**Vegetable Crops and Mango IPM in Asia Trip Report**

**Countries Visited**: Cambodia, Bangladesh, Nepal

**Dates of Travel**: January 21- February 6, 2017

**Travelers Names and Affiliations**: E. Heinrichs, Amer Fayad and George Norton (Virginia Tech), Cristina Rosa, Ed Rajotte (Penn State). Karl Markgraff, Vice President for International Programs at Virginia Tech also attended the Cambodia portion of the trip. A volunteer intern (recently completed undergraduate student at Virginia Tech), Millie Smith, also participated in the Cambodia part of the trip.

**Purpose of Trip**: To review progress on the Asian Vegetable and Mango IPM program and plan for the next year for the target countries.

**Sites Visited**: Phenom Penh and Siem Reap, Cambodia; Dhaka, Gazipur, Jessore in Bangladesh; Kathmandu and Nepalganj (Banke), and Surkhet in Nepal.

**Description of Activities/Observations**:

*January 21- 22:* U.S. scientists left United States.

*January 22-23:* Scientists arrived in Phenom Penh, Anise Hotel. Fayed, Rajotte, and Rosa arrived on Jan 22, but due to flight problems, Heinrichs, Markgraff, and Norton arrived on January 23.

*January 23:* Phenom Penh – Group went to RUA, joined by John Bowman, IPM IL AOR, from USAID, and met with two faculty (plant pathologist and entomologist) and five undergraduate students who presented results of their field trials on the project. Koy Chakriya presented varietal screening of rootstocks to search for resistance to *Ralstonia.* Some of the tested rootstocks showed a good level of resistance to *Ralstonia*, and the group was interested in continuing the testing by grafting the resistant material and by testing the resistance in greenhouses or in the field. A copy of the presentation was provided. Students who planted cucumber and kale trials at RUA lost their trials to an unusually severe flood and have replanted. They describe their planned trials, showed the newly replanted ones, and there was discussion. Use of undergrad students perform some of the IPM IL component research appears to be working well and contributes to capacity building. The plant pathologist mentioned she is in the process of testing different sources of *Trichoderma*, including a locally isolated strain at RUA, for effectiveness. The team also discussed strategies to combat tomato pests and diseases including *Helicoverp*a, whitefly transmitted viruses, damping off, and setting up pheromone traps to monitor *Tuta absoluta*. Discussions also covered pests and diseases of eggplants, cucurbits, and crucifers. The team stressed the importance to conducting the trails at least twice for the results to be meaningful and publishable.

Group visited the Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CESAIN) in the afternoon and met with Borarin Buntong (deputy center director), Manel Mao (program manager), and Se Deng. CE SAIN integrates innovative strategies/techniques to demonstrate model farming systems to showcase best management practices. It is designed to build capacity for RUA faculty, help apply for grants and provide demonstrations, fund students to pursue higher degrees in SAIN, and establish technology parks to show case demonstrations and show small-scale farmers the tools to improve food and nutritional security. They will produce brochures, conferences, guest lectures, and demonstrations and will help coordinate projects being

implemented by of the six ILs in Cambodia. CE SAIN started in September 2016 and will run for five years. ILs can set up trials on the model farms. Can access info via RUA website. Final recommendations to CE SAIN: integrate IPM into their model farming system, establish local contacts on each IL to get frequent updates, formally introduce CE SAIN to the ILs so they know what to expect, decide how to distinguish CE SAIN from other similar model parks

A planning meeting for RUA was held. The RUA students will write short proposals for the experiments they want to complete. They will continue to test IPM component technologies so they can be built into IPM packages. Since the IPM-IL had difficulties last year in recruiting a student from Cambodia for long term training as graduate student at Virginia Tech, and since lack of preparation to pass the GRE tests and unavailability of GRE testing centers in Cambodia was reported as limiting factor in student recruitment, the IPM-IL group suggested CESAIN to provide RUA students with assistance on this issue.

January 24: Group left hotel, picked up John Bowman at his hotel and went to the General Directorate of Agriculture where we met with the Director, KER Monthivuth the Plant Protection Services Program (PPSP) and Deputy Directors, NY Vuthy and OP Pich among others. The Director indicated that PPSP wants to be a part of the implementation of IPM and wishes it had a bigger role. The forthcoming problem of *Tuta absoluta* was discussed. We emphasized that *Tuta* will probably arrive in Cambodia in the next year or so, posing a dangerous threat to tomato production. We suggested that pheromone traps be strategically placed at borders and other ports of entry to act as an early warning system. The purpose of the IPM IL was discussed and the Director indicated that he wished there was a more formal relationship with a Cooperative Framework (simple MOU) for the project. PPSP supports biocontrol. It is one of 10 departments under GDA and has a staff of 60. It is responsible for quality assurance, pest surveillance, forecasting, training, phyto-sanitary inspection, issuing certificates, and drafting legislation. More progress has been made on rice than vegetables. They bring in biocontrol agents and they coordinate with the CABI Plant Doctor program. They have a research station 60 kilometers away. The IPM IL team observed the labs. No other major donor is helping with IPM work (outside of rice). The Director has a vision for a major facility that will bolster IPM R&D. The Director wants the group to collaborate with this agency and work with researchers and experts within PPSP that are desperate for knowledge. The IPM IL will bring representatives from PPSP/GDA together in meetings when IPM IL team visits and sets goals, operating within the budget for the IPM IL program. John Bowman feels that we need a short document or MOU that outlines cooperation. The director mentioned that GDA needs more capacity in nematology and virology especially in identification and diagnostic capabilities.

In the afternoon, the team went to USAID mission and met with Vuthy Theng and Michael Monteleone. Vuthy feels that each IL should give a lecture when it comes at RUA. The team described the program and discussed it with the mission.

Later in the afternoon, Norton, Heinrichs and Bowman met with Rica Flor of the Cambodia Rice IPM IL project. She will coordinate with VT Grad student Sydni Jackson on data summary format and we will produce a joint report on the baseline survey. There will also be joint papers on IPM adoption, economic impacts, and gender. Rica will collect economic data from the farm-level trials.

January 25: Group flew to Siem Reap where we met at iDE office with Fen Beed and Stu Brown of iDE and Bruce Todd and An Moyngech of iDE. The IPM IL project was briefly reviewed for Fen and Stu, and then Stu and Fen described their activities. Stu is focusing on home gardens. He focuses on a seed kit and reached 1300 households last year. Recommends rotation of bittergourd, pumpkin, leafy brassicas and chili. They use Moringa trees for a living fence. The series of seed rotations should provide a 4-person household with the necessary vegetables to meet nutrition requirements;

they have a demonstration garden near Siem Reap: 6 x 6 ft divided into 10 3-ft growing areas, high turnover and rapid rotation for maximum productivity. They use a simple IPM component. Not contemplating any use of chemical pesticides (or fertilizers) because women and children are involved. Stu is concerned with scaling up, how to utilize the private sector? East/West Seeds has been helpful. They are not working with the government – only long-embedded organizations here in order to ensure sustainability. Conducting a Randomized Controlled Trial (RCT).

Fen Beed said the AVRDC has gone through management change: new director general. He described the AVRDC program generally. Discussion of need for quality control and availability of Trichoderma and seeds

After lunch, Kim Hian made a presentation about progress on the workplan.
Workplan Activity 1: participatory appraisals, crop/pest monitoring and farm surveys are complete: stakeholder meetings, surveys of 400 vegetable growers for 10 vegetables. Need to download data from baseline survey, virus and nematode surveys, and pest and disease survey. Millie Smith and local person will help. Activity 2: Collaborative on-farm research: Currently in progress: on-field trials (2 IPM packages with 12 cooperative farmers; 10 farmers with iDE-CODES and 2 with women's conservation ag group plus on-station trials (at RUA). Also, Training Workshops for a)*Trichoderma*, b) Diagnosis and management of plant virus diseases, c) Awareness workshop on S. American Tomato Leafminer, *Tuta absoluta.* There has been cooperation with Hort Innovation Lab and others:

  - Hort IL: collaborate on training activities and field trials -- candidates for participating in IPM trials at nethouses in the future, or at least derive info from their work
  - Con. Agr.: Testing IPM trials
  - RUA: training workshop and on-station trials
  - GIZ-ASEAN SAS: support Dept of Ag Legislation to promote registration/use/trade of BCAs
  - CODES: staff participation in trainings, joint IPM field trials, info sharing with Plant & Food Research (CODES partner)
  - GDA-PPSP: *Tuta absoluta* workshops
  - UBB: IPM-IL workshop training/participation
  - PDA-BTB: baseline survey in Battambang province
- Challenges:
  - Weather: no rainfall at beginning of season, but then too much at end
  - Baseline survey:
    - Farmers were occupied with rice harvest
    - Difficulty finding some famers in the sample
    - Questionnaire length and complexity

More detail on IPM Package Trials: Cucumber

- Aug 2016 – Oct 2016
- Treatments:
  - BAU: business as usual (= farmer's practice) - particularly uses pesticides
  - IPM package: healthy seedling technique (sowing media, *Trichoderma*, tray and insect exclusive net), yellow sticky traps, Bt, selective pesticides
  - Control: no pesticides
- Results:
  - Too much rain during growing season suppressed plant growth in general and caused damage due to waterlogging
    - Harvesting period was also shortened by waterlogging
- Expenses for cucumber trial:

    - General expense: around $0.55 USD/sq meter without depreciation and around $0.25/sq m after depreciation of inputs (plastic mulch, drip irrigation, trellis)
    - BAU additional expense: $1-1.5 USD more for growth regulators and pesticides on ~150 sq m
    - IPM additional expense: $30 USD for insect exclusion net, trays, *Trichoderma*, sowing media, yellow sticky trap, Cuelure, Bt, and fungicides
    - Control plots generally yielded the most, then BAU, then IPM
- Profit:
    - After depreciation of inputs: $0.3 USD/sq m for all three treatments
    - Without depreciation, no profit for all treatments but more loss for IPM package plots
- Important findings:
    - Nursery practice – BAU used only direct seeding or using banana leaf tray with fertile soil mix/cow manure; IPM included a sterile tray, cocopeat, *Trichoderma*, and insect exclusion net
        - Seedlings were far healthier in IPM trays – larger and less waterlogged, also less damping off
        - Pest and disease – Melon worm and white grubs; downy mildew, *cercospora* leaf spot, *Alternaria* leaf spot: *Send pics to Sally, send samples to RUA?*

Comments:

- Amer: using term "farmer practice" is a more consistent term rather than BAU
- Stu: could this information apply to the cucurbit family? → yes
- Moy: initially the IPM plots had fewer problems and then switched
- George: will timing of the growing cycle be similar in this year compared to other years? Kim Hian: the seasons were unusual this past year because they wanted to start in June, but there wasn't enough rain for planting crops; this delayed everything.
    - We don't have a survey to do this year, so reprioritizing and studying another crop might be good (cucumber in Feb, eggplant or bitter gourd in March, kale in October)

Future planning

- 2 villages (total), 6 farmers (per crop)
- Feb – Cucumber
    - Traps: fruit flies (quality Cuelure/Kairomone [elevated bowl with mashed cucumber, water, and one drop of pesticide]), Trichoderma; thrips, aphid, white fly: Protecting seed beds and early transplants is important – either netting or insecticides – after first few weeks the plants can get disease but still remain productive; Imidacloprid in soil after transplanting
- June – long bean
    - Package: certified seeds, sterile seed bed, Trichoderma, transplant,
- Oct – kale
    - Traps: DBM & web worms (pheromone)
    - Trichoderma
    - Nets, trays, coco-peat, Bt
- Scouting targets: web worm, diamond back moth, flea beetles
    - Periodic assessments, pheromone traps (Megan will bring over)

January 26: Field visit in the morning to two farms:

Prasath Bakong district: Poe Seng (farmer). Major problems for eggplant are white fly and leafhopper, and insecticide can control fruit borer. Started seeing white flies last month and uses a local insecticide once a week. Wilting and then plant death in some places; spread to other adjacent plants. Local market is very close, they transport with carriage on back of motorbike; drip irrigation comes from water in pond. Eggplant most profitable crop due to best price, long-term production

and stable price. He keeps his own seed for eggplant and bean (olny from healthy looking plants/ pods) and sells bean seeds $2.5/100g.; for other crops he buys from the market. Does not have access to Trichoderma; uses trays for some seedlings - from iDE; $1 cost to the farmer if he buys more. Uses a compost mix for seedbeds -- cannot afford coco-peat. Pod borer is major problem with long beans: pod borer (cannot be controlled with insecticide), sometimes aphids (can be controlled). Uses organophosphate and pyrethroid. It costs $6.50 for 350 sq m long bean plot. Sprays for ants and aphids. Market problems are the biggest barrier to expansion of this farm - inconsistent market prices.

Farmer 2: Has cucumbers with viruses and downy mildew. Has Kale with beetles and DBM. Coco-peat not useful for Kale. He uses mulching, and yellow sticky traps ad has an increase in yield as a result. He he occasionally spreays pesticides.

Afternoon: Planning meeting

Ed: we need consistency in the farmers we select, and we should choose farmers who are nearby to limit travel time

- Kim Hian: we can use farmers from the NZ project and women's group
    - Need 12 total
- Improvements from last year:
    - Separate control zone (BUA|IPM|Cont), only sampling from middle rows to reduce treatment drift
    - Interview farmers to find out what plots are the most time-intensive and about how much time they spend with each pest management practice
        - Series of retrospective questions or task-specific estimates
- Graham from NZ will send info on thrips and look into disease identification. Fayad stressed the importance of proper disease identification, especially regarding virus diseases and including appropriate management practices.
- Megan can come during the spring semester or as late as June – might need to bring traps/pheromones/pesticides

Pest tracking

- Planting → Pest measure → Harvest
    - Pest tracking every week
    - Use matrices for each farmer that include incidence of pests/diseases
        - Also severity ranking for disease
        - Example sheet (per farmer):

| | Quantity Week 1 | Severity | Quantity Week 2 | Severity | Quantity Week 3 | Severity | Final Yield |
|---|---|---|---|---|---|---|---|
| Pest 1 | | | | | | | |
| Pest 2 | | | | | | | |
| Pest 3 | | | | | | | |
| Notes | | | | | | | |

Cucumber (February)

- Key pests and diseases – scouting every week for:
    - Insects – fruit flies, melonworm, pumpkin beetle, thrips, aphids
    - Disease – downy mildew, cercospora, alternaria, virus
- Package:

- Cuelure (Ed will look for for Melon worm), imidacloprid drench after transplanting, chlorothalanil
- Ask Sally about fungicides for mildews. Copper?
-

Long beans (June)

- Key pests and diseases – scouting every week for:
  - Insects – *Maruca vitrata*, aphid, leaf hopper, mites, thrips, stink bug
  - Disease – bean rust, angular leaf spot, virus
- Package:
  - Certified (virus resistant) seeds, Trichoderma (soil, transplant drip), transplant, *Maruca* pheromone trap, imidacloprid drench, trap crop (crotalaria)

Kale (October)

- We can wait to arrange the details of this later

Other notes:

- Crotalaria trap crop could be a component technology(?) and tested by a thesis student at RUA
- New trials with root grafting
- How do we scale up? How do we spread information to growers? We need to partner with other projects:
  - Ed: Ricky Bates from gender project (Women in Agriculture Network (WAgN) is coming in two weeks and is interested in integrating packages
  - Harvest project
  - CE
  - PPSP – We gave Tuta pheromone traps already in the workshop. PPSP has responsibility for monitoring and early detection of Tuta.
- Diagnostics; Capacity building
- Might do eggplant experiment in 2018

*January 27*: Concluding meeting at iDE:

- Discussed how to expand technologies to RUA students, especially students supervised by our plant pathology and entomology collaborating faculty
- Cristina: Kim Hian should collect samples of leaves showing viral symptoms and we can provide identification later; we can send tubes and solutions for nucleic acid preservation (RNAlater) that can be used to store the collected samples and can be sent back to the US for virus identification.
- Ecological studies are costly but useful, USAID could benefit from research
- Future student projects (RUA):
  - Crotalaria trap crop
- Data analysis: George might hire undergrad students to help
- Cambodian Department of agricultural legislation is under MAF and they are collaborating with GIZ on pesticide regulation and drafting appropriate legislations.
- Build in another workshop on biocontrol agents/Trichoderma
  - Depends on the budget listed for next year
  - Fits into the fifth objective of the workplan
- There should be a skype session call scheduled (8PM/AM) once a month
- Kim Hian will hire another person to help record data from field trials.

Fayad, Norton, Heinrichs, Rajotte, and Rosa flew to Bangladesh, arriving at 8:30 pm.

*January 28:* Team met with Bangladesh Site coordinator Yousuf Mian in Dhaka who discussed several issues. Yousuf described current state of the Tuta infestation in the Northwest. He also will need some interactions with Sally on country bean diseases. He worries that it is getting harder to bring farmers to field days without paying them to come. Yousuf would like an MOU between BARI and DAE for transferring IPM IL technologies, but is also concerned that the IPM IL does not have an MOU with BARI (We do have a letter of commitment from the previous BARI DG). He says he needs a power supply unit for when the power goes off, which he was told by Norton that he is authorized to buy with his supply money. Yousuf said that the new BARI Director would prefer it we gave up the IPM IL office space and that is one reason he would like to have an MOU. Norton then met with graduate student Sadique Rahman to discuss his thesis progress.

*January 29:* The group travelled to BARI in Gazipur for a planning meeting at the Horticultural Research Center. Director of Support Services for BARI chaired the session in which Yousuf Mian gave a welcoming address and remarks were given by Dr. Rezaul Karim, former IPM IL Director for the Bangladesh site, Dr. Norton, the new Director of the HRC, and the BARI Director of Training and Communication. The meeting was attended by 28 BARI scientists, including nine women. MCC, DAI, and CNFA were also represented.

Dr Shahadath Hossain presented the results of the mango fruit fly (bagging) trial and the tomato leafminer (Tuta) monitoring. Dr M.S. Nahar presented the results of the Country bean research. She presented data on use of tricho-compost. She says that TC also controls Ralstonia to some extent. Dr. M.A. Goffar discussed the results for the IPM package on summer tomatoes and rootstock experiment for bacterial wilt. Dr. M.A.T. Masud presented the results for the IPM package on bittergourd. Mr. Sadique Rahman presented some results on the economic impacts of IPM on brinjal, tomato, and all vegetables. Brinjal has lower cost for IPM but the same yield. Tomato IPM has a higher yield and lower cost. There are higher net returns for IPM on all vegetables.

Mr. Serajul Islam of the DAI run USAID Ag Value Chain project described how it works in the southern part of Bangladesh to strengthen markets commercialize technologies. Mr. Syed M. Huq of CNFA described how it had developed the Agro-Input Retailers Network (AIRN), which is a private extension network, an advising service for retailers and famers. It has 3000+ retailers. They do training and distribute fact sheets. Each retailer has 200 farmers. A representative from the NGO: MCC described how it transfers IPM IL technologies to marginal, mostly tribal, farmers in the northern part of the country. MCC has worked with the IPM CRSP and IL since 2005 and also with GKSS. Dr. Nahar gives MCC inoculum for Trichoderma every 2 months. Their farmers produce about 150 - 200 tons of tricho-compost per year. They currently work with 550 farm families. They produce pesticide free vegetables. They use pheromone traps, neem, and tricho-compost and sell vegetables in a supermarket after processing and packaging. They use an “organic village” brand but are not certified as organic.

Future planning with BARI scientists – Bt eggplant experiment went in the ground on Jan 20-21. They use grafted Bt eggplant seedlings. They are using pheromone traps for surveillance of Tuta. Mango hopper experiment is underway. While mold research on country bean continues and are conducting two trainings of 100 people each on Tricho-compost. They are continuing with grafting research and summer tomato trial. Suggestions were made by our team to introduce untreated controls in farmers’ fields to measure the pest pressure and the efficacy of the IPM-package vs. farmer’s practice in the bittergourd experiments. Other suggestions were to set up the experiments to have a replicate in each location.

*January 30:* Rajotte, Rosa, and Heinrichs went with Dr Shahadath Hossain to Jessore to observe the field trials.
The IPM-IL group observed two fields where *Bt* eggplant experiment went in the ground on Jan 20-21. Transplants were young and were still having the clips used to support the grafting junction. One of the two fields experienced drought and many transplants were dead and needed to be replanted. The treatments consist of BT eggplant +IPM and Non-Bt eggplant + IPM. Visited Tuta monitoring site. So far no Tuta have been detected in traps at this site but have been detected in Bogra area. Visited BARI-Jessore station experiments in the pm. Observed vegetable IPM experiments being conducted by non-IPM IL collaborators. Met with the Director of the Jessore station. Bangladesh is unique in that it has approved field trials of transgenic eggplant. While the transgenic plants promise to control a key pest, eggplant fruit and shoot borer, other pest insects and diseases will not be affected. The success of Bt-transgenic technology in this crop depends on its being a part of a comprehensive IPM approach. During the afternoon the IPM IL team observed various field experiments at the BARI research station in Jessore including other IPM component and package research being done by other scientists. The team returned to Dhaka in late afternoon.

Norton, Fayad, and Mian met at USAID with Matt Curtis and M. Shibley to discuss the IPM IL Asian vegetable and mango IPM program. Each component was summarized by Norton, Tuta was discussed, and Matt Curtis said that one key plant disease issue now in Bangladesh is wheat blast. Tim Krupnik of CIMMYT is working on it. Matt suggested Mian connects with Krupnik and attend their meetings.

*January 31*: IPM IL team flew to Nepal. Met with iDE Director Luke Colavito. Luke discussed the iDE program to help address Tuta and he is hoping that other donors will help support the effort. The next tomato season is April to December and they have student interns helping to survey losses due to Tuta and what farmers are doing. Luke said that the PAHAL project has been terminated for iDE due to leadership issues on the project within the prime contractor, Mercy Corps.
He said that the IPM IL has reached 67,000 households totally and has supported 100 Community Business Facilitators (CBFs).

*February 1:* Planning meeting at iDE office: Lalit Sah, IPM IL veg project coordinator for Nepal, welcomed the IPM IL group to the meeting which was attended by representatives of NARC from Entomology and Plant Pathology departments (S.N. Mahto, Chief Plant Pathology Division), Plant Protection Division (Dilli Ram Sharma), CEPRED (K.D. Joshi), Tribuvan University (Jha) , AFU, and several others. The new Secretary of Livestock and former DG of the Department of Agriculture, Dr. Yubak Dhoi G.C., also participated briefly. Luke C. gave a powerpoint overview of the IPM program in Nepal. Only 20% of Nepal's Agriculture is marketed with the rest consumed in the household where produced. He ladid out a scaling up strategy that involves working through CBFs, collection centers, projects such as ENBAITA, and Learning Centers with demonstration sites. Of the 67,000 households reached thus far, 2300 are in the IPM IL site areas, others in related project sites. Each CBF sells about $400 per month in products (CBF keeps 10%). There was discussion of Tuta. iDE has done rapid solution testing and needs to verify technologies.
Current trials in the field include onion, French beans, chllis and okra. Also, 2 students from HICAST who are working in the field on thesis topics. One student is conducting a survey of Tuta and finding it causes 25-30% loss (100% without management). For Tuta, the trial includes light traps, neem, and Emamectin Benzoate every other week to achieve 80-90% control. Several other practices being tested. There is a PPD/DOA Task force on Tuta. One Nepal scientist stated that there is less damage in open field conditions than under plastic. The World Bank has recently funded the PPD to implement SPS standards, including for tomato and PPD will do a nationwide compliance survey. Plant Path Dept head feels a need to use more TV to promote Tuta Mgt. One NARC scientist is

working on Tuta (predators and parasites). The new Secretary of Livestock (Dhoi), who formerly also headed IPM in the country, feels that Bt and NPV will help along with parasitic nematodes.

For next year there will be an expansion of the Tuta verification and trials. There will also be more work on bittergourd and cucumber fruit flies, eggplant FSB, and tomato pith necrosis. There will be a paper to highlight economic losses due to viruses. Netting for plastic houses and biopesticides to manage Tuta were identified as priorities for trials. Task force for Tuta needs to be more active. Sharma says that there will be an intensive survey for Tuta in 75 districts.
For onion, need to focus on purple blotch, thrips and downy mildew. CEPRED says there needs to be a resource center for products. Dr Jha from Tribhuvan University says the climate change and biodiversity project is studying how to manage invasive species. Plant Path Dept Head of NARC says that more extensive surveillance of viruses and training in virus diagnostics are needed; he also noted that more formal collaboration should occur between NARC and the IPM IL. PPD director Sharma says that there is a problem of lack of demand for IPM products.

IPM IL team flew to Nepalgunj, joined by two NARC representatives, CEPRED, Tribhuvan rep, and PPD Director. Much of the visit there was led by Yubral Dhakal, who works for the IPM IL program. We visited an Agr-input wholesaler who supplies 16 districts with products including IPM products. He has trained 130 CBFs and partners with companies in Kathmandu to get his supplies such as *Trichoderma*, Pseudomonas, lures. Sold $3500 in IPM products last year but IPM products are less than 1% of his sales.

Checked into hotel and Norton met with Arjun Khanel to discuss his thesis (impact assessment) progress.

*February 2:* Field visit to Surkhet village. Farmers' group there since 2011 and used IPM since 2014. Switched from subsistence to commercial farming. Have confidence in IPM practices and each farmer has 100 meters, 50 with IPM and 50 without. One farmer is CBF with 100 customers. Sold $1000 worth of IPM products last year. CEPRED is using the Learning Center in the village to test IPM and train farmers with the KISAN project.

Visited Agrovet Mehlkum – His sales grew of biopesticides by 20-30% since the KISAN project began. He attended the virus workshop and other training. He likes the CBF model and works with 4 of them. 1200 kilos of *Trichoderma* sold last year. Took him 5 years to build up his business.

Another farmer group was visited, mostly women. For brasscias they use biopesticides and pheromone traps for Spodoptera. For Tuta uses light and water traps and yellow sticky traps. We saw only modest damage from Tuta but it was present in a field of 5-month-old tomatoes.

Visited veg Collection center in Surkhet. $22,000 in sales last year. 300 households in center and switched from pesticides to IPM last year due to the danger. Two CBFs in the service area.

*February 3:* Visited women farmers and research trials in Banke. Observed French beans, onions, bittergourd and tomatoes. Saw net house for tomatoes.

Flew back to Kathmandu and in the afternoon, held planning session at iDE. Discussed Tuta IPM practice verification trials in greenhouse, open field, seedbed and nursery. Protocols developed which Lalit will send us after the visit. If no Tuta, need to monitor. Package includes Tuta exclusion on transplant seedlings, removing and burning or burying old crop residue and mass trapping prior to planting in 12 X 6 greenhouse. Can use mini-green house for control. Apply Bt as soon as you see moths in traps and twice more a week apart. Use light traps and pheromone traps. Only spray if Tuta

in traps. Once Tuta is seen inside the leaves, squash them. If severe, apply Coragen® (chlorantraniliprole). Need to add pollinators or shake flowers in greenhouse. At the seedling stage, use a trial with and without net. Want to cluster households if possible. Data should include incidence and severity and students should score other pests and diseases as they could be affecting yield as well.

Luke says that IPM IL can collaborate with the IPM IL Climate Biodiversity project by placing exclusion houses at various elevations if they are in the same area and they pay for materials. Otherwise, our project can invite them to training. NARC could do simple component trials as well.

February 4: One HICAST students joined the group, Aasha Lamsal and one AFU student, Divya Joshi, who are interning on the project. Also, Ajay Pratap Giri attended who works as a program officer at iDE joined the meeting. Divye works on Tuta practices and Aasha on biorationals for Tuta.

Discussed chilli plan protocol. Need to gather data on all inputs and labor along with weather station data. Lalit will send us the protocol discussed. Discussed the design of the ASD and Lalit will send it to Sally. We discussed the protocol for fruit fly trapping for cucurbits (cuelure and pumpkin, cuelure and protein bait, etc.).
They also reviewed their plan for French bean IPM trials. Fayad questioned their intent to use a herbicide and stressed the importance of using only approved pesticides; the team agreed to remove the herbicide from the list of components. The team also reviewed the planned activities for onion IPM trials.

Perhaps there are too many trials in the plan and we discussed dropping pith necrosis tomato trial and FSB eggplant trial.

iDE preparing posters on Tuta identification and management.

*February 5*: Heinrichs, Norton, Rajotte, and Rosa arrive in the U.S. and Fayad arrived in Senegal.

**Suggestions, Recommendations, and/or Follow-up Items**:

- Formalizing a simple framework for collaborating with PPSP in Cambodia was requested by PPSP.
- Need to plan to give lectures at RUA during future visits.
- Need more regular group Skype sessions (once a month?) with Kim Hian 8:00 am/pm
- Kim Hian should take viral samples and we can provide identification later; we can send tubes and liquid for preservation of evidence
- Need to send CE SAIN a fact sheet for every package
- Future student project (RUA): Crotalaria trap crop
- Kim Hian will hire another person to help record data
- Yousuf Mian will purchase a Power Supply Unit
- Lalit Sah in Nepal will send revised protocols that we discussed
- Set up thrips kairomone evaluation with kairomones obtained from New Zealand.

**List of Contacts Made**:

| Name | Title/Organization | Contact Info (address, phone, email) |
|---|---|---|
| Seng Kimhian | IPM IL Coordinator, Cambodia | skimhian@ide-cambodia.org |
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