ASSOCIATE AWARDS

indonesia | african food security initiative

Associate Awards

Indonesia

Principal Investigator: Michael Hammig

Co-investigators: Merle Shepard, Gerry Carner, Eric Benson, Guido Schnabel

Objective: Development of IPM tactics for cocoa, papaya, and high value vegetable crops, by coordinating activities with key collaborating institutions including IPB, UNSRAT, ICCRI, IVEGRI, and Udayana University.

Clemson scientists traveled to Indonesia and met with scientists from each of these institutions to assess potential integration of IPM CRSP into USAID/Indonesia programs for vegetables in Bali, coffee and cocoa with ICCRI, and shallot research with IVEGRI. Workplans have been prepared and, in some cases, field activities have begun. Pending additional funding from USAID/Indonesia, plans are in place for expanded activities with each institution.

Potato

Pathogenicity and efficacy of entomopathogenic nematode *Heterorhabditis* sp. against the potato tuber moth, *Phthorimaea operculella*

Lufthi Rusniarsyah, Samsudin, Supramana, Aunu Rauf

The highland of Pacet-Cianjur has been designated to be a potato seed production area in West Java by the government. The potato tuber moth, *Phthorimaea operculella* (Lepidoptera: Gelechiidae), is one of the most important potato pests in the country, especially in the storage warehouses. The potential loss will reach almost 100% if control is not performed well. The effectiveness of entomopathogenic nematodes *Heterorhabditis* to control several crop pests has been studied. Infective juveniles (IJs) of nematodes are capable of seeking and infecting insects that live in soil and in plant tissues. The objectives of the research were to study the pathogenicity and efficacy of *Heterorhabditis* sp. against *P. operculella* under laboratory conditions. Plate assays were performed to study the pathogenicity of different concentrations of the entomopathogenic nematode. The third instar of the potato tuber moth larvae were exposed to five concentrations of the nematode (100, 200, 300, 400, 500 IJs/ml). Mortality of insect stages was checked every 3 hours for 2 days for all concentrations, and percentage mortality was calculated for each insect stage at different concentrations. Complementary assays were also conducted to determine the efficacy of the entomopathogenic nematode against PTM in the tuber. Dosages tested were 200, 400, 600, 800, and 1000 IJs/tuber. Results showed that the *Heterorhabditis* sp. nematode caused high mortality (≥ 85%) of the potato tuber moth larvae 24 hours after application, even at the lowest concentration (100 IJs/ml) (fig. 1). On the tuber assay, the mortality of *P. operculella* larva living in the tubers was generally 30%-35%. The high pathogenicity of *Heterorhabditis* sp. against PTM larva as well as efficacy in the tuber suggest that the nematode has the potential as a biocontrol agent for management of *P. operculella*, but more studies are required.

Cassava

Bioecology of the cassava mealybug

Nila Wardani, Aris Rama, Aunu Rauf, Sugeng Santoso, I Wayan Winasa

The cassava mealybug, *Phenacoccus manihoti* (Hemiptera: Pseudococcidae), is one of the most severe pests of cassava in the world. It is native to South America, but it has become naturalized throughout Sub-Saharan Africa since its inadvertent introduction into the continent in the early 1970s. *P. manihoti* was not known to occur in Asia until 2009, when it was first detected in Thailand. Since that year, it has spread aggressively throughout neighboring countries, including Indonesia. In 2010 the pest was found causing heavy damage on cassava in Bogor. Biological studies of the cassava mealybug were carried out for development of integrated pest management of the pest. To study the development and reproduction, the cassava mealybugs were caged individually on cassava cuttings in the laboratory. Immature development, adult longevity, and number of eggs laid were checked daily. Field studies were carried out in cassava plots to determine population dynamics, level of damage, and natural enemies of *P. manihoti*.

Our laboratory study confirmed that *P. manihoti* has three nymphal instars, producing only females (thelytokous parthenogenesis). The adult female lived for 34 days and laid up to 570 eggs in an ovisac. The entire life cycle from egg to adult took about 21 days (tab. 1).

P. manihoti is parthenogenic, and hence a single immature or adult may be sufficient to start an outbreak. Ovisacs are sticky and can adhere to clothing, facilitating long-distance mealybug dispersal. Eggs hatch into mobile crawlers that can spread over the plant or be passively dispersed to neighboring plants by wind. Crawlers commence feeding from phloem fluids in young leaves and stems. The mealybugs are generally located on the underside of the cassava canopy leaves, mainly around major leaf veins and at low density inside growing tips. With increasing density, they spread over the entire plant. Cassava infested by the mealybug showed bunchy tops due to shortening of the youngest internodes (fig. 2), and based on farmer experience this damage can reduce yields by 50%. During heavy rains many mealybugs are washed off their host, so infestations are thus most serious during the dry season. Figure 3 shows development of cassava mealybug infestation during the dry season based on biweekly observation on a cassava field with 1,504 plants. Within 5 months, all cassava plants

Figure 1. Mortality of PTM larva at five concentration of Heterorhabditis sp.

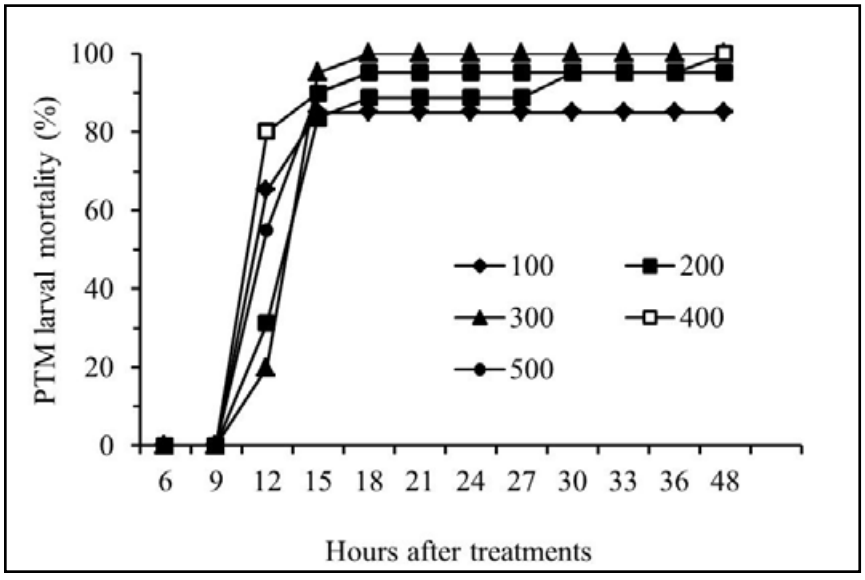


Table 1. Duration of developmental stages and fecundity of the cassava mealybug

Developmental Stages	x ±SD (days)
(n = 40)	
Egg	7.55 ± 0.50
Nymph-1	4.58 ± 0.78
Nymph-2	4.20 ± 0.56
Nymph-3	4.58 ± 0.55
Adult (female)	34.38 ± 9.58
Praoviposition	4.70 ± 0.69
Oviposition	21.19 ± 3.33
Postoviposition	8.50 ± 7.98
Fecundity (eggs/ female)	568.68 ± 144.89

Figure 2. Cassava tree infested by P. manihoti showing bunchy top

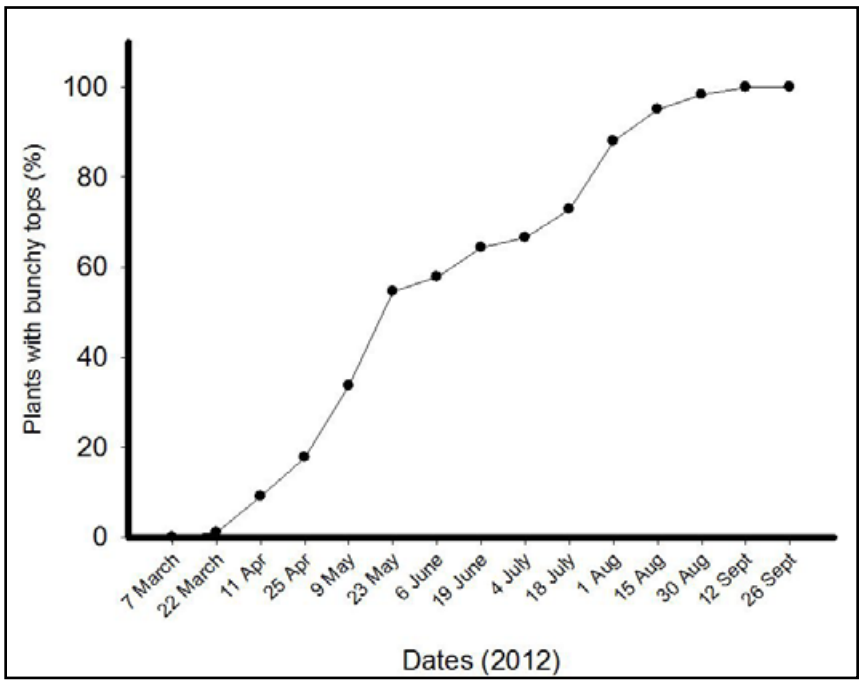


Figure 3. Development of P. manihoti infestation in cassava field

(100%) were infested by the mealybug as indicated by bunchy tops. During field studies we found that the most common predator associated with cassava mealybug infested leaves was chrysopids. To date, no parasitoids have been found which may mean that a parasitoid introduction program may be necessary. Parasitoids have successfully controlled this pest in many other countries.

Tomatoes

Farmer Participatory Research

Suhendar, Wahyu Haidir, Dedih Ruhyatna, Aunu Rauf

See table 2.

Effect of botanical insecticides and Trichoderma on tomato production

Research on the effectiveness of botanical insecticides (*Derris eliptica*, *Melia azadarch*, and *Aglaia odorata*), *Trichoderma* sp, plastic mulch to control *Liriomyza sativae*, and *Fusarium* wilt and their effects on tomato production was carried out on tomato crops in Toure. Results showed that all botanical insecticides combined with plastic mulch and *Trichoderma* provided better control of *L. sativae* and *Fusarium* wilt and gave higher tomato production. Highest percentage of infestation by *L. sativae* was on plots without treatments of plastic mulch and *Trichoderma*.

Chili pepper

Farmer Participatory Research

Ujang Dayat, Wahyu Haidir, Dedih Ruhyatna, Aunu Rauf

The objectives were to compare alternative IPM strategies and existing farmers' practices for managing pests and diseases in chili pepper. The design of the chili pepper IPM trials were similar to those of tomatoes and included: (a) use of commercial variety TM 999, (b) screened-beds to prevent early infestation by insect vectors, (c) use of plastic mulch, (d) pouring bokashi mixed with *Trichoderma* into planting holes, (e) dipping seedlings in *Bacillus subtilis* and *Pseudomonas fluorescens* 12 hours before transplanting, (f) lower rate of synthetic fertilizers, (g) hand picking caterpillars from infested plants, and (h) need-based pesticide applications. As with tomato trials, result showed that IPM

Table 2. Budget analysis of IPM and farmer practice on tomatoes

Items	IPM	Farmer Practices
Yield (kg)	12,295	10,305
Gross income (Rp)	18,442,500	15,457,500
Cost (Rp)	2,484,000	2,802,500
Net income (Rp)	15,958,500	12,665,00
B/C ratio	7.4	5.5

Table 3. Budget analysis of IPM and farmer practice on chili pepper

Items	IPM	Farmer Practices
Yield (kg)	1,525	1,025
Gross income (Rp)	15,250,000	10,250,000
Cost (Rp)	2,693,600	2,749,200
Net income (Rp)	12,556,400	7,500,600
B/C ratio	5.7	3.7

treatments gave a higher yield and income and was more profitable than farmers' practices as indicated by B/C ratio (tab. 3).

Shallot

Management of pests of shallot

An initial study was conducted by IVEGRI in Brebes, Central Java to assess the potential of shade netting and SE-NPV for managing insect pests in shallot (*Allium cepa*) in order to reduce the use of pesticides and to improve the quality of the product. Four treatments — mosquito nets (white) + Trichoderma (T1); fishing nets (blue) + Trichoderma (T2); Se NPV + Trichoderma (T3); and farmers practices (T4) — were assessed with a control treatment (without shade netting and SE-NPV). The results showed that shade netting with white color had the lowest number of both beet armyworm (*Spodoptera exigua*) and thrips (*Thrips tabaci*). Furthermore, the lowest % pest damage and the highest quality of yield were in plots mosquito-nets (white) + Trichoderma (T1) followed by fishing-nets (blue) + Trichoderma (T2); Se NPV + Trichoderma (T3) and farmer practices (T4).

ACTIVITIES IN PROBOLINGGO, EAST JAVA

Shallot in Indonesia is mainly grown in the lowland area in the north coast of Java. The major production area is concentrated in nine districts of four provinces: Brebes, Tegal in Central Java; Probolinggo, Kediri, Nganjuk of East Java; Bandung, Cirebon, Majalengka West Java; and outside Java in Bima district of West Nusa Tenggara.

The Probolinggo is the second largest shallot plantation area of. The cropping pattern in Probolinggo is seasonal, based on the rainy and dry seasons. In the rainy season (December to March) the majority of farmers plant rice. Only a few farmers plant shallot to produce seed for the dry season shallot planting season. In the first dry season (March-June) farmers start planting shallot. In the second dry season (July-November), usually farmer plant shallot, chili, or corn.

Actitivies in Probolinggo consist of Farmer Action Research on shallot in Waru Jinggo village. During the first season, farmers conducted an IPM FFS on shallot and then continued with a field study to compare different treatments for controlling *Spodoptera exigua*: 1) use of net, 2) use of Se-NPV (the bioagents were provided by Bukit Tinggi Laboratory of West Sumatera), and 3) chemical control (farmer's practice).

Spodoptera exigua is the major pest of shallot. The farmers spray three times per week in the rainy season and two-three times per week in the dry season, the season when the pest is more serious. Nearly 50% of the farmers use screen netting to control Spodoptera. The cost of the netting is very high for small scale farmers (22 million Rupiah/Ha). The netting lasts for 6 growing seasons. The netting reduces 90-95% pesticide applications, especially in the dry season; but farmers still have to spray fungicides (Anthracol), and most farmers still include insecticides (Tracer, Buldok, Dursban), especially to control thrips.

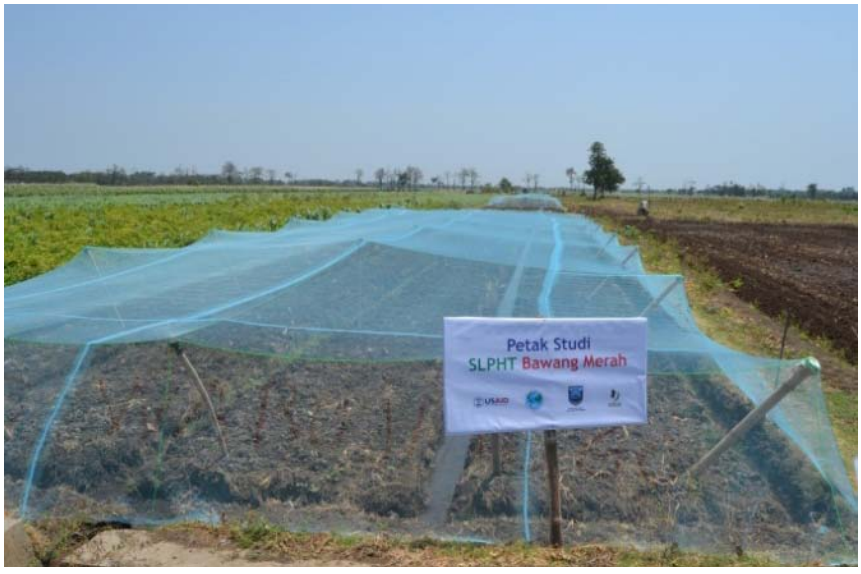
Farmer Field School

A Farmer Field School (FFS) was conducted in the Waru Jinggo village, sub-district Leces.

In it, 25 farmers attend the meeting weekly. During the field school the farmers were separated into five sub groups doing weekly agroecosystem observvation and analysis. During the agroecosystem analysis, farmers made comparisons between current practice polt and FFS plot.

In the field school, two separated side by side plots (500 m2 each) were provided for the farmers group. One plot was treated with practices used by the majority of farmers in the area (farmer's practice - FP), and the other plot was treated with IPM components. The FP plot was treated with pesticides every two days.

Figure 4. Experimental plot



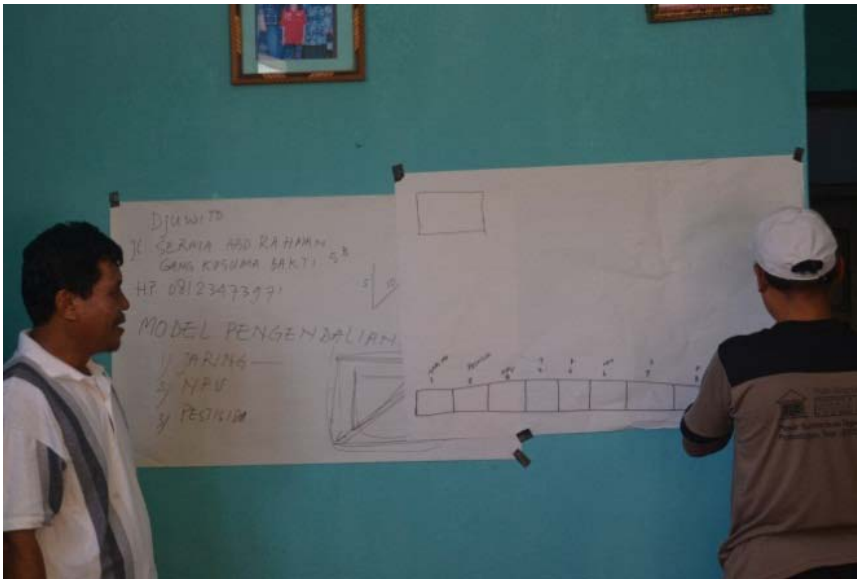


Figure 5. Farmers recording weekly observations

Farmer Action Research

Following the field school, in the second season (dry season) the farmer action research was conducted by the farmers group. The farmer action research objective was to compare the effect of using nets and using NPV compared to FP in controlling *Spodoptera*.

The design consisted of nine plots. There were nine treatments with nine replications:

- P1 : Current farmer practice
- P2 : Netting
- P3 : Application of NPV

Farmers met every week, and they were divided into five small groups. After weekly observations, farmers conducted agroecosystem analysis.

Coffee and citrus

Pest Survey in Pakpak Bharat, North Sumatera

To expand the program to the new site, on September 2012, a survey was conducted in the Pakpak Bharat district of North Sumatera Province. The survey team consisted of Dr. Donald Tambunan from USAID Indonesia, Dr. Merle Shepard and Dr. Gerry Carner from Clemson University, and Mr. Engkus Kuswara and Widyastama Cahyana from FIELD. The objective was to assess the local condition to see the possibility for IPM program implementation on coffee and citrus

During the survey, the team met the citrus and coffee farmers, the local government staffs, and the District Head of Pakpak Bharat (Bupati). The Bupati and his staff showed interest and enthusiasm for the IPM program on coffee and citrus in the district.

Some problems on citrus and coffee were identified during the field visit and discussion with farmers. Some of the key problems on citrus are that

- Growing citrus is quite new for local farmers and is becoming wider spread.
- An understanding about citrus and citrus agro-ecosystem is still low, so an improvement is needed, (i.e, need more understanding about the balance between number of fruits and leaves, and nutrition).
- Farmers focus mainly on insect pests, and of that, mainly fruit fly, while the problems faced are not only of insect pests, but also of diseases, nutrition, etc.
- The problem of falling fruit is not only caused by fruit fly.
- In the fruit fly trap, the insects found to be trapped mainly are not fruit fly.
- There is a marketing problem. Farmer organization is weak, and there is no farmer network for marketing, which them much weaker to deal with traders

Figure 6. Farmers who grow citrus and coffee face several pest and plant disease problems

Vegetable crops

Mass-rearing of predators and parasitoids

Aunu Rauf, Ridwan Sufyana, Wawan Yuandi, Saodik

The densities of natural enemies in natural environments are usually low. In order to increase their ability to suppress pest populations, mass production and release of them to crop fields becomes necessary. Therefore, mass-rearing techniques of both target insects and their natural enemies need to be established to lead to a sound biological control program. Mass-rearing of stink bug, *Andralus spinidens*, is just being initiated in the laboratory. This predator has been fed with armyworms *Spodoptera exigua* and *S. litura*, cabbage cluster caterpillar, *Crocidolomia pavonana*, and banana leafroller, *Erionota thrax*. The predatory stinkbug has potential for

controlling caterpillaras on vegetables such as *C. pavonana* on crucifers, *S. exigua* on green onion, and *Athalia proxima* on Chinese cabbage. Another predator being mass-reared is green lacewing, whose larvae prey on a variety of insects, such as spider mites, aphids, whiteflies, thrips, mealybugs, and the eggs or young stages of lepidopterans and coleopterans. The larva uses its piercing mouthpart to suck out the body fluids of the victims. The emptied victim's body is then carried on the back of the larva to act as camouflage. Cassava mealybugs reared on cassava cuttings were used to feed the green lacewing. Continuous production of the two predators will depend on the availability and abundance of the food or prey. Therefore, we started rearing rice moth *Corcyra cephalonica.* We will use the eggs of *C. cephalonica* for rearing green lacewing and will use those of larvae for rearing the predatory stink bug.

We also just initiated rearing a plataspid bug, *Brachylpatys* sp., using sebania (*Sesbania grandiflora*) seedlings and gliricidia (*Gliricida sepium*) cuttings. We are going to use its eggs for mass-rearing *Paratelenomus* sp., a parasitoid that has potential for controlling invasive kudzu bug (*Megacopta cribraria*) in the U.S.

Farmer training on mass-production of *Trichoderma* and PGPR

Meity Sinaga, Giyanto, Ujang Dayat, Dedih Ruhyatna

Training on mass-production of *T. harzianum* and plant growth-promoting rhizobacteria (PGPR) was conducted in Pasirsarongge on April 25, 2012. Training topics of *Trichoderma* included preparation of corn media, use of plastic bags for holding media, methods for sterilization of hands and equipment, and inoculating media with hyphae of *Trichoderma*. The IPM CRSP team provided the farmers' group with an inoculation box, stove, gas, burner, and a pure culture of *Trichoderma*. Training topics of PGPR consisted of obtaining and culturing the endophytic bacteria (*Bacillus subtilis* and *Pseudomonas flourescens*) from bamboo or weed roots. Farmers make their own medium from potato as the carbohydrate source and chicken legs as the protein. The containers of liquid medium are aerated by bubbling air through a solution of Calcium permanganate. Incubation is 5 days. There were 30 participants (12 women) from 6 farmer groups. Six extension agents also participated.

Mobile plant clinics

Titiek Yuliani, Supramana, Nina Maryana, Tri Asmira Damayanti, Dewi Sartiami

In collaboration with the Mobile Plant Pest and Disease Diagnostic Clinics of Bogor Agricultural University (IPB) and the Agricultural Extension Agency of the District of Cianjur, the IPM CRSP Team conducted plant clinics on June 18, 2012 for vegetable farmers in Pacet. The objective was to determine what problems farmers were having in their fields. The van is equipped with microscopes, a generator, and other materials necessary for determining pest problems. Clinics were open for about 4 hours (9:00 am to 1:00 pm). Thirteen farmers visited the clinics and brought samples of infected plants, which consisted of green onion, chili pepper, crucifers, Chinese cabbage, and potatoes. Among major pests and diseases detected from the samples were: potato leafminer (*Liriomyza huidobrensis*), black aphid (*Neotoxoptera formosana*), and bacterial rot (Erwinia) on green onion; blight (*Phytophthora capsici*) on chili pepper; *Phoma lingam* and *Meloidogyne* on cabbage; sawfly (*Athalia proxima*); and late blight (*Phytophthora infestan*) and root knot nematode on potatoes. In addition to farmers, there were five extension agents, two pest observers, and one college student who participated. Following the detection session, there was a discussion on the management of various pests and diseases found in the samples.

Pest Surveys in North Sulawesi

Surveys, carried out from January to July 2012, showed that the papaya mealybug, *Paracoccus marginatus,* has established in the city of Manado and the region of Minahasa. Small infestations were observed in the district of East Bolaang Mongondow. The cycad scale, *Aulacaspis yasumatsui,* and chrysomelid beetle, *Oulema* sp., were found infesting the *Cycas* spp. This is the first record of these two pests in North Sulawesi.

Production of vegetables free of pesticide residues

Agricultural extension service provided training on organic farming and elimination of pesticide residues to farmer's groups in Tomohon and Modoinding. Farmer field schools were conducted in Rurukan and Kumelembuay, with particular emphasis on organic farming of cabbage in collaboration with the Bureau of Food Crops and Horticulture of Tomohon.

Associate Awards

African Food Security Initiative (AFSI)

The AFSI associate award closed on April 30, 2012. A project close-out meeting was held on the April 18-19, 2012, in St. Louis, Senegal, to bring together Ugandan, Senegalese, and American project partners to present results of their activities. Because of the political upheaval in Mali and the resulting U.S. suspension of assistance to institutions of the government of Mali, none of the Malian project partners could be present at the meeting. The suspension of assistance prevented Virginia Tech from being able to pay outstanding invoices to Malian partners, so USAID authorized a no-cost extension through April 30, 2013.

Short-term training: Two Senegalese from ISRA were funded by AFSI, and two Malians from IER were funded by the Mali associate award to learn tomato grafting at North Carolina State University in the laboratory of Frank Louws. Bob Gilbertson's laboratory at UC Davis took the four trainees on a tour of industrial tomato seedling management in addition to providing training on laboratory methods of virus detection. Upon returning home, the participants were tasked with adapting the grafting techniques they had learned to local conditions for eventual promotion as a small enterprise for women's groups and, in Mali, a handicapped association.

MALI

In the *Cercle de Kati* in Mali – an important tomato production area that supplies vegetables to Bamako and to distant parts of Mali – OHVN and IER worked together closely to establish area-wide management of tomato viruses in villages within five *communautes rurales*: Diago, Diao-Gare, Kalifabougou, Yelekebougou, and Winzinbougou. Two hundred and eighty growers with whom OHVN worked in 2010 were given additional training in FY2011 (224 men 56 women). As tomato yields rose, land used for tomato production increased 65ha from the 181ha baseline in 2009 among the five *communautes rurales*. There was an overall increase of 20ha of land under vegetable cultivation (tomatoes plus pepper) and a total of 287ha under area-wide virus management by April 2012. Kati is one of the few places in Mali where tomatoes are grown for market during the rainy season. Yield during the rainy season was 33 to 40T/ha using improved varieties Shasta, H8804, or Qwanto compared to 25T/ha for the commonly used variety Roma VF. During the dry season, the improved varieties produced 20-30T/ha compared to 5-to 12T/ha for Roma VF or Tropimech.

Production of certified NERICA 4 rice seed was successful with a grower association in M'Pegnesso, Mali and failed at a women's association in Nièna, Mali. This activity was done in collaboration with the West African Seed Alliance (WASA). It demonstrates the feasibility of treating rice as a high-value product for raising incomes of smallholder rice farmers.

IER completed field tests of light traps in Bema in western Mali in October 2011 that demonstrated the effectiveness of 470nm blue LED light to trap the head-damaging blister beetle *Psalydolytta vestita*.

Building Local Capacity in IPM Solutions

The Mali IPM CRSP associate award (MIPM) was awarded in January 2010 for three years. It had three primary activities: 1) promote technology transfer for area-wide virus management in commercially important areas of tomato production; 2) re-build the capacity of the national pesticide residue laboratory; and 3) expand the IPM pesticide safety training program to a national scale. Additional work promoted improved technologies in tomato pest management and long-term degree training for Malian researchers.

In FY2012, the Mali associate award workplan added two activities from the closing AFSI project that aligned with USAID/Mali's Feed the Future commodities. MIPM chose to support IER's testing of millet varieties resistant to blister beetle attack and testing environmentally benign spraying with neem extract, the organic insecticide spinosad, or insect trapping with portable light traps. Pending a favorable funding decision for the Malian program of WASA, MIPM was going to continue collaborating with WASA to promote certified rice seed production among smallholder producers (focusing on women) in the seasonally flooded *bas-fond*s rice fields of Sikasso in southeastern Mali.

In February 2012, the Mali Mission communicated its requirement that all project activities be moved into the communes that had been selected for its Feed the Future implementation. Two of MIPM's approved partners have geographically limited zones of intervention outside these areas. Before adjustments to the program were completed, a *coup d'état* in March 2012 halted all project activities. Shortly after the coup, the north of Mali was overrun by Tuareg separatists and Islamic extremists, putting the FTF focus zone of Timbuktu off limits and making activities in the FTF region of Mopti uncertain. The U.S. State Department issued a suspension of assistance to the Government of Mali on April 2, 2012. All of MIPM's host country partners are government public institutions, so the project's activities have stopped.

Among the activities completed before the suspension of U.S. government assistance resulting from Mali's coup d'état were: a weeklong training by partner OHVN training of pesticide safety trainers from four national services; and an awareness-building workshop for pesticide vendors, led by the *Direction de Protection Végétaux.* Equipment purchases and laboratory enhancements were underway at the Environmental Toxicology and Quality Control Lab, but orders had to be canceled because of the suspension. The laboratory thus remains far from the analytical capacity that the project resources would have enabled. IER began tomato varietal trials across Mopti and Sikasso.

Short- and long-term training: Three men and three women undertook 20.5 person-months of short-term training on technical subjects and language. The training increased capacity at IER to organize and code socioeconomic survey data, help the pesticide residue laboratory finalize a protocol for detecting synthetic pyrethroid insecticide residues using thin layer chromatography, and transfer skills for vegetable grafting and containerize seedling production.

At the time of the suspension of assistance, four men and four women were being supported by MIPM for degree training in Mali or in the region. Four students were from IER and four students were from the pesticide residue laboratory.

SENEGAL

A repetition of the 2010 field leveling experiment was carried out in irrigated rice fields in the Senegal River Valley during the FY2012 season. Combined with prior results, the small scale leveling experiment showed reduced weed density in leveled fields. The 2012 results showed yield gain of 1T/ha in each of two leveled fields compared with the unleveled companion plots.

Season-long evaluation in two localities in southern Senegal of rice varieties previously registered based on trials in northern Senegal indicated a varietal sensitivity to rice blast and varietal resistance to rice yellow mottle virus (RYMV). Incidence (96-100%) of rice blast in four NERICA varieties in the humid Lower Casamance was comparable to that of a local variety. Rice blast incidence was four times less in the somewhat drier region of Upper Casamance than Lower Casamance. Symptoms were far more severe in Lower Casamance, indicating a need for blast-resistance there. Under relatively high disease pressure in Lower Casamance, the NERICA varieties (7%) had more than four times lower incidence of RYMV than the local variety (32%). In Upper Casamance, RMYV pressure was not high, resulting in similar levels of disease incidence between NERICA varieties and the local variety.

UGANDA

Completion of multi-location field trials of the tomato variety MT56 resulted in a portfolio for submission to Uganda's registration authority. Among five varieties, MT56 showed superior resistance to bacterial wilt.

A survey of tomato fields in different parts of Uganda showed that 60% of fields had virus-infected plants. Incidence and severity of tomato viruses increased throughout Uganda compared with a survey conducted five years earlier. Districts where continuous tomato cropping is common had the highest incidence of tomato viruses. Co-infection with *Cucumber mosaic virus* and *Tomato mosaic virus* was common. The *Tomato mosaic virus* strain is unique to Uganda.

RYMV was characterized in Ugandan rice fields. Molecular sequencing of viral RNA demonstrated 95% identity among samples from Uganda, but only 85% homology with the type virus from Côte d'Ivoire. An important finding was that viral genetic factors linked to RYMV's ability to break resistance in rice varieties were not present in the Ugandan genotype, suggesting that varietal resistance may be used against it.