

Trip Report

Countries Visited: Bangladesh, Nepal, and India

Dates of Travel: January 28 to February 16, 2010

Travelers Names and Affiliations: Ed Rajotte (PSU), George Norton (VT), Sally Miller (OSU), Doug Pfeiffer (VT), Maria Elisa Christie (VT), R. Muniappan (VT), Bob Hedlund (USAID AOTR)

Purpose of Trip: IPM CRSP South Asia Program Planning

Sites Visited: Gazipur, Bangladesh; Kathmandu, Nepal; and Coimbatore, Ooty, and Trichi, Bangalore, New Delhi in India.

28 January 2010

Travel to Bangladesh

Bangladesh: Annual Meeting

30 January 2010

US Team arrived in Dhaka

Met with Dr. Karim in the evening to discuss schedule for coming days and strategy for upcoming meetings.

January 31, 2010

Team meeting at BARI (Bangladesh Agricultural Research Institute)

- Introductory comments were made by Dr. George Norton
- Dr. M. Z. Abedin (IRRI representative for IRRI) Commented that Global warming is a very serious issue for Bangladesh. Agriculture contributes to this and to health issues by overuse of pesticides. IPM is important for reducing pesticide use. Asked that researchers look beyond production side and see how end users are affected.
- Dr. Bob Hedlund commented on the history of the IPM CRSP and the enthusiasm of the scientists at BARI and other institutions.
- Dr. Wais Kabir (Executive Chairman, BARC) welcomed the gathering.

Review of progress

M. A. Hoque gave an overview of IPM Activities in Vegetables

Resistant/tolerant vegetables varieties:

Eggplant: BARI Begun -6, -7, -8, -9, -10 are resistant bacterial wilt and jassids; moderately resistant to FSB)

Pumpkin Mistikumra-1 and 2 are resistant to viral diseases.

2008-2009

1. Development of virus-resistant pumpkin lines:

WMV-2 and Papaya Ringspot Mosaic Virus

2. Development of virus-resistant cucumber lines: seven lines are promising, of which CS 0079 and CS 0080 were selected

3. Pod borer and YVMV-resistant hyacinth bean

4. Okra varieties resistant to yellow vein mosaic virus were screened, of the 75 lines
4 lines selected

Varieties with virus resistance were released to seed companies for seed multiplication and sales to farmers. Virus resistance is based on field screening results; several years ago Masud identified PRMV and WMV-2 as the dominant viruses by ELISA. These tests have not been conducted recently. Facilities are not available to test resistance in isolated inoculated trials. USAID ABSP2 also providing funding – for BT-transgenic lines of brinjal. FSB infestation was found to be 3-4% - 40% in the transgenic lines. Non-transgenic resistance in BARI Begun-6 was 18-20% (winter), 20-25% (summer). Don't know how long BT-brinjal trait will persist in the field. There is a need to promote refuges with non-transgenic brinjal. In India, cotton farmers are not following these rules, so it is unlikely that Bangladesh farmers will be willing to do this for brinjal. BT-resistant varieties can be tested in brinjal IPM package in farmer fields after the lines are released. Still need to go through the regulatory mechanisms. It may take about 2 years and on-station trials could start in the next season.

IPM Activities in Plant Pathology: Drs. Shahabuddin Ahmad, Shamsunnahar and Rahman

1. Summarized screening results for RKN and BW in tomato and eggplant.
 2. Surveyed diseases of summer tomatoes under polytunnel - 12 locations and 30 fields.
BW, black leaf mold (*Pseudocercospora*) and RKN most abundant; TYLCV and TSWV are common.
 3. Nematode - a soil-enrichment indicator (nematode trophic groups); this area of research was initiated during Dr. Shamsunnahar's Ph.D. sandwich program at OSU (supported by IPM CRSP) and is an important advancement for South Asia.
Compared IPM and non-IPM system;
Treatments with poultry refuse, mustard oil cake, vermicompost, neem oil cake, cowdung, and *Trichoderma* increased beneficial nematodes and reduced plant feeders compared to the artificial fertilizer.

IPM system reduced harmful nematode populations.
 4. Tricho-compost and effectiveness
T. harzianum, *T. virens* – poultry refuse, cowdung and barley + sand, Water hyacinth, poultry refuse, molasses, etc. carrier.

Trichocompost significantly increased yield over non-treated for several vegetable crops.
- Muniappan mentioned reports of *P. fluorescens* combined with *Trichoderma* in the field to control RKN. Asked whether this could be tested?
- Muniappan said that Naidu will test for TSWV if FTA card blots were sent. Permit is good until Sep 2010.

Insect Pest Management - Dr. S. N. Alam

1. Mite problem increasing as a result of overuse of pesticides

Eggplant>cucumber>aroids in the order are susceptible to mites.

2. Biological control

Bracon hebetor is an aggressive parasitoid that is reared on wax moth larvae. Wax moth larvae are reared on artificial diet.

Green lacewing mass reared in the laboratory.

Trichogramma; mass reared on rice moth eggs.

1 g parasitized eggs (80 Taka)/hectare/week is effective in control of *Spodoptera*. Population of *Spodoptera* is increasing due to climate change

3. IPM Packages

Country bean

aphids, pod borer complex

Hand-picking infested flowers and pods

Community approach

Weekly release of two parasitoids

Spot spraying of soap for aphids

Significantly less insect problems in IPM than insecticide spray plots

Cabbage and Cauliflower

DBM, common cutworm

Hand-picking

Release of parasitoids

Tomato

Hand-picking

Parasitoid

ToYLCV and whitefly-resistant lines

Cucurbits – fruit fly

Area wide trapping was carried out 20.5 Ha in 2004 and 350 Ha in 2009

Trap catches reducing fruit fly population in the fields

Other problems: *Spodoptera* and pumpkin caterpillar

IPM programs publicized in television programs and 73 news articles; 12 articles during 2008-09. The IPM packages are shown on BTV for 5 minutes each week.

Support from several agencies has been received. Regional cooperation with Vietnam, Nepal and Sri Lanka is being maintained.

Private companies are also participating in the program. Isphanti, a large tea company has adopted the parasitoid rearing methods of IPMCRSP, and they have established their own rearing facilities. Biocontrol agents are distributed to client farmers. The U.S. company, Farmatech, continues to sell fruit fly pheromone (Cuelure) in Bangladesh. IPMCRSP has been a major factor in establishing a South Asia market for this company.

Problems:

- Insufficient budget
- No funds for promotional activities

Suggestions:

- Increased sandwich programs
- IPM CRSP should arrange regional workshop in Bangladesh

About 3,000 hectares are under vegetable IPM now. About 8-10 farmers are in a hectare.

Abedin (IRRI) commented on the need for wider adoption of IPM and also the need for more focus on marketing aspect. IPM products are being lost among the non-IPM products. Separate sales of IPM products are needed to secure better prices. Also he proposed that IPM CRSP work together with small homestead farmers project to increase the impact.

Impact Assessment of IPM CRSP-BARI technologies – Dr. Alamgir Hossain

1. Tricho-compost

- Yard-long bean, okra, cucumber, eggplant; 60 non-IPM and 60 IPM (15 per crop) are being examined.

Mennonite Central Committee Bangladesh (MCC) is involved in technology transfer.

Technologies for Transfer

- POULTRY REFUSE
- MUSTARD OIL CAKE
- Different composts on eggplant

Training and Workshops – 2009

Workshop on Pesticide Free Vegetable Production – 487 participated

Demonstrations – 2009

Poultry refuse in seedbed

Hand picking

Sex pheromone traps for BFSB

Sex pheromone traps for CFF

Limited hand weeding

Tricho compost preparation – MCC training farmers to prepare this compost.

MCC also did economic assessment and showed that use of these technologies increased yield and income. Some problems – lack of market differentiation between non-IPM and IPM technology. MCC is planning to extend the extension efforts further and trying to find funding.

US Team Presentations

Muniappan presented an overview of the IPM CRSP – “the key to green agriculture”.
Ed Rajotte presented an overview of the IPM CRSP South Asia program.
Sally Miller presented an overview of the Diagnostics Global Theme program.

Monday, February 1, 2010

Sally Miller presented an overview of the Virus Global Theme program (for Naidu Rayapati).

Maria Elisa Christie presented an overview of the Gender Global Theme.

George Norton presented an overview of the Impact Assessment Global Theme.

Planning Meeting

Packages – can the list of crops and technologies be streamlined? Maximize similarities between crops.

1. Tomato – summer (needs a lot of work) and winter
2. Eggplant – can go to farmers with season-long program
3. Cucurbits (gourds and cucumbers); for some crops packages are ready, others need research.
 - Season-long package ready for bitter, sweet (pumpkin), ash and teasel gourds
 - Cucumber and pointed gourd need research
4. Okra
 - Research needed
5. Cabbage/cauliflower
 - Packages are ready for the field
6. String bean
 - Needs research
7. Country bean
 - Have some mature technology but need some work –promotional work can be started

Dissemination of packages

- Need to work with extension service and NGOs to provide technologies.
- DANIDA project – only expanding technology in FFSs; to train farmers and set up small experiments; train farmers in producing their own biocontrols e.g. ladybugs
- IFAD funded Climate Change project – focused on producing vegetables in coastal areas; interested in collaborating with IPM CRSP – build capacity in IPM

for their trainers (3 locations in coastal area); project staff can come to BARI for training.

- BARI Farming Systems group – disseminates BARI technology throughout the country. Works with NGOs and DA to some extent.
- MCC
- Publicity – N. Alam has:
Good relationships with government-run television
Programs come to BARI for content
12 other channels – all have agriculture programs once a week.
Channel 1 has agriculture program 6 days a week. It will publicize IPM packages free.
IPM CRSP could arrange to bring farmers from different farming communities to one place for a farmer's field day – farmers take information from other farmers.
Farmers Exchange Visits to regional meetings in which farmers talk with each other. Data need to be collected on come back from these (when farmers take technology back and apply it). Collaboration with BARI Farming Systems group, Climate Change, MCC, etc is encouraged.

Alam – scientists must be involved in training to make sure packages are put forth properly. Trainers must be knowledgeable.

- It is necessary to write a dissemination plan for mature packages. Think in detail about how this will be done. Ask projects to propose how the dissemination will be done.
- Keeping records of information on economics – budgets, etc is important.

Components

Trichoderma production (Rahman) – Production of Tricho-compost will continue in BARI and with NGOs. Dissemination: Further development of partnerships with NGOs and training in *Trichoderma* production need to be provided. It will take one or two years until production goes out to NGOs exclusively.

Continuing research: On rate of compost application; also may need testing in soils of different composition e.g. coastal soils

Biocontrol production (Alam) – Research continues on biocontrol agents for *Epilachna* beetle (parasitoid mass rearing research); Leaf miner (*Liriomyza*) – research needs to be started on parasitoid identification and mass-rearing. (Rajotte) Reduction of pesticide use may reduce the leaf miner incidence and increase parasitoids in the field.
NPV for *Spodoptera* and *Helicoverpa*. Muniappan mentioned the need for staff to be trained in NPV production. Alam said one staff member was trained 6 months at TNAU for NPV research. Papaya mealybug – could do a survey with IPDN funds.

Tuesday, February 2

Special Global Themes Projects

Baseline survey (G. Norton)

Survey instrument in development

300 farmers in Jessore, Comilla, Bogra and Narsinghi will be surveyed.

50 questions – key ones relate by crop to farmer perceptions of pests and IPM practices (using or not), pesticide usage; factors that influence adoption.

Four enumerators including one female so that women can be asked.

It will be done by November 2010 including data entry.

Another survey will be done in 2013

IPM Packages

Budget form needs to be completed for each.

IPDN development

Workplan must be accomplished.

Need to work with the virus global theme.

M. Rahman will be the coordinator for Bangladesh.

Virus Capacity Building

Gender Activities workshop

Training needs

Discussion about what is the point of making the list since there does not seem to be enough funding to cover the training.

The salaries of Bangladesh government employees have increased 80-100%; per diems and hourly wages have also significantly increased. This causes difficulties with the budget of the IPM CRSP.

Nepal

Thursday, February 4, 2010

Field trip to Salyan (Lalitpur district)

We met with the “Active Women/Sisters Organization, a local cooperative producing vegetable crops for increased livelihood. This group has 37 women members who farm 4.5 hectares. Most of these women are the principal farmers in the family as males are working off farm in the city or abroad. These women farmers were using IPM CRSP technology – pheromone traps, biofertilizers and biopesticides. We visited the on-farm plot where a cabbage clubroot (identified as a major problem) trial with these inputs was established.

Field trip to nursery operator

In Lalitpur district trained by the Department of Agriculture in cooperation with IPM CRSP in tomato grafting, the farmer built a graft healing house and has started making grafted seedlings with *Solanum syssimbrifolium* rootstock. Nurseries are getting 8 rupees/grafted seedling.

Met with officials in Ministry of Agriculture,

They are cooperating closely with Nepal IPMCRSP project.

Friday, February 6, 2010

Meeting with USAID

We met with Bill Patterson, Director, General Development Office. He stated that Nepal was chosen as a Food Security Initiative country and could expect extra U.S. investments. However, he was not sure what the process would be. We should keep watching the mission web site for announcements. He also noted that in the future we will need to notify the Embassy in advance of any visit to Nepal.

Review of past work 10:00 am – 5:00 pm

Overview by Luke Colavito

Project results – B.K. Gyawali

1st phase successful technologies

Technologies from Bangladesh

- Soap water (in traps) better than insecticide in pheromone traps and Delta Sticky Trap for fruit fly trapping in cucurbits.
- Mashed sweet gourd in combination – as a food lure for fruit flies. Works better than alternative; handed over to DA
- Grafting technology – tomato and eggplant
Good result and minimizing cost of pesticide use
Graft house developed by NARC < \$100
92% survival rate (NARC)
NARC also set up environmental parameters
- Root stock *Solanum torvum* – takes too long to establish; others from AVRDC are not resistant to RKN; Using EG203, EG195, HI 7996
- Farmers getting 44.5% increase in yield in eggplant and 65% increase in yield in tomato by grafting.
Fruit fly identification
Seven species have been identified in Nepal.

Coffee IPM

- White stem borer problem

Cross vane traps with cwsb lure are used. Pheromone from India did not work in the beginning and by changing the height of pheromone traps to 4.5 ft, it worked.

Biofertilizers and bio-pesticides + micro-irrigation

- Best yield in tomato with biofertilizer + biopesticides package/ higher profit.
- Organically approved
- Tea quality also improved
- Farmer practice is heavy pesticide use

Biofertilizer – N-fixing bacteria (Azillosporom), P-solubilizing bacteria, VAM, Bio-hume (humic acid + micronutrients) (all from India)

Biopesticide – compost (cow dung + farm waste) + *T. viride* (better in slightly alkaline soil) ½ + *T. harzianum* (effective for acidic soils (1/2)(from India) + *P. fluorescens* + *Bacillus subtilis*; spray

Phase 2

Crops

- Brinjal
- Tomato
- Cucumber
- Cauliflower/cabbage
- Coffee
- Tea

Districts: Terai and Rupendehi

Technology proposals:

- Pheromones
- Bio-fertilizers and bio-pesticides
- Bagging – from SIMI
- Mulching – from SIMI
- Soil solarization – from SIMI

16 elements required by the plants as nutrients (high yielding varieties require a high level of nutrients) – nutrient deficiencies are a problem. Chemical dealers prescribe pesticides for nutrient deficiencies.

pH is critical – nutrient availability and disease management; high pH needed to control clubroot in cole crops

Overviews of IPM CRSP Phase IV (Phase II in Nepal)

IPM CRSP - Muniappan

IPM CRSP South Asia – Ed Rajotte

IPDN and Virus global themes – Sally Miller

Gender global theme – Maria Elisa Christie

Impact Assessment global theme – George Norton

Videos

Viewed a video of set up of cabbage trial.

Viewed a video of tomato grafting training in Terai (Rupandehi district).

Packages developed for tomatoes, cucurbits and tea

See below

Economic data needed

Enterprise budget

Record costs common across treatments

Record yields

Record price received by farmers

George will send common template

Priority Crops

1. Tomato

Pests

Root Knot Nematode (RKN)

Bacterial wilt

Fusarium wilt (sporadic)

Bacterial stem rot

Late blight

Whitefly

Tomato Yellow Leaf Curl Virus (whitefly vector)

Tomato Mosaic Virus (mechanical/seedborne/aphid(?))

Cucumber Mosaic Virus (aphid)

Tomato Spotted Wilt Virus (reported but not a problem)

Leafminer

Fruit borer (*Helicoverpa armigera*)

Alternaria leaf spot/early blight

Septoria leaf spot

2. Cucurbits

PESTS

Fruit fly

CMV/virus (aphid transmitted)

Red (2-spotted) spider mites

Downy mildew

Powdery mildew

RKN

Fusarium (fruit)

Aphids

Red pumpkin beetle

Cole crops

Chilis – hot

Eggplant

Tea

Pests

Mites: Scarlet mite

Tea mosquito

Thrips (black thrips)

Blister blight (Exobasidium)

Fusarium wilt

Coffee

Potato

Maize

Build an IPM Package – IPM CRSP South Asia (Nepal)

See Appendix

India IPM CRSP Phase IV

February 7, 2010

Arrived in Coimbatore February 7, 2010 about noon (delayed in Delhi by late flight – overnigheted in Bangalore)

2:00 pm Introductory Meeting in Tamil Nadu

G. Karthikeyan, Virology,

C. Durairaj, Entomologist

R. Samiyappan, Director, Center for Plant Molecular Biology (plant pathology)

K. N. Selvaraj, Professor of Ag Econ, Head of IPR Cell

K. Angappan, Center for Plant Molecular Biology

V. Udayasuriyan, Head, Dept. Plannt Molecular Biology and Biotechnology

S. Mohankumar, Entomology

Nutan Kaushik, TERI, Plant Biotechnology (NGO)

US Team: Bob Hedlund, George Norton, Sally Miller, Ed Rajotte, Doug Pfeiffer, Maria Elisa Christie, Muniappan,

Introductions

Chair – S. Mohankumar

R. Hedlund, remarks

R. Samiyappan:

TNAU very famous for biocontrol of insects and diseases

P. fluorescens marketed throughout India (90% market share)

Major emphasis will be given to diagnostics in this phase of IPM CRSP

G. Norton, remarks

Progress Report

S. Mohankumar; program began in June 2002

Activity 1. Evaluation of CryIAb transgenic eggplant resistant to BSFB (developed by IARI, New Delhi)

Phase 1. Evaluated transgenic cryIAB plants in the field at Coimbatore; 45-65% reduction in damage.

Mini participatory appraisal with farmers; price fluctuation one of major factor in IPM adoption, especially in tomato. Price is high in summer – make lots of money with good crop. Virus problem very severe.

Phase 2. Tested transformed brinjal with cry2Aa gene (w/ Greg Welbaum, VT);

Conducted national symposium on transgenic crops in pest management; trained three scientists from Bangladesh; sent three cry proteins to Bangladesh and Philippines

Work led to involvement in ABSP II

If Feb 10 decision by government is favorable, will release Mahico transformant. *Note added in report: The Indian government placed a moratorium on release of Bt-brinjal until further studies are completed.

Phase 3.

Evaluated cry2Aa gene at greenhouse level – selected two plants from 42 transformants (#4 and 6);

IPM Field Trials

IPM field trials for BFSB and yellow vein mosaic virus of okra – seven trials, variety evaluation + seed treatment with *P. fluorescens*, neem cake soil amendment; + yellow sticky trap + foliar spray of NSKE (neem seed kernel extract) 5% + foliar spray of fish oil rosin soap (FORS) + *Trichogramma chilonis* + coriander as food source (nectar) for *Trichogramma* parasitoids); other treatments minus one individual treatment at a time (NSKE and fish oil rosin soap against sucking pests): Full IPM, and IPM minus *P. fluorescens*, neem cake and yellow sticky trap all very good control of *L. orbinalis*; Minus NSKE, FORS, *Trichogramma* and intercropping less effective (probably ineffective).

Farmers want ready-made formulation of NSKE – this one requires a lot of labor – being used by organic farmers but others don't want to use it. Many technologies are available but need to be formulated, scaled up and commercialized.

Bacterial wilt not a problem in Tamil Nadu; grafting technology demonstrated here but not used. *S. torvum* resistant to a mite. (*P. fluorescens* + *Paecilomyces* controls RKN (TERI)). IPM practice is better than farmers practice in brinjal.

Looked at insecticide resistance in *Bemisia* and *L. orbinalis*. Resistance was found in field to all of the insecticides.

RAPD marker profile of whitefly: Did find variable markers but now repeating with SSR markers. Am. J. Biochem and Biotechnol 5: 40-46 (2009).

Phase 4.

Trained vegetable nursery producers in grafting (but adoption rate is zero since bacterial wilt is not a problem).

Characterized whitefly population using 16S primers and mitochondrial genes.

Ghandi Karthikeyan - IPM for thrips-borne tospovirus July 2008-Sep 2009

Focused on Peanut bud necrosis virus (PBNV) in tomato

Objectives:

Document new virus problems in vegetable systems

Samples blotted on FTA cards and shipped to Naidu

Papaya ringspot virus on pumpkin

Chili veinal mottle virus on chili and *S. nigrum* (805% homology with chili strain)

New virus on bean different from bean common mosaic by RT PCR with degenerate primers

Evaluate tomato cultivars – 15 cultivars against PBNV and TLCV

None resistant to both

A few are “tolerant”

‘Abhinav’ most resistant (13% incidence) in two locations

- quality not acceptable to farmers because it is not sour and cannot be used for chutneys, etc. (TERI)
- Cooking types preferred in market
- Variety preference occurs at market level

Yield did not correlate with resistance

No significant differences in thrips populations among varieties

Effect of roguing (symptoms appear in seedlings)

Removed infected seedlings at the time of planting

90 DAT, 18% rogued vs. 50% unrogued; 44% increase in yield

Next phase – more training will be given to educate nursery growers
Government promoting nursery production by farmers; now using shade netting but screen not insect-proof
60 paise/seedling (1 paise = .01 rupee)
Management of nurseries is by males – most of workers female
Need to educate nursery growers
In next phase need to evaluate different size and types of screens to prevent insect pests
No differences between test sites or varieties

Seed Transmission of Tobacco Streak Virus (TSV) in okra
Symptoms on seedlings and fruit but not in between
Percent transmission 0 – 29% in seeds from different areas
Next phase – identification of the virus source

US Team presentations

Muni – IPM CRSP
Ed – IPM CRSP South Asia site
Sally – IPDN in South Asia

February 8, 2010

9:00 am

US Team presentations (cont.)

Sally – Virus global theme
Maria Elisa – Gender global theme
George – Impact assessment global theme

S. Mohankmar TNAU team efforts

South Asia Regional IPM program Phase IV (2009-2014)
Theme: Promotion of IPM for safe vegetable cultivation and consumption
Collaborator: TERI

Target Crops

Tomato
Eggplant
Okra
Chilies
Onion
Cole Crops (cabbage, cauliflower)
Cucurbits
Under exploited vegetables

Research Approach

Participatory Appraisal

Package development

Collaborative research

Technology development

Botanicals, bio-agents and attractants and repellants, inter-crops

Molecular approaches in diagnostics and virus/vectore interactions

IPM modules in open and protected systems

Vegetable food safety - pesticide residues

Monitoring and impact of transgenic vegs

IPM for under-exploited vegs

Integration of biorationals in IPM

IPM Components

Summer plowing

Field sanitation

Plant resistance

Seed treatment – bioinoculants

Soil amendments

Nursery managemnt – soil solarization

Bioagents promotion

Pesticide-free period (no spray first 30 days)

Storage IPM

IPM Training

Farmers and farm women

Women's self-help groups – big in Tamil Nadu; train in IPM

Pesticide dealers – “extension agents” – most farmers get info from them

Hort officers and extension functionaries

KVK plant protection scientists

e-velanmai groups (farmers groups – function on plant protection)

NGOs

Vegetable nursery growers

Regional Network Establishment

Look for support from USAID office in Delhi?

Promote Regional and International Communication

Website

Establish a Yahoo group on South Asia IPM

Establish an expertise directory; identification, etc.

Starting and publishing e-newsletter on South Asia IPM activities (quarterly)

Collaborate with Global Theme Projects and Regional Centers

Meet with lead PIs of global theme projects

Develop baseline information

Multi-PA for crops other than eggplant, okra and tomato

Pesticide usage survey, etc.

Farmer participatory technology development

Germplasm collection

Evaluate pest resistance (conventional and molecular)

Develop mass multiplication procedure for pests and natural enemies

Develop IPM package for gourds

Develop IPM package for vegetable nursery

Develop IPM package for cabbage/cauliflower

Develop IPM package for protected vegetable cultivation

Molecular diagnostics

Etc.

Institutional Capacity Building

Sandwich programs

Improved techniques for nematode resistance breeding

Molecular characterization of viruses and vectors

Liquid formulation and toxicological data generated for biocontrol agents

Semiochemicals with special emphasis on pheromones

Workshops and short-term training

4-week workshop – Biopesticides

3 weeks TNAU, 1 week company \$1,000 per person _ per diem and travel

Impact of climate change on vegetable pest complex

Model organisms

DBM

PBNV and thrips

RKN

Studies

Biology etc.

Nutan Kausik: Energy and Resources Institute (TERI)

Demonstration and Validation of IPM Modules on Vegetable Crops in the Villages of Andhra Pradesh, Karnataka and Uttar Pradesh

Vegetable pests and diseases – 30% losses; 15-30 sprays/crop/season

Targeted Crops:

Farmers Practice (survey)

Locally available varieties

No seed treatment; usually seed comes treated with fungicides

No soil amendments

Only chemical treatment; some farmers use neem extracts

Not aware of microbial biopesticides

Not staking, usually

IPM Components of packages

Brinjal

Bacterial diseases – *Pseudomonas* as a seed treatment.

Fungal diseases – *Trichoderma* seed treatment

Soilborne diseases – neem cake (quality is variable)

Whiteflies and jassids – yellow sticky traps, neem and acetamiprid

Earias fabia (okra fruit borer) – pheromone and Bt

Management of diseases in vegetable crops by using *Trichoderma* and *Pseudomonas*

N. Kaushik, TERI, New Delhi, INDIA

Phytopathology 99:S62 (2009).

Vegetable farmers, particularly smallholders, confront a number of constraints in the vegetable production. The production risks are high primarily because of considerable production losses caused by pests. These are estimated to be about 30% of the total vegetable output. The farmers end up giving 15–30 sprays with pest control below their satisfaction level. Demonstration of IPM package involving seed and seedling treatment with *Trichoderma* and *Pseudomonas* for disease management in vegetable crops viz. eggplant (brinjal), okra (lady finger), and tomato, were carried out in 15 villages of Uttar Pradesh, Karnataka, and Andhra Pradesh in India under USAID IPMCRSP program. The IPM practices not only helped in reducing the reliance on pesticide by 50–70% reduction in pesticide spray but also enhanced the quality of the produce, production and income of the farmers. Farmers got 2–3 times higher price for their produce.

**K.P. Jayanth: BCRL – commercial production of biocontrol agents at Bangalore

**Company has a diagnostic lab – should be member of IPDN

MoU with Univ. Agriculture Bangalore

Field Extension Activities

Residential training of farmers – 5 days

Projects National and International Research Organizations
Operation of Plant Clinics – CABI Global Plant Clinic (Eric Boa there last week)

NPV – large scale year round production of host insects
Heli-Cide (100,000 larvae bottles used for NPV production)
100 – 3500 between 1999 and 2009
NPV effective against *Helicoverpa armigera* in tomato

T. harzianum (TNAU strain) (NIPROT)
Phytophthora spp capsule rot of cardamom and foot rot of pepper
Trichoderma mixed with compost and applied to soil, around each plant
Perennial crops:
Produced in high rainfall regions (monsoon areas)
Apply *Trichoderma* before monsoons
Used for other spices also

Beauveria bassiana SC (MycoJaal) - DBM management
India' first oil-based mycopesticide
Also effective in management of mango hoppers and *Diaphania indica* (cucurbits in eastern India)

Sugarbeet soilborne pathogens – NIPROT + Su-Mona (*Pseudomonas*)

Metarhizium anisopliae – white grub management: Grub-X
Potato, groundnut and sugarcane

Pheromones
India's first and only commercial synthesis facility – started in 1979; now 100 kg/yr.
Also makes traps.

Coffee White Stem borer:
Studies by CCRI with PCI lures and traps; must have community approach to be effective.

Autoconfusion Technology = Developed by Exosect Ltd, UK
Same as mating disruption; males used to disperse female pheromone; carnauba wax; males can't find females and other males chase them
Currently trials on yellow stem borer of rice (basmati)

LASTRAW
Organic salt for management of soft bodied insects
Removes waxy coat and insect dehydrates
Tested in Tashkent by Barno (IPM CRSP regional coordinator)

Global Plant Clinic
Training farmers to be plant doctors

Preparing fact sheets

Afternoon Planning Session

Crop Prioritization

Tomato

Okra

Chilis

Onion

Cole crops (cabbage/cauliflower)

Cucurbits

Underexploited vegetables

Tuesday, February 9

The team visited Ooty hill station to observe cole crop production.

Wednesday, February 10

The team visited Trichi and participated in a Farmer Field Day conducted in the fields where IPM package for onion production was introduced.

Thursday February 11

Meeting with Vice-Chancellor P. Murugesu Boopathi, TNAU.

Wrap-up meeting

Doug Pfeiffer – described VT Scholar Web portal <https://scholar.vt.edu/portal>

Budget Discussion

Very important for coordinators in regional sites to coordinate with global themes chairs.

Coordinate between TNAU and TERI

Mohankumar and Karthikeyan - co-chairs of IPDN project for southern India and the South Asia region.

USAID interested in emerging pests/invasive species

What are the future pest problems in India?

Top Insect Pests

1. Papaya mealybug
2. Coconut Eriophiyd mites
3. Whitefly complex
4. Thrips
5. Pod borer complex in pulses

Top Nematode Pests

1. Root Knot Nematode and nematode complex
2. *Helicotylenchus* (spiral nematode)
3. Lesion nematode (*Pratylenchus*)
4. *Radopholus similis* (burrowing nematode)
5. Potato cyst nematode

Top Fungal Diseases

1. *Fusarium* complex
2. Wheat Stem Rust UG99
3. Macrophomina
4. *Sclerotium rolfsii*
5. Mycotoxins in stored products

Top Viruses

1. Tospovirus (thrips transmitted)
2. Geminivirus (whitefly transmitted)
3. Papaya ringspot virus
4. Bean yellow mosaic (potyvirus)

Top Bacterial Pathogens

1. Banana *Xanthomonas* wilt and *Erwinia* rot
2. *Xanthomonas campestris* pv. *malvacearum* (cotton, esp. Bt-cotton)
3. Bacterial leaf blight of rice – *Xanthomonas oryza*
4. Citrus canker (*Xanthomonas campestris*)
5. Potato ring rot
6. Coconut lethal yellowing - phytoplasma

Papaya mealybug

Cotton mealybug

Coconut hispid beetle (*Brontispa* sp.)

Eriophyid mite of coconut (*Aceria guerreronis*)

Fruit fly (*Bactrocera invadens*)

Diseases/pathogens

* Not in India yet

Wheat stem rust

Tobacco streak virus in okra

Iris yellow spot virus in onion

Bean mosaic virus

Peanut bud necrosis/tomato spotted wilt virus

*Wheat stem rust UG99

Okra Yellow Mosaic
Tomato Leaf Curl
Cassava Mosaic Virus
Yellow Mosaic in black and green gram
Fusarium complex in many crops
*Banana Xanthomonas wilt
Banana bunchy top virus

Parthenium
Eichornia spp. (water hyacinth)
Sclerotium rolfsii (wide host range)
Macrophomina (wide host range)

Sally Miller - IPDN web portal demonstration

Maria Elisa Christie –Introduced Uma as Regional Coordinator for the Gender Global Theme.

Friday, February 12

Ed Rajotte and R. Muniappan visited Biological Control Research Laboratories in Bangalore. Dr. Jayanth gave a tour of the facilities.

In the afternoon we visited Project Directorate of Biological Control and met with Dr. Rabindara, Director and Dr. V. Venkatasubramanian, Assistant Director General of ICAR for extension.

Saturday, February 13

Visited TERI field demonstration plots in Kolar and Madanapalli.

Sunday, February 14

Travelled to Delhi from Bangalore and met with Dr. V. Venkatasubramanian who introduced us to the Dr. Ayyappan, Director General of ICAR.

Monday, February 15

In the morning we met with Mr. Daniel Miller, Project Development Officer, USAID, New Delhi and in the afternoon we met with Dr. Nutan Kaushik at the TERI offices.

Tuesday, February 16

Visited Indian Agricultural Research Institute and met with Dr. V.V. Ramamurthy, Entomologist and Dr. A.K. Ganguly, Nematologist.
We left New Delhi in the evening.

Appendices

Bangladesh Crop Priorities and Packages

Beans

Build an IPM Package – IPM CRSP South Asia (Bangladesh)
2 Feb 2010

Country Bean

Target regions: Norsindhi

Site Selection

Well-drained, medium - high land

Soil treatment

Seedlings

Prepare in polybags
Tricocompost or poultry refuse in potting media

Variety selection

BARI SEEM-1, or -4 (winter country bean)
BARI SEEM-3 or IPSA SEEM-1 (summer country bean)

Seeds

Collect seeds from healthy plants
Vitavax seed treatment for fungal disease management

Transfer of seedlings to field

Field management

- Apply Tricho-compost or poultry refuse as a fertilizer and for disease (RKN) management

- Raised bed 15-20 cm with pits

Insect pest management

- Aphids (*Aphis craccivora*); soap water spray + spot application of botanicals

- Scout once per week

- At flowering – Helicoverpa and Maruca

- Handpicking every other day for entire cropping period

- Release of biocontrol agents – Trichogramma and Bracon as for

eggplant

Disease management

- Bean Yellow Mosaic Virus (BYMV) and Bean Common Mosaic virus (BCMV) both transmitted by aphids and BCMV also seedborne
 - Rogue infected plants
- Anthracnose – farmers spray fungicides (carbendazim and propiconazole)

End of season

Data from plots

1. Insect pest infestation –
2. Disease incidence and severity
3. Yield
4. Costs of production disaggregated by inputs
5. Marketing – make linkage with grocery stores interested in pesticide-free product
6. Price farmers get

Research

Bruchid seed pest – post-harvest
Impact of Coccinelids and lacewings on aphids

Virus –resistant varieties - breeding
Anthracnose
Fungicide efficacy – less toxic fungicides
Timing to reduce # of applications

String Bean Research

Main problem is blue butterfly (*Euchrysops cnejus*)
Biocontrol –based research
#2 - *Lyriomyza* leafminer (same research program as for tomato)
Parasitoids
Determine level of pesticide use that results in leafminer problem
Aphids
Jassids

BCMV main problem

- Varietal screening
- Seed treatment
- Roguing

Brinjal (eggplant)

Build an IPM Package – IPM CRSP South Asia (Bangladesh)
1 Feb 2010

Brinjal – mature technology

Target regions: Narsingdi

Site Selection

Total area of field (fragmented among farmers) considered for biocontrol
Crop rotation?

Does the field have a history of bacterial wilt? Just assume BW is there.
Crop history is important; brinjal should not follow Solanaceous crops

Soil treatment

Apply Tricho-compost up to 1 day before transplanting

Seedbed management

Raised beds
Apply Tricho-compost into seedbed up to 1 day before seeding

Variety selection

BARI- Begun-8 (almost immune to BW) (now with seed companies)

or graft onto a BW-resistant rootstock (*S. sissymbriifolium*)
also graft onto BW-resistant rootstock if field has history of RKN

Transfer of seedlings from seedbed to field

Field management

2 weeks after planting begin to scout for flagged tips (FSB);

- as soon as flagged tips are noticed set out pheromone traps 10m apart
- release weekly one jar of Bracon and 1 g Trichogramma per HA for 5 weeks

Scout for jassids; If 2-3 jassids per leaf, start applying neem seed extract

Scout for little leaf – if found rogue diseased plant

At end of season if southern wilt (*Sclerotium rolfsii*) is present, destroy affected plants to remove sclerotia.

End of season

Pull plants and use for fuel

Data from plots

1. Insect pest infestation
2. Disease incidence and severity
3. Yield
4. Costs of production disaggregated by inputs
5. RKN incidence and severity at harvest
6. Marketing – make linkage with grocery stores interested in pesticide-free product
7. Price farmers get

Cabbage

Build an IPM Package – IPM CRSP South Asia (Bangladesh)
2 Feb 2010

Brassica Vegetables: Cabbage/Cauliflower

Target regions: Bogra

August planting: Problem mainly early season; insect problems at heading
November planting: Some different problems

Site Selection

Field should be well-drained, highland soil

Soil treatment

Tricho-compost or poultry refuse for RKN control
Raised beds

Seedbed management

Raised beds
Tricho-compost application

Variety selection

No recommendation

Seeds

Transfer of seedlings from seedbed to field

Field management

- Apply Tricho-compost as a fertilizer and for disease management
- August planting: *Spodoptera* mass trapping with pheromones + parasitoid release
Trichogramma bactri and *Bracon* released as for eggplant beginning 2 weeks after transplanting

- Scout once per week beginning after transplanting
- Handpick DBM and *Spodoptera* caterpillars once per week beginning 2 weeks after transplanting
- November planting: *Spodoptera* mass trapping with pheromones two weeks after transplanting
- Scout once per week beginning after transplanting
- Handpick DBM and *Spodoptera* caterpillars once per week beginning 2 weeks after transplanting

End of season

Data from plots

1. Insect pest infestation – collect data from 10 heads; number infested; cut heads and count larvae of *Spodoptera* and DBM
2. RKN incidence and severity at harvest
3. Yield
4. Costs of production disaggregated by inputs
5. Marketing – make linkage with grocery stores interested in pesticide-free product
6. Price farmers get

Research

Cauliflower

For seed production, brown rot (*Alternaria*) is a problem

Brown rot can also be a problem during the season – curd infection

Cucurbits

Build an IPM Package – IPM CRSP South Asia (Bangladesh)

1 Feb 2010

Cucurbit – mature technology: bitter melon only

Target regions:

Site Selection

Soil treatment

Tricho-compost, mustard oil cake or poultry refuse to control RKN and some fungi

Seedbed management

Produce seedlings in polybags;

Soil treatment with defined rate of

poultry refuse or

Tricho-compost or

mustard oil cake or

sawdust burning

Prepare soil 15 days before sowing

Variety selection

Select a virus-resistant variety if available or farmer's variety

Seeds

Seed should have been selected from virus-free plant

Transfer of seedlings from seedbed to field

Field management

Use Tricho-compost (RKN, Fusarium wilt)

Raised beds

Gourds – for red pumpkin beetle and RKN cover with a net for first 30 days after transplanting

Trellis plants: cucumber, bitter melon, teasel melon, bottle melon, white melon, snake melon, ridge melon, sponge melon, pointed melon

Pest management

Early season – borer (*Spodoptera litura*) and pumpkin caterpillar (bitter, teasel and small bitter gourds)

Use biocontrol agents as described for tomato and brinjal – begin when fruit set starts.

Start Cuelure pheromone trapping at flowering (fruit fly); 15 m separation; 70 per HA
Change water every 5-7 days, depending on how dry the weather is.

Rogue virus-infected plants if plants have symptoms before fruiting

Watermelon and cucumber – scout for two-spotted spider mites 2 weeks after planting;
apply botanicals (neem seed oil) when mites first noticed

End of season

Save seeds from virus-free plants only

Data from plots

1. Insect pest infestation
2. Disease incidence and severity
3. Yield
4. Costs of production disaggregated by inputs
5. RKN incidence and severity at harvest
6. Marketing – make linkage with grocery stores interested in pesticide-free product
7. Price farmers get

Research

Floating row covers to protect plants from aphids early season (protect from virus)

Reflective mulches to repel aphids

Treatment for elimination of viruses from seeds

Sequential cage experiments to find out how long it is necessary to keep aphids away from plants to protect them from virus problems

Powdery mildew management with biorational products

Research on Phytophthora blight/Tricho-compost and downy mildew (???)

Systemic resistance inducer e.g. actigard/bion for virus management(?) - check if labeled on cucurbits in the US

Okra

Build an IPM Package – IPM CRSP South Asia (Bangladesh)

2 Feb 2010

Okra: Research only

Target regions: on-station

Site Selection

Gazipur, Jessore, Ishurdi, Norsingdi

Soil treatment

Tricho-compost or poultry refuse for RKN and foot rot (*Sclerotium rolfsii*) control

Seedbed management

Direct sowing

Variety selection

Virus (Yellow Vein Mosaic (YVM)) problem # 1

Varietal screening and selection in field, microplots and lab (artificial inoculation)

Confirm four varieties with moderate resistance

Create variation by hybridization with other germplasm; screen by artificial inoculation (YVM)

Seeds

Transfer of seedlings from seedbed to field

Field management

Okra SFB - OFSB

Pheromone trapping, sanitation and biocontrol agent release

Whitefly (transmits YVM)

Botanicals, parasitoid (*Encarsia*)

Host-free period?

Jassids

Botanicals, esp. neem seed extract + other commercial neem products

Aphids

Soap water and spot application of botanicals

Rogue virus-infected plants

Powdery mildew

Milk

Botanicals

Spacing, pruning(?)

Pseudocercospora (black leaf mold)

Botanicals

End of season

Data from plots

Depends on program

Tomato

Build an IPM Package – IPM CRSP South Asia (Bangladesh)

1 Feb 2010

Tomato – Winter season

Target regions: Narsingdi

Site selection

Crop history – choose an area without recent solanaceous crop

Soil treatment

Use Tricho-compost up to 11 day before transplanting

Use raised beds

Seedbed management

Tricho-Compost application up to 1 day before transplanting

Netting for non-virus-resistant varieties

or seed treatment with imidacloprid at 5g/Kg seed

Variety selection

Virus-resistant variety BARI tomato-15 or TLB-182; graft onto *S. sissymbriifolium* for BW and RKN management

Transfer of seedlings from seedbed to field

Fruiting stage

Use biocontrol agents (same as brinjal)

Data from plots

1. Insect pest infestation
2. Disease incidence and severity
3. Yield
4. Costs of production disaggregated by inputs
5. RKN incidence and severity at harvest
6. Marketing – make linkage with grocery stores interested in pesticide-free product
7. Price farmers get

Research needed

Late blight

Leaf miner

Bacterial wilt grafting – still need work on rootstocks

NPV

Molecular breeding for bacterial wilt resistance

 Marker-assisted selection; work with traditional breeding program

 Three races of *R. solanacearum* in Bangladesh: race 1, 3 and 5 – no more research needed on strain characterization

Tomato – Summer season

Target regions: Jessore

Site selection

Crop history – choose an area without recent solanaceous crop

Use polytunnel

Soil treatment

Use Tricho-compost up to 11 day before transplanting

Use raised beds

Seedbed management

Tricho-Compost application up to 1 day before transplanting

Netting for non-virus-resistant varieties

or seed treatment with imidacloprid at 5g/Kg seed

Variety selection

Virus-resistant variety BARI hybrid tomato-3 or -4; graft onto *S. sisymbriifolium* for BW and RKN management

Transfer of seedlings from seedbed to field

Fruiting stage

Use biocontrol agents (same as brinjal)

End of season**Data from plots**

1. Insect pest infestation
2. Disease incidence and severity
3. Yield
4. Costs of production disaggregated by inputs
5. RKN incidence and severity at harvest
6. Marketing – make linkage with grocery stores interested in pesticide-free product
7. Price farmers get

Research needed

Late blight
Leaf miner
Bacterial wilt grafting – still need work on rootstocks
NPV
TSWV – thrips transmitted
Black leaf mold
Blossom end rot
Micro-irrigation (gravity fed)?

Nepal Crop Priorities and Packages

Cucurbits **Target regions: Terai (Rupandehi); Hill district (Kaski); Lalitpur**

Site selection

Upland, well-drained soil

Soil treatment

Raised beds
Biofertilizer amendment as for tomatoes; compost mixture as for tomatoes + neem or mustard oil cake + Paecilomyces

If RKN pressure, use biogas slurry

Trellis as appropriate by crop

Seedbed management

Produce seedlings in polybags with solarized soil + compost mixture as for tomatoes + neem or mustard oil cake + Paecilomyces
Seedling net to prevent virus transmission

Variety selection

Bhaktapur local (cucumber) (not resistant) – farmer preference

Seed

Good seed, registered from reputable company

Transfer of seedlings from seedbed to field

Bio-hume seedling drench

Production stage (vegetative and fruiting stage)

Fruit fly – pheromone traps w/ soap water + fruit lure (mass trapping) – set out 15-30 days before flowering. Check 2x per week to make sure the traps don't dry out.

Replace mashed sweet gourd and soap water every 4 days.

Spray foliage with BioSulf for powdery mildew and mites

Rogue virus-infected plants

Nettle extract in cow urine spray for mildews

Copper spray or other fungicide (metalaxyl+mancozeb) for downy mildew

Scout for red pumpkin beetles; when see adults spray Metarrhizium+Beuveria +Verticillium cocktail to foliage (drench)

Data from plots**Research needed**

Effect of sulfur sprays on herbivorous and predacious mites

Evaluate Prevental and milk spray for efficacy against viruses (compare with no action and roguing)

Build an IPM Package – IPM CRSP South Asia (Nepal)

05 Feb 2010

Tea Target regions: Terai (Rupandehi); Hill district (Kaski)**Season**

Pruning (complete by January)

Bud-break (late Feb to - March)

Picking (ave. mid-May) – pick every 6-7 days until late November

Mites – start in April

Black thrips – April - June

Tea mosquito - July - Sep

Blister blight - July - Sep

IPM Package**Pruning**

Prune once in 5 years

Pruning – bud-break (January – Feb)

Control mites – BioMite application

Picking

Thorough plucking (remove buds) to control black thrips and tea mosquito

Apply organic insecticide (Multineem, or Spinosad (?)) if necessary to control thrips and tea mosquito

Spray fungicides for blister blight as soon as symptoms appear with organic fungicides – Trichoderma (Multiplex)

Data from plots

Research needed

Evaluate Biomite and karinjin against mites

Determine impact of fungicidal sprays on mite predators and efficacy against blister blight

Evaluate plant extracts – local plants – against blister blight

Effect of more frequent pruning on mite populations

Evaluate predatory mites

Evaluate biological control (*Orius*, predatory thrips, mites) against thrips

Evaluate pheromone for tea mosquito (new pheromone)

Fusarium wilt management with Trichoderma, Pseudomonas or other biological control

India Crop Priorities and Packages

IPM Package for Brinjal

Brinjal mealy bug – emerging problem

RKN

Indigenous pheromone baiting for FSB control

Ashweevil - root rot complex

NSKE formulation development with TERI

Trichogramma: natural augmentation of Trathala

Demonstration and dissemination

IPM, RKN management, soil amendments

Antagonistic crops for RKN management

Biocontrol of soilborne pathogens

Powdery mildew management with botanicals

Yellow sticky traps

IPM Package for Tomato

PBNV

TLCV

RKN

Continuing grafting for resistance and scion resistance to viruses
Need to evaluate BARI varieties as possible rootstocks
Predisposition of leafminer to Alternaria leaf spot

Technology development

Resistant variety for PBNV and TYLC and their vectors, RKN

Need diagnostic kit – ELISA for PBNV

Trap evaluation

IPM for protected cultivation

Etc.

Chilies

Thrips and mites

Viral diseases – very important

IPM package

Resistant variety development for virus complex and vectors aphids thrips and mites

Anthracnose

Etc.

IPM for Onion crop

Thrips, purple blotch – combined is really a problem

Leaf miner

Cutworm – Spodoptera, another

Iris Yellow Spot Virus?

Already working on IPM modules

Cucurbits IPM Package

Resistance for CMV, fruit fly, leaf miner; attractant development;

Management of RKN

Biocontrol of soilborne diseases

IPM package for protected cultivation

Organic amendments for pests, nematodes and diseases

Cabbage/Cauliflower IPM Package

Insecticide resistance management for DBM

IPM for changing pest scenario in hill and plain cole crop ecosystem

Pheromone technology; trap crop technique

Biocontrol of fungus-nematode complex

Name	Title/Organization	Contact Information
A.N.M. Karim	Bangladesh site coordinator	Horticulture Research Center, Agricultural Research Institute (BARI), Gazipur-1701, Bangladesh Phone: 880-2-9256407 E-mail: ipmcrsp@bdcom.com anmkarim@gmail.com
Mohammed Zainul Abedin	IRRI Representative for Bangladesh	House 104, Masjid Road Banani DOHS Dhaka 1206, Bangladesh Phone: 880-2-8711991-3 E-mail: m.z.abedin@cgiar.org
Syed Nurul Alam	Principal Scientific Officer, Entomology	Division of Entomology Bangladesh Agricultural Research Institute, Joydebpur, Gazipur – 1701, Bangladesh Phone: 9257400 E-mail: entoipm@bdcom.com
Md. Ismail Hossain	Director, Support Services	Bangladesh Agricultural Research Institute, Joydebpur, Gazipur – 1701, Bangladesh Phone: 9252527 E-mail: mdismail53@yahoo.com
Abdul Muquit	Senior Scientific Officer, Plant Pathology	Bangladesh Agricultural Research Institute, Joydebpur, Gazipur – 1701, Bangladesh Phone: 9261501-6 Ext.5269 E-mail: muquit65@yahoo.com
Md. Khalequzzaman Chowdhury	Member Director (Crops)	Bangladesh Agricultural Research Council, Airport Road, Farmgate, Dhaka 1215 Bangladesh Phone: 88-02-8118275 E-mail: zamanbarc@agni.com
Yousuf Mian	Director General	Bangladesh Agricultural Research Institute Gazipur-1701 Bangladesh Phone : 880-2-9252715 E-mail : dg.bari@bari.gov.bd
Mark Visocky	Deputy Office Director, Economic Growth Office	USAID, American Embassy Madani Avenue, Bandhara Dhaka 1212, Bangladesh Tel: 880-2-885-5500 x2720 E-mail: mvisocky@usaid.gov

Shahidur Rahman Bhuiyan	Sr. Project Management Specialist,	USAID, American Embassy Madani Avenue, Bandhara Dhaka 1212, Bangladesh Tel: 880-2-885-5500 x2518 E-mail: sbhuiyan@usaid.gov
Aniruddha Hom Roy	Private Sector Advisor	USAID, American Embassy Madani Avenue, Bandhara Dhaka 1212, Bangladesh Tel: 880-2-885-5500 x2541 E-mail: aroy@usaid.gov
Ms. Fawzia Yasmeen	Sr. Manager, Supply Chain and Head of Business Development	M.M. Ispahani Limited Ispahani Building, 2 nd Floor, 14-15, Motijheel C/A, Dhaka-1000, Bangladesh Phone: 88-031-711846 E-mail: fawzia@mmispahani.com
Luke A. Colavito	Country director	IDE, Bakhundole, Lalitpur, Nepal Phone: 977-1-5520943 E-mail: lcolavito@idenepal.org
William M. Patterson	Director, General Development Office	USAID, U.S. Embassy P.O. Box 295, Maharajgunj Chakrapath, Kathmandu Nepal Phone: 977-1-400-7200 x4549
Gyawali, Bishnu K.	Consultant	IDE/Nepal, Bakhundole, Lalitpur, Nepal Phone: 0977-1-5524461/554882 E-mail: bkgyawali@wlink.com.np
Komal Pradhan	IDE/Nepal	Bakhundole, Lalitpur P.O. Box 2674, Kathmandu, Nepal Tel. 977-1-5320943 email: kpradhan@idenepal.org
Mrs. Ram Devi Timila	Senior Scientist, Plant Pathology	Nepal Agricultural Research Council, Khumaltar, Lalitpur Nepal Phone: 977-1-5523143 E-mail: ppd@narc.gov.np
Daniel Miller	Project Development Officer Office of Program Support	USAID, American Embassy Chanakyapuri, New Delhi 110021 India Tel: 91-11-2419-8443 E-mail: damiller@usaid.gov
R. Samiyappan	Director, Centre for Plant Molecular Biology	Tamil Nadu Agricultural University, Coimbatore 641003 India Phone: 91-422-6611262

		E-mail: rsamiyappan@hotmail.com
E.I. Jonathan	Director Center for Plant Protection Studies	Tamil Nadu Agricultural University Coimbatore 641003 India Phone : 91 422 6611237 E-mail: directorcpps@tnau.ac.in
P. Murugesu Boopathi	Vice-Chancellor	Tamil Nadu Agricultural University, Coimbatore 641003 India Tel: 91-422-2431788 E-mail: vc@tnau.ac.in
V. Udayasuriyan	Professor and Head Dept of Plant Molecular Biology	Tamil Nadu Agricultural University, Coimbatore 641003 Phone: 91-422-2453157 E-mail: udayvar@yahoo.com
V. Venkatasubramanian	Assistant director General, ICAR	Krishi Anusandhan Bhavan – 1 Pusa, New Delhi 110012 India Phone: 91-11-2584-3279 E-mail: vvsmn@yahoo.com
Karthigeyan, G	Associate Professor Dept of Plant Pathology Centre for Plant Protection Studies	Tamil Nadu Agricultural Univer Coimbatore - 641 003 India Phone: 0422-6611226 (office); E-mail: agrikarthi2003@yahoo.com
Mohankumar, S	Professor Dept. of Plant Mol. Biology & Biotechnology	Tamil Nadu Agricultural University, Coimbatore- 641003, India Ph: 91-422-6611353 e-mail: smohankumar65@yahoo.com smk65@hotmail.com
Nutan Kaushik	Fellow & Area Convenor Plant Biotechnology	The Energy and Resources Institute, Darbari Seth Block IHC Complex Lodhi Road, New Delhi 110003, India Phone: 2468-2100 E-mail: kaushikn@teri.res.in
V.V. Ramamurthy	Principal Scientist, Entomology	Indian Agricultural Research Institute, New Delhi 110012 India Tel: 91-11-2584-2042

		E-mail: vvr3@vsnl.com
R.J. Rabindra	Director, National Bureau of Agriculturally Important Insects	P.O. Box 2491, H.A. Farm Post, Bellary Road, Bangalore 560024 India Phone: 91-80-23414220 E-mail: rjrbindra@rediffmail.com
K.P. Jayanth	Vice President	Bio-control Research Laboratories 36/2 Sriramanahalli, Bangalore 561203 India Tel: 91-80-28561953 E-mail: jayanth.kp@pcil.in