The Importance of Horticulture Research and Development to the Feed the Future Initiative

Presentation Transcript

May 29, 2013

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Zachary Baquet: Good morning everyone. My name is Zachary Baquet. I'm the knowledge management specialist for the Bureau for Food Security who is sponsoring these, the Ag Sector Council seminar series. So I welcome you today. These are implemented by the knowledge driven micro enterprise development project who helps us put on these events. So thank you to them today as well.

So this is our Ag Sector Council for July. It's on the importance of horticulture, research and development to the Feed the Future initiative. So I welcome our online audience as well as our in-person audience to this event. Just a few sort of housekeeping things. Please turn off cell phones or put them on vibrate so we don't interrupt the speakers.

Also, hold questions till the very end. We're going to let all the speakers go and then we're going to do the Q&A. This is to help with our online audience because they can't hear if you don't have a microphone. So please hold your questions until the end. When asking questions please state your name and organization before asking the question.

To name some of the upcoming Agrilinks events we have sort of an e-consultation that's happening on the Agrilinks website on the IPM, the Integrated Pest Management sort of research thoughts or priorities that's happening June 4th and 7th. You can check out Agrilinks for that. There's also another e-consultation on sustainable intensification that's happening June 18th through the 21st. Then the next Ag Sector Council which is going to be on scaling technologies in agriculture is going to happen June 26th. So please stay tuned for those. Check out Agrilinks for those upcoming events. With that I'm going to hand it over to John Bowman who's a senior agricultural advisor for the Bureau for Food Security in the Office of Agriculture Research and Policy. John will do the introductions.

John Bowman: Thanks for coming. The purpose of today's Sector Council is to give you a brief exposure to some of the interesting things we're doing in Feed the Future in the field of Horticulture. So why do we work in horticulture? I think I'm preaching to the choir here and probably most likely but it's an extremely effective tool in terms of reducing poverty and hunger. We incorporate horticulture into primary education systems in developing countries. It promotes gender equality. It empowers women. It can reduce job mortality and greatly improve maternal health. So these are some of the top five millennium goals which are highly compatible with Feed the Future objectives.

But the real key to the role of horticulture in Feed the Future is that it serves this important role in terms of the nexus between agriculture and nutrition. It not only provides high income and diet diversity but it

essentially provides – it's a provision tool for high levels of micronutrients which many of the other crops don't provide. In particular in Feed the Future we have these lofty goals that have been set out by FAO realizing that by 2050 we have 9 billion to feed and we have to increase agricultural productivity by 70 percent. So horticulture is a very important tool in the toolbox to meet these goals.

One of the biggest problems is that we have decreasing amounts of arable utilizable land. We have climate change reducing land. We have urbanization reducing land and other factors. So horticulture is a way to on small pockets of land to produce high amounts of food, to get high amounts of income, get high nutrient production and we can capture on small pockets of land large quantities of micronutrients. Through food processing and food preservation technologies we can distribute those micronutrients over wider expanses of land and to many small holder farmers.

I won't spend a lot of time on this but just to show you the importance of horticulture to the Feed the Future missions right from the very start it turns out that in more or less of the 20-some Feed the Future focal countries 14 of them now have horticulture as high priority value chain selection. So the missions themselves have chosen horticulture something like 6 out of the 11 in East and Southern Africa and all the missions in Asia and Latin America and in Caribbean. So about 14 out of the 20-some Feed the Future countries the mission have chosen horticulture as high priority.

In the Agriculture Research and Policy Office I think many of you are aware that – we work on many technologies, many aspects of horticulture in many countries but we have been asked to focus our research efforts in four agro-ecologies. The Indo-Gangetic Plains, the Ethiopian Highlands, the Mixed Maize systems of East and Southern Africa and the Sudano-Sahelian agro-ecology of West and Central Africa. So we're focused on working with the missions to promote sustainable intensification of crop production in these systems. In terms of where horticulture will feature prominently is mainly in the Indo-Gangetic Plains where we'll be integrating horticulture with rich and wheat systems and then these mixed maize systems of East and South Africa where we'll be integrating horticulture with maize and legumes.

So I just wanted to give you a little feel for in Tanzania in these sloping hillside areas in Morogoro in the SAGCOT corridor. On these elevated slopes maize and legumes grown together are more or less the order of the day but more and more farmers are trying to integrate tomatoes, peppers, cabbage, onion and other crops into the system but unfortunately a lot of what they're doing in terms of their trying to do horticulture by the seat of

their pants they're not using good, sustainable agricultural practices. In some cases they're just planting horticultural crops in vertical strips up the hillside instead of using of course more sustainable contour techniques that would preserve the ecological balance of the hillside. So this type of research we have to do in horticulture to teach these farmers how to integrate with maize and legume systems.

Just a quick look at the major ways that we work with horticulture under Feed the Future. In my office, the Agricultural Research and Policy Office we have four major mechanisms. We have the innovation labs which you'll hear from today, horticulture and integrated pest management. They are all focused on horticulture of course. We have a major investment with the Asian Vegetable Research and Development Center in Taiwan also known as the World Vegetable Center. They work on aspects of horticultural breeding. They work on production aspects all along the value chain. We've made a significant new investment with them in the area of post harvest horticultural management.

In terms of the CGIR systems the world Agroforestry Center works on many different fruits and of course the International Potato Center have world mandate for potato and sweet potato. Also in the office we have a whole suite of biotechnology research projects and these projects are focused on giving high degrees of disease resistance and certain horticultural crops such as eggplant, potato, papaya and banana. Then we have a bio-fortification effort that's run by Harvest Plus focused on higher levels of vitamin A and other nutrients in orange flesh sweet potato. That's run by IFCRE.

Then we have all the value chain projects that are run out of the mission to compliment these research activities. As I've mentioned many of the missions have chosen horticulture to be of highest priority. I wanted to mention that this is not only from the get go of Feed the Future but in some of the most recent high level procurements in Feed the Future horticulture still remains to be of high priority. For example, the new Feed the Future project in Nepal that's led by Winrock, the new caves project in Kenya led by Thin Track and a big, new Feed the Future North project in Haiti led by DAI. In all of these new procurements horticulture features extremely prominently.

I just wanted to emphasize that we don't just work on horticultural research technologies development. We have some concerns right now that are very high level in the research office and we have to bring horticulture into the mix. We are focused on relationship building between our horticultural research projects in these mission value chain projects. It's a high priority. We are trying to find a role for horticulture in our sustainable intensification efforts mainly in Africa and we have a

brand new technology scaling effort where we are trying to work with the missions to identify the most appropriate horticultural technologies that can be scaled. So just doing the work that we normally do we now have these kind of three kind of top tier initiatives high priority that our office is concerned with not only in horticulture but also in other areas.

I want to emphasize that all these three high priority areas the whole key to success in these is a high degree of collaborative research. Collaboration between the research projects and then collaboration between research project and mission value chain project, private sector reading projects. Collaborative research is key. So I'd like to close by just showing one example of a collaborative initiative that we have in Kenya. We're working on African indigenous vegetables there. These are vegetables such as African eggplant, amaram, spider plant grown traditionally by small holder farmers, very disease resistant, very highly nutritious. Many of the farmers aren't aware of the nutritional value but they grow them in backyard plots. They have very high demand in the marketplace.

But we are trying to lend a new level of sophistication to growing these AIVs. So through research at the Asian Vegetable Research Development Center we're breeding very high level improved elite lines of these AIVs and AVRDC is providing seed to many of our research and development projects. In Kenya we also have the Horticulture Innovation Lab working on trying to develop the best possible agronomics in terms of these new, improved seeds in terms of using drip irrigation, fertilizer, regimes, roast baseing, some cultural practices and also doing very sophisticated nutritional analysis of these different strains of AIVs.

In collaboration with the horticulture value chain projects in Kenya from the mission led by Thin Track this particular project is supporting an agro business, Maize Foods, to find market linkages in Europe to essentially sell processed, dehydrated, high quality, packaged AIVs to the European diaspora. They're working on the market linkages and our projects in terms of our seed research, our research in the best practices links up and helps feed the supply chains for companies such as Maize Foods. In addition to that, we have some health projects in this part of Kenya. This is near Eldoret. The Ampath Project works exclusively with HIV affected small holder farmers. So in addition to helping them to teach them how to grow the AIVs, to market them and to prepare them for processing by companies we also encourage through behavioral change to make sure that they consume these vegetables in combination with their antiretrovirals and it gives them much better synergistic effect.

So that ends my talk in terms of an overview and introduction. So you'll be hearing from the Horticulture Innovation Lab led by U.C. Davis. They

work on very innovative pioneering aspects of horticultural technologies. You'll be hearing from the IPM Innovation Lab led by Virginia Tech. They work on true and tried IPM technologies and they apply adaptive research through the Feed the Future span of countries. Then you'll hear from DAI, Development Alternative Inc. and they have been a thought leader in value chain analysis, value chain development for over 30 years and they run some of the horticultural value chain projects for Feed the Future in countries such as Haiti, Liberia and Tajikistan. So with that my presentation is over and I'd like to introduce Beth Mitcham to come and give her talk.

So Beth grew up in a suburb of D.C. She attended the University of Maryland where she obtained her PhD in horticulture and she's been on the faculty of U.C. Davis since 1992 where she directs the Post Harvest Technology Center in addition to directing the Horticulture Innovation Lab.

Beth Mitcham: That's something literally. Thanks. Thank you. Thank you John and I really appreciate the invitation to be here today and to talk to you about our passion in horticulture. So John touched on this a bit but just to reiterate why horticulture is important. Of course it's a high value crop by definition and so it's a crop that can lead to income generation but also income diversification. Also horticultural crops can be produced on very small plots of land and yet still generate a reasonable income for the farmer. We'll talk a little bit more about some of the nutritional benefits of horticulture but I think here in the developed world we're all very aware of how important it is to eat our fruits and vegetables. Finally, women in the developing world are very heavily engaged in horticulture, production and marketing. So horticulture is a great entryway to empower women and improve their livelihoods.

A recent study published in 2010 highlights the importance of a diverse diet in terms of a nutritional adequacy. They found in these five different regions that there was a strong correlation between the number of food groups that were consumed and the adequacy of the diet. There also have been linkages between diet diversity and malnutrition for infants and young children. So efforts that we can make to improve on farm crop diversity through production of crops like horticulture increase the likelihood that a family will have a diverse diet. Also consuming nutrient dense foods including fruits and vegetables is important for optimal physical as well as mental development.

But how can we assure that production of horticultural crops and other nutrient dense products will lead to improved nutrition? There's not always a clear path between the two. But studies have shown that by making these nutrient dense foods more available by increasing their

production it is one of the most effective strategies to diversify people's diets and increase their micronutrient intake. Other strategies that have been proven to increase consumption and diet diversification are to increase women's income. Generally when women have higher income they'll be more consumption of crops like fruits and vegetables. Also if we can increase production of underutilized crops like the African indigenous vegetables that John Bowman mentioned this also increases diet diversification. You'll see through my presentation that the Horticulture Innovation Lab, formally Horticulture Crisp is involved in project addressing each of these areas.

In terms of gender and horticulture I'd like to elaborate a little bit here. We know that women grow and provide labor for horticultural crop production in many parts of the world yet the gap in income for women versus men who are growing the same crop is quite large and that's generally because women lack access to input including land and also education. So if we can work to close this gap with research and development. This can lead to women's empowerment which many of us recognize leads to better nutrition for the family and also improve family education. So there's lots of reasons to promote improved horticultural production particularly by women in the developing world.

If we looked at improved horticultural technologies these might be improving the production process and if we can particularly look at technologies that help women to do a better job with horticultural crop production this is important. If we can save them time and reduce the amount of unpaid labor that they have in their daily lives that can be helpful. Things like improving processing technologies so that they're more convenient, easy to use, less expensive, we can help them with their business and all of these things will ultimately improve household nutrition by improving women's income but also the availability of nutritious foods.

I really believe that the key to adoption of these improved horticultural practices is access to a viable market. I really think this is the key. Farmers need to understand that there is a likely return on the investment that they're going to make. It needs to be a reliable market for their crop. I also believe that the ability to store the crop through post-harvest practices such as cool storage and other methods gives farmers the ability to bargain and to obtain a better price for their product. Access to transportation that the farmer has some control over can also empower farmers to get a better price for their product. Of course it's hard for a single farmer to do these things on their own. So I think farmer associations and other sorts of group activities are important.

At the Horticulture Innovation Lab we're testing a number of different technologies and today I'm just going to touch on a few of them. I'll talk to you more about the seed drying beads and the pest exclusion nets and the Cool Bot cold rooms. We're also looking at improving solar drying, soil solarization. We're working on market linkages. We have a project looking at indigenous vegetables and the nutritional value of these. John mentioned some of that work in his talk. We're looking at processing of orange flesh sweet potato into various products to enhance their consumption. New variety evaluation for horticultural crops and also irrigation particularly solar powered pumps as an example.

So just to talk about a few of these. We've been doing a lot of work with a product called the Cool Bot. It's a unit. It's a small controller. This is what it looks like here. It works with a standard air condition unit and it controls the unit so that it will actually cool to lower temperatures than a typical air conditioner would. So we can cool down to 2 degrees Celsius, 36 degree Fahrenheit and by combining that with an inexpensive, insulated structure we can have a small scale cold room for much lower price than would typically be necessary.

We've actually installed a number of these around the world. Many of our research projects PIs have determined that this technology is useful for their programs. So there have been many of them installed around the world. One project in particular I wanted to mention was a project we're working on together with SIP in Bangladesh looking at potato storage. So this showing potato harvest in Bangladesh and some of the problems they have with the ambient storage that's typically used there are things like sprouting and soft rot. So this really limits the ability to store the potatoes. So our project is looking at different types of storage facilities including the Cool Bot unit with the air condition, the typical ambient storage and then an improved ambient storage that has been developed by BRAC in Bangladesh.

The improved ambient storage has an under-floor water reservoir that can provide some evaporative cooling in some situations. So we're going to be comparing these three. We just collected the potatoes and they're going to be going into storage soon. We have every expectation that the Cool Bot will be able to keep potatoes in much better quality for a much longer period of time.

We've also been working on a product related to drying of seeds. We're working with a technology that's available from a commercial company. It's a special type of zeolite made by Rhino Research. They're based out of Thailand. It can be used to dry seed among other products. Of course, in very humid climates being able to dry seed is – well drying seed is very challenging because if you're trying to dry it in the sun you really can only

dry so far because of the ambient humidity levels. So seed viability over time is much reduced.

With this technology you can put the seed together with these beads, within a 24 hour period, generally less the seeds are dry and you can store them in a sealed container which protects them from rodents and insects and other pests. They've done a lot of studies and while I'm sure you can't see these labels you'll notice that some of these rows are not very full. The seedlings are sparse and they're very small. Those were the seed that were dried in the sun as compared with the seed dried with the zeolite beads which are much hardier, healthier plants and with a higher germination rate. You can see here these are beds with seeds inside and this is a humidity meter showing essentially 0 percent relative humidity inside. The beads can be regenerated 10,000 times. So they can be used over and over again.

So this is an example where we're working together with a private company, also with the Cool Bot also. That unit is produced by a company in the U.S., in the Northeast here. We've also been focusing on post-harvest. We believe that with horticultural crops post-harvest handling is a really critical component to success and it's a place where we can really make a big impact. One of the things we recently did was open a post-harvest training and services center at the World Vegetable Center in Tanzania. This project also worked to train 36 master trainers from various countries in Africa and those people are charged with training farmers. While they've been charged with training over 10,000 farmers a year we expect they're going to greatly exceed that number based on what they've done so far.

John mentioned the work on African indigenous vegetables. We've been looking at improving the value chain, looking at the improved varieties produced by AVRDC, improving production practices, marketing and then looking at their nutritional value at harvest but also after cooking with traditional methods. We've been working on trying to link farmers to markets. The project that we have in Zambia has linked women's groups who are actually first time vegetable farmers. They've been trained how to grow vegetables and they have a ready market at a local hotel and now we're branching out to local supermarkets in Zambia. We're working with them to improve their production as well as their post-harvest practices. This project because of that linkage to the market has been very successful.

We also have a project in Uganda that's looking at participatory market chain analysis where you bring together various market chain actors and talk about the market and the possible opportunities to work together on

joint business ventures. Then you work together with the group to try to implement some of these business models.

In terms of pest control we do have one project that's looking at pest exclusion nets. These are actually insect netting that's been repurposed for this application. There's a company in Tanzania called A to Zed and they provide these nets and work closely with us on this research. It does exclude a number of insect pests. It also seems to modify the ambient environment and in some places that leads to better growth of the plants, better moisture management, slightly higher temperatures. Of course in really hot climates it can be a challenge. So we're looking at different pore size for the nets to make sure the environment's favorable in various places.

Then finally, to try to get some of these technologies out and adopted one of the approaches we're taking is the opening of regional centers of innovation. We've opened three centers over the last four years. The first one was opened in Thailand at Kasetsart University. The second one in Honduras at Zamorano and earlier this month we opened our third as a participatory training center in KARI Thika Kenya. At these centers we'll be highlighting some of the technologies that we've been working on, bringing in local entrepreneurs to try to encourage them to adopt these technologies, perhaps provide them for the local community and then of course demonstrating them to farmers as well.

At our center in Thailand last fall we were pleased to – we had a seed drying bead expo at the center and the Princess of Thailand came to our event which was quite a coup for us. We got a lot of good PR out of that activity. But this is one of the ways that we're trying to get technologies out the door and hopefully picked up by some of the value chain projects and other programs that are working with large numbers of farmers.

So I'd like to thank the many collaborators whose work I have presented in this short presentation and their names are listed here. If you'd like more information our website has a lot of information you can get. So thank you very much.

[Applause]

John Bowman: As Zachary mentioned earlier we're going to hold questions till the end for all three speakers combined. Next I'd like to introduce Dr. "Muni" Muniappan, director of the IPM Innovation Lab. Muni has worked for more than 40 years on biological control, integrated pest management, agricultural research management in the tropical context. He's worked on biological control of Papaya Mealybug in Pacific South Asia, Southeast Asia, Middle East and West Africa. The benefits from this Papaya

Mealybug work in India alone are estimated at over $1 billion of cost savings.

Dr. Muni has also worked on biologic control of the Pink Hibiscus Mealybug, the Read Coconut Scale, the New Guinea Sugar Cane Weevil, Ivy Gord, Siam Weed and Lantano which are among other invasive species and pests. He served as the director of the IPM Innovation Lab since 2006 and he's been instrumental in developing IPM packages for tropical vegetable crops. Recently he's published two books, *Biological Controls of Weeds in the Tropics* through Cambridge University Press and *Arthropod Pests of Horticultural Crops in Tropical Asia* published by CABI. Dr. Muni?

Rangaswamy (Muni) Muniappan: Thank you John for the introduction. IPM is key for green conserve because this where Dr. Swamina then said when he visited Virginia Tech over two years ago and I'm sure IPM is going to be key for the next Green Revolution whenever it is going to happen. So IPM is one of the important aspects in the developing world for agricultural improvement. IPM Innovation Lab has been working mostly on the high value vegetable crops and developing IPM packages and also on selected food and cash crops.

In the case of cereal crops we are working mostly just addressing a few components of IPM in sorghum, wheat and rice. What IPM package means is we are developing technologies that will replace, that there is a need to use the chemical pesticide for the farmers who need some of the solutions from the time of planting the seed up to the harvest. So we address all the _____ fest by the farmer and in the plant protection side in the continuation of crops. So IPM Package plants that we farm consist of several companies starting with solarization of the seed _____ greenhouses are skin houses because plenty of sun is available in the tropics.

We so utilize the sun for solarization. That will control some of the weed seeds, fungal diseases as well as bacterial diseases. It is important that we start with a healthy seed and seedling production. So also this is free wants that is also very important in the IPM, that we also consider as one of the component.

Then we also recommend treating the seeds or the seedlings with trichoderma which is an antagonistic fungus and it protects the seedlings from the attack by the soil borne fungal pathogens. We also recommend treating the seeds or seedlings with pseudo _____ or _____. They give protection to the seedling by inducing difference of that. We also

recommend using van. That's a micro razor fungus that helps the seedling grow and also using nin cake and other argo _____. Nin cake is known to control nematodes. That is widely used in some of the Asian countries for nematode control.

Then these are some other companies that we have integrated to the IPM package and I'll just be highlighting a few of those company names we have to give you, the focus mirrored in them. So drafting, sticking and winching using sticky traps to kind of catch these insects like white flies, the African _____ from on traps to monitor the place ahead of time so that once they are seen in the traps we can start the control measures. Also we use it in the area wide management. Cost free period and drugging to control some of the wettest diseases that cause serious damage to the vegetable crops. Then we also recommend use of pesticides but as an end product. _____ _____ _____ suggest an end product and also we have very early _____ technologies within the developing countries for production of microbial pesticides like nuclear polyhydrosis _____, metrasin buvaria and others.

Also we are just tackling the invasive species. For example, the tomato leaf miner _____ _____ it is a native of South America. In 2006 it got introduced to Spain and now it has spread all over Europe. _____ _____ Mediterranean region. Recently it showed up in Senegal, Niger, Sudan and Ethiopia. So we join with the African Bureau and conducted a workshop to centers in Senegal to sensitize the countries in Central and West Africa about this problem so that they would be aware of the problem. Start have them monitoring, put them on traps different parts of their country so that once the pest shows up they will know what to do.

Well there is one of the company that we introduced in Southern India. In the past the farmers used to grow their seedlings in one corner of their field in the sire. Usually they would lose anywhere from 30 to 60 percent of their seedlings due to pythium and other fungal diseases. By introducing this for plastic face and also using the coconut coir pith in the past, over ten years ago in India coconut coir pith was thrown out as a waste now they make it in a small box and put them in the plastic trays and put a _____ on it and it works.

That's very good job as a seedling block. This block also very amenable for treating with trichodermas, rudamonas and other _____ pesticides. Now there are several nurseries that have come up in the southern part of India and most of the farmers now buy their seedlings from the nurseries and they don't produce their own seedlings as in the past because they found by getting the healthy seedlings – they can almost double their production. This technology now we are introducing into Northern India as well as other Asian countries and to African countries.

Another technology that we help promote is the production and use of trichoderma. As I mentioned earlier trichoderma is an antagonistic fungus and when the seedlings are treated with trichoderma and planted in the field this fungus grows around the root as root junk and prevents the pathogenic fungus attacking the seedlings. So this has become very popular in some of these Asian countries like India, Bangladesh, Indonesia, Philippines, Nepal and recently we introduced that into African countries like Uganda, Senegal, Mali and Kenya. Also one of the collaborating institution in India there's _____ Agricultural University has several specialist in production end use of this trichoderma. So they were kind enough to organize two international workshops in India. In those workshops they helped train over 25 scientists from 8 different countries from different parts of the world.

In this slide you can see the _____ University. They are producing the trichoderma on the _____ corn kernels, packaging them and shipping them to different parts of the country. This shipment is going from Boga to _____ for treating the iPhone sickness. This _____ _____ is from Bangladesh. She started production of trichoderma in compost, in _____ _____ _____ the compost and then she sells the dried compost to the farmers. She started business over five years ago in association _____ to help from Bangladesh _____ _____ _____ dispute and now she's a fairly good – her business has become a fairly good size and she's able to supply this compost throughout Bangladesh. This is one of the public and private partnership that IPM Innovation Lab has been producing in Bangladesh.

Similarly in India these two scientists are from the Bangladesh Biological Control Research Laboratories in Bangalore and this laboratory is able to produce several _____ sites and also produce the nuclear polyhydrosis virus for _____. It's a serious pest for tomatoes and other vegetables. That technology was developed at the _____ _____ University and transferred to this _____ company. It's another example of the public and private partnership that was introduced by the IPM Innovation Lab.

You can see some of the field trials connected with trichoderma. We had field trials conducted in Indonesia and _____. The crop that is treated with trichoderma produced a nice head than the one that wasn't treated. Similarly here you can see in Philippines the flower treated with trichoderma has a very good stand of garlic and the one that is not treated was not that good. Here this picture was taken in India that the voka field was treated with trichoderma. You can see a very good stand of the cob. The untreated one was very poor stand.

Other technology that we have introduced through the IPM Innovation Lab is grafting of the eggplant and tomato to overcome the Bacterial Wilt Disease. Bacterial Wilt Disease is soil borne disease. If you plant the eggplant, tomato or pepper in the infected soil it will come up to flowering stage and the die. So we introduce grafting system where the _____ core, the severity of tomato or eggplant is grafted on the top of the root stock of the wild eggplant that is resistant to the bacterial wilt. This technology was introduced about ten years ago in Bangladesh and it caught up and the farmer's found that it grew about 220 percent in yield and also about 300 percent in profit. So this technology has been transferred to several places to like India and Nepal through things, Uganda, Honduras, Nicaragua, Senegal and Kenya. This technology is also beneficial to women. Women seem to be good in grafting than men. So several nurseries employ women for grafting the seedlings.

The same technology was transferred to Honduras not for Bacterial Wilt control but for controlling _____ Wilt in _____ _____. _____ is an Indian crop grown in Nicaragua and other Andean region, other prentice in the Andean region where _____ Wilt is a serious problem. They found one of the wild _____ to be resistant to this disease so they use the wild _____ as the root stock and graft all of the _____ on the top of the root stock.

We also introduce vermouth for monitoring the pest. That's for less for doing some of these, the area where management here. This picture was taken in Bangladesh where they use cooler on a radio when business to control the _____ fly pest. We also help in our host countries in production of biological agent. You can see just a small number two was set up with some leaves and this set up provides nesting for the ants and the ants in turn chase off the coco palm bug. It's a very simple technique and works very well. Also we help them in producing _____ mites in Honduras as well as other producers' natural enemies.

We have also introduce Ming as a bio pesticide and we promoting this technology to some interval for these small scale farmers use as a less by the companies. The companies produce some of the ingredients into different formulations and sell them as a direct in product. Another serious problem is the Tomato Yellow Leaf Grow Virus. It causes almost 50 percent year direction in tomatoes that Bob _____ from U.C. Davis has come up with a technology known as horse free period. If the farmers don't grow tomato or pepper for over three months in an area and then come up with a crop they are able to get a good one. What happens is the white flies don't get the whitest. They don't have the tomato and pepper for three months and then by the time the white flies get this virus it is too – the crop is already in production stage. It doesn't affect it that much.

We also followed up with monitoring the impact of our technologies that John Norton has followed. I've estimated our analysts have worked nine technologies that were introduced and he found so far the benefit has been about $750 million to $1.75 million that's analyzing nine technologies. We feel the cost benefit ratio for this is $15.00 to $35.00 for each dollar spent in IPM Innovation Lab. We feel that we have almost 100 different ones to be analyzed and if that one is analyzed the cost benefit ratio would be $150.00 to $350.00 for each dollar spent. We also follow with invasive species. The Papaya Mealybug as I mentioned it _____ as invasive species got introduced to India. This is how the plant looked like when it infested. We introduced the biological control agent in 2010. In six months it control the pest and the benefit has been tremendous. Also we have been following this _____ _____ in Africa and trying to help control the pests.

We also concentrate on the gender issues and we can see here in Bangladesh women are producing trichoderma and using it in their backyards less and less in their fields. Here this picture was taken in Cambodia. There too women participate in trichoderma production. Here Marty McFell, one of the boyfriend members addressing a women gathering in India. In Mali they are mapping out all the acting technologies introduced over there.

We also get wisters from USAID emissions to our field sites. Here is that Gary Robbins and _____ _____ from USAID emission in India visiting one of the field sites in Southern India. Thank you.

[Applause]

John Bowman: Thank you Muni. Now for our last presentation. I'd like to introduce Don Humpal. Don is a senior agriculturist and senior principle development specialist at DAI or Development Alternative Inc. He's worked for more than 30 years on agricultural production, post-harvest production, handling and storage, marketing, food safety primarily in Africa and also in Eastern Europe, Caribbean and Middle East. He's worked on a wide variety of crops and processing enterprises across tropical, sub-tropical and Mediterranean environments for donor organizations, foundations and private sector clients.

Don grew up on a dairy farm. Actually it was dairy mixed with field crops and vegetables in Rhode Island and he served as a Peace Corps volunteer in Senegal in the '70s. He holds an MS from U.C. Davis and will today talk to us about the DAI experience using horticulture research and development and project implementation.

Don Humpal: Thank you John. It's my pleasure to be here today. I'd like to talk a little bit about how we look at the issue of scaling some of these technologies along with implementation projects which has that as an objective. Just a general introduction to DAI. Around since 1970. We currently implement about 100 projects in 70 countries and most of them focused on turning some of these ideas into action that generates economic growth and benefits the participating producing households. Many clients, staff of about 2,300, about 70 percent of whom are local. About 30 percent of our projects currently have either horticultural components or horticultural activities involved in them. All of them use a value chain approach as something that DAI is noted for for a long time. Here's a simplified horticultural value chain and it's very interesting listening to both Beth and to Muni who work at both the supply side of the issues but we have a very strong focus on the demand side.

If you take a look at this one which is just an example of how value builds and cost build from the production point. This is oranges in the U.S., recent scan data, about $0.16 a pound at the production level. Once you move through the post-harvest handling process on fresh about $0.57 a pound paid at the retail market for fresh oranges. About $1.00 per pound if we're talking about canned products, a very small part of it. But what I wanted to point out here is that we look at these value chains and say, "Yes, we move back from the markets," every one of these points whether it's input supply at the production level, packaging and handling at the post-harvest level, the processing issues, the transport and logistics issues, the management and logistics of marketing and sales are all researchable points and all points that we pull on research across our projects.

The reason that I say that is that we are concerned that everyone in this process is a winner and they can't be a winner if the gross margins aren't there in the product, if the risks are not manageable and if the opportunity cost which is often a forgotten factor as we look at technology changes met. I'll give you a simple example. Over 30 years seen very many efforts to try to move containers from a very large 50 kilo or 100 kilo box for tomatoes down to a 5 or 10 kilo crate for transport. People say, "Well why hasn't it been done in very many places," particularly for the national marketplace. We look at that and say, "Well those traders are coming down, putting their products on undifferentiated trucks. Those truckers overload their trucks often carrying a lot of passengers.

If you run a little experiment and try to put a five or ten kilo plastic crate that would protect those tomatoes in you find that some interesting things happen. A five or ten kilo crate can be stolen and moved a lot faster and easier than a 50 or 100 kilo box. You can say the opportunity cost of that particular investment in plastic crates could be 30 to 40 percent loss in those systems compared to delivering some of those crushed and hot

tomatoes into a marketplace where there's a very strong price differential in the marketplace and you have people who take the already crushed tomatoes to make sauce at the local market, sort out the other ones, sell them to a different price responsive customer and move into – and even do some top grading and move those into the top end of the marketplace locally. So we have to look carefully at these issues of the economics, at the risks and the opportunity costs throughout these innovation systems.

We also look at the issues of scaling. You look at all of these very nice technologies and the question is, "How do they get built into a system and grow over time?" One of the interesting things that we've come across is that there have been a greater focus through Feed the Future on the domestic marketplaces. When we look at these dynamics you see some very interesting things. I realize you can't read all of the vegetables that are noted in there going from production to the retail level but when you do a good piece of market research and this is work done by Michigan State and the Food Security Research Program in Zambia for us you take a look at the sources of the products and you end up in this case in Lusaka with very many sources that differ seasonally but you also see that particularly in many parts of Africa that there are large numbers of indigenous vegetables, particularly leafy vegetables that are moving into the market for many small producers in quite large quantities. In this case in a two month period somewhere near 10,000 tons or so moving through an urban market.

These issues bring up some interesting points when we look at seasonality of supply and the availability of some of these vegetables over time. You can't see all the details in some of these figures but if you just take a look at the bottom right hand side looking at onion supply into the Lusaka marketplace there are actually three countries involved; South Africa because of their production of the Granex longer storing of onion varieties that are going into this tropical highlands environment, the Zambian production locally and production from nearly 200 miles away in Malawi coming in at different times. We look at this and say, "What can we do? Is there an import substation opportunity here for the transfer of varieties?" We have some issues certainly in onions and damping off and looking at seedling quality coming into this system. Can we compete of when we're looking at the issue of suppliers of a better storing variety against some of the Bermuda type onions that have a much shorter storage ability here? So varietal introductions are pretty important.

I'd like to take a quick look at some of our projects. In Burundi with about 60,000 households targeted, Tajikistan currently with about 46,000 thousand and Liberia with about 54,000 all of which have productivity of private enterprise, market development, human capacity of development elements. In Burundi which was coffee, horticulture and dairy what we

found early on was that we were pretty able to work with the better off farmers in supplying urban markets with vegetables. We had to move parts of this value chain structure from sorting and packaging, wholesaling, shipping and retailing down to less advanced farmers. That requires us in most cases to take a look at how the financing of these activities gets done. What's going to pull this part of the value chain down into the more resource constrained farmers in order to generate their adoption of either different varieties, different production technologies, different post-harvest production technologies.

Over time basically through using association development activities and with about two-thirds female members we're able to improve the transfer of these technologies, improve the linkages back to the marketplaces using a combination of grants and better financing. Tajikistan family farming, the link here you see a series of vegetable crops. We have a very strong focus here on nutrition. Nearly over a single quarter about 200 demonstration sites of about a little over 1,000 different plots that get used as training points on nutrition issues and nutrition specific focus that – over about a quarter trained about 3,000 women on various nutrition themes.

There were really two areas of the research here. The RDC came in to Tajikistan and their central Asia program, took a look at the consumption of vegetables and said, "We have a seasonal availability problem on access to vegetables during a good chunk of the year. How do we address this issue?" One of the issues, seasonal extension, is a very common theme and in this particular case there were two solutions. One, is better household processing which immediately brings in both packaging those costs, food safety issues in terms of the thermal processing to preserve vegetables in canned form.

The second thing is seasonal extension of the production of these vegetables through nurseries to get an earlier start, get some earlier vegetables in there or moving to tunnels and greenhouses to extend the availability of vegetables but also to improve incomes as you're getting a broader spread. This is one of the issues that we come across very frequently in horticulture oriented programs that if you get a big build up in the main season's productions of the vegetables what happens in the domestic market? The prices go down. Therefore there's less of an incentive for the people involved to produce these crops. You get movement into other areas.

Men and women are both equally involved here in the training through a whole series of issues that take both the vegetable varieties that come out of AVRDC, that give them some of the seasonal extension that are the disease tolerance. The focus here that I wanted to point out that this farm

management research, again the gross margin risk assessment opportunity cost is a vital element about switching crops, in this case moving from dwarf fruit tree production into vegetable production for greater income and better household supply as well as some of the organizational work on the fundamental productivity issues here, what are user associations that are being developed to try to improve the access to water in Tajikistan which is vital to extending supply since many of these are degraded systems. But again, these are transfer costs, major public investments to try to drive the productivity of those systems, to drive greater irrigation and greater overall supply of fruits and vegetables into the system.

In Liberia we're rebuilding across a wide number of crops. I'll just mention a few things here. On seed available and equality and on erosion management – I think John already mentioned this in some of the up and down plantings. As we go into these areas, a very high rainfall situation, about 100 inches a year of rainfall. A lot of real and sheet erosion meaning that if peri urban gardening is to expand and you're going to maintain the productivity that some of these basic investments in improving soil and water conservation are essential to preserving both the incomes and the supply of these products. So a lot of work done on contro-bed alignment, contro-stabilization of those with verterer and veringa for other uses.

In this type of situation we're rebuilding some of the basic capacity in soil analysis and research is there. Pest and disease identification is being done. We're finding a number, for example, of Broad Mites on chilies which were seen originally by many of the people as a viral disease, just a mistake in the diagnosis. I've been trying to do the inventory of beneficial insect identification where we certain feel that IPM given AIDS concerns about pesticides uses, the periswaps that go in place, integrated pest management and the integrated pest management tools are something that we actually find lacking in a lot of situations. We also find the need to try to move those technologies into suppliers of those products throughout the value chain. Thank you very much.

[Applause]

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