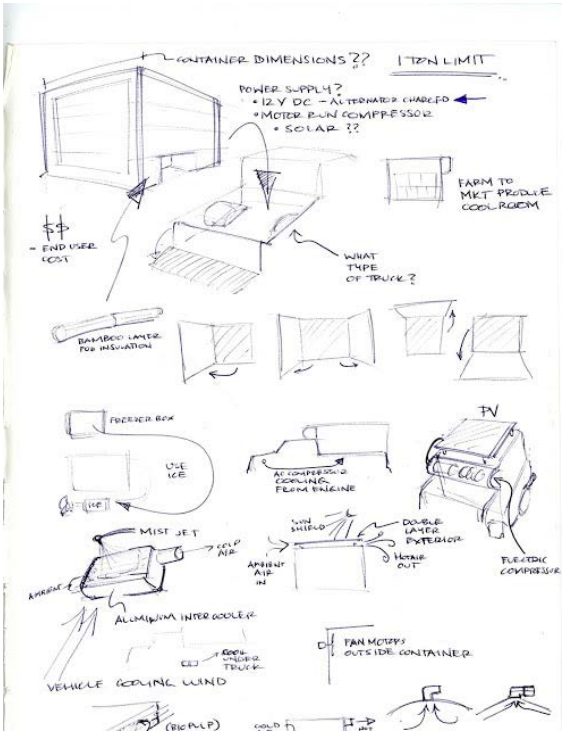
Project Background:
There is no existing cool chain technology for farmers and small/medium enterprise in Thailand to transport their product to customers or wholesale market. A dedicated refrigerated truck would be expensive for this purpose. The project involves designing a low cost cool room/container (with temperature adjustable between 10 to 20 degree celcius) that can be mounted on the back of a 1 ton pickup truck.

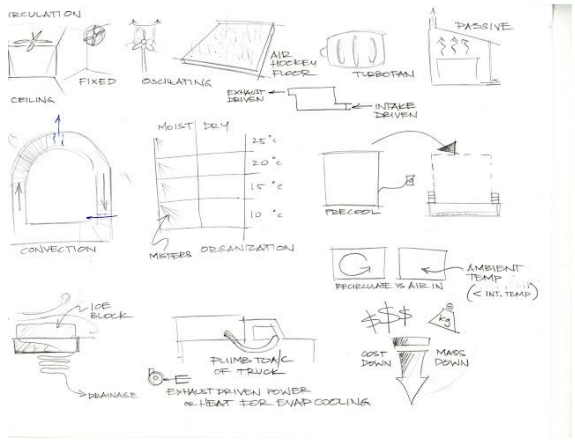
Problem Statement:
Design a low cost cool room\container for cooling agricultural produce (with temperature adjustable between 10 to 20 degree Celsius) that can be mounted in the bed of a 1-ton pickup truck in Thailand.

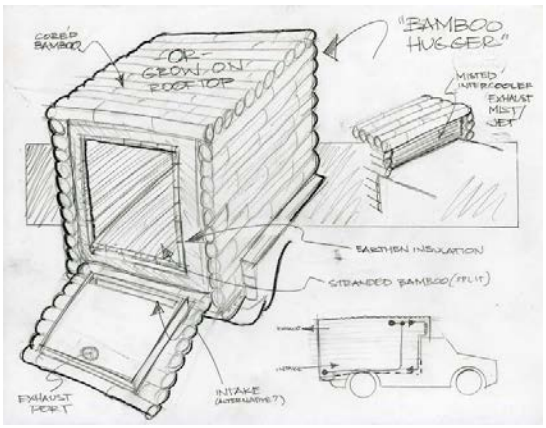
Design Brief:
The D-Lab team constructed a prototype cooling box made of multiple wood layers with an evaporative cooling system made from a aquarium pump, small fans, powered by a car battery.

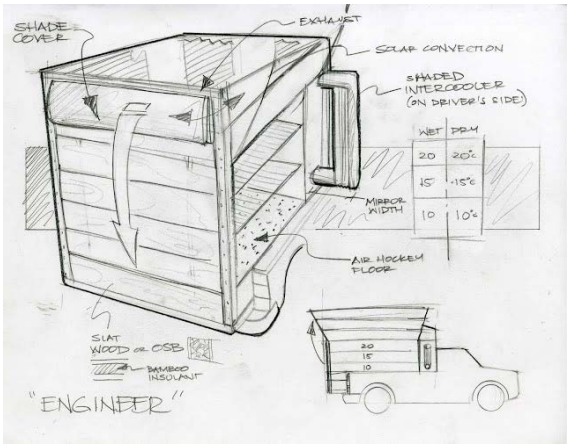
Results:
The prototype successfully kept the horticultural produce cool during testing in a Davis, CA greenhouse. However, the evaporative cooling system is not appropriate for the humid conditions in Thailand and desired cooling temperatures would not be replicable there.

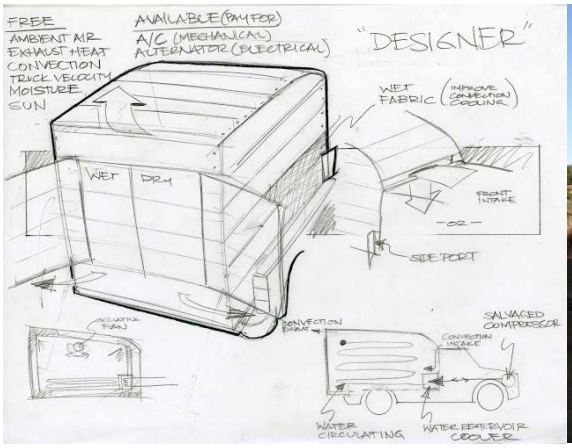
Future Work:
Consider alternative cooling technologies, such as forced air with a 12V air compressor delivered through the truck's air conditioning system. Consider a shaded or reflective roof and elevated base to reduce solar radiation. Consider improving insulation and sealing to improve inner box cool air retention.


CONTAINER DIMENSIONS ??
1 TON LIMIT
POWER SUPPLY ?
• 12 V DC – ALTERNATOR CHARGED
• MOTOR RUN COMPRESSOR
• SOLAR ??
FARM TO MKT PRODUCE COOLROOM
- END USER COST
WHAT TYPE OF TRUCK ?
BAMBOO LINER FOR INSULATION
FREEZER BOX
USE ICE
AC COMPRESSED COOLING FROM ENGINE
PV
MIST JET
COLD AIR
AMBIENT
AMBIENT AIR IN
WIND SHIELD
DOUBLE LAYER EXTERIOR
HOT AIR OUT
ELECTRIC COMPRESSOR
ALUMINUM INTERCOOLER
COOL UNDER TRUCK
VEHICLE COOLING WIND
FAN MOTORS OUTSIDE CONTAINER
(BICYCLE)
COLD
HOT


CIRCULATION
FIXED
OSCILLATING
AIR HOCKEY FLOOR
TURBOFAN
PASSIVE
CEILING
EXHAUST DRIVEN
INTAKE DRIVEN
MOIST
DRY
25°c
20°c
15°c
10°c
PRECOOL
CONVECTION
MISTERS
ORGANIZATION
AMBIENT TEMP (< INT. TEMP)
PRECOOLING VS AIR IN
ICE BLOCK
PLUMB TO A/C OF TRUCK
COST DOWN
MASS DOWN
DRAINAGE
EXHAUST DRIVEN POWER OR HEAT FOR EVAP COOLING


CORED BAMBOO
OR GROW ON ROOFTOP
"BAMBOO HUGGER"
MISTED INTERCOOLER
EXHAUST MIST JET
EARTHEN INSULATION
STRANDED BAMBOO (SPLIT)
EXHAUST PORT
INTAKE (ALTERNATIVE?)


SHADE COVER
EXHAUST
SOLAR CONVECTION
SHADED INTERCOOLER (ON DRIVER'S SIDE)
WET
DRY
20
20°c
15
15°c
10
10°c
MIRROR WIDTH
AIR HOCKEY FLOOR
SLAT WOOD or OSB
BAMBOO INSULMAT
"ENGINEER"


FREE
AMBIENT AIR
EXHAUST HEAT
CONVECTION
TRUCK VELOCITY
MOISTURE
SUN
AVAILABLE (PAY FOR)
A/C (MECHANICAL)
ALTERNATOR (ELECTRICAL)
"DESIGNER"
WET FABRIC
WET
DRY
FRONT INTAKE
SIDE PORT
SALVAGED COMPRESSOR
CONVECTION INTAKE
WATER CIRCULATING
WATER RESERVOIR COOLER

Section Four - Trellis Project

The Trellis Fund provides small-scale, in-country development organizations access to U.S. graduate student expertise, providing benefit to both the student and the in-country 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.

Reporting period 2:

At a Glance:

- 124 training and extension meetings that reached 1,935 farmers (1,492 women)
- 10 demonstration plots
- 7 radio and theatre programs on nutrition with a projected audience of 1,950
- 10 research stations, universities and agricultural NGOs
- 10 U.S. graduate students were awarded
- 6 developing-world graduate students engaged

Project Narrative:

In January of 2011, Hort CRSP issued a Request for Proposals for the pilot round of the Horticulture CRSP Trellis Fund. We sent the RFP to over 630 NGOs, universities and research stations in Feed the Future countries. For the modest $2,000 contract opportunity, Hort CRSP received 68 proposals. The $1,500 fellowships offered to graduate students attracted 30 applications from committed students.
In July of 2011, Hort CRSP funded ten Trellis Fund projects. With a $35,000 investment,
Hort CRSP funded:

- 124 training and extension meetings that reached 1,935 farmers (1,492 women)
- 10 demonstration plots
- 7 radio and theatre programs on nutrition with a projected audience of 1,950

Hort CRSP engaged:

- 10 research stations, universities and agricultural NGOs
- 10 U.S. graduate students
- 6 developing-world graduate students

The implementing partners who developed and conducted the 118 training and extension meetings are from local NGOs, universities and outpost research stations. They benefited from close ties to their communities and first-hand knowledge of the problems facing local farmers. They reported that, of the 1,935 farmers reached in the training programs, 1,390 farmers adopted new practices, which is much higher than the 10% adoption rate project management was expecting. Although these reported rates are high, this miscalculation could be mitigated by the fact that local agronomists are in a very good position to identify the improved varieties and production practices that are best suited to their surrounding farmers.

The U.S. graduate students met once per month to discuss their challenges and successes. A member of the Horticulture CRSP Management Entity presided over most of the meetings in order to impart knowledge on international development and extension.

In the pilot year, the main challenge was getting the Developing World Organizations (DWOs) to engage the U.S. graduate students. Many of the DWOs were more interested in the $2,000 contract than a partnership with a foreign graduate student who they had never met. Confident that the ten selected graduate students had relevant knowledge and information resources to offer to their respective organizations, Horticulture CRSP encouraged the students to persist. A number of the students prevailed in forging excellent working relationships with their counterparts, despite early difficulties. One such example is Allison Ferry, a Ph.D. candidate in Plant Pathology. Initially she had trouble getting her partner organization in Nepal to respond. However, by the end of the project period, her partner organization was going beyond the scope of the project and soliciting her technical expertise on a range of issues. They continue to send her pictures of farmers' fields and ask her assistance in identifying diseases.

The two students who used their $1,500 fellowship to travel to their partner organization developed better relationships with their partners and were more engaged in their projects. Consequently, in the second round, the graduate students will be required to travel to their partner organizations at the beginning of the project, and we will increase the graduate student fellowships to $2,000 to ensure the students have adequate resources for the trip. Furthermore, in the RFP we will ask the DWO to provide greater detail of the activities they have planned for their graduate student partner. The RFP will also stress the importance of the relationship by making the DWO's plan to engage the students worth half the evaluation points in the proposal review process.

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