



# FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative



## 2018 Integrated Pest Management Innovation Lab Semi-Annual Report (October 1 2017 - March 31 2018)

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Funded by the United States Agency for International Development under  
Cooperative Agreement No. AID-OAA-L-15-00001.



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## Map of Countries Where We Work



(Click to View Country Profiles)

### Asia

[Bangladesh](#)

[Cambodia](#)

[Nepal](#)

[Vietnam](#)

### Africa

[Ethiopia](#)

[Kenya](#)

[Tanzania](#)

## **Program Partners:**

### **U.S. Partners**

Cornell University, Louisiana State University, New York State Agricultural Experiment Station, Ohio State University, Pennsylvania State University, University of California – Davis, University of Minnesota, Virginia State University, Virginia Tech, Washington State University, City University of New York, North Carolina State University, University of Florida.

### **U.S. Governmental Agencies**

USAID, U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS).

### **International Agricultural Research Centers**

Center for Agriculture and Bioscience International (CABI), Food and Agriculture Organization (FAO), French Agricultural Research Centre for International Development (CIRAD), International Centre of Insect Physiology and Ecology (ICIPE), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Institute of Tropical Agriculture (IITA), International Rice Research Institute (IRRI), World Vegetable Center (AVRDC).

### **Host Country Universities, Government Agencies, Institutions, and NGOs**

Agriculture and Forestry University (Nepal), Agricultural Research Council and Plant Protection Research Institute (South Africa), Ambo University (Ethiopia), Amhara Regional Agricultural Research Institute (Ethiopia), Bangladesh Agricultural Research Institute (Bangladesh), Can Tho University (Vietnam), Cambodian General Directorate of Agriculture, Cambodian Center for Study and Development in Agriculture, Ethiopian Institute for Agricultural Research (Ethiopia), Haramaya University (Ethiopia), Hawassa University (Ethiopia), Horticultural Development Council (Tanzania), iDE (Nepal and Cambodia), Indian Institute of Horticultural Research (India), Kenya Agricultural and Livestock Research Organization (Kenya), Mikocheni Agricultural Research Institute (Tanzania), Nagoya University (Japan), Nong Lam University (Vietnam), Real IPM (Kenya), Sokoine University of Agriculture (Tanzania), Southern Horticultural Research Institute (Vietnam), Tribhuvan University (Nepal), and Vietnam National University of Agriculture (Vietnam), French National Institute for Agricultural Research (France).

## Acronyms

APHIS Animal and Plant Health Inspection Service  
ARC Agricultural Research Center  
ARS Agricultural Research Service  
AVRDC World Vegetable Center  
BARI Bangladesh Agricultural Research Institute  
Bt *Bacillus thuringiensis*  
CABI Center for Agriculture and Biosciences International  
CARDI Cambodian Agricultural Research and Development Institute  
CEDAC Cambodian Center for Study and Development in Agriculture  
CIRAD Agricultural Research for Development  
CUNY City University of New York  
EPIC Ecologically Based Participatory IPM Package for Rice in Cambodia  
ESA Entomological Society of America  
FAO Food and Agricultural Organization  
GDA Government Directorate of Agriculture  
GDP Gross Domestic Product  
GIZ Deutsche Gesellschaft für Internationale Zusammenarbeit  
iDE International Development Enterprises  
*icip*e International Center for Insect Physiology and Ecology  
ICRISAT International Crops Research Institute for the Semi-Arid Tropics  
IITA International Institute for Tropical Agriculture  
INRA French National Institute for Agricultural Research  
IPM IL Integrated Pest Management Innovation Lab  
IRRI International Rice Research Institute  
KAVES Kenya Agricultural Value Chain Enterprises  
KALRO Kenya Agricultural and Livestock Research Organization  
MARI Mikocheni Agricultural Research Institute, Tanzania  
MOU Memorandum of Understanding  
NARO National Agricultural Research Organization  
NGO Non-governmental Organization  
PERSUAP Pesticide Evaluation Report and Safe Use Action Plan  
PPRI Plant Protection Research Institute  
RUA Royal University of Agriculture, Cambodia  
SOFRI Southern Horticultural Research Institute, Vietnam  
SUA Sokoine University of Agriculture, Tanzania  
USAID United States Agency for International Development  
USDA US Department of Agriculture  
VietGAP Vietnamese Good Agricultural Practices  
VT Virginia Tech

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## I. Executive Summary

Over the past six months, the IPM Innovation Lab Management Entity has participated in several national and international conferences, workshops, and meetings.

At the annual meeting of the Entomological Society of America, the IPM Innovation Lab (IPM IL) organized two symposia: IPM Packages for Tropical Crops and Management of *Tuta absoluta*. The director of IPM IL gave keynote addresses at the 22<sup>nd</sup> Meeting and Conference of the African Association of Insect Scientists at Wad Medan, Sudan in October 2017 and 12<sup>th</sup> Arab Congress on Plant Protection at Harghada, Egypt in November 2017. We participated in the annual meetings of the Vegetable IPM projects in Asia in January 2018 and Africa in March 2018, respectively. In January 2018, we met with Tribhuvan University, Nepal faculty and revised the proposal of the project “Climate Change and Biodiversity.” In February, we attended a meeting on Fall Armyworm organized by Mercy Corp in Washington, D.C. In March, we organized two mini-symposia at the International IPM Symposium in Baltimore.

Because of budget cuts in FY2017 and non-release of FY 2018 allocations during this whole term, IPM IL program activities were severely affected. Delays in obtaining approval from Congress for Cambodia and Ethiopia, Congressionally restricted countries, and Bureau of Food Security in issuing MOU almost brought activities in these two countries to a halt. The sub-awards with CABI in the *Parthenium* project and Exportable Fruit Crops IPM project in Vietnam, and the sub-award with Russell Mizell of Florida, were terminated for lack of progress. The sub-award with the City University of New York was terminated due to poor performance.

We conducted two webinars: one on [Neem-based Pesticides in Integrated Pest Management](#) on October 17, 2017 and the other on [Trichoderma in Integrated Pest Management](#) on February 28, 2018.

A [PERSUAP for use of pesticides in Vietnam](#) prepared by IPM IL has been approved by USAID.

On May 9<sup>th</sup> Mr. Laouali Amadou, a student from the University of Maradi who was trained at the IPM Innovation Lab, received the [BIFAD Award for Scientific Excellence in Research](#).

Dr. Guru Ghosh, Vice President for Outreach and International Affairs awarded a \$50,000 grant to conduct an impact assessment of the introduction of *Trichoderma* and coconut pith technologies in India, Nepal and Bangladesh.

The IPM IL received a Buy-In from the USAID mission in Egypt to conduct a Risk Assessment of Fall Armyworm: [Egypt FAW Risk Assessment](#).

**The following news releases were published by and about our project activities during this semi-annual reporting period:**

1. “Virginia Tech provides key intel in U.C. and Egyptian-led battle against a major pest.” *Virginia Tech News* (USA). March 2018.
2. “Using Integrated Pest Management to Reduce Pesticides and Increase Food Safety.” *Agrilinks* (USA). March 2018.
3. “Killer weed in East Africa No Match for Virginia’s Land-Grant Institutions.” *VT News* (USA), reposted in *CBS*, *Augusta Free Press* (USA), *Connected Africa* (Africa), *Virginia Tech Magazine* (USA). January 2018.

4. "IPM Innovation Lab Presents Webinars on Neem and Trichoderma." *IAPPS Newsletter* (USA). March 2018.
5. "Countries get heads up about tomato leafminer thanks to Virginia Tech." *Virginia Tech News* (USA). March 2018. Reposted on *HortiDaily* (EU).
6. "Biological Control of Parthenium (*Parthenium hysterophorus* L.) in Ethiopia." *IOBC Newsletter* (USA). December 2017.
7. "Two Sides of the Same Leaf: Controlling Pests in Cambodia." *Feed the Future Newsletter* (USA). February 2018.
8. "Women Find Work with the Help of an Entrepreneur and a 'Fighting' Fungus." *Global Plant Protection News*. April 2018.
9. "Connecting smallholder tomato producers to improved seed in West Africa." *Agriculture and Food Security*. December 2017.
10. "Student from Niger with ties to Virginia Tech wins major award." *Virginia Tech News* (USA). March 2018.
11. IPM Innovation Lab Three-Year Book. January 2018.
12. IPM Innovation Lab Spring Newsletter. March 2018.

## II. Program Activities and Highlights

### *Activities:*

The program continued development and implementation of IPM packages for fruit crops in Vietnam, for vegetable crops in Bangladesh, Cambodia, Ethiopia, Kenya, Nepal and Tanzania, rice in Tanzania and Cambodia, maize in Ethiopia, Kenya, and Tanzania, and chickpea in Ethiopia. It monitored the spread of *Tuta absoluta* in Africa and Asia and has been field releasing natural enemies for control of the weed, *Parthenium* in Ethiopia.

### *Highlights:*

- Receipt of a buy-in of \$50,000 from the USAID Mission in Egypt for preparation of Fall Armyworm Risk Assessment.
- Receipt of \$50,000 in leveraged funds from the Vice President for Outreach and International Affairs for assessing the impact of introduction of *Trichoderma* and coconut pith in Bangladesh, India and Nepal.
- Approval of PERSUAP for Vietnam by USAID.
- Publication of a booklet on IPM IL achievements over the past three years.
- Reviewed research project proposals of the Western IPM Center.
- Guided a student from the University of Maradi who received BIFAD Award for Scientific Excellence in Research.
- Organized webinars on neem, *Trichoderma* and *Tuta absoluta*.
- Organized symposia at the Annual Meeting of the Entomological Society of America at Denver, and the 8<sup>th</sup> International IPM Symposium at Baltimore.
- Gave Keynote addresses at the African Association of Insect Scientists in Sudan and Arab Congress on Plant Protection in Egypt.
- Revised the Climate Change and Biodiversity project.
- *Zygothrips bicolorata* and *Listronotus setosipennis* were introduced to Uganda.
- Finding parasitoids on Fall Armyworm in Ethiopia, Kenya, and Tanzania.



### III. Key Accomplishments

Listed under Highlights.

### IV. Research Program Overview and Structure

Eight projects are operating in seven countries.

### V. Research Project Reports

#### 1. Strengthening Production and export of Vietnamese fruit crops through innovative and market-orientated IPM

**Location:** Southern Horticultural Research Institute (SOFRI), Chau Thanh District, Tien Giang Province, Vietnam.

**Principal Investigator:** Nguyen, Van Hoa, SOFRI, Vietnam.

**Description:** Developing and implementing IPM programs of the following fruit crops: longan, lychee, mango, and dragon fruit.

**Collaborators:** Maria Elisa Christie, Virginia Tech; Naidu Rayapati, Washington State University; Plant Protection Research Institute; Fruit and Vegetable Research Institute; Plant Protection Department, Nong Lam University; Can Tho University; and Vietnam National University of Agriculture, Vietnam.

**Achievements:** The targeted fruit crops in this project are: dragon fruit, longan, lychee, and mango. For dragon fruit disease control bagging of fruits was developed and implemented. The entomopathogenic fungi, *Lecanicillium* spp. and *Metarhizium* spp. were evaluated for control of stinkbugs. Introduced two dragon fruit cooperatives to seven fruit exporting companies. The project conducted two field workshops, participated in two TV shows and produced two video clips on dragon fruit pest management.

An IPM package for longan has been developed incorporating methods to manage witches' broom disease. Neem extract at 5 % was found to be effective in controlling eriophyid mite, *Aceria (Eriophyes) dimocarpi*. Three farmers groups were introduced to two fruit companies. Impact of introduction of IPM technologies for longan on gender being studied.

The major pests of mango were bacterial black spot *Xanthomonas compestris* pv. *mangiferae*, anthracnose *Colletotrichum* sp., Oriental fruit fly *Bactrocera dorsalis*, fruit borer *Deanolis albizonalis*, leafhopper *Idioscopus niveosparsus*, and thrips *Scirtothrips dorsalis*. Bagging mango fruits found to be effective in controlling fruit flies. In addition, setting up of pheromone traps and application of entomopathogenic nematodes were recommended. Farmers cooperatives were introduced to fruit companies.

For lychee crop, two IPM and VietGAP farmers training workshops were conducted. Lychee stinkbug *Tessaratomya papilosa* and erionose mite *Aceria lichii* were the common pests encountered in this season.

#### Presentations and Publications:

- “Application of biological methods, stimulation of resistance pest production control fruit and vegetable.” Theme: Solution of sustainable development for fruit crops in Southern provinces. @ Agricultural extension forum. National Agricultural Extension Center. Ministry of Agriculture and

Rural Development, Ben Tre, 16/2017: 31-40

- “Integrated pest management on mango and longan in Southern provinces.” Theme: Solution of sustainable development for fruit crops in Southern provinces. @ Agricultural extension forum. National Agricultural Extension Center. Ministry of Agriculture and Rural Development, Ben Tre, 16/2017: 54-60
- “Morpho-biological characteristics of predatory mite (*Amblyseius longispinosus*), a biological control agent of *Eriophyes dimocarpi* on longan.” *Journal of Agricultural Science and Technology of Vietnam*. 2018. (86): 64-68
- “Identification of *Colletotrichum truncatum* causing anthracnose on dragon fruit and effect of botanical extracts on fungus growth.” *Journal of Vietnamese Agricultural Science and Technology*. 2018. (86): 83-88
- “Primary results of the establishment of phylogenetic tree *Colletotrichum* spp. causing anthracnose disease in the Southern provinces.” *Journal of Vietnamese Agricultural Science and Technology*. 2018. (86): 68-72
- “Study on the antagonism of actinomycetes to causing anthracnose and canker disease on dragon fruit in vitro.” *Journal of Vietnamese Agricultural Science and Technology* 1 (86): 78-82.

## 2. Innovative Scientific Research and Technology Transfer to Develop and Implement Integrated Pest Management Strategies for Vegetable and Mango Pests in Asia.

**Location:** Cambodia (Siem Reap, Battambang, Phenom Penh), Bangladesh (Gazipur, Narsingdi, Mymensing, Comilla, Moulvibazar, Hobigonj, Sylhet, Jessore, Bogra, Pabna, Rjshahi, Gaibanda, panchagar), and Nepal (Banke, Surkhet, Lalitpur, Kavre).

**Principal Investigator:** George Norton, Virginia Tech

**Description:** Implementation of IPM for tomato, Chinese kale, cucumber, long bean, and cabbage in Cambodia, for tomato, onion, chili, bitter melon, French beans, and okra in Nepal, and for tomato, eggplant, cabbage, bitter melon, cauliflower, country bean, and mango in Bangladesh.

**Collaborators:** Megan O’Rourke and Maria Elisa Christie, Virginia Tech; Edwin Rajotte, and Cristina Rosa, Pennsylvania State University; Sally Miller, Ohio State University; Naidu Rayapati, Washington State University; Yousuf Mian, Shahadath Hossain, M.A. Goffar, M.S. Nahar, and A.T.M. Masud, Bangladesh Agricultural Research Institute; Luke Colvito, Lalit Sah, Komal Pradhan, iDE; P. Sharma and B. Mahto, National Agricultural Research Council; Keshab Datta Joshi and Yubraj Dhakal, CEAPRED, Nepal; M. Roberts, Kimhian Seng, An Moyngch and An Chanratha, iDE Cambodia; Khun Kimkhuy, Ong Socheath, and Soth Seyboth, Royal University of Agriculture, Cambodia.

**Achievements:** In Cambodia – Field trials were completed with yard long bean incorporating liming, raised beds, mulching, trellising, drip irrigation, use of *Bacillus thuringiensis*, *Bacillus subtilis*, *Beauveria bassiana*, *Trichoderma* sp., orange oil, yellow sticky traps, and pheromone traps. Trials were conducted to evaluate efficacy of *Trichoderma harzianum*, *Trichoderma viride*, and *Trichoderma koningii* for control of damping off of tomato, evaluation of rootstocks for control of bacterial wilt of tomato, eggplant and chili, and use of *Ocimum* spp. as insect repellent plants on Chinese kale at Royal University of Agriculture. A joint trail on yard long bean IPM package was conducted at the CE SAIN Technology

Park in Siem Reap.

In Bangladesh – Field trails were conducted to assess the performance of Bt and non-Bt eggplant under IPM package, management of mango leafhopper and fruit fly, and white mold of country bean. Economic impact of vegetable IPM in Bangladesh is being assessed by two PhD students.

In Nepal – An IPM package for tomato incorporating *Tuta absoluta* management has been developed. IPM packages for onion, chili, cucumber, bitter melon, and French bean have been tested. Temporal and spatial distribution of eggplant fruit and shoot borer, *Helicoverpa armigera*, *Spodoptera litura* and *Tuta absoluta* are being studied.

#### **Presentations and Publications:**

- “Economic feasibility of an augmentative biological control industry in Niger.” *Crop Protection*. March 2018.
- “Returns to investment in developing IPM research and efficiency of vegetable growers in selected areas of Bangladesh.” PhD dissertation, Bangladesh Agricultural University, March 2018.
- “Tomato leafminer, *Tuta absoluta*, and its management in Nepal.” Presentation at ESA's 65th Annual Meeting, November 5-8, Denver, Colorado.
- “Designing IPM approaches for management of tomato leafminer, *Tuta absoluta* and its management in Nepal.” Presentation at 9th International IPM Conference, March 18-22, 2018, Baltimore, Maryland.
- “Designing IPM solutions for vegetable pests and management of *Tuta absoluta* in Nepal.” Presentation at 11th National Organic Fair organized at Rupandehi Butwal, February 15 to 19, 2018.
- “IPM cucumber package in Cambodia.” Presentation at ESA's 65th Annual Meeting, November 5-8, Denver, Colorado.
- “Lessons learnt from IPM trials.” Presentation at the dissemination workshop on the Prakas of BCAs, jointly organized by the government & GIZ, December, 2018, Phnom Penh, Cambodia.
- “Why IPM Makes a Difference.” Plenary presentation at 9th International IPM Conference, March 18-22, 2018, Baltimore, Maryland.
- IPM Nepal coordinator Mr. Lalit Sah presented a paper on *Tuta absoluta* and its management in Nepal at ESA's 65th Annual meeting held at Denver Colorado, USA, 2017. He also presented a paper on Nepal *Tuta* work in the 9th IPM international symposium held at Baltimore, Maryland in March, 2017.

### **3. Development of Ecologically based Participatory Integrated Pest Management (IPM) Packages for Rice in Cambodia (EPIC).**

**Location:** Cambodia (Battambang, Kampong Thom, Prey Veang, Takeo)

**Principal Investigator:** Buyung Hadi, IRRI

**Description:** To develop a rice IPM package validated for Cambodian biophysical conditions in collaboration with rice value chain projects in Cambodia. It will reduce losses due to pests and diseases, minimize pesticide use, and include tactics such as cultural control, host plant resistance, and biological control.

**Collaborators:** Chou Cheythyrih, General Directorate of Agriculture; Khay Sathya, CARDI; Keam Makarady, CEDAC; Sotaro Chiba, Nagoya University; George Norton and Doug Pfeiffer, Virginia Tech; and Harvey Reissig, Cornell University.

**Achievements:** The project completed 12 adaptive field trails at eight villages and four research stations. *Trichoderma* experiments are being continued in Battambang, Kampong Thom and Prey Veang. Adaptive trials were conducted on weed management, rodent management, and use of bio-pesticides. IPM technologies are showcased at the CE SAIN technological parks at Battambang and Kampong Thom. IPM IL participated in the 1<sup>st</sup> SAI conference in January 2018.

The annual planning meeting was conducted in November 2017. Funding delay caused curtailment of several planned activities.

In collaboration with GDA, CARDI and PDAFF, a number of farmers' training/engagement meetings were conducted. About 984 farmers were trained on various IPM components.

The dry season 2017/2018 data confirmed the results that trap barrier system, optimized herbicide application, use of *Trichoderma* and *Beauveria* are more effective in suppressing pests/diseases/weeds. Most collaborating farmers are willing to test selected technologies in larger parts of their farms.

#### **Presentations and Publications:**

- “Vegetable based ecological engineering: Participatory development of a conservational biological control method for Asian rice landscape.” Presentation at 2017 annual meeting of Entomological Society of America. November 8, 2017.
- “EPIC: developing ecologically-based participatory IPM package for rice in Cambodia.” Presentation at the International Sustainable Agriculture and Nutrition Conference, Royal University of Agriculture, Phnom Penh, Cambodia. January 10 2018.
- “Can adaptive research approach facilitate innovation process for Integrated Pest Management in Cambodia?” Presentation at the International Sustainable Agriculture and Nutrition Conference, Royal University of Agriculture, Phnom Penh, Cambodia. January 10 2018.
- “Innovation systems and technological lock-in for Integrated Pest Management.” Seminar given at the Knowledge, Technology and Innovation Seminar Series, Wageningen University, Wageningen, Netherlands. November 28 2017.
- “Activity of insectivorous bats over rice fields surrounding free-range bat guano farms in Cambodia.” Poster presentation at the International Sustainable Agriculture and Nutrition Conference, Royal University of Agriculture, Phnom Penh, Cambodia. January 10 2018.

#### **4. A High-Resolution Interaction Based Approach to Modeling the Spread of Agricultural Invasive**

## Species.

**Location:** Virginia Tech; North Carolina State University; University of California-Berkeley; Senegal; France.

**Principal Investigator:** Abhijin Adiga, Biocomplexity Institute, Virginia Tech

**Description:** Model the spread of *Tuta absoluta* around the world and determine the identity of groundnut leafminer in Africa.

**Collaborators:** Madhav Marathe, Stephen Eubank, Achla Marathe, Srinivasan Venkataramanan, Sichao Wu, Bowen Shi, George Norton, Joseph McNitt, and Henning Mortveit, Virginia Tech; J. B. van Kretschmar, and Godshen Robert Pallipparambil, North Carolina State University, Lalit Sah, Ajay P. Giri, and Luke Colavito, iDE, Nepal; V. Sridhar, S. Nitin, and R. Asokan, Indian Institute of Horticultural Research, India; Thierry Brevault, Anais Chailleux, and Arame Ndiaye, Senegal; Nicolas Desneux, Mateus Ribeiro de Campos, and Philippe Bearez, France; Antonio Biondi and Luigi Ponti, Italy; and Andrew Gutierrez, University of California-Berkeley.

**Achievements:** A network-based propagation model to study the spread of invasive species has been described. It has been applied to study the possible spread of *Tuta absoluta* in Southeast Asia. Incorporating elements from recent modeling efforts in the context of human and livestock disease spread, this stochastic, spatially-explicit model captures the pathways of natural and human-mediated spread. This model incorporates disparate datasets corresponding to natural factors (precipitation, elevation, vegetation, humidity, and temperature), host plants (seasonal presence, host preference), trade dynamics (imports, exports, domestic trade, city location, distance between cities) and demographic factors (consumption, GDP, population).

*Tuta absoluta* has already invaded Myanmar in April 2017 and we could predict it to move into Thailand before the end of 2018.

To assess the risk of introduction of *T. absoluta* into North America, a MOU between USDA-APHIS and Virginia Tech has been established to permit access database of interception records.

To confirm the species and identity of the possible origin of groundnut leafminer, *Aproerema modicella* in Eastern and Southern Africa, samples are being collected for molecular analysis.

### Presentations and Publications:

- “Towards robust models of food flows and their role in invasive species spread.” *IEEE*. December 2017.
- “Modeling commodity flow in the context of invasive species spread: Study of *Tuta absoluta* in Nepal.” *Virginia Tech*. November 2017.

## 5. Participatory Biodiversity and Climate Change Assessment for Integrated Pest Management (IPM) in the Chitwan-Annapurna Landscape, Nepal.

**Location:** Chitwan, Kapilbastu, Nawalparasi, Kaski, Syangja

**Principal Investigator:** Nir Krakauer, City University of New York

**Description:** To study changes in fauna, flora, crop phenology, and incidence of pests and diseases due to variation in temperature, rainfall, and humidity from the Terai region to higher altitudes in the Himalayas.

**Collaborators:** J.D. Anadon, D.L. Lohman, T. Lakhankar, and A. Jha, CUNY, New York; Pramod Kumar Jha, Tribhuvan University, Nepal; and Nab Raj Devkota, Agriculture and Forestry University, Nepal.

**Note:** The sub-award with the City University of New York was terminated on December 31, 2017 due to poor performance. A revised project was prepared and a sub-award given to Tribhuvan University in Nepal to implement the project with support from Biocomplexity Institute at Virginia Tech. Two MS students completed their dissertation, 10 MS and five PhD students are continuing their research.

### **Presentations and Publications:**

“Performance evaluation of locally developed black light trap for maize insects monitoring in Chitwan, Nepal.”  
*Journal of Maize Research and Development*. 2017.

## **6. Integrated Pest Management (IPM) for Vegetables in East Africa.**

**Location:** Ethiopia, Kenya, and Tanzania

**Principal Investigator:** John Cardina, Ohio State University

**Description:** Development and implementation of IPM packages for vegetable crops in Ethiopia, Kenya, and Tanzania.

**Collaborators:** Amon Maerere, Sokoine University, and Peter Sseruwagi, Mikocheni Agricultural Research Institute, Tanzania; Jesca Mbaka, KALRO; Stephen New, KAVES; Henry Wainwright, Real IPM; and Danny Coyne, IITA; Kenya; and Ferdu Azerefegne, Hawassa University, Ethiopia.

**Achievements:** In Kenya – A baseline survey was completed. WhatsApp IPM diagnosis and management network is being formed. Trial were conducted for validation of biopesticides for their efficacy in controlling bacterial wilt of tomato, black rot and soft rot on cabbage, arthropod pests on cabbage and French beans, and diseases on French beans.

In Tanzania – A baseline survey was completed. A training on onion production and pest management was conducted for farmers from five villages of Kilosa, Iringa rural and Kilolo districts. In an onion varietal trial conducted, the variety Red Creole had low thrips infestation and purple blotch incidence. Varieties Russet and Jambir were susceptible to thrips and purple blotch. Treatment with neem cake gave better control of nematodes in tomato and cucumber fields during the dry season.

Training on IPM for tomato and Chinese cabbage was conducted in Morogoro and Iringa regions. In Ethiopia – An onion thrips threshold study was conducted in Rift Valley. A trial using nets in the hot pepper was conducted to reduce the incidence of viral diseases. Netting for 80 days gave less incidence of viral diseases. A trial on weed control in onion fields is in progress.

From the baseline surveys in Kenya and Ethiopia, it was concluded that distance from town reduced pesticide applications. Further from town reduces both the probability of IPM adoption and the use of pesticides

## Presentations and Publications:

- Two posters presented in the Horticultural Association of Kenya (HAK) Scientific Conference, Pwani University, Kilifi, Kenya February 12-16 2018

## 7. Rice, Maize and Chickpea Integrated Pest Management (IPM) for East Africa.

**Location:** Ethiopia, Kenya, and Tanzania

**Principal Investigator:** Tadele Tefera, *icipe*, Ethiopia

**Description:** Development and implementation of IPM packages for maize and rice in Tanzania, maize and chickpea in Ethiopia, and maize in Kenya.

**Collaborators:** *Ethiopia* - Ethiopian Institute of Agricultural Research, Ambo University, Haramaya University, Addis Ababa University, and Jimma University *Kenya* - Kenya Agricultural and Livestock Research Organization, and Kenya Agricultural Value Chain Enterprises (KAVES) in Kenya *Tanzania* - Sokoine University, University of Dar es Salaam, Agricultural Research Institute, and National Biological Control Programme

**Achievements:** In Ethiopia – The chickpea variety Habru seed dressed with Lamdex and planted on raised beds showed considerable levels of resistance to wilt diseases. Local strains of *Beauveria bassiana* and *Metarhizium anisopliae* gave good control of *Helicoverpa armigera* in the laboratory studies. Promising parasitoids found on fall armyworm were: the larval braconid parasitoid *Cotesia icipe* in Ethiopia, the tachinid fly *Palloxoria zonata* in Kenya, and *Charops ater* and *Coccygidium luteum* in Kenya and Tanzania.

In Kenya – Push-pull technology for stem borer control was demonstrated with 40 maize farmers. A mean maize yield increase of 12.7% was obtained by adopting this technology. The yield increases were obtained by farmers with no prior skills in practicing this technology; it is expected that yield differences could increase if the technology was practiced over several seasons.

In Tanzania – The push-pull technology was introduced in maize fields in Morogoro and Mvomero districts. It reduced stem borer damage by 56.81% and *Striga* weed infestation by 40.19%. It also increased per acre yield of maize by 24.94%.

The rice varieties TXD 306 and Komboka, which are resistant to rice blast, late bacterial blight and yellow mottle virus disease, yielded 38% and 40.5% respectively over the local variety. In the laboratory studies, *Bacillus subtilis* treatment gave better control of rice blast disease than *Trichoderma*, Linkimil and hot water.

The braconid parasitoid *Cotesia flavipes* was found parasitizing stem borer larvae at 36 to 48% in the fields.

## Presentations and Publications:

- “Farmers’ knowledge, perceptions, and management practices of the new invasive pest, fall armyworm (*Spodoptera frugiperda*) in Ethiopia and Kenya.” *International Journal of Pest Management*. January 2018.

- “Farmers’ perceptions of rice production constraints and stem borers management in Tanzania.” *Journal of Agricultural Science*. April 2018.
- “Distribution of rice stem borers and their parasitoid in irrigated low land rice ecosystem in Kilombero valley, Morogoro, Tanzania.” *Journal of Entomology and Zoology Studies*. February 2018.
- “Smallholder farmers' knowledge, perception and management of rice blast disease in upland rice production in Tanzania.” *Journal of Agricultural Science* (proposed Vol. 10 No.5 of June, 2018).
- “IPM approaches for fall armyworms in Africa.” International Symposium of IPM, March 19-22, 2018, Biltmore, USA.
- “Biological control of fall armyworms, ToT training workshop for eastern and Central Africa,” organized by the USAID and CIMMYT, November 9-11, 2017, Addis Ababa, Ethiopia.
- “Progress report on rice, maize and chickpea project, national annual planning and review meeting.” Presentation Nov 3, 2017, Morogoro, Tanzania.
- “Maize stem borers and striga management in Tanzania using the push pull technology.” Progress report presented in annual review and planning meeting, Morogoro, Nov 3, 2017.
- “Screening and verification of rice varieties against blast, yellow mottle rice virus and blight diseases.” Progress report presented in annual review and planning meeting. Morogoro, Nov 3, 2017.
- “Integrated management of rice blast in Tanzania.” Progress report presented in annual review and planning meeting.” Morogoro, Nov 3, 2017.
- “Integrated management of rice stem borers in Tanzania.” Progress report presented in annual review and planning meeting. Morogoro, Nov 3, 2017.

## 8. Biological Control of the Invasive Weed *Parthenium hysterophorus* in East Africa.

**Location:** Ethiopia, South Africa, Tanzania, and Uganda

**Principal Investigator:** Wondi Mersie, Virginia State University

**Description:** Biological control of the invasive weed *Parthenium hysterophorus*, in Ethiopia, Tanzania, and Uganda using the natural enemies *Zygogramma bicolorata* and *Listronotus setosipennis*.

**Collaborators:** Arne Witt, CABI; Melkamu Birhanie and Walleign Zegeye, Amhara Regional Agricultural Research Institute; Tesfaye Amare, Ambo University; Kassahun Zewdie, Ethiopian Institute of Agricultural Research; Lisanework Nigatu, Haramaya University; Ferdu Azerefege, Hawassa University; Asmare Dejen Demeke, Wollo University; Lorraine Strathie, Agricultural Research Council, South Africa; Richard Molo, National Agricultural Research Organization, Uganda; Samora Macrice (Sokoine University, Tanzania); Ramadhan Kilewa, Tropical Pesticide Research Institute, Tanzania; and Lidya Alemayehu, Virginia State University.



**Achievements:** In Ethiopia - The rearing of natural enemies, *Zygogramma bicolorata* and *Listronotus setosipennis* continued at Wollenchiti and Ambo University (Guder Campus). *Z. bicolorata* was reared at Haramaya University.

Field release of these natural enemies will be done after the onset of the rainy season in June 2018. In Kenya – Steps are being taken to secure permits from the Kenyan Government and USAID to introduce *Z. bicolorata* and *L. setosipennis*.

In Uganda – Dr. Richard Molo and Dr. James Ogwang, NARO, Uganda visited Agricultural Research Council of South Africa with support from another funding source in February 2018. They received training in rearing of natural enemies of *Parthenium*. Later they received a total of 1,000 *Z. bicolorata* adults and 200 larvae of *L. setosipennis*.

In South Africa – The Plant Protection Research Institute of Agricultural Research Council is collaborating with IPM IL *Parthenium* project. They provide technical assistance, training, and natural enemies.

Gender assessment at Wollenchiti was completed.

#### **Presentations and Publications:**

- “Helping Workitu Eirgu and other rural women in Ethiopia tackle the scourge of the invasive weed parthenium.” IPM IL Website at Virginia Tech.
- “Update on biological control of *Parthenium* (*Parthenium hysterophorus* L.) in Ethiopia.” IPM IL website at Virginia Tech.
- “Biological control of *Parthenium hysterophorus* with the USA and African partners.” *Plant Protection News* 110: 6.
- “Killer weed in East Africa no match for Virginia’s land-grant institutions.” *Virginia Tech Magazine*–Spring 2018 page 8.
- “The invasive alien plant *Parthenium hysterophorus* and livestock production in KwaZulu-Natal.” KZN DARD Livestock Research Symposium, Cedara, March 8, 2018. About 180 participants attended the symposium.
- The results of the two phases of the gender assessment have been prepared into a presentation accepted at the American Association of Geographers. The presentation was in April 2018.

## **VI. Associate Awards/Buy-ins**

The IPM Innovation Lab received a buy-in from the USAID mission in Egypt for \$50,000 to prepare a [“Pest Risk Assessment of the Fall Armyworm, \*Spodoptera frugiperda\* \(Lepidoptera: Noctuidae\) in Egypt, Africa”](#) on September 27, 2017. The report was prepared and submitted to the mission on December 14, 2017.

## **VII. Human and Institutional Capacity Development**

### a. Short-Term Training

<b>Biological Control of the Invasive Weed <i>Parthenium hysterophorus</i> in East Africa</b>							
Type	Location	Date	Number Female Participants	Number Male Participants	Total Participants	Home Institution (if applicable)	Training Institution
Biocontrol Agents demonstration	Wollenchiti	Dec 6, 2017		6	6	IPM IL	IPM IL
Experiential training on weed biocontrol (including parthenium) for undergraduate students	ARC-PPRI South Africa	Jan 8-Feb 2, 2018	3	0	3	University of KwaZulu-Natal	ARC-PPRI Cedara, South Africa
Training on biocontrol of parthenium, biocontrol of other invasive plants and insects	ARC-PPRI South Africa	Feb 11-17, 2018	0	1 (2 were expected)	1	Of participant: National Agricultural Research Organization, Uganda	ARC-PPRI Cedara, South Africa
Symposium in South Africa	Natal	March 8			180	ARC-PPRI	ARC-PPRI

<b>Developing Ecologically-based Participatory IPM package for Rice in Cambodia (EPIC)</b>							
Type	Location	Date	Number Female Participants	Number Male Participants	Total Participants	Home Institution (if applicable)	Training Institution
Farmers' field visit	Takeo	October 18 2017	3	23	26		
Farmer field visit	Battambang	October 23 2017	30	16	46		
Exchange visit by farmers from Prey Veang	Takeo	October 24 2017	25	0	25		
Exchange visit by farmers from Takeo	Prey Veang	October 25 2017	25	2	27		
Farmers' field visit	Prey Veang	October 27 2017	4	14	18		
Farmers' field visit	Prey Veang	November 1 2017	1	15	16		
Farmers' field visit	Takeo	November 7 2017	11	18	29		
Farmers' field visit	Battambang	November 7 2017	7	23	30		

Farmers' field visit	Takeo	November 7 2017	11	18	29		
Farmers' field visit	Prey Veang	November 9 2017	10	21	31		
Farmers' field visit	Takeo	November 10	3	25	28		
Exchange visit of farmers from Bati to Traing village	Takeo	November 13 2017	6	14	20		
Field day	Prey Veang	November 23 2017	16	39	55		
Field day	Battambang	November 28 2017	20	29	49		
Farmers' field visit	Prey Veang	November 28 2017	8	29	37		
Field day	Takeo	November 30 2017	23	33	56		
Farmers' field visit	Battambang	December 11 2017	14	12	26		
Farmers' field visit	Kampong Thom	December 14 2017	8	19	27		
Farmers' field visit	Kampong Thom	December 19 2017	4	19	23		
Field day	Battambang	December 21 2017	18	27	45		
Farmers' field visit	Kampong Thom	December 26	11	16	27		
Farmers' field visit	Battambang	January 4 2018	6	13	19		
Farmers' field visit	Kampong Thom	January 8 2018	14	15	29		
Farmers' field visit	Kampong Thom	January 22 2018	7	20	27		
Farmers' reflection meeting	Battambang	January 22 2018	10	8	18		
Farmers' reflection meeting	Battambang (different village)	January 23 2018	7	8	15		
Farmers' field visit	Kampong Thom	January 23 2018	17	13	30		
Field day	Kampong Thom	January 24 2018	4	40	44		
Exchange visit of Battambang farmers to Kampong Thom	Kampong Thom	January 24 2018	7	3	10		

Reflection meeting	Prey Veang	February 13 2018	4	16	20		
Reflection meeting	Prey Veang (another village)	February 14 2018	1	16	17		
Reflection meeting	Takeo	February 20 2018	9	10	19		
Reflection meeting	Takeo (another village)	February 22 2018	3	11	14		
Farmers' field visit	Takeo	March 10 2018	29	23	52		
Internship	Phnom Penh	January-February 2018	1	0	1		

### Strengthening production and export of Vietnamese fruit crops through innovative and market-orientated IPM

No Short-term Training

Rice, Maize and Chickpea IPM for East Africa							
Type	Location	Date	Number Female Participants	Number Male Participants	Total Participants	Home Institution (if applicable)	Training Institution
<b>Ethiopia</b>							
Training on PPT for new recruited farmers and technology adopters (for experience sharing)	Hawasa Zuria district	28 March – 5 April 2018	28 (2 adopters)	601 (15 adopters)	629		icipe
Push Pull Technology Establishment and management -for Development Agents	Hawassa	12-13, March 2018	16	92	108	Regional Bureau of Agriculture	icipe
Consultative meeting with SNNPR regional, zone and district Higher Officials	Hawassa	5 March 2018	--	7	7		icipe
<b>Total</b>				<b>44</b>	<b>700</b>	<b>744</b>	
<b>Kenya</b>							
Field day and	Kiambogo	3-5	30	75	105	ICIPE,	icipe

farmers training at the IPM Maize Push-Pull demo site	Gilgil (in Nakuru county)	October 2017				KALRO & Ministry of Agriculture	
Consultative meeting	Kiambogo, Gilgil sub-county	27 February 2018	12	23	35	ICIPE & KALRO	
<b>Total</b>			<b>42</b>	<b>98</b>	<b>140</b>		
<b>Tanzania</b>							
Push –pull technology sensitization meetings before site selection	Morogoro and Mvomero districts	21 <sup>st</sup> -27 <sup>th</sup> Feb 2018 and 4 <sup>th</sup> -7 <sup>th</sup> March 2018	64	33	97	Village offices	
Technology awareness creation through mass media (Tanzania broadcasting Corporation) - Radio programme)	Was broadcasted throughout the country	17 <sup>th</sup> March 2018	NA	NA	NA	Tanzania Broadcasting Corporation Radio house in Dar Es Salaam)	
Training on good agricultural practice in order to minimize the occurrence of rice diseases	Mvomero	18th March 2018	10	--	10	ARI Dakawa, NAFKA	
Training on good agricultural practice in order to minimize the occurrence of rice diseases	Mkindo	19th March 2018	6	6	12	ARI Dakawa, NAFKA	
Training on good agricultural practice in order to minimize the occurrence of rice diseases	Kigugu	20th March 2018	10	8	16	“ “	
Training on good agricultural practice in order to minimize the occurrence of	Dihinda	21st March 2018	17	3	20	“ “	

rice diseases							
Training on good agricultural practice in order to minimize the occurrence of rice diseases	Mbogo	22nd March 2018	9	9	18	“ “	
Training on good agricultural practice in order to minimize the occurrence of rice diseases	Lukenge	23rd March 2018	20	11	31	“ “	
Training on good agricultural practice in order to minimize the occurrence of rice diseases	Hembeti	24th March 2018	19	5	24	“ “	
Training on good agricultural practice in order to minimize the occurrence of rice diseases	Mgudeni	25th March 2018	22	4	26	“ “	
Training on good agricultural practice in order to minimize the occurrence of rice diseases	Dihombo	26th March 2018	12	10	22	“ “	
Training on good agricultural practice in order to minimize the occurrence of rice diseases	DIGOMA	27th March 2018	5	9	14	“ “	
Training on good agricultural practice in order to minimize the occurrence of rice diseases	Kipera	29th March 2018	21	10	31	“ “	

		<b>Total</b>	<b>191</b>	<b>108</b>	<b>299</b>		
<b>Grand Total</b> <b>(Eth + Ke + Ta)</b>			<b>277</b>	<b>906</b>	<b>1183</b>		

<b>Innovative Scientific Research and Technology Transfer to Develop and Implement Integrated Pest Management Strategies for Vegetable and Mango Pests in Asia</b>							
Type	Location	Date	Number Female Participants	Number Male Participants	Total Participants	Home Institution (if applicable)	Training Institution
IPM package trials undergraduate theses	Phnom Penh, Cambodia	Oct 17 – Mar 18	5	5	10	Royal University of Agriculture (RUA)	RUA & VT
Guest lecture	Phnom Penh, Cambodia	Feb 08, 18	8	9	17	Royal University of Agriculture (RUA)	Penn State
Field day: long bean IPM package	Siem Reap, Cambodia	Mar 01, 18	71	29	100	N/A	iDE, PDAFF, EWS & AI
Nine farmer field days/demonstrations on IPM practices	Banke and Surkhet Nepal	Oct 17 to March 18	95	50	145	N/A	iDE
IPM trials undergraduate theses	Banke, Nepal	Oct 17 – March 18	4	0	4	HICAST	HICAST
IPM training in School	Surket, Nepal	March 18	36	23	59	N/A	iDE and ANUKUL AN
Training of staff of LIBRD project on Tuta absoluta	Banke, Nepal	Feb 2018	4	7	11	LIBIRD	iDE

<b>A High-resolution Interaction Based Approach to Modeling the Spread of Agricultural Invasive Species</b>							
Type	Location	Date	Number Female Participants	Number Male Participants	Total Participants	Home Institution (if applicable)	Training Institution
12 <sup>th</sup> Arab Congress on Plant Protection	Egypt	Nov 2017	20	80	100		

Annual meeting of the Entomological Society of America	Denver	Nov 2017	10	40	50		
IPM Symposium, Baltimore	Baltimore	March 2018	5	35	40		

<b>Research and Technology Transfer for Vegetable Crops</b>							
Type	Location	Date	Number Female Participants	Number Male Participants	Total Participants	Home Institution (if applicable)	Training Institution
Staking of tomatoes as an IPM tool	Mbuiuru-Mwanjati	10/12/2017	18	11	29	Farmer group	KALRO
Seedling selection	Nthambo	11/08/2017	11	8	20	Farmer group	KALRO
Identification of tomato diseases	Mbogoni	01/10/2018	12	10	22	Farmer group	KALRO

**Participatory Biodiversity and Climate Change Assessment for Integrated Pest Management in the Chitwan-Annapurna Landscape, Nepal**  
No Short-Term Training

## **b. Long-Term Training**

### **i. Students and post-docs being trained**

<b>Strengthening Production and Export of Vietnamese Fruit Crops through Innovative and Market-orientated IPM</b>							
Name (first, last)	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
Dang Thi Kim Uyen	F	Can Tho University	PhD	Plant Protection	November 2020	N	Vietnam
Duyen Luong Thi	F	Can Tho University	MS	Plant Protection	August 2019	N	Vietnam
Tuyen Le Ngo Nhu	F	Can Tho University	MS	Agricultural Economics	January 2019	N	Vietnam

**Innovative Scientific Research and Technology Transfer to Develop and Implement Integrated Pest Management Strategies for Vegetable and Mango Pests in Asia**



Name (first, last)	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
Farhanaz Sharma	F	Virginia Tech	PhD	Economics	May 2019	N	Bangladesh
Sadique Rahman	M	Tribbuvan University and Virginia Tech	PhD	Economics	March 2018	Y	Bangladesh
Arjun Khanel	M	Virginia Tech	PhD	Economics	December 2018	N	Nepal
Ram Khadka	M	Ohio State University	PhD	Plant Pathology	May 2020	N	Nepal
Sulav Paudel	M	Pennsylvania State University	PhD	Entomology	May 2020	N	Nepal
Kaitlyn Spangler	F	Virginia Tech	MS	Geography (Gender Studies)	June 2018	N	USA

<b>Participatory Biodiversity and Climate Change Assessment for Integrated Pest Management in the Annapurna-Chitwan Landscape, Nepal</b>							
Name (first, last)	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
Anju Sharma	F	Tribhuvan University	PhD	Botany	June 2019	N	Nepal
Bidya Maya Shrestha	F	Tribhuvan University	MSc	Environmental Science	May 2018	N	Nepal
Bivekananda Mahat	M	Agriculture and Forestry University	MSc	Entomology	January 2018	N	Nepal
Dol Raj Luitel	M	Tribhuvan University	PhD	Botany	May 2019	N	Nepal
Ghanashyam Bhandari	M	Agriculture and Forestry University	PhD	Entomology	May 2019	N	Nepal
Hom Nath Giri	M	Agriculture and Forestry University	PhD	Horticulture	May 2019	N	Nepal
Madhu Sudhan Ghimire	M	Agriculture and Forestry University	MSc	Plant Pathology	January 2018	N	Nepal
Pratiksha Sharma	F	Agriculture and Forestry University	MSc	Environment and Conservation	January 2018	N	Nepal
Pristi Dangol	F	Tribhuvan University	MSc	Ecology	April 2018	N	Nepal
Ramesh Upreti	M	Agriculture and Forestry	MSc	Horticulture	January 2018	N	Nepal

		University					
Sarita Sapkota	F	Agriculture and Forestry University	MSc	Entomology	January 2018	N	Nepal
Seerjana Maharjan	F	Tribhuvan University	PhD	Ecology	May 2019	N	Nepal
Yashoda Panthy	F	Agriculture and Forestry University	MSc	Biodiversity	January 2019	N	Nepal

<b>Development of Ecologically-based Participatory Integrated Pest Management (IPM) Package for Rice in Cambodia (EPIC)</b>							
Name (first, last)	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
Chhun Sokunroth	M	University of Battambang	MS	Agronomy/ Weed Science	December 2018	N	Cambodia
Chou Cheythyrih	M	Nagoya University	PhD	Plant Pathology	July 2019	N	Cambodia
Ong Socheath	F	Nagoya University	PhD	Plant Pathology	September 2020	N	Cambodia
Sek Pisey	M	Royal University of Phnom Penh	MS	Conservation Biology	December 2017	N	Cambodia
Rica Joy Flor	F	IRRI	Postdoc	Agricultural Economics	September 2019	NA	Philippines
Corey Riedel	M	Virginia Tech	MS	Entomology	September 2018	N	USA

<b>A High-resolution Interaction Based Approach to Modeling the Spread of Agricultural Invasive Species</b>							
Name (first, last)	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
Mateus Ribeiro de Campos	M	Institut National de la Recherche Agronomique INRA	Postdoc	Research Engineer level 1	January 2019	NA	France
Joseph McNitt	M	Virginia Tech	MS	Mathematics	May 2018	Y	USA
Saliou Djiliw	M	Université Cheikh Anta Diop (UCAD)	MS	Entomology	December 2017	N	Senegal
Ahmadou Sow	M	CIRAD-BIOPASS	PhD	Entomology	April 2018	N	Senegal
Mame Diarra	F	Université	MS	Entomology	January 2018	N	Senegal

Bouso		Cheikh Anta Diop (UCAD)					
Serigne Sylla	M	Université Cheikh Anta Diop (UCAD)	PhD	Entomology	Feb-17	Y	Senegal
Bryan Kaperick	M	Virginia Tech	BS	Computation Modeling & Data Analytics	May 2018	N	USA

**Biological Control of the Invasive Weed *Parthenium hysterophorus* in East Africa**

Name (first, last)	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
Ethel Xolile Magoso	F	Tshwane University of Technology	B Tech	Agriculture (Crop Production)	May 2018	N	South Africa

**Rice, Maize, and Chickpea IPM for East Africa**

Name (first, last)	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
Birhanu Sisay	M	Haramaya University	MS	Crop Protection	December 18	N	Ethiopia
Denberu Kebede	M	Addis Ababa University	MS	Applied Microbiology	December 18	N	Ethiopia
Gezahegn Getaneh	M	Jimma University	PhD	Plant Pathology	June 2019	N	Ethiopia
Nana Ameri	F	University of Dar Es Salam	MS	Applied Microbiology	December 18	N	Ethiopia
Tarekegn Fite	M	Ambo University	PhD	Agricultural entomology	June 2019	N	Ethiopia
Josphat Korir	M	University of Nairobi	PhD	Agricultural Economics	June 2019	N	Kenya
Bonaventure January	M	Sokoine University of Agriculture	PhD	Agricultural entomology	June 2019	N	Tanzania
Ibrahim Hashim	M	Sokoine University of Agriculture	PhD	Plant Pathology	June 2019	N	Tanzania

**Integrated Pest Management for Vegetables in East Africa**

Name (first, last)	Gender	University	Degree	Major	Program End Date (month/year)	Degree Granted (Y/N)	Home Country
Feyisa Bekele	M	Hawassa University	MS	Weed Science	September 2019	N	Ethiopia
Kumsa Dida	M	Hawassa University	MS	Entomology	December 2018	N	Ethiopia
Cecilia Ngugi	F	University of Nairobi	PhD	Entomology	September 2019	N	Kenya
Denis Nyamu	M	Ohio State University	MS	Entomology	September 2019	N	Kenya
Joshua Kinene	M	Chuka University	MS	Plant Pathology	September 2019	N	Kenya
Ester Rehema Matendo	F	SUA	MS	Entomology	December 2017	N	Tanzania
Happiness Christopher	F	SUA	MS	Plant Protection	November 2018	N	Tanzania
Hellen Kanyagha	F	Ohio State University	PhD	Plant Pathology	2020	N	Tanzania
Peter A. Maerere	M	SUA	MS	Entomology	November 2018	N	Tanzania
Tumsifu Samwel	M	SUA	MS	Plant Protection	November 2018	N	Tanzania
Zuwena Msuya	F	Sokoine University of Agriculture	MS	Plant Protection	November 2018	N	Tanzania

## VIII. Leveraged Funds:

The IPM Innovation Lab received \$50,000 from the Vice President for Outreach and International Affairs to conduct an impact assessment of introduction of the IPM components *Trichoderma* and coconut pith in to Bangladesh, India and Nepal. Ms. Elli Travis, Office of Economic Development at Virginia Tech., is carrying out this work.

## IX. Scaling:

- Management of *Tuta absoluta* without using chemical pesticides in Nepal.
- Bagging mangoes in the trees to protect from fruit fly attack in Bangladesh and Vietnam.
- Mass multiplying and field release of the natural enemies *Zygogramma bicolorata* and *Listronotus setosipennis* for control of *Parthenium* in Ethiopia.
- Use of *Trichoderma* in Cambodia.
- Bagging of dragon fruits in the field to control canker disease in Vietnam.
- Management of witches' broom syndrome of longan in Vietnam.
- Push-Pull adoption in Ethiopia, Kenya and Tanzania.
- Survey for natural enemies of Fall Armyworm in Eastern Africa.

## X. Appendices

## Appendix A: Success Story on Women Entrepreneurs in Bangladesh



# Women Find Work with the Help of an Entrepreneur and a “Fighting Fungus”



GKSS employees sieve Tricho-compost to ensure consistency.

In fields and farms of the Bogura District of Bangladesh, entrepreneur Rebaka Sultana is giving an already prolific fungus even more transformative power.

*Trichoderma* is a beneficial fungus that naturally occurs in all soils. Up close, it resembles wild and overgrown snowflakes, and similarly, embodies a kind of versatility difficult to match. The fungus can be used in liquid or solid form, it attacks harmful soil-borne diseases, assists crops in nutrient and water absorption, strengthens seedlings, and promotes overall crop health and growth. Now, with the help of Sultana's ingenuity, the “fighting fungus” is doing more than fighting crop disease, but fighting for equitable opportunity as well.

Sultana is the Executive Director of Grameen Krishok Sohayok Sangstha (GKSS), a Bangladesh-based organization created to mitigate frequent crop problems like low quality seeds and fertilizers, and to provide a unified space for farmers. One of Sultana's major successes and continued goals is helping women become self-reliant and find job opportunities otherwise not available to them.

Sultana is the first to sell *Trichoderma* in the form of Tricho-compost, where the fungal culture is added to compost sold in conveniently-packaged bags. She also develops Tricho-leachate, a liquid solution “leached” from Tricho-compost that can be sprayed on leaves, and vermicompost, a kind of composting that uses worms to strengthen soil.

“GKSS has given me a good working environment,” Sultana said. “When I see farmers benefiting due to our initiatives, I feel good.”

Agriculture is the largest sector of employment in Bangladesh; many women, if employed, work solely in home-based agricultural activities.

The composting sector of GKSS employs both salaried men and women. The majority, however, are women. Sultana aims to include small and marginal farmers as contract growers for compost production, where women farmers are given priority. She said that the ability to earn additional income could help women “broaden their way to empowerment both in their families and in society as well.”

Sultana maintains that farmers from all levels are eligible for purchasing compost from GKSS.



Rebaka Sultana speaks with farmers and customers about GKSS products.



Beyond being responsible for her business, Sultana is also involved in the advancement of young women and girls outside of the Bogura District's agricultural industry. She has established an education center for children from low-income families, an orphanage center for girls, and a center for children who have disabilities.

The Feed the Future Innovation Lab for Integrated Pest Management (IPM IL) has promoted *Trichoderma* for use on small farms in developing countries including Bangladesh, India, Indonesia, Nepal, and the Philippines, and collaborates with the institutions that provide the *Trichoderma* cultures that help GKSS thrive, and women like Sultana achieve independence in an industry where men often dominate powerful positions.

Sometimes, not all is fair in farmer and fungi. Despite *Trichoderma's* multipurpose qualities, production and commercialization of organic compost comes with many challenges like availability of raw materials, political unrest, *Trichoderma's* uncommonness as a marketing item, the ability to receive loans, and financial assurance from banks and organizations. Also, since very few businesses in Bangladesh, especially agricultural businesses, are owned and operated by women, navigating uncharted terrain is difficult in itself.

"At least I have been able to prove that this sort of business is possible by a woman," she said. "Every woman has potential to do better."

In giving advice to women interested in starting their own businesses, Sultana said, "Trust yourself and go ahead." To countless others, she need not say much at all, as the truth will soon be blossoming from the ground.

(Top) A GKSS employee manages and monitors compost nourished with *Trichoderma* in a facility that has grown dramatically in size as GKSS has become more productive. (Bottom) Young girls who live in the orphanage Sultana operates place intricate beading on cloths.

[www.feedthefuture.gov](http://www.feedthefuture.gov)

<p><b>Feed the Future Innovation Lab for Integrated Pest management (IPM IL)</b></p> <p>Virginia Tech   CIRED 526 Prices Fork Road (0378)   Blacksburg, VA 24061</p> <p>@IPM_IL <a href="https://ipmil.cired.vt.edu/">https://ipmil.cired.vt.edu/</a></p> <p>Director Muni Muniappan</p> <p>(540) 231-3516 rmuni@vt.edu</p>	<p><b>General</b></p> <p>The IPM Innovation Lab is housed in the Center for International Research, Education, and Development, a university-wide office at Virginia Tech that supports the university's international efforts in learning, discovery, and engagement. With a portfolio of close to \$100 million, the office manages projects in 30 countries and partners with 80 NGOs, research organizations, private sector concerns, and governmental organizations.</p>	<p><b>Funding</b></p> <p>The Innovation Lab for Integrated Pest Management is supported by a grant from USAID and managed by Virginia Tech's Center for International Research, Education, and Development (CIRED).</p>
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