Integrated Pest Management - Innovation Laboratory Program

Report of the External Evaluation Team

An Evaluation Report of Phase IV and Plan for Phase V of the IPM Innovation Lab Activities

Team Members:

James Litsinger[1], James Starr[2], and Hanu Pappu[3]

July 2013

[1]Independent Consultant, Team Leader

[2]Professor, Department of Plant Pathology and Microbiology, Texas A & M University, College Station, TX

[3]Professor and Chair, Department of Plant Pathology, Washington State University, Pullman, WA

Photos left to right: Tomato breeding in Nepal by a private company, *Trichoderma* trial in Bangladesh, Tomatoes in plastic tunnels in Uganda

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List of Acronyms

AOR	Agreement Officer's Representative (USAID)
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AVRDC	Asian Vegetable Research and Development Center, Taiwan
BARI	Bangladesh Agricultural Research Institute
BFS	Bureau of Food Security (USAID)
BIFAD	Board for International Food and Agricultural Development
CAADP	Comprehensive African Agriculture Development Programme
CABI	Commonwealth Agricultural Bureau International (UK)
CARE	US NGO
CEAPRED	Center for Environment and Agricultural Policy Research, Extension and Development (NGO in Nepal)
CIAT	International Center for Tropical Agriculture, Colombia
CGIAR	Consultative Group for International Agricultural Research

CIP	International Potato Center, Peru
CORAF	West and Central African Council for Agricultural Research and Development
CSIR	Council for Scientific and Industrial Research
CRI	Crops Research Institute (Ghana) (within CSIR)
ECOWAS	Economic Community of West African States
EEP	External Evaluation Panel
EET	External Evaluation Team
ERA	Education and Research in Agriculture
FAO	Food and Agriculture Organization (United Nations)
FIELD	Indonesian NGO
FTF	Feed the Future
G8	Group of eight countries (France, United States, United Kingdom, Russia, Germany, Japan, Italy, and Canada) that hold periodic economic summits
GKSS	Grameen Krishok Sohayak Sangstha NGO Bangladesh
GMO	Genetically Modified Organism
HIDC	Human and Institutional Capacity development
IARC	International Agricultural Research Centers
ICM	Integrated Crop Management
iDE	International Development Enterprises , a NGO in Nepal
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture, Nigeria
IL	Innovation Laboratory (USAID)
IPB	Bogor Agricultural University (Indonesia)
IPDN	International Plant Diagnostic Network
IPM	Integrated Pest Management
IPM CRSP	IPM Collaborative Research Support Program
IPM IL	IPM Innovation Lab
IRRI	International Rice Research Institute (Philippines)
KISAN	Knowledge Intensive-based Integrated Sustainable Agriculture and Nutrition Project (USAID project in Nepal)
KNUST	Nwame Nkrumah University of Science and Technology (Ghana)
M&E	Monitoring and Evaluation
ME	Management Entity
MCC	Mennonite Central Committee
NARO	National Agricultural Research Organisation, Uganda
NARS	National Agricultural Research Systems
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental Organization
OIRED	Office of International Research, Education, and Development (Virginia Tech)
OSP	Office of Sponsored Programs (Virginia Tech)
PAB	Program Advisory Board

PI	Principal Investigator
PIPM	Participatory IPM
RFA	Request for Application (USAID)
RFP	Request for Proposal (USAID)
SANREM IL	Sustainable Agriculture and Natural Resource Management Innovation Lab
TC	Technical Committee
TERI	The Energy and Resource Institute, India
TNAU	Tamil Nadu Agricultural University, India
USAID	United States Agency for International Development
US/HC	U.S./Host Country
USDA	U.S. Department of Agriculture
USDA APHIS	USDA Animal and Plant Health Inspection Service
USDA NIFA	USDA National Institute of Food and Agriculture
VAM	Vesicular Arbuscular Mycorrhizae (fungal bio-fertilizer)

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Executive Summary

A three-person External Evaluation Team (EET) reviewed the management and technical performance of the Innovation Laboratory for Collaborative Research on Integrated Pest Management (IPM IL) March-July 2013 at the end of the second ten-year cycle of the USAID funded project. As funding comes from Feed the Future, focusing on horticultural crops reflects the President's Initiative's goals of improved nutrition, increased income, and food security. One of the biggest impacts of the IPM IL has been institutionalizing the Participatory IPM (PIPM) method in partner countries, particularly with regard to research being conducted on-farm with farmers collaborating and providing feedback. However more partners should organize community advisory committees as recommended in the PIPM method. Using PIPM, IPM IL has been highly successful in developing pest control technologies that increase crop yields in a wide array of horticultural crops while reducing synthetic pesticide usage. The greatest immediate impact of IPM IL has stemmed from the deployment of crop specific IPM practices that address multiple pests of specific crops. An average of 90% reduction in pesticide usage has been documented with this adaptive research approach. These achievements are the result of a research program focused on labor-intensive IPM practices, thus the technologies are most suited for small-scale land holders who have surplus family labor. Examples of these technologies are grafting tomatoes onto pest resistant eggplant rootstocks and farmers culturing species of fungi such as *Trichoderma* or bacteria such as *Pseudomonas* which act as preventative biocontrol agents (so called bio-pesticides). As horticulture crops can be readily marketed, the IPM IL developed technologies which are assembled into packages of practices to provide the means for adopters to earn disposable income, breaking the yoke of poverty. With irrigation these small-scale farmers can harvest three crops a year, making up for their small holdings. The result has been to dramatically reduce the negative effects of pesticides impacting human health and the environment in rural communities in partner countries, and in some markets farmers fetch a bonus price for reduced or no synthetic pesticides on their fresh produce. The EET would like to see more partners undertake IPM in the context of integrated crop management (ICM) where improved agronomic practices such as bio-fertilizers and drip irrigation are also utilized as part of the packages of practices. Combining ICM with IPM has given positive synergistic responses in field trials.

Overall, administrative and fiscal management were found to be effective for the portfolio of 16 national partners, but this total is probably near the maximum number of partners that can operationally be handled under current funding levels. One issue is that the C Asia region is represented by only one country (Tajikistan) which may be a contributing reason for its low performance to date. EET recommends either reactivating partners in Kyrgyzstan and Uzbekistan to C Asia or linking Tajikistan with S Asia to form only five regions. In only one of the past five years has funding been reduced, nevertheless some U.S. based PIs said they were constrained by funding from visiting more partners each year. It is the conclusion of the EET that IPM IL is underfunded and could do a better job with a larger budget. One possibility for increasing funds is for IPM IL to merge with the Horticultural IL and the EET recommends that a committee be formed to determine feasibility.

The EET offers recommendations to improve the program management and technology performance of IPM IL. The IPM IL should be funded for an additional term starting in 2014 in order to bring in new Feed the Future countries and phase out mature partners. The ME needs to come up with a plan for this transition. The VT-led IPM IL has 20 years' experience and milestones need to be established for partners who reach maturity and therefore should be replaced to make room for new partners. Mature partners should take on the role of mentors of

new entrants. It is anticipated that future IPM packages can be developed within a 10-year timeframe, but to achieve this the ME has to develop a plan for each new partner from year one to ensure a requisite number of staff are trained in the key disciplines needed to achieve the goal of replacing synthetic pesticides. The ME has to be more proactive in seeing that all partners field the full complement of disciplines in PIPM teams. The ME needs to focus now on uplifting the lower performing partners. Deficiencies in personnel (numbers and/or disciplines) suggest a need for additional scholarships and/or possibly alliances with other institutions. Field trials need to be improved in terms of design by having sufficient replication and all trials should be statistically analyzed. The EET observed that a number of underperforming partners were not testing the range of technologies that would lead to the fewest pesticide applications. This stems from insufficient number of scientists in key disciplines conducting research as well as partners not aware of the results from more advanced partners despite having attended joint meetings. Some solutions are offered but the ME should address this soon. EET encourages partners to invite representatives from other agricultural institutions as a means of informing them of the PIPM method. PIs should give greater research emphasis on fungal diseases and nematodes and more research is needed on screening varieties for host plant resistance as some partners have become too dependent on PIs providing them. Therefore there is less need to develop new technologies through embarking on a program of basic research due to cost and a long timeframe for results. Many researchers already work in these areas and IPM IL does not have a comparative advantage nor is funding guaranteed or sufficient at the present time. IPM IL has been very successful in utilizing applied research and relying heavily on research accomplishments of others rather than developing new technologies. Although there is much need for additional research to elucidate pest biologies and epidemiology especially as related to invasive species and newly recognized pests, the amount of funds for basic research needs to be carefully weighed against reducing the number of partners. The EET would rather see more countries being served now in the third cycle and put off embracing either basic research or spreading the PIPM to more institutions within partner countries in a possible fourth cycle.

The IPM IL should now stress engaging in strategic research to backstop technologies that are not effective in some agro-ecological zones such as the EET noted for pest resistant eggplant rootstock. New improved pest resistant varieties will always be needed therefore selection needs to be continuously carried out. The research design used in Nepal, where the benefit of bio-fertilizers has been shown, needs to be adopted by other countries. Different organic fertilizers also need to be tested with various microbial agents to determine the best performing combinations. In a number of packages, microbial agents acting either as bio-pesticides or bio-fertilizers are used together with bio-pesticides (the Philippines and Nepal). Research is needed to determine the benefit of each beneficial microbe in the complex and especially if there are additive, synergistic, or competitive interactions among these organisms.

The beneficial results of combating invasive species by biological means are also very important and should be continued. The ME needs to create a full time position to address invasive species to allow a Project Director to work full time supervising all IPM IL programs to focus on uplifting underperforming partners. There is a vacuum worldwide in agencies that can deal with invasive pest species and nations need technical assistance. IPM IL is particularly suited to fill this role as CABI and FAO are downgrading their roles.

A highlight of IPM IL has been the large number of national and U.S. based scientists trained through both short and long term scholarships/short courses over the life of the project. 40% of IPM IL budget is spent on training, a level which EET endorses. The EET noted most training occurred in relevant disciplines, and trainees come from appropriate research institutions, both national programs as well as in the U.S. Attrition has not been a significant problem as most scholars rejoin their IPM IL programs. Scholarships and short term training have expanded the skills of partner scientists and should be continued at current levels except for the lower

performing partner countries where more staff should be trained. More scholars should be sought from Nepal, Senegal, Tajikistan, Honduras and Guatemala. As a minimum, the IPM IL should fill four PhD scholarships from each partner as these scientists will be tomorrow's leaders and policy makers. More PhDs are needed from Latin America, W Africa, and Nepal.

Gender inclusion studies have been found highly useful and should continue in each new partner country added to the program. The EET noted that few peer reviewed publications were written on gender studies by IPM IL social scientists. The percentage of women scientists in the IPM IL in the U.S. and national partners has trended upwards over the years. Still there is much room for improvement, therefore EET encourages IPM IL to promote more female scientists in both U.S. and partner countries to participate in IPM IL, especially in S Asia and W Africa. Short and long term training programs should continue to target more women.

Successful IPM packages will have the greatest impact when the appropriate technology is successfully transferred to farmers. It does little good to develop new technologies without a mechanism to train farmers to adopt them. IPM IL should also encourage more NGOs, who can get their own funding, to transfer IPM results to farmers. The EET believes that the IPM IL funds should be used mainly for research but the project should act as a facilitator to piggyback or leverage funds so that other entities can do the training. The new USAID KISAN project in Nepal is a useful example. The EET would like to see partner research institutes facilitate farmer training so more farmers can avail of these findings. Leveraged funds from Missions as well as from local government may provide necessary resources for additional training activities. USAID Missions told the EET they have high praise for the project based on field results. IPM IL has generated more external funding than all other ILs and over the past 20 years almost $10 million has been raised just in IPM IL.

More special studies should be encouraged that document pests, pest control practices, and knowledge and attitudes of farmers in key crops. As the IPM IL does not utilize its own project indicators, more special studies are needed to learn of the farmers' knowledge of common pests and control methods. This information is useful later for designing training curricula. Furthermore adoption studies should be carried out to document knowledge gained by farmers as a result of trainings.

The IPM IL should form linkages with the Horticultural IL on developing more efficient and effective extension methods, with SANREM IL on tillage systems to see if bio-pesticides can become sustainable, and with the Mycotoxin-Peanut IL on control of an invasive leafminer species. IPM IL does evaluate some AVRDC varieties for resistance to bacterial and viral diseases, but should do more as pest resistance is a key IPM tool that is readily adoptable by farmers. Collaboration with USDA has been mainly on tackling invasive insects and weeds and this should continue. IPM IL engages the private sector mainly through technology transfer. Partner programs should continue to attract the private sector to offer IPM products to farmers.

IPM IL is doing an excellent job in carrying out impact assessments. All partners where the project has been active for ten years should have completed an impact assessment. Impact assessments of the benefits from farmers adopting IPM IL technologies annually equate to some $788 million over the past 12 years representing a 20-30-fold increase over the investment costs of the project.

Selection of ad hoc reviews of proposals by the ME needs to be more stringent and the ME should make sure that there are no real or perceived conflicts of interest. The ME should replace the current members of the EEP whose reports lack beneficial constructive criticism. The external reviewers should be leaders in their fields and half of the EEP members should be rotated out every five years. Project staff requested special training on how to write grants to seek research funds.

I. Synthesis of Findings and Conclusions:

A. Program Management

Overall management, including fiscal management, appears to be effective. While the ME appear to be sufficiently staffed (with the exception of a full staff to work on invasive species) delivering an impressive level of commitment, the direct involvement of the Project Director in conducting research appears to have resulted in lack of sufficient oversight in managing the various regional and country programs. Care needs to be exercised by the ME to prevent their enthusiasm for the research components from interfering with management responsibilities. Specifically, the EET felt that it was incumbent on the ME to ensure that the desired effect of numerous and various efforts at communication were actually effective. There was evidence that even though local research cooperators were given ample opportunity to teach about successful IPM packages or components of these packages there was limited evidence of their testing the similar package by other partners. The ME should concentrate on ensuring the communication efforts are effective. There is not sufficient evidence of rigorous external evaluation of the various component programs. For example the recent external evaluations done on regional basis while justifiably complimentary, were short on providing constructive and necessary criticism.

B. Research Performance

There are many positive aspects to the project and much progress has been achieved with demonstrable benefits in reduction of pesticide use, increased crop yields with a current economic benefit. In some markets IPM IL farmers fetch higher prices for produce with low levels of pesticide residues or none at all. However the research performance is not as uniformly of a high standard as desired. Greater emphasis on providing guidance to underperforming partners is needed. The U.S. PIs need to provide greater oversight to local PIs in experimental design, data collection, and analysis. Some country programs lack the necessary breadth of expertise and a concerted effort is needed to address these deficiencies, by inviting scientists from other institutions in the country to join the effort or by developing close linkages with other projects within the same region. The IPM IL emphasizes the application of concepts of pest management to reduce pesticide use, improve pest management efficacy, and increase crop yields. It relies heavily on basic research accomplishments of the past and focuses on adaptive research and is less active on current basic research topics. Nonetheless there is much need for additional research on pest biology and epidemiology, especially as related to invasive species and newly recognized pests

II. Introduction

Feed the Future is the US Government's newest global hunger and food security initiative and supports country-driven approaches to address the root causes of hunger and poverty. Feed the Future is led by the U.S. Agency for International Development (USAID). The Integrated Pest Management Innovation Laboratory (IPM IL) was formerly known as the IPM CRSP and is one of eight collaborative research support programs set up by USAID to leverage the expertise found at the American land grant universities and in developing countries around the world. By combining strong regional IPM programs with critical global cross-cutting themes, the IPM IL seeks to develop and implement agricultural IPM programs that benefit small-holder farmers and their communities. The IPM IL is funded through this Presidential initiative.

The IPM IL first ten year term started in 1993 and has been funded in two 10-year cycles, each divided into two 5-year phases. The second phase is now ending for VT and it is required by USAID that at the end of each 10 year term that a review of administrative and technical programs be undertaken by an independent evaluation team. The team is termed the External Evaluation Team (EET) and is composed of two U.S. university scientists and an international consultant with expertise in plant pathology and entomology. The purpose of this external evaluation is to assess the program management and research performance. This evaluation will help inform USAID on whether to 1) create another Innovation Lab with the similar research focus, 2) to change the research focus or 3) not to continue funding in this area. Accordingly three reviewers were contracted to carry out this assignment. The statement of work is in Annex A.

The evaluation included the following: a) a desk review of IPM IL project documents, publications and web sites with a list in Annex D, b) responding to a list of questions developed by the USAID AOR and BFS staff, c) visiting the IPM IL Management Entity (ME) staff in Virginia Tech University, d) meeting and contacting IPM Innovation Lab principal investigators (PIs) and stakeholders, e) developing an anonymous survey of all relevant host country principle investigators analyzed by a third party, f) travel by the EET leader to attend the BIFAD meeting March 14-15, 2013; and g) an international trip by the EET to visit host country partner programs in Ghana, Uganda, Bangladesh, and Indonesia April 13-29, 2013. One of us (JL) visited Nepal 21 June-12 July to work with the USAID KISAN project which is training farmers in IPM IL technologies. The itinerary is in Annex B and the persons contacted in Annex C and locations and dates of field trips in Annex E. The EET visited IPM field trials and interacted with farmers in all four countries. The team also met leaders of partner institutions and was given presentations of the results by scientists.

The EET was to give its opinion whether funding should continue for an IPM Innovation Lab. The EET was to evaluate both administrative and technical programs as an independent team assembled for this purpose. The current program carries out applied research in 16 countries which are organized into six regions. The regions are West Africa, East Africa, South Asia, Southeast Asia, Central Asia, and Latin America/Caribbean. The U.S. universities initially bid to carry out the research program for each region in the second term led by VT beginning in 2004 and made alliances with partner institutions which are universities, national research organizations or NGOs. Research has also been organized around five Global Themes: Pest Diagnostics, Invasive Species, Plant Viruses, Gender Inclusion, and Impact Assessment. Currently the IPM IL involves staff from 15 U.S. universities: Virginia Tech (17), Penn State (6), Clemson (6), Michigan State (6), Ohio State (4), Florida (3), Purdue (2), Kansas State (1), Univ. California Davis (1), Arizona (1), Denver (1), Georgia (1), Virginia State (1), Washington State (1), and Fort Valley State (1).

III. Program Management

A. The structure of the Management Entity (ME):

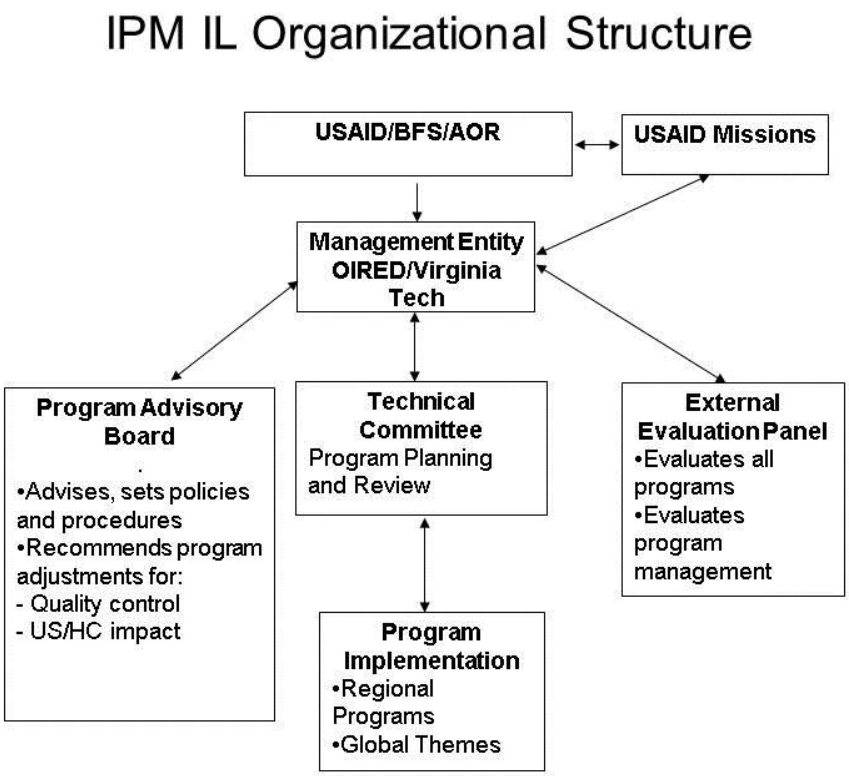

Figure 1. Organizational chart of the IPM Innovation Lab and its different components.

B. Technical leadership

1. Some of the examples of technical leadership displayed by the ME

The EET found that the ME offered competitively awarded planning grants to U.S. PIs interested in applying for the grants to visit and meet with potential collaborators in implementing countries about the priorities, individual, and institutional interest in participating in the program. Through these planning grants, the ME developed priorities for specific regions. The call for proposals for the second (2004-2009) 10-year cycle included cross-cutting programs in gender, impact assessment, invasive species, insect-transmitted viruses, and plant disease diagnostics. In the 2009-2014 phase, the ME re-organized the regional projects around development of comprehensive IPM packages for a particular crop, rather than individual tactics for priority pests. Regional workplans are evaluated annually by ME, in person or by conference calls. The regional project PIs and scientists meet annually to review those plans and the AOR approves the overall workplan and the annual reports. The TC as well reviews the workplans. Same applies for the annual reports. Annual meetings were held to coincide with meetings of professional societies in order to enhance the programs' outreach to the broader scientific community. Within the IPM IL, the ME has encouraged regional and trans-regional technical trainings and workshops on plant disease diagnostics, production of bio-pesticides such as *Trichoderma* and *Pseudomonas*, economic impact assessment, gender equity in IPM, and other technologies to replace synthetic pesticides. However, during our visits to some of the partner

countries in Africa and Asia, it became apparent that these efforts have not uniformly resulted in a more widespread testing and adoption of technologies such as bio-pesticides. The ME should take a more active role to ensure that knowledge sharing results in more widespread testing of proven technologies.

2. Balance among research, implementation activities, training and capacity building
From our review, it was apparent that the primary focus of the program was testing and implementing known IPM practices. Thus, across the IPM IL-funded projects, research per se, with a view to generate new knowledge or information, was limited. The EET felt that there has been an adequate emphasis on implementation activities and training and capacity building. A highlight is the large number of graduate students and scientists who received training in various U.S. and partner institutions and the number of graduate degrees awarded under the current funding cycle. Future focus should be on both discovery and adaptive research and knowledge dissemination and regular monitoring of the adoption of IPM practices by farmers. It does little good to develop new technologies if there is no mechanism to extend this information to farmers. Severe personnel shortages in extension in many of these countries are the major impediment for achieving this latter goal, however, other USAID projects can provide funding to hire more trainers as well as aid existing extension workers. The future IPM IL should play an active role to find partners that can carry on the work of training farmers in the crop specific technology packages. In Nepal for example a new project KISAN funded by USAID will train 200,000 farmers on pesticide reducing technologies developed by IPM IL over the next five years. The EET recognizes the budgetary constraints towards focusing on increased technology transfer, however, we believe that that future IMP ILs must include a plan for how to ensure and enhance technology transfer. This is where the EET saw a need for an increased interaction with local country Missions, local country extension programs, and/or NGOs. Continued close relationships with USAID Missions that resulted in Associate Awards in Indonesia and Bangladesh need to continue so that the results of the research can be disseminated to farmers. The IPM IL on balance has good relations with USAID Missions and regularly schedule debriefings during country visits. The IPM IL has much to show and should invite senior officials of partner institutions to field days to generate more interest in getting local funding for farmer training.

3. The ME's success on building on earlier investments
The ME identified and supported existing programs and collaborations. This should continue based on performance of currently funded projects. Most host country institutions have longstanding relationships with IPM IL, for example, East African and South Asian countries. Each project awarded under the core program has a minimum timeframe of five years. Given the nature of the field research required in this project the five-year time-frame should be maintained. However, the anticipated penetration of the proven IPM packages into farmers' fields has been uneven over regions. Some partners actively fund extension activities with existing budgets while others do not. In the Southeast Asia program, host country partners in Indonesia and the Philippines have acted as mentors for the newer Cambodia program. Most recently, U.S. and Indonesian scientists organized a virus diagnostics workshop in Cambodia. This type of intra-regional training should be encouraged and supported. Similarly, another welcome example of a host country taking the lead in training other countries is when Tamil Nadu Agricultural University, India has hosted two workshops on the production of biocontrol agents and two workshops on virus diseases that were attended by participants from most of the other regional projects.

4. ME's success and future plans in improving alignment with the Feed the Future Global Hunger and Food Security Research Strategy

The EET detected confusion and conflicting opinions among USAID personnel with regard to how the IPM IL is aligned with Feed the Future goals, especially on crops of emphasis. Flexibility in deciding on focus crops should be maintained. IPM IL has maintained focus on the original objectives and goals upon which the current five-year cooperative agreement is based and upon which all of the program's multi-year proposals were based. The overall goals of the IPM IL are highly compatible with the newly developed Feed the Future goals.

5. Promoting and maximizing values such as collaboration, capacity building and outreach among sub-awardees

Overall, IPM IL did a good job of placing emphasis on collaboration between regions. While annual meetings are held to bring various regions together, there seems to be a gap in effective communication between regions such that IPM methods proved successful in one region are not being adequately tested in other regions. The EET felt that the travel budget was adequate but the ME should ensure that such communication efforts actually translate to learned technologies. Outreach/extension efforts were measured annually as a performance indicator in terms of the number of farmers of farm households receiving IPM information.

6. Mechanisms that the ME developed to ensure that local, national and regional needs and priorities will continue to be incorporated into the development of the research agenda

Previous funding cycles offered preliminary planning grants when only one partner country was involved. As Regional themes emerged, this practice was not used for the current funding cycle. Individual countries within a region were asked to develop their own priorities and submit proposals accordingly. Regional expertise was incorporated into the conception of the proposals following Feed the Future goals, and host country partners helped refine implementation of each project through their participation in annual planning meetings. IPM components or technologies developed in the previous phases have been combined to develop IPM packages for selected crops in each country. The ME reviews annual work plans and attends planning meetings of the individual projects.

Whereas the funded projects in host countries involved respective national research organizations (universities or national research institutes), not many NGOs were involved. The EET detected little involvement of CGIAR institutions with the exception of AVRDC and that will decline as they say there is not enough funding to attract their attention. The Global Impact Assessment program has linkages with IFPRI and recently CIAT has indicated interest in collaborating in the biocontrol of cassava mealybug in Indonesia. Though CGIAR center scientists were on the technical committee of IPM IL, it was not clear how this benefitted the host country scientists in information exchange and coordination. The local USAID Missions generally felt that they were not adequately involved in development of goals and priorities. Sometimes the turnover in staff at the Missions leads to loss in communication. Nonetheless, overall the process that was used has been effective in identifying priorities for each region/country.

7. The ME's efforts in facilitating the participation of new partners

Little evidence was noted of efforts to expand the reach of the various projects to new institutions and the IPM IL appears to rely heavily on long standing relationships with partner institutions. The Philippines is the best example of involving new institutions as the years went by, first with PhilRice and the University of the Philippines in Los Baños. Over time other institutes were brought into the project ranging from Central Luzon State University near PhilRice where staff can take degree courses. In addition a national research station in La Trinidad, Benguet province, Luzon, was included as the station undertakes research on IPM of

strawberries. The University of Southern Mindanao where vegetables are intercropped with rubber trees also has joined the project. These were formal arrangements where the institutes received funding from the project. This shows that partners that lack sufficiently trained staff to carry out research in bio-pesticide culture for example can take the lesson of the Philippines where the funds are shared between a half dozen institutions. Indonesia did it with Mission Awards, and Uganda, Nepal and India have brought in NGOs to supplement field testing. Funding limitations greatly hampers potential expansion of the project to new partners.

In the current phase the following new host country institutions were added: private institutions – The Energy Research Institute and Biocontrol Research Laboratories in India; Agroexpertos and Universidad del Valle in Guatemala; government institutions – Indonesian Vegetable Research Institute, Indonesian Coffee and Cocoa Research Institute, Udayana University in Indonesia, also FIELD, an Indonesian NGO.

The ME focused its efforts in the Feed the Future countries with the exception of Indonesia, India, Philippines, Ecuador and funding was curtailed in Kyrgyzstan Uzbekistan and the Dominican Republic in 2012 by BFS USAID, they were host countries in the last funding cycle. Western Africa was expanded to three countries from Mali which was one of the original partners. A relatively new entrant is central Asia with Tajikistan. Two other countries were also in the Central Asia group but were dropped due to lack of alignment with Feed the Future funding. The ME should focus its efforts to ensure that these new entrants are integrated into the existing framework.

8. Balancing the core program activities with the additional management demands of Associate Awards
The IPM IL has been highly successful in received associate awards. This needs to continue with the ME managing these awards and the overall program.

9. Engaging USAID bilateral Missions, and other donors and partners in the IPM IL's research and capacity building activities

Involvement of USAID missions varied from region to region. While host country scientists made efforts to keep the USAID Missions informed of the IPM IL activities, more can be done in this area. USAID missions that we met had limited knowledge of several components of the IPM IL. They were not well-aware of the various outcomes and impacts of the IPM IL projects in their countries. We were told by a USAID Mission we visited that they were not invited to the planning and review meetings. There seems to be some disconnect, and IPM IL should engage USAID Missions more effectively. One problem that host country scientists highlighted was the frequent change in USAID personnel in these Missions, which in turn lead to changes in policies such as moving between a few large projects to many smaller projects, creating a challenge in developing effective personal and professional relationships. The EET thought that the Mission personnel have such large portfolios that it is difficult to be adequately informed of all projects, hence often limited awareness of the IPM IL program.

C. Administration

1. Keeping research activities on track according to IPM IL program goals
Each project submits an annual work plan that is reviewed by the ME and the Technical Committee (TC). The TC is comprised of the PI of each regional and cross-cutting project, the AOR, a host-country member, an IARC representative, a gender specialist, and an external member from one of the following: the private sector; an NGO; a relevant U.S. Federal Agency; or a non-participating U.S. university. The director, associate director, assistant director, and

administrative PI participate in TC meetings as non-voting members. Every year the ME reviews each project with the PI either in person or by conference call. Representatives of the ME attend planning meetings of all regional projects. The ME organizes workshops, meetings and symposia in national, regional, and international conferences facilitating participation of the host country scientists and to validate scientific vigor of the program. The EET felt that these processes and activities provided adequate direction with respect to the technical aspects of the various projects and the overall program.

2. Roles and functions of advisory committees
The Program Advisory Board (PAB) provides administrative and policy guidance to the ME and serves as the top policy-making body for the IPM IL. Its membership includes six to eight high-level administrators of active U.S. consortium partner institutions, host country institutions, and the international agricultural research centers (IARCs), who serve on a rotating basis. The AOR is a voting member. The director, associate director, and the administrative PI are ex-officio non-voting members. The PAB is responsible for overall policy concerning programs and operations for the IPM IL. These responsibilities include, but are not limited to providing the ME with advice on program policy issues; evaluating the content and balance of the program, and the adequacy of funding and resources; reviewing the progress/ accomplishments of the IPM IL through reports from the annual TC review or major reviews conducted by the External Evaluation Panel (EEP); recommending actions in cases of poor performance and making suggestions for funding modifications; approving additions/deletions/modifications to components of the IPM IL; and suggesting and approving nominations for the EEP to be submitted to USAID Washington D.C.

The EEP is a standing body of researchers engaged by the ME to provide external perspective and make recommendations on performance of the regional and cross-cutting project. The EEP is charged with overall program guidance and evaluation, including the competitive awards program, program direction, and research collaboration with host countries. The EEP will conduct evaluations according to the need and availability of funds. The EEP provides written evaluations and recommendations for retention, addition, elimination, and/or modification of IPM IL component projects. The EEP completed an evaluation in 2008 and served as the proposal evaluation committee in 2009. Since 2012 Barry Jacobsen and Dely Gapsin have reviewed South Asia and Southeast Asia regional projects, respectively and submitted their reports. Dely Gapasin had been to LAC regional project planning meeting during March 2nd to 6th and expecting receive the report shortly. William Overholt went to review the East Africa project in April 2013.

Overall, the advisory board appeared to have provided the necessary oversight and advice to IPM- IL. However, the EET found that the composition of EEP needs adjustment going forward as there could be a potential conflict of interest in having the ME select the EEP and having this group evaluate the ME. The AOR approves the panel. One possible course correction could include the ME suggesting five or six potential EEP members from which the USAID AOR could choose the final EEP members to do the review.

The EET felt that the PAB and EEP have been complimentary in their roles. Some of the EEP reports were found to be more focused on summarizing the program's accomplishments and complimenting the ME rather than providing constructive criticisms.

3. Challenges
Because the ME makes commitments of four and five years to winning proposals, cuts to core funding are deleterious to performance. In the current phase (2009–2014) there has been only

one year in which funding was cut forcing IPM IL to cut off three partners. The ME also responded by ending participation by three countries.

EET feels that the current funding model of 5 year-time frame should be maintained but on a need-basis, should also have provision to award short term projects to address emerging failures in technology/new pests that seem to threaten a particular crop in a given region. While the current IPM IL model of 5-yr grants to regional geographic areas seems to be effective, the EET is concerned about Central Asia having only one country and it is underperforming at present. It would be better to link Tajikistan with South Asia making five regional programs. The other alternative would be to add two more Central Asian countries but the budget is probably not enough. IPM IL should continue supporting cross-cutting programs that evaluate and adopt certain IPM technologies across regions. The current ratio of regional programming to cross cutting activities seems to be adequate.

Contributions for the annual report are voluminous. The most recent report is 140 pages. Compiling and editing it are always a strain on the ME. The ME has altered reporting dates to have more time to work on the report and has increased the separation of the due dates for PIs for work plan submission and report submission. More attention should be spent to ensure that all experiments are properly statistically analyzed so that treatment differences can be properly evaluated. Some experiments now erroneously suggest that the top yielding treatment is best.

After managing the IPM IL with both regional and cross-cutting projects from 2004-2009, the ME recognized that the intended close collaboration between them was not at acceptable levels. For the 2009 – 2014 phase, they instituted closer collaboration by putting funds for cross-cutting activities in the host countries into the regional programs rather than that of the cross-cutting programs. Each year the PI of each cross-cutting program must jointly program the funds with the PI from each regional program. This seemed to have worked in some regions and the EET feels that this should be continued.

4. Management style of the ME regarding PIs and sub awardees
The ME considers PIs as leaders of their respective projects. The ME's principal responsibility is to oversee progress toward the objectives that each PI proposed. Technical guidance is frequently offered, and an ME member is present at each regional project's annual planning meeting to offer input on technical issues and identify management issues that may need to be taken up with the PI.

5. Appropriateness of the administrative cost of the IPM IL
The administrative costs and ME size are appropriate for the complexity of the program and the importance of the objectives. ME should focus full time on administering the program and not spend time on research themselves.

6. Communication between the ME and the collaborating partners
Communication within any particular program is largely the responsibility of the PI. The ME's communication approach has been to channel communications through the PIs. While there have been ample meetings at regional and country levels, the EET is not sure effective communication has been taking place. EET felt that the lengthy progress reports/annual reports were not carefully read or assimilated by all the award recipients across regions. Why hasn't the research design pioneered in Nepal which shows the benefit of bio-fertilizers been followed by other partners? Why is the Philippines the only site to test VAM? One way to address this barrier is to have one-page 'take home' messages containing technologies that could be adapted to other countries in a given region or across regions, the currently published in

"Success Stories". However, scientists in developing countries are not responding to such information to the degree hoped for. The ME and PIs should assess and identify ways to make inter-regional and intra-regional communication more effective.

D. Financial management

1. ME's management of the financial aspects of the IPM IL and potential issues with host country collaborators

Considering the magnitude of the program and the involvement of multiple institutions in the U.S. and in other countries, the ME has managed the financial aspects of the IPM IL well. The host country collaborators that the EET met with were largely satisfied with the ME's financial management. Some voiced concern about the long delay in getting the expenses reimbursed. In one instance, grant dollars are being managed locally by IRRI, which is charging an administrative fee. The reason and or benefits from this arrangement were unclear.

2. Potential issues with U.S. collaborators

The EET met with two of the U.S. PIs during their visit to Indonesia and discussed this topic. No serious issues were brought to our attention by the U.S. PIs. There seems to be general satisfaction with the ME's financial management and the U.S. PIs expressed hope that the funding will continue to support IPM IL in the future.

3. Allocation of project resources:

Each fiscal year the PI submits an overall budget for their respective Regional or Global Theme project. Based upon this budget, allocations are made as sub-awards on the project through a modification generated by Sponsored Programs. The ME does not allow additional allocations until the sub-awardees have invoiced at least 90% of their current overall budget. If the sub-awardee has extenuating circumstances, the Director will deem whether or not the next allocation can be made early. A common example would be a time lag between the expenditures being incurred and the institution's Sponsored Programs invoicing the ME, as the sub-award needs additional funding to continue their program activities.

4. Reimbursement of expenditures

For U.S. institutions the reimbursement procedure seems efficient. The majority of U.S. invoices submitted are free of error or budget inquiries. For those with errors that need correction, there is a dedicated fiscal administrator to handle any issues. Significant delays can occur if there is an expense listed in a line item for which there was no line item. Resolving such cases can require re-budgeting or investigation on the part of the sub-awardee.

For host country institutions there is a range of efficiency when reimbursing. For institutions with a dedicated on site accountant (IRRI is good example), any inquiries or needed corrections can typically be resolved in a timely manner. For institutions without a dedicated accountant or with multiple people managing finances, clearing up invoice issues can be a lengthy process. Therefore sub-awardees should nominate a single person to handle invoices.

It is common for host country institutions to invoice on an irregular basis. When there have been several months since the previous invoice the number of expenditures submitted for review can be substantial. The review process of such invoices takes more time and there are typically more issues to be resolved.

5. Cost matching requirements by all partners

At this time, overall cost sharing requirements have been met by the project and cost share reporting has been suspended until further notice. The suspension went into effect May 4, 2011 and was communicated to all U.S. collaborators. Quarterly analyses of cost sharing levels are done by the Office of Sponsored Programs (OSP) administrator of Virginia Tech. Further documentation on this will be with OSP.

E. USAID's role

1. Contributions of USAID Agreement Officer's Representative (AOR)
The EET feels that the AOR is an important and critical participant and contributor to the success of the program. The AOR is the person at BFS most familiar with the activity and performance of the IPM IL and is the ME's 'go to person' in USAID. The AOR communicates closely with the program director on routine programmatic issues as well as requests to respond to additional information needs of the agency. While the AOR should provide a higher level of engagement with the Mission staff first and foremost, the EET suggests the AOR have an increased involvement in the project by ensuring improved engagement of Mission staff with host country collaborators.

2. Effect of changes in USAID priorities on IPM IL
The EET was told during their meetings with some of the USAID missions that the priority crops for Feed the Future will be cereals. However, we were also told that individual countries could have other commodity focuses such as vegetables. In Uganda, for example, priority crops for Feed the Future are corn, beans and coffee. This is understandable since the crop profiles and their relative importance vary from country to country and region to region. It is likely that as the Feed the Future program matures the IPM IL will evolve with clearer understanding of changing goals and make appropriate modifications of its own goals as the Missions have to balance the goals of their partners with those of Feed the Future.

IV. Research Performance

The EET responded to questions that USAID prepared for the review.

A. Research focus and output

1. Are the depth, breadth and rigor of the research and development activities sufficient to achieve stated program goals and objectives? How could the major themes or topics be refined to increase impact?

In many instances there is excellent breath, depth and rigor of the research program, but not uniformly. Pest control technologies are estimated by the ME to be directed to arthropods 55% of effort (insects 45%, mites 10%), diseases 39% (viruses 30%, bacteria 5%, fungi 4%), nematodes 1%, and weeds 5%. This is a good balance but greater attention could be given to fungal diseases and nematodes. In some cases the national programs do not have a complete complement of scientific disciplines to address the range of pests due to lack of staff or replacements for those in training elsewhere. Therefore if staffing is incomplete and cannot be covered by training, then the EET recommends an alliance with another research institution. Ghana is a good example of a partner that would benefit from linking with another research institute such as Nwame Nkrumah University of Science and Technology (KNUST) as the Crops Research Institute (CRI) lacks manpower in biocontrol of insects, diseases, and nematodes as well as culturing bio-pesticides as the best performing IPM IL partners are doing. U.S. PIs need to provide greater guidance and oversight of national programs to ensure that more of the available technologies and packages are tested by each partner. Additionally, where field tests

lack appropriate rigor in terms of inclusion of all appropriate treatments, sufficient plot size and or replication, the U.S. PIs need to provide more guidance and constructive critiques. Data should be analyzed by appropriate statistical tests for means separation for reporting purposes. Also IPM should be tested within the context of integrated crop management. In Agogo, Ghana the EET saw tomato being grown where 2 m-tall elephant grass had been cleared and burned. The crop was suffering from drought stress and only inorganic fertilizer was provided. The farmers should have used the elephant grass for mulch and not burned it and should have made compost and added it to the planting holes. IPM performs better when farmers follow improved crop management methods to raise the yield potential. Organic fertilizers and bio-fertilizers should be tested along with other IPM practices. Farmers should also have been encouraged to test on-farm ponds or tanks to use for simple drip irrigation systems by making arrangements with appropriate research institutions as is done in Nepal. In such instances up to three crops of vegetables can be grown per year.

2. What have been the significant accomplishments in terms of research and technology dissemination?

First and foremost is the Participatory IPM method. It has been consistently and successfully applied since the inception of the IPM IL. This approach is iterative in nature, consisting of four sequenced steps: 1) identification of stakeholder groups and research locations; 2) farmer identification and prioritization of pest problems, including an initial baseline survey followed by pest and disease monitoring and diagnostic program; 3) testing of proto-type management technologies in the laboratory and/or on-station trials followed by the bundling and testing of these technologies in on-farm trials with grower groups; and 4) evaluation and assessment of packages to determine project impacts, including enhanced farmer knowledge of pests and alternative pest management practices, utilization/adoption of IPM strategies, reductions in pesticide use, and increased farm productivity and incomes. The iterative process is crucial to ensure that problems and solutions are commonly understood and that strategies promoted by the IPM IL are useful for adoption by end users. The program's research and technology dissemination have created enormous worldwide benefits. Published impact assessment studies by the Impact Assessment Global Theme have documented annual benefits of over $784 million from program technology (Table 1). Some examples came from research conducted before the fourth phase of the project but the returns to farmers occur annually and include:

a. Biocontrol for the papaya mealybug: - The program identified and introduced a parasitic wasp for the control of papaya mealybug in India and Sri Lanka that had been effective in other countries. A Global Impact Assessment team has assessed benefits from this biocontrol release to be over $500 million (Sirisena & Jonathan 2013). This effort was part of the Invasive Species project of IPM IL.

b. Grafting technology in Bangladesh to control soil-borne diseases in tomatoes and eggplant: - By training practitioners with other NGOs and extension workers, this technology has been expanded far beyond the initial intervention site. The technique has helped create small nursery businesses that sell the grafted plants to local farmers. The technology has also been transferred to India, Nepal, Uganda, Kenya, Honduras, Ecuador, and even the United States.

c. Host-free period for tomato in West Africa: - A technology transferred by the program from the Dominican Republic to West Africa and incorporated into an IPM package for tomato growers has resulted in $24 million in benefits. The insights gained from Innovation Lab -funded research on biology and management of diseases have helped growers in the U.S. manage and monitor the spread of a tomato virus and have provided accurate information about the potential for the disease to impact tomato production.

d. Additionally there have been many additional benefits from introduction of simple IPM based practices and combinations of practices (IPM packages). Many crop packages have eliminated most of the need for synthetic pesticides. These include:

i. Identification and introduction of crop cultivars with genetic resistance to viruses, soil-borne bacterial wilt, and nematodes.
ii. A wide variety of organic materials (including poultry refuse, compost, and mustard oil cakes) were tested for control of several seedling diseases caused by fungal pathogens. Further, this benefit is enhanced when the organic amendment is treated with the biocontrol agents Trichoderma spp. and/or Pseudomonas spp.
iii. Mass trapping of insects from use of pheromone traps and other attractants
iv. Use of organic mulch for suppression of weed competition
v. Use of clear plastic mulch to reduce aphid attraction to passion fruit
vi. Use of high tunnels to minimize the spread of soil-borne plant diseases to allow vegetable cropping in the monsoon season for high profits
vii. Use of yellow sticky traps and netting to protect crops from plant virus vectors
viii. Roguing virus infected plants
ix. Mass rearing and release of arthropod parasitoids and predators

Table 1. Selected IPM Innovation Lab impact assessments from ten studies. [1]/

Country and authors	Crop	IPM practice	Net benefits (millions)
Albania, Daku (2002)	Olives	Cultural	$39–52
Bangladesh, Debass (2000)	Eggplant, cabbage	Cultural practices	$26–29
Bangladesh, Rakshit et al. (2011)	Cucurbits	Pheromone traps	$3–6
Ecuador, Quishpe (2001)	Potatoes	Resistant variety	$50
Ecuador, Baez (2004)	Plantain	Cultural	$59–63
Honduras, Sparger et al. (2011)	Eggplant, onion, tomato, and pepper	Cultural practices	$17
India, Selvaraj, (2012) (preliminary analysis)	Mulberry, papaya, cassava	Papaya mealy bug parasitoid release	$500
Mali, Nouhoheflin et al. (2011)	Tomato	Cultural	$21–24
Uganda, Debass (2000)	Beans and maize	Cultural	$36–202
Uganda, Moyo et al. (2007)	Peanuts	Virus-resistant variety	$33–36
		Total	$784-979

[1]/ Data from ME 2012

3. Program-organized workshops that bring together program scientists, partner organizations, and students

One example is the plant virology workshop at Tamil Nadu Agricultural University (TNAU) in India, “Research and Management of Insect-Transmitted Virus Diseases in the Tropics and Subtropics” as well as the TNAU workshop “International Workshop on Production of Biocontrol Agents (Pseudomonas and Trichoderma)”. Unfortunately, these efforts are not as effective as one would like. There is a need to document the effectiveness of such efforts – just holding the activity is not sufficient. It is necessary to evaluate participants to ensure appropriate learning has occurred. Follow up surveys 2-6 months after the event to measure changes in participant knowledge and research goals would be helpful. The main reason appears to be that some national programs lack sufficient staff to test the practices that they learn about in workshops. PIs need to be cognizant of this need so that if there are not adequate staff in the national institution, then there is a need to sign up an additional institution. The Philippines has done this

with the same budget. Finally, it is obvious from our interviews that many potential partners and clientele groups are not aware of these efforts and successes. The USAID country missions often are not always unaware of the successes of the Innovation Lab. This is often due to staff changes or that some Mission staff were not present when the PIs visited.

4. Among the projects making significant progress, which ones are scalable for a greater impact?
Nearly all of the packages being developed and tested are scalable for greater impact. In Bangladesh, melon fly control in bitter melon adapting area wide management has been well documented. Implementation of the biocontrol of papaya mealybug in India involved collaboration with the USAID Mission, national institutes and regional universities. Unfortunately lack of knowledge and appropriate scientific expertise often is limiting for other IPM packages. U.S. PIs need to spend more time in country providing guidance to and oversight of local country research and technology dissemination programs. There is a need for development of specific plans for technology transfer. The IPM IL must develop close linkages with the local USAID missions in the development of the technology transfer plans and thus will often be eligible for additional support from the missions via Associate Awards and other funding mechanisms. Nearly all of the target countries are deficient in multiple skills or technologies for more complete testing and adoption of IPM packages. Thus scaling up of a large number of activities will have significant benefits to crop yields, reduced reliance on pesticides, and economic well-being. IPM IL will need to bring in other players to ensure that this is carried out.

There is a need to document how these efforts actually lead to effective transfer of knowledge and that successful technologies are tested and or adopted elsewhere. In India, a program-funded, 20-week Farm School Radio on All India Radio (Trichy) enrolled 1,400 farmers and likely reached thousands more, on sustainable, bio-intensive IPM packages for onion (2011-2012). In Indonesia, program scientists appear regularly on Edelweis radio, just outside of Jakarta. Edelweis, managed by an organic farming group, is a medium for the spread of information about sustainable agriculture and integrated pest management. Some 55,000 farmers bought pheromone traps last year in Bangladesh so the farmers there are also voting for IPM IL practices with their pocketbooks.

5. What activities have not been as successful as planned and why?
Great discrepancies in progress towards goals were observed among the different country programs. A prime example is the IPM package of grafting to resistant rootstocks coupled with soil amendments, especially those supplemented with biocontrol agents that are proving highly successful in India and other parts of Asia but are hardly tested in Africa. Grafting for bacterial wilt resistance is done in Uganda, Senegal, Mali and Kenya but not in other African countries. The responsible U.S. PI and the ME needs to carefully evaluate less successful programs and determine likely reasons for the limited success and then develop appropriate strategies for correcting the evident deficiencies. The ME needs to determine: When does the ME need to move to new participants due to failure to make adequate progress? When is a program mature and able to stand on its own? How can mature and successful programs be used to “mentor” less successful programs? Training in technical aspects of the IPM research needs to be accompanied by some training in managerial skills. How do the U.S. PIs select the most motivated and capable PIs, especially in targeted countries. Are there mechanisms for replacing less productive PIs? How well are the research activities strategically sequenced to ensure targeted development outcomes within a known period? How does the ME ensure that research activities or themes complement and do not duplicate other development initiatives in the regions where the IPM IL is active? The progress in West Africa regional project has been

slow hence the PI and some scientists involved have been replaced. Even in the ME changes have been implemented to remedy problems in West Africa.

From discussions with local AID mission staff it is clear that there are a large number of ongoing agricultural development projects in each country. Sponsors include not only USAID but various NGOs. Despite the current efforts, there is insufficient coordination and collaboration with some important programs. The USAID mission in Ghana suggested that the IPM IL identify the known regional centers of excellence and then ensure that appropriate linkages are established with these. Because of the large number of programs operating in some countries and regions, it is difficult to determine degree to which duplication of efforts is occurring. Also many of these regional programs are supported by partner countries and as such influence local changes in Feed the Future general policies such as key crops to fund. Missions have to satisfy both. A key Feed the Future dictum is that it supports the will of national partners in terms of policies and development objectives.

6. How do the program's activities complement the Horticulture IL and/or AVRDC's investments in this area?
There is insufficient coordination and collaboration between the IPM and the Horticulture IL, the EET strongly encourages greater efforts in this area. The IPM IL has worked collaboratively with AVRDC in Bangladesh and Indonesia but these efforts have been reduced in recent years due to funding limitations. The IPM IL continues to screen germplasm from AVRDC relative to pest and disease resistance and their potential value in IPM packages for different crops. Both IPM IL and the Horticulture IL have shared interests. The Horticulture IL has some IPM activities and recommends some of the same technologies as recommended by the IPM IL. The Horticulture IL is undertaking research on extension methods in a number of countries and the EET believes that the IPM IL should also. It would make sense if both ILs worked together on this. The EET recommends that a committee study the possibility of the IPM IL and Horticultural IL merge. There are complementarities and overlapping activities that make the merger attractive. A larger budget would allow more partners and programs to be served.

7. Do research goals have national policy implications? If so, how are they addressed? Give examples.
Many countries lack appropriate mechanisms for regulating introduction of biological resources, including exotic biocontrol organisms or crop germplasm with needed traits. Thus work with the local governments is required before technologies based on such introductions can be widely adopted. Bangladesh worked for more than three years to successfully change the policy where pheromones could be imported and not treated like synthetic pesticides. Most partners that IPM IL collaborates with have IPM as a national policy and thus the research conducted is highly relevant to this goal. Environmental ministries of national partners have policies to reduce pesticide pollution in the environment which is achieved by the scope of IPM IL research. In both of these cases the Ministries of Agriculture in each partner country are highly supportive of the work they see and are now more willing to put up their own funding. Selection of ad hoc reviews of proposals by the ME needs to be more stringent and the ME should make sure that there are no real or perceived conflicts of interest.

8. What was the process for sub-award selection? How effectively did the process yield a high quality, relevant portfolio of activities?
The ME has provided the following description of the sub-award selection process:
"The review panel consisted of five external evaluators plus the USAID AOR. The external evaluators were Dr. Barry Jacobsen, a plant pathologist at Montana State University, Dr. Roy Nishimoto, a weed scientist at the University of Hawaii, Dr. Dely Gapasin, an entomologist and

gender specialist, retired from the World Bank, Dr. Susan Capalbo, an economist at Oregon State University, and Dr. Revathi Balakrishnan, a retired gender specialist formerly with FAO. They read each proposal and then filled out a score sheet according to the point values described in the RFA. They then met in person at Virginia Tech to discuss the merits of each, provided overall rankings, considered the required balance of programs to the CRSP, and made recommendations to the ME. In addition to recommendations as to which proposals merited funding, in some cases they made comments on weaknesses that needed to be addressed." Nonetheless the question remains, were the highest rated proposals always given the grants? The IPM IL programs have a reputation among U.S. universities as being closed systems with little opportunity for other institutions to compete effectively for future awards. That relatively few of the large number of highly qualified U.S. institutions have been awarded contracts seems to support this conclusion. The EEP appears highly qualified but it is not known how long they have served. It is recommended that at least half of the review team be rotated off and replaced with new members for each new round of proposal review. The review panel largely consists of retired scientists whereas the EET felt that scientists still actively engaged in research and extension should form the core of the review panel.

9. Assess the balance of domestic versus overseas research in terms of effectiveness of solving constraints in developing countries. Are changes needed in the balance?
The research has been primarily adaptive that must be done in the country/crops in which it is intended to be used and has been based on principles and technologies developed over the past 30 years in the U.S. The differences in cropping systems and environments across regions make it difficult for the systems being researched and deployed in target countries to be used in U.S. agricultural systems. However, there is a growing sector of American agriculture that is based on organic production, often of relatively small holding sizes. Substantial future impacts of these IPM packages on small U.S. farmers, especially the growing organic farming sector is anticipated. Additionally the identification and characterization of new pests (especially viruses) by U.S. scientists provides important data for potential new pests and pathogens of U.S. crops in terms of plant quarantine. Similarly, effort by U.S. scientists to address invasive species has important implications for the U.S. Lessons learned and techniques developed will be employed on the increasing number of invasive species threatening the U.S. No change in balance is recommended.

10. Assess the balance within the IPM Innovation Lab's portfolio on basic research, applied research, implementation, and human and institutional capacity building.
Applied research is the major focus of the IPM IL, building on several decades of emphasis in pest management to develop effective packages for a variety of horticulture crops in several environments. Recently developed diagnostic tools based on previous basic research are critical components of the current program. The discovery of new pests and pathogens, especially viruses, leads to basic research to fully characterize these pests. Similarly new invasive species in several countries would benefit from basic research on the biology and ecology of these organisms, which should lead to the development of IPM packages for the management of these new pests. Other research entities are also working on these problems. The EET presented a list of problems that would benefit from basic research but the reality is that funding levels are too low for IPM IL to make any serious impact in these areas, therefore the IPM IL should continue along the current path of emphasizing adaptive and backstopping research.

11. IPM IL's response to the Title XII "Famine Prevention and Freedom from Hunger" Amendment to the Foreign Assistance Act of 1961 and the benefit to the U.S. from the IPM IL's research.

In the U.S., just as in the developing world, farmers deal with the scourge of bacterial wilt, a disease that attacks solanaceous crops. The IPM IL has introduced grafting as a way to prevent the disease in the developing world. The technique originally developed in Japan and adopted by AVRDC and IPM IL, has, through the IPM IL come back to the U.S. Here's how: An Ohio State professor, Matt Keinhenz, learned about grafting while he was in Uganda: He witnessed farmers trained through the IPM IL program doing tomato grafting. Meanwhile, back in the U.S., there was a growing interest in extending the growing season for tomatoes and also in the disease management of tomato plants, and so, according to Sally Miller, "A role for grafted tomato seedlings began to emerge. In 2008, Ohio State University (OSU) was awarded a USDA Integrated Organic Program grant of over $800,000 to develop rootstocks and increase awareness of tomato grafting in Ohio, Minnesota and North Carolina. This project is led by David Francis, a tomato breeder/geneticist and Matt Kleinhenz, and includes a number of researchers including myself [Sally Miller]. Mohammad Abu Masud, a Bangladeshi Ph.D. student (sandwich program with Bangalbandhu Sheikh Rahman Agricultural University and OSU) partially supported by IPM IL, has been working with us for two years, in part to transfer his knowledge of tomato grafting to our project in Ohio." Dr. Miller continues, "We just completed a tomato grafting workshop in Wooster with 26 Ohio farmers participating, and will hold another one in central Ohio next month. I think this is a good example of ways in which USAID investments in developing countries can have economic benefits back in the U.S. (email communication from S. Miller to M. Muniappan on 2/26/09).

The IPM IL has, in turn, benefited from the vegetable grafting capacity of American universities that was originally stimulated by IPM IL. In March 2012, the IPM IL trained four people from West Africa in vegetable grafting at North Carolina State University with a team of trainers that had been developed for local farmers.

Bob Gilbertson at UC Davis was not stumped when a new disease resembling tomato yellow leaf curl virus was identified in California. Having worked with tomato yellow leaf curl virus disease for years in the Dominican Republic and Mali he confirmed its identity and was able to confidently provide California tomato growers with factual information on management based on experience.

Additionally the identification of pests in the partner countries assists USDA APHIS quarantine efforts worldwide.

B. Alignment with Feed the Future research priorities

The new Feed the Future initiative has the overarching goal of sustainably reducing global poverty and hunger. A further goal is to help the vulnerable become more resilient to food shortages. Feed the Future supports country-driven approaches that incorporate the wishes of national partners for determining research objectives. A method of raising productivity is to reduce risk from pests through adoption of IPM practices. The Feed the Future's research strategy (U.S. Government 2011) outlines three major programmatic focus areas: 1) advancing the productivity frontier, 2) transforming production systems, and 3) enhanced nutrition and food security in collaborating countries. IPM IL has a critical and important role to play in all of these stated themes. The document places increased emphasis on investment in agricultural research and its undeniable benefit both short term and long term in reducing poverty and hunger in several developing countries with agrarian economies where under nutrition is a major issue. Feed the Future strategy emphasizes 'purpose-driven research'. The document specifically identified priority, researchable areas and several of these relate to pests and diseases. As stated elsewhere in this report, the EET fully agrees with the suggested strategy of investing in purpose-driven research on priority issues (that are relevant to and identified by

the Feed the Future countries) and future design of the IPM- ILs should align with this strategy of supporting projects that are aimed at innovation/discovery type of research that have an well-articulated plan for integrating research discoveries with subsequent information dissemination and technology adaptation.

Feed the Future supports country-driven approaches that incorporate the priorities identified by the national partners for determining research objectives. A method of raising productivity is to reduce risk from pests through adoption of IPM practices. The focus of Feed the Future in terms of priority crops should continue to be country and/or region-driven ('bottom-up' or participatory) with active participation and input from national agricultural research systems (that include 'active' scientists as well as administrators) – the criteria for selecting focus crops could be diverse and in some countries we learned that a particular crop may not be a staple food crop but has a great export value (for example, coffee in Uganda). This strategy of taking into account various factors and diverse criteria should continue in selecting "Feed the Future crops", for each of the Feed the Future country.

Feed the Future's stated goal is to focus collective efforts advance global stability and prosperity by improving the most basic of human conditions: the need that families and individuals have for a reliable source of quality food and sufficient resources to purchase it. Horticulture crops fulfill the second half of this goal as farmers need not only calories but also nutrition and income to pay for medicines and school fees. The IPM IL goals of increasing crop productivity, and thus economic well-being of target farmers, while reducing use of pesticides is a perfect fit with the goals and philosophies of Feed the Future. The following table documents alignment of the Feed the Future countries with previous and current target countries of the IPM IL.

Table 2. Comparison of countries that Feed the Future endorses and those where IPM Innovation Lab has worked.

Region/Country	Feed the Future	IPM Innovation Lab
South Asia		
Bangladesh	Yes	1998- 2014
India	No	2004-2014
Nepal	Yes	2004-2014
Southeast Asia		
Cambodia	Yes	2009-2014
Indonesia	No	2004-2014
Philippines	No	1993-2014
Central Asia		
Kyrgyzstan	No	2004-2012
Tajikistan	Yes	2004-2014
Uzbekistan	No	2004-2012
East Africa		
Ethiopia	Yes	2004-2014
Kenya	Yes	2004-2014
Malawi	Yes	Not a partner
Mozambique	Yes	Not a partner

Rwanda	Yes	Not a partner
Tanzania	Yes	2004-2014
Uganda	Yes	1998-2014
Zambia	Yes	Not a partner
West Africa		
Ghana	Yes	2009-2014
Liberia	Yes	Not a partner
Mali	Yes	1993-2014
Senegal	Yes	2004-2014
Latin America/Caribbean		
Dominican Republic	No	2004-2012
Ecuador	No	1998-2014
Guatemala	Yes	1993-2014
Haiti	Yes	Not a partner
Honduras	Yes	1998-2014
Jamaica	No	1993-2004

The table shows that IPM IL has worked or is working in 13 of the 19 of Feed the Future countries. Of the six that have not yet been with IPM IL, five are in Africa with the other being Haiti, the closest to the U.S. but as it does not have a functioning Ministry of Agriculture Haiti lacks counterparts necessary for IPM IL to function.

As mentioned earlier USAID Missions have to relate their support of projects to the wishes of national partners, as it supports country-driven approaches to address the root causes of hunger and poverty and forge long-term solutions to chronic food insecurity and under-nutrition. Therefore the agricultural goals and policies of partners should be supported and in each of the four countries the EET visited these were not necessarily the same as those of Feed the Future. In addition to partner countries, Feed the Future has identified key districts in each country that should be served in a number of countries the IPM IL work occurred in districts that were not always those identified as Feed the Future districts but these were exceptions more than the rule.

C. Human and institutional capacity development (HICD)

The ME estimates that HICD receives 40% of the IPM IL annual budget. This has been ample considering the funding longevity of the IPM IL and that it is a high priority of the project. Other Innovation Labs spend only 20-25% on HICD (IPM CRSP 2008). Investment in human resources should be a key goal of IPM IL.

1. Long term training

Long term training takes the form of scholarships for research staff to obtain a higher degree (BS, MS or PhD). The training comes through on-the-job training by both national and U.S. partners working together. Training is also made available to U.S. scientists who plan for careers in international crop protection and development. Most arrangements call for both U.S. and host country students to carry out their research in the program sites. Thus national

scientists spend more time on the research problem while the function of the U.S. university scientist is mostly advisory through periodic visits.
Many target country personnel cannot meet the entry requirements of U.S. institutions, thus a regional university should be sought with supplemental short term training in a U.S. university. Those receiving training come from institutions that have partnered with IPM IL and receive training in disciplines important to the IPM. The trend now is to do a 'sandwich program' where the student takes a degree from his or her country then goes to a U.S. university for two years of coursework. Research is conducted primarily in his/her country under supervision of U.S. and national partner professors. Sandwich programs are less expensive and take scientists out of their institutions for a shorter period of time. Problems encountered include students that cannot finish their research as planned due to lack of resources, time conflicts due to job responsibilities or failure of biological components to behave as needed (pest populations or disease pressure may not be adequate within limited time period and test regions). The result is sometimes an incomplete thesis in which the thesis advisory committee needs to relax their standards. Therefore sandwich training programs may be more suitable to economics studies where finishing a thesis on time is more predictable.

The IPM IL has provided scholarships to train310 scientists from partner countries and the U.S. (Table 3). A total of 126 host country scientists obtained degrees from 15 US universities as well as two in Europe and 225 scientists from 26 partner universities. Some 41 scholars attended both a partner and international university. Data show that 53% of scholarships were for a MS degree, with 29% for PhD, and 18% for a BS degree. Many staff who received scholarships for advanced degrees, particularly PhDs, will become policy makers in the future. They will also become professors and scientists who teach and perform research and serve on international agricultural bodies. In this way IPM IL carries out its mandate to bring lasting change. Therefore the ME must ensure that in each partner country a sufficient number of PhD scholarships are offered to achieve this goal. The number of PhDs was lowest in C Asia and E Europe mainly due to the few countries and limited project years, but more PhD scholars should be sought in Latin America/Caribbean and W Africa.

Table 3. Data on the number of scholarships offered in IPM IL from 1992-2012. [1]/

Region	Total	% Scholar-ships by region	% PhD	no. BS	no. MS	no. PhD
East Africa	87	28	21	23	50	14
SE Asia	52	17	37	10	25	17
Latin America/Caribbean	48	16	25	21	20	7
Developed countries	46	15	59	0	31	15
South Asia	35	11	63	0	14	21
West Africa	20	6	40	1	10	9
Cental Asia	19	6	63	0	13	6
Eastern Europe	3	1	50	0	1	2
Total	310			55	164	91
Average			29			

[1]/ Data provided by IPM IL ME

Gapasin et al. (2007) noted in a review made by the EEP that training represented relevant disciplines and came from appropriate institutions, with which the EET agrees.

An analysis was carried out by the EET to quantify how each of the 16 partner countries was performing regarding the breadth of control practices being developed and incorporated into the various IPM packages. The top four performers were Asian countries where, with the exception of Nepal, there were scientists from a wide array of disciplines are involved (Table 4). The top

performer was Bangladesh, which has expertise in plant breeding and resistant varieties, grafting pest resistant rootstock, use of botanical insecticides, use of microbial bio-pesticides for control of nematodes, plant diseases, and insect pests. In addition augmentation of arthropods to control insect and mite pests was conducted as well as various cultural and mechanical control methods. The vegetable research institute of Bangladesh Agricultural Research Institute (BARI) was able to develop this suite of technologies due to their large staff representing a wide array of disciplines. In contrast, the lower performers lacked staff in many key disciplines. Therefore the EET concludes that the ability for each partner to achieve project goals is based on research teams composed of the most complete diversity of necessary disciplines. A more proactive approach is warranted by the ME to raise the level of the underperforming partners. If the cooperating research institute does not have enough staff or that sending off staff on scholarships will create a gap in key disciplines, then the ME and PI, in collaboration with the partner, should seek an alliance with another research institution in the country to achieve the critical mass of scientists. For example, when the EET visited Ghana it was obvious that achieving better performance would be dependent on development of a more complete team of scientists. The ME and PIs should ensure that ample numbers of research staff are working in each partner country. Additional linkages with other research centers may be required. In the case of Ghana, the obvious choice is to link with the Kwame Nkrumah University of Science and Technology in Kumasi.

Table 4. Scorecard showing the range of pest control methods being evaluated in field testing in partner countries. The more methods used means the fewer synthetic pesticide applications utilized. [1/]

					Plant resistant varieties																	
			No. crops	No. packages	Grafting	Other than	Pesticides based on	Field application Insecticides		Bio-	Off season cropping/	Netting sticky traps, or	Mulching	Cultural	Biocontrol augmentation parasitoids/	Trapping with attractants	Crop free	Adopting integrated crop management				
Region	Country	Years	tested	field tested	rootstock	grafting	thresholds	Botanicals	Pathogens	fungicides	tunnels	barriers	solarization	controls	predators	pheromones	periods	Compost	Bio-fertilizers	Green manure	Soil testing	Total
SAsia	Bangladesh	10	>2	>2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes			14
SAsia	India	15	>2	>2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes			13
SAsia	Nepal	10	>2	>2	Yes		Yes	Yes	Yes	Yes	Yes		Yes			Yes		Yes	Yes			10
SEAsia	Indonesia	10	>2	>2	Yes				Yes	Yes	Yes	Yes	Yes	Yes		Yes		Yes	Yes			10
EAfrica	Uganda	15	>2	>2	Yes	Yes	Yes				Yes		Yes	Yes				Yes			Yes	8
SEAsia	Philippines	20	>2	>2	Yes		Yes		Yes	Yes		Yes	Yes	Yes				Yes				8
LA/Carrib	Guatemala	20	>2	>2			Yes	Yes	Yes	Yes	Yes				Yes						Yes	7
LA/Carrib	Ecuador	5	>2	>2	Yes		Yes		Yes	Yes		Yes				Yes					Yes	7
WAfrica	Mali	19	>2	2		Yes	Yes	Yes	Yes			Yes		Yes			Yes					7
EAfrica	Kenya	10	>2		Yes	Yes	Yes			Yes	Yes		Yes									6
LA/Carrib	Honduras	10	>2		Yes								Yes		Yes		Yes			Yes		5
EAfrica	Tanzania	10	>2				Yes					Yes	Yes		Yes							4
WAfrica	Ghana	5	2	2		Yes	Yes							Yes								3
WAfrica	Senegal	10	>2			Yes								Yes								2
SEAsia	Cambodia	5	>2							Yes								Yes				2
CAsia	Tajikistan	10	2	1		Yes									Yes							2

[1/] Data from 2011 and 2012 Annual Reports of IPM CRSP

The ME acknowledged the problem of insufficient discipline representation, but told the EET that it was taking efforts to correct the situation by joining hands with other projects involved in capacity building. For example, the Education and Research in Agriculture (ERA) project in Senegal supported two candidates for training in a recent Trichoderma production workshop in India. However, it is the opinion of the EET that the best way to achieve more scholarships in locations where scientists in key disciplines are lacking is for the current partner institution to join with another research center. The Ghana CRI is deficient in plant pathologists with specializations in mycology and bacteriology. They also lack an entomologist with expertise in biocontrol. Also lacking is expertise in crop culture, particularly in use of organic mulch, staking, and making compost for tomato culture that would raise yields and hence profits of farmers and make IPM more profitable. Therefore CRI needs to liaise with horticulturalists to improve their crop management. The EET believes the problem is not a lack of universities but that the PI is not focusing on assisting in making the necessary linkages.

Such an analysis should be made by the ME during the first year of a new partnership to ensure that a sufficient range of disciplines will be present through scholarships and that substitutes are available to fill in when staff are out of the country. For example there is a gap in Ghana as the economist will be away for three years with no one to fill in. Such a gap will compromise the research effort. Experience has shown the difficulty of removing scientists from research systems without substitutes available to do their jobs while they are gone. This is less of a problem if several institutions are partners in a country or if a university is a partner compared to a federal research organization.

The EET thinks an appropriate proportion of resources are invested in long- term training and institutional capacity building. Great care must be undertaken in the selection of scholarship candidates. High on the list of criteria is the need for partners to be trained in areas where expertise is lacking in IPM teams. HICD is the key to expanding IPM skills and thence IPM technologies thus needs more advance planning to capture the most benefits.

There is a need to ensure that scientists who go abroad return home, and in most cases the EET found attrition has not been a serious problem. All IPM IL international graduate students educated at US institutions are required to return to their home country as a term of their J-1 visa and TraiNet entry. An estimate from George Norton (PI of the Impact Assessment Global Theme) over the length of the project was that two thirds of economists who went for training still work at their IPM IL institution, while Sam Kyamanywa from Uganda said most scholars have returned to their host institution.

2. Short term training

Short term training (one week to six months) is given to farmers, extension workers, input dealers, students, and research staff. For scientists training is focused on specific techniques such as learning new scientific methods, improving pest diagnosis, gender sensitization, and how to conduct an impact study. The EET found that the summary reported in annual reports does not make this clear nor what method of training was provided. Short term training was highest for extension workers followed by research staff (Table 5). More accurate reporting by designation of those who received training is needed such as farmer, extension worker, student, research staff etc. Now many of those are lumped into one category.

Table 5. Short term training by country for research scientists, extentionists, and policy makers in 2012. [1]/

Country	Students	Extension officers	Scientists/ research staff	Input dealers	Policy makers	Total
Cambodia	0	300	0	0	0	300
Honduras	55	122	31	0	0	208
Indonesia	0	104	82	0	15	201
India	0	0	47	35	0	82
Uganda	0	0	77	0	0	77
Tajikstan	61	0	1	0	0	62
Bangladesh	0	0	11	0	0	11
Kenya	0	7	0	0	0	7
Ghana	0	0	4	0	0	4
Guatemala	3	0	0	0	0	3
Ecuador	0	0	1	0	0	1
Philippines	0	0	0	0	0	0
Nepal	0	0	0	0	0	0
Total	119	533	254	35	15	956

[1]/ Data from ME as reported in the 2012 Annual Report

The highest numbers of people trained by short term training was farmers (Table 6). Farmer training was highest in Asia and lowest in Africa particularly West Africa. The EET considers these numbers are much too low but feels that IPM IL should become a catalyst to facilitate more linkages to improve numbers of farmers trained.

Farmer training should be based on targeting agro-ecological zones. These may be divided by cropping pattern, climate, topography, etc. and even biological characteristics such as which biotype of *Ralstonia* is present and therefore guide a decision as to which resistant rootstock to use. From such mapping the ME can make a training plan specifying the total number of farmers that will be trained each year. This process is now lacking in the program. Once these data have been compiled the ME can more accurately report what percentage of farmers has been trained each year which is more meaningful that just a total.

Table 6. Listing of the number of farmers trained by country in 2012. [1]/

Country	no. Farmers
Philippines	2,133
Nepal	1,436
Indonesia	1,034
India	1,079
Tajikstan	440
Honduras	228
Guatemala	360
Kenya	300
Uganda	225
Cambodia	0
Bangladesh	0
Ghana	0
Ecuador	0

[1]/ Data from ME as reported in the 2012 Annual Report

3. Institutional capacity building

The IPM IL has played a leading role in institutionalizing the Participatory IPM method in partner institutions. Researchers now undertake trials in farmers' fields as well as experiment stations. IPM per se has been a focus of agricultural institutions for decades but performing adaptive research trials in farmers' fields is new. The Participatory IPM method has led to the highly practical IPM packages of practices for a wide range of crops in partner countries. The IPM IL deserves kudos for this achievement.

Funding through the IPM IL can build institutional capacity, as shown through the *Parthenium* global program's work in Ethiopia. There, the program established the first government quarantine facility and weed biocontrol program in that country, the Ambo Quarantine Facility. The Ambo center now serves a two-fold mission: as a testing and research facility and as a training center on the management of quarantine facilities and biocontrol. The EET believes this effort should be expanded based on the interest of partners.

4. IPM in elementary and secondary schools

IPM has been introduced into schools in the U.S. and should be introduced into curricula in schools in developing countries. When taught about agro-ecology and IPM at a young age, students become more informed consumers and farmers. They also can influence their farmer parents. The IPM IL has introduced IPM curricula into secondary agricultural schools in India and Indonesia. Having understood IPM concepts in secondary schooling, less effort is needed to train farmers as they will already know many concepts and these can be linked to new concepts, which is how we learn. The EET supports regional IPM programs being more proactive in establishing IPM curricula in public education schools.

D. Collaboration, outreach, technology dissemination

The IPM IL performs its adaptive research program by collaboration with a wide array of partners as well as links with other institutions and ultimately plays a key role in technology transfer. Following a participatory method involves collaboration and alliances at different levels and with multiple partners.

1. Collaboration

Collaboration has been the fundamental organizing principle of IPM IL and occurs at many levels beginning among scientists from different research centers as well as with extension officers and farmers. Each partner in a multi-disciplinary Participatory IPM IL team brings his or her knowledge based on their experience and background.

Due to limited resources, scientists and extension staff interact directly with few farmers, thus for efficiency farmers who have formed their own groups are selected for on-farm research including trials to develop packages as well as multi-location verification trials to determine the range of locations the packages are effective, and finally to large scale farmer training activities which involve demonstration plots. IPM IL should seek out farmers who are organized into groups to carry out on-farm research trials as information dissemination to all members is more assured. The anonymous special survey found that the community advisory committee served this purpose if farmers were not organized. IPM on-farm testing takes place in farming communities thus the project needs to liaise with local stakeholders such as political leaders from the village and district as well as institutional representatives of key governmental organizations, particularly from the extension service from the district head to the extension agent that serves the villages in which on-farm testing will take place. The PIPM method (Norton et al. 2005a) recommended that a community advisory committee be formed in all locations where field trials are undertaken. Such a committee should be composed of political leaders, bankers, marketing agents, and farmer groups or cooperatives where present. In discussions with PIs during the four country tour the EET found that no community advisory committees were formed and instead a series of meetings is conducted to advise local government and farmers regarding the intentions of the project in each area where field trials are conducted. This less formal arrangement seems to work well. However in the anonymous special survey 64% of respondents said that community advisory committees were formed and were useful. The EET agrees and PIPM should be undertaken under the supervision of these community advisory committees.

2. Outreach

Outreach involves linkages made with other institutions by implementing IPM IL institutions.

a. Information dissemination to other institutes within partner countries

Partners normally involve one or two research institutions in a country. The EET found that once an IPM package has been developed, researchers and extension specialists from other institutions within the country often are invited to IPM IL events. These visits are arranged in venues ranging from workshops, planning meetings, symposia, and field trips taken to see

demonstration plots. Other institutes also learn of the progress of IPM IL from presentation scientific papers during plant protection society forums within the host country. The Philippines and Bangladesh have involved the most institutions followed by partners in East Africa. In each country in East Africa the total approach or specific components are being applied by a wide array of development partners/stakeholders including new universities such as Gulu University and Nkozi Catholic University in Uganda, University of Dodoma in Tanzania and other more established universities in Kenya such as Egerton, Nairobi, and Jomo Kenyatta.

The results in other countries seem to be mixed but the EET believes that effort should be expended to have partners in both a federal research organization and a university. More effort is needed here to make a greater impact in partner countries of the IPM IL approach utilizing the PIPM method of on-farm adaptive research.

b. Regional and global dissemination of IPM technologies

The IPM IL has done a good job in disseminating research at regional and global levels, to multiple audiences, and in diverse forums. For example the technology of creating a host-free period for tomato in West Africa for management of white flies and white fly-transmitted viruses came from the Dominican Republic and was incorporated into an IPM package for tomato growers in Mali. The grafting technology has been transferred from Bangladesh to India, Nepal, Uganda, Kenya, Honduras, Ecuador, and even the U.S. (Ohio) from information exchange platforms such as annual planning meetings, workshops, and seminars where partners from different regions gather. Each of the six regional programs holds an annual planning meeting where the venue within each region changes so there is fertile ground for information dissemination. The IPM IL hosts a yearly meeting for all PIs as ways for researchers to share program outputs. The EET encourages this practice to be continued.

Results are also posted on the IPM IL website and published in research articles in journals, book chapters, and conference proceedings. In the current phase, researchers have published findings related to program-funded research in books and academic journal articles. A list of publications by IPM IL staff is posted on the website. In order to reach policymakers, other development practitioners, and the general public, the IPM IL publishes non-technical Success Stories and Impacts in print and online. These stories are written by the Director of Communications based in the ME and have made it to a wider audience through appearances on Virginia Public Radio and in Agrilinks, newspapers, USAID's Frontlines, and the Feed the Future newsletter. Summaries of results have also been covered by many researchers' own home institutions and universities reaching an audience of students, faculty, and the wider university community.

IPM IL has also organized specialized symposia and workshops on IPM technologies, which bring together program specialists, collaborators, other outside researchers, and students. Upcoming events are: the Biodiversity and IPM conference in Indonesia (July 2013) and a workshop co-sponsored by CORAF, USAID West Africa Bureau, and USDA on the control of the tomato leafminer, *Tuta absoluta* in West Africa. A record of publications can be found in the publications section of every annual report. IPM IL has also organized symposia at the American Phytopathological Society meetings, the 7th International IPM Symposium, the Mesoamerican IPM Congress, and the Entomological Society of America meeting, reaching hundreds of specialists around the world.

Scientists in developing countries become better informed not from reading but from interpersonal interactions. Therefore the project should not expect that many scientists will access information from websites and journal articles. Therefore PIs need to interact with their partners to share research findings in other countries verbally during their visits or personally hand out reprints of important results.

c. Inter-Innovation Lab collaboration

There are three Innovation Laboratories where the IPM IL has had limited collaboration to date.

Horticulture IL. The IPM IL focuses on high-value crops (i.e. vegetables and fruits) and exclusively on pest management. The Horticulture IL has some activities which feature IPM methodologies. Eight countries overlap with IPM IL and some activities are similar to those utilized by IPM IL, such as: 1) grafting seedlings onto disease resistant root-stocks, 2) using plastic high tunnels for management of aphid borne viruses of tomatoes and peppers, 3) training diagnosticians in identifying plant diseases, 4) producing local seeds of disease resistant vegetables, 5) developing an alternative to fungicides to combat postharvest decay in tropical fruit such as papaya and mango, and 5) creating a market niche for safe vegetables. The Horticulture IL focuses on short-term projects along the post-harvest portion of the value chain. They stress extension and undertake research on extension methods. They have developed a participatory extension model to enhance smallholder production and marketing. They work to strengthen farmer groups for vegetable production. They have developed three Regional Centers of Innovation (Thailand, Honduras, and Kenya). These are training centers where demonstration plots are set out. The Trellis Fund matches graduate students in agricultural sciences with in-country NGOs that work with smallholder farmers. For each project, organizations are provided $2,000 to support their work, and graduate students are awarded travel funds plus $300 to continue providing horticulture consultation remotely throughout the year. Some 20 students are sponsored each year. This enhances collaboration. The best example of collaboration to date is in Kenya where grafting and high tunnels are employed in tomato production near Thika.

SANREM IL. In Ecuador, IPM IL and SANREM IL have jointly developed potato and naranjilla production practices. Collaboration is made easier as both MEs are located in the same building in Virginia Tech. SANREM IL has developed methods to make compost which is a needed input to nurture preventative bio-pesticides in the soil. They also demonstrate alternative tillage systems and use of green manures which lend themselves to preventive IPM using microbial agents. For example zero tillage systems may allow soil-applied bio-pesticides to become sustainable and therefore the farmer would not need to apply them each year.

Mycotoxin-Peanut IL. A leafminer *Aproarema modicella* pest was introduced from Asia in 1998 into Uganda and USAID wants classical biocontrol to be carried out. Mycotoxin-Peanut IL funds will be used to set up an insectary to rear a parasitoid and the IPM IL will assist in obtaining it.

More effort is needed to build stronger linkages in the future with these three Innovation Labs. In particular with the Horticulture IL for researching new extension methods, for SANREM for compost making and tillage systems, and with the Mycotoxin-Peanut IL on control of the leafminer.

d. Collaboration with USAID bilateral Missions

IPM IL has had very close relationships with the Missions based on comments the EET received in its visits to four missions. The ME and U.S. PIs regularly meet with Mission personnel on most country trips. Mission relationships vary, however, as Mission personnel rotate and as Mission priorities change. Missions also develop policies for each country and know other national and regional entities that are important to the particular country that relate to IPM IL programs in agriculture. Thus each Mission must make its programs follow Feed the Future policies plus those of the host countries and the regions in which they are located. For example in Ghana Feed the Future is focused on Northern Ghana and IPM IL's partner CSIR has PIPM plots located there. There are regional economic unions for groups of neighboring countries to Ghana which have developed agricultural priorities such as the Economic Community of West African States (ECOWAS). The African Union, through New Partnership for Africa's Development (NEPAD), has identified agriculture as the most important sub-sector to support rapid economic

growth in the region. As a result, NEPAD has developed the Comprehensive African Agriculture Development Programme (CAADP) as a strategy to foster agriculture led development to attain this growth and contribute to the UN Millennium Development Goal of poverty reduction and hunger eradication. These African led initiatives are supported by USAID. It is important that the IPM IL in Ghana is following the stated policies of each organization. The G8's recommendations were for agriculture to be driven by the private sector also come to play. Given that research is replacing pesticides and improving pest control on key crops, means that IPM IL's objectives fall within the stated policies.

Table 7. Leveraged Funds and Associate Awards of the IPM IL Since 2008 [1]/

Item funded	US$
Bangladesh buy-in	191,900
Nepal Associate Award	500,000
Mali Associate Award	2,500,000
AFSI Associate Award	1,000,000
Indonesia	
Indonesia Associate Award	900,000
Harvest/ USAID Diagnostics workshop	3,500
Host country personnel salaries	8,000
Local funds for biocontrol of papaya mealybug	18,000
Ministry of Research support for biocontrol activities	15,000
Government support for compost house at Capung	10,000
Govt support for compost house at Jayagiri	11,500
Govt support for digging wells at Padajaya	1,000
Govt support for packing house at Mandiri	9,000
Mobile plant clinic	2,000
A strategic coalition for sustainable development	150,000
Sam Ratulangi Univ. support for conferences	6,340
Govt support	5,850
Dan's time contribution	2,700
South Asia	
Penn State contribution to tuition of graduate students	50,000
India	
Papaya mealybug biocontrol	500,000
Tamil Nadu Agricultural University (TNAU)	200,000
ICAR	
Pheromone technology	30,000
Onion IPM (TNAU)	20,000
Personnel	20,000
Equipment and supplies	90,000
Ghana	
Office and field in kind contribution	5,000
Equipments	9,500
East Africa	
OSU tuition waiver	14,000
Hort CRSP contribution in Kenya	75,000
Uganda	
Graduate training	16,700
IPM conference	6,500
Ethiopia	
EIAR salaries	40,000
EIAR utilities	60,000
Haramaya University contribution	80,000
Latin America and the Caribbean	
Blackberry project USAID support	10,000
SENACYT sustainable agriculture	250,000
SENACYT graduate student support	80,000
Guatemala personnel time	125,000
Honduras personnel time	200,000
Ecuador personnel time	225,000
Penn State graduate student support	400,000
Penn State faculty time	350,000
Virginia Tech graduate student support	200,000
Virginia Tech faculty time	250,000
Perdue faculty time	200,000
Lab support	100,000
USDA Beltsville lab support	175,000
Philippines	
Gawad Kalinga and BAR	218,000
IPVDN	
Transagricola, Dominican Republic	40,000
Agricultural Knowledge Initiative, APLU	120,000
Naidu Rayapati's grant from USDA	26,865
Honduras	
FAO	9,702
FINTRAC (RED project)	6,000
Senegal	
Tuta absoluta workshop	100,000
Diagnostics	
Africa Rising	22,500
AVRDC - *Ralstonia* screening	460
AGRI support for diagnostics workshop	5,000
USDA/FAS Bacterial canker workshop, Guatemala	20,000
OSU contribution to Sally Miller's time	25,000
Impact Assessment	
VT contribution to salary	60,000
Ahsan's (graduate student) tuition from VT	75,000
BARI salaries for Impact Assessment staff	75,000
TNAU salaries for Impact Assessment staff	30,000
TERI salaries for Impact Assessment staff	5,000
Total	**9,955,017**

[1]/ **Data provided by ME**

The missions in Bangladesh, Indonesia, and Nepal were granted associate awards of $1.59 million in January 2013. In 2010 the Mission in Mali awarded $2.5 million. Of all of the Innovation Labs, the IPM IL deserves kudos as it probably has received the most funding from associate awards of all of the Innovation Labs. A total of almost $10 million has been leveraged since 2008 (Table 7). These awards have meant that the IPM Innovation Lab can develop more technologies to reach more farmers than would have otherwise been the case. This is a remarkable achievement. The reason why IPM IL is being successful in raising money from Missions is that the PIs visit the Missions regularly but more importantly the project has achieved success in minimizing pesticides as well as raising income of impoverished people in Feed the Future countries.

e. Collaboration with other international entities

CGIAR. CGIAR participation was a requirement for proposals during the 2004-2009 funding phase. The amount of money was not large from the perspective of CGIAR centers, but was in line with other overseas partners. Current collaborative projects include: 1) impact assessment with IFPRI, 2) the IPDN held jointly with IITA as well as a special IPM IL session held at the 12th International Plant Virus Epidemiology Symposium organized by IITA in Arusha, Tanzania February 2013, 3) Central Asia Region with CIP; 4) South Asia Region with IRRI, and 5) Southeast Asia Region with CIAT and FAO. Recently IPM IL has collaborated with CIAT for the biocontrol of the invasive cassava mealybug in Indonesia.

AVRDC should have the most collaboration. An AVRDC entomologist is a member of the IPM IL Technical Committee. The IPM IL collaboratively works with AVRDC in Bangladesh and Indonesia where both have associate awards. For example one award is entitled 'Growing vegetables for improved nutrition, empowerment of women and a healthy vegetable value chain in southern Bangladesh'. AVRDC's vegetable breeding programs are not duplicated by the IPM IL because IPM IL does not financially support breeding programs. In the past IPM IL used to provide some funds to AVRDC for collaboration in South Asia and East Africa, however its administration decided not to collaborate with the IPM IL as funds provided were not considered significant to warrant the effort. IPM IL does evaluate

some AVRDC varieties for resistance to bacterial and viral diseases but should do more as pest resistance is a key IPM tool that is readily adoptable by farmers. In July 2013, the USAID mission in Bangladesh channeled $500,000 to the IPM IL through CIP, initiating a two year collaboration in IPM for high value vegetables in high priority production zones.

USDA. A plant pathologist from USDA National Institute of Food and Agriculture (NIFA) is a member of the IPM IL Technical Committee. USDA APHIS collaborates with the invasive pest species global project and provides some natural enemies and as well as training to the *Parthenium* biocontrol of weeds project. The biocontrol campaign against the papaya mealybug in India and Sri Lanka is a success and involved collaboration with USDA-APHIS to secure release of beneficial parasites (Sirisana & Jonathan 2013). An upcoming workshop co-sponsored by CORAF (USAID West Africa Bureau), and USDA will be held on the control of the tomato leafminer *Tuta absoluta* as previously mentioned. In the planning stages are additional workshops on tomato leafminer for East Africa possibly conducted in Ethiopia in association with ASARECA and USDA APHIS and a similar workshop for Central America to be conducted in Panama also in association with USDA APHIS. In 2008, Ohio State University was awarded a USDA Integrated Organic Program grant of over $800,000 to develop rootstocks and increase awareness of tomato grafting in Ohio, Minnesota and North Carolina. This project is led by David Francis, a tomato breeder/geneticist and Matt Kleinhenz, and includes a number of researchers including Sally Miller, a PI in the IPM IL.

Others. CABI fulfills a similar role with invasive pest control but is more constrained by budget.

The degree of collaboration with CGIAR centers, the USDA, and CABI has not been extensive as the amount of funding has been low, thus the current level of collaboration is not likely to increase in the future.

Training in the area of pesticide usage and safety, the need which emerged from working with farmers and observing pesticide misuse, has been offered to the Uganda National Agro Inputs Dealers Association and the East African Grain Council. The IPM concepts of field scouting, sampling and thresholds were introduced in each of these trainings. On another project, IPM IL co-PIs also extended the PIPM approach to the FARM Project in South Sudan managed by ABT and Associates.

f. Collaboration with the private sector

Transferring technologies to the private sector ensures crop protection sustainability in the long run. Technologies developed in Bangladesh, Ecuador, India, Indonesia, Nepal, and the Philippines have been transferred to private enterprises. When the program has successfully developed a method to control a pest, the production and marketing of the technology is transferred from national research institutions and universities to private enterprises. In many cases the farmers themselves formed small business in producing grafted seedlings for sale to their neighbors. This has been particularly true in Bangladesh with tomato and eggplant. In other cases existing companies became interested in producing IPM products developed by IPM IL. Ispahani, a company in Bangladesh visited by the EET cultures *Trichoderma* for sale to farmers and rears and markets parasitoids to control caterpillar pests as well pheromones to control moths that attack vegetables. More private companies will engage in this business as more farmers adopt IPM IL technologies and demand more products. TNAU transferred the technology to commercially produce a pathogenic virus that controls caterpillars that attack tomato and cabbage to the BioControl Research Laboratories in Bangalore. Several small companies in India produce and market beneficial fungal and bacterial strains that control soil-borne pathogens in vegetables. Over 20 different pheromones are locally produced and sold in the country. Ecuador is home to PIL BVICSA, a private company that produces and markets grafted seedlings of naranjilla, a high value fruit tree, which is resistant to *Fusarium* fungal wilt. In Tamil Nadu India, a

parasitic wasp, which parasitizes the papaya mealybug and successfully controls it, is produced by a number of small companies and sold to farmers. In Indonesia, *Trichoderma* is produced by Pak Ujang a farmer in W Java and packaged and marketed by a private company PT Fumure. Lembaga Pertanian Sehat, a small business produces and markets biopesticides and botanical insecticides to control vegetable pests. PT Agrotech Sinarindo, a small business firm, is now producing biopesticides and marketing them to farmers. The EET saw a small scale farmer in Puncak turn his skills into producing and selling *Trichoderma* and P*seudomonas* to his neighbors. In Nepal small nurseries have taken over tomato and eggplant grafting producing wilt-resistant plants for sale to farmers. In the Philippines VAM mass production has been transferred to farmers and small businesses to sell to other farmers. *Trichoderma* is being produced by communities and a private firm.

The EET feels more emphasis should be taken to link project farmers with other USAID projects that are focused on marketing. This will require more time of the PIs to increase the frequency of visitation to Missions.

g. Collaboration with NGOs

In East Africa with collaborative efforts in Uganda, the IPM IL has worked the non-governmental organizations such as Rice-NET and Self-Help Africa and CABI in working directly with grower groups in plant diagnostics and protection of pests and diseases. The IPM IL Uganda group also established linkages with the Pesticide Use, Health and Environment NGO group and worked with them to implement PIPM with tomato. The Mennonite Central Committee (MCC) and GKSS (both NGOs) produce and market *Trichoderma* to farmers. Through their assistance this technology has been expanded far beyond the initial intervention site in each country to other institutions within each partner country. A number of partners contract with NGOs to carry out farmer training. TERI and iDE (both NGOs) have been contracted to undertake the PIPM trials of testing horticulture packages in farmers' fields in India and Nepal, respectively. TERI manages research and demonstration projects in three states (Uttar Pradesh, Andhra Pradesh and Karnataka). They have been highly effective in disseminating IPM technologies of the IPM IL and represent an option from the more traditional government to government collaboration and should be encouraged in the future to spread non-pesticidal technologies among the NGO community.

3. Technology dissemination by training farmers

Generally only some partners allocate funds for training farmers from IPM IL budgets. A number of partners directly train farmers near their research institute such as PhilRice, Makerere University, TNAU, and BARI. The usual model is for the partner to engage national extension services or NGOs to conduct training programs after they are provided with the IPM technologies to be disseminated using funds from other sources than IPM IL. Some places such as Ghana, where extension agents are few but highly motivated, claim success by training groups of farmers. Trained farmers then teach their neighbors. If there are inadequate government extension services, then NGOs such as CARE and World Vision can be contracted to undertake the technology transfer. The transfer entity actively disseminates research results at the local, regional, and global levels to multiple audiences and in diverse forums. The best strategy is for the project to utilize a mix of technology transfer methods. Some create awareness such as mass media radio and TV.

Probably the best example of innovative outreach that provides sustained communication to large numbers of farmers is the series of rural radio programs on IPM developed by TNAU (http://www.oired.vt.edu/ipmcrsp/SuccessStories/ FarmSchoolRadio.html). Scientists at TNAU organized a 20-week radio series on IPM methods that was broadcast on All India Radio which reaches 60% of the state and broadcasts in Tamil, the local language. Many messages can be broadcast more quickly via radio than by any other medium. Over 1,400 farmers officially enrolled

in the course. Each broadcast is a 30-minute pre-recorded segment involving specialists and farmers who were assembled in a classroom on the TNAU campus. After a brief presentation, farmers asked questions. Participants received certificates for their attendance which should be a standard practice in all farmer training events. The experience has been that farmer enthusiasm for receiving training has been high. The main messages are for farmers to adopt non-pesticidal technologies which also largely contrast with what extension agents normally provide. Farmers are used to learning about the latest pesticides rather than learn other practices. Radio programs where extension agents can reach farmers are also available in Ghana in a weekly one-hour program. TV spots have been used in Bangladesh, one of which explained the area-wide management of mass trapping fruit flies using baited traps for bitter gourd. Other mass media methods are publishing farmer leaflets and posters which are placed where farmers congregate.

Many of the IPM practices lend themselves to hands-on demonstrations as a learning method. So other extension methods demonstrate single technologies in half day workshops where groups of farmers practice culturing Trichoderma or make protective tunnels out of plastic sheeting. For example, farmers can see how grafting is performed and practice it themselves. Farmers can see the process of mixing microbial agents in compost at the time of planting and practice it themselves. Numerous other techniques can be illustrated in short training sessions.

The EET believes that it does little good to develop new technologies without a mechanism to train farmers on existing technologies. Fewer than one hundred thousand farmers have been trained over the past 20 years came mostly from IPM IL funds where some regions emphasized training while others did not. Training hundreds of thousands of farmers is a huge job particularly so the more illiterate they are as learning takes longer. Illiterate farmers have a difficult time relating IPM concepts to what they know. Farmers also learn from each other more than a trainer so farmers should be taught in groups of 25 or so. The EET supports a greater effort in facilitating farmer training but knows that funds to do so will come from other projects with the IPM IL playing on a role as facilitators to train the trainers. The only way to build up to a level of training for the needed thousands of farmers is to work with USAID's portfolio of existing projects that involve farmer training and to the include a connection with the IPM IL. IPM IL can piggyback IPM technology as a part of the training curriculum on existing USAID funded projects such as KISAN in Nepal. KISAN will train 200,000 farmers in IPM of vegetables, rice, maize, and lentils. To obtain such collaboration means the PIs need to frequently visit USAID missions and to sit down with each project partner to see if there are opportunities for collaboration. This will take more time to accomplish. The PIs will also need to make follow up visits to USAID and to areas where other USAID projects are being implemented to make training plans and training the trainers. Funds for farmer training must be sought from existing projects to link with their training and then leveraged to get funds from local government. NGOs such as CARE, Save the Children, Mennonite Central Committee, and BRAC have their own funds or can leverage funding from local government where the role of IPM IL would be to train the trainers.

E. Gender inclusion

It has been found that inclusion of women in project programming has a demonstrated positive impact on development efforts. Evaluation of gender is mandated by USAID in its projects for ethical reasons to reduce hunger, poverty, and gender inequity in the world. The IPM IL gender program is carried out by OIRED's Program Director for Women and Gender in International Development. The Gender Global Theme incorporates and builds gender expertise within all Regional Programs, holds workshops to raise awareness about gender issues, and identifies gender-based constraints and opportunities for IPM. The main goal is to ensure that IPM IL programs include women, their knowledge, and addresses the constraints faced by farmers be they women or men.

The input from gender inclusion has produced significant results in partner countries. The gender program is highly integrated into IPM IL and positive impacts have occurred in each partner country. The program has identified gender specialists in 11 of 16 partner countries (except Ecuador, Ethiopia, Senegal, Nepal, and Tajikistan due to lack of qualified partners). These specialists are active in training project researchers both in the U.S. and in the six regional programs abroad in gender equity issues that affect the choice of research topics, technology transfer, and distribution of benefits. The teams sensitize staff in collaborating institutions as to how to integrate gender into their programs and how to eliminate gender barriers in research and extension roles. IPM IL created an on-line worksite in the Collaboration and Learning Environment web resource hosted at Virginia Tech called Scholar. The worksite contains teaching modules for a Women and Development class.

Research in the IPM IL sites has dispelled the myth that women do not participate in pest control. On the contrary, in many sites women have considerable influence over outcomes and impacts. For example in Mali women played a large role to convince all farmers not to plant tomatoes and peppers for several months (even in their kitchen gardens) to create a plant host free period causing virus plant pathogens to succumb. Also a recent study in Indonesia, Cambodia, and Bangladesh tracked Trichoderma home production and use which heavily involved women. Women's important role in decision-making and allocation of household finances in many cultures alone warrants targeting them in IPM research and training.

All survey results are disaggregated by gender for baseline socio-economic surveys, awareness/ knowledge/ attitudes/practices surveys, as well as impact assessment and monitoring and evaluation data. Gender is also included in HICD annual summaries of scientists in research teams and farmers trained. This information has delineated women's roles in productive labor and decision-making related to IPM; and farmer-collaborative field research incorporates female farmers and, where relevant, includes women's gender-specific crops or productive activities all of which greatly benefits the IPM IL objectives (Russ et al. 1998, Hamilton et al. 2001). The gender program first undertakes a rapid gender assessment in new countries as an initial scoping exercise to be able to make more focused survey questionnaires to follow (Hamilton et al. 2005, Erbaugh et al. 2010). Surveys then quantify the role of men and women based on the initial findings. Recommendations follow based on how the project can involve women more and be more effective.

Table 8. Data on the number of scholarships to women offered in IPM IL from 1992-2012.

		% Women	
Region	Total	1992-2011 [1]/	2012 [2]/
Eastern Europe	3	67	
SE Asia	52	52	
East Africa	87	40	
Cental Asia	19	40	
Developed countries	46	38	
Latin America/Caribbean	48	36	
South Asia	35	21	
West Africa	20	12	
Total	310		85
Average		38	47

[1]/ Data provided by IPM IL ME

[2]/ 2012 Annual Report. The total represents the number of students studying not those who obtained their degree in 2012

The number of women scientists has been increasing in most regions over time but still lags behind men. It is important to have female scientists from the U.S. side because it encourages women in partner countries to play a more prominent role in the project. A project goal is that researchers must work to ensure that 50% of the participants and beneficiaries are women. A quick count of the project staff in IPM IL in 2012 revealed 22% of U.S. based scientists were women while 31% were from the national programs showing progress is still needed. When the U.S. and partner scientists are both female, more women scientists in partner countries will be taken seriously.

Care must be taken to ensure that all types of training and educational opportunities are equitably available to women and men. Training programs should continue to target more women. Studies showed that women are less likely to prioritize spending on pesticides, are more concerned about health consequences of pesticides, are more likely to replace pesticides with alternatives, and

have specialized knowledge of crops and pests but have less access to information. In terms of long term training, from the 1992-2011 period of the project, 38% were women compared to 47% for 2012 showing 24% progress over a decade (Table 8). More effort is needed in S Asia and W Africa to sponsor women scholars. One of the highlights of the findings was studies that revealed tasks and crops are separate by gender, and it is an exercise in futility if the crop is a female crop and males are trained. Notification of village meetings now seek both men and women participants. NGOs who undertake most training programs hire more women trainers which would be difficult for the Ministry of Agriculture. When women asked for separate farmer field schools, they were established for them. Short term training data from 2012 showed 30% scientists and 37% of farmers trained were women. So there still is work to be done to achieve the goal of 50% equity. Even though numbers are low, a positive trend was noted in short term training of scientists and farmers from 2006 data where 12% and 17%, respectively were women. The EET noted that despite its success, few peer reviewed publications were produced by the Gender Global Team.

F. Monitoring and evaluation

To ensure that project goals are met, performance indicators (established by Feed the Future) are compiled each year by the ME and national partners before submitting to USAID. Performance indicators are measures of project impacts, outcomes, outputs, and inputs that are monitored during project implementation to assess progress toward achieving project objectives. The performance indicators currently in use appear to be generic for the Feed the Future in general, to be used by many projects, as only those of relevance to IPM IL are answered.

All IPM IL programs report the same set of indicators. Host country coordinators are responsible for arranging data collection and reporting to PIs and in turn, PIs review, edit, and submit these to the ME and onto USAID. The ME sent a copy of the 2012 indicators to the EET. The main indicators were: 1) the number of hectares under improved technologies, 2) the number of individuals in long-term or short-term agricultural training broken down by farmers and scientists as well as by gender, 3) the number of private or public NGOs or farmer groups, 4) the number of rural households, and finally 5) the number of new technologies that were tested. The number of individuals trained or receiving assistance can sometimes be misleading as an individual might receive several trainings per year. The most difficult information to get is estimating farm area that had received project benefits. The ME first has to estimate the average field size for each commodity. Previously reporting was done for each commodity but now the data are lumped together for all commodities. The number of project indicators has dramatically declined in recent years, making reporting easier.

These same indicators are also used by the IPM IL ME as one way to monitor progress, impact, and gender related aspects of the project. In addition to the performance indicators, the ME also submits success stories on select projects and regions (as requested by USAID and Feed the Future) in addition to the number of people in short- and long-term training and the number and kind of publications from all projects annually. The ME has provided the data for each year to USAID as required.

In addition to performance indicators, IPM IL partner sites are monitored via baseline socio-economic and biological surveys that have been carried out in all partner countries (e.g., Sibuga et al. 2007). Baseline surveys are considered as part of the methodology for impact assessment as a description of the farm communities before the project has introduced interventions. The 2004 RFP called for an assessment four years after the baseline to measure progress for the first cycle which has been handled by the Impact Assessment Global Theme who have produced numerous studies. Baseline data are collected for each activity where IPM versus non-IPM tactics is compared. Baseline surveys are an important component of project monitoring and

evaluation and represent a starting point that provides a comprehensive characterization of important variables so that later changes in its attributes can be measured. Baseline studies quantify the results of project intervention and serve as means of triangulating or verifying outputs and benefits in a statistical manner. Most impact assessments have been carried out by thesis students but not in all countries.

As part of the PIPM process, scientists have carried out various descriptive studies to determine levels of awareness, knowledge, attitude, and practices of the target farmers on selected topics in specific geographic areas (Asante et al. 2013, Erbaugh et al. 2001, Isubikalu et al. 2000). Such studies also determine key pests and what methods farmers used to control them (Kyamanywa et al. 2000). In cases where the project is responding to an emerging pest or new problem, the baseline is not well established as the immediacy of the problem requires immediate action. Also special studies are undertaken to determine how much information farmers learned in training programs (Erbaugh et al. 2010). The EET believes that more of these studies should be carried out for all partners in order to quantify learning by farmers from short term training activities as well as studies that document the pests, pest control practices, and knowledge and attitudes of farmers.

Impact assessment quantifies how much farmers have benefitted from the project as well as the return on project investment by taxpayers. Such studies are carried out after farmers have begun to adopt the project's packages of practices for various crops and measure economic gains by farmers using economic surplus models. Impact assessments are mainly conducted by students under the direction of U.S. project economists. Impact assessment studies compare IPM trained and untrained farmers (Norton et al. 2005b, Kiruthika 2011). The Impact Assessment Global Theme is doing an excellent job and be carried out for all partners.

Table 1 documents some of the economic impact of the IPM IL. This table is not meant to be exhaustive; instead, it shows the net profits from a sampling of IPM projects over a 12-year period, from 2000 to 2012. If the average annual budget for the IPM IL is taken at $3 million, then over 12 years the project spent $36 million, thus the investment is returned by a factor of 20-30 fold. Clearly the IPM IL has paid for itself. The EET feels that these figures are realistic as returns to investment in agricultural research normally are very high due to the large areas grown to the crops and that the benefits accrue each season. That the many studies from different partners have consistently shown high benefits lends further credence to the scale of these results. The EET believes that all partners where the project has been active for ten years should have performed an impact assessment.

V. Potential Research Directions

A. Do the results achieved justify a new IPM IL?

The IPM IL has demonstrated consistent success in reducing pesticide usage and increasing yields of horticulture crops. The impact assessment portion of the project has documented returns on investment of 20 to 30-fold. Further, the cooperating scientists and farmers in the participating countries all expressed high praise for the project. These observations collectively suggest that the project is generating a great deal of good will towards the U.S.

It is highly recommended that the IPM IL continue but with the several suggested revisions by the EET. The project should replace mature partners with new Feed the Future countries. There are six from Africa which would greatly benefit from the program. The improvements in agricultural systems in targeted countries have been substantial and these benefits will continue to accrue to

all participants as the research findings and resultant IPM packages spread to greater numbers of farmers and to additional crops. A frequent comment to the EET was that the farmers were spending increased incomes on the education of their children. Continuance of the IPM IL is needed both to engage with more countries as well as spread the results of the on-farm testing process to more research institutions and farmers by scaling up extension training. In most partner countries probably < 1% of potential farmers have been trained on the new technologies.

B. How well does IPM IL contribute to goals of Feed the Future?

IPM IL will reduce poverty and hunger by improving the ability of farmers to grow horticulture crops. IPM IL reduces hunger indirectly by enabling farmers tilling small plots to buy more food from profits from sale of horticulture crops. Most farmers sell to local markets thus providing a supply of nutritious food to their neighbors. The private sector also is involved by producing bio-pesticides which provide better control of pests than synthetic pesticides. Further, the private sector creates markets and can enter into contract growing with groups of farmers.

The goals of Feed the Future are to turn agricultural development including extension and marketing into an engine of economic growth. Through research, the IPM IL has shown the path leading out of poverty by the knowledge of growing successful cash crops. These vegetable crops also contribute greatly to the nutritional well-being of the farmers. Greater production leads to greater consumption of vegetables rich in vitamins, antioxidants, and protein.

In Puncak, Indonesia we saw that farmers had paved foot paths with concrete so they could take their produce out by motorcycle. They started growing vegetables in pots around their homes and on the concrete walkways. We saw tomatoes, eggplant, and cucurbits in pots around their yard trying to fill all vacant space. Some of these farmers have become entrepreneurs through the production of *Trichoderma* and grafted seedlings. Some started to produce fermented fertilizer in 500 gallon drums (*bokasi*) and made screenhouses in their backyards to be able to boost yields even higher.

C. What research topics for US universities and for NARS?

The following research topics are suggested by EET:

The U.S. PIs should continue research into modern, rapid and accurate pest identification systems, with emphasis on those that can be adapted to resource poor institutions.

Research emphasis is needed on pest population genetics and into the genetic mechanisms that result in emergence of new biotypes and virulence races. Further, additional research is needed into how the IPM packages, after being developed and deployed, will drive pest population evolution (especially the rate and probability of predicting precise directions of change- especially at the gene level).

The continued development of GMO traits in crops of importance is needed. It is important to be proactive and having such constructs ready to deploy on the assumption that acceptance of GMO crops will increase in the future. Do not back away from this issue because of current political opposition.

Some of the IPM packages rely in part on application of microbial agents for biocontrol of soil-borne pests and pathogens. Yet ability of such introduced agents to become established and flourish in an established microbial community is typically limited. Research is needed on microbial ecology to address the issue of improved efficacy and sustainability of introduced biological agents.

Research into the development of microbial agents with improved efficacy through genetic alteration (including GMO approaches) to enhance the expression of genes in the microbes that are keys to their biocontrol activities.

Although the IPM IL is primarily a research project and not a technology development and transfer project, the EET believes that there are tremendous benefits to be realized from adaptive research based on current pest management technologies and concepts. We recommend that any new IPM IL include an extension research project, ie. conducting research into the best extension methods and practices for the recipient countries, which are likely to different from best practices used in the U.S. Gender issues will be highly important in this regard.

The NARS needs to focus sharply on adaptive research in the testing and development of IPM packages for their specific crops of interest. The US PIs should provide guidance in this effort and ensure that NARS scientists are conducting appropriate research with respect of topics and rigor. When possible the NARS scientists need to test complete packages that have been successful in other countries rather that a piecemeal testing of individual components of the package. As stated previously, the IPM IL needs to ensure that communication of successes leads to testing, modification, and adoption in other countries/regions.

D. Where IPM IL should be in the research pipeline?

IPM IL has utilized adaptive research to find and tailor existing technologies to solve pest problems of high value crops. The success of the IPM IL has been in the ability of U.S. scientists to identify new technologies and utilize IPM to adapt them to local farming systems in specific agro-ecological zones. The result has been that cash crop production, primarily with horticulture crops has been made more economically attractive to small-scale farmers in the 16 partner countries. After 20 years of research, the IPM IL has been able to find technologies that have greatly reduced reliance on synthetic pesticides. Many of these methods are labor intensive and thus fit well with the most Feed the Future countries. By focusing on high value crops and more intensive production practices, small-scale farmers can earn sufficient income to enter the lower middle class in their societies. They have broken the yoke of poverty with these technologies.

In the upcoming third 10-year cycle IPM IL should expand coverage to more Feed the Future countries and phase out mature partners. In the fourth 10-year cycle IPM would have a choice of either spreading PIPM to more institutions within partners or embarking on a basic research program. IPM IL has no comparative advantage in undertaking upstream research as the amount of funding that would be required is beyond the current funding level of Innovation Labs let alone the time requirement to show results. New cutting edge technologies need to be developed to the stage of field testing before the IPM IL adopts them. Results from adaptive research come much more quickly and thus if additional funding were available it would be best utilized for adaptive research purposes. Responding to the scope of work, the EET presents a short list of some of these technologies that could be taken up by U.S. universities and IPM IL partners if funding were provided:

1. Continue research into modern, rapid, and accurate pest identification systems, with emphasis on those that can be adapted to resource poor institutions. The most obvious success to date is pest diagnostics with plant viruses setting an example. Here diagnostic methods developed by U.S. universities are being used to identify which plant viruses are present in each partner country. In some cases new viruses are being found, but the methods used to find them are standard diagnostic protocols.

2. Research emphasis is needed on pest population genetics and into the genetic mechanisms that result in emergence of new biotypes and virulent races. Further, additional research is needed into how the IPM packages after being developed and deployed will drive

pest population evolution (especially the rate and probability of predicting precise directions of change- especially at the gene level).

3. Continued development of GMO traits in crops of importance – being proactive and having such constructs ready to deploy on the assumption that acceptance of GMO crops will increase in the future. Do not back away from this issue because of current political opposition.

4. Partners need to make alliances with centers that breed pest resistant varieties to receive the most promising cultivars for field testing. IPM IL partners now rely too much on U.S. PIs to provide them. Pest resistant varieties come from private sector seed companies, IARCs, and universities. U.S. universities are focusing on finding out how to deploy genetic resistance to make varieties more durable by slowing down the development of new biotypes that overcome the resistant genes. Grafting tomatoes, eggplants, or peppers onto resistant rootstock has been very popular as farmers have the labor to perform this method.

5. Some of the IPM packages rely in part on application of microbial agents for biocontrol of soil borne pests and pathogens. Yet ability of an introduced microbial agent to become established and flourish in an established microbial community is typically limited. Ecological research is needed to address the issue of improved efficacy of introduced microbial biological agents. Research into the development of microbial agents with improved efficacy through genetic alteration (including GMO approaches) to enhance the expression of genes in the microbes that are keys to their biocontrol activities.

6. Research should engage in testing endophytic microbial agents to replace foliar fungicides and bacteriocides.

7. Biocontrol of weeds such as the *Parthenium* example in IPM IL in Ethiopia can be expanded to include other invasive weeds in partner countries. USDA and universities are actively pursuing such efforts.

8. Augmentation of arthropod biocontrol agents (parasitoids or predators) is an active field that now mainly targets greenhouse culture. Private sector companies, universities, and USDA are involved not only in identifying new biocontrol agents but in improving rearing methods and better methods to release them in the field.

9. USDA and universities are actively pursuing research on discovering ecological methods of pest control that involve species diversity and crop diversification. These are plants that attract natural enemies, act as trap crops, or bio-fumigants that are green manures or rotational crops.

Now that partners have developed packages of practices for many horticulture and cash crops, the IPM IL should begin to focus on strategic research to backstop technologies that in time may fail such as being currently experienced where some eggplant rootstocks that are not resistant to all bacterial wilt strains or nematodes. Research needs to be carried out to find new resistant eggplant varieties as replacements. This is a example of the classic environment x technology interaction that is the reason why nations like the U.S. have so many branch research stations (Zandstra et al. 1981). Backstopping will be an important area of strategic research for U.S. universities until national programs can do it on their own. There will always be a need for backstopping and keeping IPM technologies up to date. This is a never ending process due to evolutionary processes, and partner research teams are being trained to be able to carry this out.

E. Ideal project size for IPM IL

The IPM IL began in 1993 and is now going into the third ten -year cycle. The project is still funding Philippines and Guatemala from the original partners twenty years later. The IPM IL has

only funded 21 countries, some only for less than five years. Currently there are 16 countries in the project which seems to be near the maximum that can be adequately managed. Surprisingly the EET has noted that the ME has not developed criteria to declare project completion whereupon partners would graduate into a mature status and funds for IPM trials would be transferred to new partners. Mature countries might have travel budgets for research staff to attend regional meetings as well as visit the countries they are mentoring. They would have a small budget to support scholars from the countries they mentor and would fund raise and piggyback on other USAID projects. There are six Feed the Future countries in Africa which would benefit from IPM IL.

F. Scaling up IPM technologies

The question being asked here is how might a new IPM IL build on its strengths by obtaining Mission Associate Awards to expand the number of partner institutions conducting IPM as well as bringing research outputs to farmers' fields at scale? The IPM IL has been very successful in obtaining awards from Missions and can use this method to expand or scale up its activities in partner countries. About $10 million has been generated for these efforts (Table 7). The IPM IL also responds to the request of Missions for assistance in dealing with pest problems in areas outside of the project mandate of a region. In Indonesia, for example, the IPM IL will work on citrus and coffee which offers opportunities to expand the PIPM method to more research institutions. The objectives in the Mission Awards are the same as in the normal IPM IL activities of adaptive research to develop IPM practices that replace pesticide usage as well as develop other environmentally sound practices. Scaling up therefore expands the number of institutes in partner countries where the PIPM methodology would be expanded and creates funding opportunities for more farmer training.

Farmer training is important to Feed the Future as two of their performance indicators (number of hectares under improved technologies and number of producers that have received short term training) relate to this activity. The current budgets in the regions have little funding for farmer training under short-term training as applied research and training scientists are the priorities of IPM IL. The less than one hundred thousand farmers that have been trained over the past 20 years came mostly from farmer cooperators that were performing the IPM research plots and their neighbors or farmers living near to the research institutions. Training hundreds of thousands of farmers is a huge job, particularly if most are illiterate. Illiterate farmers have a difficult time relating IPM concepts to what they know. Funding for farmer training must come from outside of IPM IL but the project can facilitate training by making proposals and linking with training partners as it has done in a number of cases to date. Mission Associate Awards allow a larger geographic area to be covered by IPM IL efforts as well as other crops.

What has been lacking, however, is a strategic plan for farmer training. In most plans the idea is to spread the training thinly over a large area by targeting a few farmers in each village. Ideally training would occur for 25 individuals in each village within the extrapolated recommendation domains. The idea is that the trained farmers would influence their neighbors. In time training would occur in most villages.

G. IPM IL strategic and demand driven research

Strategic research backs up technologies developed by adaptive research and would respond to new pest situations when the IPM packages of practices no longer cause suppression. For example as the packages of practices are extended to wider geographic areas the local strains of bacterial wilt may no longer be controlled by what was believed to be resistant rootstocks. New sources of resistant rootstocks will need to be identified in these situations. In many IPM packages soil incorporation of microbial agents are being introduced that have both bio-pesticidal and bio-fertilizer properties. Strategic research needs to determine which species of microbes are

compatible and are needed and which are not. This point was stressed by Jacobsen (2012) in his trip report to Nepal. Jacobsen also encouraged the IPM IL to incorporate more virus assessment work in evaluating IPM packages being implemented by regional projects. For example, evaluation of the virus disease suppression widely observed in many IPM package trials incorporating *Pseudomonas fluorescens* seed treatment and *Trichoderma* treatments, rogueing, yellow sticky trap treatments, etc. He also encouraged the IPM IL to conduct a workshop for seed companies on seed-borne virus detection and methods for producing virus free seeds. He noted that seed-borne viruses are important in cucurbit and okra crops and that this needs to be addressed. Strategic research, through collaboration with IARCs, would include efforts to find durable sources of pest resistance.

Demand driven research can include strengthening farmer organizations through NGOs to teach farmers how to do farmer-led research and extension. The FIELD NGO in Indonesia has expertise in this area and can be a model as they work with FFS trained farmers who continue to meet after the training. It is the view of the EET that BIFAD has probably overestimated the value of the U.S. scientists' role in the IPM package development. Few of the practices in the packages are actually new technologies. The only technologies new to science are new pest resistant varieties which have come from diverse sources: IARCs, private seed companies, and U.S. universities. Other new technologies allowed better identification of pests such as viruses. This would aid in the development of new technologies but in itself is not a control method. The main contribution of U.S. scientists is their ability to seek knowledge from the world literature to bring to bear on each pest problems. These technologies are then evaluated and a few are chosen to test in PIPM research sites. Grafting is an example and is not a new idea but an ancient one from China, although we learned in Indonesia that the Dutch also practiced it in earlier years. Perhaps the Dutch obtained the knowledge from China or independently developed it themselves.

Culturing *Trichoderma* is an existing technology from greenhouse pest control and private firms produce it for sale. Much of the research for this however was done not only in universities but also by private companies but certainly was not a new development of IPM IL. It is true that the genesis of many of the new technologies came from universities but this had occurred before 1993. It is also noteworthy that many technologies in the IPM IL packages came from farmers such as hand picking and use of tunnels to cover crops in the rainy season.

H. What elements of the current IPM IL that should be altered or improved?

As stated previously, despite the total effort and methods of communications, it is obvious to the EET that many partner scientists are still poorly informed. Thus there must be some mechanism for ensuring that the essential lessons are being learned. Many scientists in participating countries are still not using the resources available to them, especially with regard to electronic access to information. The Project Director is being sidetracked in spending a significant amount travelling and providing personal technical assistance to many of the projects. The coordination between regions has suffered because of it. The Project Director should devote 100% of his time managing the project. In fact the EET recommends that a second assistant director be hired to increase the coordination between the 16 countries and spending more time with the weaker partners. Problems of lack of focus to such objectives have been identified in some trip reports (IPM-CRSP GU-1 2012). The ME should focus on uplifting underperforming partners.

I. Are there research topics that should be continued, refocused, or eliminated?

Continue testing IPM packages stressing technologies that reduce the need for synthetic pesticides and improve crop yields. This is a major achievement of the IPM IL and in Bangladesh they claim to have led to a national reduction of pesticide. The gender issues deserve increased emphasis if technology transfer is to be more effective and the multitude of potential benefits of the IPM IL is to be fully realized. Similarly, the assessment of the economic benefits of the

various IPM packages needs to be continued. The mature partners need to focus more on farmer training and extension activities. More sites need to test IPM technologies along with improved agronomic practices. The results from Nepal and the Philippines on the benefit of bio-fertilizers should be tested by all sites in the context of Integrated Crop Management. Even the experimental design developed in Nepal should be adopted by other sites. Simple drip irrigation systems developed by iDE in Nepal should be tested by other countries as the benefits from growing horticultural crops in three seasons allow resource-poor, small-scale farmers to rise above poverty. IPM IL should take a lesson from the work in the Cropping Systems Program at IRRI to undertake research that focuses on technology x environment interactions (Zandstra et al. 1981).

Refocus/improve:

Although the primary emphasis of the IPM IL is on research, the EET is strong in the belief that greater focus on the technology transfer is needed. Part of this emphasis can be through research into enhanced technology transfer systems adapted to the specific needs of the individual Feed the Future countries. Further, it should be a requirement that especially the regional projects develop necessary linkages with other appropriate agencies to ensure developed technologies are moved rapidly into farmer training and “extension” programs.

For topics that should be eliminated the EET notes that work on vegetables in rice systems can and should be funded by PhilRice, and not IPM IL.

VI. Lessons learned

The following points have been lessons learned:

Looking at Table 4 shows differences between partners and those at the bottom of the list are underperforming. The main reason for underperformance is that there are not enough staff in key disciplines to be able to undertake the necessary research to replace as many applications of synthetic pesticides as possible while implementing other agronomic practices to ensure optimum crop yields. Model countries to this end have been Bangladesh, India, Nepal, Indonesia, Uganda and the Philippines. In Ghana there are many gaps in specializations due to the small number of scientists at Crop Science Institute in Kumasi. Makerere University in Uganda has joined with NARO stations. BARI in Bangladesh and TNAU have very large number of staff and there are replacements for most positions even using junior staff if necessary. IPM IL needs to be proactive in this key facet of PIPM development early in each country’s program to ensure these specializations will be present through training and linkage with other institutions if necessary.

The project director is very important in opening up the channels of communication between regions and needs to quiz partner PIs on what they are expected to do. It is important to get the scholarships in order the first year of the project so that as soon as the staff graduate they can make significant contribution to the IPM program.

The project director of IPM IL should be full time in overseeing the research program and spend less time providing persona, technical assistance to individual projects.

One cannot assume that communication is occurring between different regions just because of the many meetings, workshops, and PI visits to other regions. A scientist from Ghana undertook a training course in the production of bio-pesticides in TNAU but for him this was academic as there is no person in his institute who can culture microbial agents. He tested hybrid and open pollinated tomato varieties brought in by the U.S. PI and the hybrid performed best due to disease resistance but there is no source of this seed in his country. Three strains of Ralstonia were identified but no grafting is being done with resistant rootstock. The staff had never heard of

plastic tunnels to raise vegetables in the wet season or the use of green manures. The U.S. PIs and project director need to sit down with the partner PIs to ensure that they are aware of the progress made in other sites and are able and willing to conduct tests on IPM packages of proven effectiveness. Ghana for example has to link with another institution and we suggest KNUST just a few km away.

After 20 years' experience and the focus now on horticultural crops the ME must have developed milestones for each partner country of what is expected during each cycle. Now it should take less than one cycle to achieve the first objectives of developing pesticide free horticulture crops.

If partner countries lack private companies to locally produce IPM tools such as bio-pesticides the project should link with an USAID agribusiness project to achieve these goals.

The local community advisory committee was only established in 64% of countries based on the anonymous special survey. This committee was to be one of the hallmarks in the PIPM method that links the research institute with the local community (Norton et al. 2005c). The committees would include farmer leaders, bankers, marketing associations, extension, and community leaders. Due to the many communities where PIPM trials took place it became a burden to establish them and the project utilized meetings to take their place.

The IPM IL has had an External Evaluation Panel over the period of the project but the panel members have not changed much over time and the evaluations have not been as useful as they could if the panel members were rotated more frequently. Beneficial constructive criticism therefore has been missing. Potential conflicts of interest can be avoided if the EEP is selected by someone other than the ME.

Selection of ad hoc reviews of proposals by the ME needs to be more stringent; external reviewers, as mentioned above, should be leaders in their fields and the ME should make sure that there are no real or perceived conflicts of interest.

A. What has made the current IPM Innovation Lab particularly successful?

Production agriculture is resource intensive and the increasing demand to produce enough food to ever growing population, especially in developing parts of world, calls for significant investments in agricultural research to boost productivity – in the face of increasing challenges of reduced arable land, urban growth, less water availability, soil erosion, and climate change. These challenges are further compounded in developing country production systems due to the small farm size, lack of effective extension service, political instability, subsistence farming, and resource-poor farmers.

Despite rapid and significant advances in improving crops by developing new varieties that yield more and other agronomic traits (such as shelf life), the full yield potential of these improved varieties is not yet to be realized due to pests during production and storage. As much as 30% of the produce/yield was lost due to biotic stresses in many developing countries. While investing in developing higher yielding varieties should continue to be a priority, realizing the existing yield potential by protecting the crops in the field and storage can address food shortages in the immediate term. IPM tactics played and will continue to play a central role in accomplishing this important objective: Benefits are tangible and significant and cross-cutting: reduced pesticide usage, increased yield, value addition, better price, increased income, and better environmental stewardship. IPM IL has had a tremendous success, over the years, in facilitating some of the goals and objectives of Feed the Future

Horticulture systems, often overlooked by donors who were more interested in staple cereals, were ripe for proven IPM technologies. There is no CGIAR center that works on vegetables. AVRDC, located in Taiwan, is not in the CGIAR. We have also seen that AVRDC is not interested in applying for awards through IPM IL. Horticultural crops have also been examples of the worst

scenarios for overuse of pesticides. The EET gathered anecdotal evidence of growers applying pesticides as frequently as every 1 to 3 days! Further, the IPM IL focused on small-scale farmers with small land holdings and they belonged to the most impoverished of farmers. They have more available labor but little capital which fit well with the mainly preventative pest control measures. Farmers with small holdings need to earn high returns to make up for their lack of land. Thus the emphasis was put on horticulture crops and not staple cereal crops where prices are low because of government regulation favoring urban masses.

Among the most successful technologies were use of Trichoderma along with compost for control seedling damping off diseases and bacterial wilt. Also grafting susceptible scions onto bacterial-wilt resistant root stock supplemented the role played by Trichoderma provided further protection against bacterial wilt. Other bio-pesticides have also been utilized by partners for example Pseudomonas and Bacillus for nematode control. Viruses were contained by roguing infected plants and host-free periods to reduce the population densities of whiteflies that vector plant viruses. Insecticide applications were replaced by insect pathogens and botanicals that affected insect pests, mass trapping with fruit fly attractants and pheromones, use of mesh to cover seedbeds, use of sticky traps to capture flying insect pest vectors, hand picking cabbage insect pests, and release of cultured predators and parasitoids.

Using compost in the planting hole gave a suitable environment for the development of the beneficial micro-organisms to enhance their effect. Thus linking IPM with Integrated Crop Management (ICM) brings beneficial results. This includes paying close attention to good horticulture practices that raise the yield potential such as using mulches and planting on raised beds. Small scale drip irrigation and plastic tunnels offer great promise as noted in a number of partner packages of practices. The role of zero tillage in perpetuating beneficial microbial organisms in the same was as *Rhizobium* bacteria can linger in the soil may show promise.

Regional PIs should plan the scholarships to begin in the first year to ensure that gaps in specializations will be filled during the first phase with the benefit of better trained personnel coming during the second phase as was done in BARI.

Project directors need to supervise and ensure communication between regions is carried out so technologies successful elsewhere are well known to all researchers. It cannot be assumed that this will come from reading annual reports which few researchers do as exemplified from discussions with them.

The EET felt that IPM IL is the flagship program in USAID that directly contributed to better environmental stewardship, economic development, and agricultural sustainability. It has taken 15-20 years to come up with the IPM IL horticultural crops model and now is the time to transfer it to as many countries as possible. Focusing on the model means that partners should achieve success in less than 10 years if the project is well planned.

B. What is the opportunity cost of not continuing the IPM Innovation Lab?

IPM IL is on the threshold of assisting millions of small holder farmers out of poverty and malnutrition. The technologies have been perfected over a 15- to 20-year period which is now just becoming adopted by farmers near the research plots. Few partners have funded large scale extension programs and a breakthrough is now needed to find a mechanism to do so. Although traditional systems for technology transfer are effective, addition research is need to develop much more efficient systems. The gender study efforts are critical to the future success of these efforts. Linking with the Horticultural IL which has ample extension expertise should also be pursued. The technology to lift impoverished small scale farmers out of poverty has been developed by the horticultural model. To stop the program now would prevent this achievement, and the goals of Feed the Future out of reach.

The packages, however, are dependent on local supplies of IPM products being available from local suppliers, many of whom can be new businesses formed to fill in the need. In Bangladesh an entrepreneur who was a tea exporter filled the need. If none emerges the new IPM IL may need to stimulate it perhaps through a USAID agribusiness project.

Now the IPM IL needs to expand to new Feed the Future countries primarily in Africa. There is only one C Asian partner in Tajikistan and it is a bit worrying because there is no country that can serve as a mentor as they seem very far behind. More thought has to be given on how this could occur.

The IPM IL should continue to fill the roles of training the trainers for extension programs and to undertake backstopping research to ensure that the technological packages are kept sound. Pests vary over geographic regions and technologies need to be adapted to each region. The PIPM teams in the partner countries can fulfill this role supported by U.S. university experts that can 'put out the fires' that are sure to come in the future.

VII. Recommendations

The EET makes the following recommendations:

A. Recommendations for administration

Overall, administrative and fiscal management was found to effective for the portfolio of 16 national partners including Mali which is now inactive. This is probably near the maximum number of partners that can effectively be managed under current funding levels. The IPM IL by focusing on horticultural crops satisfies most of the goals of Feed the Future particularly in regard to targeting impoverished small-holder farmers and raising crop yields, improving nutrition, and enhancing food security. The only variances were that field trials were being carried out in some districts not designated by Feed the Future as Zones of Influence and the fact that horticultural crops are not the preferred staple cereal crops. The EET learned that Missions have to strike a balance between Feed the Future goals and the goals of the partner countries. The IPM IL can organize future field research in priority districts but if the project focused on cereal crops small holder farmers would not earn enough money due to their small field sizes and the low prices cereals fetch. Farmers can grow vegetables during the rainy season to earn nine times the price in the dry season. Indeed those farmers who have mastered the package of practices can rise out of impoverishment particularly if they have irrigation and grow three crops a year. Vegetable farmers earn enough to be able to purchase their staple cereal needs and have money left over to send their children to private schools. Project farmers and their neighbors will benefit from the better nutrition from vegetables for most of the year. It is a simple fact of life that to make the same money that vegetable farmers make in one year by growing cereals would require much larger field sizes.

USAID Missions told the EET they have high praise for the project as they have seen the field results. They also said that of the different ILs in their country that the IPM IL was making the most progress. The IPM IL has to be commended as it has generated the most external funding than all other ILs and since 2008 almost $10 million has been raised.

Only in one year was there a significant funding problem and work in three countries was halted and the number of partners was reduced to 16. This has meant that C Asia is represented by only one country Tajikistan which is the lowest performing country. EET recommends either reactivating Kyrgystan and Uzbekistan to C Asia or linking Tajikistan with S Asia to form only five regions. Annual funding has been about $3 million which the EET feels is less than adequate.

The ME needs to develop milestones for partners that have matured and can continue research on their own. The ME believes no country has matured to date thus the same countries are included each year and no new partners are brought in. The EET believes that the Bangladesh, Philippines, Uganda, India, and Indonesia have attained mature status and the project should accept new entrants in their place. They still can remain in the project in a mentor but their budgets would be dramatically reduced to allow the new countries to operate. The IPM IL should be funded for another ten year cycle to bring in new Feed the Future countries. Candidate Feed the Future countries are Ethiopia, Malawi, Mozambique, Rwanda, Zambia, and Liberia.

Also several invasive pests have been brought under control by the efforts of IPM IL at minimal cost and great return on investment. Some of the best examples are the papaya mealybug, the cassava mealybug, and Parthenium weed. IPM IL with assistance from USDA has essentially filled the vacuum as CABI or FAO can no longer assume the role of responding to invasive species. IPM IL therefore fills a vital need worldwide. More work on recognizing and combating invasive weeds should be encouraged. Communication between regions by workshops, annual planning meetings, training courses appears to not be enough as the EET found that some partners were unaware of major technologies commonly used in other regions. Just holding a workshop is not as effective as one would like because not all participants are adopting the new technologies they see and learn from abroad. The main reason appears to be they lack staff in the research areas or lack sources of key inputs such as disease resistant hybrid varieties. Therefore PIs need to insure that all partners know what significant results are being found. For example grafting was introduced to Asia a few years ago but only recently into West Africa. The expectation is that all partners need to continue to improve and have sufficiently trained staff to do so. Underperforming partners such as Ghana and Tajikistan need to develop a plan to overcome obstacles to their developing a full complement of IPM technologies. Staff from Ghana for example had never heard of plastic tunnels to raise vegetables in the wet season or the use of green manures. While detailed and voluminous reports were produced on a regular basis, it is critical that progress be made in one region be communicated in real time to those in other regions. Regular weekly or monthly ‘news flashes’ to participating scientists across the regions via cellphones should be considered by the ME. The ME should be a more effective clearing house for information dissemination to all funded PIs. The effectiveness of the technical committee meetings, country meetings, and regional meetings should be monitored and assessed to make sure effective communication took place. One criterion is to evaluate how many collaborations or adoption of technologies took place following a regional or global meeting.

Field tests often lacked appropriate rigor in terms of inclusion of all appropriate treatments, sufficient plot size, and or replication, thus the U.S. Partners need to adopt the five treatment design successfully used by Nepal which shows the benefits of ICM. PIs need to provide more guidance and constructive critique and insist that all PIPM trials be statistically analyzed. A review of annual reports shows great deficiencies here where treatments that yield the most are judged superior without statistical analysis to back it up. Nowadays with software packages statistical analysis is an easy task. PIs need to provide oversight of national staff regarding experimental design, plot layout, number of replications so that proper statistical testing can be carried out (see Annual Reports for deficiencies in these areas). ‘Preliminary trials’ or trials with insufficient replication to perform statistical analysis should not be funded. The ME should look into holding short courses for national staff on proper experimental design and statistical analysis.

Local partners did not always field a sufficient complement of scientific disciplines to embrace the breadth of IPM technologies showing good results by the better performing partners. If staffing is incomplete and cannot be covered by training then an alliance with another research institute should be pursued. For example, Ghana CSI should join with KNUST to obtain the needed

expertise. Such deficiencies can and should have been detected during the first year that Ghana joined IPM IL and remedied then. Much time has been lost not to mention resources.

The ME should make extra effort to advertise the call for proposals on a much wider basis. A few outlets to share the RFP to some of the professional societies such as the American Phytopathological Society, The Entomological Society of America, Grants.gov, through various USDA NIFA regional IPM centers. The EET felt that the process was not as transparent as it could have been. External reviews of proposals should be done by those considered experts in that area and should be free of any potential conflicts of interest.

The ME should not select the EEP. Reviewing recent reports by EEP members found constructive criticism missing and only accolades with a call for more funding. The reports mostly summarized accomplishments reading more like annual reports than evaluations. The current EEP members should be replaced. Half of the EEP members should be replaced every five years. EEP members should also be active scientists.

Financial management appeared to be effective as only the problem of reimbursements surfaced during interviews. Reimbursement of expenses can be expedited if one person per partner country handles finances be they a dedicated accountant or scientist.

B. Recommendations for research

One of the biggest impacts of the IPM IL was institutionalizing PIPM in partner countries, particularly with regard to research being conducted on-farm with farmers collaborating and providing feedback. IPM had been introduced before the project to national programs but the adaptive research focus and the goal to replace synthetic pesticides with more environmentally friendly methods was new. All partners have developed technologies to reduce pesticide application significantly. The special survey noted that a 90% reduction was reported by respondents. In some cases synthetic pesticide usage has been entirely replaced on vegetable crops (e.g. Bangladesh). BARI claims that pesticide usage in the country has significantly decreased as a result of the project. Research has led to increased crop yields with higher economic returns than before the project as the replacement methods in many cases were more effective.

The greatest immediate impact of the IPM IL has been from the actual deployment of crop specific IPM packages that address multiple pests and diseases of specific crops. Therefore this activity should continue to be of the highest priority. IPML is relying heavily on research accomplishments of the past rather than developing new technologies. There is much need for additional research to elucidate pest biologies and epidemiology especially as related to invasive species and newly recognized pests. PIs should give greater research emphasis on fungal diseases and nematodes and more research is needed on screening varieties for host plant resistance.

Despite the many successes of the past IPM IL, there has been relatively little advancement in basic understanding of pest and pathogen biology, their interactions with crop species or biocontrol agents. Regardless of the specific topics that receive the highest priority, there will be competition for limited resources required to fund all important activities. The potential payoffs from new technologies developed are great but will typically take many years to realize whereas the adaptive research results in more immediate benefits. At current funding levels, however, the focus should be on adaptive and backstopping research.

Only 64% of partners have formed community advisory committees as recommended in the PIPM method. Many partners now only hold one or two meetings with local stakeholders whereas standing committees should be established as per plan.

C. Recommendations for HIDC

A highlight of IPM IL has been the large number of national and U.S. based scientists both trained through short and long term scholarships/short courses over the life of the project. 40% of IPM IL budget is spent on training including training of farmers, a level which EET endorses. Most training occurred in relevant disciplines and trainees came from appropriate research institutions both in national programs as well as in the U.S., and attrition was not a significant problem as most scholars sent to the US, regional universities or in universities at home returned to their home institute to rejoin in the PIPM research programs. Institution building took place in Ethiopia where a quarantine lab was set up for the introduction of biocontrol agents against an invasive weed. A similar lab in S Africa provided training. To their credit the Philippines, India, and Bangladesh have successfully spread the PIPM method to a half dozen research institutions in their respective countries. EET encourages partners to invite representatives from other agricultural institutions as a means of informing them of IPM IL and to spread the PIPM method.

The ME should do an assessment of all partners to determine if there are the necessary disciplines represented by the research staff to achieve the goals of IPM IL. This should be done in year one in order for the trained scientists to return and make a significant contribution. Training of plant pathologists in Indonesia and Bangladesh to PhD level in culturing microbial pesticides was the key to the success of both of these countries in making the greatest impact in synthetic pesticide reduction. Most sites are systematically replacing usage of synthetic insecticides with other practices but this is only successful if there are scientists available in the needed disciplines. Most lacking are plant pathologists with expertise in fungal and bacterial diseases and insect pathologists and entomologists with expertise in biocontrol; i.e., rearing parasitoids and predators for augmentation. If there are not enough scientists to train then the ME and PIs should try to make linkages with other research institutions.

More scholars should be sought from Nepal, Senegal, Tajikistan, Honduras and Guatemala. As a minimum the IPM IL should fill four PhD scholarships from each partner as these scientists will be tomorrow's leaders and policy makers. More PhDs are needed from Latin America, W Africa, and Nepal. 'Sandwich training' programs may be more suitable to economics studies where finishing a thesis on time is more predictable. Researchers who cannot meet the entry requirements to undertake an advanced degree in the U.S. should seek a regional university and or have supplemental short term training at a U.S. university. More staff from extension services should be given scholarships. IPM was introduced into secondary agricultural schools in India and Indonesia. Regional PIs should look into introducing IPM principles into primary and secondary school curricula by working with the local Departments of Education to see if there is scope for this activity to be carried out. Lack of trained nematologists in some of the partner countries is a constraint to achieving IPM IL goals. Plant parasitic nematodes will cause significant losses if not addressed and increased emphasis nematode management is needed. U.S. students should spend more time in the host country as they perform a valuable contribution as mentors.

The EET found that the numbers of persons trained reported in annual reports often lumps farmers, extension workers, students under one category and thus does not make clear the designation and gender of those trained.

D. Recommendations: Collaboration

The ME has done a good job to sponsor information exchange platforms such as annual planning meetings, workshops, and seminars where partners from different regions gather as well as organizing field trips taken to see demonstration plots. IPM IL has on balance good relations with USAID Missions and regularly schedule appointments or PIs make phone calls during visits. IPM has much to show in the way of results so USAID task officers should continue to invite senior officials from national programs to see the results and benefits to farmers of IPM packages.

Successful IPM packages will have the greatest impact when the appropriate technology is successfully transferred to farmers. It does little good to develop new technologies without a mechanism to train farmers to adopt existing technologies. The EET notes that most of the Feed the Future countries lack appropriately integrated extension systems for technology transfer. Thus it is likely that alternative technology transfer programs will need to be implemented. The EET believes that adding a research program that focuses on developing a better understanding of issues that affect technology transfer and how to overcome such obstacles would be highly beneficial and collaboration should be established with the Horticultural IL which has expertise as well. The ever-broadening range of electronic and other media solutions increase the options for reaching policy makers and the general public. Increased opportunities for distance learning and video conferencing should facilitate IPM educational programs over the next five years. However, there is the caveat that internet access is greatly restricted in most of these Feed the Future countries, especially in rural environment, and training programs must plan accordingly.

As a critique, the IPM IL has no strategic plan for technology dissemination in any partner country except to train men and women. To date it is all done on an ad hoc basis. Therefore a plan for developing needed collaboration is needed. It does need to develop strategic training plans and recognize the need for agro-ecological zone targeting. The EET believes that the IPM IL funds should be used mainly for research but the project should act as a facilitator to piggyback or leverage funds so that others will do the training. The IPM IL should train the trainers. To carry out such a plan the PIs have to maintain their contacts with the Missions and lobby the project design teams to train vegetable farmers in IPM in partner countries where packages of practices have been developed. For example in Nepal a new USAID project KISAN will train 200,000 vegetable farmers on IPM with the IPM IL training the trainers. All farmers that are trained should receive a certificate stating that they passed the training.

NGOs and other entities should be sought as IPM training vehicles and the IPM IL should facilitate such development. National and international NGOs have been highly effective in disseminating IPM technologies from IPM IL research and represent an option from the more traditional government to government collaboration and should be encouraged in the future to spread non-pesticidal technologies among the NGO community. NGOs such as CARE, Save the Children, Mennonite Central Committee, BRAC etc. can generate their own funding and represent another avenue than USAID. In Indonesia the NGO FIELD is undertaking farmer training with funding awarded to IPM IL by the Mission in Jakarta. FAO also undertakes farmer training on IPM.

More effort is needed to build stronger linkages in the future with three Innovation Labs. In particular with the Horticulture IL for researching new extension methods, for SANREM for compost making and tillage systems, and with the Mycotoxin-Peanut IL on control of an invasive leafminer species. The IPM IL should have the most collaboration with AVRDC among IARCs but unfortunately nowadays collaboration is less due to budget issues. IPM IL does evaluate some AVRDC varieties for resistance to bacterial and viral diseases but should do more as pest resistance is a key IPM tool that is readily adoptable by farmers.

Institutional training should be given in more countries regarding how to handle invasive species, both weeds and insect pests following the example in Ethiopia. Collaboration with USDA has been mainly on tackling invasive insect and weed species and this should continue.

IPM IL engages the private sector mainly through technology transfer. Partner programs should continue to attract the private sector to offer IPM products to farmers. Workshops can be organized in each region to foster more private investment in producing IPM technologies. In addition more attention should be given to opening more private sector marketing through linkage with ongoing USAID agribusiness projects.

E. Recommendations: Gender Inclusion

Inclusion of gender has produced positive impacts in improving IPM packages and farmer training in partner countries. The EET noted in Mali women led efforts to create a tomato crop free period for virus disease control and Trichoderma production is mainly done by women at the village level. Studies found that crops in some cultures are cultivated only by women therefore it is women who should be trained. It is well documented that failure of programs to consider the role of gender in the training farmer groups and in the eventual adoption of new technologies will lead to a high rate of failure. Gender inclusion studies should continue in each new partner country added to the program. The EET noted that few peer reviewed publications were written on gender studies in the IPM IL. This gap should be remedied.

The percentage of women scientists in the IPM IL in the U.S. and national partners has trended upwards over the years. Still there is much room for improvement therefore EET encourages IPM IL to promote more female scientists in both US and partner countries to participate in IPM IL, especially in S Asia and W Africa. Short and long term training programs should continue to target more women.

F. Recommendations for M&E

The ME has annually sent Feed the Future requested performance indicators even though the indicators have significantly changed over the years. As the IPM IL does not utilize its own project indicators, more special studies are needed to learn of the farmers' knowledge of common pests and control methods. This information is useful later for designing training curricula. Furthermore adoption studies should be carried out to document knowledge gained by farmers as a result of trainings.

IPM IL is doing an excellent job in carrying out impact assessments. The significant impact of successful IPM packages as documented by the assessment studies is truly impressive. It is therefore critical that the assessment portion of the project continue or it is likely that future claims of success will not be properly received. All partners where the project has been active for ten years should have performed an impact assessment. Impact assessments of the benefits from farmers adopting IPM IL technologies annually equate to some $788 million over the past 12 years representing a 20-30-fold increase over the investment costs of the project.

U.S. farmers are benefitting from IPM IL research. Grafting of susceptible tomato varieties onto resistant rootstalk has found a niche in a half dozen states. USDA APHIS benefits from the identification of pests in partner countries regarding establishing quarantine regulations for specific pests.

G. Recommendations from the anonymous survey

The anonymous special survey provided some recommendations for improving IPM IL. Most respondents felt the focus on horticulture crops was more relevant than on staple cereal crops, thus the project should continue to emphasize horticulture crops.

In addition most respondents supported the community advisory committees based on their beneficial function linking on-site research teams to farm communities. Therefore these committees should be encouraged when new research sites are contemplated. The local community should invite IPM IL to conduct on-farm research after an orientation explaining the purpose, etc.

PIs should lend their advice on how to perform experimental design with sufficient rigor to undertake statistical analysis. All trials involving comparison of pest control treatments also included an untreated check and the farmer practice. In those trials where bio-fertilizers were used additional treatments of the fertilizers alone, pest control alone, and combined were most revealing as they documented the contributions of each to yield.

Project staff request special training on how to write grants to seek research funds. Some U.S. based PIs said they were constrained by funding to visit more partners each year.

VIII. Annexes

Annex A. Statement of work

The IPM Innovation Lab develops and implements approaches to IPM in order to raise incomes and increase the food security of farm households by reducing agricultural losses due to pests, to minimize damage to natural ecosystems, and to avoid pollution and contamination of food and water supplies. The mission of the IPM Innovation Lab is to implement participatory, farmer-focused, and innovative integrated pest management programs involving research, training, and information exchange that will be adopted in horticulture and other food production systems. The IPM Innovation Lab is included within the Program for Sustainable Intensification of the Food Security Innovation Center and is in its fourth year of a second and last five year phase, due to end on September 30, 2014. The IPM Innovation Lab is one of ten Innovation Labs conducting collaborative research with eligible U.S. universities1 that are supported by USAID's Bureau for Food Security.

The purpose of this external evaluation of the Feed the Future Food Security Innovation Lab: Collaborative Research on Integrated Pest Management (IPM) (hereafter referred to as the IPM Innovation Lab) is to assess the program management and research performance, and to provide recommendations on possible program direction for the U.S. Agency for International Development (USAID). This evaluation will help inform USAID on whether to create another Innovation Lab with the same research focus, to change the research focus or not to continue funding in this area.

Annex B. Itinerary

Date	Country /location	Activity
MARCH		
10	Blacksburg VA	EET travels to Virginia Tech
11		AM/PM discussions at Virginia Tech with IPM IL staff
12		AM continued discussions
		PM return home
14	Colombia MO	AM Team leader travels to University of Missouri to attend BIFAD meeting
15		AM/PM BIFAD meeting
16		AM return home
APRIL		
13 Sat	Travel	Team flies to Accra, Ghana
14 Sun	Ghana	Team arrives in Accra and stays in Coconut Grove Regency Hotel discussion with PI
15 Mon	Accra	AM Meet USAID West Africa Bureau and Ghana Mission escorted by PI
	Kumasi	PM Fly to Kumasi with PI and check in to Royal Park Hotel

1 Eligible universities are land-grant universities, sea-grant colleges, Native American land-grant colleges and others as spelled out in Section 296(d) of Title XII.

16 Tues	Kumasi	AM Council for Scientific and Industrial Research, Crops Research Institute (CRI) for briefing with PIPM team and meet directors
	Agogo	PM field trip to tomato area in Agogo for talks with Dept Agr extension officer and farmer group.
	Asiwa	PM move to Bosome Freho District in Asiwa town of the Nnongo Ashanti Region to see cabbage fields and visit farmers group
17 Wed	Kumasi	AM Nwame Nkrumah University of Science and Technology (KNUST) to meet nematologist and department head
		AM To CRI for debriefing with Depty Director
	Travel	PM fly back to Accra and depart for Uganda in evening via Nairobi
18 Thurs	Uganda	AM arrive Entebbe and drive to Kampala to check into Protea Hotel
	Kampala	PM meet PI in hotel for briefing
19 Fri	Kampala	AM PI escorts team to USAID Mission for briefing with Economic Growth Team
	Kampala	AM to Makerere University with PI for briefing by PIPM team
	Namulonge	PM drive to Continuing Education Center to have lunch and visit tomato trial with Dept Agr extension agent and farmer group
	Kiwenda	PM drive to Kiwenda Farmers Organization and see tomato demonstration with Dept Agr extension agent and farmer group
20 Sat	Kampala	AM wrap up discussions with PI
	Travel	PM fly to Dubai
21 Sun	Dhaka	
22 Mon	Joydebpur	AM drive to BARI for review of IPM IL activities with PI
	Konabari	PM drive to Ispahani Biotech with PI to see mass production of biocontrol agents and return to Hotel
23 Tues	Dhaka	Remain in Hotel due to political disturbances
24 Wed	Dhaka	PM visit with USAID mission
	Travel	PM fly to Singapore
25 Thurs	Jakarta	AM arrive in Jakarta and met by PI and together visited USAID office
	Bogor	PM drive to Bogor and check into Novotel Hotel

26 Fri	Cipanas	AM with PI drive to Cipanas to visit farmer group in Padajaya village where farmer entrepreneur produces microagents for sale (Trichoderma and Pseudomonas). Also observed was grafting tomato and chlii seedlings onto Solanum torvum resistant rootstock Next visit was to Cipendawa to see a mobile plant clinic from the Department of Agriculture and a farmer and university student training center begun in 1974 and funded by local government and a Japanese foundation. Students spend most of the time in the field growing vegetables. Lectures given by IPB plant mycologist Dr. Titik and entomologist Dr. Edap Hardono PM travel to Ciherang town to Cemerling village to sit in on a farmer field school learning celery IPM where farmers learned to culture Trichoderma. Finally travelled to Cipendama town in the same Pacet subdistrict to Pasir Cina village to see successful farmer group growing and marketing vegetables and undertaking farmer-led experiments in grafting tomato onto wild resistant potato and potato seed production. On the trip the EET pathologists identified root knot nematode on celery and potato, and a probably a new record of a thrips-borne topovirus on onion
27 Sat	Bogor	AM met Mike Hammig and Eric Benson and with PI drive to Sukaraja near Bogor to see papaya mealybug in a farmer's cassava field. Visited yard long bean field infected with begomoviruses and took samples. PM Drove to IPM campus and to see the Plant Protection Department and process bean samples to identify the virus. Visited plant pathology and entomology labs
28 Sun	Bogor	Report writing
29 Mon	Travel	AM Visit to IPM PM Team drives to Jakarta and returns to US

Annex C. List of persons contacted

Country	Agency	Office	Person	Title	Email
USA	USAID Bureau of Food Security	Research Division, Office of Agriculture Research and Policy	Lindsay Parish	Evaluation Manager	lparish@usaid.gov
			John Bowman	Program Manager Agriculture and CTO IPM Innovation Lab	jobowman@usaid.gov
			Saharah Moon Chapotin	Division Chief	schapotin@usaid.gov

	Virginia Tech University	IPM Innovation Lab, Management Entity	Michael Bertelsen	Acting Executive Director OIRED	bertel@vt.edu
			R. (Muni) Muniappan	Director	rmuni@vt.edu
			Larry Vaughn	Associate Director	larryjv@vt.edu
			Amer Fayad	Assistant Director	afayad@vt.edu
			Maria Elisa Christie	Director, Women and Gender in International Development	mechristie@vt.edu
			Miriam Rich	Communications Director	mrich@vt.edu
		Plant Pathology, Physiology, and Weed Science Department	Sue Tolin	Chair, International Plant Virus Diseases Network	stolin@vt.edu
		Economics Department	George Norton	Chair, Technical Committee, Chair Impact Assessment Global Theme	gnorton@ve.edu
		Entomology Department	Doug Pfeiffer	PI West Africa	dgpfeiff@vt.edu
	Clemson University	Coastal Research and Education Center	Merle Shepard	Entomologist	mshprd@clemson.edu
		Department of Applied Economics & Statistics	Michael Hammig	PI SE Region	mhammig@clemson.edu
		Entomology Department	Eric Benson	Entomologist	
	Ohio State University	International Programs in Agriculture	Mark Erbaugh	Director,	erbaugh.1@osu.edu
	Penn State University	Entomology Department	Ed Rajotte	IPM Coordinator, PI S Asia	egrajotte@psu.edu
	University of California, Davis	Horticulture CRSP	Eizabeth (Beth) Mitcham	Director	ejmitcham@ucdavis.edu
			Amanda Crump	Associate Director	

Nepal	/DE/Nepal	KISAN project	Bishnu Gyawali	IPM Specialist	bkgyawali@idenepal.org
			Luke Colavito	Country Director	lcolavito@idenepal.org
	CEAPRED Nepalgunj	KISAN project	Ms Vijaya Poudyal	IPM Program Officer	
	Surkhet District		Lalit Prasad Sah	IPM Program Officer	
	Winrock	KISAN project	Bill Collis	Chief of Party	bcollis@field.winrock.org
			Uttam Dhakal	Capacity Building and Training Manager	udhokal@field.winrock.org
Ghana	USAID, Accra	West African Bureau	Candace Buzzard	Head Economic Growth Regional Agriculture Director	cbuzzard@usaid.gov
			Jorge Oliveira	Seed program director	joliveira@usaid.gov
		Ghana Mission, Economic Growth Office	Belay Mengistu	Agricultural Development Officer	bmengistu@usaid.gov
			Peter Trenchard	Office Director	ptrenchard@usaid.gov
			Justice Odoi	Environmental Specialist	jodo@usaid.gov
	Council for Scientific and Industrial Research	Crops Research Institute, Kumasi	Michael Osei	Team Leader/Tomato breeder and PI IPM Innovation Lab	Mk.osei@cropsresearch.org oranigh@hotmail.com
			Dr. JNL Lamptey	Deputy Director/Virologist	jniInnovation Labamptey@yahoo.co.uk
			Dr. MB Mochiah	Entomologist	mochiah63@yahoo.com
			Dr. Kingsley Osei	Nematologist	oseikingsley4@gmail.com
			Dr. Haurna Braimah	Entomologist	braimah_haruna@yahoo.co.uk
			Dr. Grace Bolfrey Arku	Weed Scientist	gbarku@yahoo.co.uk
			Dr. A. Dankyi	Socio economist	dankyiaa@yahoo.com
			Dr. J.N.Berchie	Agronomist	jnberchie@yahoo.com

			Mrs. Joyce Haleegoah	Sociologist/Gender	haleegoahj@yahoo.co.uk
			Dr. Hans Adu-Dapaah	Director	Hadapaah@yahoo.com
	Ministry of Food and Agriculture	Agogo-Asante Akim Municipality, Ejura Sekyedumase District, Ashanti Region	David Dauda	District Agr Extension Officer	
	Ministry of Food and Agriculture	Asiwa, Bosome Freho Dist, Ashanti Region	Mr. Acheampong	District Office Director and six subject matter specialists	
	Kwame Nkrumah University of Science and Technology (KNUST)	Department of Crop and Soil Sciences	Dr. Charles Kwoseh	Nematologist/ phytopathologist	ekwoseh@hotmail.com
Uganda	USAID, Kampala	Uganda Mission, Economic Growth Office	Simon Byabagambi	Agronomist/Program Management Specialist	sbyabagambi@usaid.gov
			Corey Fortin	Agriculture Officer	cfortine@usaid.gov
			Ms Kevin Nanwbembwa	Agribusiness Specialist	knanwbembwa@usaid.gov
	Makerere University, Kampala	College of Agricultural and Environmental Sciences	Dr. Sam Kyamanywa	Agriculture Principal, entomologist, and PI	principal@cas.mak.ac.ug, skayamanywa@agric.mak.ac.ug, skyiamanywa@gmail.com
			R. Emegu Isoto Agr	Economist	
			Jeniah Karungi	Entomologist	
			Charles Ssemwogerere	Entomologist	

			Mildred Ochwo-Ssembakula	Plant pathologist/ virology	
			Chris Tanansi Muwanika	Plant pathologist/ bacteria	
			G. Tusiime	Plant pathologist/ fungi, bacteria	
			PR Rubihayo	Plant Breeder/ tomatoes	
			M. Najjingo-Mangheni	Gender extension	
			R. Miiro	Extension	
			SB Makasa	Plant pathologist/ virology	
			Warren Arinaitwe	Plant pathologist/ virology	
	National Agriculture Research Organis-ation (NARO)	National Crops Resources Research Institute (NACRRI), Namulonge	G. Asea Maize breeder		
			T. Kaweesi		
		Coffee Research Cen ter (COREC), Kituza	M. Abiguba	Plant pathologist	
			M. Otim	Entomologist	
Bangla-desh	Bangladesh Agricultural Research Institute (BARI)		Dr. Md. Rafiqul Islam Mondal	Director General	Dg.bari@bari.gov.bd
			Dr. Md. Khaled Sultan	Director Research	
		Horticulture Research Center	Dr. Md. Altab Hossain	Director	
			Dr. Md. Yousuf Mian	Coordinator IPM Innovation Lab	Yousuf.main96@gmail.com

			Dr. ANM Rezaul Karim	Ex-Coordinatior IPM Innovation Lab	
			Dr. SN Alam	Head, Division of Entomology	Alamsn09@gmail.com
			Dr. MA Rahman	Plant pathologist	
			Dr. GMA Halim	Plant pathologist	
			Dr. Guffar	Plant pathologist	
			Dr. Nazim Uddin	Plant breeder	
			Dr. MS Nahar	Plant pathologist	
	Ispahani Biotech	Dewaliabari, Konabari, Gazipur	Kbd. Md. Ibraim Khalil	Senior Scientific Officer	Ibrahim_ibt@yahoo.com
			Khd. Md. Akhar Hossain	Scientific officer	akhtar.ibt@gmail.com
	USAID	Economic Growth Office	Mohamed S. Shibly	Project Management Specialist	mshibly@usaid.gov
			Md. SR Bhuiyan		
			David Yanggen	Deputy Director	dyanggen@usaid.gov
Indonesia	USAID	Economic Growth Office	J Michael Nehrbass	Director	mhehrbass@usaid.gov
			Dr Donald Tambunan	Project Management Specialist	dtambunan@usaid.gov
	Bogor Agricultural University (IPB)	Department of Plant Protection	Dr. Aunu Rauf	PI IPM Innovation Lab	aunu@indo.net.id
			Dr. Supramana	Nematologist	
			Dr. Hendrastut Hidayat	Plant virologist	
			Dr. Tri Asmira Damayanti	Plant virologist	
			Rita Noveriza	Plant virologist	
			Dr. Abdjad Asih N	Plant bacteriologist	
			Dr. Kikin H Mutaquin	Plant bacteriologist	
			Dr. Titik	Plant mycologist	
			Dr. Meity Suradji Sinaga	Plant mycologist	
			Dr. Aunu Rauf	Entomologist	

			Dr. Sugan Santo	Entomologist	

Annex D. List of materials reviewed

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Annex E. Locations and dates of field visits

Date/country	Location	Description
16 April Ghana	Agogo	PM field trip to tomato area in Agogo to meet the Dept Agr extension officer and visit a farmer group in the field and see farmer adoption
	Asiwa	PM move to Bosome Freho District in Asiwa town of the Nnongo Ashanti Region to see cabbage fields and visit farmers group and see farmer adoption
19 April Uganda	Namulonge	PM drive to Continuing Education Center to have lunch and visit tomato trial with Dept Agr extension agent and farmer group
	Kiwenda	PM drive to Kiwenda Farmers Organization and see tomato demonstration trial with Dept Agr extension agent and farmer group
22 April Bangladesh	Joydebpur	AM drive to BARI to see field trials in the research station including cucurbits and eggplant

	Konabari	PM drive to Ispahani Biotech to see mass production of biocontrol agents
26 April Indonesia	Cipanas	AM drive to Cipanas to visit farmer group in Padajaya village where farmer entrepreneur produces bioagents for sale (Trichoderma and Pseudomonas). Also observed was grafting tomato and chili seedlings onto Solanum torvum resistant rootstock Next visit was to Cipendawa to see a mobile plant clinic from the Department of Agriculture and a farmer and university student training center begun in 1974 and funded by local government and a Japanese foundation. Students spend most of the time in the field growing vegetables. PM travel to Ciherang town to Cemerling village to sit in on a farmer field school learning celery IPM where farmers learned to culture Trichoderma. Finally travelled to Cipendama town in the same Pacet subdistrict to Pasir Cina village to see successful farmer group growing and marketing vegetables and undertaking farmer-led experiments in grafting tomato onto wild resistant potato and potato seed production. On the trip the EET pathologists identified root knot nematode on celery and potato, and a probably a new record of a thrips-borne topovirus on onion
25 June	Kathmandu	AM visited tomato culture in plastic houses and reviewed management practices
2 July	Nepalgunj	From Nepalgunj went to B-igao village, Bageshwori VDC in Kajura town of Banke District to see IPM IL vegetable marketing group and visited the field see eggplant nursery with iDE and **CEAPRED** staff
3 July	Birendra-nagar	Chhinchu VDC, Birendranagar town in Surkhet District to visit tomato nursery for IPM IL field trial managed by iDE and **CEAPRED** staff

Annex F. Anonymous survey results

USAID arranged a consultant to conduct a special survey of a wider number of IPM IL staff than could be visited by the EET. The survey was undertaken by email among IPM IL staff both foreign partners and U.S. based PIs. The questions were made by the EET and sent out by a neutral third party who summarized the data so that the responses were anonymous. IPM IL staff were selected from a listing maintained by the ME and given to the EET in a Briefing Book. Unfortunately only 11 of the 33 staff contacted responded.

Project objectives. Project staff were asked for their opinion as to different objectives of the IPM IL. 82% said the objectives were to develop IPM packages for three crops, 73% said replacing synthetic pesticides, and 73% said training PIPM research teams from several institutions. 64% rated annual horticulture crops as being more important than food or perennial crops.

Research discipline representation. Regarding the right mix of various disciplines among IPM IL partners, the majority (64%) said coverage was fine. But those that said some disciplines were missing mentioned economists, breeders, social scientists, weed scientists, and agronomists.

Contribution of PIPM. Assessing the various PIPM components in terms of what national partners learned most from IPM IL, 82% said impact assessment and developing IPM packages for targeted locations, 73% mentioning gender analysis, and 64% each for involvement of farmer organizations,

involvement of extension personnel, participatory appraisal, baseline survey, and research priority setting.

Accessing funding outside of USAID. When asked if the IPM IL provided training on how to seek funding for research by writing grants to sources outside of USAID, 55% said no. Those in the affirmative mentioned DFID, EU, and Borlaug as funding sources. But 91% said they would like such training to be given.

Reduction in pesticide usage. Respondents listed 13 crop packages that have been developed quantifying the degree of pesticide reduction due to PIPM research. The average was 13 fewer applications per crop over a wide variety of crops that began with over a range from 1 to 30 applications. This is a reduction of 90% in pesticide usage. In most cases the need for synthetic pesticides was replaced with more environmentally friendly technologies.

Why extend funding into a phase V. When respondents were asked what was still lacking to be achieved to justify further project funding 73% each said more scientists were in need of training, impact assessment was not yet completed, and 64% said more research institutes in country need training/support.

Some further comments:

PIPM teams said that 1) even though IPM packages were developed for target crops, these needed continued refinement and improvement, 2) additional resources would be required to disseminate and scale up the technology to farmers, 3) sources of clean or resistant seed have not been located, and 4) more crops should be covered.

PIPM advisory committee. Community advisory committees have been functioning in 64% of projects surveyed. Membership included District Department of Agriculture Extension staff including subject matter specialists as well as representatives from local government, farmer organizations/coops, retail stores, and NGOs. When asked what contributions they made, 36% of respondents commented that they helped form farmer organizations, 27% said they facilitated marketing, 18% said they delineated geographic target areas, 9% each said they facilitated farmer credit and local government provided funding for extension. Other outcomes were noted by respondents such as the IPM packages were endorsed by high level government committees which led to releasing f funds to train thousands of farmers. IPM was also integrated into ongoing USAID programs. Field days demonstrating IPM technologies that led to higher quality produce was showcased to input dealers and local farmers. Also more farmers became motivated to adopt IPM practices the following season.

Field trials. Several questions focused on the experimental designs of PIPM field trials. The number of treatments per trial varied from 2-10 with a mean of 4.3. Some 55% sought the advice of a statistician who also aided in the analysis of the experiments. The number of replications per trial varied from 3-4 with 73% of respondents replicating across farmers' fields.

Frequency of visitation to partners. A question was asked of respondents to comment on the visitation frequency of US-based project staff to partner countries. 36% said the frequency was just about right, 27% said frequency should be increased, with 9% saying visitation was too frequent. A mean of 4.7 persons visited each site per year based on responses. U.S. PIs who responded were able to visit 3-5 countries per year, but the problem is not lack of desire to visit, but lack of funding to do so. Most U.S. PIs communicate frequently by email or Skype. But some partners say there is no communication with Skype or only once a month.

Basic versus applied research. When asked if the IPM IL should engage in basic research, 55% answered in the affirmative. Partners felt the following technologies developed by IPM IL were new to science, although most respondents probably interpreted this question to mean new to their country:

> Incorporation of bio-products into compost in the planting hole that produced synergistic benefits of improved crop nutrition and prevention of pest losses
> New resistant varieties; grafting onto pest resistant rootstock; use of plastic high tunnels in the rainy season; molecular diagnostic assay for plant pathogens (PCR); first reports of invasive species; Trichoderma production by small holder farmers
> Soil solarization as means of soil pest management
> Strategic application of biopesticides according to the stage of the pest gives better control.
> Adoption of bio-intensive IPM and the PIPM research method

One respondent commented that developing technologies new to science is not what the IPM IL is about.

Conclusions: The following conclusions were drawn from the survey:

> Respondents thought the purpose of IPM IL was both in developing technologies to replace pesticides as well as in training research teams to do so.
>
> Most felt the focus on horticulture crops was more relevant than on staple food crops.
>
> Disciplines most deficient in PIPM research teams were economists, breeders, social scientists, weed scientists, and agronomists.
>
> Most partners utilized community advisory committees and found them useful in organizing farmers and facilitating marketing.
>
> Most partners sought the advice of statisticians in conducting and analyzing their experiments.
>
> Respondents requested training on how to write grant proposals.
>
> All research teams produced results that led to significant reduction in pesticide usage with a mean of 11 applications per crop over a wide range of crops.
>
> As reasons to continue the research, most felt that more national scientists needed training, more institutions should be brought into the project, more crops needed IPM packages, more impact assessments were needed as well as backstopping, refinement, and scaling up of IPM packages.
>
> Most partners felt that the frequency of visitation of 4.7 visitors per country per year was ample, but U.S. PIs said they would visit more frequently if funding were increased. Email and Skype are often used to aid communication.
>
> Most partners felt that IPM IL should engage in basic research.

Annex G. Management Entity Response to Evaluation

Page 20. “Grafting for bacterial wilt resistance is done in Uganda and Kenya but not in other African countries”. Later in the report (page 22) you do mention that IPM Innovation lab trained scientists in Senegal and Mali. Grafting does not need to be introduced in countries wherein bacterial wilt is not a problem: for example, Tanzania.

Page 21. “The EET recommends that a committee study the possibility of an IPM IL and Horticultural IL merger”. Horticulture is a commodity Innovation Lab and IPM is a systems Innovation lab. Even though IPM Innovation Lab addresses mostly high value horticultural crops, it also addresses crops

like coffee, citrus, cocoa, potato, sweet potato, mango, and banana which no other Innovation lab addresses. Recently it has developed a project to participate with Mycotoxin-Peanut Innovation Lab. In addition, we would like to point out that the "SP-IPM" of CGIAR system no longer exists and the IPM Innovation Lab is the only one that addresses global pest problems. While we agree that more collaboration is needed between the Horticulture and IPM innovation Labs, the suggestion to combine two Innovation Labs would likely not serve objectives of either. As you acknowledge, there is already significant cooperation among the Labs; "The Horticulture IL has a subprogram on IPM where it features a number of IPM methods in its program, which no doubt came from the IPM IL." Stronger future collaboration can be built on this foundation.

Page 38. In India alone IPM Innovation Lab-led papaya mealybug control work has touched the lives of more than 100 million people.

Page 42. "The Project Director is being sidetracked ---. The project director should devote 100% of his time managing the project." The Project Director does devote 100% of his time to managing the project. There is no Global Project of Invasive Species and the Project Director is not PI of any such project. There is a global theme project on Parthenium, an invasive weed, but Wondi Mersi is PI on that project. The team may have misunderstood the Project Director's participation with the PIs of South Asia and Southeast Asia regional projects in identifying papaya mealybug in India, Indonesia, Bangladesh and other countries. This is resulted in over $500 million in estimated benefits in India alone which you highlight elsewhere in the report. Papaya mealybug is a polyphagus pest which attacks several horticultural crops. In India, it attacked eggplant for which we had a package, however without controlling this pest; our package would not have been complete. In Senegal, he participated with the West Africa team in identifying *Tuta absoluta*, which is serious pest of tomato which is one of the target crops. Certainly his time devoted to these types of highly-related and highly impactful activities cannot be construed as being sidetracked.

The Project Director does spend some of his personal time producing various high quality scholastic contributions, such as writing a book on Pests of Horticultural Crops in Tropical Asia, This type of scholarship synthesis integrates very well into the overall IPM CRSP IL mandate is an expectation of his position.

EEP has cited a trip report (IPM-CRSP GU-1 2012) for its criticism of lack of focus on coordination. First of all, a trip report is not the best document to cite for such a major criticism and secondly, the Project Director was one of the team members for the report.

Page 43. IPM Innovation Lab does not work on rice in the Philippines in the current phase.

Page 43. Project Director does not work on individual projects for an unreasonable amount of time.

Page 44. Two out of the four external evaluation members have been changed in the current phase.

Page 45. We do not agree with the recommendations and discussions referring to IPM biofertilizer and biopesticide development in Nepal for the following reasons. The chair of EET traveled to Nepal, outside of the SOW issued by USAID, and met with one of his former students who worked previously as an entomologist at iDE and participated in IPM package development. Unfortunately, this person

bought the IPM package compounds sold by a private company in India, without going through proper quarantine clearance, and tested them in Nepal. None of the components of biofertilizer and biopesticide mentioned in the report were individually tested in Nepal. In addition, there may be an appearance of a conflict of interest as the former employee of iDE has his own personal company through which he markets this product.

Page 47. The suggestion for creating a full time position for invasive species in the ME will contradict the intent of the USAID. The ME is for management and not for conducting research projects in host countries.

The project in Ghana is only 4 years old and it should not be compared with countries participating for the past 15 or 20 years.

Page 48. The ME has forwarded four reports from the EEP. The ME feels that these reports do contain constructive criticism.

Page 49. Students trained were clearly identified with sex disaggregated data in the annual reports.

Page 50. IPM Innovation Lab is participating with KISAN in the Nepal associate award. It also works with value chain projects in Bangladesh and Indonesia.

Page 59. List of materials reviewed is a poorly defined and incomplete list. The EET needs to provide further details on what criteria were used for settling on this list. Very few materials from the last phase of the program were used.

Page 63. The l survey only had 11 responses and we feel that a larger sample size would be needed to be representative.