USAID/Haiti Mission-Wide
Pesticide Evaluation Report and Safer Use Action Plan
(PERSUAP)

Partners: CRS, DEED, USAID, WINNER and World Vision

Prepared for:

USAID
FROM THE AMERICAN PEOPLE

Prepared by:

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I. SUMMARY OF KEY FINDINGS AND RECOMMENDATION

Economic losses of crops to pests – Interviewed Haitian farmers reported, and were observed, suffering up to 100% crop losses due to inadequate or non-existent pest management strategies. IPM plans for each crop have been developed (see Annex 1) in an attempt to address this issue, reduce the need for pesticides and give farmers low-cost non-chemical control alternatives. Farmers will be trained to monitor and recognize economically damaging pest populations and appropriately apply the lowest-risk pesticides only when all other recommended alternatives prove ineffective. Local availability of less-toxic alternatives is a problem throughout Haiti and USAID partners will make every possible effort to maximize availability and use of less toxic alternatives. As lower-risk alternatives become available on the market, they should be incorporated into the IPM program.

Current agricultural practices and pesticide use in the region – The use of pesticides that are harmful to both humans and the environment was observed throughout Haiti. During a farmer association focus group attended by Sun Mountain staff, farmers reported recent use of DDT, a WHO and US EPA banned pesticide, on corn crop pests. Another focus group reported the prevalent employment of professional pesticide applicators that eat and smoke while applying chemicals. In general, the findings related to pesticide use behaviors demonstrated that, while most farmers realize the general health risk associated with pesticides, they lack the resources, opportunities and access to information to properly protect themselves, their families and environments. Furthermore, use of acutely toxic chemicals, in combination with improper application methods (use of a broom and bucket), exacerbate many pesticide's environmental and human health risks.

All nematicides encountered in the field and all chemical nematicide alternatives found during research and analysis were registered as EPA RUP (Restricted Use Pesticides). There is a microbial nematicide that was encountered during research and is recommended for use in this PERSUAP. RUP nematicides cannot be recommended in this PERSUAP and any RUPs promoted by USAID funded programs require a further environmental assessment, specifically concerning the environmental costs and the social and economic benefits related to their use, before they can be approved for use by USAID funded projects.

Agro supply stores – The Sun Mountain International team has, during its field work for the completion of the USAID Mission-Wide PERSUAP, discovered several environmentally concerning and potentially hazardous behaviors related to the sale and use of pesticides among farmers, 'professional' pesticide applicators and agro-input store staff in the USAID partner project regions surveyed.

Many of the agro-input supply stores visited did not sell adequate PPE or application equipment. Backpack sprayers were often in short supply or out of stock, forcing farmers to use unsafe application methods. Furthermore, the majority of store pesticide inventories are made up of RUP's and expired products are often placed on shelves for sale. There was also a shortage of staff trained in pest management and the use of hazardous pesticides. Some stores claimed to

have a trained technician on staff although these professionals were never encountered. To the degree allowed by partner project mandates, collaboration and capacity building of ago-input supply stores would be highly beneficial. Training of store staff in integrated pest management, and collaboration to increase supplies of low-toxicity GUPs, appropriate PPE and application equipment, could greatly improve farmer pesticide-use safety and access to information concerning effective and low-risk pest management.

Regulations, labeling and packaging – The Ministry of Agriculture, Natural Resources and Rural Development (MARNDR) is responsible for regulation of pesticide import, distribution, use and disposal; however, various informal sources reported that Haiti does not currently have functional legislation governing pesticide import, distribution, or use. Products were found to be imported from the United States, South and Central America, Europe and China. Some labels follow the WHO recommended color toxicity coding system and many do not. Labels and safety information were frequently found in English, Spanish and even Chinese, but rarely in French and never in Creole. Many stores visited were in the habit of removing products from original containers and selling them in smaller containers such as plastic or brown paper bags.

Spray drift risks and chemical storage – Most Haitians have very small plots (often less than 1 hectare total); in such a situation it is important that pesticide use be avoided near homes and potable water sources. Generally, pesticide applications should avoid coastal and estuarine areas as many products have adverse impacts on non-target species inhabiting these environments. In irrigated areas where pesticides are used, use of irrigation water for drinking, washing, cooking, etc. should be prohibited as pesticide residues and drift can build-up in canals.

Farm families often store goods, including pesticides, in an attic above the main room of the house which is only accessible by ladder, in locked rooms, outside, and buried in fields. Leaking containers and fumes pose potential hazards to inhabitants of the house. Proper storage of pesticides separate from foods for human or animal consumption, in a separate structure with proper signs reading “Danger” will be promoted under the program.

Disposal of containers and expired products – Solid waste collection programs in rural Haiti are essentially nonexistent; re-use of pesticide containers is a potential concern. One group of farmers visited by the Sun Mountain field team reported using old pesticide containers for water storage and as water bottles. Farmers will be trained to puncture and bury empty pesticide containers, and an awareness campaign targeting non-farmers, especially women and children, will discourage re-use of pesticide containers. The creation of a pesticide container collection problem would be a highly valuable exercise for any current or future agricultural program.

Among the agro-supply stores visited in Haiti, improper and unsafe disposal of expired pesticides (i.e. burning, pouring into latrines, or throwing away with other trash) was frequently observed. Expired pesticides may be less effective but the safest disposal tactic is application of the product in accordance with the instructions on the label. In spray form the active ingredients are sufficiently diluted to minimize risk of human and environmental intoxication.

Integrated pest management and pesticide safer use training – USAID agricultural assistance programs will train farmers on integrated pest management (IPM), good agricultural practices

(GAPs) and will promote cultural, biological and reduced-risk pest management. Practices such as biological and botanical controls will be recommended before the pesticides evaluated in this report. Farmers will be trained to properly identify and monitor economically damaging pest levels and to only apply pesticides when pest populations surpass economic thresholds and at times during the growing season and pest life cycle when pesticides are most effective, thus reducing the need for additional applications. As a general rule, the following cultural practices will be promoted in the programs included in this PERSUAP:

- Planting with pest-resistant and/or more productive seed varieties;
- Proper crop spacing and irrigation management to prevent fungal diseases and preserve soil quality;
- Coordinating planting calendars to offset pest life cycles;
- Crop rotation with pest non-host or pest-suppressive crops, management of host weeds and location of fields away from potential pest hosts;
- Conservation of beneficial insects and natural enemies by delaying pesticide application when beneficial insects are foraging or appear to be gaining control over pests;
- Pruning of tree crops and management of air flow to reduce fungal infection.

Several GAPs promoted by USAID partners are being adopted by beneficiary farmers. Composting (especially in nurseries), use of seedling nurseries, pruning, biological and cultural controls (especially on smaller plots during low pest pressures), use of improved varieties and improved planting strategies to reduce favorable conditions for infestations were reported by, or observed among, significant portions of the beneficiary farmers contacted.

Annex 1: Integrated Pest Management Plans by Crop provides crop specific IPM measures at each stage of the growing season, to be promoted in the program. Selected crops are divided by fruits and vegetables with a description and IPM plan of each pest affecting each crop. General pest sections can also be found at the beginning of the fruit and vegetable groups which provide IPM information concerning pests found throughout the entire group of crops. The chemical treatment options for each crop are listed in the order in which they are recommended (i.e. lowest risk measures first), and will only be recommended if the cultural controls fail to keep pest populations below economic thresholds.

II. Background

This Haiti USAID Mission-Wide PERSUAP is designed to serve as an umbrella reference and field document related to the USAID's ongoing and future food security, agricultural technical assistance and development programs. USAID implementing partner programs covered specifically in this report include: CRS's 2008-2012 MYAP in the Tiburon – Saint Jean watershed, DAI's USAID-DEED (Economic Development for a Sustainable Environment), Chemonics' USAID-WINNER (Watershed Investment for National Natural Environmental Resources) and World Vision's 2008-2012 MYAP The PERSUAP is an environmental assessment aimed at evaluating impacts of agro-chemical control methods that are either, directly promoted by USAID implementers or used by beneficiary farmers. The Haiti USAID Mission takes the following perspective on the Regulation 216 requirements for agricultural partners:

> If your organization is working in agriculture in Haiti, some of your project target population is probably using pesticides, and therefore your program is dealing with or affected by pesticides and pest management. Your organization, therefore, is required to complete a PERSUAP, regardless of whether or not you are purchasing, recommending or providing technical assistance concerning pesticide use.
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> - USAID Partner Meeting Minutes on Mission-Wide PERSUAP; Dec. 17th, 2009

The broad and inclusive focus of the Mission-Wide approach was selected as the best strategy to address USAID partner's PERSUAP requirements. This approach proved to fulfill many of the anticipated benefits in terms of partner cost reduction and sharing, facilitating field data collection, analysis and development of scientific data. One of the principal strengths of this report will be its ability to provide all partners with lessons learned from each USAID program's experiences in pest management and agricultural development within their specific project regions. It is the hope of the authors that the agricultural techniques, training strategies, planting systems, cropping, pest management practices and other general farming system information from various departments of Haiti, will help inform ongoing and future USAID agricultural assistance and development programs in the country and across the globe.

This PERSUAP recommends the lowest human- and environmental-risk products available for control of only the most economically damaging pests reported during field work in Haitian project regions, for which non-chemical controls are insufficient. For each product included in this assessment there is a 12 step evaluation to determine the appropriateness of the product for use in Haiti and the conditions under which the product should be used (See Sections IV and V) In an effort to promote safer pesticide use and Integrated Pest Management (IPM) this report identifies a list of non-chemical, cultural, biological and mechanical controls to be exhausted prior to use of agro-chemical control options.

For each USAID partner included in this assessment there are some unique variables specific to each of their respective project regions. In Haiti, the agro-ecological zones, corresponding pests and common control strategies are largely the same throughout departments and project regions, with some exceptions. The project and region specific variables will be discussed below for each of the participating implementing partners.

II A. Introduction to participating Haiti programs and regions

i. CRS: Kole Zepol MYAP: 2008-2012 Saint Jean – Tiburon Watershed

The Catholic Relief Service agricultural component of the 2008-2012 MYAP in the Tiburon – Saint Jean watershed develops community management capacities of natural and agricultural resources. This project aims to accomplish the following objectives: 1) provide 6,000 small farmers with training in agro-forestry practices, 2) implement a food-for- work program to rehabilitate and stabilize more than 55 kilometers of erodes ravines, 3) protect 550 hectares worth of communal farm land and give 2,250 workers and their families improved livelihood opportunities during the lean season. The MYAP has three main agricultural components:

1) Natural Resource Management: Trainings in soil conservation, agro-forestry nursery and tree grafting trainings;
2) Increasing Agricultural Production: Demonstration plots will introduce improved agricultural techniques, multi-story fertilizer use trainings, and collaboration with the Center for International Agriculture in the Tropics (CIAT) and Caritas for distribution of improved and resistant varieties seed and training of trainers in improved techniques;
3) Agro-entrepreneurship: Organizational capacity building, seed and fertilizer fairs, money management and personal finance trainings.

The following primary outputs will be achieved through the above activities:

1) Vulnerable communities have increased farm and off-farm income;
2) Farmers groups practice improved agricultural techniques;
3) Agro-enterprise practices adopted by vulnerable rural households;
4) Internal savings and lending methods successfully adopted by vulnerable rural households.

ia. Project regions and cropping by agro-ecological zones

CRS's project region is located in the Tiburon-Saint Jean watershed in the Southern Department of Haiti. Included in this watershed are three regions where CRS activities are concentrated: Les Anglais, Tiburon and Chardonnieres. Project activities occur in each of the four principal agro-ecological zones found throughout Haiti: Irrigated plains, non-irrigated (dry) plains, dry and humid hillsides. The greatest differences in cropping occur between farmer plots in irrigated areas and those plots in the dry plain or hillside areas.

In the irrigated plains monocultures of beans, corn and rice are common whereas in the hillsides and in un-irrigated areas, corn and beans are grown as part of intercropping systems that incorporate staple food crops such as yams, manioc, sweet potato, plantains, pigeon pea and peanut. In addition, high-value vegetable crops (tomato, pepper, cabbage, broccoli etc.) are being promoted by CRS in demo-plots. Coffee is also grown in small quantities in the humid

hillside zones but, as is the case in many regions of Haiti, coffee production is declining as a result of low international market prices and the increased production of high-value vegetables.

CRS will provide technical support for the following crops and livestock:

Bean	Onion	Yam
Beet	Peanut	Avian
Broccoli	Pepper	Cattle
Carrot	Pigeon pea	Goat
Cabbage	Plantain	Sheep
Corn	Sorghum	
Eggplant	Stored grains	
Manioc	Sweet potato	
Okra	Tomato	

ib. Principal pests and common control practices

In the lowland irrigated areas of the Southern department, agro-chemical use is quite common Monoculture planting predominates in this region and is associated with high levels of agricultural inputs including insecticides, fungicides and herbicides and synthetic fertilizers. Pests most commonly associated with major losses of rice, bean and corn crop in this region include caterpillars, rice water weevil, aphids, bean-leaf beetles, and golden mosaic virus, weeds such as itch grass and other perennial grasses. Chemical controls are utilized for all of these pests, except the rice water weevil for which no products were found to be currently available. Agro-chemical products used by farmers in this area, as in most of Haiti, are selected based on availability rather than their appropriateness for use on pests and crops in question. The most common products found in use by farmers during field interviews were Malathion, Karate, Curacron, Tricel, Dithane, and Fusilade. Of these products, over half are Restricted Use Pesticides (RUPs) (Malathion, Karate, Tricel EC and Curacron). The remaining products are General Use Pesticides (GUPs) (Dithane and Fusilade).

Haitian pesticide use and application practices are generally unsafe and pose high risks to humans and the environmental. In Les Anglais, where the highest incidence of pesticide use in CRS project regions was reported, the practice of hiring 'professional' pesticide applicators was reported to be common by several farmers of irrigated lands. When contacted, these hired applicators reported several concerning behaviors. Applicators described using small carpenter's masks as their only form of PPE and improper mixing, transport, storage and application practices. Some reported stomach and respiratory ailments which they supposed were associated with their frequent exposure to pesticides. Training of this particular group of farm workers was discussed as a potentially valuable aspect of CRS MYAP activities to be considered in the future.

CRS agronomists, field agents and community training facilitators are currently promoting exclusively non-chemical controls methods. If any chemical controls are to be promoted, it will be in the context of an integrated pest management strategy promoting cultural and reduced-risk biological controls before recommending non-RUP pesticides (for specific IPM plans by crop

see Annex 1). When pest populations reach economically damaging levels despite implementation of best practices, extension officers will recommend only USEPA-approved non-RUP products and will provide training on safer use (including transport, mixing, proper application, storage and disposal). To the extent possible, field officers will recommend locally-accessible formulations which are of lowest-risk in the local context but remain effective (see section IV. Pesticides Evaluation Report and section V. Safer Use Action Plan for more detail).

CRS field agents and staff will monitor pesticide use on demo plots and will make adjustments as necessary. Availability of reduced-risk agrochemicals in Haiti is a country-wide challenge however, and CRS staff will work with agro suppliers to order reduced-risk products for future growing seasons whenever possible. It is hoped that with the proper implementation of the IPM plans for each crop, the need for pesticides will be reduced with each growing season.

Mechanical controls such as hand picking of caterpillars, beetles and weeds are common practices on smaller plots but these practices are prohibitively expensive on larger irrigated lands according to contacted farm owners. Biological controls such as neem and chili powder sprays are not uncommon but are employed predominantly by farmers in hillside and un-irrigated regions where, generally speaking, agro-chemical use is much lower than in the Southern department. Use of neem, which grows naturally in many CRS project areas, is, despite CRS efforts to promote these types of biological controls, still minimal in their project region. Distribution of mosaic resistant bean varieties has been carried out by CRS partner CIAT causing increased yields in both lowland and hillside demonstration plots.

GAPs such as crop rotation and association, fertilization with organic nutrients or compost, drip irrigation, pruning, proper planting techniques, spacing and use of plant nurseries are all being promoted by CRS and their agricultural partners but were not common practices for most beneficiaries prior to their work with CRS. In non-monoculture hillside areas these improved practices and non-chemical controls were, according to the majority of farmers surveyed, sufficient to prevent major crop losses.

iic. Livestock component

The CRS MYAP activities include the provision of technical support and training in livestock management and technology transfer of good animal husbandry practices. The livestock trainings emphasize improved animal sanitation and nutrition to minimize sickness and disease.

The use of agro-chemical livestock products are employed in Haiti for the control of external (mites, lice, earworms and flies) and internal (tapeworms, stomach and intestinal worms) goat parasites provided that veterinarians provide safe and proper use trainings for farmers and assistance in administration of products. Two products, Albendazole and two forms of Ivermectin (topical and injected varieties), are commonly used by the largest veterinary service agency in the country (Veterimed) for management of livestock parasites in Haiti.

CRS is not currently promoting farmer use of any chemical controls for livestock pest management. However, if any agro-chemicals are to be used by farmers they should be selected from the list of veterinary products included in this PERSUAP. Chemical controls for livestock parasites should only be used after farmers have exhausted all non-chemical controls

recommended in the livestock IPM plan. Any promotion of chemical livestock parasite controls should be accompanied by trainings in safe transport, mixing, dosing, application, storage and disposal of veterinary products.

ii. DAI : Dévelopement Economique pour un Environnement Durable (DEED) 2007-2010 in Limbe and Montrouis Watersheds

The DEED project aims to protect and rehabilitate target watersheds through a market-based approach, to improve resource and land management and agricultural infrastructure (i.e. irrigation canals) through an expansion of enterprise, incomes and employment opportunities in the production of high-value crops. To achieve these objectives DEED activities focus on the following activities: 1) initiating investments in sustainable watershed and resource management thereby minimizing vulnerability of local environments, 2) promoting and training in agro-forestry planting strategies and construction of hillside soil conservation structures 3) Value chain analysis and technical assistance improving high value crop/product yields and quality.

iia. Project regions and cropping by agro-ecological zones

Due to the DEED mandate for watershed protection, the majority of project activities occur in two hillside agro-ecological zones: the dry and humid hillside regions and the lowland regions (particularly in the Montrouis area). Projects aim to augment high value crop production through farmer field school and value chain approaches. The cropping strategies promoted by DEED's market based watershed protection strategy for increasing farmer's economic benefits through agricultural production, introduce some novel crops, planting strategies and growing techniques to project beneficiaries.

As in most Haitian regions, cropping differences are greatest between hillsides and irrigated lowland areas. There are also significant cropping differences between the two DEED project regions of Montrouis and Limbe. In Montrouis the most significant hillside crops consist of beans, broccoli, corn, cabbage, coffee, yam and pigeon peas along with some limited plantain and citrus trees surrounding farmer plots. The most common crops in irrigated lowland plots include corn, plantains, eggplant, peppers, tomatoes, beans. All of these common crops are shared by the un-irrigated plains region with the addition of melons and sorghum..

In Limbe and Montrouis, the DEED project activities are focused primarily on hillside plots and promote a combination of crops commonly grown in these areas and other high-value crops selected for introduction by a study carried out by a group from the US Forestry Service. This study identified the most productive intercropping strategies that also serve the purpose of increasing farmer incomes, conserving soil structure and minimizing erosion through promotion of a phased shift from annual to high-value perennial crops. Key crops included in this strategy are: sugar cane, cacao, coffee, pigeon pea, yams, pineapples, forages, squash, peanut, plantain, manioc and fruit and forest trees (avocado, citrus, mango, moringa, glycidia, cedar, etc) that are valuable for roles in honey, fuel wood or fruit production. Crops are planted in multi-culture hillside hedgerows supported by vegetative material and living fence posts. Other vegetable food crops (cabbage, beans, corns, peppers, tomatoes, etc.) are intercropped between hedgerows to provide more immediate short term gains in terms of food for family consumption and marketing.

DEED will provide technical support for the following crops:

Avocado	Eggplant	Pineapple
Bean	Elephant grass	Plantain
Broccoli	Lettuce	Sugar cane
Cacao	Mango	Sweet potato
Carrot	Manioc	Forest and bio-fuel tree species
Cabbage	Onion	
Citrus	Peanut	Tomato
Coffee	Pepper	Yam
Corn	Pigeon pea	Goat

iib. Principal pests and common control practices

The incidence of pesticide usage varies significantly between the two DEED project regions. While DEED promotes exclusively non-chemical cultural and biological controls and all beneficiaries interviewed reported chemical free pest management strategies, other non-beneficiary Montrouis area farmers reported agro-chemical use, suggesting that chemical use is not unknown to the region. If any chemical controls are to be promoted it should be in the context of an integrated pest management strategy promoting cultural and reduced-risk biological controls before recommending non-RUP pesticides (for specific IPM plans by crop see Annex 1). When pest populations reach economically damaging levels despite implementation of best practices, extension officers will recommend only USEPA-approved non-RUP products and will provide training on safer use (including transport, mixing, proper application, storage and disposal). To the extent possible, field officers will recommend locally-accessible formulations which are of lowest-risk in the local context, but also effective (see section IV. Pesticides Evaluation Report and section V. Safer Use Action Plan for more detail). DEED field agents and staff will monitor any pesticide use on demo plots and will make adjustments as necessary.

Principle pests reported for the irrigated perimeters in the Montrouis project areas include for plantains; black and yellow sigatoka, banana root borer, and nematodes; for peppers and tomatoes; tomato yellow leaf-curl virus; or eggplant peppers and tomatoes; whiteflies, in beans; golden mosaic virus and in corn; aphids were found to be the principle source of losses for each of these respective crops. As stated above, beneficiary farmers interviewed were encouraged by DEED to utilize non-chemical mechanical, cultural and biological controls such as handpicking, chili pepper and garlic sprays, ash, neem oil and Zohar LQ-17, Bio-Life, Vektor, Bro-Carril and Mastercop 25 SC.

Among non-beneficiary farmers, particularly of plantains in the Montrouis region, use of nematicides such as Vydate and Mocap (two highly toxic RUPs) was found to be common. Non-DEED associated farmers also used chemical controls including the insecticides, Malathion, Tricel, Curacron, Karate and Sevin for whitefly controls on papayas, tomatoes, melons, manioc

and okra, and Glysell (a broad spectrum herbicide, glyphosate) in plantain fields, and Dithane for fungal diseases of beans and peppers.

In the Montrouis hillside regions (dry and humid hillside agro-ecological zones) agro-chemical use is significantly less common. The principle pests discovered during field interviews in Fond Baptiste include: for cabbage, corn, pigeon pea, broccoli and manioc; caterpillars and snails; in beans; aphids and golden mosaic virus; in carrots; powdery mildew; for yams; nematodes; for citrus; no significant pest problems were reported although melanose[1] was observed on lemon and grapefruits; and in coffee; coffee berry borer are the causes of the greatest percentages of crop losses according to farmers and DEED field staff contacted. Control methods in the form of mechanical, cultural and biological options are utilized. Handpicking, olive oil and mixtures of chili pepper, garlic and soap were found to be among the most common forms of insect control Ashes were used for slug control by hillside farmers.

In the Limbe project areas, there is a significantly lower incidence of pesticide use, due largely to the complete absence of formal agricultural input supply stores selling agro-chemicals. Farmers choosing to use pesticides must either find an informal supplier, or travel to a Haitian or Dominican city with access to agro-chemical products. In addition, DEED's activities involving cacao farmer field schools and their interest in organic certification, has prompted a zero tolerance stance towards agro-chemical use by beneficiaries. DEED project staff and farmers also explained that they had no choice but to find non-chemical pest controls due to both the limited availability in the Northern department and their inability to afford chemical products even if they were available.

In the dry and humid hillside farms the principle pests reported include: for pineapple, sugar cane, and citrus; ants; for sugar cane, corn, beans, cabbage, and tomatoes; caterpillars; in peppers and tomatoes; whiteflies; in coffee; coffee berry borer; and for yams; white grubs are the most significant sources of crop losses in the regions in the North department visited.

Control options implemented by beneficiary farmers include mechanical, cultural and biological controls such as, handpicking, soap, tobacco, garlic and pepper sprays along with neem.

DEED is also involved in trainings to promote good agricultural practices such as rotation, composting, use of seedling nurseries, pruning, etc. Some farmers contacted were familiar with and practiced several of these techniques such as composting, use of seedling nurseries and pruning. The adoption of these techniques was much higher among beneficiaries than non-beneficiaries contacted.

iic. Livestock component

One of DEED's activities includes the distribution of goats, accompanied by animal-husbandry technology transfers and veterinary service trainings contracted through the national veterinary health service Veterimed. The livestock trainings emphasize cut-and-carry feeding to minimize

[1] This superficial blemish does not affect overall production but can reduce the market value

grazing of tree seedlings and a passing-on the gift [2] methodology to reach greater numbers of community members.

The Veterimed contract is the only aspect of the DEED program which indirectly employs the use of agro-chemical products in the control of external (mites, lice, earworms and flies) and internal (tapeworms, stomach and intestinal worms) goat parasites. Veterimed trained veterinarians provide capacity building exercises and medical supply kits to trained community veterinarians and administer products, minimizing the risk of misuse and negative health impacts. Two products, Albendazole and two forms of Ivermectin (topical and injected varieties), are used for management of goat parasites. Proper application practices such as the use of protective gloves were reported. However, there were also reports of improper syringe disposal practices. Unsafe pesticide disposal behaviors were found throughout the course of field work for this PERSUAP and stem directly from the poorly functioning, under resourced waste management systems which currently exist in Haiti. These already weak systems also suffered severe reductions in capacity resulting from the January 2010 earthquake.

DEED currently isn't promoting farmer use of any chemical controls for livestock pest management. However, if any agro-chemicals are to be used by farmers they should be selected from the list of veterinary products included in this PERSUAP. Chemical controls for livestock parasites should only be used after farmers have exhausted all non-chemical controls recommended in the livestock IPM plan. Any promotion of chemical livestock parasite controls for use by farmers should be accompanied by trainings in safe transport, mixing, dosing, application, storage and disposal of veterinary products.

[2] The passing-on the gift strategy, developed by the Heifer Project International, requires beneficiary families receiving an animal must give up one of that animal's offspring to another community member as a form of resource sharing, community-building and promoting food security among a greater number of beneficiaries.

iii. Chemonics – WINNER (Watershed Investment for National Natural Environmental Resources) 2010 – 2014

The Watershed Investment for National Natural Environmental Resources (WINNER) project aims to provide agricultural extension and training to a total of 860 farmers in CRDDs (Sustainable Agriculture Training Centers) located in the West, Central and Artibonite departments. WINNER will provide technical assistance to farmers over the next five years by disseminating best practices, techniques and technologies to improve productivity and prevent crop losses through responsible IPM (Integrated Pest Management) strategies. Training of trainers will be carried out using a module approach covering the following key areas: 1) Animal production; 2) Soil Conservation; 3) Crop production (cereals – hot zone); 4) Vegetable crops (temperate); 5) Agricultural mechanization; 6) Post harvest technology; 7) Environment (afforestation and soil conservation) and 8) Family planning.

WINNER is also committed to working with agro-input suppliers in their project areas to provide capacity building trainings in order to improve their business management, knowledge of pesticides, pest management, safe and effective use of USAID PERSUAP approved chemical products. Through partnership with agro-input stores and the placement of young university accountants and business students under the supervision of agronomists to work with agro-input store staff, WINNER will significantly develop the capacity of these stores and their access to good agricultural practice information, such as integrated nutrient and pest management strategies.

These trainings will fulfill the following objectives:

- Inform and raise awareness of weakness in current local agricultural practices
- Disseminate alternative methods and technologies to improve sustainability
- Assist farmers in adapting alternative methods and technologies to local conditions
- Improve understanding of factors of production
- Provide technical expertise to better manage the farm and non-agricultural activities
- Empower farmers to become community leaders in popularizing best practices relating to agricultural environmental protection.

WINNER will provide technical support for the following crops:

Avocado	Leek	Rice
Beet	Lettuce	Sorghum
Bean	Mango	Spinach
Broccoli	Manioc	Sugar cane
Cabbage	Onion/Shallot	Swiss chard
Carrot	Papaya	Potato
Citrus	Peanut	Sweet potato
Coffee	Pepper	Forest and bio-fuel tree species
Corn	Pigeon pea	
Eggplant	Pineapple	Tomato
Elephant grass	Plantain	Watermelon

Yam	Cattle	Sheep
Avian	Goat	

iiia. Project regions and cropping by agro-ecological zones

WINNER has CRDDs in five regions: Kenscoff (dry and humid hillside zones), Bas-Boen (irrigated, un-irrigated plains, dry and humid hillside zones), Mirebalais (irrigated, un-irrigated plains, dry and humid hillside zones), Cabaret (irrigated and un-irrigated plains and dry and humid hillsides) and Gonaives (irrigated and dry plains, dry and humid hillside zones. The crops of primary importance vary slightly by region as will be shown below.

In Kenscoff, which lies in the hillsides directly south of PAP, there is a focus on vegetable crops for sale in local and Petion Ville markets. WINNER trainings here focus on vegetable production, soil conservation agriculture techniques (i.e. terracing, contour farming, veltivier plantings, etc.), and farm business management and partnership and training with local agro-input suppliers. Through these trainings WINNER will also seek to address key soil stability and erosion vulnerabilities threatening this area. The most important crops for this area include: plantains, potatoes, tomatoes, carrots, broccoli, beans, beets and lettuces.

The region covered by the Bas-Boen CRDD includes the Riviere Gris catchment area known as the Plaine du Cul-de-Sac and the hillside areas between Croix-des Bouquets and Mirebalais. Beneficiary farmers own plots located in four primary agro-ecological zones: irrigated and dry plains, along with dry and humid hillsides. In the plains, corn, sorghum, okra, eggplant, beans, rice, sugar cane, onion, pepper, shallot and plantains are among the dominant crops. In the hillside plots these lowland crops are incorporated into poly-culture farming systems with other staple food crops including, yams, manioc, mangoes, sweet potatoes, and pigeon peas.

To the north into the Central Plateau, the CRDD in Mirebalais, will be responsible for training of farmers in the same principle agro-ecological zones as the Bas-Boen, that is: irrigated and un-irrigated plains, and dry and humid hillsides. At the time of field visits the Mirebalais training center was under construction and relationships with farmer beneficiaries had yet to be fully formed. For this reason we focused our interviewing on the head agronomist and director of the training center. In the plains of Mirebalais, principle crops were reported to be: corn, peanut, pigeon pea, sorghum, and beans, and in the hillside regions the main crops of importance included: beans, corn, sweet potato and plantain. WINNER trainings will focus on crops that have potential to provide rapid short term increases in income. Rice, cabbage, eggplant, carrot, onion, lettuce, okra, tomato and pepper varieties once proven to be successful in local conditions at demonstration plots are among the crops WINNER will be considering for introduction through their crop specific training modules.

The Cabaret CRDD will be working in each of the four major agro-ecological zones identified above and, as in Mirebalais, the project here is also still in the process of identifying key focuses for their training components. For the plain farmers, key crops include: plantains, corn, beans, eggplant, pigeon pea, watermelon, tomato, pepper, okra. In the hillside farmers primarily grow corn, sorghum, beans, manioc, plantains, sweet potato and melon.

Gonaives CRDD will also work in the four main agro-ecological zones identified in the two regions above. The farmer trainings will focus on cereal and livestock agricultural production training modules,

mechanization of agriculture, family planning, and environmental management. The principle crops were reported as largely similar in the plains and the hillside areas, the main difference being the planting technique, which in the irrigated lowlands has a greater tendency towards monoculture or intercropping of two crops. In the highlands poly-culture plantings with 3-4 different crops are more common and staple food crops are predominate these mountainous plots. Key crops for this region include: corn, rice, sorghum, eggplant, pigeon peas, beans, peanuts, okra, sweet potato, manioc and citrus.

iiib. Principle pests and control practices

The principle pests discovered were found to be largely the same from region to region while the control methods and availability of chemical controls had greater regional variability. Our field work discovered most significant pest pressure differences between agro-ecological zones as compared to differences from geographical region to region. For this reason, this section will elaborate on principle pests between the two climactic extremes, the plains and the upper watershed hillside agricultural areas in the WINNER project regions. Common control practices will be elaborated upon by region.

In the plains the principle pests were reported for each of the major crops as follows: for plantains; nematodes, black and yellow sigatoka, banana root borer; in corn, beans, pigeon pea, tomato, pepper, sorghum, manioc; caterpillars; for eggplant, tomato, pepper, beans, corn and okra; aphids and whiteflies; beans; golden mosaic virus; in sorghum and sweet potato; nematodes and the sweet potato weevil (sweet potato specific); in citrus and sugar cane; ants; for watermelon, onion and shallot no major pests were reported. Principle pests reported in the hillside zones included: for cabbage, carrots, lettuce, manioc and tomatoes; caterpillars; in cabbage; fusarium wilt/yellows; for tomatoes, broccoli, carrots, beans; powdery mildew and; in tomatoes; TYLCV; beans; damping-off, rust and whiteflies; in yams, sweet potatoes and plantains; nematodes; for pigeon peas, sorghum and melons no major pest were reported. In general, there were found to be greater incidences of powdery mildew, rust and other fungal disease at the higher more humid agro-ecological zones, such as Kenscoff, than in the lowland regions.

In Kenscoff pesticide use is common among farmers and products are widely available in the nearby Petion Ville and greater Port au Prince chemical supply stores. WINNER promotes neem, Sevin and Dithane currently in this area in partnership with the local agro-input supply store. Farmers also reported using, Mesurol (molluskicide), insecticides such as neem, Sevin, Malathion, Sumithion and Tambo and fungicides, Dithane and Ridomil. Of these products mesurol, malathion, sumithion and tambo are RUPs and/or unregistered for agricultural use by the US EPA.

The Plaine du Cul-de-Sac, Mirebalais, Cabaret and Gonaives regions have similarly widespread pesticide availability due to either proximity to major PAP agro-input suppliers or the presence of national agro-input supplier stores locally. Farmers interviewed in these regions report using a wide variety of products commonly available on the Haitian agro-chemical market. These include such insecticides as: Tricel, Curacron, Luphos, Malathion, Sumithion, Vydate, Sevin, Karate, Actara and neem along with the fungicides, Ridomil, Dithane, and Mancozeb. Malathion, Karate, Luphos, Curacron, Sumithion, and the most common emulsifiable concentrate formulation of Tricel found in Haiti, are all RUPs. Other products also available in supply stores included the broad spectrum herbicides Glysell (glyphosate) a GUP. According to farmers and WINNER staff interviewed, agro-chemical use is reduced but not unheard of in the hillside zones of these regions, as is the case for most hillside regions in Haiti.

WINNER project area beneficiaries and other farmers in the regions contacted reported use of several GAPs that were reported to be effective in management of some crop pest and disease. Practices such as the use of seedling nurseries, composting, and pruning
were reported by nearly half of beneficiaries contacted. These techniques along with others including, improved crop varieties, planting, crop production strategies, spacing and association of crops for pest control and post-harvest treatments are being incorporated into WINNER trainings.

On the whole, as has been noted in previous sections of this program background section, pesticide use behaviors in Haiti are quite dangerous and carry with them high risks of severe negative health and environmental impacts. The majority of farmers using agro-chemicals reported unsafe practice throughout various stages of use (mixing, dosage, application, storage and disposal). When asked, farmers are generally aware of the dangers represented by agro-chemicals but often lack the technical knowledge, resources and access to information to take the proper precautions.

WINNER is currently only promoting chemical controls approved in the ACDI-VOCA PERSUAP. These chemical options are promoted in the context of an integrated pest management strategy promoting cultural and reduced-risk biological controls before recommending non-RUP pesticides (for specific IPM plans by crop see Annex 1). When pest populations reach economically damaging levels despite implementation of best practices, extension officers will recommend only USEPA-approved non-RUP products and will provide training on safer use (including transport, mixing, proper application, storage and disposal). To the extent possible, field officers will recommend locally-accessible formulations which are lowest-risk in the local context, but also effective (see the following sections for more detail: *IV. Pesticide Evaluation Report* and *V. Safer Use Action Plan*).

WINNER and all field staff contacted are committed to promoting best practices among beneficiaries, and agro-input supply store staff. Demo-plot owners are provided with proper protective equipment and assistance in selecting appropriate pesticides, calculating dosage, mixing, and safe application trainings. Pesticides provided to agro-input supply stores and beneficiaries have been limited to those approved products covered in the existing Haiti PERSUAPs and in accordance with Regulation 216. All agro-chemicals provided in the future will be limited to those included in the body of this document.

WINNER will carry-out multi-faceted trainings, technology transfers and awareness raising campaigns in the effort to promote responsible IPM strategies that emphasize pesticide use as a last resort control method and provide ample non-chemical control options in order to minimize risk of harm to users, community members and the environment. WINNER field agents and staff will monitor pesticide use on demo plots and will make adjustments as necessary. It is hoped that with the proper implementation of the IPM plans for each crop, the need for pesticides will be reduced with each growing season.

iiic. Livestock component

The WINNER project activities include the provision of technical support and training in livestock management and technology transfer of good animal husbandry including improved, nutrition, driving, breeding, reproductive health and disease prevention practices.

The use of agro-chemical livestock products are employed in Haiti for the control of external (mites, lice, earworms and flies) and internal (tapeworms, stomach and intestinal worms) goat parasites, provided that veterinarians provide safe and proper use trainings for farmers and assistance in administration of products. Two products, Albendazole and two types of Ivermectin (topical and injected varieties), are used for management of livestock parasites in Haiti. Proper application practices such as the use of protective gloves were reported however there were also reports of improper syringe disposal practices (Ivermectin is also available in vaccine form). Unsafe pesticide disposal behaviors were found throughout the course of field work for this PERSUAP and stem directly from the poorly functioning, under resourced waste management systems, and complete lack of facilities for dealing with hazardous wastes currently existing in Haiti. These already weak systems also suffered severe reductions in capacity resulting from the January 2010 earthquake.

Any agro-chemicals to be used should be selected from the list of veterinary products included in this PERSUAP. Chemical controls for livestock parasites should only be used after farmers have exhausted all non-chemical controls recommended in the livestock IPM plan (See Annex 1: IPM Plans). Any promotion of chemical livestock parasite controls should be accompanied by trainings in safe transport, mixing, dosing, application, storage and disposal of veterinary products (See sections IV. Pesticides Evaluation Report and section V. Safer Use Action Plan for more detail).

iv. WVI: SAK REP MYAP: 2008-2012, Central Plateau and La Gonave

The agricultural component of World Vision's (WV) 2008-2012 MYAP aims to diversify and increase farmer's production in an environmentally responsible manner. Through a market based, cooperative and integrative watershed resource management approach WV's Sak Plen Resiliency Enhancement Program (SAK REP) will improve economic opportunities, increase incomes and reduce disaster risks for farmers in the Central Plateau and isle of La Gonave. The program targets approximately 400,000 beneficiaries and has the following objectives:

1.) Increased, diversified and environmentally responsible household production: Genetically improved seeds, crop and soil management, seed reserves and grain storage.
2.) Enhanced market-based livelihoods: Strengthen farmer groups, production technology for agricultural products, market access, water user groups, Food for Assets (FFA) program
3.) Rehabilitated natural resources resiliency and local response capacity: Integrated landscape management, water source protection, early warning system and risk management.

WV will provide technical support for the following crops:

Avocado	Mango	Sweet potato
Bean	Onion	Tomato
Broccoli	Papaya	Forest trees species
Cacao	Peanut	Yam
Cabbage	Pepper	Avian
Citrus	Pigeon pea	Goat
Corn	Plantain	Pig
Eggplant	Sorghum	
Manioc	Stored grains	

iva. Project region, cropping by agro-ecological zones

WV's MYAP focuses on three main project regions including the Central Plateau, the Artibonite Valley and the island of La Gonâve. Within each region WV is focusing on selected communities to advance food security and resiliency of vulnerable household's. The following communities have been selected by WV: Central Plateau; Hinche, Thomonde, Boucan Carre, Thomassique, Cerca-La-Source Cerca-Carvajal, La Gonâve; Anse-à-Galets, Pointe-à-Raquette.

The majority of farm visits within the selected communities were conducted in lowland and mountainous agro-ecological zones of the Central Plateau[3]. In the mountainous communities of Thomonde Baille Tourible the following dominant crops were observed during the field visits: Peanut, sugarcane, corn, pigeon peas, congo peas, banana, manioc, sorghum, sweet potato and yam.

[3] The island of La Gonave was not visited during field visits due to its remoteness and time constraints. However, a representative sampling of agro-ecological zones on the main land, similar to those on the island, and anecdotal accounts from WV staff provided key information on this particular region.

Field visits to the lowland communities of Savanette, Laschobas and Thomonde (Bernaco) observed all of the same dominant crops as well as rice, mangoes, hot peppers and onion. WV will work with farmers to determine which crops are most marketable and sustainable. After establishing "best bet" marketable crops in each target community, WV will assist in linking producers with local and international markets. WV will also seek to provide communities with improved seed varieties and emergency grain stores and will also provide high-quality local breeds and technical assistance in small livestock animal husbandry.

ivb. Principle pests and control practices

Pests affected these crops were reported as similar in each region visited and included: aphids, nematodes, whiteflies, caterpillars, mosaic virus, sigatoka and others. Use of pesticide controls ranged from heavy to non-existent in the various regions depending on the availability of products and their expense. WV is currently only promoting non-chemical control measures among beneficiary farmers, and as a pre-requisite for becoming beneficiaries farmer must commit to not using chemical controls in their fields and demo-plots. Within the mountainous region of Thomonde, for example, farmers interviewed were no longer using pesticides due to their partnership with WV. However, among some non-beneficiaries interviewed pesticide use was reported.

The lowland region of Thomonde (Bernaco) used very few pesticides due to their prohibitive expense. However, in severe cases of pest infestation, chemical products were acquired in Hinche and applied. The most widely-cited pesticides used included:, Dithane, Ridomil, Celchron, Actara, Karate, Malathion and Sevin.

Haitian pesticide use and application practices are generally unsafe and have high human and environmental risks. Furthermore, all pesticide users contacted in this region lacked adequate personal protection equipment due to the restrictive prices of the equipment, and also, the general lack of availability in agro supply stores. Furthermore, there were reports of improper pesticide mixing, as well as use of empty pesticide cans as drinking receptacles. Farmers also reported some children in their community having health problems such as skin rashes after having played with pesticide cans or backpacks.

WV is promoting GAPs such as, crop rotation, conservation and community water use plans, drip-irrigation, contour farming, composting, mulching and improved varieties. Several community groups reported compost and crop rotation were widely implemented. Several communities however are unable to accumulate sufficient compost in which case fertilizers are used. Communities abstaining from pesticide used cultural and biological controls such as hot pepper, garlic, ash, soap and neem oil.

While WV as mentioned above only promotes non-chemical cultural and biological controls and all beneficiaries interviewed reported chemical free pest management strategies, other non-beneficiary area farmers reported agro-chemical use, suggesting chemical use is not unknown to the region. If any chemical controls are to be promoted by WV it should be in the context of an integrated pest management strategy promoting cultural and reduced-risk biological controls before recommending non-RUP pesticides (for specific IPM plans by crop see Annex 1). When pest populations reach economically damaging levels despite implementation of best practices, extension officers will recommend only USEPA-approved non-RUP products and will provide training on safer use (including transport, mixing, proper application, storage and disposal). To the extent possible, field officers will

recommend locally-accessible formulations which are lowest-risk in the local context, but also effective (see section IV. Pesticides Evaluation Report and section V. Safer Use Action Plan for more detail). AGRIDEV field agents and staff will monitor any pesticide use on demo plots and will make adjustments as necessary.

iiic. Livestock component

The WV project activities include the provision of improved local breeds, technical support and training in small-livestock management and good animal husbandry including improved, nutrition, disease prevention and waste recycling practices.

The use of agro-chemical livestock products are currently employed in Haiti for the control of external (mites, lice, earworms and flies) and internal (tapeworms, stomach and intestinal worms) goat parasites provided that veterinarians provide safe and proper use trainings for farmers and assistance in administration of products. Two products Albendazole and two types of Ivermectin (topical and injected varieties) are used for management of livestock parasites in Haiti. Proper application practices were reported that included the use of protective gloves however, there were reports of improper syringe disposal practices (Ivermectin also is available in vaccine form). Unsafe pesticide disposal behaviors were found throughout the course of field work for this PERSUAP and stem directly from the poorly functioning, under resourced waste management systems, and complete lack of facilities for dealing with hazardous wastes currently existing in Haiti. These already weak systems also suffered severe reductions in capacity as result of the January 2010 earthquake.

WV currently isn't promoting any chemical controls for livestock pest management. However, if any agro-chemicals are to be used they should be selected from the list of veterinary products included in this PERSUAP. Chemical controls for livestock parasites should only be used after farmers have exhausted all non-chemical controls recommended in the livestock IPM plan and still require additional parasite controls (See Annex 1). Any promotion of chemical livestock parasite controls should be accompanied by trainings in safe transport, mixing, dosing, application, storage and disposal of veterinary products (See section IV. Pesticides Evaluation Report and section V. Safer Use Action Plan for more detail).

III. Assessment methodology

The Sun Mountain field team visited 5 of the 10 Haitian departments for the completion of the field work for the Mission-Wide PERSUAP. Meetings with key USAID partner field, training, agronomist and veterinary staff and on-site field interviews were held with farmers and local extension officers to collect information on current pest issues, perceptions of pesticides and safety, and pesticide use practices in each of the major project regions of the USAID partner programs included in this report. Field visits in all four principle agro-ecological zones found in Haiti, were conducted to observe crop health, cropping and planting strategies, pest issues, common pest control practices and pesticide use behaviors. Approximately 160 farmers and 23 partner field staff were consulted during approximately four total weeks of field data collection.

Eight pesticide input stores were visited in partner project areas throughout Haiti in order to determine pesticides commonly available, inspect labeling procedures, state of products, availability of safety information, equipment and pest management knowledge of store staff.

Representatives from the Ministry of Agriculture, Natural Resources and Rural Development (MARNDR) were not interviewed during the most recent round of fieldwork due to the sufficient amount of information that was acquired while collecting data for previous Haiti PERSUAP's for MarChe and ACDI/VOCA. Discussions with Ministry of Environment contact Ronal Touissant informed our team that the already weak capacity of the Ministry has been further reduced since the January 12 earthquake. During research for the MarChe PERSUAP, a consultant for MARNDR, Scutt Rico, was interviewed concerning his knowledge of the subject matter and of fruit flies in the Jacmel region in particular. Mr. Rico worked closely with Gordon Tweed, consultant for MarChe's Mango Production Program. During the creation of the ACDI/VOCA PERSUAP, additional representatives from MARNDR were consulted for information concerning Haitian pesticide regulations.

The MARNDR regulates pesticide import, distribution, storage, use and disposal and oversees agricultural extension officers in various parts of Haiti. Enforcement of regulations is often not implemented however, especially at the local level. The MARNDR does not currently maintain a database of pesticides approved for use in the country, nor does it implement a pesticide container collection program.

A thorough review of IPM options and pesticides was conducted using existing IPM sources (see Bibliography). All IPM plans, training, mitigation and monitoring recommendations were validated with partner staff and field officers to ensure feasibility. Because the majority of program beneficiaries have less than one hectare of productive land and the level of food security is so low in the region, many IPM strategies such as fallow periods or rotation with non-crop species are not feasible.

Pesticides were selected based on toxicity level and availability in Haiti. Preference was given to General Use Pesticides (GUP's) with low levels of negative impact on human and environmental health. No Restricted Use Pesticides (RUP's) were recommended. The selectivity of the recommendations was due to the fact that the majority of Haitian farmers interviewed lack either the knowledge or equipment to properly apply chemicals of high toxicity. Challenges arose however in identifying locally available product alternatives that are not too expensive for Haitian farmers. Almost all locally available products

are US-cancelled products or RUP's; USAID partners are committed to working with agro supply stores to import less-toxic alternatives from the Dominican Republic and the US.

In relation to low toxicity pesticides available in Haiti, it was discovered that many of the products approved in the ACDI-VOCA PERSUAP were being promoted by USAID partners included in this report, in accordance with Regulation 216. As result, availability of reduced-risk products such as Neem, Dipel, Actara, Dithane, Sevin, etc. seems to be increasing. However, as these products are largely unfamiliar to farmers, less toxic, and often more specialized in terms of their target species without proper training on pest identification, selection of appropriate control options and application techniques their effectiveness can be reduced. This point is supported by farmers who reported that these new products were ineffective in controlling their pest problems and partner field staff who report that this is largely the result of improper product selection and application. Training on IPM strategies along with identification of pest species will remain a key component of IPM technical assistance in Haiti.

This PERSUAP provides a substantial base of IPM and product options in order of lowest toxicity to enable the immediate implementation of pest management strategies in the current growing season. The authors of this report hope to provide key IPM information for principle pests identified during field work to facilitate technology transfers by USAID partner field staff to their participant farmers.

IV. PESTICIDE EVALUATION REPORT

A. Table 1: USEPA registration status and toxicity class of recommended products

No.	US Commercial Name (Formulation) [Haiti product]	Active Ingredient(s) %	EPA Reg. Status / #	Pesticide Use Type	Toxicity Class	Product Type - Chemical Class
1	Kocide 4.5 lf (F)	Copper Hydroxide 37.5%	Active / 352-684	GUP	Class III	Fungicide, algacide - Inorganic copper
2	Phyton-016-B [Mastercrop 25 SC]	Cooper Sulfate (pentahydrate) 21.3%	Active / 49538-5	GUP	Class II	Fungicide, algacide - Inorganic copper
3	Dithane M-45 WP (WP)	Mancozeb 80%	Active / 62719-387	GUP	Class III	Fungicide
4	Dithane F-45 (FC)	Mancozeb 37%	Active/ 62719-396	GUP	Class III	Fungicide
5	Quadris (F)	Azoxystrobin 22.9%	Active/100-1222	GUP	Class III	Fungicide
6	Ridomil Gold (EC)	Mefenoxam 49%	Active/100-801	GUP	Class III	Fungicide
7	Sulfur	Sulfur	Several active products	GUP	Class III	Fungicide, miticide – Inorganic
8	Biolife 20 SL	Organic acids 20%	Registered Inert ingredients	Minimum risk pesticide	N/A	Fungicide
9	Maxim XL (EC) [Dekalb – Hybrid Corn]	Fludioxonil 21% ,metalaxyl-M 8.4 %	Active/100-916	GUP	Class III	Fungicide (seed treatment)
10	Batallion 0.2 (EC) [Dekalb – Hybrid Corn]	Deltamethrin 2.86%	Active/ 66330-373	RUP *	Class I	Insecticide (seed treatment) - Pyrethroid
11	Thiram 75 (WP)	Thiram 75%	Active/457 28-21	GUP	Class III	Fungicide (Seed treatment),

						repellent
12	Fusilade (no info)	Fluazifop-p-butyl 24.5 %	Active/100-1070	GUP	Class III	Herbicide
13	Accord (S) [GLYSELL]	Glyphosate, isopropylamine salt 41.5%	Active /524-326	GUP	Class III	Herbicide
14	Actara 240 sc (EC)	Thiamethoxam (21.6%)	Active /100-1250	GUP	Class III	Insecticide - Neonicotin-oid
15	Actellic 5e (EC)	Pirimifos Metil 57%	Active/138 1-170	GUP	Class I	Insecticide - Organopho sphate
16	Admire 2 (FC)	Imidacloprid (21.4%)	Active/264-758	GUP	Class III	Insecticide-Neonicotin oid
17	Gaucho 600 F	Imidacloprid (48.6%)	Active/264-968	GUP	Class III	Insecticide, miticide
18	Chancellor (SC)	Bacillus firmus (0.66%)	Active/ 82608 -1	GUP	Class IV	Microbial - nematicide
19	Dimethoate 2.67 (EC)	Dimethoate 30.5 %	Active/347 04-489	GUP	Class II	Insecticide, miticide - Organopho sphate
20	Insecto (D)	Diatomaceous earth 90%	Active/485 98-1	GUP	Class III	Insecticide, miticide – Inorganic
21	Lorsban 75 (WG) [Tricel]	Chlorpyriphos 75%	Active/627 19-301	GUP	Class III	Insecticide, miticide – Organopho sphate
22	Pounce 25 wp	Permethrin 25%	Active/279-3051	GUP	Class II	Insecticide, miticide – Pyrethroid
23	Sevin (WSP)	Carbaryl 80%	Active/432-1226	GUP	Class II	Insecticide - Carbamate
24	Trebon 3g G	Ethofenprox 3%	Active/336 57-39	GUP	Class III	Insecticide - Pyrethroid relative

25	Beauveria bassiana h [Brocaril 50 WP]	*Beauveria bassiana* 95%	Active/70787-1	GUP	Class III	Insecticide – Microbial
26	Dipel (WP)	*Bacillus Thuringensis,* Kurstaki, ABTS-351, 58.2%	Active/73049-8	GUP	Class III	Inseciticed, miticide - Microbial
27	Milky Spore (WP)	*Bacillus popiliae* .02%	Active / 63191-1	GUP	Class III	Insecticide – Microbial
28	Spinosad [GF-120]	*Saccharopolyspora spinosa*	Active/62719-314	GUP	Class III	Insecticide -Microbial
29	M-pede (SL) [Zohar LQ-215 and 17 -47 % (SL)]	Potassium laurate 47%	Active / 62719-515	GUP	Class II	Insecticde, surfactant
30	Vektor	*Entomophthora virulenta*	Organic	GU	Not Listed	Insecticide
31	Velbazen oral drench	Albendazole 11.36%	CAS #: 54965-21-8	GU	Not listed	Parasiticide
32	Ectoban pour-on	Permethrin 1%	Active/279-3051	GUP	Class II	Parasiticide

***** This product is to be used only as a seed treatment. It is our recommendation that, due to the low dosage concentration present on the treated seed, the restricted-use status and toxicity classification for the original product should not prevent use of this product in the form of treated seed.

B. Table 2: USEPA registration status of products encountered in the field but not recommended in the PERSUAP.

No.	Commercial Name [Haiti Product] (Formulation)	Active Ingredient(s) %	EPA Reg. Status / #	Pesticide Use Type	Toxicity Class	Rationale for Exclusion
1	Bayleton PM (WP)	Triadimefon 50%	Active/264-737	GUP	Class III	Non pertinent *
2	Benomyl WP	Benomyl 50%	Cancelled/37 843-858	GUP	Class III;	Cancelled registration - Carcinogen
3	Damoil spray [Damoil 98 EC]	Paraffin oil 98%	Active / 19713-123	GUP	Class III	Carcinogen
4	Difolatan F	Capatafol 39.0%	Cancelled/23 9-4168	GUP	Class III; Carcino gen	Cancelled registration
5	Karate EC	Cyalotrine lambda (13.1%)	Active/100-998	RUP	ClassI	RUP
6	Sumithion (EC)	Fenitrothion (47.5)	Cancelled/39 398-28	RUP	Class II	RUP/ Cancelled Registratio n
7	US = Monophos (55%) (S) [Luphos (36%) SL]	Monocrotophos	Cancelled/10 163-612	RUP	Class Ib Highly Hazardo us	RUP/ Cancelled Registratio n
8	Celcron (50%) /Curacron (73%) (EC)	Profenofos (73%)	Ative/100-669	RUP	Class III	RUP
9	Decis 1.5 EC	Deltamethrin (16%)	Active/264-1011	RUP	Class I	RUP
10	US = Monitor 4 Tamaron 600 SL	Metamidofos 40%	Active/264-729	RUP	Ib, Highly Hazardo us	RUP
11	Diazinon 50 WP	Diazinon 50%	Active/66222 -10	RUP	Class III	RUP
12	Vydate L	Oxamil 24%	Active/352-372	RUP	Class I	RUP

13	Mocap (G)	Ethoprop 15%	Active/264-457	RUP	Class I	RUP
14	Lorsban 4E (EC) [Tricel]	Chlorpyriphos 44.9%	Cancelled /62719-220	RUP	Class II	RUP
15	Denim (EC)	Emamectin Benzolate 2.15%	Active/100-903	RUP	Class I	RUP
16	Dylox 6.2 granular insecticide	Triclorphon 6.2%	Active/432-1308	GUP	Class III	Non pertinent
17	Snip-fly	Azamethiphos + (Z)-9-tricosene	Not Registered/129101	GUP	Class III	Less toxic product available
18	Mesurol 2% bait (G)	Methiocarb (2%)	Active/10163-232	GUP	Class III	Non pertinent
19	Ivomec	Ivermectin (1%)	CAS #: 70288-86-7	N/A	Not listed	Less toxic product available

***Note:** "Non pertinent" signifies products that were excluded because they are not registered for use on common crops grown in Haiti.

Table 3: PERSUAP Crop , Pests and Control Options Table

Crops, Pests and Sequential Control Options				
Crop	**Pest**	**Non-Chemical Control Method (Option 1)**	**Reduced- Risk Controls (Option 2)**	**Chemical Controls (Option 3)**
General Pests	Whiteflies	Coordinate planting calendars with other farmers in the area planting whitefly host crops. Adjust planting dates based on historical whitefly outbreaks – delaying planting 3 weeks can help disrupt whitefly reproduction cycles. During periods of heavy whitefly migration, avoid planting susceptible crops such as tomato and cole crops. Install yellow sticky traps mounted on stakes next to plants Remove and destroy all crop residues as soon as possible after harvest.	Sticky traps	Actara, Imidacloprid
	Aphids	If populations are localized, prune and dispose of infested areas. Knock aphids off with a strong stream of water.	Wood ash (dust plants with ash when leaves are not too dry nor too wet). • Insecticidal soap (Safer ® Soap or homemade: 1 ½ teaspoons liquid soap, i.e. dish detergent, per quart of water). • Garlic and chili spray Neem Oil.	Actara
	Caterpillars	Hand-pick caterpillar larvae and kill by dropping into a container with soap and water or a salt solution. Discing fields after harvest Otherwise, bury any remaining plant matter to destroy any eggs and larvae that may remain.	Bacillus thuringensis	Sevin

		Rotate with less susceptible crops such as carrot or green onion. Do not rotate with cabbage, swiss chard, spinach, tomato, or eggplant.		
	Anthracnose	Select fields with lowest or no recent incidence of Anthracnose. Prune out dead limbs and twigs with visible infections. Avoid over-irrigation during growth. Prune low branches 60 cm off the ground to reduce humidity. Prune and harvest preferably during dry conditions. Inter-crop with fruit-bearing shrubs and annual vegetables to help conserve biodiversity and reduce pest population.	Copper compounds	Quadris, Dithane
Avocado	Mites	Reduce dust around field Good weed management Remove all excess plant debris Avoid rotating with other host crops such as banana, plantain cassava, cocoa	Sulfur, Vektor	Dimethoate 2.67
	Lacewing	Provide proper irrigation and plant care to ensure crop vigor. Damaged foliage should be removed. Pruning should be done carefully so as not to expose the plant to too much sunlight. Clean all bins and receptacles used for harvesting avocadoes		Pounce 25 WP
	Phytophthora Root Rot	Avoid soils that are poorly drained, or pathogen-infested and high in saline. Do not work in infested groves when the soil surface is wet Begin harvesting and other activities in healthy areas of the grove; work in diseased areas last to minimize pathogen movement.	Copper compounds Biolife 20 SL	Ridomil Gold

		Skirt pruning		
Beets	Cercospora	Remove infected material Provide adequate distance between plants	Sulfur Biolife 20 SL	Ridomil Gold
Banana / Plantain	Nematodes	Nematode-suppressive green manure/fallow crops Remove all weeds and excess plant matter.	Sticky board traps Organic soil amendments (Neem or Jatropha seed cakes mixed into soil) Neem (Azidachtrin 0.6%) Chancellor (SC)	
	Yellow and Black Sigatoka	Remove infected plants quickly. Promote air flow among crops.	Serenade (Bacillus subtillus) Biolife 20 SL	Copper compounds
	Root Borer	Transportation of planting material from infested fields to uninfested ones should be avoided to prevent rapid dispersal of this pest to uninfested areas.		Imidacloprid 2 FC, Gaucho 600
Beans	Damping- Off	Suspected plants should be carefully dug and washed, because pulling plants may leave tissues with characteristic symptoms in the soil.	Sulfur Dust Biolife 20 SL	Ridomil Gold, Dithane
	Bean leaf Beatle	Manually remove beetles and utilize row covers if feasible. Spraying a mixture of crushed turnips mixed with corn oil, has been proven affective.	Sulfur Mixture of turnips and corn oil	Lorsban 4E, Dimethoate 2.67
	Powdery Mildew	Avoid over-crowding Orient rows in same direction as prevailing winds Good weed management Disc fields after harvest	Sulfur	Ridomil Gold, Dithane
	Itch Grass	Use cover crops such as legumes Post-harvest flooding Inter-cropping with corn		Fusilade
	Mustia Fungus	Avoid irrigation immediately after planting and avoid over-irrigation during growth. Use drip-irrigation	Sulfur Dust	Ridomil Gold, Dithane

		Suspected plants should be carefully dug and washed, because pulling plants may leave tissues with characteristic symptoms in the soil.		
	Golden Mosaic Virus	Remove crop residue post-harvest and maintain fields free Control aphids and leafhoppers	See controls for aphids (general pest controls) and leafhoppers (peanuts)	
Broccoli	Downy Mildew	Remove infected plant material before spores can develop.	Sulfur	Quadris, Ridomil Gold EC, Dithane
	Diamondback Moths	Remove all excess plant material Use sprinkle irrigation to reduce activity		Pounce 25 WP
	Alternaria leaf spot	Remove infected parts of leaves before sporulation occurs.	Sulfur, Copper compounds Biolife 20 SL	Quadris flowable
Cabbage	Diamondback Moths	Sprinkle irrigation may reduce the number of caterpillars in the field. If it is applied at dusk, it may limit the activity of adults.	Bacillus Thuringensis, Kurstaki, ABTS-351, 58.2%	Pounce 25 WP
	Fusarium yellows	Clean all farm equipment regularly to reduce the risk of spreading the fungus.	Maxim XL (seed treatment) Biolife 20 SL	Copper compounds
Carrot	Powdery mildew	Overhead sprinkling can help wash spores off of the plant and reduce mildew. However, overhead sprinklers should be used with caution on vegetables because their use may contribute to other pest problems. Avoid over-crowding and keep plantings free of weeds as long as is practical.	Sulfur	Ridomil Gold, Dithane
	Snails	Surround crops with loose material such as sand, sawdust and eggshells. Hand picking.	Salts and beer traps	
Cassava	Rats	Wooden snap traps can be placed both indoors and outdoors.		

		Create fences and other barriers around the crop field.		
Cauliflower	Aphids	See General pest section above		
Citrus	Citrus Root weevil	Plant in areas with good drainage (sandy soils are best) Regular irrigation and fertilization are important to promote root grow back Skirt pruning and trunk banding.		Sevin WSP
	Ants	Tilling Reduction of plant material, aphids and whiteflies	Garden lime paste Soap mixture Zohar	Lorsban 4E
	Scales	Maintain adequate space between branches of adjacent plants. Pruning	Natural soaps and oil	Sevin WSP
Cocoa	Monilla	Regular complete harvesting of pods is almost certainly the most effective cultural technique. Other techniques include enforcing a break in pod production and removal/burying/enclosing husks. Infected pods must be removed before sporulation begins.	Horticultural soaps and oils	Copper compounds
	Phytophthora	Use natural barriers, such as are oil palm, coffee and citrus to prevent or slow-down the spread of the mealy bugs within cocoa farms. Reduce humidity levels and amount of shade by pruning.	Copper compounds	Ridomil Gold
Coffee	Anthracnosis	Harvest fruit when in early maturity, destroying infected fruit and branches and even leaves on trees around infected fruit, avoid overhead irrigation. Clean up all harvesting bins and anything that the fruit will touch using a 1:5 bleach to water solution.	Copper compounds	

	Berry Borer, Cercospora	Remove any berries that have fallen to the ground. Prune the trees.	Beauveria bassiana	
Corn	Green stink bugs	Tilling fields significantly reduces stink bug population by removing all host foliage.		Lorsban 75 WG
	Itch grass	The use of cover crops such as certain legumes can reduce itch grass. Intercropping with legumes. Post-harvest flooding can effectively remove itch grass.		Fusilade
	Damping-off	Suspected plants should be carefully dug and washed, because pulling plants may leave tissues with characteristic symptoms in the soil. Improve soil irrigation.	Sulfur	Ridomil Gold, Dithane
	Cricket	Tillage of fallow fields in late-summer discourages the laying of eggs. Remove plant debris from field.		Lorsban 75
	Corn Borer	Corn stubble must be plowed underground or removed to lessen chances of the borers surviving the winter. Late planting can be effective in reducing first generation borer populations.		Pounce 25 WP
Eggplant	Green stink bugs	Tilling fields significantly reduces stink bug population by removing all host foliage. Destroy all weeds and possible hosts such as legumes and mustards.		Actara 240 Sevin
	Damping-off	Suspected plants should be carefully dug and washed, because pulling plants may leave tissues with characteristic symptoms in the soil. Improve soil drainage	Sulfur	Ridomil Gold, Dithane
	Tobacco Flea	Covering the crop with gauze or mesh can reduce beetle populations.		Actara 240 Pounce 25 WP
Lettuce and Spinach	Fusarium yellows	Clean all farm equipment after use.	Maxim XL Biolife 20 SL	Copper compounds
	Aphids, Caterpillars	See general pest controls		
Mango	Mango scales	Pruning Maintain adequate space between plants	Natural soaps and oil	Sevin WSP

	Cercospora	Remove infected plant material. Provide adequate distance between plants	Sulfur Biolife 20 SL	Ridomil Gold
	Fruit flies	Remove rotten fruit Place lightweight netting over trees	Vektor	Spinosad GF 120
	Green stink bugs	Tilling fields significantly reduces stink bug population by removing all host foliage. Destroy all weeds and possible hosts such as legumes and mustards.		Actara 240
Okra	Damping off	Remove infected plant material. Ensure adequate drainage.	Sulfur	Ridomil Gold, Dithane
	Green stink bugs	Destroy all weeds and excess plant material. Tilling		Actara 240 SC
	Potato Aphid	See general pest controls above		
Onion, Leeks and Shallots	Pythium root rot	Plant in raised beds Improve soil drainage Use drip irrigation where feasible.	Sulfur Dust Copper compounds Biolife 20 SL	Ridomil Gold, Dithane
	Thrips	Till and remove weeds from fields pre-planting Avoid planting near grain fields Destroy all crop residues	Neem Oil, Vektor	Lorsban 75 WG
	Onion Smut	Use nursery grown seedlings Remove and destroy all infected plant matter.	Thiram and Maxim (seed treatment)	
Papaya	Papaya fruit fly	Remove rotten fruit Place lightweight netting over trees	Sulfur, Vektor	Spinosad GF 120
Peanut	Nematodes	Avoid planting in fields previously planted with sweet potato or yam Incorporate organic material and/or jatropha seed cakes into soil Rotate with nematode suppressing crops, i.e. cereal crops, jatropha.	Incorporate Neem or Jatropha seedcakes into soils Neem (Azidachtrin 0.6%) Chancellor (SC)	
	Ants	The reduction of aphids and whiteflies will discourage ants, who are attracted by the excretion of honeydew.	Apply the following mixture: 2 tbsp dish washing soap, 2 tsp vegetable oil, 2 tbsp salt a few drops of vinegar and 4 liters of water.	Pounce 25

			Zohar	
	Leafhoppers	Remove garbage and debris from the field. Floating row covers can be effective if population is not too large.	A mixture of 100 grams of chopped garlic with 10 liters of water can be applied.	Actara 240
	Caterpillars, whiteflies and aphids	See general pest controls above		
	Green Stink bugs	Tilling fields significantly reduces stink bug population by removing all host foliage. Destroy all weeds and possible hosts such as legumes and mustards.		Actara, Sevin
Pigeon Pea	Black legume aphid	See general pest controls above		
Pineapple	Ants	Reduction of aphids and whiteflies	Garden lime paste Soap mixture	Sevin WSP, Lorsban 4E
Potato	Powdery Mildew	Avoid over-crowding Orient rows in same direction as prevailing winds Good weed management Disc fields after harvest	Sulfur	Ridomil Gold, Dithane
	Late Blight	Avoid over-crowding Good weed management	Sulfur	Ridomil Gold EC, Dithane
	Nematodes	Avoid planting in fields previously planted with sweet potato or yam Incorporate organic material and/or jatropha seed cakes into soil Rotate with nematode suppressing crops, i.e. cereal crops, jatropha.	Incorporate Neem or Jatropha seedcakes into soils Neem (Azidachtrin 0.6%) Chancellor (SC)	
	Crickets	Manual removal Chickens can be effective in reducing grasshopper populations as long as they don't damage the crop.		Actara 240, Dimethoate 2.67
Rice	Rice water weevil	Effective weed management Drill seeding		Trebon 3G Foliar application

	Stem rot and sheath spot	Select most resistant varieties available Avoid overly dense rice stands Do not over fertilize, excess nitrogen fertilization increases stem rot		Quadris
Sorghum	Sorghum Midge	Coordination of planting calendars Early planting or delayed planting depending on the sorghum midge life cycle Destruction of host weeds such as johnsongrass	Neem Oil	Sevin Lorsban 75 WG
Stored grains	Beetles, Granary and rice weevils	Sanitation and humidity controls of storage areas and containers Sort grains prior to storage and remove broken kernels and foreign materials Do not overfill bins and silos	Surface grain treatment of Insecto applied on top of stored grain (4lbs / 1000 sq.ft. of stored grain)	Actellic 5e
Sugarcane	Ants	Tilling Reduction of plant material, aphids and whiteflies.	Garden lime paste Soap mixture Zohar	Lorsban 75 WG
Sweet potato	Sweet potato weevil	Destroy potential host weeds (i.e. morning glory) Use cutting no longer than 30cm Fill in or cover cracks in earth caused by root growth Remove all tubers roots and plat debris post-harvest	Cylas pheromone traps	Actara Sevin (cutting treatment)
	White Grubs	Avoid fields previous planted with sweet potato or used for pastureland Destroy all crop residues	Milk spore (Bacillus popilae)	Imidacloprid 2 FC
	Nematodes	Avoid planting in fields previously planted with sweet potato or yam	Incorporate Neem or Jatropha seedcakes into soils Neem (Azidachtrin 0.6%)	

		Incorporate organic material and/or jatropha seed cakes into soil Rotate with nematode suppressing crops, i.e. cereal crops, jatropha.	Chancellor (SC)	
Swiss Chard	Caterpillars, Whiteflies and aphids	See general pest controls		
	Damping-Off	Plant in raised beds in soils with good drainage Do not over water/irrigate Remove or bury infected plant material, if buried soil will have to be treated prior to next planting	Sulfur	Ridomil Gold EC, Dithane
Tomato	Caterpillars, Whiteflies and aphids	See general pest controls		
	Late Blight	Select resistant varieties Avoid wetting foliage when irrigating Proper spacing and staking of plants Apply fertilizer at planting Destroy any infected plants by burning; remove all remnants of plant matter from field.	Sulfur Copper compounds	Ridomil Gold EC, Dithane
	Mildew	Plant rows in direction of prevailing winds Avoid overcrowding of plants Do not apply excess fertilizer Till fields post harvest	Sulfur	Ridomil Gold EC, Dithane
	Green stink bugs	Destroy weeds pre-planting Fully cover planted seeds Early planting Till fields post harvest		Actara, Sevin

	Tomato Yellow Leaf Curl Virus (TYLCV)	Manage whiteflies Select resistant varieties Maintain fields weed free Avoid rotating with whitefly or TYLCV hosts	See controls for whiteflies in general control options	
Yam	White Grubs	Avoid fields previous planted with sweet potato or used for pastureland Destroy all crop residues	Milk spore (Bacillus popilae)	Imidacloprid 2 FC
	Storage rots	Sanitation and humidity controls in storage areas Gentle handling to avoid damage to tubers Cure yams in sunlight and high humidity	Lime, chalk or wood ash dusted on tubers	Ridomil Gold EC, Dithane
	Nematode	Avoid planting in fields previously planted with sweet potato or yam Incorporate organic material and/or jatropha seed cakes into soil Rotate with nematode suppressing crops, i.e. cereal crops, jatropha.	Incorporate Neem or Jatropha seedcakes into soils Neem (Azidachtrin 0.6%) Chancellor (SC)	
	Root Borer	At planting completely cover yam seed to prevent egg laying on seed. Harvest yams as soon after they have ripened as possible.		Imidacloprid 2 FC
Livestock: Cattle, Goat Sheep, Pig, Avian	External parasites: face flies, ear worms	Livestock nutrition Apply a thin coat of vegetable oil to suffocate insects Garlic powder can be used as a topical treatment and incorporated into feed Clean and elevate food and water receptacles Maintain dung beetle populations Leave the field fallow for 12 months or rotate with crops.	Rub 2 to 3 handfuls of sulfur along the animal's spine Several studies have shown that the use of Insecto (diatomaceous earth) has reduced larvae	Valbazen Ectoban Delice Pour-on, Sevin 85 WP (for ear worms)

	Internal parasites: roundworms, tapeworms, stomach, lung and intestinal worms	Livestock nutrition Clean and elevate food and water receptacles Maintain dung beetle populations Leave the field fallow for 12 months or rotate with crops.	The feeding of garlic can reduce internal parasite counts	Velbazen

❖ SECTIONS B – H OF PESTICIDE EVALUATION REPORT

Fungicides

1. Kocide 4.5 lf (F) - Copper hydroxide 37.5%
2. Phyton-016-b (SC) – Copper sulfate (pentahydrate) 21.3%
[Mastercop – Copper sulfate (pentahydrate) 21.36%]

B. Basis for Selection of Pesticides:

Copper based fungicides are used to control bacterial and fungal diseases of several important fruit, vegetable, nut and staple field crops in Haiti including; avocado, banana, beans, corn, eggplant, pepper, tomatoes, mangoes, rice and others. The following are acceptable labeled uses: soil, foliar, greenhouse/nursery, post- and pre- fruit set sprays, tree trunk applications and seed treatments at various times throughout growing season. Copper sulfate can be combined with lime and water (Bordeaux mixture) applied as preventative seed and leaf fungal treatments. This preventative treatment can help improve the management of existing soil-borne fungal plant pathogens.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Most fungal plant pathogens are already present in soils and cause disease when environmental conditions are optimal for growth; thus, few effective IPM options to combat fungal disease currently exist. Nevertheless, the following cultural practices will be followed to minimize the need for fungicides:

Cultural controls	Reduced-risk controls
• Crop rotation with non-host crops; • Use of resistant varieties and non-damaged, non-infested seed; • Planting schedules according to crop forecasts (delaying if conditions are optimum for fungal disease development); • Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues.	• Sulfur; • Dithane • Seed treated with Maxim XL and/or Thiram [4]

[4] Treated seeds farmers pose a lower exposure risk to humans, especially non-farmers, than backpack spray applications since seed treatments are applied under controlled, contained conditions and only one application is needed. Seed treatments also contain a dye to signal presence of pesticide. Farmers handling treated seed will be trained to use all recommended PPE when handling treated seed. Non-farmers will be trained on recognizing treated seed and will be discouraged from handling.

Kocide and Phyton 016-B is compatible with the IPM programs because they can be used as a preventative treatment which provides good control throughout the growing season. See Annex 1 for more detail.

D. Proposed method or methods of application, including the availability of application and safety equipment

Kocide 4.5 lf is a liquid flowable formulation should be diluted with water and applied with backpack sprayers (unless label specifies otherwise) to soil, vegetable, fruits and tree parts. Good coverage is necessary for achieving effective fungal controls.

Phyton 016-B is a soluble concentrated that should be diluted with water and applied with backpack sprayer (unless label specifies otherwise) to soil, vegetable, fruits and tree parts. Good coverage is necessary for achieving effective fungal controls.

PPE for Kocide: Long sleeves, long pants, chemical resistant gloves, shoes plus socks and protective eyewear (goggles).

PPE for Phyton 016-B: Chemical resistant gloves, apron and boots. Protective eyewear (goggles) and availability of emergency eye wash and shower facilities should be provided. Should be used and mixed in sufficiently ventilated areas as defined on label.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: Kocide has a slight acute toxicity and causes moderate eye irritation and is harmful if swallowed or absorbed through skin. Applicators and users should avoid breathing vapor or spray mist and contact with skin, eyes or clothing. Kocide may be reactive to masonry and metal and contact with these surfaces should be avoided.

Phyton has moderate acute toxicity and is corrosive and its EPA Class II Toxicity Classification is due to this hazardous property. Toxic exposure pathways are usually through skin, eye contact or inhalation of powders or dust. Applicators should avoid breathing vapor, spray mist, contact with skin, eyes or clothing. Phyton is not compatible with highly alkaline pesticides nor should it be allowed to come into contact with masonry or metal surfaces.

Mitigation: Use, and proper maintenance/washing, of appropriate PPE, obeying REI and PHI and selecting lowest possible dosages limit risks to human health. Use of the liquid formulation of Phyton will reduce risk of user inhalation of powders or dusts. In addition, sprayers should wash with soap and change clothes before eating, drinking or chewing gum. PPE must be washed after each use with soap and water, separate from other clothing, and should only be used for spraying. Users should avoid allowing Kocide or Phyton 016-B to come in contact with masonry or metal.

Environmental Risk: Kocide is acutely toxic to fish and aquatic organisms and should not be applied near surface waters. Phyton has high acute toxicity to birds. Copper persists in soils and due to its high water solubility, copper is one of the more mobile heavy metals in surface environments. However, its high

binding capacity to organic, clay and mineral materials minimizes its leaching potential in all but sandy soils.

Mitigation: Apply Kocide and Phyton in the morning and evening when winds are low to minimize spray drift. Runoff should be limited by soil trenching or planting of vegetation along field borders and avoiding spraying when rain is likely. Phyton should not be applied where birds are commonly found foraging.

F. Effectiveness of the requested pesticide for the proposed use

Kocide and Phyton can be applied as a preventative and reactive treatments for a wide variety of fungal diseases. In general applications should begin with signs of disease and continue every 7-14 days, use shorter intervals when conditions favor disease.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems

Due to Kocide's acute toxicity to aquatic organisms it should not be used in intertidal areas, where surface waters are present and leaching and run off should be minimized through low application rates only after other non-chemical IPM measures have proven ineffective.

H. Conditions under which the pesticide is to be used, including climate, geography, hydrology, and soils

Kocide and Phyton can be rinsed away with rain and should not be applied when rain is likely. Spraying should not occur in windy conditions, morning and evening applications avoid high winds and minimize spray drift. Neither Kocide nor Phyton will be applied near surface waters or intertidal areas,

I. Availability of other pesticides or non-chemical control methods

Several non-chemical control methods are outlined in Annex I's IPM plans for each crop (See Annex I). Kocide is one of the lower risk fungal controls and its low price and widespread availability make it an ideal product for Haitian farmers and for USAID partners working in Haiti, where procurement and agro-chemical input availability are constant challenges. Phyton is more hazardous than Kocide and should only be used on fungal diseases that can be managed by recommended alternative non-chemical and chemical controls.

Copper hydroxide and copper sulfate has a fungicide resistance classification of M1. Copper hydroxide should be rotated with similar products of different resistance classification in order to prevent pest tolerance although cases of resistance have not been widely reported.

3. Dithane M-45 WP (Mancozeb 80%)
4. Dithane F-45 FC (Mancozeb 37%)

B. Basis for Selection of Pesticides:

Dithane is a broad-spectrum fungicide effective against fungal diseases, including anthracnose, Alternaria and phytophthora leaf blights, cercospora, powdery mildew, downy mildew, damping-off

(rhizoctonia and pythium spp.) and rust for a number of fruit, vegetable, and field crops. It provides multi-site activity, reducing opportunities for resistance. Dithane is a very cost effective product and is the most widely used fungicide in the world.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program.

Most fungal plant pathogens are already present in soils and cause disease when environmental conditions are optimal for growth; thus, few effective IPM options to combat fungal disease currently exist. Nevertheless, the following cultural practices will be followed to minimize the need for fungicides:

Cultural controls	Reduced-risk controls
• Crop rotation with non-host crops; • Use of resistant varieties and non-damaged, non-infested seed; • Planting schedules according to crop forecasts (delaying if conditions are optimum for fungal disease development); • Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues.	• Sulfur; • Kocide • Seed treated with Maxim XL and/or Thiram [5]

Dithane is compatible with IPM programs because it can be used as a preventative treatment which provides good control throughout the growing season. See Annex 1 for more detail.

D. Proposed method or methods of application, including the availability of application and safety equipment.

Dithane is diluted with water and applied to soil or plants with a knapsack sprayer.

PPE for Dithane: Long sleeves, long pants, chemical resistant gloves, shoes plus socks and protective eyewear (goggles).

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards.

Dithane is harmful if swallowed, absorbed through skin, or inhaled and may cause moderate eye irritation. Properly used and maintained PPE for Dithane should prevent exposure. Users should wash with soap and water after use and before eating, drinking or chewing gum. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose

[5] Treated seeds farmers pose a lower exposure risk to humans, especially non-farmers, than backpack spray applications since seed treatments are applied under controlled, contained conditions and only one application is needed. Seed treatments also contain a dye to signal presence of pesticide. Farmers handling treated seed will be trained to use all recommended PPE when handling treated seed. Non-farmers will be trained on recognizing treated seed and will be discouraged from handling.

other than spraying. Dithane M-45 is locally available, but Dithane F-45 is a lower-risk formulation which will be recommended over Dithane M-45 as it becomes available.

Human Risk: Dithane is a potential carcinogen and reproductive/developmental toxin due to ethylenethiourea (ETU), a breakdown product of mancozeb.

Mitigation: Women should be discouraged and pregnant women are prohibited from handling Dithane or entering fields where Dithane has been applied. Pregnant women are prohibited from handling or washing PPE.

Environmental Risk: Dithane is slightly toxic to aquatic invertebrates and fish, and should not be applied near surface waters. Dithane is not persistent in soils (field half-life 1-7 days in soil). It is practically insoluble in water and thus is unlikely to be carried down by rains to groundwater.

Mitigation: Dithane will not be applied in windy conditions. Runoff will be minimized by trenching or planting of vegetation barriers around fields.

F. Effectiveness of the requested pesticide for the proposed use.

In combination with non-chemical control methods (see Annex 1), Dithane provides good control of *Phytophthora spp., Alternaria,* and *Pythium spp.* diseases of roots, foliage and fruits.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Dithane is toxic to aquatic organisms and risks can be mitigated by minimizing drift and runoff.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Dithane will not be applied near surface waters and runoff and drift will be minimized to protect aquatic organisms. Dithane has little to no negative effects on other wildlife.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable fungicides include Ridomil Gold (mefenoxam) and seeds treated with Thiram (Thiram 75%) and Maxim (Fludioxonil 2,5 % , metalaxyl -M 1.0 %).

Mancozeb has a fungicide resistance classification of M3. Mancozeb should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

Note: Thiram also has a fungicide classification of M3.

5. Quadris (Azoxystrobin 22.9%)

B. Basis for selection of the pesticide

Azoxystrobin is a broad spectrum fungicide with activity against several diseases on many fruit, vegetable and field crops. In particular this pesticide was chosen for its control/prevention of various rice diseases (stem rot blight and sheath spot). Quadris provides complete protection throughout the plant through excellent xylem mobile systemic activity. Quadris provides control of a wide spectrum of fungal diseases and offers application flexibility and long-lasting residual disease control.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Most fungal plant pathogens are already present in soils and cause disease when environmental conditions are optimal for growth; thus, few effective IPM options to combat fungal disease currently exist. Nevertheless, the following cultural practices will be followed to minimize the need for fungicides:

Cultural controls	**Reduced-risk controls**
• Crop rotation with non-host crops; • Use of resistant varieties and non-damaged, non-infested seed; • Planting schedules according to crop forecasts (delaying if conditions are optimum for fungal disease development); • Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues.	• Sulfur; • Copper compounds • Seeds treated with Thiram and/or Maxim with proper handling precautions.[6]

D. Proposed method or methods of application, including the availability of application and safety equipment

Azoxystrobin is a suspension concentrate that should be mixed with water and sufficiently agitated to keep mixture in suspension (the mixture should be mixed every minute). Quadris may be applied as a foliar spray in accordance with label instructions.

[6] Seed treatments applied by trained agronomists or farmers pose a lower exposure risk to humans, especially non-farmers, than backpack spray applications since seed treatments are applied under controlled, contained conditions and only one application is needed. Seed treatments also contain a dye to signal presence of pesticide. Farmers handling treated seed will be trained to use all recommended PPE when handling treated seed. Non-farmers will be trained on recognizing treated seed and will be discouraged from handling.

PPE for Quadris: Long shirt and pants, chemical resistant gloves and shoes plus socks.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Azoxystrobin is of low acute and chronic toxicity to humans and is not considered a human carcinogen.
Mitigation: PPE for Quadris when properly worn and maintained should prevent any problems. Users should wash with soap and water after use and before eating, drinking or chewing gum. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose other than spraying.

Environmental risk: Azoxystrobin has a low acute toxicity in, birds, mammals, and bees but is highly toxic to freshwater fish, freshwater invertebrates, and estuarine/marine fish, and very highly toxic to estuarine/marine invertebrates. Field dissipation studies indicate that Azoxystrobin is moderately immobile and relatively non-persistent under actual use conditions. There is the potential for azoxystrobin to contaminate groundwater if used in highly porous soils.
Mitigation: Quadris will not be applied in windy conditions or near intertidal areas or surface waters. Quadris will not be applied in sandy, gravelly or otherwise highly porous soils and/or where water tables are high (see V. Safer Use Action Plan and the table on page 85) for more specific mitigation measures concerning potential groundwater contaminants). Runoff will be minimized by trenching or planting of vegetation barriers around fields.

F. Effectiveness of the requested pesticide for the proposed use

If maximum recommended application of azoxystrobin, a Group 11 chemical, has been applied use another registered fungicide for additional applications. If resistant elements are present azoxystrobin should be rotated with a product containing an active ingredient in another chemical class. Increased rates and shorter applications intervals may be required when conditions favor disease.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems

Quadris has low toxicity for beneficial such as bees, although highly toxic for freshwater, marine and estuarine fish and invertebrates. Quadris is also a potential groundwater contaminant. Quadris will not be applied in coastal and intertidal zones or near surface waters, in high wind conditions and trenching and vegetation along field borders will be used to minimize leaching and runoff.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils

Quadris will not be applied near surface waters, permeable soils or areas with high water tables. Runoff and drift will be minimized to protect aquatic organisms. Quadris has little to no negative effects on other wildlife.

I. Availability of other pesticides or non-chemical control methods

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable fungicides for control of some similar fungal diseases include Copper compounds, Dithane, Ridomil Gold EC, Sulfur, Thiram and Maxim treated seeds.

Azoxystrobin has a fungicide resistance classification of 11. Azoxystrobin should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

Note: The above recommended alternatives have the following resistance classifications: Thiram M3, Copper compounds M1, Dithane M3, Ridomil n/a, Maxim n/a.

6. Ridomil Gold EC (mefenoxam 49%)

B. Basis for selection of the pesticide

Ridomil Gold is a systemic fungicide effective against fungal diseases including, Pythium soil-borne diseases, downy mildew, damping-off, phytophthora spp., rhizocontia rots, and cercospora leaf spot, in a number of vegetable, fruit and field crops. It provides multi-site activity and is versatile enough to be used for fungal diseases affecting different plant parts and at different times during the growing season. Ridomil offers a unique control of soil borne diseases which allows for in furrow application on soil as well as seed treatment with various partners.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Most fungal plant pathogens are already present in soils and cause disease when environmental conditions are optimal for growth; thus, few effective IPM options to combat fungal disease currently exist. Nevertheless, the following cultural practices will be followed to minimize the need for fungicides:

Cultural controls	**Reduced-risk controls**

• Crop rotation with non-host crops; • Use of resistant varieties and non-damaged, non-infested seed; • Planting schedules according to crop forecasts (delaying if conditions are optimum for fungal disease development); • Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues.	• Sulfur; • Copper compounds • Seeds treated with Thiram and/or Maxim with proper handling precautions.[7]

Ridomil is compatible with IPM programs because it can be used as a preventative treatment or a control measure if fungal diseases develop during the growing season on a variety of crops. See Annex 1 for IPM plans for specific fungal diseases and for more detail on how Ridomil will be incorporated into these IPM plans for each crop.

D. Proposed method or methods of application, including the availability of application and safety equipment

Ridomil Gold EC is diluted with water to create a suspension and applied to soil or plants with a knapsack sprayer.

PPE for Ridomil: Long shirt and pants, Chemical resistant gloves and shoes plus socks.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: Ridomil is harmful if swallowed, absorbed through skin, or inhaled and may cause moderate eye irritation.
Mitigation: PPE for Ridomil which is properly worn and maintained should prevent any problems. Users should wash with soap and water after use and before eating, drinking or chewing gum. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose other than spraying.

Environmental Risk: Ridomil is slightly toxic to aquatic invertebrates and fish and a potential groundwater contaminant. Ridomil's active ingredient, mefenoxam, is slightly persistent in soils (half-life

[7] Seed treatments applied by trained agronomists or farmers pose a lower exposure risk to humans, especially non-farmers, than backpack spray applications since seed treatments are applied under controlled, contained conditions and only one application is needed. Seed treatments also contain a dye to signal presence of pesticide. Farmers handling treated seed will be trained to use all recommended PPE when handling treated seed. Non-farmers will be trained on recognizing treated seed and will be discouraged from handling.

60 days in aerobic soil conditions). Mefenoxam is not water soluble but has potential mobility in very sandy or otherwise permeable soils.
Mitigation: Ridomil will not be applied in windy conditions or near intertidal areas or surface waters. Ridomil will not be applied in sandy, gravelly or otherwise highly porous soils and/or where water tables are high (see V. Safer Use Action Plan and the table on page 85) for more specific mitigation measures concerning potential groundwater contaminants). Runoff will be minimized by trenching or planting of vegetation barriers around fields.

F. Effectiveness of the requested pesticide for the proposed use

Ridomil Gold is a formulation that has been optimized to achieve the same results with half the dose. Often one preventative treatment at planting is enough to control fungal disease in most crops. Extremely wet conditions may require additional applications to achieve control.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems

Ridomil is only slightly toxic to aquatic organisms and is a potential groundwater contaminant risks can be mitigated by avoiding use in areas with porous soils, minimizing spray drift and runoff.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils

Ridomil will not be applied near surface waters and runoff and drift will be minimized to protect aquatic organisms. Ridomil has little to no negative effects on other wildlife.

I. Availability of other pesticides or non-chemical control methods

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable fungicides for control of some similar fungal diseases include Copper compounds, Dithane, Quadris, Sulfur, Thiram and Maxim treated seeds.

7. Sulfur

B. Basis for selection of the pesticide

Sulfur, a contact and protectant fungicide and secondary miticide, is a less hazardous alternative to systemic fungicides used for Powdery mildew, rust, cercospora, alternaria blight and mites in Avocadoes, Beans, Broccoli, Carrots, Cabbage, Citrus, Corn, Eggplant, Mangos, Onions, Potatoes, Peanuts, Peppers, Sorghum and Tomato. Elemental sulfur is found as an active ingredient in over 250 actively registered products and is considered to have good compatibility with other products.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Most fungal plant pathogens are already present in soils and cause disease when environmental conditions are optimal for growth; thus, few effective IPM options to combat fungal disease currently exist. Nevertheless, the following cultural practices will be followed to minimize the need for fungicides:

Cultural controls	Reduced-risk controls
• Crop rotation with non-host crops; • Use of resistant varieties and non-damaged, non-infested seed; • Planting schedules according to crop forecasts (delaying if conditions are optimum for fungal disease development); • Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues.	• Seed treatments of Thiram and/or Maxim with proper handling precautions. • Copper compounds

Sulfur is ubiquitous throughout the environment and is compatible as a preventative treatment with the IPM measures described above (see Annex 1 for further IPM measures for specific fungal controls).

D. Proposed method or methods of application, including the availability of application and safety equipment

Sulfur in a dust or granular form is diluted with water and applied using knapsack sprayers.

PPE for sulfur: Long sleeves, long pants, chemical resistant gloves, shoes plus socks and eye protection (goggles).

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Sulfur has low acute toxicity but is mildly irritating to eyes and harmful is absorbed through skin or inhaled.
Mitigation: Sulfur has no known chronic health effects when used properly. Precaution should be used to avoid inhaling sulfur dust.
Environmental risk: Sulfur is present in most aquatic and terrestrial environments and is therefore unlikely to have adverse effects on non-target organisms or ecosystems. Elemental sulfur leaches slowly in soils. Sulfur is not considered a potential groundwater contaminant and autotrophic soil bacteria break down sulfur into sulfates.

Mitigation: Drift should be minimized by using granular applications if possible and by applying when winds are low. As a precaution sulfur should not be applied directly to surface waters or near water sources.

F. Effectiveness of the requested pesticide for the proposed use

Sulfur has been used as a fungicide for years, and is effective as a protectant treatment against several vegetable, fruit field and nut crop fungal disease *(listed in section B)* and also acts as a secondary miticide.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Because it is a naturally-occurring compound, sulfur is unlikely to have adverse effects on non-target organisms or ecosystems, but as a precaution should not be applied near water sources. Drift should be minimized by using granular applications if possible and by applying when winds are low.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils

Sulfur should not be applied when temperatures are very hot as it can burn vegetation. It should not be applied when winds are high, or near water sources.

I. Availability of other pesticides or non-chemical control methods

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical fungal control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable fungicides for control of some similar fungal diseases include Copper compounds, Dithane, Quadris, Ridomil Gold EC, Thiram and Maxim treated seeds.

Biological fungicides

8. Biolife 20 SL (organic acids)

B. Basis for Selection of Pesticides:

Biolife 20 SL is an antimicrobial suspension liquid containing 20% water soluble organic acids. Biolife is an organic fungicide and can be applied to a wide range of crops to prevent infections such as fusarium yellows, pythium rot, cercospora and sigatoka. Biolife can also be used to disinfect farming equipment and seeds. All active ingredients included in this product (ascorbic, citric, lactic acids) are all naturally occurring compounds that are classified as minimum risk pesticides by the EPA and most are exempt

from federal registration, residue allowances and health testing requirements mandated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)'s Section 25(b).

Note: Other names include: Lionlife, Citrex, Agrilife and Dipper. Each of these products contain the same active ingredients, concentrations may vary, although they

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following measures to combat insect pests will be recommended before application of Biolife. (see Annex 1 for more information on IPM plans specific to each crop):

Cultural controls	**Non-pesticide/botanical controls**
• Coordinate planting calendars and crops with other farmers in the area; • Avoid rotating with aphid host crops (especially tomato, spinach, peppers, eggplant, and cole crops) or allow maximum time between these crops; • Ensure plant health by using nursery grown seedlings, resistant varieties, and by managing irrigation and fertilization whenever possible; • Avoid over-applications of fertilizer, especially nitrogen; • Manage host weeds around field edges; • Remove and destroy crop remnants to kill any remaining eggs or larvae.	• Insecticidal soaps (applied in the early morning or late evening to avoid leaf burn) • Garlic and chili spray (applied in the early morning or late evening to avoid leaf burn) • Neem oil

D. Proposed method or methods of application, including the availability of application and safety equipment

Biolife is generally applied at a rate of .75 to 1 liter per hectare depending on the crop. Consult the product label for precise application directions.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Biolife poses no major risks to human health but should not be ingested. Biolife can cause moderate eye irritation.
Mitigation: Farmers applying Biolife should not spray the product while eating, drinking or chewing gum. Proper PPE should be worn.

Environmental risk: Principle active ingredients of Biolife include ascorbic acid, citric acid and lactic acid. Both ascorbic and citric acid are registered as 4A minimal risk inert ingredients by the USDA. Lactic acid is registered as a 4B minimal risk inert ingredient by the USDA. As defined by the USEPA, the determination that a chemical is of minimal risk, is based on the overall safety and toxicity of the chemical after considering all available information on the chemical's properties and history of use. The ingredients will not adversely affect human health or the environment. Biolife 20 SL has a very low level of persistence in soil. The product is eliminated 100% from the soil within 28 days of exposure.

PPE for Biolife: Eye protection, long pants and long sleeved shirt. Shoes with socks.

F. Effectiveness of the requested pesticide for the proposed use
Biolife reduces the effect of pathogenic microorganisms by direct effect, destroying the cell wall, and indirectly as a bio-stimulant of the natural defense mechanisms of the plant.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems
Biolife has minimal adverse effects on the surrounding environment.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils
Biolife should not be sprayed if rain is imminent. Spraying should take place in the morning or evening to minimize drift and should not occur in breezy or windy conditions.

I. Availability of other pesticides or non-chemical control methods
Haiti has limited options for pest control and many new, less toxic alternatives (such as this product) have not yet become widely available on the Haitian market. USAID partners will, whenever possible, work with agrochemical suppliers to increase awareness of the hazards of RUPs and increase supplies of safer alternatives, such as botanicals and biopesticides. Insecticidal soap (a liquid soap and water solution) and Neem oil, provides some control of whiteflies and aphids, but often fails to control populations below economically damaging levels. Crop rotation and measures to preserve natural enemies will be practiced (see Annex 1: IPM Plans by Crop for more information).

Seed Treatments

9. Maxim XL (EC) – (Fludioxonil 21%, Metlaxyl 8.4%)
(Fludioxonil .00375%, metalaxyl – M .0015% *Percentages found in treated Monsanto Dekalb Hybrid Corn seed)

B. Basis for selecting pesticide

Maxim is a seed treatment fungicide which controls certain soil-borne and seed-borne diseases of crop plants. Maxim provides protection against downy mildew, damping-off, seed borne diseases of pythium and fusarium spp. and soil borne rhizoctonia diseases. Pre-treated corn seeds are available and being promoted by USAID partners working with agro-supply stores. These treated seeds provide fungal controls that reduce farmer's and supply-store staff exposures by reducing the need for spray applications of fungicides.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Most fungal plant pathogens are already present in soils and cause disease when environmental conditions are optimal for growth; thus, few effective IPM options to combat fungal disease currently exist. Nevertheless, the following cultural practices will be followed to minimize the need for fungicides:

Cultural controls	Reduced-risk controls
• Crop rotation with non-host crops; • Use of resistant varieties and non-damaged, non-infested seed; • Planting schedules according to crop forecasts (delaying if conditions are optimum for fungal disease development); • Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues.	• Sulfur • Copper compounds

D. Proposed method or methods of application, including the availability of application and safety equipment

Maxim is a water based slurry that should be diluted with water and applied to seeds. However, currently USAID partners and farmers are not treating seed themselves but rather handling already treated seeds purchased in stores.

PPE for handling treated seeds: Chemical-resistant gloves. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: Maxim is harmful if swallowed or absorbed through skin.

Mitigation: Avoid contact with eyes, skin, or clothing and inhalation of treated seed dust. Proper use of PPE will reduce the risk of intoxication and harm to human health.

Environmental Risk: Maxim is toxic to fish and aquatic invertebrates and one of its active ingredients, mefenoxam, has potential to leach through permeable soils and contaminate groundwater, especially in areas with high water tables and sandy or gravelly soils. Treated seed can be toxic to humans and animals if consumed.

Mitigation: Run-off and leaching risks are reduced because Maxim treated seeds bought in stores are the most common instance of this chemical in Haiti. All treated seed should be brightly dyed and be labeled as "Not for human or animal consumption." Corn and sorghum forage may not be grazed until 30 days after planting.

F. Effectiveness of the requested pesticide for the proposed use

Maxim, along with non-chemical controls will provide effective protection against seed- and soil-borne diseases. Fungal resistance can be avoided by rotating Maxim treated seed with other fungal controls from different chemical classes.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Maxim is toxic to fish and aquatic invertebrates and is a potential groundwater contaminant, -off and leaching risks are reduced because Maxim treated seeds bought in stores are the most common instance of this chemical in Haiti.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Treated seeds will not be disposed of or used in areas where they could directly contaminate surface or groundwater.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable fungicides for control of some similar fungal diseases include Ridomil Gold (mefenoxam), Copper compounds, Dithane, Quadris, Thiram and Sulfur.

10. Batalion 0.2 EC (Deltamethrin 2.87 %)
*Information found on label of treated Monsanto "Dekalb" Hybrid Corn seed
Treatment product: K-Obiol 25 EC (Deltamethrin 2.5%); Active ingredient dosage: Deltamethrin .0001%)

B. Basis for selecting pesticide

Batalion was selected due to its similar concentration and formulation to K-Obiol 25 EC (Deltamethrin 2.5%) indicated on the treated corn seed label. K-Obiol 25 EC could not be found registered in the appropriate concentration indicated on the product label. Batalion 0.2 EC is an insecticide that is labeled as a RUP with a Class I toxicity. However, it is our recommendation that, due to the low dosage concentration present on the treated corn seed, the restricted-use status and toxicity classification for

the original product should not apply to the treated corn seed. Deltamethrin is a non-systemic pyrethroid used for control of grain weevil, borer and flour beetle infestations in stored grain seed.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Most fungal plant pathogens are already present in soils and cause disease when environmental conditions are optimal for growth; thus, few effective IPM options to combat fungal disease currently exist. Nevertheless, the following cultural practices will be followed to minimize the need for fungicides:

Cultural controls	**Reduced-risk controls**
• Crop rotation with non-host crops; • Use of resistant varieties and non-damaged, non-infested seed; • Planting schedules according to crop forecasts (delaying if conditions are optimum for fungal disease development); • Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues.	• Sulfur • Copper compounds

D. Proposed method or methods of application, including the availability of application and safety equipment

Batalion 0.2 EC is an emulsifiable concentrate that should be diluted with water and applied as a foliar application. However, the only recommendation for use of deltamethrin is in the instance of the treated corn seed product Deklab. Neither USAID partner staff nor farmers will apply deltamethrin sprays and will only come into contact with corn seed treated with very low amounts of this active ingredient.
PPE for seeds treated with Deltamethrin: Mask and chemical resistant gloves

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: Deltamethrin has moderate acute toxicity and is highly toxic if inhaled or swallowed.
Mitigation: Avoid contact with eyes, skin, or clothing and inhalation of treated seed dust. Proper use of PPE will reduce the risk of intoxication and harm to human health.

Environmental Risk: Deltamethrin is highly toxic to fish and aquatic invertebrates although it has low groundwater contamination potential. Deltamethrin is highly toxic to mammals and bees.
Mitigation: Run-off, leaching and environmental risks are reduced because Deltamethrin treated seeds bought in stores are the most common instance of this chemical in Haiti. All treated seed should be brightly dyed and be labeled as “This seed has been treated with [product active ingredients]. Do not use for feed, food, or oil purposes.” Corn and sorghum forage may not be grazed until 30 days after planting.

F. Effectiveness of the requested pesticide for the proposed use

Deltamethrin, along with non-chemical controls will provide effective protection against seed- and soil-borne diseases. Fungal resistance can be avoided by rotating Deltamethrin treated seed with other fungal controls from different chemical classes.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Deltamethrin potential to intoxicate fish and aquatic invertebrates is greatly reduced because pre-treated seeds bought in stores will be the only use of this chemical by USAID partners.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Treated seeds will not be disposed of or used in areas where they could directly contaminate surface or groundwater and negatively affect wildlife.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable fungicides for control of some similar fungal diseases include Ridomil Gold (mefenoxam), Copper compounds, Dithane, Quadris, Sulfur and Thiram and Maxim seed treatments.

Deltamethrin has a fungicide resistance classification of 3. Deltamethrin should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

Note: The above recommended alternatives have the following resistance classifications: Thiram M3, Copper compounds M1, Dithane M3, Quadris 11 Ridomil n/a, Maxim n/a.

11. Thiram (Thiram 75%)
(*Widely available in agro-supply stores visited Seminis vegetable seeds are labeled as being treated with Thiram although no information on active ingredient concentration was found)

B. Basis for selecting pesticide

Thiram is a seed treatment fungicide and repellent which controls certain soil-borne and seed-borne diseases of crop plants. Thiram provides protection against rhizoctonia blight, damping off, seed rot, rodents. Pre-treated vegetable seeds were the only discovered instance of the Thiram as a fungal control in Haiti. These treated seeds are being promoted by USAID partners working with agro-supply stores. Treated seeds provide fungal controls, usually at very low active ingredient concentrations, that

reduce farmer's and supply-store staff exposures by reducing the need for spray applications of fungicides. Thiram is a very versatile product and can be used as a seed treatment, foliar spray and bird repellent. Furthermore, Thiram degrades rapidly in soil and does not reach groundwater.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Most fungal plant pathogens are already present in soils and cause disease when environmental conditions are optimal for growth; thus, few effective IPM options to combat fungal disease currently exist. Nevertheless, the following cultural practices will be followed to minimize the need for fungicides:

Cultural controls	**Reduced-risk controls**
• Crop rotation with non-host crops; • Use of resistant varieties and non-damaged, non-infested seed; • Planting schedules according to crop forecasts (delaying if conditions are optimum for fungal disease development); • Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues.	• Sulfur • Copper compounds

D. Proposed method or methods of application, including the availability of application and safety equipment

Thiram is a water based slurry that should be diluted with water and applied to seeds. However, currently USAID partners and farmers are not treating seed themselves but rather handling already treated seeds purchased in stores.

PPE for handling treated seeds: Chemical-resistant gloves. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: Thiram has moderate acute toxicity and may cause contact irritation to eyes, skin and respiratory tract. Thiram may cause damage to liver and kidney with repeated exposures. It is a suspected endocrine disruptor and a developmental toxin.
Mitigation: Treated seeds contain low concentrations of active ingredients and should reduce risk of health risk by minimizing exposure. Avoid contact with eyes, skin, or clothing and inhalation of treated seed dust. Proper use and maintenance of PPE will reduce the risk of intoxication and harm to human health. Pregnant women should never handle seed treated with Thiram. All treated seed should be

brightly dyed and clearly labeled, “This seed has been treated with [product active ingredients]. Do not use for feed, food, or oil purposes.”

Environmental Risk: Thiram is acutely toxic to fish and aquatic invertebrates and moderately toxic to bees, birds and mammals. Thiram has low water solubility and low potential to contaminate groundwater.

Mitigation: Thiram pre-treated seeds, the most common instance of this chemical in Haiti, reduces the risk of environmental contamination and impacts. All treated seed should be brightly dyed and clearly labeled, ““This seed has been treated with [product active ingredients]. Do not use for feed, food, or oil purposes.”

F. Effectiveness of the requested pesticide for the proposed use

Thiram seed treatments allow for preventative control of fungal diseases already present in the soils. Pre-treated seeds reduce the exposure risks for users and the environment. Resistance management strategies should be put in place, and Thiram, a Group M chemical, should be rotated with other non-Group M fungal controls. Loss of pest control may occur if Thiram is used in the same field year after year.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Thiram is toxic to fish and aquatic invertebrates and is moderately toxic to beneficials such as bees and earthworms. Seeds pre-treated with Thiram will be the only use of this chemical by USAID partners. Pre-treated seeds greatly reduce the risks of this product contaminating non-target species and ecosystems.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Treated seeds will not be used, stored or disposed of in areas where they could leach into surface waters and estuarine environments or be eaten by birds.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable fungicides for control of some similar fungal diseases include Ridomil Gold (mefenoxam), Copper compounds, Dithane, Quadris, and Sulfur.

Thiram has a fungicide resistance classification of M3. Thiram should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

Note: The above recommended alternatives have the following resistance classifications: Copper compounds M1, Dithane M3, Quadris 11 Ridomil n/a, Maxim n/a.

Herbicides

12. Fusilade (Fluazifop-p-butyl 24.5%)

B. Basis for selection of pesticide

Fluazifop-p-butyl is a selective phenoxy herbicide used for post-emergence control of annual and perennial grass weeds. It is used primarily on beans in Haiti. It is not effective against broad leaf weeds or sedges but the compound is compatible and can be mixed with many broad-leaf control herbicides. Fusilade 'rainfast' one hour after application. Fusilade is a highly active product that controls both annual and perennial weeds. It is especially effective against grass weeds.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Fusilade will be used as a last resort for weed control after the following non-chemical controls have failed to be effective.

Cultural controls	Other available non-chemical controls
• Crop rotation; • Use of certified, weed - free seed; • Shallow tillage before planting to promote early weed germination can facilitate control; • Hand weeding when feasible; • Intercropping • Post-harvest field flooding	• Good weed management in first 3-5 weeks of crop growth as beyond that time frame most crops can outcompete weeds • Smother small weeds with soil • Planting in warm soil can help speed crop emergence and improve crop's ability to outcompete weeds

D. Proposed method or methods of application, including the availability of application and safety equipment

Fusilade should mixed in the appropriate amount with water and applied with a back pack sprayer to achieve uniform coverage of target weed foliage.

PPE for Fusilade: Long sleeves, long pants, chemical resistant gloves, shoes plus socks and eye protection (goggles) and chemical resistant apron when mixing and loading product.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Fusilade is moderately toxic through oral ingestion and highly toxic through inhalation. The compound has a low to moderate toxicity when in contact with the skin. It is only a mild skin and eye irritant and causes no skin sensitization. According to the Pesticides Action Network, there is some evidence of pre and post-natal toxicity.
Mitigation: PPE for Fusilade when worn and maintained should prevent any problems. Users should wash with soap and water after use and before eating, drinking, chewing gum/tobacco or using the bathroom. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose other than spraying. As a precaution, pregnant women should not handle or be exposed to Fusilade.

Environmental risk: Fusilade has moderate acute toxicity for fish and aquatic invertebrates. Fluazifop-p-butyl has a very low toxicity to bees. Fluazifop-p-butyl breaks down rapidly in moist soils and is therefore is not considered a threat to groundwater.
Mitigation: Fusilade will not be applied in windy conditions or near intertidal areas or surface waters and trenching or vegetative barriers on field borders will reduce run-off and leaching. Fusilade will not be applied when honey bees are actively foraging.

F. Effectiveness of the requested pesticide for the proposed use

Fusilade is effective as a foliar treatment against non-broad leaf perennial weeds. Good weed management in first 3-5 weeks of crop growth as beyond that time frame many crops can outcompete weeds Resistance and loss of control can develop with repeated applications of Fusilade on the same field year after year.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Fusilade is moderately toxic to fish and aquatic invertebrates and as a pre-caution will not be applied near surface waters or intertidal areas. Fusilade has very low toxicity to bees and as a precaution should not be applied when bees are actively foraging.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Fusilade should not be applied near surface waters or intertidal areas.

I. Availability of other pesticides or non-chemical control methods.

Other herbicides available include Glycel (Glyphosate, isopropylamine salt 41.5%) which is used for control of broad-leaf weed species for which Fusilade does not offer any protection. Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical controls include: the use of cover crops or intercropping with crops such as legumes, post-harvest flooding can effectively remove itch grass and crop rotation.

Accord (Glyphosate, isopropylamine salt 41.5%) is another acceptable herbicide for weed control.

Fluazifop-p-butyl has a herbicide resistance classification of A1. Fluazifop-p-butyl should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

Note: The above recommended alternatives have the following resistance classifications: Glyphosate n/a.

13. Accord (Glyphosate, isopropylamine salt 41.5%)
[Glysel SL – Glyphosate, isopropylamine salt 41% *Product available in Haiti]

B. Basis for selection of pesticide

Accord has a formulation and concentration of glyphosphate that matches more closely with Glysel, not registered in the US, than any other US EPA registered product. Glyphosphate is a broad spectrum, non-selective systemic herbicide registered for use on all fruit, vegetable, fruit and field crops considered in this assessment. Accord/Glysel provides post-emergence control of many broad leaf grasses and sedges.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Glyphosphate will be used as a last resort for weed control after the following non-chemical controls have failed to be effective.

Cultural controls	Other available non-chemical controls
• Crop rotation; • Use of certified, weed - free seed; • Shallow tillage before planting to promote early weed germination can facilitate control; • Hand weeding when feasible; • Intercropping • Post-harvest field flooding	• Smother small weeds with soil • Planting in warm soil can help speed crop emergence and improve crop's ability to outcompete weeds

D. Proposed method or methods of application, including the availability of application and safety equipment

Accord/Glysell are soluble concentrates that should be mixed in the appropriate amount with water and applied with a back pack sprayer to achieve uniform coverage of target weed foliage. Contact with non-target vegetation should be avoided as this may result in damage or destruction of desirable vegetation.

PPE for Accord/Glysel: Long sleeves, long pants, chemical resistant gloves, shoes plus socks.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Glyphosate is of relatively low oral and dermal acute toxicity. It has been placed in Toxicity Category III for these effects. The acute inhalation toxicity study was waived because glyphosate is non-volatile and because adequate inhalation studies with end-use products show low toxicity. EPA has stated that glyphosate is non-carcinogenic to humans.
Mitigation: PPE for Glyphosate when worn and maintained should prevent any problems. Users should wash with soap and water after use and before eating, drinking, chewing gum/tobacco or using the bathroom. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose other than spraying.

Environmental risk: Glyphosate adsorbs strongly to soil and therefore, is not likely to move to ground water. However, glyphosate does have the potential to contaminate surface waters due to its aquatic use and through erosion, as it adsorbs to soil particles suspended in runoff. Glyphosate is not readily broken down by water or sunlight. Glyphosate is no more than slightly toxic to birds and is practically non-toxic to fish, aquatic invertebrates and honeybees. EPA does not expect that most endangered terrestrial or aquatic organisms will be affected by the registered uses of glyphosate.
Mitigation: Glyphosate will not be applied in windy conditions or near surface waters and trenching or vegetative barriers on field borders will reduce run-off and leaching.

F. Effectiveness of the requested pesticide for the proposed use

Accod/Glysel is effective as a foliar treatment against annual and perennial weeds and woody plants. Resistance and loss of control can develop with repeated applications of Glyphosate on the same field year after year. Accord/Glysel is a Group 9 herbicide and should be rotated with herbicides in other chemical groups to avoid resistance build-up.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Glyphosate has minimal toxicity to fish, aquatic invertebrates and beneficials and should not affect non-target species. Glyphosphate will not be sprayed in high wind conditions or near surface waters to reduce the risk of its water source contamination. Trenching and planting of vegetation along field borders will reduce run-off and leaching potential of Glyphosate.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Glyphosate should not be applied near surface waters or in areas where erosion and run-off put nearby surface waters, especially surface drinking waters, at risk of contamination.

I. Availability of other pesticides or non-chemical control methods.

Other herbicides available include Fusilade which is used for control of broad-leaf weed species for which Accord/Glysel does not offer any control. Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical controls include: the use of cover crops

or intercropping with crops such as legumes, post-harvest flooding can effectively remove itch grass and crop rotation.

Other acceptable herbicides for control of some similar weeds include Fusilade.

Insecticides

14. Actara 240 sc (Thiamethoxam (21.6%)

B. Basis for selection of the pesticide

Actara is a reduced-risk, foliar-application neonicotinoid insecticide. Good coverage is necessary for effectiveness, but an advantage of Actara is that it is effective at very low dose rates. Actara provides good control for most sucking insect pests such as aphids, whiteflies, stink bugs, adult weevils, and grasshoppers. Actara is registered for use on a wide variety of vegetable crops.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following measures to combat sucking insect pests will be recommended before application of Actara (see Annex 1 for more information on IPM plans specific to each crop):

Cultural controls	Non-pesticide/botanical controls
• Coordinate planting calendars and crops with other farmers in the area; • Avoid rotating with whitefly or aphid host crops (especially tomato, spinach, peppers, eggplant, and cole crops) or allow maximum time between these crops; • Ensure plant health by using nursery grown seedlings, resistant varieties, and by managing irrigation and fertilization whenever possible; • Avoid over-applications of fertilizer, especially nitrogen; • Manage host weeds around field edges; • Remove and destroy crop remnants to kill any remaining eggs or larvae.	• Sticky traps (whiteflies) • Insecticidal soaps (applied in the early morning or late evening to avoid leaf burn) • Garlic and chili spray (applied in the early morning or late evening to avoid leaf burn) • Neem oil

When these cultural and non-pesticide controls do not sufficiently control sucking insect pests, Actara will be recommended. Actara is a selective insecticide which is rapidly absorbed into plant foliage, and thus causes minimal harm to beneficial arthropods once it is dry, even if beneficial are present on the leaf surface. However, Actara should not be sprayed during blooming when bees may be actively foraging. Resistance can develop and Actara should not be sprayed repeatedly, especially within the same growing season. Agrochemicals with different modes of action (i.e., non-neonicotinoid insecticides) such as Sevin (carbaryl) will be rotated with Actara application.

D. Proposed method or methods of application, including the availability of application and safety equipment

Actara will be diluted in water and applied with knapsack sprayers.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Actara is potentially harmful if swallowed, absorbed through skin, or inhaled and may cause moderate eye irritation.
Mitigation: PPE for Actara which is properly worn and maintained should prevent any problems. Sprayers should wash with soap and change clothes before eating, drinking or chewing gum. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose other than spraying.

Environmental risk: Actara is toxic to aquatic invertebrates and is moderately persistent in soil (half-life 54 days in sandy loam soil). Actara has high potential for mobility in some soil types and may contaminate groundwater; however, when applied as a foliar spray, the product is absorbed into plant foliage, thus reducing the risk for groundwater contamination. Actara will not be applied to gravelly or highly porous soils and/or where water tables are high (see V. Safer Use Action Plan and the table on page 37 for more specific mitigation measures concerning potential groundwater contaminants).
Mitigation: Actara should not be applied near surface waters. Runoff will be minimized by trenching or by planting vegetative borders around fields. Actara will be applied in the morning or evening when winds are low and potential for drift is minimum.

PPE for Actara: Long sleeves, long pants, shoes plus socks, gloves and eyewear

F. Effectiveness of the requested pesticide for the proposed use

Actara is taken up by plant tissue and is thus a systemic insecticide – plant matter or sap must be consumed for the pesticide to be effective, which makes it well-suited to combat sucking insects. Actara has long residual effects, greatly reducing the number of applications needed per season. It is registered by the USEPA for use as a foliar treatment against whiteflies, aphids, stink bugs, weevils and grasshoppers.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems

The low rates of application of Actara and its selectiveness for those insects which consume sap or leaves lower the risk of harmful effects on both target and non-target ecosystems. Caution should be used in areas near surface waters, and during flower bloom or where bees are actively foraging.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils

Once dried on leaves, Actara is resistant to rain, but should not be sprayed if rain is imminent. Spraying should not occur in breezy or windy conditions and should take place in the morning or evening to

minimize drift. Actara will not be applied to fields near surface waters. Actara will not be applied during flower bloom or if bees are actively foraging.

I. Availability of other pesticides or non-chemical control methods

Haiti has limited options for pest control and many new, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work with agrochemical suppliers to increase awareness of the hazards of RUPs and increase supplies of safer alternatives, such as botanicals and biopesticides. Insecticidal soap (a liquid soap and water solution) and Neem oil, provides some control of whiteflies and aphids, but often fails to control populations below economically damaging levels. Crop rotation and measures to preserve natural enemies will be practiced (see Annex 1: IPM Plans by Crop for more information).

Thiamethoxam has an insecticide resistance classification of A4. Thiamethoxam should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

Note: Other products for control of similar pests include Admire/Gaucho (Imidacloprid); chemical resistance class 4B

15. Actellic 5e (EC) – (Pirimifos Methyl 57%)

B. Basis for selection of pesticide

Actellic is a broad spectrum organophosphate miticide used for control of grain weevils, borers and beetles in stored grains, such as rice, corn and sorghum. This low-odor formulation reduces the inhalation risk of exposure for applicators and handlers of this product.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The most effective controls for the preventing infestations of stored grains are sanitation and humidity controls related to storage containers and areas. The most frequent source of insect infestations is grain residues from the previous year's stored crops. Actellic will be used as a last resort when infestations cannot be prevented or managed economically with the below controls.

Cultural controls	**Low risk controls**
• Repair and maintain storage containers to prevent grain spillage; • Bins and silos should be cleaned thoroughly two weeks prior to grain storage and all old grain removed; • Clean and sort grain to eliminate broken kernels and foreign material prior to storage; • Harvest grain when crop moisture is at its lowest possible;	• Apply preventative treatment of Insecto (diatomaceous earth 97%)

• Do not overfill bins or silos, leave head room for air circulation and monitoring every 2-4 weeks;	

D. Proposed method or methods of application, including the availability of application and safety equipment

Actellic will be diluted in water and applied with knapsack sprayers.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Actellic has moderate acute oral toxicity, if inhaled or swallowed and is a cholinesterase inhibitor. Actellic is corrosive and can cause contact dermatitis and irreversible damage to eyes.

Mitigation: PPE for Actellic which is properly worn and maintained should prevent problems. Sprayers should wash with soap and change clothes immediately after handling Actellic. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose other than spraying. *Wash the outside of gloves before removing.*

Environmental risk: Actellic has moderate to high acute toxicity for fish, aquatic invertebrates, birds and honeybees. Actellic is moderately persistent in soil (half-life 39 days in typical soils). However, Actellic has low potential for mobility and water solubility, and breaks down quickly in the presence of light and should not pose a high groundwater contamination risk, although it may contaminate surface waters.
Mitigation: As a grain treatment in storage facilities Actellic's risk of drift, leaching and effects on non-target organism are greatly reduced. Actellic should not be applied near surface waters. Do not wash PPE in, or allow rinsate, to contaminate surface waters.

PPE for Actellic: Chemical resistant coveralls/apron over Long shirt and pants, chemical resistant footwear plus socks, water proof gloves and protective eyewear (goggles).

F. Effectiveness of the requested pesticide for the proposed use

Actellic can, where technological capacity exists, be applied as an admixture to uniformly cover grain as it enters the storage container or, as is more suited to the Haitian case, as a layered application (incorporated into bottom and top 10cm of stored grains) to prevent migrating insects from infesting grain. Only one treatment of grain per season should be administered for each crop and Actellic residual control is reported as quite good. Stored grains treated in accordance with labeled rates have no REI and can be used immediately after treatment for food and feed purposes.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems

The application of Actellic in storage settings should greatly reduce the risk of negative effects on non-target species and eco-systems. Caution should be used when washing PPE in areas near surface waters.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils

Applications of Actellic in dusty settings should be avoided.

I. Availability of other pesticides or non-chemical control methods

Haiti has limited options for pest control and many new, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work with agrochemical suppliers to increase awareness of the hazards of RUPs and increase supplies of safer alternatives, such as botanicals and biopesticides. Insecto (Diatomaceous earth 97%) is an organically accepted treatment of storied grains that allows control for a greater array of storage insect pests than Actellic and should be used whenever possible as a safer alternative to Actellic. Storage sanitation and humidity controls are the most effective controls for preventing stored grain infestations. (see Annex 1: IPM Plans by Crop for more information).

Pirimifos Methyl has an insecticide resistance classification of 1B. Pirimifos Methyl should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

16. Admire 2 (FC) (Imidacloprid 21.4%)/ Gaucho 600 (Imidacloprid 48.6%)

B. Basis for selecting pesticide

Imidacloprid is a neonicotinoid insecticide that provides good control for most sucking and chewing insect pests such as leafminers, mealybugs, thrips, beetles, whiteflies and grubs. The product has been proven effective on the following crops: bananas, beans, broccoli, cabbage, cassava, citrus, eggplant, pigeon peas, peppers, tomatoes, okra, plantains, swiss chard, yams. Admire has long residual effects and requires fewer lower dosage applications per growing season than other alternative chemical products.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program.

The following measures to combat sucking insect pests will be recommended before application of Admire (see Annex 1 for more information on IPM plans specific to each crop):

Cultural controls	**Reduced-risk controls**

• Coordinate planting calendars and crops with other farmers in the area; • Avoid rotating with whitefly or aphid host crops (especially tomato, spinach, peppers, eggplant, and cole crops) or allow maximum time between these crops; • Ensure plant health by using nursery grown seedlings, resistant varieties, and by managing irrigation and fertilization whenever possible; • Avoid over-applications of fertilizer, especially nitrogen; • Manage host weeds around field edges; • Remove and destroy crop remnants to kill any remaining eggs or larvae.	• Sticky traps (whiteflies) • Insecticidal soaps (applied in the early morning or late evening to avoid leaf burn) • Garlic and chili spray (applied in the early morning or late evening to avoid leaf burn) • Neem oil

D. Proposed method or methods of application, including the availability of application and safety equipment.

Admire and Gaucho will be diluted in water and applied with knapsack sprayers. Knapsack sprayers are used widely by smallholder farmers all over the world and are not likely to have high risks if used properly. Knapsack sprayers are used widely by smallholder farmers and are not likely to have high risks if used properly. Use sufficient water to obtain full coverage. Do not store diluted material.

PPE for Admire: Long sleeved-shirt, long pants, shoes plus socks, chemical-resistant gloves and protective eyewear (goggles).

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards.

Human Risk: Admire and Gaucho are potentially harmful if swallowed, absorbed through the skin, or inhaled and may cause mild eye irritation.
Mitigation: PPE for Admire/Gaucho which is properly worn and maintained should prevent any problems. Sprayers should wash with soap and change clothes before eating, drinking or chewing gum. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose other than spraying.

Environmental Risk: Admire and Gaucho are highly toxic to birds, aquatic invertebrates and honeybees. There is generally not a high risk of groundwater contamination with Imidacloprid; however, it may move more easily through gravelly or porous substrates depending on irrigation practices.
Mitigation: Neither Admire nor Gaucho should be applied near surface waters. Runoff will be minimized by trenching or by planting vegetative borders around fields. Admire will be applied in the morning or evening when winds are low and potential for drift is minimum. These products will not be applied in on crops that attract birds, or when bees are likely to forage.

F. Effectiveness of the requested pesticide for the proposed use.

Imidacloprid is effective against sucking pests both on contact and through ingestion. Admire has long residual effects, greatly reducing the number of applications needed per season. It is registered by the USEPA for use as a foliar treatment against whiteflies and aphids.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

The low rates of application of Admire and Gaucho along with its partial selectiveness for those insects which consume sap or leaves lower the risk of harmful effects on both target and non-target ecosystems. Caution should be used in areas near surface waters, and during flower bloom or where bees are actively foraging.

Admire and Gaucho are moderately persistent in soils (half-life > 1 year in oxygenated sandy loam soils) and eventually breaks down to form carbon dioxide. There is generally not a high risk of groundwater contamination with Imidacloprid; however, it may move more easily through gravelly or porous substrates depending on irrigation practices. Imidacloprid breaks down more quickly when exposed to light (39 days on sandy loam soil). Neither Admire nor Gaucho will be applied to gravelly or highly porous soils and/or where water tables are high.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Once dried on leaves, Admire and Gaucho are resistant to rain, but should not be sprayed if rain is imminent. Spraying should not occur in breezy or windy conditions and should take place in the morning or evening to minimize drift. These products will not be applied to fields near surface waters nor will they be applied during flower bloom or if bees are actively foraging.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Imidacloprid has an insecticide resistance classification of 4B. Imidacloprid should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

18. Chancellor (SL) – (Bacillus firmus .66%)

B. Basis for selecting pesticide

Chancellor is a microbial, naturally occurring soil bacterium with nematicidal activity. This product can be used on a wide variety of fruit, vegetable and field crops that are affected for control of a wide variety of nematodes including: reniform, root knot, ring and citrus nematodes among others. This product is a low-risk alternative to highly toxic and dangerous chemical nematicides currently in use by Haitian farmers.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Cultural controls	Reduced-risk controls
• Fallow periods greater than a year • Rinse corms in running water and hot water (125°F) for 20 minutes • Rotation with nematode suppressive or non-host crops (sorghum, jatropha, velvelt and castor bean, etc.); • Introduction of chitin containing materials (crab and prawn shells); • Remove all weeds and excess plant material;	• Jatropha seed cakes • Jatropha, sorghum, velvet and castor bean green manure • Chancellor (*Bacillus firmus)*

D. Proposed method or methods of application, including the availability of application and safety equipment

Chancellor is soluble concentrate that should be dilute with water and applied as a soil treatment. Knapsack sprayers are used widely by smallholder farmers and are not likely to have high risks if used properly. Use sufficient water to obtain full coverage. Do not store diluted material.

PPE for handling Chancellor: Protective eye wear

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Bacillus firmus is not considered to have any negative human health effects due to its low toxicity, lack of infectivity and pathogenicity for mammalian species.
Mitigation: As a precaution handlers and applicators should wear protective eyewear

Environmental risk: No non-target species are adversely impacted by Bacillus firmus. Chancellor is considered safe for fish, birds, mammals, honeybees and earthworms.
Mitigation: N/A

F. Effectiveness of the requested pesticide for the proposed use

Chancellor provides significant reduction in target nematode levels through colonization and destruction of nematode egg sacs before nematode larvae can hatch and damage plant roots. This product is relatively new but it has achieved widespread use in a very short time.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Chancellor does not have any adverse impacts on non-target ecosystems or species.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Chancellor does not present any water contamination risks or and is considered safe for mammals, fish, and aquatic invertebrate and flora species. No specific conditions for use need be applied to the use of this product in order to further reduce risks of human or environmental contamination.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market, including perhaps Chancellor. However, USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

This biological nematicide is a relatively new nematode control option that should be promoted to the greatest extent possible by USAID Haiti programs. Other nematode controls currently in use by Haitian farmers are all RUPs and cannot be recommend and nor will they be promoted by any USAID partner without first carrying out an additional environmental assessment specific to nematode induced crop losses and risk-benefit of highly-toxic nematicide use.

19. Dimethoate 2.67 (EC) (Dimethoate 30.5 %)

B. Basis for selecting pesticide

Dimethoate 2.67 is an organophosphate pesticide that is very effective against leaf miners, thrips, beetles, weevils, whiteflies, mites, leafhoppers and loopers. The product can be used on the following crops: beans, broccoli, cabbage, cauliflower, citrus corn, pepper, tomatoes, swiss chard, peas, sorghum. This control was selected for cases when biological and less toxic caterpillar controls for the approved crops prove ineffective at maintaining pest levels below economically damaging levels. Furthermore, Dimethoate's water soluble packet formulation reduce the risks of human and environmental impacts

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following cultural practices will be followed to minimize the need for pesticide:

Cultural controls	Reduced-risk controls

• Use of resistant varieties and non-damaged, non-infested seed; • Manual removal of pests. • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues. • Early and effective weed control.	• Dipel (Bacillus thuringensis) • Neem oil

D. Proposed method or methods of application, including the availability of application and safety equipment

A water-soluble packet containing the correct dose of Dimethoate wettable powder is diluted in water and applied with knapsack sprayers. Knapsack sprayers are used widely by smallholder farmers and are not likely to have high risks if used properly. Use sufficient water to obtain full coverage. Do not store diluted material.

PPE for handling Dimethoate insecticide: Chemical-resistant gloves, long sleeved shirt and pants, shoes plus socks and protective eyewear. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: Harmful if fatal or swallowed. May cause irritation of the skin and eyes.
Mitigation: Avoid contact with skin and eyes. Follow PPE guidelines, outlined above. Avoid breathing vapor or spray. Use only in well ventilated areas.

Environmental Risk: Dimethoate is known to leach through soil into groundwater under certain conditions as a result of label use. This chemical is very hazardous to bees.
Mitigation: Do not apply directly to water. Do not apply where runoff is likely to occur. Do not contaminate water when disposing of equipment wash waters. Do not apply this product or allow it to drift to blooming crops if bees are visiting the area.

F. Effectiveness of the requested pesticide for the proposed use

Dimethoate can be very effective in preventing both chewing and sucking pests when used in combination with cultural practices.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Dimethoate is known to leach through soil into groundwater under certain conditions as a result of label use. Use of this chemical where soil is permeable may result in ground water contamination. This chemical is very susceptible to run-off for several days after application. Dimethoate is very hazardous to bees.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Dimethoate should not be applied on permeable soil, near water sources or when bees are likely to be foraging (during flower bloom).

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable pesticides that can be used to combat similar pests include Lorsban 75 WP and Actara 240 sc (EC).

Dimethoate has a pesticide resistance classification of 1B. Dimethoate should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

Note: The above recommended alternatives have the following resistance classifications: Lorsban 1B, Actara A4.

20. Insecto (D) Diatomaceous earth 90%

B. Basis for selecting pesticide

Insecto is an insecticide made out of refined diatomaceous earth. It kills insects by causing microscopic lacerations on their bodies causing them to lose their body fluid. Insecto is effective against weevils and beetles and can be used on stored grains, beans corn and sorghum.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following cultural practices will be followed to minimize the need for pesticide:

Cultural controls	Reduced-risk controls

• Use of resistant varieties and non-damaged, non-infested seed. • Monitoring of stored grains every 2-4 weeks. • Once containers are filled, stored crop should be leveled at the top to reduce risk of pest problems and facilitate even product application if necessary.	• Humidity and sanitation controls

D. Proposed method or methods of application, including the availability of application and safety equipment

INSECTO is intended for application with hand or power duster, or other suitable means, to hiding and running areas and places insects are found. To apply INSECTO into cracks and crevices, use Bulbous Duster or other suitable equipment. INSECTO should be dusted lightly, approximately one (1) pound per 1,000 square feet on all interior wall surfaces of clean empty storage areas.

PPE for Insecto: Protective eyewear and mask are recommended.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: Insecto can be harmful if inhaled and can irritate the eyes. Soreness of the eyes, throat and nose may occur.
Mitigation: Measures should be taken to reduce dust. Avoid contact with eyes. All broken bags or containers should be sealed immediately.

Environmental Risk: N/A
Mitigation: In the case of a spill or leak, a vacuum equipped with a HEPA filter can be used. A dust suppressant such as water can also be used.

F. Effectiveness of the requested pesticide for the proposed use
Insecto can be used with other cultural practices to effectively remove pests from stored crop material.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.
If used properly Insecto does not have any negative effects on surrounding ecosystems.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.
Insecto should be applied in a well ventilated area so as to avoid accumulation of dust.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical humidity and sanitation controls, sorting damaged and broken grain kernels and cleaning storage facilities thoroughly after pre and post-storage.

21. Lorsban 75 (WG) Chlorpyriphos 75%

B. Basis for selecting pesticide

Lorsban 75 WG is an organophosphate pesticide that can be used to prevent and remove mites, thrips, beetles, stink bugs, scales, aphids, ants, caterpillars, grasshoppers and nematodes. It is effective on the following crops: Broccoli, citrus, cabbage, cauliflower, corn, onions and sorghum.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following cultural practices will be followed to minimize the need for pesticide:

Cultural controls	Reduced-risk controls
• Hand-pick and kill larvae in soap and water or saltwater. • Garlic and chili spray. • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues. • Early and effective weed control.	• Neem • Sevin (carbaryl 80%)

D. Proposed method or methods of application, including the availability of application and safety equipment

A water-soluble packet containing the correct dose of Lorsban wettable powder is diluted in water and applied with knapsack sprayers. Knapsack sprayers are used widely by smallholder farmers and are not likely to have high risks if used properly. Use sufficient water to obtain full coverage. Do not store diluted material.

PPE for handling hazardous insecticide: Chemical-resistant gloves, long sleeved shirt and pants, shoes plus socks and protective eyewear. For dust exposure, wear as a minimum, a properly fitted half-face or full-face air purifying respirator which is approved for pesticides. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: May cause slight eye irritation. Single exposure to dust is not likely to be hazardous. A single prolonged exposure is not likely to result in the material being absorbed through the skin in hazardous amounts. Lorsban may be fatal if inhaled or swallowed.
Mitigation: PPE for Lorsban which is properly worn and maintained should prevent any problems. Users should wash with soap and water after use and before eating, drinking or chewing gum. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose other than spraying.

Environmental Risk: This pesticide is toxic to fish, aquatic invertebrates, small mammals and birds. Drift and runoff from treated areas may be hazardous to aquatic organisms in water adjacent to treated areas. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds.
Mitigation: Do not apply directly to water, to areas where surface water is present, or
to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash-waters or rinsate. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.

F. Effectiveness of the requested pesticide for the proposed use
Lorsban is effective against both sucking and chewing pests when used in combination with other non-chemical controls.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.
This pesticide is toxic to fish, aquatic invertebrates, small mammals and birds. Drift and runoff from treated areas may be hazardous to aquatic organisms in water adjacent to treated areas. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Lorsban 75 will not be applied near aquatic habitats or down gradients in proximity to aquatic habitats. This product will not be applied during high rainfall or windy conditions so as to prevent drift and runoff. Do not apply Lorsban on blooming crops when bees will be actively foraging.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable pesticides that can be used to combat similar pests include: Sevin(carbaryl) WSP 80% and Pounce 25 WP.

Chlorpyriphos has an insecticide resistance classification of 1B. Chlorpyriphos should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

Note: The above recommended alternatives have the following resistance classifications: Sevin 1A , Pounce 3.

22. Pounce 25 wp Permethrin 25%

B. Basis for selecting pesticide

Pounce 25 wp is a Pyrethroid insecticide for use on spiders, leafminers, thrips, beetles, weevils, scales, whiteflies, aphids, leafhoppers, mealy bugs, caterpillars/loopers, diamondback moth, ants and borers. It can be used against these pests on many crops including: Avocado, eggplant, peppers, tomatoes, broccoli, cabbage, cauliflower, corn and swiss chard.

Note: Farmers in the U.S. report preference for Permethrin due to its low level of human toxicity, especially in comparison to organophosphate chemical alternatives.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following cultural practices will be followed to minimize the need for pesticide:

Cultural controls	Reduced-risk controls
• Use of resistant varieties and non-damaged, non-infested seed; • Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues. • Early and effective weed control.	• Neem • Dipel (*Bacillus thuringensis)*

D. Proposed method or methods of application, including the availability of application and safety equipment

Pounce 25 WP insecticide is a 25% wettable powder formulation of the insecticide permethrin. Apply Pounce 25 WP when insects appear or feeding is noticed. The higher rate should be used as pest populations increase. Knapsack sprayers are used widely by smallholder farmers and are not likely to have high risks if used properly. Use sufficient water to obtain full coverage. Do not store diluted material.

PPE for handling hazardous insecticide: Chemical-resistant gloves, long sleeved shirt and pants, shoes plus socks and protective eyewear. For dust exposure, wear as a minimum, a properly fitted half-face of full-face air purifying respirator which is approved for pesticides. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: This pesticide causes substantial but temporary eye damage and is harmful if swallowed. Effects of overexposure result from either swallowing, inhaling, or coming into direct contact with skin or eyes. Symptoms of overexposure include diarrhea, salivation, tremors, convulsions, hyperactivity and hypersensitivity.
Mitigation: Do not get in eyes or on clothing. Wash thoroughly before eating, drinking, chewing gum, or using tobacco. Remove and wash contaminated clothing before reuse. For dust exposure, wear as a minimum, a properly fitted half-face of full-face air purifying respirator which is approved for pesticides.

Environmental Risk: This pesticide is extremely toxic to aquatic organisms, including fish and invertebrates. Drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. This pesticide is highly toxic to bees exposed to direct treatment on blooming crops or weeds.
Mitigation: Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean water mark. Do not apply when weather conditions favor drift from treated areas. Do not contaminate water when disposing of equipment wash waters. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area.

F. Effectiveness of the requested pesticide for the proposed use
Pounce is effective against a wide range of chewing and sucking pests when used in combination with other non-chemical controls.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.
If there are nearby down gradient aquatic habitats (such as lakes, rivers or natural ponds), Pounce should only be applied to crops that are surrounded by a 10-foot-wide vegetative filter strip of grass or other permanent vegetation. Pounce should not be applied when bees are likely to be exposed to the product.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Pounce will not be applied near aquatic habitats or down gradients in proximity to aquatic habitats. This product will not be applied during high rainfall or windy conditions so as to prevent drift and runoff.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable pesticides that can be used to combat similar pests include: Lorsban 75 WP Chlorpyriphos 44.9%.

Permethrin has an insecticide resistance classification of 3. Permethrin should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

Note: Chlorpyriphos has an insecticide resistance classification of 1B.

23. Sevin (WSP) *Carbaryl 80%*

B. Basis for selecting pesticide

Sevin is a broad-spectrum carbamate insecticide which is registered for use to combat caterpillars, beetles, whiteflies, aphids, stink bugs and weevils. Sevin can be used to prevent these pests in the following crops: peppers, eggplant, tomatoes, Swiss chard, broccoli, cabbage and citrus crops. It is effective either through ingestion or through direct contact. It has low REI and PHI, and has long residual effects, reducing the need for additional applications throughout the season. It is available in a water-soluble package, eliminating the need for farmers to come in direct contact with the powder during measurement. See below, section E, for toxicity information.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program.

Cultural controls	**Reduced-risk controls**
• Coordinate planting calendars and crops with other farmers in the area; • Avoid rotating with cole crops, bean, spinach or allow maximum time between these crops; • Ensure plant health by using nursery grown seedlings, resistant varieties, and by managing irrigation and fertilization; • Manage host weeds around field edges; • Remove and destroy crop remnants to kill any remaining eggs or larvae, or if a tractor is available, disc fields to destroy any remaining larvae. • Dig deep trenches with the steep side facing the crop to discourage armyworm migration into the field • Hand-pick caterpillar larvae and kill by placing in a bucket of soapy water.	• Garlic and chili spray. • *Bacillus thuringiensis* as it becomes locally available.

If the above measures are ineffective in controlling caterpillar pests below damaging levels, Sevin will be recommended. Because of its broad-spectrum action, Sevin is effective in pest resistance management programs; however, it loses effect as larvae grow. It can be used in combination with reduced-risk IPM measures, such as spraying Sevin during the beginning of the larval stage and then picking caterpillars or older larvae that remain. However, care should be taken to preserve natural enemies; careful monitoring of pest populations versus beneficial insect populations will aid in the decision to treat or not. Sevin should not be applied during flower bloom or when bees are actively foraging.

D. Proposed method or methods of application, including the availability of application and safety equipment.

A water-soluble packet containing the correct dose of Sevin wettable powder is diluted in water and applied with knapsack sprayers. Knapsack sprayers are used widely by smallholder farmers and are not likely to have high risks if used properly. Use sufficient water to obtain full coverage. Do not store diluted material.

PPE for handling hazardous insecticide: Chemical-resistant gloves, long sleeved shirt and pants, shoes plus socks and protective eyewear. For dust exposure, wear as a minimum, a properly fitted half-face of full-face air purifying respirator which is approved for pesticides. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards.

Human Risks: Sevin is potentially harmful if swallowed, absorbed through skin, or inhaled and may cause moderate eye irritation. Sevin is potentially carcinogenic and may have endocrine-disrupting effects.

Mitigation: PPE for Sevin (long sleeves, long pants, shoes plus socks and gloves) which is properly worn and maintained should prevent any problems. Sprayers should wash with soap and change clothes before eating, drinking or chewing gum. PPE should be washed after each use with soap and water, separate from other clothing, and should not be used for any purpose other than spraying. Furthermore, the proper use of the water-soluble packaging formulation, obeying REI and PHI, and use of lowest possible dose rates minimize these risks.

Environmental Risks: Sevin is moderately toxic to aquatic invertebrates. Sevin has a low persistence in soil (half-life of 7-14 days in sandy loam soil and 14-28 days in clay loam soil). It is bound by organic matter and can be transported in soil runoff.

Mitigation: Runoff will be minimized by trenching or by planting vegetative borders around fields. Sevin will be applied in the morning or evening when winds are low and potential for drift is minimum. Sevin should not be applied near surface waters.

F. Effectiveness of the requested pesticide for the proposed use:

Sevin's broad-spectrum action is effective against a variety of caterpillar pests at all larval stages, but loses effectiveness as larvae grow. Sevin has long residual effects, greatly reducing the number of applications needed per season. It is registered by the USEPA for use as a treatment against caterpillar pests on a number of crops.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems:

Low application rates make Sevin generally compatible with target and non-target ecosystems. It can have negative effects on beneficial insect populations; thus careful monitoring of pest and beneficial insect populations is important to allow beneficial populations a chance to combat caterpillar pests.

Caution should be used in areas near surface waters, and during flower bloom or where bees are actively foraging.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils:

Sevin is resistant to rain, but should not be sprayed if rain is imminent. Spraying should not occur in breezy or windy conditions and should take place in the morning or evening to minimize drift. Sevin will not be applied to fields near surface waters. Sevin will not be applied during flower bloom or if bees are actively foraging.

I. Availability of other pesticides or non-chemical control methods:

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Carbaryl has an insecticide resistance classification of 1A. Carbaryl should be rotated with similar products of different resistance classification in order to prevent pest tolerance.

24. Trebon 3G (Ethofenprox 3%)

B. Basis for selecting pesticide

Trebon is a low toxicity pesticide that has been proven effectiveness against rice weevils on rice crops.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following cultural practices will be followed to minimize the need for pesticide:

Cultural controls	**Reduced-risk controls**
• Use of resistant varieties and non-damaged, non-infested seed; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues. • Remove all weeds from levees and irrigation banks.	• Monitoring of rice weevil populations with traps to time interventions appropriately

D. Proposed method or methods of application, including the availability of application and safety equipment

A single application of Trebon 3G may be applied at the rate of 6 to 9 lbs. per acre. Do NOT apply more than once. Do NOT apply more than 9 lbs. of Trebon per acre. Do NOT release permanent flood waters until 21 days after application.

Note: Do not apply Trebon within sixty days of harvest.

PPE for handling Trebon: Chemical-resistant gloves, long sleeved shirt and pants, shoes plus socks and protective eyewear. For dust exposure, wear as a minimum, a properly fitted half-face of full-face air purifying respirator which is approved for pesticides. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: Inhalation of the product can cause irritation and nausea. Excessive inhalation can cause unconsciousness and death. Contact with eyes can cause severe irritation and permanent lesions. Trebon can be absorbed through the skin and will cause light to moderate irritation. Ethofenprox
Mitigation: Follow all PPE guidelines and frequently wash all contaminated clothing. Do not wash contaminated clothing at home.

Environmental Risk: Etofenprox is acutely toxic to fish and honeybees and is moderately toxic to birds. Trebon has a moderate level of persistence in soil and a very high level of aqueous persistence.
Mitigation: Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean water mark. Do not apply when weather conditions favor drift from treated areas. Do not contaminate water when disposing of equipment wash waters. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area.

F. Effectiveness of the requested pesticide for the proposed use

Trebon is affective against rice weevils if applied correctly and if over-application is carefully avoided.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Soil decomposition studies showed that the half-life of Trebon was approximately 1-3 weeks in aerobic soils. Trebon can be very damaging to aquatic life if the product is not used correctly.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Trebon should not be applied when winds are high; spraying is recommended in the morning or in the evening. The product should not be sprayed near non-target water bodies due to its toxicity to aquatic life. During flowering periods and/or if bees are actively foraging, the product should not be sprayed; once dry, it presents a much lower risk to bees.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Biological Insecticides

25. Beauveria bassiana 95%

B. Basis for selecting pesticide

Beauveria bassiana is a naturally occurring fungal insecticide that is commonly found in soils worldwide. It has been proven to be effective against the coffee berry borer among coffee fruit.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following cultural practices will be followed to minimize the need for pesticide:

Cultural controls	Reduced-risk controls
• Harvest ripe berries as soon as possible. • Pruning of the tree can increase plant vigor and circulation. • Mulching with banana leaves can increase plant vigor but may also attract other pests. • Reducing shade will make conditions more favorable to berry borer predators. • Early and effective weed control.	• N/A

D. Proposed method or methods of application, including the availability of application and safety equipment

Both liquid and powder formulations are available. In one study, an ES (emulsifiable suspension) formulation showed better ability to withstand rain than the comparable WP (wettable powder) form. Knapsack sprayers are used widely by smallholder farmers and are not likely to have high risks if used properly. Use sufficient water to obtain full coverage. Do not store diluted material.

PPE for Beauveria bassiana: Chemical-resistant gloves. Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: There are no expected health risks to humans who apply this insecticide or to people who eat the crops that have been treated with the fungus.
Mitigation: Proper PPE should be followed properly in order to minimize health risks. Precaution should be taken since they can be irritants to the skin, eyes and lungs.

Environmental Risk: Considered non-toxic to mammals, birds and plants. The two commercial strains of *B. bassiana* (GHA and ATCC 74040) have been tested against rats and rabbits and the results indicate they are not considered to be pathogenic, infective or toxic. Since this product is used to control a broad range of insect types (including beetles and ants), predators in these insect classes could also be affected.
Mitigation: Do not apply directly to water, to areas where surface water is present, or
to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash-waters or rinsate. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area. Caution should be used when applying it when honeybees are actively foraging.

F. Effectiveness of the requested pesticide for the proposed use
Beauveria bassiana can be used very effectively against coffee berry borers especially when used in combination with cultural controls.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.
This pesticide is non-toxic to mammals, birds and plants. Caution should be used when applying it when honeybees are actively foraging.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.
The product should not be applied under windy or rainy conditions.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

26. Dipel - Bacillus Thuringensis Kurstaki, ABTS-351, 58.2%

B. Basis for selection of the pesticide

Dipel*, Bacillus thuringiensis* (Bt) is a highly selective biopesticide for use on various caterpillar pests which damage crops by consuming leaves. It stops caterpillar feeding almost immediately and kills the pest in several days. The product can be used on crops including, Broccoli, Bananas, Citrus, Corn,

Carrots, Cabbage, Eggplant, Leeks, Onions, Pepper, Potatoes, Peanuts, Tomatoes, Sorghum. It poses almost no risks to humans or wildlife (see below).

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program.

The following cultural controls will be recommended before applications of Bt:

Cultural controls	Reduced-risk controls
• Coordinate planting calendars and crops with other farmers in the area; • Avoid rotating with cole crops, bean, spinach or allow maximum time between these crops; • Ensure plant health by using nursery grown seedlings, resistant varieties, and by managing irrigation and fertilization; • Manage host weeds around field edges; • Remove and destroy crop remnants to kill any remaining eggs or larvae, or if a tractor is available, disc fields to destroy any remaining larvae. • Dig deep trenches with the steep side facing the crop to discourage armyworm migration into the field • Hand-pick caterpillar larvae and kill by placing in a bucket of soapy water.	• Neem • Chili pepper spray mixtures

If the above measures are not effective in controlling caterpillar pests, Bt will be recommended. Because of its highly selective nature (i.e., it must be ingested to work), Bt is well-suited to IPM programs. Preservation of natural enemies is one of the most effective IPM measures against caterpillar pests, and since Bt must be ingested to work, it has little or no effects on beneficial insects. See Annex 1 for more information on IPM plans specific to each crop.

D. Proposed method or methods of application, including the availability of application and safety equipment.

Bt is sold as a wettable powder or slurry and is then sprayed onto foliage of crops using a knapsack sprayer. Knapsack sprayers are used widely by smallholder farmers all over the world and are not likely to have high risks if used properly.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards.

Human Risk: Bt poses very few health risks to humans or wildlife. It may be harmful if swallowed or inhaled and causes moderate eye irritation. High levels of exposure may cause allergic sensitization.

Mitigation: Properly worn PPE will minimize risks – users should also take care not to inhale dust.

Environmental Risk: Bt is non-toxic to birds, fish, bees, or beneficial insects. Bt breaks down quickly in the environment.
Mitigation: Bt should not be applied directly to water. Drift will be minimized by applying only when winds are low.

F. Effectiveness of the requested pesticide for the proposed use.

Caterpillars which have ingested Bt stop feeding almost immediately and continue to not feed. They generally die from starvation several days later. Farmers should be made aware that presence of live caterpillars after treatment does not mean that Bt did not work – when feeding stops, damage stops, even if caterpillars are still present.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Bt is a naturally-occurring soil bacterium and does not harm non-target organisms. Bt breaks down quickly in the environment.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Bt can be used under most environmental conditions. It is not highly persistent in direct sunlight, thus additional applications may be needed, but do not pose higher environmental risks than a single application. The application should not be applied during high wind so as to minimize drift.

I. Availability of other pesticides or non-chemical control methods.

The most effective cultural control method is to preserve natural enemies or create trenches to prevent armyworm migration into fields. Bt is highly compatible with these methods.

Other insecticides include Sevin WSP (carbaryl 80%), which is readily available in Haiti but is more toxic (see above); as Bt becomes available at agro supply stores, Sevin will be phased out.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

27. Milky Spore Bacillus popiliae .02%

B. Basis for selecting pesticide
Bacillus popilliae (Bp) is a naturally-occurring soil bacteria and a highly selective biopesticide for use on white grubs (scarab beetle larvae pests), which damage yellow yam and sweet potato by feeding. It

stops feeding within days and provides control of white grub for several years after only one or two applications. It poses almost no risks to humans or wildlife (see below).

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following cultural practices will be followed to minimize the need for pesticide:

Cultural controls	Reduced-risk controls
• Pheromone traps. • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues. • Do not rotate with yellow yam or sweet potato; • Do not plant in fields recently used for pasture;	• N/A

D. Proposed method or methods of application, including the availability of application and safety equipment

Milky spore should be dispersed throughout the field with a concentration of no more than ten pounds per acre. Apply application the powder should be lightly watered to allow the spores to soak into the soil.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human Risk: Milky spore is damaging if inhaled or allowed to come into contact with the eyes. High levels of exposure may cause allergic sensitization.
Mitigation: Do not allow milky spore to come into contact skin or eyes.

Environmental Risk: Bp is non-toxic to birds, fish, bees, or beneficial insects, but as a precaution should not be applied directly to water.
Mitigation: Keep out of lakes, ponds and streams. Do not contaminate water by cleaning of equipment.

F. Effectiveness of the requested pesticide for the proposed use

Bp is effective when ingested by white grubs. It should be applied when actively feeding white grubs are present and soil temperatures are warm. Bp does not provide immediate knockdown, but because it multiplies within larvae and is released upon their death, it becomes increasingly effective with each growing season. It does not multiply in other hosts. Milky spore, along with cultural practices can effectively reduce white grub populations among yam and sweet potato.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Bp is a naturally-occurring soil bacterium and does not harm non-target organisms.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

The product will not be disposed of or used in areas where they could directly contaminate surface or groundwater.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

Other acceptable pesticides that can be used to combat similar pests, during periods of more intense pest pressure, include Admire 2 (FC) Imidacloprid (21.4%).

28. Spinosad Saccharopolyspora Spinosa

B. Basis for selection of the pesticide.

Spinosad is highly effective on many pest species, including the Caribbean Fruit Fly (Anastrepha suspensa) and West Indian Fruit Fly (Anastrepha obliqua) It is very effective when used on mango and is safe for use with most beneficial insects. It has low mammalian toxicity, and low avian and fish toxicity.

C. **Extent to which the proposed pesticide use is, or could be, part of an IPM program.**

Cultural controls	**Reduced-risk controls**
• Avoid planting host crops, such as coffee and other fruiting trees Good drainage and air circulation of greenhouses, fields, and storage facilities; • Maintenance of plant vigor through appropriate and consistent irrigation and fertilization; • Post-harvest removal and burying of all crop residues. • Early and effective weed control. • Properly manage irrigation and pruning.	• N/A

D. **Proposed method or methods of application, including the availability of application and safety equipment.**
The Spinosad GF-120 formulation is applied as a foliar spray bait, or can be applied as a dip to substrates such as corn cobs, rolls of paper, or heart of palm and hung from tree branches; though the latter reduces the probability of spray drift and human exposure to spinosad, it also greatly reduces the feeding area and requires an excessively large number of hanging baits to achieve the same level of effectiveness as the foliar spray. Foliar spray applications should begin 6 to 8 weeks before mango harvest, and must be re-applied weekly. The foliar spray is not resistant to rain, and applications should be postponed if rain is imminent. If a rain occurs within 24 hours of application, the foliar spray should be re-applied. It is worth mentioning that spinosad will not eliminate the need for hot water immersion treatment, as it is a U.S. export requirement. For spot applications, a backpack applicator with the MeterJet gun is recommended.

PPE for handling Spinosad: Long-sleeved shirts, long pants, shoes, and socks.

E. **Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards.**

Human Risk: Spinosad has slight acute toxicity. It is not a likely carcinogenic, and does not act as a cholinesterase inhibitor. Spinosad has been classified by the World Health Organization (WHO) as an insect control product "unlikely to present acute hazard," which represents the most favorable of 5 classifications recognized by this advisory body. There are minimal safety precautions and pre-harvest and re-entry intervals for this reduced risk product.
Mitigation: Proper use of PPE will greatly reduce the risk of harm.

Environmental Risk: Spinosad is harmful to aquatic invertebrates and bees.
Mitigation: Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean water mark. Do not apply when weather conditions favor drift from treated areas. Do not contaminate water when disposing of equipment wash waters. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area.
F. Effectiveness of the requested pesticide for the proposed use.

Spinosad has been proven very effective in removing fruit flies, especially when used in combination with cultural controls.

G. **Compatibility of the proposed pesticide use with target and non-target ecosystems.**

Spinosad has relatively low activity against predaceous beetles, sucking insects, lacewings and mites, which are an important component of IPM programs.

Spinosad is hazardous to aquatic organisms and to some non-target insects. Spinosad is highly toxic for Hymenoptera (bees, bumble bees, parasitoid wasps, ants) and earwigs (Dermaptera) when they are directly sprayed or exposed to fresh residues. However, once residues have dried completely, toxicity to foraging bees is considered negligible (Mayer and Lunden, 1998).

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography

Spinosad should not be sprayed if rain is imminent or when winds are high; spraying is recommended in the morning or in the evening. The product should not be sprayed near water bodies due to its toxicity to aquatic life. During flowering periods and/or if bees are actively foraging, the product should not be sprayed; once dry, it presents a much lower risk to bees.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides. Non-chemical control methods include crop rotation, post-harvest field sanitation, and management of irrigation and soil moisture.

29. Vektor (*Entomophthora virulenta* 25%)

B. Basis for Selection of Pesticides:

Entomophthora virulenta is a natural fungus that belongs to the Zygomycotina subdivison. Vektor can be applied on a wide range of crops including melon, pepper, onion, banana, garlic, citrus and other fruits. Vektor effectively controls aphids, mites, flies and thrips. This naturally occurring compound was selected due to no know human and environmental impacts and risks associated with its use.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

The following measures to combat insect pests will be recommended before application of Vektor (see Annex 1 for more information on IPM plans specific to each crop):

Cultural controls	**Non-pesticide/botanical controls**
• Coordinate planting calendars and crops with other farmers in the area; • Avoid rotating with aphid host crops (especially tomato, spinach, peppers, eggplant, and cole crops) or allow maximum time between these crops; • Ensure plant health by using nursery grown seedlings, resistant varieties, and by managing irrigation and fertilization whenever possible; • Avoid over-applications of fertilizer, especially nitrogen; • Manage host weeds around field edges; • Remove and destroy crop remnants to kill any remaining eggs or larvae.	• Insecticidal soaps (applied in the early morning or late evening to avoid leaf burn) • Garlic and chili spray (applied in the early morning or late evening to avoid leaf burn) • Neem oil

D. Proposed method or methods of application, including the availability of application and safety equipment

To create the most effective mixture, it is recommended that Vektor be mixed with water between ph levels 5.5 and 7. In order to reduce the risk that rain water and poor mixing water quality can have, it is recommended that Vektor be mixed with a wetting agent. The wetting agent should be poured into a container followed by Vektor. This mixture should then be added to the appropriate amount of water for the crop area, as indicated on the product label (ranging between 1 to 2 liters per hectare, depending on crop). The product should be applied with backpack sprayers the same day that it is mixed.

PPE for Vektor: Not required

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Entomophthora virulenta poses no risks to human health but should not be ingested.
Mitigation: Farmers applying Vektor should not spray the product while eating, drinking or chewing gum.

Environmental risk: Entomophthora virulent causes no known damage to vertebrates, birds, fish or aquatic invertebrates.

F. Effectiveness of the requested pesticide for the proposed use

During the process of fermentation, *Entomophthora virulenta* produces secondary metabolites which lead to lack of coordination, immobility and ultimately death among target insects.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems

Vektor poses no threat to non-target ecosystems.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils

Vektor should not be sprayed if rain is imminent. If product must be applied during the rainy season, mixture with a surfactant is recommended. Spraying should not occur in breezy or windy conditions and should take place in the morning or evening to minimize drift.

I. Availability of other pesticides or non-chemical control methods

Haiti has limited options for pest control and many new, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work with agrochemical suppliers to increase awareness of the hazards of RUPs and increase supplies of safer alternatives, such as botanicals and biopesticides. Insecticidal soap (a liquid soap and water solution) and Neem oil, provides some control of whiteflies and aphids, but often fails to control populations below

economically damaging levels. Crop rotation and measures to preserve natural enemies will be practiced (see Annex 1: IPM Plans by Crop for more information).

30. M-pede (SL)
[Zohar 17 -47 % (SL)]

B. Basis for selection of pesticide

Zohar is a contact non-systemic insecticide, fungicide and surfactant. Zohar is based on plant oils and is completely biodegradable, causing no environmental harm. It is useful in the suppression of powdery mildew and viruses that are vectored by aphids. It is also affective against whiteflies and can be applied to all crops.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Cultural controls	Non-pesticide/botanical controls
• Coordinate planting calendars and crops with other farmers in the area; • Avoid rotating with whitefly or aphid host crops (especially tomato, spinach, peppers, eggplant, and cole crops) or allow maximum time between these crops; • Ensure plant health by using nursery grown seedlings, resistant varieties, and by managing irrigation and fertilization whenever possible; • Avoid over-applications of fertilizer, especially nitrogen; • Manage host weeds around field edges; • Remove and destroy crop remnants to kill any remaining eggs or larvae.	• Sticky traps (whiteflies) • Insecticidal soaps (Vektor), applied in the early morning or late evening to avoid leaf burn • Garlic and chili spray (applied in the early morning or late evening to avoid leaf burn) • Neem oil

D. Proposed method or methods of application, including the availability of application and safety equipment

Zohar is sold in concentrations of 170 gr. per liter. The products should be added to a sufficient volume of spray so that it reaches 0.4% of the total mixture. No personal protection equipment is required for the application of Zohar.

PPE for Zohar: As a pre-caution handlers and applicators should wear gloves and protective eyewear.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Zohar is non toxic orally and dermally although it is a skin and eye irritant.
Mitigation: Handlers and applicators should as a pre-caution wear gloves and protective eyewear.

Environmental risk: Zohar is completely biodegradable and poses no threat to mammals, birds or soil organisms. However potassium fatty acids are slightly toxic to fish and highly toxic to aquatic invertebrates.
Mitigation: Zohar will not be applied near surface waters or tidal areas where spray drift can accumulate in these bodies.

F. Effectiveness of the requested pesticide for the proposed use

Zohar instantly controls whitefly larvae and pupae upon direct contact. The product is also very effective against powdery mildew and diseases vectored by aphids.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.
Potassium fatty acids are found naturally in the soil and are therefore a natural part of bird's, mammal's and invertebrate's diets. These acids are quickly broken down in soils and their half-life is estimated to be ½ a day. Zohar is highly toxic to aquatic invertebrates and will not be used in areas where spray drift could accumulate in aquatic ecosystems.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.
Zohar will not be applied near surface waters or tidal areas where spray drift could accumulate in these bodies. Zohar will be applied in the early morning or late evening when winds are low and spray drift will be minimized.

I. Availability of other pesticides or non-chemical control methods.

Zohar is considered a minimum risk insecticide soap that was found in use by some USAID partners. Haiti has limited options for pest control and many newer, several less toxic alternatives (such as Zohar) have not yet become available on the Haitian market. USAID partners have begun and will continue to, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides.

Other minimum risk controls of whiteflies include other soaps such as Vetor, Safer soap and chemical products for more severe infestations include: Actara; chemical resistance class A4, and Admire/Gaucho (Imidacloprid); chemical resistance class 4B.

Parasiticides

31. Valbazen Oral Drench (11.36% Albendazole Suspension)

B. Basis for selection of pesticide

Valbazen is a broad spectrum anthelmintic used for treatment of internal parasites such as roundworms, tapeworms, lung and intestinal worms. It is very effective in eliminating adult worms and fourth stage larvae and can be administered orally in very small doses. Valbazen is usually sold as a blue odorless liquid.

IMPORTANT: Cattle must not be slaughtered within 27 days following last treatment. Sheep must not be slaughtered within 7 days following last treatment. Because a withdrawal time in milk has not been established, do not use in female dairy cattle of breeding age.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Valbazen will be used as a last resort for parasite after the following non-chemical controls have failed to be effective.

Cultural controls	**Other available non-chemical controls**
• Livestock nutrition • Controlled grazing and forage management • Clean and elevate food and water receptacles • Maintain dung beetle populations • Leave the field fallow for 12 months or rotate with crops.	• Several studies have shown that the diatomaceous earth has reduced larvae count in the field • The feeding of garlic can reduce internal parasite counts

D. Proposed method or methods of application, including the availability of application and safety equipment

Valbazen Suspension should be administered to cattle at the recommended rate of 4 mL/100 lb of body weight (equivalent to 4.54 mg of albendazole/lb, 10 mg/kg) and to sheep at the recommended rate of 0.75 ml/25 lb. of body weight (equivalent to 3.4 mg of albendazole/lb, 7.5 mg/kg). Velbazen should be administered orally using a specific type of dosing gun, hook drencher or syringe.

Accurate estimates of the weight of the cattle and sheep to be treated are essential for most effective results with this product.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Albendazole is a skin eye and respiratory irritant and has moderate acute toxicity to mammals. Prolonged exposure to albendazaole may result in organ damage (possible liver toxicant). This product has potential to cause mutagenic and development impacts.
Mitigation: Livestock should be adequately restrained to prevent spillage. Long pants, long sleeved shirt, shoes with socks and gloves should be worn. Proper maintenance and use of PPE should significantly

reduce the risk of human intoxication and negative health impacts. Women of child bearing age should not be permitted to handle or come into contact with albendazole products.

Environmental risk: Any residue will bind to soil and rapidly degrade upon exposure to sunlight
Mitigation: Valbazen will not be applied in windy condition or nearby bodies of water. Mounding and or vegetative barriers at the edges of fields will also be used to reduce the risk of run-off in aquatic areas at risk of contamination.

F. Effectiveness of the requested pesticide for the proposed use

Valbazen is effective in reducing parasite count among livestock. Valbazen effectively kills adult worms and fourth stage larvae.

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

Valbazen has low bioaccumulation potential and has moderate acute toxicity for mammals. Information and studies of albendazole's affects on aquatic species are not available.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.
Due to the lack of information related to albendazole's aquatic toxicity this product will not be applied near surface waters or tidal areas and at time when winds are low to minimize spray drift (early mornings and late afternoons).

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides.

Non-chemical controls include: incorporating garlic powder into animal feed and the use of Insecto (diatomaceous earth) to reduce larvae counts.

32. Ectoban Delice Pour-on (Permethrin 1%)

B. Basis for selection of pesticide

Ectoban Pour-on is an oil based pesticide that can be used as a pesticide any time of year. The product can be applied safely to beef cattle and both lactating and non-lactating dairy cattle. Ectoban is most effective against lice, corn flies, face flies, black flies, mosquitoes and ticks.

Note: Farmers in the U.S. report preference for Permethrin due to its low level of human toxicity, especially in comparison to organophosphate chemical alternatives.

C. Extent to which the proposed pesticide use is, or could be, part of an IPM program

Ectoban will be used as a last resort for parasite after the following non-chemical controls have failed to be effective.

Cultural controls	Other available non-chemical controls
• Livestock nutrition • Controlled grazing and forage management • Clean and elevate food and water receptacles • Maintain dung beetle populations • Leave the field fallow for 12 months or rotate with crops.	• Apply a thin coat of vegetable oil to suffocate insects • Scrub animal with iodine, repeat one a week • Garlic powder can be used as a topical treatment and incorporated into feed • Rub 2 to 3 handfuls of sulfur along the animal's spine • Several studies have shown that the diatomaceous earth has reduced larvae • The feeding of garlic can reduce in parasite counts

D. Proposed method or methods of application, including the availability of application and safety equipment

Ectoban Pour-on is sold as a premixed, amber, odorless formula with no dilution necessary. It is recommended that Ectoban Pour-on be applied along the back and down the face of cattle. Approximately ½ fl oz. of mixture should be applied per 100 lbs. of animal body weight. No more that 5 fl. oz should be applied on any one animal. The product should not be applied more than once within a 14 day time period.

PPE for Ectoban Pour-on: Long sleeves, long pants, chemical resistant gloves, shoes plus socks, eye protection with side shields. Respirators are recommended for large-scale operations.

E. Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards

Human risk: Ectoban pour-on can be absorbed through the skin and is harmful to the eyes and skin. Irritation of the upper respiratory tract may also occur. Ingestion of large amounts of Ectoban can cause seizures and coma. This product is combustible.
Mitigation: Wear required personal protection equipment. Use only in well ventilated areas. Store product in a shady area where temperatures will not exceed 39 degrees Fahrenheit.

Environmental risk: This product is extremely toxic to fish and aquatic organisms.
Mitigation: Do not add directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water by cleaning of equipment or disposal of wastes.

F. Effectiveness of the requested pesticide for the proposed use

Ectoban is effective in reducing external parasite count among cattle. The product can be applied at any time of year to all kinds of cattle. Ectoban can also be applied frequently (every 14 days).

G. Compatibility of the proposed pesticide use with target and non-target ecosystems.

This product is extremely toxic to fish and aquatic organisms.

H. Conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils.

Ectoban will not be applied near surface waters or intertidal areas. Ectoban is COMBUSTIBLE and should be stored in a cool, shaded place away from open flame.

I. Availability of other pesticides or non-chemical control methods.

Haiti has limited options for pest control and many newer, less toxic alternatives have not yet become available on the Haitian market. USAID partners will, whenever possible, work to increase information available in agrochemical supply stores on the hazards of RUPs and promote the import of safer alternatives such as botanicals and biopesticides.

Non-chemical controls include: the use of vegetable oil, iodine and garlic powder.

❖ SECTIONS J– L OF PESTICIDE EVALUATION

J. Host country's ability to regulate or control the distribution, storage, use, and disposal of the requested pesticide.

The Ministry of Agriculture, Natural Resources and Rural development (MARNDR) regulates pesticide import, distribution, storage, use and disposal of pesticides and also has agricultural extension officers in various parts of Haiti. However, enforcement of regulations is generally not implemented, especially at the local level. For a product to obtain a permit for sale on the market, it must submit paperwork to the MARNDR specifying toxicity information (LD50), target pests, required PPE, etc. The MARNDR does not currently maintain a database of pesticides approved for use in the country, nor does it implement a pesticide container collection program. At agro supply stores, most products have a toxicity labeling system based on color. Labels are usually in English or sometimes French.

K. Provision for training of users and applicators.

USAID partners promoting reduced-risk pesticide use will train demo-plot, beneficiary farmers and agro-input store staff on proper handling, storage and disposal. These partners will also be responsible for providing appropriate PPE for demo plot farmers, partner agro-supply store staff and pesticide use trainees. Partners should also encourage and work with agro-input supply stores in project regions to increase PPE supplies and affordable use options for non-demo plot farmers. Field officers will provide training and technical assistance to farmers on integrated pest management of fruit and vegetable plots (see Annex 1).

The following is a summary of pesticide safer use training topics to be addressed:

- **Chemical knowledge:** Registration, correct use, application procedures and label specifications. This training includes an in-depth review of label information (resources in Creole and/or with photos will be provided wherever possible), as well as a discussion of dosage rates, application rates, equipment calibration and maintenance, application intervals, re-entry and pre-harvest intervals and demonstrations of proper equipment use.
- **Storage:** Proper storage of chemicals in relation to other structures on the property. The need for a separate, clearly marked and locked facility will be emphasized for exclusive storage of farm chemicals. Pesticides should be kept away from food for human or animal consumption or sources of drinking water. Pesticides should **always** be stored in their original containers.
- **Transport:** Safe transport of pesticides will be discussed (i.e. not using public transportation if possible, keeping chemicals in a closed environment, how to avoid punctures and torn bags, etc).
- **Worker protection:** Types of personal protective equipment (PPE), when they should be worn and why, and how they should be cared for. The basic PPE recommended for all pesticide applications includes long-sleeved shirts, long pants, shoes and socks. Depending on the toxicity and label directions, chemical-resistant gloves, aprons, and masks may be required, which will be provided by USAID partners and are available at local agro supply stores. Participants will be encouraged to wash PPE separate from everyday clothing and to keep their PPE in good condition.

- **Safety practices:** Proper mixing techniques, the importance of using clean water for mixing, and the importance of not contaminating water sources. The types of containers used in chemical preparation, their proper use, cleaning and storage will be addressed. Applicators are taught not to eat, drink or smoke while applying pesticides.
- **First aid and medical facilities:** First aid materials must be made available (soap, clean water and a towel) in case of spills. Participants will be taught to identify the primary symptoms of chemical exposure and what do to in an emergency.
- **Waste Management:** How to clean up and safely dispose of any chemical not used. For liquids, empty containers should be rinsed 3 times, and rinsate emptied into the spray tank as part of the application mixture. When the product is used completely, chemical containers should be triple rinsed and punctured before being buried. Containers should **never** be reused.
- **Protection of drinking water:** Training will emphasize the importance of protecting potable water sources and avoiding contamination of ground and surface waters. Participants will be trained to identify their drinking water source and to keep all pesticides away from that source. Characteristics of the water source and mitigation measures to avoid contamination will be addressed.
- **Environmental safety:** The importance of protecting natural resources and the proper use of pesticides to avoid environmental contamination and impacts on non-target organisms will be addressed.

For groups promoting pesticide use an additional training phase should be targeted towards women and children who may come enter production fields or who may be exposed indirectly to spray drift or residues on the pesticide users clothing at home. Basic training materials in the form of operational pesticide safety field guides in Creole with illustrations will be developed by SMTN for use by partners.

L. Methodology to monitor the use and efficacy of the pesticide.

USAID partner agronomists and field staff spend the majority of their time in the field and on farms, monitoring cultural practices, plant nutrition, crop health and pest control, and providing technical assistance to farmers when problems arise. Pesticide safer use will be monitored as part of these field visits. Farmers and field staff must keep records of any pest problems and pesticide applications. *See Section V: Safer Use Action Plan and Monitoring Tables (See below for more details).*

V. SAFER USE ACTION PLAN

As mentioned previously, the program faces significant challenges in terms of local availability of reduced-risk options. Partners involved in agricultural use involving IPM and agro-chemical controls will make every effort to promote the locally-available options that do exist:

1. IPM plans by crop (Annex 1) – cultural controls will be recommended first and farmers will be trained to a) monitor and recognize economically damaging pest levels and b) to properly apply pesticides at the correct time, in order to reduce the need for pesticides. Field extension officers will provide technical assistance in pest monitoring, as well as proper pesticide use, throughout the growing season.
2. As less toxic alternatives become available on the Haitian market, these alternatives will be recommended and more toxic chemicals will be phased out of the program. A PERSUAP amendment will be completed for any new products to be recommended which are not included in the present document.
3. Early control of pests when less toxic alternatives are more effective.
4. Preservation of natural enemies through more selective or reduced-risk alternatives.
5. Coordination of planting calendars among all farmers in a region to offset pest life cycles and reduce probability of severe infestations.
6. Use of sticky traps to monitor and control whiteflies.
7. Promotion of reduced-risk or botanical insecticides and nematicides such as insecticidal soaps, garlic and chili sprays, and neem oil, neem or jatropha seed cakes.
8. Promotion of reduced-risk formulations available in Haiti (such as water-soluble packaging or granules instead of sprays whenever possible and effective for the proposed use).

Training on pest management and proper pesticide use, storage and disposal will be implemented on demo plots as part of farmer trainings, including the topics mentioned previously. Because pesticide use is still fairly uncommon in some areas of the project, an awareness campaign in Creole targeting producer family members, particularly women and children, would be a extremely beneficial exercise. This campaign should cover the dangers of improper pesticide use and handling, entering treated fields during REI, possible health and environmental risks of improper use, and will discourage re-use of pesticide containers for water collection or other purposes. Depending on the local context, these campaigns may be implemented through radio programs, schools, or in conjunction with health centers and/or USAID health partners.

Trainings on chemical safety and pesticide risks, labeling, and less toxic alternatives will also target agro supply store staff and Ministry of Agriculture agronomists. USAID partners are also committed and whenever project mandates permit will to building capacity of agro supply store staff and MARNDR technicians. Partner's will maintain a close working relationship with MARNDR staff and will invite MARNDR and agro supply store agronomists to trainings on chemical safety, integrated pest management, and pesticide alternatives. By working with agro supply store agronomists in particular, it is hoped that they will begin importing lower-risk pesticides and non-chemical alternatives which will be available to farmers throughout Haiti in the long-term.

PPE will be provided to demo plot farmers, and is available, to varying degrees, in regional agro supply stores in project regions and Port-au-Prince. The importance of PPE use and maintenance will be emphasized during farmer trainings and will be constantly monitored by field extension officers. Some

non-demo plot farmers may not have access to PPE because it is too expensive. This problem could be addressed by expanding and systematizing existing PPE rental options through working with agro-supply stores and farmer associations. Special direction on maintaining PPE that will be used so frequently should be given to these groups to ensure that pesticide residues do not build up on PPE and increase user hazards.

Water contamination is a potential concern, since inhabitants of Haiti wash in rivers. Any proposed awareness campaigns should discourage washing of pesticide containers or sprayer tanks in or near rivers, irrigation canals, or potable water sources. Rinsate should be added as part of the tank mix and not disposed of in rivers or potable water sources. PPE should not be washed in rivers and women and children are prohibited from washing PPE – PPE washers should wear gloves when washing. PPE washing stations designated strictly for this purpose may need to be established to avoid any problems.

Used pesticide containers must NOT be reused – farmers will be taught to rinse 3 times and add rinsate to tank mix, puncture, and bury.

Vi. MANAGEMENT OF PESTICIDE WASTE:

Five types of pesticide waste and best practices:

1) Empty containers
    a. Rinsing will occur before pesticide application so that rinse water can be used to dilute the product. Up to 5% of the water used for dilution can be rinse water.
    b. Empty drums, bottles and cans will be triple rinsed or pressure washed.
    c. Holes will be punched in the container to prevent reuse.
    d. The container can then be buried in a sanitary landfill, recycled or burned if local regulations and product label allows.

2) Excess mixture
    a. Excess mixture should be avoided by careful calculations and measurements.
    b. Excess mixture should be applied to a labeled site.
    c. Once mixed, most products cannot be safely stored.

3) Rinse water from containers and application equipment
    a. Rinse water has great potential to contaminate water sources both above and below ground.
        i. Do not discharge to ground, drains or septic systems.
    b. Rinse water should be minimized and applied to a labeled site.
    c. Reuse rinse water to dilute the next batch of the same product.
        i. Up to 5% of water used for mixing can be rinse water.

4) Spilled material
    a. Spilled material will be immediately cleaned through the use of an absorbent material.
        i. Soil, sawdust, cat litter, etc.

b. If done shortly after the spill, the absorbent material can then be placed in a suitable container and applied to an approved site (such as a crop field) in a manner consistent with the product label.

5) Obsolete and Unused Pesticides
   a. Pesticides become obsolete for the following reasons:
      i. Banned products
      ii. Substandard storage and management
      iii. Prolonged storage as a result of overstocking
      iv. Product expiration
   b. Pesticides should be taken to the nearest hazardous waste management center, if available.
   c. Certain pesticides can be destroyed in normal cement incinerators while others require specific high temperature toxic waste incinerators.
   d. If there is no safe way to destroy the product, field application according to the product label is likely to be the safest alternative.

Neutralization of Metal and Glass Containers:

Metals and glass containers (barrels, cans, drum, jars) contaminated with organophophorous, organochlorine compounds and derivatives of denitrophenol and other pesticides are neutralized with alkaline solutions (soda, wood ash, lime). The containers are filled with 5% solution of caustic or washing soda and left standing for 6-16 hours and are then repeatedly washed with water. Containers emptied of carbamate pesticides (thiram, carbayl) are neutralized using a 1% solution of potassium permanganate acidified with hydrochloric acid (5ml/liter) or a paste of lime chloride.

The table below summarizes key pesticide impacts, mitigation measures and monitoring indicators to be reported on by field officers:

VI. Monitoring Table: General impacts and mitigation and monitoring measures for pesticides use

Issue	Potential Impact	Mitigation Measures	Monitoring and Indicators
Spray drift	▪ Contamination of nearby water bodies or potable water sources ▪ Exposure of nearby residents	▪ Spray in the early morning or late afternoon when winds are low ▪ Apply largest droplets (> 150-200 microns) which provide sufficient coverage and control ▪ Use high flow rate nozzles to apply the highest practical spray volume ▪ Use the lower spray pressures recommended for the nozzle ▪ Train sprayers on proper spray techniques using fluorescent dye ▪ For chemicals with high aquatic toxicity: do not spray on farms with nearby streams or other natural water bodies	Field officer observations report no incorrect spray applications: ▪ No spraying near water bodies ▪ No spraying in afternoon ▪ No drift observed during spraying
Runoff	▪ Contamination of nearby streams and groundwater (especially where water table is shallow) ▪ Contamination of potable water sources (wells, streams)	▪ Do not apply known or potential groundwater contaminants where water table is shallow, or adjust soil pH accordingly to enhance adhesion/reduce leaching. ▪ Do not apply chemicals with high aquatic toxicity on farms adjacent to streams, rivers, ponds, etc. ▪ Establish trenches or vegetative barriers to minimize runoff ▪ Recommend granular formulations when available and effective	Field officer observations report no incorrect spray applications: ▪ No spraying near water bodies or potable water sources ▪ No spraying in afternoon ▪ No drift observed during spraying Trenches and/or vegetative barriers established on all demo plots
Wet and dry season applications	▪ Repetitive sprays during the rainy season (increased chemical exposure to spraymen) ▪ Heat exposure effects on spraymen in	▪ Spray in the early morning when rains are not likely. ▪ Never spray when foliage is wet. ▪ Avoid applying spray products in temperatures that exceed 36 degrees C.	Field officer observations report no incorrect spray applications: ▪ No spraying in afternoon or in hot weather ▪ No spraying when leaves are wet ▪ PPE used properly to prevent exposure

	association with pesticides (skin, eye, or respiratory tract irritation)		
Non-target organisms	▪ Negative impacts on beneficial insects such as honeybees ▪ Negative impacts on birds ▪ Negative impacts on aquatic organisms	▪ Recommend more selective, less toxic alternatives when available and effective ▪ Do not spray when and where honeybees are actively foraging. Spray in early morning. ▪ Do not spray chemicals that are toxic to birds in foraging areas or on crops that attract birds ▪ Minimize spray drift and runoff using measures described above	Field officer observations report no incorrect spray applications: ▪ No spraying during bloom periods/when bees are actively foraging ▪ No spraying near water bodies or potable water sources ▪ No drift observed during spraying ▪ No dead fauna observed in the area Trenches and/or vegetative barriers established on all demo plots
Acute human health risks	▪ Exposure effects on spraymen and farm staff (skin, eye, or respiratory tract irritation) ▪ Systemic effects ▪ Exposure effects on nearby residents	▪ Recommend less toxic alternatives when available and effective ▪ Train farm staff in pesticide safety practices (use of personal protective equipment, proper handling, mixing, storage and disposal according to labels) ▪ Ensure that appropriate personal protective equipment is available at all times ▪ Obey restricted entry intervals, pre-harvest intervals and post clearly-marked signs in Creole and with drawings around fields that have been recently sprayed ▪ Ensure that clean water, soap and towels are available in case of spills/accidents and for general clean-up. ▪ Train farm staff in exposure symptoms and first aid ▪ Discourage re-use of pesticide containers; training on triple-rinse, puncture and burying of containers	Field officers observe: ▪ Lowest application rates being applied ▪ Less toxic alternatives being used ▪ Established pesticide storage facility with clear signs ▪ No evidence of pesticide containers littered in fields, or reuse as water containers etc. ▪ Proper use of PPE ▪ No women or children applying or handling pesticides or PPE, or entering fields during REI

Chronic human health risks	▪ Carcinogenic and organ toxic effects ▪ Developmental toxicity	▪ Recommend less toxic alternatives when available and effective ▪ Rotate spraymen when using chemicals with known chronic toxicity ▪ Do not permit women or children to apply pesticides. ▪ Train local resident women and children to stay away from pesticide storage areas, fields that have been sprayed, etc. ▪ Prevent potable water source contamination by minimizing spray drift and runoff	Field officers observe: ▪ Lowest application rates being applied ▪ Less toxic alternatives being used ▪ Established pesticide storage facility with clear signs on demo plots ▪ No evidence of pesticide containers littered in fields, or reuse as water containers etc. ▪ Proper use of PPE ▪ No women or children applying or handling pesticides or PPE, or entering fields during REI
Disposal of chemicals and containers; PPE washing	▪ Spills leading to contamination of water sources or exposure ▪ Inappropriate use or reuse of pesticide containers	▪ Train farm staff in appropriate chemical and container disposal practices ▪ Discourage re-use of pesticide containers; training on triple-rinse, puncture and burying of containers ▪ Establish washing stations if necessary	Field officers observe: ▪ No washing of containers, PPE or tanks, no disposal of rinsate in water bodies ▪ No evidence of pesticide containers littered in fields, or reuse as water containers etc. ▪ Proper use of PPE ▪ No women or children applying or handling pesticides or PPE, or entering fields during REI ▪ Washing stations in use

ANNEX 1. IPM Plan by crop

IPM Plans for Fruits:

I. Principle pests affecting all fruit crops (below):

1. Caterpillars
2. White Flies
3. Anthracnose
4. Aphids

1. Caterpillars, (Armyworm, *Spodoptera exigua,* Alfalfa looper: *Autographa californica*, Cabbage looper, *Trichoplusia ni):*
Identification: Various caterpillar pests exist in the Southeast Department of Haiti and vary in color and size between different species and life stages of the same species. Loopers are green and arch their backs to crawl. Corn earworms are highly variable in coloration – young larvae are greenish with black heads and black hairs on their bodies, while mature larvae are 1.5 inches long and may be pale green, pinkish or brown. Armyworms are 1.5 to 2.0 inches in length and black with yellowish stripes on the body. Damage to bean crops by caterpillar pests includes damage to cotyledons, new leaves, and terminal buds (loopers); damage to leaves, buds, flowers, and within pods (corn earworm); skeletonization of leaves and holes in pods and beans (armyworms).


Cabbage looper at different larval stages


Cabbage looper eggs attached to leaf


Corn earworm in various stages/colors


Armyworm

Pre-planting:

- Destroy weeds along field borders which may host armyworms before planting.
- Dig deep trenches with the steep side towards crop to discourage armyworm migration into fields.

Planting and growth:

- Begin monitoring for both cabbage loopers and beet armyworms (see 6. Monitoring and treatment decision).
- Hand-pick caterpillar larvae and kill by dropping into a container with soap and water or a salt solution.

Post-harvest:

- If a tractor is available, discing fields immediately following harvest kills larvae and pupae. Otherwise, bury any remaining plant matter to destroy any eggs and larvae that may remain.

Crop rotation:

- Rotate with less susceptible crops such as carrot or green onion. Do not rotate with cabbage, swiss chard, spinach, tomato, or eggplant.

Monitoring and treatment decision:

- Inspections for caterpillar pests should begin during the vegetative growth period and should continue from flower bud to bloom and during pod fill. Plants should be inspected to observe early signs of damage to foliage and presence of caterpillars on plants when young pods are forming. To sample and hand-pick caterpillars, inspect underside of leaves for eggs and young larvae.

Control Options (to be recommended in the order listed; follow the label directions):

- Hand-pick and kill larvae in soap and water or saltwater.
- Dig deep trenches with the steep side towards crop to discourage armyworm migration into fields.
- Garlic and chili spray: 10-12 large cloves of garlic, 4-6 hot chili peppers, 2 cups water, 1 tablespoon liquid soap, and 10 drops vetiver oil (optional). Allow mixture to stand overnight; strain and store concentrate in plastic or glass bottle (not metal). To apply, dilute 2 tablespoons concentrate to every liter of water. Concentrate can be stored up to 2 months in a dry, dark place.
    - Spray during early morning or evening to avoid leaf burn.
- Dipel (*Bacillus thuringiensis)* (subspecies Aizawai or Kurstaki) (follow REI = 4 hrs, PHI = N/A).
    - Rotate sprays of different Bt subspecies and above methods to avoid resistance buildup.
- Sevin (carbaryl) WSP 80% (follow REI = 12 hrs, PHI = 7 days)

2. Whiteflies (*Tetraleurodes perseae)***:**

Identification: Silverleaf whiteflies <u>are</u> approximately 0.06 inch or 1.5 mm long in length with yellowish bodies and white wings. Their wings are tilted slightly over the body and have a small gap between

them. The greenhouse whitefly *(Trialeurodes vaporariorum)* is very similar in appearance but differs in that is wings are held flatter over the back and there is no gap between them. Adults are typically found on the underside of leaves and produce small oval-like larvae. Whiteflies damage a wide variety of crops by sucking out large amounts of sap and leaving a sticky honeydew on the surface of the plant. This honeydew promotes the growth of mold which greatly inhibits the growth of the plant.

Silverleaf Whitefly

Greenhouse Whitefly

Note: The Bandedwinged whitefly (above) is not economically damaging.

Pre-planting:

- Control weeds in non-crop areas.
- Coordinate planting calendars with other farmers in the area planting whitefly host crops. Adjust planting dates based on historical whitefly outbreaks – delaying planting 3 weeks can help disrupt whitefly reproduction cycles.
- Whiteflies reproduce more rapidly under hot, dry conditions – adjust planting dates to grow during cooler weather if possible.
- During periods of heavy whitefly migration, avoid planting susceptible crops such as tomato and cole crops.
- Avoid planting next to crops with whitefly infestations.

Planting and growth:

- Install yellow sticky traps mounted on stakes next to plants (if commercial sticky traps are not available/too expensive, sticky traps can be made out of plywood or masonite board painted bright yellow, coated in a mixture of one part petroleum jelly or mineral

oil and one part detergent). One sticky trap to every 2 or 3 large plants should be installed facing the plant at the level of infestation.
- Do not apply broad-spectrum pesticides early in the season as these can increase whitefly numbers later in the season.
- Fertilize with compost/organic fertilizer; avoid nitrogen over-fertilization.

Post-harvest:
- Remove and destroy all crop residues as soon as possible after harvest.

Crop rotation:
- Avoid rotating with other host crops such as black bean, chili pepper and tomatoes if possible. If it is necessary to rotate with one of these crops, allow the maximum time possible between host crops and produce in the shortest season possible.

Monitoring and treatment decision:
- Starting after emergence, check field margins for whiteflies, which are usually infested first. When nearby host crops are in decline, monitor twice per week for rapid population buildup. If field margins are areas of concern but field centers are not highly infested, treat only field margins to allow beneficial insects to survive and control whiteflies.

Note: Early control is critical; once populations build up they are difficult to suppress.

Control Options (to be recommended in the order listed; follow the label directions):
- Sticky traps + Insecticidal soap (Safer ® Soap or homemade: 1 ½ teaspoons liquid soap, i.e. dish detergent, per quart of water).
    - Clean sticky traps with soap and water and reapply sticky coating once a month.
    - Spray in the early morning or late evening to avoid leaf burn.
    - Spray when whitefly populations are first detected and ensure coverage on underside of leaves where eggs are laid; spray 2-3 times per week to keep populations low control. Do not spray on drought-stressed plants.
- Garlic and chili spray: (*See recipe above in control options for caterpillar)*
    - Spray in the early morning or late evening to avoid leaf burn.
- Neem oil
    - Spray in the early morning or late evening to avoid leaf burn.
    - Spray when whitefly populations are first detected and ensure coverage on underside of leaves where eggs are laid.
    - Do not spray on drought-stressed plants.
- Zohar LQ-215 or Vektor
- Admire FC (imidacloprid 21.4%); follow REI = 24 hours, PHI = 7 days

3. Anthracnose (*Colletotrichum gloeosporioides)*:
Identification: Anthracnose is a prevalent fungal disease in avocado and citrus groves. It mainly causes problems in foggy or rainy conditions. Unhealthy or dead leaves are the most obvious symptom of the disease. Brown to black lesions develop on the infected fruit but do not enlarge until fruit ripens. After harvest, lesions become darker and larger, and in time spread over the entire fruit surface and throughout the pulp.

Bananas infected with Anthracnose

Avocado with lesions of anthracnose

Mangos infected with Anthracnose

Coffee berries infected by anthracnose (a.k.a. Coffee berry disease)

http/www.fps.org.mx/divulgacion/images/stories/articulos/sinaloaproduce2009/antracnosis_01.jpg; *http://plant-doctor.net/plantdoctor/glossary/images/Anthracnose_(fruit)/avocado-anthracnose.jpg*; http://www2.hawaii.edu/~banana/1_anthracnose_banana_fruits_2.JPG

Pre-planting:

- Select fields with lowest or no recent incidence of Anthracnose.

Planting and growth:

- Prune out dead limbs and twigs with visible infections.
- Avoid over-irrigation during growth.
- Prune low branches 60 cm off the ground to reduce humidity.
- Prune and harvest preferably during dry conditions
- Inter-crop with fruit-bearing shrubs and annual vegetables to help conserve biodiversity and reduce pest population.

Post-harvest:

- Keep fruit dry and cool until sold.
- Cool fruit to approximately 41°F as soon as possible after harvest.
- Market fruit rapidly.

Crop Rotation:

- Avoid rotating with other host crops such as banana, plantains, beans and coffee.

Monitoring and treatment decision:

- The decision to apply product should be based in the following factors:
  - High Humidity Zones
  - High incidence of Anthracnose in the area
  - Prolonged periods of rain forecasted

Control Options (to be recommended in the order listed; follow the label directions):

- Prune out dead limbs and avoid over-irrigation.
- Quadris (F) Azoxystrobin 22.9% (Follow REI = 4 hours, PHI= 0 days)
- Kocide 4.5 lf (F) Copper Hydroxide 37.5% (Follow REI = 24 hours, PHI = 0 days, unless noted otherwise)
- Mancozeb 80 (WP) (Dithane) (Follow REI = 24 hours, PHI = varies by crop, refer to label)

4. Aphids:

Cabbage aphids (*Brevicoryne brassicae)*, Green peach aphids (*Myzus persicae)*, Potato aphid (Macrosiphum euphorbiae), Cowpea aphid (*Aphis craccivora)*, Bean aphid (*Aphis fabae)*, **Corn leaf aphid *(Rhopalosiphum maidi)***, Green bug aphid (*Schizaphis graminum*), Cotton/melon aphid (*Aphis gossypii).*

Identification:

Note: There are many different species of aphids that affect fruit crops. For identification purposes, a description of the aphid species specific to each crop can be found in the specific pest section. IPM and control methods for all species however are the same and can be found below:

Pre-planting:

- If possible, use aphid-tolerant tomato varieties (i.e. those containing the Mi gene).
- Destroy weeds that are hosting aphids along field edges.
- Coordinate planting calendar with other farmers planting tomatoes in the area.
- If feasible, grow seedlings under protective covers or in a closed greenhouse before transplanting to the field; this allows the plant to grow to a size that is more resistant to aphids.

Planting and growth:

- Monitor plants frequently (2-3 times per week) for presence of aphids. Check undersides of leaves as well as other plant parts. When populations are found:
- Knock aphids off with a strong stream of water (most won't climb back on to the plant).
- When populations are localized, prune and dispose of infested leaves.
- Avoid over-fertilizing with nitrogen as this favors aphid reproduction.

Post-harvest:

- Destroy crop remnants immediately after harvest.

Crop rotation:

- Avoid rotating with chili peppers, eggplant, and potato.

Monitoring and treatment decision:

- Monitor plants from bloom to early fruit set by picking the highest open flower on 20-30 plants selected at random throughout the field. Inspect leaves for live aphids, as well as mummies. Treatment is necessary if roughly half of the leaves are infested. During late fruit set, pick the leaf below the highest open flower on 20-30 randomly selected plants. Monitoring is critical during the period 6-8 weeks before harvest – if 50% of leaves are infested during this time, treatment is necessary to avoid yield losses.

- Check fields at least twice a week. Sample upwind field borders and edges next to other crucifers first. Sample the field in a zig-zag pattern, making sure to check all quadrants since aphids tend to clump. Check undersides of leaves in addition to other plant parts.

Control options (to be recommended in the order listed; follow label directions):

- Knock aphids off with a strong stream of water.
- If populations are localized, prune and dispose of infested areas.
- Wood ash (dust plants with ash when leaves are not too dry nor too wet)
- Insecticidal soap (Safer ® Soap, Vektor and Zohar or homemade: 1 ½ teaspoons liquid soap, i.e. dish detergent, per quart of water).
    - Ensure thorough coverage of foliage.
    - Spray in the early morning or late evening to avoid leaf burn.
- Garlic and chili spray: (*See recipe above in control options for caterpillar)*
- Spray in the early morning or late evening to avoid leaf burn.
- Neem oil
    - Spray in the early morning or late evening to avoid leaf burn.
    - Ensure thorough coverage on tops and bottoms of leaves.
    - Do not spray on drought-stressed plants.
- Actara (thiamethoxam) – follow REI = 12 hrs, PHI = 30 days
    - Avoid repeated sprayings of Actara to prevent resistance buildup.

II. Principle pests affecting individual fruit crops:

INTEGRATED PEST MANAGEMENT PLAN FOR AVOCADO

A. Principal pests

1. Phytophthora Root Rot (*Phytophthora cinnamomi)*
2. Avocado Lace bug (Psuedacysta perseae)

B. IPM plan for Avocado

1. Phytophthora Root Rot (*Phytophthora cinnamomi*)

Identification: Phytophthora root rot is the most serious disease of avocado worldwide, especially in areas of poor irrigation and high soil moisture. The disease usually causes leaves to turn pale green or yellow and reduces the size of the fruit. Roots can also be blackened or killed by the rot, resulting in the death of the plant.


Avocado with dead twigs, leafless branches, and sparse foliage
http://www.ipm.ucdavis.edu/PMG/P/D-AV-PCIN-BT.001.html

Pre-planting:

- Inspect roots before planting
- Avoid soils that are poorly drained, or pathogen-infested and high in saline.
- Plant on well-drained soil, or improve drainage by planting on a soil berm or building small drains.

Planting and growth:

- Do not work in infested groves when the soil surface is wet
- Begin harvesting and other activities in healthy areas of the grove; work in diseased areas last to minimize pathogen movement.
- Moderate amounts of nitrogen promote good growth that helps avocado better tolerate root rot
- Avoid over fertilization especially with fertilizers high in ammonia or salts
- Prune lower limbs so that they are 2 to 3 feet above the ground.

Post-harvest:

- Keep fruit dry and cool until sold.
- Cool fruit to 41°F as soon as possible after harvest
- Market fruit rapidly.

Crop Rotation: NA

Monitoring and treatment decision: Monitor trees for symptoms and when conditions favor disease preventative applications of fungicides may be justified in areas with histories of phytophthora fungal problems.

Control Options (to be recommended in the order listed; follow the label directions):

- Avoid soils that are poorly drained, or pathogen-infested and high in saline.
- Prune lower limbs so that they are 2 to 3 feet above the ground.
- Kocide 4.5 lf (F) Copper Hydroxide 37.5% (Follow REI = 24 hours, PHI = 0 days, unless noted otherwise)
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days

2**. Avocado Lace Bug**

Identification: Adults lace bugs are approximately 2 mm and oval shaped. They are usually black or brown with antennae, wings and legs that can be either white, orange or yellow. Nymphs are mostly

dark and orange but do not have wings. Lace bug eggs are black and shiny and laid on leaves. The majority of the pest population can be found feeding on the underside of leaves, leaving blotches which can cause severe damage and defoliation. Defoliation can result in lesser fruit yield as a result of sunburn and plant stress.

Avocado leaf infested with lacebugs.
http://www.ipm.ucdavis.edu/PMG/P/I-HM-PPER-CD.006.html

Pre-planting:

- All weeds should be removed from the field prior to planting.

Planting and growth:

- Provide proper irrigation and plant care to ensure crop vigor.
- Damaged foliage should be removed.
- Pruning should be done carefully so as not to expose the plant to too much sunlight.

Post-harvest:

- Clean all bins and receptacles used for harvesting avocadoes.
- Remove excess plant debris and weeds.

Crop rotation: NA

Monitoring and treatment decision:

- It is important to check the underside of leaves frequently for lace bugs.
- Control should be applied when adults are found on foliage.

Control Options (to be recommended in the order listed; follow the label directions):

- Remove damaged foliage
- Careful pruning to preserve sufficient shade
- Pounce 25 WP, Permethrin 25% (Follow REI = 12 hours, PHI = 7 days)

INTEGRATED PEST MANAGEMENT PLAN FOR BANANA AND PLANTAIN

A. Principal Pests

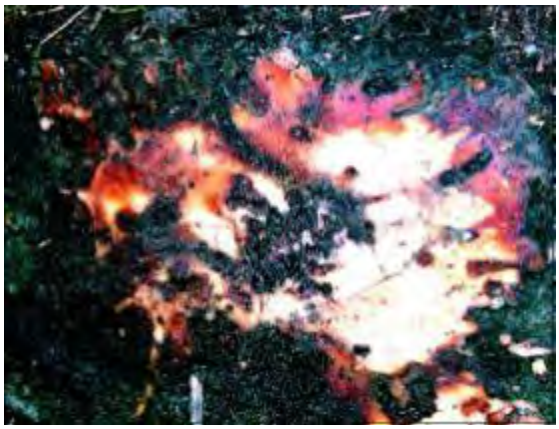
1. Nematodes
2. Root Borer (*Cosmopolites sordidus*)
3. Yellow and Black Sigatoka Disease (*Mycosphaerella musicola* and *fijiensis)*

B. IPM Plan for Banana / Plantain

1. Nematodes

Identification: Nematodes are very small, worm-like pests ranging from 0.5 to 1.0 mm in length. They can survive in many different types of habitat and feed on a wide variety of crops. Nematodes have spear-like mouthparts that allow them to feed on cells of a plant. High nematode populations can cause significant root damage resulting in stunted growth and low yield. Top-heavy plants may also fall over due to the lack of supporting roots.

Roots of plant toppled by burrowing nematode.



Reddish discoloration caused by Nematodes.

http://www.ctahr.hawaii.edu/adap/ASCC_LandGrant/Dr_Brooks/BrochureNo9.pdf
http://www.spc.int/PPS/PDF%20PALs/PAL%2005%20Banana%20Burrowing%20Nematode.pdf

Pre-planting:

- Elimination of nematodes from infested fields prior to planting is near to impossible but numbers can be reduced by having a fallow period greater than a year.
- Select suckers which will weigh at least 3/4 kg after trimming. Trim the corm tissue until all black or discolored spots have been removed, leaving only clean white tissues. Remove at least one ring of leaves. Wash corms in running water, then put in hot water (125°F) for 20 minutes. Allow them to dry before planting.

Planting and growth:

- In some cases the incorporation of chitin-containing materials (such as crushed crab and prawn shells) into the soil has been known to reduce nematode levels.
- Covering the soil with banana leaves and other plant material helps moderate soil temperatures, prevent erosion, and gradually add organic matter to soil.
- When roots have been destroyed by feeding nematodes, plants are more likely to fall over. Fruiting plants should be propped to prevent toppling due to the weight of the bunch or strong winds.

Post-harvest:

- Remove all weeds and excess plant matter.
- The planting of non-host winter crops can discourage unintentional (volunteer) peanut plants.

Crop rotation:

- Crop rotation can be very effective in reducing plant-parasitic nematodes. Rotating crop with non-hosts is recommended. Non-hosts include grasses such as jatropha, bahiagrass, bermudagrass, millet, and sorghum. It is advisable to plant one or several of these crops for at least one year before planting peanuts.

Monitoring and treatment decision:

- When sampling nematode populations it is best to take root and soil samples.

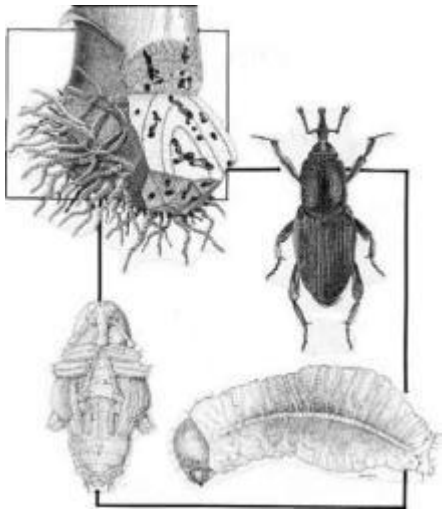
- Samples should not be taken when the soil is very dry or very wet.

Control Options (to be recommended in the order listed; follow the label directions):

- Nematode-suppressive green manure/fallow crops
  - African or French marigolds (grown then incorporated into soil)
  - Jatropha
  - Castor bean, velvetbean, forage sorghum
- Organic soil amendments (Neem or Jatropha seed cakes mixed into soil)
- Sticky board traps
- Place 1-4 sticky cards per 300 sq m field area. Replace traps at least once a week. To make your own sticky trap, spread petroleum jelly or used motor oil on yellow plywood, 6 cm x 15 cm in size or up. Place traps near the plants but faraway enough to prevent the leaves from sticking to the board. Traps when hung should be positioned 61 cm zone above the plants.

2. Root Borer (Cosmopolites sordidus)

Identification: The adult weevil is dark brown and grey in color with a body length of about 11mm. Its legs have hook-like appendages allowing it to grab onto plant material. Root borer larvae is white with a dark red head. Root borers cause damage by tunneling into the tissue of crops, weakening their structure. The adult weevil feeds and breeds at night.



Adult Banana Root Borer and Larvae
http://edis.ifas.ufl.edu/in706
http://entnemdept.ufl.edu/creatures/fruit/borers/banana_root_borer06.jpg

Pre-planting:

- Field sanitation and hot water treatments of corms have been used to manage root borers. Peeling the rhizomes free of lesions and immersing in a hot water bath at 54oC for 10 minutes is practical and effective in controlling this pest.
- Plant-clumps or mats should be cleaned of plant debris.

Planting and growth:

- At planting, rhizomes or corms should be completely covered with soil to prevent eggs from being laid on their exposed surface.

- Transportation of planting material from infested fields to uninfested ones should be avoided to prevent rapid dispersal of this pest to uninfested areas.

Post-harvest:

- Harvested plants should be removed from the field weekly to eliminate hiding places for adults. Stumps should be removed and the corms cut into 4 to 8 pieces and allowed to dry. This practice prevents larval development in the harvested plants.

Crop rotation: NA

Monitoring and treatment decision:

- Plants should be monitored occasionally especially at low altitudes.
- Root borer populations are slow to increase and are unlikely to cause significant damage in early stages as long as plants are kept healthy.
- Adults are attracted to freshly cut corms, and population estimates can easily be made using traps consisting of these plant parts.

Control Options (to be recommended in the order listed; follow the label directions):

- Transportation of planting material from infested fields to uninfested ones should be avoided to prevent rapid dispersal of this pest to uninfested areas.
- Removal of crop residues post-harvest
- Admire 2 (FC) (Imidacloprid 21.4%)/ Gaucho 600 (Imidacloprid 48.6%)

3. Yellow and Black Sigatoka Disease (*Mycosphaerella musicola* and *Mycosphaerella fijiensis)*

Identification: The first symptom of yellow sigatoka are characterized by a small yellowish green spot that appears on the third or fourth leaf from the top. Such spots or flecks will continue to grow and change in color to brown or dark red surrounded by a band of yellow. Black sigatoka is more aggressive than yellow sigatoka and is characterized by similar spots that appear on the underside of leaves. The spots also develop into dark spots but are largely limited to the leaf veins.

Banana leaf infected with sigatoka disease
http://www.pri.wur.nl/NR/rdonlyres/D3D901AE-572A-4A46-B165B20400B30EF4/64352/DSC00739602 .jpg

Pre-planting:

- Use clean and disease-free suckers.

Planting and growth:

- Plant density is important in reducing the spread of sigatoka. No more than 700 banana plants should be planted per acre.
- Diseased leaf tissue (source of spores) should be removed regularly throughout the year.

- Pruning to increase airflow around leaves
- Maintain sufficient water supply to promote new leaf emergence
- Effective weed control is necessary to eliminate the microclimate that promotes the development of the disease.

Post-harvest:

- Destroy excess plant material and weeds.
- Clean all receptacles and equipment used during harvest.

Crop rotation: NA

Monitoring and treatment decision:

- When 50% of the leaf is affected it should be trimmed to remove all infection.
- When over 75% of the leaf is infected it should be entirely removed

Control Options (to be recommended in the order listed; follow the label directions):

- Remove infected plants quickly.
- Promote air flow among crops with pruning and proper spacing
- Kocide 4.5 lf (F) Copper Hydroxide 37.5% (Follow REI = 24 hours, PHI = 0 days, unless noted otherwise)

INTEGRATED PEST MANAGEMENT PLAN FOR COFFEE

A. Principal Pests

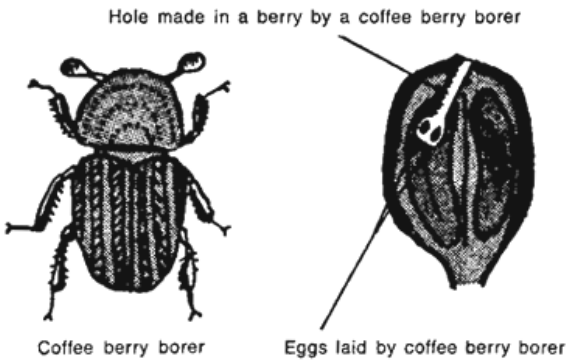
1. Berry Borer
2. Cercospora

C. IPM Plan for Coffee

1. Berry Borer

Identification: Adult berry borers are small black beetles that are between 1.8 and 1.2mm in length. They live the majority of their lives within the coffee berry and the males do not have wings. The females penetrate into mature green or red berries, usually from the tip and lay eggs within the beans. Female beetles fly from tree to tree to lay eggs. Once the eggs hatch, the larvae feed on the beans, rendering them unsuitable for commerce or greatly lowering their quality.

Coffee bean with berry borer inside



http://www.fao.org/docrep/006/ad219e/AD219E21.gif

Pre-planting:

- Use clean and pest free seeds.

Planting and growth:

- Harvest ripe berries as soon as possible.
- Pruning of the tree increases plant vigor and air circulation.
- Mulching with banana leaves or dried grass can improve plant vigor but also make the plant more attractive to other pests.
- Reducing shade will make conditions more favorable for berry borer predators.

Post-harvest:

- Remove any ripe berries that have fallen on the ground.
- Sacks or sheets can be spread at the base of the tree to prevent fallen berries from being lost in the soil.

Control Options (to be recommended in the order listed; follow the label directions):

- Remove any berries that have fallen to the ground.
- Prune the trees.
- Beauveria bassiana h Beauveria bassiana 95% (consult label for entry intervals)

2. Cercospora

Identification: Leaves infected with cercospora have small yellow spots that gradually expand to 5mm in size. The outer portion of the spot then becomes brown while the center turns grayish white. The infected berry dries up, becomes black, and develops scars on the pulp which makes de-pulping difficult.

Cercospora on leaf www.fao.org/docrep/008/ae939e/ae939e3l.jpg

Cercospora on berries. http://www.fao.org/docrep/008/ae939e/ae939e3m.jpg

Pre-planting:

- Use disease-free seeds. Heat treating seeds is also effective.
- Ensure that field is well irrigated and rich in nutrients.
- Adequate drainage is also very important.

Planting and growth:

- Avoid working when plants are wet.
- Provide adequate distance between plants and prune branches to provide good air circulation.
- Remove infected material.

Post-harvest:

- Clean all farming equipment.
- Destroy infected material and fallen berries**.**

Crop rotation:

- Crop rotation has proven to be effective in reducing cercospora.

Control Options (to be recommended in the order listed; follow the label directions):

- Maintain adequate distance between plants.
- Promote irrigation within the field.
- Serenade Max (WP) QST 713 strain of dried Bacillus subtilis (13.7%) (Follow REI = 4 hours, PHI = 0 days)

INTEGRATED PEST MANAGEMENT PLAN FOR MANGO

A. Principal Pests

1. Aphids
2. Mango Scales (*Pseudaulacaspis cockerelli*)
3. Fruit Flies (*Ceratitis cosyra; Anastrepha oblique; Anastrepha suspensa*)
4. Cercospora

B. IPM Plan for Mango

1. Aphids

Identification: Cabbage aphids are covered in a waxy coating and greenish gray in color. Populations of this aphid are typically very dense and feed on young leaves and flowering parts of certain crops.

The green peach aphid is yellowish-green. This type of aphid tends to be more randomly dispersed throughout the crop compared to the dense colonies of the cabbage aphid.

Green peach aphid

Cabbage aphid

Note: Please refer to the general pest section for IPM and control information.

2. Mango Scales (*Pseudaulacaspis cockerelli*)
Identification: Adult scales are approximately 3mm in length and oval shaped. There are many different varieties of scales but the mango scale is most likely to be found on mango plants. They are usually of a yellowish green color or gray.

Pre-planting:

- Make sure that all planted material is free of scales and larvae.
- Check that all planted crops are free of scales since the pest spreads primarily among nursery crops.

Planting and growth:

- Remove all weeds from the field.
- Spacing of plants is very important because scales rarely move from plant to plant unless they are in direct contact.
- Pruning is very important.

Post-harvest:

- Destroy crop remains and weeds.

Crop rotation: NA

Monitoring and treatment decision:

- Scales are cyclical pests that only require intervention every 5-10 years. Minor occurrences of scales can be tolerated. Monitor for newly settled scales and apply natural oils as soon as possible after a major hatch.

Control Options (to be recommended in the order listed; follow the label directions):

- Maintain adequate space between branches of adjacent plants
- Pruning
- Natural Soaps and oils
- Sevin WSP (carbaryl 80%) (follow REI = 12 hrs, PHI = 7 days)

3. Fruit fly *(Ceratitis cosyra; Anastrepha oblique; Anastrepha suspensa*)

Identification: The body of the fruit fly is yellowish in color with its sides and thorax covered in black spots. They are very small with a wing length of 4 to 6 mm.

Ceratis cosyra
http://edis.ifas.ufl.edu/in563

Mango internally damaged by fruit fly
http://www.infonet-biovision.org/default/ct/93/pests

Pre-planting:

- In Haiti, non-orchard mango production is the norm and pre-planting controls are of less use when dealing with de-centralized mature mango trees.

Planting and growth:

- Remove any fruit that has dimples or rot.
- Lightweight material such as mosquito netting can act as a physical barrier to fruit flies.
- Bags can be placed over the fruit to prevent exposure to pests.

Post-harvest:

- Fruit fly populations can be reduced by dipping the crop in hot water or keeping the fruit at or below 7.5°C for prolonged periods of time.
- Destroy all infested fruit.

Crop rotation: NA

Monitoring and treatment decision:

- Monitor fruit fly populations using traps, if monitoring is done during consecutive years then economically damaging fruit fly levels, that justify intervention, can begin to be defined.

Preventative foliar applications are necessary until systematic monitoring has been carried out to determine annual fluctuations in fruit fly populations. (See the USAID MarChE PERSUAP for more details on Caribbean Fruit Fly control and monitoring.)

Control Options (to be recommended in the order listed; follow the label directions):

- Remove rotten fruit.
- Plants can be covered with lightweight netting.
- Spinosad GF-120 foliar spray bait and traps (Follow REI = 4 hours, PHI = 1 day)

4. Cercospora

Identification: Leaves infected with cercospora have small yellow spots that gradually expand to 5mm in size. The outer portion of the spot then becomes brown while the center turns grayish white. The infected berry dries up, becomes black, and develops scars on the pulp which makes de-pulping difficult.

Cercospora on leaf
www.fao.org/docrep/008/ae939e/ae939e3l.jpg

Pre-planting:

- Use disease-free seeds. Heat treating seeds is also effective.
- Ensure that field is well irrigated and rich in nutrients.
- Adequate drainage is also very important.

Planting and growth:

- Avoid working when plants are wet.
- Provide adequate distance between plants and prune branches to provide good air circulation.
- Remove infected material.

Post-harvest:

- Clean all farming equipment.

- Destroy infected material and fallen berries**.**

Crop rotation: NA

Monitoring and treatment decision:

- Monitor fruit for infection with cercospora and intervene when disease levels reach economically damaging levels. Apply preventative applications of Sulfur when conditions favor disease.

Control Options (to be recommended in the order listed; follow the label directions):

- Provide adequate distance between plants and prune branches to provide good air circulation.
- Remove infected material.
- Sulfur - follow REI = 24 hours, PHI = 1 day
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days

INTEGRATED PEST MANAGEMENT PLAN FOR PAPAYA

A. Principal Pests

1. Papaya Fruit fly (*Toxotrypana curvicauda*)

B. IPM Plan for Papaya

1. Papaya Fruit fly (*Toxotrypana curvicauda*)
Identification: The body of the fruit fly is yellowish in color with its sides and thorax covered in black spots. They are very small with a wing length of 4 to 6 mm.

Papaya fruit fly larva

Female fruit fly and Papaya damaged by fruit fly
http://www.agric.wa.gov.au/objtwr/imported_images/f06399c.jpg

http://edis.ifas.ufl.edu/ig074

Pre-planting:

- In Haiti, non-orchard mango production is the norm and pre-planting controls are of less use when dealing with de-centralized mature mango trees.

Planting and growth:

- Remove any fruit that has dimples or rot.
- Lightweight material such as mosquito netting can act as a physical barrier to fruit flies.
- Bags can be placed over the fruit to prevent exposure to pests.

Post-harvest:

- Fruit fly populations can be reduced by dipping the crop in hot water or keeping the fruit at or below 7.5°C for prolonged periods of time.
- Destroy all infested fruit.

Crop rotation: NA

Monitoring and treatment decision:

- Monitor fruit fly populations using traps, if monitoring is done during consecutive years then economically damaging fruit fly levels that justify intervention, can begin to be defined. Preventative foliar applications are necessary until systematic monitoring has been carried out to determine annual fluctuations in fruit fly populations. (See the USAID MarChE PERSUAP for more details on Caribbean Fruit Fly control and monitoring.)

Control Options (to be recommended in the order listed; follow the label directions):

- Remove rotten fruit.
- Plants can be covered with lightweight netting.
- Spinosad GF-120 foliar spray bait and traps (Follow REI = 4 hours, PHI = 1 day)

INTEGRATED PEST MANAGEMENT PLAN FOR CITRUS

A. Principal Pests

1. Black scale (*Saissetia negleta)*
2. Citrus root weevil (*Diaprepes abbreviatus)*
3. Ants

B. IPM Plan for Citrus

1. Black scale (*Saissetia negleta)*

Identification: Adult scales are approximately 3mm in width and are oval shaped. The black scale is a soft scale that has a H shaped ridge on its back up until egg laying begins. Heavy adult scale feeding can reduce citrus plant vigor and cause fruit drop and twig dieback. The honeydew excreted by scales may also promote sooty mold growth.

Pre-planting:

- Make sure that all planted material is free of scales and larvae.
- Check that all planted crops are free of scales since the pest spreads primarily among nursery crops.

Planting and growth:

- Remove all weeds from the field.

- Spacing of plants is very important because scales rarely move from plant to plant unless they are in direct contact.
- Pruning is very important.

Post-harvest:
- Destroy crop remains and weeds.

Crop rotation: NA

Monitoring and treatment decision:
- Scales are cyclical pests that only require intervention every 5-10 years. Monitor for newly settled scales and apply natural oils as soon as possible after a major hatch.

Control Options (to be recommended in the order listed; follow the label directions):
- Maintain adequate space between branches of adjacent plants.
- Pruning
- Natural Soaps and oils
- Sevin WSP (carbaryl 80%) (follow REI = 12 hrs, PHI = 7 days)

2. Citrus root weevil (*Diaprepes abbreviates)*
Identification: Adult beetles are black with red, yellowish or white scales on wing covers. The Diaprepes root weevil can have devastating effects on citrus as larvae feed on roots all winter long which can result in death of young trees. Noticeable damage to foliage in the form of notching on leaves is the most apparent, though seldom serious, damage caused by this pest.


Adult diaprepes citrus root weevil
http://fmel.ifas.ufl.edu/images/gallery/diaprepes.jpg

Pre-Planting:
- Select phytophthora resistant root stock and certified weevil free seed
- Choose planting areas with good soil drainage (sandy soils are best)

Planting and growth:

- Regular irrigation and fertilization to promote root grow-back
- Skirt pruning and trunk banding prevents weevil movement into tree canopy
- Good weed management eliminates potential host crops

Post-Harvest: No significant post-harvest controls have been identified.

Monitoring and treatment decisions:

- Monitor presence of adult weevils in canopy visually and sticky trap substance applications to tree trunk can be used to monitor weevils as they emerge from the ground.

Control Options (to be recommended in the order listed; follow the label directions):

- Plant in areas with good drainage (sandy soils are best)
- Regular irrigation and fertilization are important to promote root grow back
- Skirt pruning and trunk banding
- Foliar application of Sevin WSP (carbaryl 80%) (follow REI = 12 hrs, PHI = 7 days) for adult weevil control

3. Ants

Identification: Ants commonly found on citrus: Argentina ant, southern and red fire ants, gray ant. Ants typically travel in trails along trees and irrigation lines and build their nests underground. Some species however nest under rocks and debris and can be known to move in irregular patterns. Ants often feed on the honeydew excreted by various other pests such as scales, mealy bugs, whiteflies and aphids.

Citrus Ants

Pre-Planting:

- Field should be tilled approximately one month before planting to destroy plant residue and weeds and allow them enough time to decompose before planting.

Planting and growth:

- Skirt pruning, remove branches within 12 to 30 inches of the ground
- Control populations of honeydew excreting pests
    - It is especially important to get rid of aphids as they are used by ants to gain access to nutrients in

- A paste made from garden lime (limestone or chalk) and water can be painted in a line around the trunk of the tree
- The bark of young trees may be wrapped for protection

Post-harvest

- Remove all plant remains and weeds.
- Flooding of the field will destroy ant colonies.
- Tilling can destroy ant larvae by exposing it to predators and direct sunlight.

Monitoring and treatment decisions:

- Citrus trees should be monitored in the spring or whenever honeydew-producing insects, such as aphids are expected to appear. The underside of ants descending the citrus trees should be checked. If the abdomen is swollen, this indentifies them as a species that collects honeydew.

Control Options (to be recommended in the order listed; follow the label directions):

- Apply the following mixture: 2 tbsp dish washing soap, 2 tsp vegetable oil, 2 tbsp salt a few drops of vinegar and 4 liters of water.
- A paste made from garden lime (limestone or chalk) and water can be painted in a line around the trunk of the tree.
- The reduction of aphids and whiteflies will discourage ants, who are attracted by the excretion of honeydew.
- Lorsban 75 (WG) [Tricel] Chlorpyriphos 75% (consult label for interval information)

INTEGRATED PEST MANAGEMENT PLAN FOR COCOA

A. Principal Pests

1. Monilia *Moniliophthora roreri*
2. Phytophthora

B. IPM Plan for Cocoa

1. Monilia (*Moniliophthora roreri)*
Identification:

Monilia Pod Rot is easily distinguished by the appearance of bumpy swellings on the pod surfaces. Sporulation begins within 12 days of pod swelling, resulting in a tan discoloration.

http://www.oardc.ohio-state.edu/cocoa/images/monilia.jpg

Pre-planting:

- The crop field should be free of weeds and well drained.

Planting and growth:

- Harvesting often and regularly can help reduce monilia.
- Trees should be kept short so it is easier to recognize and remove rotting pods.
- It is very important to remove infected pods before sporulation begins.

Post-harvest:

- All infected material should be destroyed.

Crop rotation: NA

Monitoring and treatment decision:

- Sweeps of the crop field should be conducted every 7-10 days.
- Pods are especially susceptible to rot during the first 90 days after fruit set and should be monitored carefully during this period.

Control Options (to be recommended in the order listed; follow the label directions):

- Infected pods must be removed before sporulation begins.
- Kocide 4.5 lf (F) Copper Hydroxide 37.5% (Follow REI = 24 hours, PHI = 0 days, unless noted otherwise)

2. Phytophthora (Black Pod)

Identification: The initial symptoms of black pod are the appearance of a small translucent spot on the pod surface. This spot then turns to a brown color, then continues to darken and expands with a slightly irregular border. This darkened margin can spread at an average pace of 12 mm in 24 hours.

http://www.tava.com.au/res/processing_20black_pod.jpg

Planting and growth:

- The reduction of insect vectors such as ants can reduce the spread of the disease.
- Practicing shade reduction, regular harvesting and frequent weed control may reduce infection.
- Trees should be kept short so it is easier to recognize and remove rotting pods.
- Reducing humidity by improving air circulation can reduce the spread of black pod.

Post-harvest:

- Remove all husks and plant debris.

Crop rotation: NA

Control Options (to be recommended in the order listed; follow the label directions):

- Reduce humidity levels and amount of shade by pruning.
- Kocide 4.5 lf (F) Copper Hydroxide 37.5% (Follow REI = 24 hours, PHI = 0 days, unless noted otherwise)
- Ridomil Gold (Follow REI = 48 hours, PHI = 14 days)

INTEGRATED PEST MANAGEMENT PLAN FOR PINEAPPLE

A. Principal Pests

1. Ants

B. IPM Plan for Pineapple

1. Ants

Identification: Ants typically travel in trails along trees and irrigation lines and build their nests underground. Some species however nest under rocks and debris and can be known to move in

irregular patterns. Ants often feed on the honeydew excreted by various other pests such as scales, mealy bugs, whiteflies and aphids.

Ants on a piece of pineapple Whitefly infestation on pineapple.
http://www.infonet-biovision.org/res/res/files/693.280x185.clip.jpeg

Pre-Planting:

- Field should be tilled approximately one month before planting to destroy plant residue and weeds and allow them enough time to decompose before planting.

Planting and growth:

- Skirt pruning, remove branches within 12 to 30 inches of the ground
- Control populations of honeydew excreting pests
    - It is especially important to get rid of aphids as they are used by ants to gain access to nutrients in
- A paste made from garden lime (limestone or chalk) and water can be painted in a line around the trunk of the tree
- The bark of young trees may be wrapped for protection

Post-harvest:

- Remove all plant remains and weeds.
- Flooding of the field will destroy ant colonies.
- Tilling can destroy ant larvae by exposing it to predators and direct sunlight.

Monitoring and treatment decisions:

- Pineapple trees should be monitored in the spring or whenever honeydew-producing insects, such as aphids are expected to appear. The underside of ants descending the pineapple trees should be checked. If the abdomen is swollen, this indentifies them as a species that collects honeydew.

Control Options (to be recommended in the order listed; follow the label directions):

- Apply the following mixture: 2 tbsp dish washing soap, 2 tsp vegetable oil, 2 tbsp salt a few drops of vinegar and 4 liters of water.
- A paste made from garden lime (limestone or chalk) and water can be painted in a line around the trunk of the tree.
- The reduction of aphids and whiteflies will discourage ants, who are attracted by the excretion of honeydew.
- Sevin (carbaryl) WSP 80% (consult label for interval information)
- Lorsban 75 WG [Tricel] Chlorpyriphos 75% (consult label for interval information)

INTEGRATED PEST MANAGEMENT PLAN FOR SUGARCANE

A. Prinicipal Pests

1. Ants

B. IPM Plan for Sugarcane

1. Ants

Identification: Ants typically travel in trails along trees and irrigation lines and build their nests underground. Some species however nest under rocks and debris and can be known to move in irregular patterns. Ants often feed on the honeydew excreted by various other pests such as scales, mealy bugs, whiteflies and aphids.

Ants feeding on sugarcane residue

Pre-Planting:

- Field should be tilled approximately one month before planting to destroy plant residue and weeds and allow them enough time to decompose before planting.

Planting and growth:

- Ensure plant vigor by practicing proper irrigation and fertilization
- Control populations of honeydew excreting pests
    - It is especially important to get rid of aphids as they are used by ants to gain access to nutrients in
- Pitfall traps have been proven very useful against ants affecting sugarcane

Post-harvest:

- Remove all plant remains and weeds.
- Flooding of the field will destroy ant colonies.
- Tilling can destroy ant larvae by exposing it to predators and direct sunlight.

Monitoring and treatment decisions:

- Sugarcane stalks should be monitored in the spring or whenever honeydew-producing insects, such as aphids are expected to appear. The underside of ants descending the stalks should be checked. If the abdomen is swollen, this indentifies them as a species that collects honeydew.

Control Options (to be recommended in the order listed; follow the label directions):

- Apply the following mixture: 2 tbsp dish washing soap, 2 tsp vegetable oil, 2 tbsp salt a few drops of vinegar and 4 liters of water.
- The reduction of aphids and whiteflies will discourage ants, who are attracted by the excretion of honeydew.
- Pitfall traps have been proven very useful against ants affecting sugarcane
- Sevin (carbaryl) WSP 80% (consult label for interval information)
- Lorsban 75 (WG) [Tricel] Chlorpyriphos 75% (consult label for interval information)

Note: Post-harvest burning of the field has not proven to significantly reduce ant populations.

INTEGRATED PEST MANAGEMENT PLAN FOR TOMATO

A. Principal Pests

1. Potato aphid
2. Late blight (*Phytophthora infestans*)
3. Leaf curl virus (Tomato yellow leaf curl virus)
4. Powdery mildew
5. Green stink bug

B. IPM plan for Tomato

1. Potato aphid

Identification: The potato aphid can be found in both green and pink. It is typically towards the end of the season on tomatoes. The potato aphid causes damage to tomatoes by distorting leaves and stems, stunting plants, and causing necrotic spots on leaves. Like most other aphids, the potato aphid secretes a type of honeydew which promotes the growth of dark mold on the plant surface. Plants are most susceptible 6-8 weeks before harvest; after this period, high infestations are less damaging.

Potato aphid – pink biotype.

Sooty mold produced by potato aphid.

(For information on Controls see Fruit IPM plan, above)

2. Late Blight

Identification: Symptoms of late blight appear as small, water-soaked areas that rapidly enlarge to form purple-brown, oily blotches. On lower side of leaves, rings of grayish-white mycelium and spore-forming structures may appear around blotches. Entire leaves die and infection spreads quickly to young stems. Infected fruit turns brown, beginning on shoulders of fruit. Late blight occurs when humidity is high (above 90%) and temperatures are relatively cool (60^{o} to 78^{o} F) – in these conditions, infection can occur in about 10 hours.

Late blight lesions on tomato leaves.

Stems and fruit with signs of late blight.

Pre-planting:

- Select a variety resistant to late blight.
- Remove any nearby volunteer tomato or potato plants.
- Make sure transplants are free of late blight before planting; destroy any infected plants.
- Prepare fields with good drainage.

Planting and growth:

- If weather conditions have been favorable for late blight development, consider delaying planting.
- Avoid sprinkler irrigation and, and avoid wetting foliage when irrigating if possible; if not, irrigate in the early morning to ensure that foliage dries during the day. Alternatively, use drip irrigation where feasible. Discontinue irrigation if disease develops.
- Space, stake and prune tomato plants to provide good air circulation.
- Apply fertilizer at planting.

Post-harvest:

- Destroy any infected plants by burning; remove all remnants of plant matter from field.

Crop rotation:

- Rotate with cereal crops for 1 year to reduce late blight infestation.
- Do not rotate with pepper, eggplant, potato, or cucurbits.

Monitoring and treatment decision:

- When severe symptoms appear it is often too late to treat.
- History of late blight in the field.
- Weather conditions favorable for late blight development.
- A protective treatment should be applied before disease development begins; once an outbreak occurs it is necessary to apply additional applications at regular intervals. Resistance development is a concern; fungicides with different modes of action should be rotated to avoid resistance buildup.

Control options (to be recommended in the order listed; follow label directions):

- Destroy any infected plants by burning; remove all remnants of plant matter from field.
- Sulfur – follow REI = 24 hours, PHI = 1 day)
- Kocide 4.5 lf (F) Copper Hydroxide 37.5% (Follow REI = 24 hours, PHI = 0 days, unless noted otherwise)
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days
- Dithane M-45 or F-45 – follow REI = 24 hours, PHI = 3 days

3. Tomato yellow leaf curl virus (TYLCV)

Identification: Tomato plants infected with this leaf curl virus show stunted and erect or upright plant growth; plants at early stage of growth will show severe stunting. However, the most diagnostic symptoms are those in leaves. Leaves of infected plants are small and curl upward; and show strong crumpling and interveinal and marginal yellowing.

Tomato plant infected with yellow leaf curl
http://www.ipm.ucdavis.edu/PMG/T/D-TOTYLV-FO.005.html

Pre-planting:

- Select TYLCV-resistant varieties.
- Use virus- and whitefly-free transplants.
- DO NOT import tomato (or any potential whitefly host) transplants from areas known to have the virus (Florida, Georgia and Texas in the U.S.; and Mexico).

Planting and Growth:

- Plant immediately after any tomato-free period or true winter season.
- Avoid planting new fields near older fields (especially those with TYLCV-infected plants).
- Manage whiteflies
- Dispose of diseased plants when virus infection is low and manage weeds.

Post-harvest:

- Destroy crop residues and volunteers
- Maintain fields free of weeds as they are potential whitefly host crops (e.g., nightshade and jimsonweed).

Crop rotation:

- Avoid rotating with other whitefly and TYLCV host crops such as black bean, pepper, eggplant, and cole crops if possible. If it is necessary to rotate with one of these crops, allow the maximum time possible between host crops and the shortest growing season possible for each crop.

Monitoring and treatment decision:

- Starting after emergence, check field margins for virus, which are usually infested first. When nearby host crops are in decline, monitor twice per week for rapid population buildup. If field margins are areas of concern but field centers are not highly infested, treat only field margins to allow beneficial insects to survive and control whiteflies.

Control options (to be recommended in the order listed; follow label directions):

- Manage whiteflies (*See Control options for whiteflies in IPM plan for Fruit crops)*
- Dispose of diseased plants when virus infection is low

4. Powdery Mildew (*Erysiphe polygoni)*

Identification: Leaves on infected tomato plants develop irregular, bright yellow spots; severely affected leaves die but rarely drop. Spots of dead tissue are sometimes surrounded by a yellow halo. Lesions typically affect only leaves and not fruit or stems. Severe infections kill leaves and results in sunburn fruit and weakened plants.

Powdery mildew's irregular haloed blotches on tomato leaves
http://www.ipm.ucdavis.edu/PMG/L/D-TO-LTAU-FO.001.html

Pre-planting:

- Fields that contain rich soil will help to reduce the prevalence of the fungus.
- Rows should run the direction of the prevailing wind to increase air circulation and promote leaf drying.

Planting and growth:

- Plant in sunny areas as much as possible, and avoid applying excess fertilizer.

- Powdery mildew spores can be washed away with water if caught early
- Avoid over-crowding and keep plantings free of weeds as long as is practical.

Post-harvest:
- Till fields post harvest

Crop rotation:
- Seed treatments and crop rotation have no effect on powdery mildew infection.

Monitoring and treatment decision:
- Fungicides are not needed for control unless the disease becomes extensive or appears very early in the season. If you see early symptoms, check weekly to monitor the progression of the disease.

Control options (to be recommended in the order listed; follow label directions):
- Avoid over-crowding and keep plantings free of weeds as long as is practical.
- Sulfur: 7.4 to 25 lbs/ha (follow REI = 24 hours, PHI = 1 day). Apply at first sign of disease and every 14 days as needed to maintain control.
- Ridomil Gold – (Follow REI = 48 hours, PHI = 14 days)
- Dithane M-45 or F-45 – follow REI = 24 hours, PHI = 3 days

5. Green Stink Bug

Identification: Adult green stink bugs are approximately 15 to 20mm in length and shield-shaped. They have large wings and are green in color with their head sometimes bordered by an orange line. Green stink bug eggs are approximately 1.2mm in diameter and yellowish green in color. As the eggs develop they become gray and pink in color. Eggs can be found on the underside of leaves.


http://entnemdept.ufl.edu/creatures/veg/bean/green_stink_bug.htm
http://ipcm.wisc.edu/WCMNews/tabid/53/EntryId/360/Stink-Bugs-in-Corn-and-Soybeans.aspx

Pre-planting:
- Destroy all weeds in the area.

Planting and growth:

- Early planting can significantly reduce stinkbug damage.
- It is very important to close all seed slots so the stink bug cannot feed on the seeds.

Post-harvest:

- Tilling fields significantly reduces stink bug population by removing all host foliage.
- Destroy all weeds and possible hosts such as legumes and mustards.

Crop rotation:

- Avoid rotating with legumes and tomatoes.

Monitoring and treatment decision:

- Regular field scouting before planting and crop emergence is recommended.

Control Options (to be recommended in the order listed; follow the label directions):

- Tilling fields significantly reduces stink bug population by removing all host foliage.
- Actara 240 sc (EC) Thiamethoxam (21.6%) (REI = 12 hrs, PHI = 30 days)
- Sevin (carbaryl) WSP 80% (follow REI = 12 hrs, PHI = 7 days)

IPM Plans for Vegetables:

I. Principle pests affecting all vegetable crops (below):

1. Caterpillars, (Armyworm, *Spodoptera exigu,* Alfalfa looper, *Autographa californica*; Cabbage looper, *Trichoplusia)*
2. Whiteflies (*Tetraleurodes perseae)*
3. Aphids

1. Caterpillars, (Armyworm, *Spodoptera exigua;* Alfalfa looper, *Autographa californica*; Cabbage looper, *Trichoplusia)*

Identification: Various caterpillar pests exist in the Southeast Department of Haiti and vary in color and size between different species and life stages of the same species. Loopers are green and arch their backs to crawl. Corn earworms are highly variable in coloration – young larvae are greenish with black heads and black hairs on their bodies, while mature larvae are 1.5 inches long and may be pale green, pinkish or brown. Armyworms are 1.5 to 2.0 inches in length and black with yellowish stripes on the body. Damage to bean crops by caterpillar pests includes damage to cotyledons, new leaves, and terminal buds (loopers); damage to leaves, buds, flowers, and within pods (corn earworm); skeletonization of leaves and holes in pods and beans (armyworms).

Cabbage looper at different larval stages

Cabbage looper eggs attached to leaf.

Corn earworm in various stages/colors.

Armyworm.

Pre-planting:

- Destroy weeds along field borders which may host armyworms before planting.
- Dig deep trenches with the steep side towards crop to discourage armyworm migration into fields.

Planting and growth:

- Begin monitoring for both cabbage loopers and beet armyworms (see 6. Monitoring and treatment decision).
- Hand-pick caterpillar larvae and kill by dropping into a container with soap and water or a salt solution.

Post-harvest:

- If a tractor is available, discing fields immediately following harvest kills larvae and pupae. Otherwise, bury any remaining plant matter to destroy any eggs and larvae that may remain.

Crop rotation:

- Rotate with less susceptible crops such as carrot or green onion. Do not rotate with cabbage, swiss chard, spinach, tomato, or eggplant.

Monitoring and treatment decision:

- Inspections for caterpillar pests should begin during the vegetative growth period and should continue from flower bud to bloom and during pod fill. Plants should be inspected to observe early signs of damage to foliage and presence of caterpillars on plants when young pods are forming. To sample and hand-pick caterpillars, inspect underside of leaves for eggs and young larvae, use sweep netting techniques, or place a sheet or pan under plants and beat to catch small caterpillars that fall off.

Control Options (to be recommended in the order listed; follow the label directions):

- Hand-pick and kill larvae in soap and water or saltwater.
- Garlic and chili spray: (*For recipe see Control options in Fruit IPM plan)*
    - Spray during early morning or evening to avoid leaf burn.
- *Bacillus thuringiensis* (subspecies Aizawai or Kurstaki) (follow REI = 4 hrs, PHI = N/A).
    - Rotate sprays of different Bt subspecies and above methods to avoid resistance buildup.
- Sevin (carbaryl) WSP 80% (follow REI = 12 hrs, PHI = 7 days) (All crops)
- Lorsban 75 WG [Tricel] Chlorpyriphos 75% (Follow REI = 24 hours, PHI = see label as varies by crop) Can be used on the following crops: Brocolli, cabbage, cauliflower, corn, onions and sorghum.
- Pounce 25 WP, Permethrin 25% (Follow REI = 12 hours, PHI = N/A) can be used on the following crops: Avocado, eggplant, peppers, tomatoes, broccoli, cabbage, cauliflower, corn, swiss chard.

2. Whiteflies (*Tetraleurodes perseae)***:**

Identification: Silverleaf whiteflies are approximately 0.06 inch or 1.5 mm long in length with yellowish bodies and white wings. Their wings are tilted slightly over the body and have a small gap between them. The greenhouse whitefly *(Trialeurodes vaporariorum)* is very similar in appearance but differs in that is wings are held flatter over the back and there is no gap between them. Adults are typically found on the underside of leaves and produce small oval-like larvae. Whiteflies damage a wide variety of crops by sucking out large amounts of sap and leaving a sticky honeydew on the surface of the plant. This honeydew promotes the growth of mold which greatly inhibits the growth of the plant.

Silverleaf Whitefly

Greenhouse Whitefly

Pre-planting:

- Control weeds in non-crop areas.
- Coordinate planting calendars with other farmers in the area planting whitefly host crops. Adjust planting dates based on historical whitefly outbreaks – delaying planting 3 weeks and planting in during cooler conditions can help disrupt whitefly reproduction cycles.
- Avoid planting next to crops with whitefly infestations.

Planting and growth:

- Install yellow sticky traps mounted on stakes next to plants (if commercial sticky traps are not available/too expensive, sticky traps can be made out of plywood or masonite board painted bright yellow, coated in a mixture of one part petroleum jelly or mineral oil and one part detergent). One sticky trap to every 2 or 3 large plants should be installed facing the plant at the level of infestation.
- Do not apply broad-spectrum pesticides early in the season as these can increase whitefly numbers later in the season.
- Fertilize with compost/organic fertilizer; avoid nitrogen over-fertilization.

Post-harvest:

- Remove and destroy all crop residues as soon as possible after harvest.

Crop rotation:

- Avoid rotating with other host crops such as black bean, chili pepper and tomatoes if possible. If it is necessary to rotate with one of these crops, allow the maximum time possible between host crops and produce in the shortest season possible.

Monitoring and treatment decision:

- Starting after emergence, check field margins for whiteflies, which are usually infested first. When nearby host crops are in decline, monitor twice per week for rapid

population buildup. If field margins are areas of concern but field centers are not highly infested, treat only field margins to allow beneficial insects to survive and control whiteflies.

Note: Early control is critical; once populations build up they are difficult to suppress.

Control Options (to be recommended in the order listed; follow the label directions):

- Sticky traps + Insecticidal soap (Safer ® Soap or homemade: 1 ½ teaspoons liquid soap, i.e. dish detergent, per quart of water).
    - Clean sticky traps with soap and water and reapply sticky coating once a month.
    - Spray in the early morning or late evening to avoid leaf burn.
    - Spray when whitefly populations are first detected and ensure coverage on underside of leaves where eggs are laid; spray 2-3 times per week to keep populations low control. Do not spray on drought-stressed plants.
- Garlic and chili spray: *(See Control Options in Fruit Crop IPM plan, above)*
    - Spray in the early morning or late evening to avoid leaf burn.
- Neem oil
    - Spray in the early morning or late evening to avoid leaf burn.
    - Spray when whitefly populations are first detected and ensure coverage on underside of leaves where eggs are laid.
    - Do not spray on drought-stressed plants.
- Zohar LQ-215
- Admire FC (imidacloprid 21.4%); follow REI = 24 hours, PHI = 7 days

3. Aphids:

Cabbage aphids (*Brevicoryne brassicae)*, Green peach aphids (*Myzus persicae)*, Potato aphid (Macrosiphum euphorbiae), Cowpea aphid (*Aphis craccivora)*, Bean aphid (*Aphis fabae)*, Corn leaf aphid *(Rhopalosiphum maidi)*, Green bug aphid (*Schizaphis graminum*), Cotton/melon aphid (*Aphis gossypii).*

Identification: There are many different species of aphids that affect vegetable crops. For identification purposes, a description of the aphid species specific to each crop can be found in the specific pest section. IPM and control methods for all species however are the same and can be found below:

Pre-planting:

- If possible, use aphid-tolerant tomato varieties (i.e. those containing the Mi gene).
- Destroy weeds that are hosting aphids along field edges.
- Coordinate planting calendar with other farmers planting tomatoes in the area.
- If feasible, grow seedlings under protective covers or in a closed greenhouse before transplanting to the field; this allows the plant to grow to a size that is more resistant to aphids.

Planting and growth:

- Monitor plants frequently (2-3 times per week) for presence of aphids. Check undersides of leaves as well as other plant parts. When populations are found:
    - Knock aphids off with a strong stream of water (most won't climb back on to the plant).
    - When populations are localized, prune and dispose of infested leaves.
- Avoid over-fertilizing with nitrogen as this favors aphid reproduction.

Post-harvest:

- Destroy crop remnants immediately after harvest.

Crop rotation:

- Avoid rotating with chili peppers, eggplant, and potato.

Monitoring and treatment decision:

- Monitor plants from bloom to early fruit set by picking the highest open flower on 20-30 plants selected at random throughout the field. Inspect leaves for live potato aphids, as well as mummies. Treatment is necessary if roughly half of the leaves are infested. During late fruit set, pick the leaf below the highest open flower on 20-30 randomly selected plants. Monitoring is critical during the period 6-8 weeks before harvest – if 50% of leaves are infested during this time, treatment is necessary to avoid yield losses.

Control options (to be recommended in the order listed; follow label directions):

- Knock aphids off with a strong stream of water.
- If populations are localized, prune and dispose of infested areas.
- Wood ash (dust plants with ash when leaves are not too dry nor too wet)
- Insecticidal soap (Safer ® Soap or homemade: 1 ½ teaspoons liquid soap, i.e. dish detergent, per quart of water).
    - Ensure thorough coverage of foliage.
    - Spray in the early morning or late evening to avoid leaf burn.
- Garlic and chili spray: (see Control Options in Fruit IPM plan, above)
    - Spray in the early morning or late evening to avoid leaf burn.
- Neem oil
    - Spray in the early morning or late evening to avoid leaf burn.
    - Ensure thorough coverage on tops and bottoms of leaves.
    - Do not spray on drought-stressed plants.
- Actara (thiamethoxam) – follow REI = 12 hrs, PHI = 30 days
    - Avoid repeated sprayings of Actara to prevent resistance buildup.

II. Principle pests affecting individual vegetable crops:

INTEGRATED PEST MANAGEMENT PLAN FOR BEANS
(Velvet, Black and Common)

A. Principal Pests

1. Aphids
2. Damping-off
3. Bean-Leaf Beetle

4. Powdery Mildew
5. Golden Mosaic Virus
6. Mustia Fungus
7. Itch grass

B. IPM Plan for Beans

1. Aphids

Identification: The two most common species encountered on beans are the cowpea aphid and the bean aphid. The cowpea aphid is shiny black with legs and antennae that are white to pale yellow with black tips. The bean aphid is slightly larger than the cowpea aphid, and dark olive-green to black with light-colored legs. The pea aphid is a relatively large, green, somewhat shiny aphid. Aphids damage plants by sucking plant sap which causes heavily infested leaves to curl and stunts plants; excreting honeydew which causes sticky, shiny leaves to ultimately turn black because of a sooty-mold fungus growth; and spreading plant diseases. Infestations frequently are localized with heavily infested leaves curled downward.

Cowpea aphids.

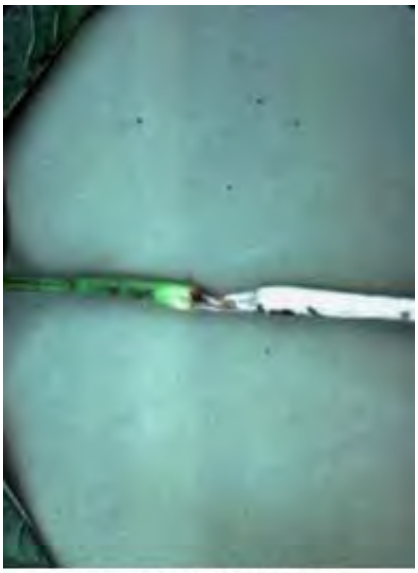
Black bean aphid.

http://www.ipm.ucdavis.edu/PMG/A/I-HO-ACRA-CD.003.html

Note: Please refer to the general pest section for IPM and control information.

2. Damping-Off

Identification: Damping-off refers to fungal disease that attacks germinating seeds and sprouts. Infected seeds may fail to germinate due to rot. Darkened watery lesions may be visible towards the base of sprouts. These lesions can grow very rapidly, resulting in the death of the plant. Roots and stems of plants that have already fully emerged can also be attacked resulting in death or fall over.



Fungal attack of bean seedling at the soil surface resulting in damping off. Note constricted stem lesion.

Fusarium root rot of bean with characteristic reddish-brown lesions on both tap and side roots.

http://ohioline.osu.edu/hyg-fact/3000/3110.html

Pre-planting:

- Plant beans only on well-drained soils or try to improve drainage

Planting and growth:

- Suspected plants should be carefully dug and washed, because pulling plants may leave tissues with characteristic symptoms in the soil.
- Avoid planting beans in fields known to be heavily infested with bean root-rot fungi.
- Delay planting until the soil is warm (above 65 F) and seed shallow and with proper spacing to insure rapid emergence.
- Do not over-fertilize, especially with nitrogen.

Post-harvest:

- Deep plowing of the previous years' crop residues will reduce bean root rot.

Crop rotation:

- Do not grow beans or other susceptible crops continually in the same location. Continuous cropping of susceptible plants will eventually lead to a buildup of these fungi in the soil. Since they are capable of long-term survival, a rotation of 4-5 years is desirable.

Monitoring and treatment decision:

- The base and stalk of the plant should be routinely checked, especially in areas with poor irrigation and drainage.

Control Options (to be recommended in the order listed; follow the label directions):

- Suspected plants should be carefully dug and washed, because pulling plants may leave tissues with characteristic symptoms in the soil.
- Sulfur dust - follow REI = 24 hours, PHI = 1 day
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days
- Dithane M-45 or F-45 – follow REI = 24 hours, PHI = 3 days

3. Bean-Leaf Beetle (*Ceratoma trifurcate)*
Identification: Adult bean leaf beetles are approximately ¼ inch in length. There is wide variation in color including green, yellow, tan and red. Bean leaf beetles have a black triangle that is found on the wings behind the head. A black triangle is always found behind the head on the wing covers. Males are distinguished from females by the black coloration between their eyes. Bean leaf beetle larvae are white and thin and can be found at the base of the bean plant.



Bean leaf beetles.
http://ipm.illinois.edu/fieldcrops/insects/bean_leaf_beetle/index.html

Pre-planting:
- Cultural control efforts may include destruction of overwintering locations such as plant residues and weeds. Adult bean leaf beetles overwinter beneath plant debris at the edge of woodlots or fence rows near bean fields.
- Delayed planting can reduce number of bean leaf beetles present in fields

Planting and growth:
- Manually remove beetles and utilize row covers if feasible
- Spraying a mixture of crushed turnips mixed with corn oil, has been proven affective

Post-harvest:
- Destroy crop residues and other overwintering locations

Crop rotation:
- Avoid rotation with other potential host crops. Do not plant beans in same field year after year if possible.

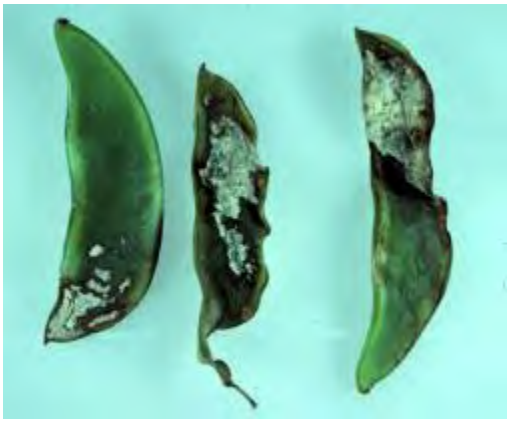
Monitoring and treatment decision:
- Beginning checking for beetles as soon as crops begin to sprout
- Late season infestations are usually insignificant.

Control Options (to be recommended in the order listed; follow the label directions):

- Manually remove beetles and utilize row covers if feasible.
- Spraying a mixture of crushed turnips mixed with corn oil, has been proven affective.
- Lorsban 75 (WG) [Tricel] Chlorpyriphos 75% - follow REI = 24 hours, PHI 35 days)
- Dimethoate 2.67 (EC) Dimethoate 30.5 %} – follow REI = 24 hours, PHI see label, as varies by crop

4. Powdery Mildew

Identification: Leaves on infected plants develop irregular, bright yellow spots; severely affected leaves die but rarely drop. Spots of dead tissue are sometimes surrounded by a yellow halo. Severe infections kill leaves and results in sunburn fruit and weakened plants. Spores from the mildew are easily blown by the wind to nearby plants. Increased humidity can increase the severity of the disease, and infection is worse during periods of heavy dew.



http://www.umassvegetable.org/images/soils_crops_pest_mgt/disease/bean_lima_phytophthora_phaseoli.jpg http://cropdisease.cropsci.illinois.edu/images/powdery-mildew2-large.jpg

Pre-planting:

- Fields that contain rich soil will help to reduce the prevalence of the fungus.
- Rows should run the direction of the prevailing wind to increase air circulation and promote leaf drying.

Planting and growth:

- Plant in sunny areas as much as possible, and avoid applying excess fertilizer.
- Spores can be washed off with water
- Avoid over-crowding and keep plantings free of weeds as long as is practical.

Post-harvest:

- Disc fields after harvest.

Crop rotation:

- Seed treatments and crop rotation have no effect on powdery mildew infection.

Monitoring and treatment decision:

- Begin monitoring early in the season. Chemical treatment is not warranted unless infection occurs very early in the season.
- Check leaf surfaces often especially among older plants and areas of the field with poor air circulation. Unlike most fungi, powdery mildew does not require accumulated moisture on the plant in order to grow.

Control Options (to be recommended in the order listed; follow the label directions):

- Avoid over-crowding and keep plantings free of weeds as long as is practical.
- Disc fields after harvest.
- Sulfur: 7.4 to 25 lbs/ha (follow REI =24 hrs, PHI = N/A). Apply at first sign of disease and every 14 days as needed to maintain control.
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days.
- Dithane M-45 or F-45 – Follow REI = 24 hours, PHI = 3 days

5. Golden Mosaic Virus

Identification: Symptoms of mosaic virus include the appearance of a light green-yellow and dark green mosaic pattern on leaves. Leaf discoloration is usually accompanied by wilting, puckering, blistering, curling and distortion of the leaf. Plants affected at a young age by the virus may be more distorted than older plants.

Leaves affected with mosaic virus
www.apsnet.org/pd/covers/2001/dse01cvr.htm

Pre-planting:

- Control aphids and leafhoppers which carry viruses.
- Select seed varieties that are resistant to and free of mosaic virus.

- For varieties that are susceptible to this virus, the disease may be minimized by establishing fields in isolated areas (i.e., not near established bean fields or in areas with extensive bean production).

Planting and growth:
- Isolate bean fields from virus host plants and whitefly susceptible crops such as tomatoes and squash.
- Plant at a time that will expose the young bean plants to the lowest whitefly activity.

Post-harvest:
- Remove crop residue after harvest and maintain fields free of volunteer plants that could serve as sources of virus inoculum during the crop free period.
- Thoroughly clean all equipment used during the harvesting process.

Crop rotation:
- Avoid rotating with vector host crops such as tomatoes, squash and peanuts.

Monitoring and treatment decision:
- Care should be taken in inspecting the primary and trifoliate leaves of the crop for small redish-brown spots surrounded by dark veins.

Control Options (to be recommended in the order listed; follow the label directions):
- Select mosaic resistant bean varieties
- Control aphids and leafhoppers (see Control Options in Vegetable crop IPM)
- Remove crop residue after harvest and maintain fields free of volunteer plants that could serve as sources of virus inoculum during the crop free period.

6. Mustia Fungus (*Thanatephorus cucumeris* or *Rhizoctonia solani*)
Identification: Mustia is a soil fungus which attacks underground plant parts such as seeds and roots. Once it become more developed it can also affect plant stems, leaves and fruit. Mustia fungus is a cause of damping off and thus has all of the same symptoms.

Initial infection on leaves

Advanced infection on leaves.

Pre-planting:

- Select fields with lowest or no recent incidence of Mustia and/or which have not been under recent bean cultivation if feasible.
- Use resistant seed varieties and discard cracked, damaged or infected seed.

Planting and growth:
- Plant when average soil temperatures are greater than 20oC and in soil that is moist but not overly wet.
- Avoid irrigation immediately after planting and avoid over-irrigation during growth. Consider using drip irrigation where feasible.
- Plant no deeper than 1 to 1.5 inches to minimize exposure of susceptible areas of the hypocotyl.
- Fertilize with compost/organic fertilizer.

Post-harvest:
- Collect and bury leftover plant matter.
- Dry beans in drying facility before storage.

Crop rotation:
- Rotate with any crop other than bean for a cycle of at least a year and up to 3-4 years in areas with high incidence of mustia.
- Note: shorter cycles are still beneficial, but to a lesser degree.

Monitoring and treatment decision:
- When symptoms appear it is usually too late to treat.
- Preventative treatments are most effective. The decision to apply a product should be based on the following factors:
    - History of high incidence of mustia in the area
    - High-humidity zones
    - Prolonged periods of rain forecasted

Control Options (to be recommended in the order listed; follow the label directions):
- Avoid irrigation immediately after planting and avoid over-irrigation during growth. Consider using drip irrigation where feasible.
- Collect and bury leftover plant matter.
- Suspected plants should be carefully dug and washed, because pulling plants may leave tissues with characteristic symptoms in the soil.
- Sulfur dust – follow REI = 24 hours, PHI = 1 days
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days
- Dithane M-45 or F-45 – follow REI = 24 hours, PHI = 3 days

7. Itch Grass (*Rottboellia cochinchinensis)*
Identification: Itch grass is a thick annual, grass-like weed that can reach a height of up to 4 meters. It reproduces through seeds that are transported by birds, water and farming equipment.

Itch grass
http://www.ipmimages.org/browse/detail.cfm?imgnum=5376739

Pre-planting:

- Shallow tillage before planting of beans can force the weed to germinate before the corn. The resulting seedlings can then be more easily managed.
- Use certified and weed free seeds.

Planting and growth:

- The use of cover crops such as certain legumes can reduce itch grass.
- Intercropping with corn has proven to be effective as well.

Post-harvest:

- Flooding can effectively remove itch grass.

Crop rotation:

- Itch grass greatly benefits from monoculture practices using bean, corn and sugarcane. Therefore crop rotation can be very effective.

Control Options (to be recommended in the order listed; follow the label directions):

- The use of cover crops such as certain legumes can reduce itch grass.
- Intercropping with legumes
- Post-harvest flooding can effectively remove itch grass.
- Fusilade, Fluazifop-p-butyl 24.5 % - follow REI = 12 hours, PHI = see label as varies by crop

INTEGRATED PEST MANAGEMENT FOR BEETS

1. Cercospora

Identification: Leaves infected with cercospora have small yellow spots that gradually expand to 5mm in size. The outer portion of the spot then becomes brown while the center turns grayish white. As the disease progresses, leaves will turn completely yellow, wither and fall off.

Initial and advanced cercospora infetion on beet leaves
http://www.ianrpubs.unl.edu/epublic/pages/publicationD.jsp?publicationId=840

Pre-planting:

- Use disease-free seeds. Heat treating seeds is also effective.
- Ensure that field is well irrigated and rich in nutrients.
- Adequate drainage is very important.

Planting and growth:

- Avoid working when plants are wet.
- Provide adequate distance between plants and prune branches to provide good air circulation.
- Remove infected material.

Post-harvest:

- Clean all farming equipment.
- Destroy infected material and fallen berries**.**

Crop rotation:

- A rotation cycle of at least three years is needed to remove cercospora from the crop field.

Monitoring and treatment decision:

- Monitor fruit for infection with cercospora and intervene when disease levels reach economically damaging levels. Apply preventative applications of Sulfur when conditions favor disease.

Control Options (to be recommended in the order listed; follow the label directions):

- Provide adequate distance between plants and prune branches to provide good air circulation.
- Remove infected material.
- Sulfur - follow REI = 24 hours, PHI = 1 day
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days

INTEGRATED PEST MANAGEMENT PLAN FOR BROCCOLI

A. Principal Pests

1. Aphids
2. Alternaria Leaf Spot (*Alternaria brassicae* and *A. brassicicola)*
3. Downy Mildew
4. Diamondback Moths (*Plutella xylostella)*

B. IPM Plan for Broccoli

1. Aphids

Identification: Cabbage aphids are covered in a waxy coating and greenish gray in color. Populations of this aphid are typically very dense and feed on young leaves and flowering parts of certain crops.
The green peach aphid is yellowish-green. This type of aphid tends to be more randomly dispersed throughout the crop compared to the dense colonies of the cabbage aphid.

Green peach aphid

Cabbage aphid

Note: Please refer to the general pest section for IPM and control information

2. Alternaria Leaf Spot (*Alternaria brassicae* and *A. Brassicicola)*

Identification: There are two species of alternaria leaf spot (*A. brassicae* and *A. brassicicola)* which have very similar symptoms. Symptoms include small dark spots that develop on leaves. These spots then develop into larger tan spores with a diameter of .25 to .5 inches. Spots eventual dry out resulting in a hole in the leaf. *A. brassicicola* causes darker spots than does *A. brassicae.* Dark green spores can grow on the spots if there is adequate moisture.

Alternaria leaf spot

Pre-planting:

- Plant resistant or tolerant varieties to reduce disease incidence.
- Use treated seeds
- Any practice which promotes the rapid drying of foliage and soils will help minimize disease incidence
- Incorporating crop residues and cover crops to promote good soil structure and drainage.

Planting and growth:

- When planting, orient rows in the direction of prevailing winds for better circulation of air through the foliage.
- Avoid over-planting or crowding plants
- All diseases have the potential of being transported to a farm on infected transplants. The best alternative is to grow your own transplants from clean seed.

Post-harvest:

- Plowing immediately after harvest helps eliminate the sources of airborn Alternaria spores and encourages the rapid decomposition of crop residues.

Crop rotation:

- Alternaria fungi requires living plant reservoirs, such as seeds, crop debris or a susceptible weed species, to winter over. Fall cabbage is a source of abundant Alternaria spores. Broccoli and cauliflower plantings should be separated from cabbage to minimize exposure of curds and florets to spores

Control Options (to be recommended in the order listed; follow the label directions):

- Remove infected parts of leaves before sporulation occurs.
- Sulfur
- Kocide 4.5 lf (F) Copper Hydroxide 37.5% (Follow REI = 24 hours, PHI = 0 days, unless noted otherwise)
- Treat with Quadris Flowable (Azoxystrobin 22.9%) (Follow REI = 4 hours, PHI= 0 days)

3. Downy Mildew

Identification: Infection of downy mildew begins as yellow patches on leaves, which later become tan and light brown in color. As the mildew develops a white fluffy fungus can grow on the underside of the plant leaves. Severe infection can cause black streaks to form on the stem and branches, stunted growth and death.

Downy mildew
http://www.omafra.gov.on.ca/

Pre-planting:

- Plant resistant or tolerant varieties to reduce disease incidence.
- All crucifer seeds should be treated to reduce or eliminate these pathogens. Seeds should be placed in water at 122^{o}F for 20 minutes, dried and coated with a fungicide Hot water treatment reduces seed viability, but is still one of the best means available to prevent disease spread.
- Any practice which promotes the rapid drying of foliage and soils will help minimize disease incidence. Start by choosing a planting site with good air and soil drainage.

Planting and growth:

- When planting, orient rows in the direction of prevailing winds for better circulation of air through the foliage. Avoid over-planting or crowding plants as this increases the drying time. In order to reduce disease spread by hand or machine, avoid working in fields while the plants are wet.
- Incorporating crop residues and cover crops into the soil helps maintain organic matter levels, good soil structure and drainage.
- Grow your own transplants from clean seed in soilless mixes or in sterilized seed beds.

Post-harvest:

- Plowing immediately after harvest helps eliminate the sources of air born mildew spores and encourages the rapid decomposition of crop residues. Broccoli and cauliflower plantings should be separated from cabbage to minimize exposure of curds and florets to spores.

Crop rotation:

- Downy mildew requires living plant reservoirs, such as seeds, crop debris or a susceptible weed species, to winter over. To control this disease, growers should skip two or three years between crucifer plantings.

Control Options (to be recommended in the order listed; follow the label directions):

- Remove infected plant material before spores can develop.
- Sulfur: 7.4 to 25 lbs/ha (follow REI =24 hrs, PHI = N/A). Apply at first sign of disease and every 14 days as needed to maintain control.
- Treat with Quadris Flowable (Azoxystrobin 22.9%) (Follow REI = 4 hours, PHI= 0 days)
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days.
- Dithane M-45 or F-45 – Follow REI = 24 hours, PHI = 3 days

4. Diamondback Moths (*Plutella xylostella)*

Identification: The diamondback moth is grayish brown in color with a slender body of approximately 6mm in length. The moth has a light brown band down its back which is sometimes constricted to form diamond-like shapes. They have relatively large wings but are very weak flyers. Diamondback larvae are small 0.33 inches in diameter. Larvae mature in 10 to 14 days and create a cocoon for themselves on leaves or stems. Diamondback moth eggs can be found on the underside of crop leaves.

http://www.ipm.ucdavis.edu/PMG/r108301311.html
http://www.ars.usda.gov/sp2UserFiles/Place/66150000/eeo/summer2002/rstype01.jpg

Pre-planting:

- It is better not to have multiple planting dates in the same area because the older plots will serve as inoculum of DBM for the new plantings. If you need to have several planting dates, plant the younger crop into the direction of the prevailing winds to make it harder for the moths to fly into new plantings.
- Seed-beds should be distant from old plantings and new plots to be planted. It is very important that seedlings are clean of DBM before transplanting to the field. On several occasions, attacks of DBM start with seedlings that are infested with DBM.

Planting and growth:

- It is preferable to plant crops in the rainy season when the population of DBM is deterred by the rain.
- Sprinkle irrigation may reduce the number of caterpillars in the field. If it is applied at dusk, it may limit the activity of adults.

Post-harvest:

- At harvest time, it is important to cut and, if possible, remove all plant materials that are not harvested. DBM can survive in plant residues and migrate to the next plot.

Crop rotation:

- In some areas, it is recommended to plant small plots of cole crops between other crops that are not susceptible to the DBM. The idea of inter-cropping is that DBM moths will have more difficulty in finding new crops when they are camouflaged between other non-susceptible crops.

Monitoring and treatment decision:

- Check fields during the seedling stage, at thinning, and just before heading. Also, record diamondback larvae numbers when you make your twice-weekly samples for other caterpillar pests. In cabbage fields, regularly monitor wrapper leaves for damage after heading.
- Adult moths frequently migrate from fields being harvested or disced under, so carefully check border rows if populations were high in adjacent fields.

Control Options (to be recommended in the order listed; follow the label directions):

- Sprinkle irrigation may reduce the number of caterpillars in the field. If it is applied at dusk, it may limit the activity of adults.
- Pounce 25 WP, Permethrin 25% (Follow REI = 12 hours, PHI = N/A)

INTEGRATED PEST MANAGEMENT PLAN FOR CABBAGE

A. Principal Pests

1. Diamondback Moths
2. Aphids
3. Fusarium Yellows

B. IPM Plan for Cabbage

1. Diamondback Moths (*Plutella xylostella)*

Identification: The diamondback moth is grayish brown in color with a slender body of approximately 6mm in length. The moth has a light brown band down its back which is sometimes constricted to form diamond-like shapes. They have relatively large wings but are very weak flyers. Diamondback larvae are small 0.33 inches in diameter. Larvae mature in 10 to 14 days and create a cocoon for themselves on leaves or stems. Diamondback moth eggs can be found on the underside of crop leaves.

http://www.ipm.ucdavis.edu/PMG/r108301311.html
http://www.ars.usda.gov/sp2UserFiles/Place/66150000/eeo/summer2002/rstype01.jpg

Pre-planting:

- It is better not to have multiple planting dates in the same area because the older plots will serve as inoculum of DBM for the new plantings. If you need to have several planting dates, plant the younger crop into the direction of the prevailing winds to make it harder for the moths to fly into new plantings.
- Seed-beds should be distant from old plantings and new plots to be planted. It is very important that seedlings are clean of DBM before transplanting to the field. On several occasions, attacks of DBM start with seedlings that are infested with DBM.

Planting and growth:

- It is preferable to plant crops in the rainy season when the population of DBM is deterred by the rain.
- Sprinkle irrigation may reduce the number of caterpillars in the field. If it is applied at dusk, it may limit the activity of adults.

Post-harvest:

- At harvest time, it is important to cut and, if possible, remove all plant materials that are not harvested. DBM can survive in plant residues and migrate to the next plot.

Crop rotation:

- In some areas, it is recommended to plant small plots of cole crops between other crops that are not susceptible to the DBM. The idea of inter-cropping is that DBM moths will have more difficulty in finding new crops when they are camouflaged between other non-susceptible crops.

Monitoring and treatment decision:

- Check fields during the seedling stage, at thinning, and just before heading. Also, record diamondback larvae numbers when you make your twice-weekly samples for other caterpillar pests. In cabbage fields, regularly monitor wrapper leaves for damage after heading.
- Adult moths frequently migrate from fields being harvested or disced under, so carefully check border rows if populations were high in adjacent fields.

Control Options (to be recommended in the order listed; follow the label directions):

- Sprinkle irrigation may reduce the number of caterpillars in the field. If it is applied at dusk, it may limit the activity of adults.
- Pounce 25 WP, Permethrin 25% (Follow REI = 12 hours, PHI = N/A)

2. Aphids

Identification: Cabbage aphids are covered in a waxy coating and greenish gray in color. Populations of this aphid are typically very dense and feed on young leaves and flowering parts of certain crops.
The green peach aphid is yellowish-green. This type of aphid tends to be more randomly dispersed throughout the crop compared to the dense colonies of the cabbage aphid.


Green peach aphid


Cabbage aphid

Note: Please refer to the general pest section for IPM and control information.

3. Fusarium Yellows

Identification: Symptoms consist of yellowing of the lower leaves, often on one side of the plant. These leaves later turn brown and drop off. Seedlings can also be affected and will typically turn red or brown before dying. Plant growth may be stunted and the cabbage will fail to form a head.


Distortion and discoloration of leaves caused by Fusarium Yellows
http://ipm.illinois.edu/diseases/series900/rpd901/ http://www.omafra.gov.on.ca/

Pre-planting:

- Avoid introducing the pathogen to clean fields. Some resistant cabbage cultivars are available. However, there are several races of the pathogen, some of which may render these cultivars susceptible and generally, resistance diminishes with increases in soil temperature.

Planting and growth:

- In areas where the fungus is known to occur, plant cabbage in spring or winter.
- Grow transplants in soil that has been disinfested by steam or a soil fumigant.

Post-harvest:

- Once present, this fungus survives indefinitely in the soil. The pathogen may be introduced to uninfested locations by the movement of infected plant residues and infested soil adhering to farm equipment
- Keep the fungus out of yellows-free fields and gardens by preventing the spread of infested soil carried on equipment, tools, feet, and running water. Do not put crop debris in compost or manure piles.

Crop rotation:

- Rotate the field or garden to non-host crops such as peppers, or tomatoes for several years to prevent buildup for the Fusarium fungus in the soil.

Control Options (to be recommended in the order listed; follow the label directions):

- Clean all farm equipment regularly to reduce the risk of spreading the fungus.
- Maxim XL (EC) Fludioxonil 2,5 % , metalaxyl -M 1.0 % (consult label for entry intervals)
- Kocide 4.5, Copper Hydroxide 37.5% (consult label for entry intervals)

INTEGRATED PEST MANAGEMENT PLAN FOR CARROT

A. Principal Pests

1. Aphids

2. Snails
3. Powdery Mildew

B. IPM Plan for Carrot

1. Aphids

Identification: The bean aphid is dark green to black in color and is easily confused with the cowpea aphid. The cowpea aphid can be distinguished by its shiny body. Another distinguishing factor is that the tail of the bean aphid has many more hairs than that of the cowpea aphid.

Cabbage aphids are covered in a waxy coating and greenish gray in color. Populations of this aphid are typically very dense and feed on young leaves and flowering parts of certain crops.

The green peach aphid is yellowish-green. This type of aphid tends to be more randomly dispersed throughout the crop compared to the dense colonies of the cabbage aphid. Turnip aphids also tend to be more randomly dispersed around the plants than the dense colonies of the cabbage aphid.

Green peach aphid

Cabbage aphid

Bean aphid

Note: Please refer to the general pest section for IPM and control information.

2. Snails *Zachrysia provisoria* and *Bradybaena similaris*

Identification: The shell of the Zachrysia is considered medium sized and measures 25-30mm in width. The shell is translucent and the speckled body of the snail is visible through the shell. They are usually

dark tan in color but can also be yellowish brown. The Bradybaena snail is significantly smaller measuring 12-15 mm in diameter. The shell is light brown with fine growth lines.

Zachrysia provisoria

Bradybaena similaris

Pre-planting:

- The movement of snails and slugs can be inhibited by loose surfaces such as sand, sawdust, eggshells etc. Surrounding crops with such material can reduce the pest population considerable.
- Remove all crop debris, wood planks, bricks, garbage or anything that could create a moist and sheltered habitat for snails.

Planting and growth:

- Lime can be used as a repellant.
- Habitat traps can be created by creating cool, moist environments in the shade.
- Hand-picking snails can be effective, especially after rainfall.
- Lures can be created by placing hollowed out grapefruit shells and decaying carrot and cabbage matter nearby the crop. These should then be checked at nighttime and have all snails removed.
- Traps can be created by sinking jars into the ground so that they are flush with the surface. These jars should then be filled with stale beer or salt and 2 tablespoons of sugar for every liter of liquid.

Post-harvest:

- Placement of traps can be continued in order to reduce remaining populations.

Monitoring and treatment decision:

- Snails and slugs are most active during the night. Therefore, populations should be sampled and traps should be checked a few hours after darkness.

Control Options (to be recommended in the order listed; follow the label directions):

- Surround crops with loose material such as sand, sawdust and eggshells
- Use beer or salt water traps
- Create lures and traps and check them nightly after sunset.
- Hand-picking

3. Powdery Mildew

Identification: Leaves on infected plants develop irregular, bright yellow spots; severely affected leaves die but rarely drop. Spots of dead tissue are sometimes surrounded by a yellow halo. Severe infections kill leaves and results in sunburn fruit and weakened plants. Spores from the mildew are easily blown by the wind to nearby plants.

Powdery mildew on a carrot leaf
http://www.ipm.ucdavis.edu/PMG/E/D-CA-EPOL-FO.001.html

Pre-planting:

- Fields that contain rich soil will help to reduce the prevalence of the fungus.
- Rows should run the direction of the prevailing wind to increase air circulation and promote leaf drying.

Planting and growth:

- Plant in sunny areas as much as possible, and avoid applying excess fertilizer.
- Overhead sprinkling can help wash spores off of the plant and reduce mildew. However, overhead sprinklers should be used with caution on vegetables because their use may contribute to other pest problems.
- Avoid over-crowding and keep plantings free of weeds as long as is practical.

Post-harvest:

- Disc fields after harvest.

- Remove excess plant matter.

Crop rotation:

- Seed treatments and crop rotation have no effect on powdery mildew infection.

Monitoring and treatment decision:

- Begin monitoring early in the season. Chemical treatment is not warranted unless infection occurs very early in the season.
- Check leaf surfaces often especially among older plants and areas of the field with poor air circulation. Unlike most fungi, powdery mildew does not require accumulated moisture on the plant in order to grow.

Control Options (to be recommended in the order listed; follow the label directions):

- Overhead sprinkling can help wash spores off of the plant and reduce mildew. However, overhead sprinklers should be used with caution on vegetables because their use may contribute to other pest problems.
- Avoid over-crowding and keep plantings free of weeds as long as is practical.
- Sulfur: 7.4 to 25 lbs/ha (follow REI =24 hrs, PHI = N/A). Apply at first sign of disease and every 14 days as needed to maintain control.
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days
- Dithane M-45 or F-45 – Follow REI = 24 hours, PHI = 3 days

INTEGRATED PEST MANAGEMENT PLAN FOR CASSAVA

A. Principal Pests

1. Rats *(Thryonomys swinderianus)*

B. IPM Plan for Cassava

1. Rats

Identification: Rats can vary greatly in size. Smaller rats are typically more agile and better at climbing while larger rats are usually stronger swimmers. The ability that many rats have to climb, swim, burrow and gnaw materials should be taken into consideration when attempting to protect stored crops.

Adult norway rat.
http://www.ipm.ucdavis.edu/PMG/R/V-MA-RNOR-AD.002.html

Pre-planting:

- Food for pets and livestock should be sealed and not left out in the open.
- Nearby vegetation should be thinned.

Planting and growth:

- Create fences and other barriers around the crop field.
- Wooden snap traps can be placed both indoors and outdoors.
    - Dried fruit, nut meat and bacon work well as bait.
    - Traps should be placed where there are dropping, gnawed wood or other such evidence.
- Rats can be flushed from there burrows with a stream of water.
- Cats and owls are effective predators.

Post-harvest:

- Storage areas should be kept free of all trash and debris. Crated, lumber and all other materials should be neatly stored to reduce the likelihood of a rat infestation.
- Make sure that storage area is well sealed so that rats cannot enter, taking into consideration the fact that rats can burrow, climb and gnaw through thin wood.
    - Steel wool and metal screens are very good for blocking small holes.

Monitoring and treatment decision:

- Rat populations should be monitored year-round.
- Action should be taken as soon as rats are observed. If rats are found outdoors and in the field, they are likely to move indoors within a short period of time.
- Look for rat droppings, nests and holes.

Control Options (to be recommended in the order listed; follow the label directions):

- Wooden snap traps can be placed both indoors and outdoors.
    - Dried fruit, nut meat and bacon work well as bait.

- Traps should be placed where there are dropping, gnawed wood or other such evidence.
- Create fences and other barriers around the crop field.

INTEGRATED PEST MANAGEMENT PLAN FOR CAULIFLOWER

A. Principal Pests

1. Aphids

B. IPM Plan for Cauliflower

2. Aphids

Identification: Cabbage aphids are covered in a waxy coating and greenish gray in color. Populations of this aphid are typically very dense and feed on young leaves and flowering parts of certain crops.
The green peach aphid is yellowish-green. This type of aphid tends to be more randomly dispersed throughout the crop compared to the dense colonies of the cabbage aphid.

Green peach aphid

Cabbage aphid

Note: Please refer to the general pest section for IPM and control information.

INTEGRATED PEST MANAGEMENT PLAN FOR PEPPER

A. Principal Pests

1. Aphids
2. Green Stinkbug

B. IPM Plan for Chili Pepper

2. Aphids

Identification: Green peach aphid is among the most common aphid species found on peppers. Its color is typically pale green, although at times it can be more of a pinkish color. During cool weather, the green peach aphid is usually more deeply pigmented. Both winged and wingless forms of the aphid have prominent cornicles on the abdomen that are markedly swollen and club-like in appearance. Winged forms of the green peach aphid have a distinct dark patch near the tip of the abdomen; wingless forms do not have this dark patch.


Green peach aphid

Note: Please refer to the general pest section for IPM and control information.

2. Green Stink Bug

Identification: Adult green stink bugs are approximately 15 to 20mm in length and shield-shaped. They have large wings and are green in color with their head sometimes bordered by an orange line. Green stink bug eggs are approximately 1.2mm in diameter and yellowish green in color. As the eggs develop they become gray and pink in color. Eggs can be found on the underside of leaves.

http://entnemdept.ufl.edu/creatures/veg/bean/green_stink_bug.htm
http://ipcm.wisc.edu/WCMNews/tabid/53/EntryId/360/Stink-Bugs-in-Corn-and-Soybeans.aspx

Pre-planting:

- Destroy all weeds in the area.

Planting and growth:

- Early planting can significantly reduce stinkbug damage.
- It is very important to close all seed slots so the stink bug cannot feed on the seeds.

Post-harvest:

- Tilling fields significantly reduces stink bug population by removing all host foliage.
- Destroy all weeds and possible hosts such as legumes and mustards.

Crop rotation:

- Avoid rotating with legumes and tomatoes.

Monitoring and treatment decision:

- Regular field scouting before planting and crop emergence is recommended.

Control Options (to be recommended in the order listed; follow the label directions):

- Tilling fields significantly reduces stink bug population by removing all host foliage.
- Destroy all weeds and possible hosts such as legumes and mustards.
- Actara 240 sc (EC) Thiamethoxam (21.6%) (consult label for entry intervals)
- Sevin (carbaryl) WSP 80% (follow REI = 12 hrs, PHI = 7 days)

INTEGRATED PEST MANAGEMENT PLAN FOR CORN

A. Principal Pests

1. Aphids
2. Green Stinkbugs
3. Itch Grass
4. Damping-Off
5. Cricket
6. Corn Borer

B. IPM Plan for Corn

1. Aphids

Identification: Several species of aphids may be found in corn, but corn leaf aphid and greenbug are the primary aphid species infesting corn in California. Corn leaf aphids are small to medium and bluish green in color and also infest small grains. The greenbug is a moderate-sized aphid. The color of the abdomen is light green with a darker stripe down the middle. Both winged and wingless forms of both aphids occur on corn plants.

Corn leaf aphid nymphs and adults

Green bug aphid

Note: Please refer to the general pest section for IPM and control information.

2. Green Stink Bug

Identification: Adult green stink bugs are approximately 15 to 20mm in length and shield-shaped. They have large wings and are green in color with their head sometimes bordered by an orange line. Green stink bug eggs are approximately 1.2mm in diameter and yellowish green in color. As the eggs develop they become gray and pink in color. Eggs can be found on the underside of leaves.

http://entnemdept.ufl.edu/creatures/veg/bean/green_stink_bug.htm
http://ipcm.wisc.edu/WCMNews/tabid/53/EntryId/360/Stink-Bugs-in-Corn-and-Soybeans.aspx

Pre-planting:

- Destroy all weeds in the area.

Planting and growth:

- Early planting can significantly reduce stinkbug damage.
- It is very important to close all seed slots so the stink bug cannot feed on the seeds.

Post-harvest:

- Tilling fields significantly reduces stink bug population by removing all host foliage.
- Destroy all weeds and possible hosts such as legumes and mustards.

Crop rotation:

- Avoid rotating with legumes and tomatoes.

Monitoring and treatment decision:

- Regular field scouting before planting and crop emergence is recommended.

Control Options (to be recommended in the order listed; follow the label directions):

- Tilling fields significantly reduces stink bug population by removing all host foliage.
- Destroy all weeds and possible hosts such as legumes and mustards.
- Lorsban 75 WG [Tricel] Chlorpyriphos 75% (Follow REI = 24 hours, PHI = 35 Days)

3. Itch Grass (*Rottboellia cochinchinensis)*
Identification: Itch grass is a thick annual, grass-like weed that can reach a height of up to 4 meters. It reproduces through seeds that are transported by birds, water and farming equipment.

Itch grass
http://www.ipmimages.org/browse/detail.cfm?imgnum=5376739

Pre-planting:
- Shallow tillage before planting of corn can force the weed to germinate before the corn. The resulting seedlings can then be more easily managed.
- Use certified and weed free seeds.

Planting and growth:
- The use of cover crops such as certain legumes can reduce itch grass.
- Intercropping with velvet bean has proven to be effective as well.

Post-harvest:
- Flooding can effectively remove itch grass.

Crop rotation:
- Itch grass greatly benefits from monoculture practices using corn and sugarcane. Therefore crop rotation can be very effective.

Control Options (to be recommended in the order listed; follow the label directions):
- The use of cover crops such as certain legumes can reduce itch grass.
- Intercropping with legumes
- Post-harvest flooding can effectively remove itch grass.
- Fusilade, Fluazifop-p-butyl 24.5 % (consult label for entry intervals)

4. Damping-Off

Identification: Damping-off refers to fungal disease that attacks germinating seeds and sprouts. Infected seeds may fail to germinate due to rot. Darkened watery lesions may be visible towards the base of sprouts. These lesions can grow very rapidly, resulting in the death of the plant. Roots and stems of plants that have already fully emerged can also be attacked resulting in death or fall over.

Damped-off corn
http://www.ipm.iastate.edu/ipm/icm/node/2256

Pre-planting:

- Plant corn only on well-drained soils or try to improve drainage. This can be done by improving soil structure and/or installing drain tiles. Sub-soiling to a depth below the plowed layer will reduce soil compaction, and improve drainage.

Planting and growth:

- Suspected plants should be carefully dug and washed, because pulling plants may leave tissues with characteristic symptoms in the soil.
- Avoid planting corn in fields known to be heavily infested with corn root-rot fungi.
- Delay planting until the soil is warm (above 65 F) and seed shallow to insure rapid emergence. Avoid planting seeds too close together-follow instructions on the seed container. Do not over-fertilize, especially with nitrogen.

Post-harvest:

- Deep plowing of the previous years' crop residues will reduce corn root rot.

Crop rotation:

- Do not grow corn or other susceptible crops continually in the same location. Continuous cropping of susceptible plants will eventually lead to a buildup of these fungi in the soil. Since they are capable of long-term survival, a rotation of 4-5 years is desirable.

Monitoring and treatment decision:

- The base and stalk of each crop should be routinely checked, especially in areas with poor water drainage.

Control Options (to be recommended in the order listed; follow the label directions):

- Suspected plants should be carefully dug and washed, because pulling plants may leave tissues with characteristic symptoms in the soil.
- Improve soil irrigation.
- Sulfur dust
- Dithane M-45 or F-45 – follow REI = 24 hours, PHI = 3 days
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days

5. Cricket / Grasshoppers

Identification: Grasshoppers and crickets are jumping insects with very pronounced hind legs. They are typically grayish-green in color and have very pronounced heads and eyes. Most species have two pairs of wings and can grow up to 44mm in length.

http://www.ent.iastate.edu/imagegal/orthoptera/ghoppersonears.html

Pre-planting:

- Tilling the crop field can sometimes be effective in burying un-hatched eggs.

Planting and growth:

- Manual removal can be effective if feasible.
- Early harvest should be practice if populations are large.
- Chickens can be effective in reducing grasshopper populations as long as they don't damage the crop.

Post-harvest:

- Tillage of fallow fields in late-summer discourages the laying of eggs.
- Remove all plant debris from field.

Crop rotation:

- Crop rotation can be very beneficial in removing grasshoppers. Rotation with small grain crops and removal of all plant debris is most effective. Avoid rotating with other late season crops such as bean, soybean, sunflower etc.

Monitoring and treatment decision:

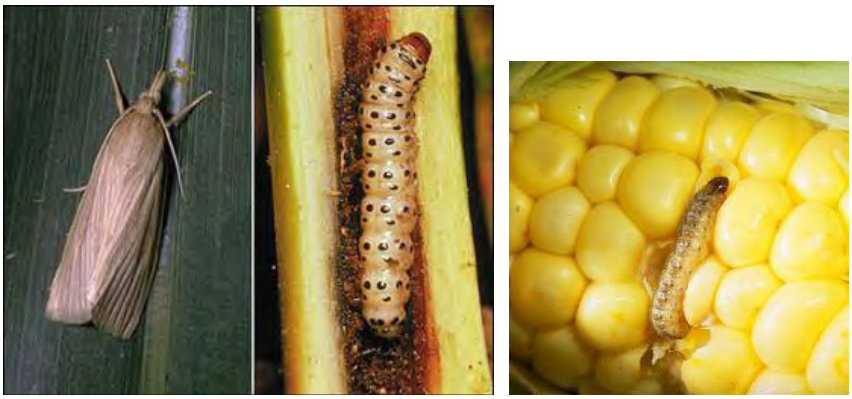
- Treatment is usually necessary if 15 or more nymphs or 8 or more adults are found in one square yard. If crop is stressed do to drought etc., treatment may be needed when lesser populations are present.

Control Options (to be recommended in the order listed; follow the label directions):

- Tillage of fallow fields in late-summer discourages the laying of eggs.
- Remove all plant debris from field.
- Lorsban 75 WG [Tricel] Chlorpyriphos 75% (Follow REI = 24 hours, PHI = 35 Days)

6. Corn Borer (*Diatraea grandiosella)*

Identification: The corn borer is a moth that targets corn and sugarcane among other crops. They are typically 20mm in wingspans and of a grayish yellow color. The larvae are of a bluish green color with dark heads and can be found boring into corn stalks.



Corn borer moth and larvae.
http://extension.missouri.edu/explore/images/g07111art01.jpg

Pre-planting:

- Tillage and destruction of weeds can reduce egg and larvae populations.

Planting and growth:

- Corn stubble must be plowed underground or removed to lessen chances of the borers surviving the winter.

- Late planting can be effective in reducing first generation borer populations. There are typically three to four generations of corn borers each year.

Post-harvest:

- Corn stubble must be plowed underground or removed to lessen chances of the borers surviving the winter.

Crop rotation:

- Rotation with small grain crops and removal of all plant debris is most effective. Avoid rotating with other late season crops such as bean, soybean, sunflower etc.

Monitoring and treatment decision:

- Samples of 20 corn plants should be conducted in 5 randomly selected quadrants. Check for larvae as well as instances of leaf damage.
- The larvae of subsequent generations are usually laid in the middle third of the tallest and greenest corn plants.

Control Options (to be recommended in the order listed; follow the label directions):

- Corn stubble must be plowed underground or removed to lessen chances of the borers surviving the winter.
- Late planting can be effective in reducing first generation borer populations.
- Pounce 25 WP, Permethrin 25% (Follow REI = 12 hours, PHI = N/A)

INTEGRATED PEST MANAGEMENT PLAN FOR EGGPLANT

A. Principal Pests

1. Aphids
2. Green stink bugs
3. Damping-Off
4. Tobacco flea

B. IPM Plan for Eggplant

1. Aphids

Identification: The two most common species encountered on eggplant are the green peach aphid and the cotton/melon aphid. Green peach aphids are pale green in color and darken with drops in temperature. There is both a winged and wingless form of this aphid. The cotton/melon aphid is highly variable in color and size and can range from yellowish green to black. There are both winged and wingless forms. Aphids damage plants by sucking plant sap which causes heavily infested leaves to curl and stunts plants; excreting honeydew which causes sticky, shiny leaves to ultimately turn black because of a sooty-mold fungus growth; and spreading plant diseases. Infestations frequently are localized with heavily infested leaves curled downward.

Green peach aphid

Color variation of the Cotton/Melon aphid

http://www.ipm.ucdavis.edu/PMG/r211300511.html

Note: Please refer to the general pest section for IPM and control information.

2. Green Stink Bug

Identification: Adult green stink bugs are approximately 15 to 20mm in length and shield-shaped. They have large wings and are green in color with their head sometimes bordered by an orange line. Green stink bug eggs are approximately 1.2mm in diameter and yellowish green in color. As the eggs develop they become gray and pink in color. Eggs can be found on the underside of leaves.

http://entnemdept.ufl.edu/creatures/veg/bean/green_stink_bug.htm
http://ipcm.wisc.edu/WCMNews/tabid/53/EntryId/360/Stink-Bugs-in-Corn-and-Soybeans.aspx

Pre-planting:

- Destroy all weeds in the area.

Planting and growth:

- Early planting can significantly reduce stinkbug damage.
- It is very important to close all seed slots so the stink bug cannot feed on the seeds.

Post-harvest:

- Tilling fields significantly reduces stink bug population by removing all host foliage.

- Destroy all weeds and possible hosts such as legumes and mustards.

Crop rotation:
- Avoid rotating with legumes and tomatoes.

Monitoring and treatment decision:
- Regular field scouting before planting and crop emergence is recommended.

Control Options (to be recommended in the order listed; follow the label directions):
- Tilling fields significantly reduces stink bug population by removing all host foliage.
- Destroy all weeds and possible hosts such as legumes and mustards.
- Actara 240 sc (EC) Thiamethoxam (21.6%) (consult label for entry intervals)
- Sevin (carbaryl) WSP 80% (follow REI = 12 hrs, PHI = 7 days)

3. Damping-Off

Identification Damping-off refers to fungal disease that attacks germinating seeds and sprouts. Infected seeds may fail to germinate due to rot. Darkened watery lesions may be visible towards the base of sprouts. These lesions can grow very rapidly, resulting in the death of the plant. Roots and stems of plants that have already fully emerged can also be attacked resulting in death or fall over.

Eggplant sprouts affected by damping-off.
http://www.ipm.ucdavis.edu/PMG/r211100311.html

Pre-planting:

- Plant eggplant only on well-drained soils or try to improve drainage. This could be done by improving soil structure and/or installing drain tiles. Sub-soiling to a depth below the plowed layer will reduce soil compaction, and improve drainage.

Planting and growth:

- Avoid planting when the soil is cool since seeds germinate faster and are more vigorous when warm.
- Infected plants should be carefully removed and washed, since pulling plants may leave symptomatic plant tissues in the soil.
- Avoid planting beans in fields known to be heavily infested with bean root-rot fungi.
- Delay planting until the soil is warm (above 65 F) and seed shallow to insure rapid emergence. Avoid planting seeds too close together-follow instructions on the seed container. Do not over-fertilize, especially with nitrogen.

Post-harvest:

- Deep plowing of the previous years' crop residues will reduce bean root rot.

Crop rotation:

- Do not grow beans or other susceptible crops continually in the same location. Continuous cropping of susceptible plants will eventually lead to a buildup of these fungi in the soil. Since they are capable of long-term survival, a rotation of 4-5 years is desirable.

Monitoring and treatment decision:

- The base and stalk of each crop should be routinely checked, especially in areas with poor water drainage.

Control Options (to be recommended in the order listed; follow the label directions):

- Infected plants should be carefully removed and washed, since pulling plants may leave symptomatic plant tissues in the soil.
- Sulfur dust
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days
- Dithane M-45 or F-45 – follow REI = 24 hours, PHI = 3 days

4. Tobacco Flea Beetle (Epitrix hirtipennis)

Identification: The tobacco flea is approximately 1/16 inch in diameter and yellowish brown in color. It is wings that are colored with a dark band. It creates very small holes in crop leaves and produces larvae in the form of small white worms.

Adult Tobacco Flea
http://www.ipmimages.org/browse/detail.cfm?imgnum=1435119

Pre-planting:

- Destroy unused plants in greenhouses or nurseries.
- Trash nearby the field or any potential hibernation sites should be destroyed.

Planting and growth:

- Covering the crop with gauze or mesh can reduce beetle populations.
- Keep field free of weeds.

Post-harvest:

- Remove all weeds and remaining plant matter.

Crop rotation:

- Avoid rotating with other host crops such as tomato and potato.

Monitoring and treatment decision:

- Monitoring should begin as soon as crops are planted with particular attention paid to the field perimeter.
- Sample the crop in groups of ten. Action should be taken if there are more than 40 beetles within each group of ten plants.

Control Options (to be recommended in the order listed; follow the label directions):

- Covering the crop with gauze or mesh can reduce beetle populations.
- Keep field free of weeds.
- Actara 240 SC

INTEGRATED PEST MANAGEMENT PLAN FOR LETTUCE AND SPINACH

A. Principal Pests

1. Aphids
2. Fusarium Yellows

B. IPM Plan for Lettuce

1. Aphids

Identification: The lettuce aphid has many color forms including green, orange and pink. These aphids can be either winged or wingless and are marked with black dots on the joints of their legs and antennae. Lettuce aphids have very short life cycles and their population can grow rapidly. This type of aphid typically feeds on the center of the plant and is usually found deep within the lettuce leaves.

Lettuce aphids
http://ag.arizona.edu/crops/vegetables/insects/advisories/2003/images/vegadv012703letaph2.jpg

Note: Please refer to the general pest section for IPM and control information.

2. Fusarium Yellows

Identification: Symptoms consist of yellowing of the lower leaves, often on one side of the plant. These leaves later turn brown and drop off. Seedlings can also be affected and will typically turn red or brown before dying. Plant growth may be stunted and the lettuce will fail to form a head.

Distortion and discoloration of leaves caused by Fusarium Yellows
http://ag.arizona.edu/yac/fusarium.html

Pre-planting:

- Avoid introducing the pathogen to clean fields. Some resistant lettuce cultivars are available. However, there are several races of the pathogen, some of which may render these cultivars susceptible and generally, resistance diminishes with increases in soil temperature.

Planting and growth:

- In areas where the fungus is known to occur, plant lettuce in spring or winter.
- Grow transplants in soil that has been disinfested by steam or a soil fumigant.
- Soil should have adequate drainage.

Post-harvest:

- Once present, this fungus survives indefinitely in the soil. The pathogen may be introduced to uninfested locations by the movement of infected plant residues and infested soil adhering to farm equipment
- Keep the fungus out of yellows-free fields and gardens by preventing the spread of infested soil carried on equipment, tools, feet, and running water. Do not put crop debris in compost or manure piles.

Crop rotation:

- Rotate the field or garden to non-host crops such as peppers, or tomatoes for several years to prevent buildup for the fusarium fungus in the soil.

Control Options (to be recommended in the order listed; follow the label directions):

- Clean all farm equipment regularly to reduce the risk of spreading the fungus.
- Maxim XL (EC) Fludioxonil 2,5 % , metalaxyl -M 1.0 % (consult label for entry intervals)
- Kocide 4.5, Copper Hydroxide 37.5% (consult label for entry intervals)

INTEGRATED PEST MANAGEMENT PLAN FOR OKRA

A. Principal Pests

1. Potato Aphids
2. Damping - off
3. Green Stink Bug

B. IPM Plan for Okra

1. Potato Aphid

Identification: The potato aphid has both a green and a pink color type. It is found on the terminals of plants later in the season. The potato aphid causes damage to plants by distorting leaves and stems, stunting plants, and causing necrotic spots on leaves. They also secrete large amounts of honeydew that leads to sooty mold on leaves and fruit.

Potato aphid – green biotype.

Potato aphid – pink biotype

Sooty mold produced by potato aphid.

Note: Please refer to the general pest section for IPM and control information.

2. Damping-Off

Identification: Damping-off refers to fungal disease that attacks germinating seeds and sprouts. Infected seeds may fail to germinate due to rot. Darkened watery lesions may be visible towards the base of sprouts. These lesions can grow very rapidly, resulting in the death of the plant. Roots and stems of plants that have already fully emerged can also be attacked resulting in death or fall over.

Okra sprouts affected by damping-off.
http://www.infonet-biovision.org/res/res/files/1528.280x185.clip.jpeg

Pre-planting:

- Plant okra only on well-drained soils or try to improve drainage. This could be done by improving soil structure and/or installing drain tiles. Sub-soiling to a depth below the plowed layer will reduce soil compaction, and improve drainage.

Planting and growth:

- Avoid planting when the soil is cool since seeds germinate faster and are more vigorous when warm.
- Infected plants should be carefully removed and washed, since pulling plants may leave symptomatic plant tissues in the soil.
- Avoid planting beans in fields known to be heavily infested with bean root-rot fungi.
- Delay planting until the soil is warm (above 65 F) and seed shallow to insure rapid emergence. Avoid planting seeds too close together-follow instructions on the seed container. Do not over-fertilize, especially with nitrogen.

Post-harvest:

- Deep plowing of the previous years' crop residues will reduce bean root rot.

Crop rotation:

- Do not grow beans or other susceptible crops continually in the same location. Continuous cropping of susceptible plants will eventually lead to a buildup of these fungi in the soil. Since they are capable of long-term survival, a rotation of 4-5 years is desirable.

Monitoring and treatment decision:

- The base and stalk of each crop should be routinely checked, especially in areas with poor water drainage.

Control Options (to be recommended in the order listed; follow the label directions):

- Infected plants should be carefully removed and washed, since pulling plants may leave symptomatic plant tissues in the soil.
- Sulfur dust
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days
- Dithane M-45 or F-45 – follow REI = 24 hours, PHI = 3 days

3. Green Stink Bug

Identification: Adult green stink bugs are approximately 15 to 20mm in length and shield-shaped. They have large wings and are green in color with their head sometimes bordered by an orange line. Green stink bug eggs are approximately 1.2mm in diameter and yellowish green in color. As the eggs develop they become gray and pink in color. Eggs can be found on the underside of leaves.

http://entnemdept.ufl.edu/creatures/veg/bean/green_stink_bug.htm
http://ipcm.wisc.edu/WCMNews/tabid/53/EntryId/360/Stink-Bugs-in-Corn-and-Soybeans.aspx

Pre-planting:

- Destroy all weeds in the area.

Planting and growth:

- Early planting can significantly reduce stinkbug damage.
- It is very important to close all seed slots so the stink bug cannot feed on the seeds.

Post-harvest:

- Tilling fields significantly reduces stink bug population by removing all host foliage.
- Destroy all weeds and possible hosts such as legumes and mustards.

Crop rotation:

- Avoid rotating with legumes and tomatoes.

Monitoring and treatment decision:

- Regular field scouting before planting and crop emergence is recommended.

Control Options (to be recommended in the order listed; follow the label directions):

- Tilling fields significantly reduces stink bug population by removing all host foliage.
- Destroy all weeds and possible hosts such as legumes and mustards.
- Actara 240 sc (EC) Thiamethoxam (21.6%) (consult label for entry intervals)

INTEGRATED PEST MANAGEMENT PLAN FOR ONION, LEEKS AND SHALLOTS

A. Principal Pests

1. Pythium Root Rot
2. Thrips
3. Onion Smut

B. IPM Plan for Onion

1. Pythium Root Rot

Identification: Pythium is a common fungal disease in greenhouse crops. Symptoms of the disease include stunting of plants, root tips that are brown and dead, plants that wilt at midday but recover at night, plants that yellow and die, and brown tissue on the outer portion of the root that easily pulls off, leaving vascular tissue exposed.

Pythium root rot in onion.

Pythium root rot in onion.

Pre-planting:

- Only use only soil known to have no Pythium present, or use heat-treated soil if feasible (entire pile of soil heated to 180^{o} F for 30 minutes).
- Before planting and periodically throughout the season, clean and disinfect any potting benches, tools and equipment which will touch the soil mix using a chlorine or soap solution.

Planting and growth:

- Avoid over-irrigation and ensure good drainage of crops through planting in raised beds. Use drip irrigation where feasible.
- Ensure good air circulation of greenhouses.
- Avoid excess fertilizer applications.

Post-harvest:

- Remove and bury any infected plant matter. Soil will have to be treated, or new soil should be used for the next season.

Crop rotation:

- Pythium is capable of infecting many greenhouse and field crops, thus crop rotation is generally not effective.

Monitoring and treatment decision:

- Pythium is difficult to control once root rot has begun. Treatment should be based on whether preventative measures such as soil treatment were taken, and previous history of Pythium.

Control options (to be recommended in the order listed; follow label directions):

- Avoid over-irrigation and ensure good drainage of crops through planting in raised beds. Use drip irrigation where feasible.
- Sulfur dust
- Kocide 4.5 lf (F) Copper Hydroxide 37.5% (Follow REI = 24 hours, PHI = 0 days, unless noted
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days
- otherwise)
- Dithane M-45 or F-45 – follow REI = 24 hours, PHI = 3 days

2. Thrips (*Frankliniella occidentalis)*

Identification: Thrips are very small and slender, measuring about 1.3mm in diameter. They are distinguished by the fact that they have two pairs of wings bordered by long hairs. They are light brown to pale yellow in color. Onion thrips have grey eyes and antennae with seven segments.

Thrip
http://www.ipm.ucdavis.edu/PMG/F/I-TS-FOCC-AD.010.html

Pre-planting:

- Tilling fields and removal of all weeds prior to planting can reduce thrip populations.

Planting and growth:

- Do not plant onions near grain fields since thrips typically build their populations among this type of crop.

Post-harvest:

- Remove remaining plant matter.

Control Options (to be recommended in the order listed; follow the label directions):

- Neem oil 3.5 liters / ha
- Overhead irrigation can reduce thrip populations but may also encourage diseases such as pythium root rot.
- Lorsban 75 WG [Tricel] Chlorpyriphos 75% (Follow REI = 24 hours, PHI = 35 Days)

3. Onion Smut

Identification: Onion smut causes brown and black blisters to form on the stalk and young leaves of the onion plant. These blisters will spread and gain in size. Well developed infections can be punctured and will leak a black powdery oil. Smut can kill an infected plant or seedling within 4 to 5 weeks.

Onion infected with smut. Onion sprouts infected with smut.
http://www.ipmimages.org/images/768x512/5364050.jpg

Pre-planting:

- Be sure to use only disinfected seeds.
- Remove field of all weeds.

Planting and growth:

- If smut is prevalent, seeds can be sprouted in a nursery and then transplanted to the field to avoid infection until the plant has greater resistance to disease.
    - Onions are thought to be ready for transplant after the sprout of the first ¨true leaf¨¨ which is the first leaf to stand straight up.

- Remove and destroy all infected plant matter.

Post-harvest:

- Remove all remaining plant matter and any weeds.

Crop rotation:

- Crop rotation with other more resistant crops can be beneficial to remove the fungus from the soil.

Control Options (to be recommended in the order listed; follow the label directions):

- If smut is prevalent, seeds can be sprouted in a nursery and then transplanted to the field to avoid infection until the plant has greater resistance to disease.
- Remove and destroy all infected plant matter.
- Maxim or Thiram treated seeds

INTEGRATED PEST MANAGEMENT PLAN FOR PEANUT

A. Principal Pests

1. Nematodes
2. Ants
4. Leafhoppers K(*Empoasca fabae*)

B. IPM Plan for Peanut

1. Nematodes

Identification: One of the most common nematodes found on peanuts is *Meloidogyne arenaria*, the peanut root-knot nematode. Nematodes are very small, worm-like pests ranging from 0.5 to 1.0 mm in length. They can survive in many different types of habitat and feed on a wide variety of crops. Nematodes have spear-like mouthparts that allow them to feed on cells of a plant. High nematode populations can cause significant root damage resulting in stunted growth and low yield. Top-heavy plants may also fall over due to the lack of supporting roots.

Peanuts infected by root-knot nematodes. Peanut roots affected by nematodes
http://edis.ifas.ufl.edu/ng016
http://www.ctahr.hawaii.edu/adap/ASCC_LandGrant/Dr_Brooks/BrochureNo9.pdf

Pre-planting:

- Elimination of nematodes from infested fields prior to planting is near to impossible but numbers can be reduced by having a fallow period greater than a year.
- Select sprouts that are clean and free of nematodes.
- Field should be tilled approximately one month before planting to destroy plant residue and weeds and allow them enough time to decompose before planting.

Planting and growth:

- In some cases the incorporation of chitin-containing materials (such as crushed crab and prawn shells) into the soil has been known to reduce nematode levels.
- Covering the soil with banana leaves and other plant material helps moderate soil temperatures, prevent erosion, and gradually add organic matter to soil.
- When roots have been destroyed by feeding nematodes, plants are more likely to fall over. Fruiting plants should be propped to prevent toppling due to the weight of the bunch or strong winds.

Post-harvest:

- Remove all weeds and excess plant matter.
- The planting of non-host winter crops can discourage unintentional (volunteer) peanut plants.

Crop rotation:

- Crop rotation can be very effective in reducing plant-parasitic nematodes. Rotating peanuts with non-hosts is recommended. Non-hosts include grasses such as bahiagrass, Bermuda grass and millet. It is advisable to plant one or several of these crops for at least one year before planting peanuts.

Monitoring and treatment decision:

- When sampling nematode populations it is best to take root and soil samples.
- Samples should not be taken when the soil is very dry or very wet.

Control Options (to be recommended in the order listed; follow the label directions):

- Nematode-suppressive green manure/fallow crops
  - African or French marigolds (grown then incorporated into soil)
  - Jatropha
  - Castor bean, velvetbean, forage sorghum
- Organic soil amendments (Neem or Jatropha seed cakes mixed into soil)
- In some cases the incorporation of chitin-containing materials (such as crushed crab and prawn shells) into the soil has been known to reduce nematode levels.
- Covering the soil with banana leaves and other plant material helps moderate soil temperatures, prevent erosion, and gradually add organic matter to soil.
- Sticky board traps
- Place 1-4 sticky cards per 300 sq m field area. Replace traps at least once a week. To make your own sticky trap, spread petroleum jelly or used motor oil on yellow plywood, 6 cm x 15 cm in size or up. Place traps near the plants but faraway enough to prevent the leaves from sticking to the board. Traps when hung should be positioned 61 cm zone above the plants.

- Lorsban?

2. Ants

Identification: Ants that affect peanuts usually vary in color from black to red and have white larvae. Ants typically damage peanuts by taking sown seeds into their colony. If populations are high enough this can result in significant crop loss and uneven distribution of plants in the field.

http://www.pan-germany.org/download/field_guide_peanut.pdf

Pre-planting:

- Field should be tilled approximately one month before planting to destroy plant residue and weeds and allow them enough time to decompose before planting.
- This will increase soil quality and plant vigor.

Planting and growth:

- Increase the number of seeds planted and then thin out the crop later if necessary.
    - While this may cost more it will be cheaper than applying pesticide.
- The reduction of aphids and whiteflies will discourage ants, who are attracted by the excretion of honeydew.
- It is especially important to get rid of aphids as they are used by ants to gain access to nutrients in the plant.

Post-harvest:

- Remove all plant remains and weeds.
- Flooding of the field will destroy ant colonies.
- Tilling can destroy ant larvae by exposing it to predators and direct sunlight.

Control Options (to be recommended in the order listed; follow the label directions):

- Apply the following mixture: 2 tbsp dish washing soap, 2 tsp vegetable oil, 2 tbsp salt a few drops of vinegar and 4 liters of water.
- The reduction of aphids and whiteflies will discourage ants, who are attracted by the excretion of honeydew.
- Pounce 25 WP, Permethrin 25% (consult label for entry intervals)

4. Leafhoppers (*Empoasca fabae)*
Identification: Adult leafhoppers are light green in color and a wedge-shaped body measuring about 3mm in length. Larvae are about 1mm long and white in color.

Adult Leafhopper
http://ipcm.wisc.edu/Portals/0/Blog/Files/19/307/potato%20leafhopper%20adult.jpg

Pre-planting:

- Field should be tilled approximately one month before planting to destroy plant residue and weeds and allow them enough time to decompose before planting. This will increase soil quality and plant vigor.

Planting and growth:

- Remove garbage and debris from the field.
- Floating row covers can be effective if population is not too large.

Post-harvest:

- Destroy all weeds and plant remains.

Crop rotation:

- Avoid rotating with other host crops such as potatoes and soybeans.

Monitoring and treatment decision:

- Leafhoppers can be found primarily on the underside of leaves.
- Plants affected by the leafhopper often become curled in one direction and covered with a yellowish rash.

Control Options (to be recommended in the order listed; follow the label directions):

- Remove garbage and debris from the field.
- Floating row covers can be effective if population is not too large.
- A mixture of 100 grams of chopped garlic with 10 liters of water can be applied.
- Actara 240 sc (EC) Thiamethoxam (21.6%) (consult label for entry intervals)

INTEGRATED PEST MANAGEMENT PLAN FOR PIGEON PEA

A. Principal Pests

1. Black legume aphid

B. IPM Plan for Pigeon Pea

1. Black Legume Aphid

Identification: The legume aphid is shiny black in color and can be both winged and wingless. The body is pear-shaped. They are distinguished by two parallel limbs that emerge from the rear sides of their bodies.

Black legume aphid **(**http://www.infonet-biovision.org/print/ct/130/crops

INTEGRATED PEST MANAGEMENT PLAN FOR POTATO

A. Principal Pests

1. Nematodes
2. Crickets / Grasshoppers
3. Powdery Mildew
4. Late blight (*Phytophthora infestans)*

B. IPM Plan for Potato

Identification: Nematodes are very small, worm-like pests ranging from 0.5 to 1.0 mm in length. They can survive in many different types of habitat and feed on a wide variety of crops. Nematodes have spear-like mouthparts that allow them to feed on cells of a plant. High nematode populations can cause significant root damage resulting in stunted growth and low yield. Top-heavy plants may also fall over due to the lack of supporting roots.

Potato affected by nematodes.
http://www.ipm.ucdavis.edu/PMG/r607200111.html

Pre-planting:

- Elimination of nematodes from infested fields prior to planting is near to impossible but numbers can be reduced by having a fallow period greater than a year.

Planting and growth:

- In some cases the incorporation of chitin-containing materials (such as crushed crab and prawn shells) into the soil has been known to reduce nematode levels.
- Covering the soil with banana leaves and other plant material helps moderate soil temperatures, prevent erosion, and gradually add organic matter to soil.
- When roots have been destroyed by feeding nematodes, plants are more likely to fall over. Fruiting plants should be propped to prevent toppling due to the weight of the bunch or strong winds.

Post-harvest:

- Destroy all weeds, plant remains and tubers that may sprout after harvest.

Crop rotation:

- Leaving the field fallow and weed free for at least one year will significantly reduce nematode populations.

Control Options (to be recommended in the order listed; follow the label directions):

- Nematode-suppressive green manure/fallow crops
  - African or French marigolds (grown then incorporated into soil)
  - Jatropha
  - Castor bean, velvetbean, forage sorghum
- Organic soil amendments (Neem or Jatropha seed cakes mixed into soil)
- In some cases the incorporation of chitin-containing materials (such as crushed crab and prawn shells) into the soil has been known to reduce nematode levels.
- Covering the soil with banana leaves and other plant material helps moderate soil temperatures, prevent erosion, and gradually add organic matter to soil.
- Sticky board traps
- Place 1-4 sticky cards per 300 sq m field area. Replace traps at least once a week. To make your own sticky trap, spread petroleum jelly or used motor oil on yellow plywood, 6 cm x 15 cm in size or up. Place traps near the plants but faraway enough to prevent the leaves from sticking to the board. Traps when hung should be positioned 61 cm zone above the plants.

- Lorsban 75 (WG) [Tricel] Chlorpyriphos 75% (follow REI = 24 hours, PHI 35 days)

2. Crickets / Grasshoppers

Identification: Grasshoppers and crickets are jumping insects with very pronounced hind legs. They are typically grayish-green in color and have very pronounced heads and eyes. Most species have two pairs of wings and can grow up to 44mm in length.

http://www.ent.iastate.edu/imagegal/orthoptera/ghoppersonears.html

Pre-planting:

- Tilling the crop field can sometimes be effective in burying un-hatched eggs.

Planting and growth:

- Manual removal can be effective in small fields.
- Early harvest should be practice if populations are large.
- Chickens can be effective in reducing grasshopper populations as long as they don't damage the crop.

Post-harvest:

- Tillage of fallow fields in late-summer discourages the laying of eggs.
- Remove all plant debris from field.

Crop rotation:

- Crop rotation can be very beneficial in removing grasshoppers. Rotation with small grain crops and removal of all plant debris is most effective. Avoid rotating with other late season crops such as bean, soybean, sunflower etc.

Monitoring and treatment decision:

- Treatment is usually necessary if 15 or more nymphs or 8 or more adults are found in one square yard. If crop is stressed do to drought etc., treatment may be needed when lesser populations are present.

Control Options (to be recommended in the order listed; follow the label directions):

- Manual removal

- Chickens can be effective in reducing grasshopper populations as long as they don't damage the crop.
- Actara 240 sc (EC) Thiamethoxam (21.6%) (consult label for entry intervals)
- Dimethoate 2.67 (EC) Dimethoate 30.5 % (consult label for entry intervals)

3. Powdery Mildew (*Erysiphe cichoracearum*)
Identification: Leaves on infected plants develop irregular, bright yellow spots; severely affected leaves die but rarely drop. Spots of dead tissue are sometimes surrounded by a yellow halo. Severe infections kill leaves and results in sunburn fruit and weakened plants. Spores from the mildew are easily blown by the wind to nearby plants. The powdery mildew fungus can reproduce under relatively dry conditions. Increased humidity can increase the severity of the disease, and infection is worse during periods of heavy dew.


Powdery Mildew

Pre-planting:
- Fields that contain rich soil will help to reduce the prevalence of the fungus.
- Rows should run the direction of the prevailing wind to increase air circulation and promote leaf drying.

Planting and growth:
- Plant in sunny areas as much as possible, and avoid applying excess fertilizer.
- Overhead sprinkling may help reduce powdery mildew because spores are washed off the plant. However, overhead sprinklers are not usually recommended as a control method in vegetables because their use may contribute to other pest problems.
- Avoid over-crowding and keep plantings free of weeds as long as is practical.

Post-harvest:
- Disc fields after harvest.

Crop rotation:

- Seed treatments and crop rotation have no effect on powdery mildew infection.

Monitoring and treatment decision:

- Begin monitoring early in the season. Chemical treatment is not warranted unless infection occurs very early in the season.
- Check leaf surfaces often especially among older plants and areas of the field with poor air circulation. Unlike most fungi, powdery mildew does not require accumulated moisture on the plant in order to grow.

Control Options (to be recommended in the order listed; follow the label directions):

- Avoid over-crowding and keep plantings free of weeds as long as is practical.
- Sulfur: 7.4 to 25 lbs/ha (follow REI =24 hrs, PHI = N/A). Apply at first sign of disease and every 14 days as needed to maintain control.
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days.
- Dithane M-45 or F-45 – Follow REI = 24 hours, PHI = 3 days

4. Late blight (*Phytophthora infestans)*

Identification: Late blight lesions can occur on all aboveground potato plant parts. Leaf lesions are small pale to dark green, water-soaked, irregularly-shaped spots surrounded by yellowed tissue. As the disease progresses, lesions expand rapidly and turn brown to purplish black as the leaf dies. White spores can be observed when humidity is high. On stems, lesions are brown or black and may also produce spores.

Potato plant leaves and stem with late blight.

Affected tuber

Pre-planting:

- Check seed tubers for signs of late blight – destroy any infected seed pieces infected. Prepare fields to ensure good drainage.
- Avoid planting in fields with recent incidence of late blight (or fields where related crops have been planted – see 5. Crop rotation). Use resistant varieties if possible.

Planting and growth:

- Do not plant when soil temperatures are very cool or when rainy weather is forecasted.
- Do not over-irrigate: irrigate just enough to avoid soil cracking and ensure good yields. Irrigate in the early morning so that foliage has time to dry completely during the day.

Post-harvest:

- Remove and bury all remnant plant matter. Dispose of cull potatoes and seed chips by burying. Completely clean out any storage facilities between seasons.
- Storage facilities should be well-ventilated and maintained at proper humidity and temperature.

Crop rotation:

- Rotate with any crop other than tomato, pepper, or eggplant.

Monitoring and treatment decision:

- Late blight monitoring should occur throughout the growing season and during storage, and especially from post-emergence to harvest. Temperatures below 78^{o} F, humidity levels above 90% and free moisture on foliage for 8-12 hour periods are favorable for late blight development. When weather forecast favors disease, a preventative treatment may be necessary. Treat when signs of late blight on stems or foliage appear.

Control options (to be recommended in the order listed; follow label directions):

- Remove and bury all remnant plant matter. Dispose of cull potatoes and seed chips by burying. Completely clean out any storage facilities between seasons.
- Sulfur dust
- Ridomil Gold (follow REI = 48 hours, PHI = 14 days)

- Dithane M-45 or F-45 (follow = REI 24 hours, PHI = 7 days)

INTEGRATED PEST MANAGEMENT PLAN FOR RICE

A. Principal Rice pests in Haiti

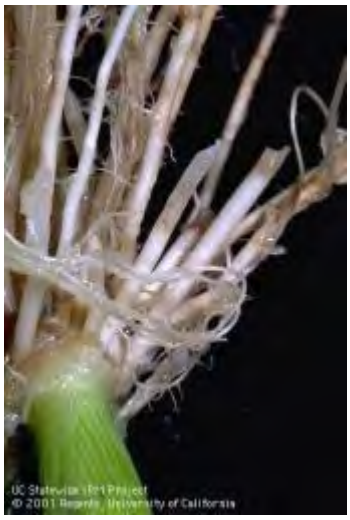
1. Rice water weevil (Lissorhoptrus oryzophilus)
2. Rot (Aggregate Sheath spot, *Rhizoctonia oryzae-sativae* and Stem rot, *Sclerotium oryzae)*

B. IPM plan for Rice:

1. Rice water weevil (Lissorhoptrus oryzophilus)

Identification: The rice water weevil adult is gray, about 4 mm in length, with a prominent beak and dark marking on its back from the base of its head to the middle of its wing covers. It can overwinter as an adult at the base of grass clumps, weeds, levees and banks of irrigation ditches. Root pruning by larvae causes the greatest reduction in yields as plants with such damage will become stunted and experience decreased yields resulting from either reductions in tillers and panicles or delayed maturity. With stunting of rice plants, weeds often become better established.

Rice water weevil



Rice water weevil larvae damage to rice roots

http://www.ipm.ucdavis.edu/PMG/L/I-CO-LORY-AD.006.html

Pre-planting:

- Remove weeds on levees in spring near time of seeding to reduce rice water weevil infestations and populations of larvae.

Planting and growth:

- Early and effective weed control can minimize competition for nutrient resources and aid crop recovery from rice water weevil damage.

- If compatible with weed control strategies use drill seeding: Drill seeding involves seeding the dry rice field, irrigating the soil to germinate the seed, and keeping the soil moist for 6 to 8 weeks, at which time the field is then flooded. By the time the field is flooded, rice plants are more tolerant to rice water weevil injury. This method of control reduces or eliminates exposure of susceptible plants to weevil populations.

Post-Harvest:

- Maintain levees and irrigation banks weed free as these are the most significant areas of water weevil infestation.

Crop Rotation:

- Rotation of rice paddies is unfeasible as they are usually highly specialized for rice irrigation schedules

Monitoring and treatment:

- Treatment decisions for the water weevil should be based on past history of a particular field, proximity to weevil overwintering sites (ditch banks, riparian areas, weedy canal banks, etc.) and economics. A floating barrier trap can be used and placed in fields immediately after flooding. If one rice water weevil adult per trap per day is collected during the first 7 days after flooding, damaging larval populations will likely develop and a post-flood insecticide application should be considered.

Control options (to be recommended in the order listed; follow label directions):

- Effective weed management combined with drill seeding, if feasible, and appropriate flooding schedule listed above in Planting and Growth.
- Trebon 3g foliar application

2. Rots (Aggregate Sheath spot and blight, *Rhizoctonia oryzae-sativae* and Stem rot, *Sclerotium oryzae)*

Identification: Stem rot first appear during the tillering stage as small, black lesions on leaf sheaths at the water line, the disease progression caused infected sheaths to die and slough off may eventually penetrate the main stem (culm). Aggregate sheath spot lesions also appear near the water line during this initial vegetative growth stage. Lesions are circular in shape and are gray-green at the center encircled by brown margins. Later in the season further infection can cause lesions well above the water line. Both fungal disease overwinter in infected rice residues left in fields with a new season's flooding the fungal agents, sclerotia, float to the surface infecting young rice plants at the water line. With infection grain quality and panicle size are reduced, and in more severe infections tillers are killed and fail to develop panicles

Stem rot
http://www.ipm.ucdavis.edu/PMG/S/D-RI-SORY-FU.009.html

Pre-planting:

- Select most resistant varieties available

Planting and Growth

- Avoid overly dense rice stands
- Do not over fertilize, excess nitrogen fertilization increases stem rot

Post-Harvest

- Destroy post harvest crop residues (i.e. burning or cutting rice at ground level and removing straw from field)

Monitoring and treatment decisions:

- After tilling, examine tillers weekly for presence and progress of aggregate sheath spot lesions in several locations throughout paddies. If lesions are approaching the flag leaf sheath or the leaf sheath below the flag leaf, a treatment may be justified. Treat before lesions spread to the leaf sheath on the leaf below the flag leaf. Crop growth stage should also be considered before treating, lesions represent a graver risk to yields if approaching flag leaf before flowering than after flowering. Chemical treatments for sheath rot have been found not to be economically beneficial.

Control Options (to be recommended in the order listed; follow the label directions):

- Select most resistant varieties available
- Avoid overly dense rice stands
- Do not over fertilize, excess nitrogen fertilization increases stem rot
- Treat with Quadris Flowable (Azoxystrobin 22.9%) (Follow REI = 4 hours, PHI= 0 days)

INTEGRATED PEST MANAGEMENT PLAN FOR SORGHUM

A. Principal Sorghum pests in Haiti:

1. Sorghum midge (*Contarinia sorghicola)*
2. Nematodes

B. IPM plan for sorghum:

1. Soghum midge (*Contarinia sorghicola*)

Identification: The sorghum midge in its adult form is a small (1-1.5 mm without ovipositor), orangish, gnat-like fly which can be found on flowering sorghum heads. Full-grown larvae are 1.5-2 mm long. The sorghum midge deposits eggs on flowering heads. Larvae feed on developing seeds and may leave an entire sorghum head empty of seeds.

Sorghum midge adult on flowering head


Sorghum midge damage

Pre-planting:

- Early and uniform planting is the most effective cultural control measure – when sorghum flowers are available in the same area for an extended period of time, sorghum midge populations can build to damaging levels. Farmers **must** coordinate sorghum planting calendars. Destroy wild host plants such as Johnson grass before planting. Use resistant varieties of sorghum.

Planting and growth:

- Monitor for presence of sorghum adults on flowering heads (see 6. Monitoring and treatment decision). Conserve natural enemies by ensuring that insecticides are absolutely necessary before applying (see 6. Monitoring and treatment decision).

Post-harvest:

- Remove and destroy all remnant plant matter since larvae can survive in seed heads for long periods of time. Dry sorghum in drying facility before storage.

Crop rotation:

- Rotating with soybean or cotton reduces sorghum midge populations. Following an infestation, destruction of remnant plant matter, Johnson grass, and delaying planting by 5 or 6 weeks can disrupt populations enough to reduce them below economic threshold levels.

Monitoring and treatment decision:

- Monitoring for sorghum midge adults should begin when 25% of the field begins to bloom. Sorghum heads on field edges can be inspected in the morning when winds are low by slowly approaching the plant and placing a plastic bag over the head and shaking vigorously – adult midges can then be counted. An average of more than 1 adult per

head is considered the threshold level for economic damage. Inspection during the flowering period should occur every 2 to 3 days until the soft dough stage.

- Applications of insecticide for sorghum midge control are generally not considered cost-effective because only the adult stage is susceptible - once the larvae are inside the heads, insecticides are ineffective. Any insecticide applications must be well-timed during the adult stage. Cultural controls and well-coordinated planting calendars are the most effective long-term measures to reduce sorghum midge populations.

Control options (to be recommended in the order listed; follow label directions):

- Coordination of planting calendars, early planting or delayed planting, depending on the sorghum midge life cycle
- Destruction of host weeds such as johnsongrass
- Neem oil (apply in early morning or late evening to avoid leaf burn; do not spray on drought-stressed plants)
- Sevin (carbaryl) WSP 80% (follow REI = 12 hrs, PHI = 7 days)

2. Nematodes

Identification: Nematode species typically found on sogrhum include sting (*Belonolaimus longicaudatus*), stubby root (*Paratrichodorus* spp.), lesion (*Pratylenchus* spp.) and ring (*Criconemella* sp.) nematodes. Nematodes rarely cause severe damage to sorghum unless the crop has been monocultured for several years in a row.

Sorghum root affected by sting nematodes
http://www.ipmimages.org/browse/detail.cfm?imgnum=1234122

Pre-planting:

- Elimination of nematodes from infested fields prior to planting is near to impossible but numbers can be reduced by having a fallow period greater than a year.
- Select sprouts that are clean and free of nematodes.
- Field should be tilled approximately one month before planting to destroy plant residue and weeds and allow them enough time to decompose before planting.

Planting and growth:

- In some cases the incorporation of chitin-containing materials (such as crushed crab and prawn shells) into the soil has been known to reduce nematode levels.
- Covering the soil with banana leaves and other plant material helps moderate soil temperatures, prevent erosion, and gradually add organic matter to soil.

- When roots have been destroyed by feeding nematodes, plants are more likely to fall over. Fruiting plants should be propped to prevent toppling due to the weight of the bunch or strong winds.

Post-harvest:

- Remove all weeds and excess plant matter.
- The planting of non-host winter crops can discourage unintentional (volunteer) peanut plants.

Crop rotation:

- Crop rotation can be very effective in reducing plant-parasitic nematodes. Rotating sorghum with non-hosts is recommended. Field corn and millet share many common nematode pests of sorghum. If these crops recently had a problem with nematodes in a specific field site, sorghum could possibly be affected if planted at the same location.

Monitoring and treatment decision:

- When sampling nematode populations it is best to take root and soil samples.
- Samples should not be taken when the soil is very dry or very wet.

Control Options (to be recommended in the order listed; follow the label directions):

- Nematode-suppressive green manure/fallow crops
  - African or French marigolds (grown then incorporated into soil)
  - Jatropha
  - Castor bean, velvetbean, forage sorghum
- Organic soil amendments (Neem or Jatropha seed cakes mixed into soil)
- In some cases the incorporation of chitin-containing materials (such as crushed crab and prawn shells) into the soil has been known to reduce nematode levels.
- Covering the soil with banana leaves and other plant material helps moderate soil temperatures, prevent erosion, and gradually add organic matter to soil.
- Sticky board traps
- Place 1-4 sticky cards per 300 sq m field area. Replace traps at least once a week. To make your own sticky trap, spread petroleum jelly or used motor oil on yellow plywood, 6 cm x 15 cm in size or up. Place traps near the plants but faraway enough to prevent the leaves from sticking to the board. Traps when hung should be positioned 61 cm zone above the plants.

INTEGRATED PEST MANAGEMENT PLAN FOR STORED GRAINS

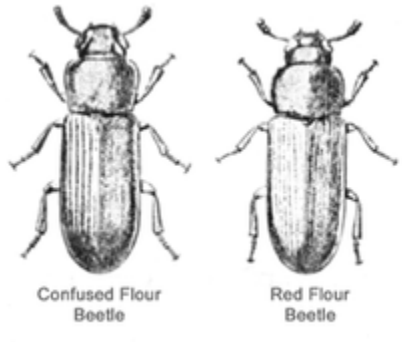
A. Principal pests of Stored Grains in Haiti:

1. Beetles (Red flour beetle, *Tribolium castaneum* and Confused flour beetle, *Tribolium confusum)*
2. Weevils - Granary Weevil **(***Sitophilus granarius Linnaeus)*, Rice Weevil *(Sitophilus oryzae Linnaeus)*, Maize Weevil *(Sitophilus zeama)*

1. Beetles (Red flour beetle, *Tribolium castaneum* and Confused flour beetle, *Tribolium confusum)*

Identification: The red flour beetle (*Tribolium castaneum)* and confused flour beetle (*Tribolium confusum)* are both 3-4 mm long and reddish brown, they are secondary pests of a wide range

of stored products. They can fly and are often the first pest to recolonize food stores after chemical treatments and are one of the most common and damaging stored grain pests in tropical climates. Undamaged, whole grain kernels are not susceptible to flour beetle damage which feed primarily on grain dusts, meals and broken kernels.

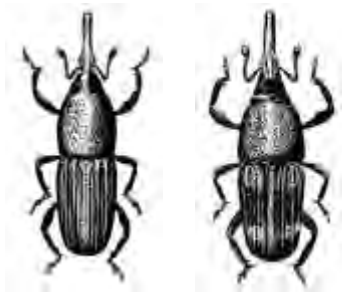


http://ento.psu.edu/extension/factsheets/flour-beetle

Note: Control measures for beetles and weevils are largely the same for stored grains. Prevention including proper storage sanitation and humidity controls is the most effective control measure (*See Grain Weevil section below for more detailed control options).*

2. Grain Weevils

Identification: Granary and rice weevils (*Sitophilus granarius Linnaeus* and *Sitophilus oryzae Linnaeus*), are often called snout weevils due to the elongated chewing mouthparts that protrude from their heads. They can be from 3-5 mm in length; in smaller grains, such as sorghum, weevils are often smaller than those found in corn. The adult granary weevil is shinny and reddish-brown with elongated pits on its thorax whereas the adult rice weevil has a similar coloring with irregular shaped pits on the thorax and spotted wing covers. The maize weevil (*Sitophilus zeama)* is similar to the rice weevil in appearance only larger. These weevils penetrate and feed on whole grains during their larval stages making them very difficult to detect.



Granary Weevil Rice Weevil

Adult granary weevil on damaged grain

http://ohioline.osu.edu/hyg-fact/2000/2088.html

http://www.ent.uga.edu/pubs/imageshomeipm/granary_weevil.jpg

Pre-storage:

- The majority of insects infecting grain are found among the residue of the previous year's stores. Therefore meticulous storage area sanitation is of the upmost importance in storage pest prevention. Newly harvested grain should never be placed on top of old grain. Clean and sort grain prior to storage to eliminate broken or damaged kernels and foreign material. Bins and silos should be cleaned thoroughly at least two weeks prior to grain storage and all cracks and damage that would allow spillage repaired.

In- storage:

- Storage area and containers should be monitored for pest infestations and kept as clean and dry as possible. Harvest should be done when crop moisture is at its lowest possible level. Do not over fill bins and silos, headroom should be left for aeration as well as periodic grain inspection and sampling. Once filled the grain should be leveled at the top to reduce risk of pest problems and facilitate even product application if necessary.

Post-storage:

- Once storage containers are emptied they should be sanitized in preparation for the next harvest storage and to prevent storage pests from becoming established. Spilled and residual grains in storage area should be removed.

Crop rotation: NA

Monitoring and treatment decisions:

- Stored grain should be monitored carefully every 2-4 weeks and samples taken from grain at bottom and top of storage bins. 1 pint / 1000 bushels of grain should be measured.

Control options (to be recommended in the order listed; follow label directions):

- Sanitation and humidity controls of storage areas and containers
- Harvest when crop moisture is at its lowest possible
- Do not overfill bins and silos
- Surface grain treatment of Insecto applied on top of stored grain (4lbs / 1000 sq.ft. of stored grain)
- Treatment with Actellic 5e (Pirimiphos-metil 57%) (consult label for entry intervals)

INTEGRATED PEST MANAGEMENT PLAN FOR SWEET POTATO

A. Principal pests of Sweet potato in Haiti:

1. Sweet potato weevil (*Cylas formicarius elegantulas*)
2. White grub
3. Nematodes (root knot and reniform nematodes)

B. IPM plan for sweet potato weevil:

1. Identification: The larval stage of the sweet potato weevil (SPW) is found in the upper 15 cm of tubers and lower 10 cm of vines. Larvae are legless and white, and range from 0.29 to 0.78 mm in size. Adults tend to aggregate in fields. Adults have bodies, legs and heads which are long and thin, giving them an ant-like appearance. The head is black, the thorax and legs orange to reddish-brown, and the abdomen is metallic blue. The most distinguishing characteristic is the long, slightly curved snout typical of weevils. Antennae are attached mid-snout.

SPW adult.

SPW larvae.

Tubers damaged by SPW larvae.

Pre-planting:

- Destroy any wild SPW hosts such as morning glory near fields before planting (be sure to uproot to prevent re-growth). Locate fields far away from recent sweet potato fields and storage facilities (SPW dispersal rates can reach 150 m per day in some cases). Monitor propagation beds for presence of SPW and treat as necessary to avoid distribution of infected seed to other areas.

Planting and growth:

- Use only clean cuttings no longer than 30 cm as older portions of vine may be infested with weevil eggs and larvae. Cuttings may be soaked in an insecticide solution to remove any weevils (see below).

Seal off area around vines with soil to prevent access by adults to underground plant parts. During the growing season, eliminate land cracks (caused by growth of underground storage roots) to prevent access by adults to tubers by stirring soil to close cracks as soon as they appear.

Post-harvest:

- Remove all tubers, debris and small pieces of root from the field. Clean storage houses thoroughly after use.

Crop rotation:

- Rotate with any crops other than sweet potato to reduce weevil populations – longer rotation cycles will have greater effects on weevil populations.

Monitoring and treatment decision:

- Monitoring should take place during propagation and the entire growth cycle. Pheromone traps are very useful in monitoring adult populations, as growers don't usually catch new infestations until harvest. Chemical treatments for the sweet potato weevil generally are not effective since larvae live within tubers. If found in propagation beds, dip cuttings in an insecticide solution before transplanting. Strict cultural practices are currently the most effective measures against SPW.

Control options (to be recommended in the order listed; follow label directions):

- Cylas pheromone traps (maximum distance between each trap = 10-15 meters)
- Entomopathogenic nematodes (*Heterorhabditus bacteriophora*)
    - Apply according to label directions to moist soil in the early morning or late evening when temperatures are lower. Continue to keep soil moist but not drenched. Apply whenever grubs are present. Weevil larvae will begin to stop feeding after 3-4 days and maximum control will occur over 2-4 weeks.
- Actara 240 sc (EC) Thiamethoxam (21.6%) (consult label for entry intervals)
- Cuttings treatment: Sevin (follow label directions for a tank mix – solution can be reused for other cuttings)**.**

2. IPM plan for white grubs in sweet potato:

Identification: White grubs are the larvae of scarab beetles such as Japanese or May/June beetles and have tan or brown head capsules, curved bodies and six legs. They may reach up to an inch in length. They are white or whitish cream in color. Grubs cause damage to sweet potato by feeding, carving broad, shallow areas on the root.

White grubs in soil Close-up of white grub

White grub damage

Pre-planting:

- Avoid planting in fields that were previously used for pastureland.

Planting and growth:

- Ensure plant health through proper irrigation and fertilization.

Post-harvest:

- Remove all tubers, debris and small pieces of root from the field.

Crop rotation:

- Do not rotate with pastureland, yam or sweet potato.

Monitoring and treatment decision:

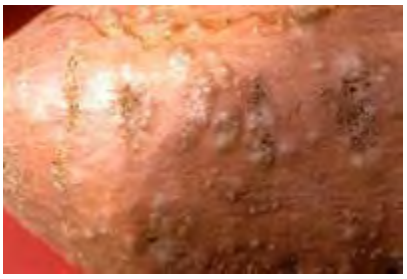
- Monitor vegetative growth for signs of adults or adult damage (notches on leaf edges) and record infestation levels of harvested sweet potatoes. Preventative treatments are most effective, especially biological controls which can give good long-term control with as little as one application.

Control options (to be recommended in the order listed; follow label directions):

- Pheromone traps
- Milky spore (*Bacillus popilliae*) powder
    - Apply according to label directions just before a rain, or gently water in for 15 minutes after application. Must be ingested by grubs to work; apply at about mid-season, when soil temperatures are warm and an actively feeding grub population is present. Does not provide immediate knockdown but is increasingly effective with each growing season. One treatment controls grub populations for 10-20 years or longer.
- Admire 2 (FC) Imidacloprid (21.4%) (consult label for entry intervals)

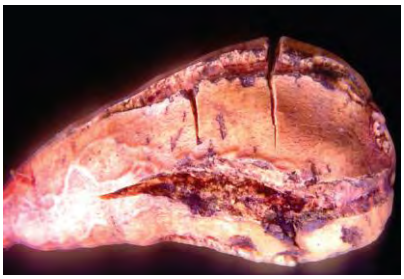
3. Nematodes:

Identification: Nematodes are very small, worm-like pests ranging from 0.5 to 1.0 mm in length. They can survive in many different types of habitat and feed on a wide variety of crops. Nematodes have spear-like mouthparts that allow them to feed on cells of a plant. High nematode populations can cause significant root damage resulting in stunted growth and low yield. Top-heavy plants may also fall over due to the lack of supporting roots.



Sweet potato with symptoms of root-knot

Root-knot galls on sweet potato plant.



Cracking of root due to root-knot nematodes.

Pre-planting:

- Avoid planting in fields where sweet potato or yam was cultivated prior to the current growing season.
- Use resistant varieties if possible.
- Transplants should be free of nematodes.
- Incorporate organic soil amendments into the soil to ensure high water and nutrient holding capacity of the soil, and activity of natural enemies.
    - Incorporate Neem or Jatropha seed cakes as an organic soil amendment.
    - Incorporation of chitin-containing materials (such as crushed crab and prawn shells) into the soil has in some cases reduced nematode levels.

Planting and growth:

- Optimize plant health by correctly managing irrigation, fertilization and by controlling other pests.

Post-harvest:

- Remove and bury any remnant plant matter.

Crop rotation:

- Crop rotation is one of the most effective measures against nematodes. Do not rotate with sweet potato, yams, or most vegetable crops. Cereal crops are a good crop rotation option.
- If feasible, rotations with nematode-suppressive crops such as mustard, rapeseed, or Jatropha, which are later mixed into the soil, reduce nematode populations substantially.
- Green manures such as castor bean, velvet bean, pearl millet, and forage sorghum are also effective in reducing nematode populations.

Monitoring and treatment decision:

- Soil testing to determine what species of pathogenic nematodes are present is recommended if nematode symptoms are present. Close inspection of roots at harvest should occur to determine whether an infestation occurred and how severe it was. Growers should also watch for above-ground symptoms and make decisions on future growing seasons as necessary.
- Prevention is the safest and most effective long-term option for nematode control. The above-mentioned cultural practices should be followed, in addition to the use of green manures or organic soil amendments.

Control options (to be recommended in the order listed; follow label directions):

- Nematode-suppressive green manure/fallow crops
  - African or French marigolds (grown then incorporated into soil)
  - Jatropha
  - Castor bean, velvetbean, forage sorghum
- Organic soil amendments (Neem or Jatropha seed cakes mixed into soil)
- Lorsban??

INTEGRATED PEST MANAGEMENT PLAN FOR SWISS CHARD

A. Principal pests of Swiss Chard:

1. Damping-off (*Pythium sp.* or *Rhizoctonia sp*)

1. Damping-off (*Pythium sp.* or *Rhizoctonia sp.*)

Identification: The fungal disease "damping-off" in Swiss chard is caused by *Pythium* or *Rhizoctonia* sp. and kills seedlings before emergence, or shortly after emergence. Damping-off refers to fungal disease that attacks germinating seeds and sprouts. Infected seeds may fail to germinate due to rot. Darkened watery lesions may be visible towards the base of sprouts. These lesions can grow very rapidly, resulting in the death of the plant. Roots and stems of plants that have already fully emerged can also be attacked resulting in death or fall over.

Pre-planting: NA

Planting and growth:

- Avoid over-irrigation and ensure good drainage of crops through planting in raised beds. Use drip irrigation where feasible to better control water quality.
- Avoid excess fertilizer applications.

Post-harvest:

- Remove and bury any infected plant matter. Soil will have to be treated, or new soil should be used for the next season.

Crop rotation:

- Do not plant in fields where *Pythium* on green onion or *Rhizoctonia* (mustia) on beans has been a problem. Rotate with any crop other than green onion, beans or Swiss chard.

Monitoring and treatment decision:

- Both *Pythium* and *Rhizoctonia* are difficult to control once infection has happened. Treatment should be based on whether preventative measures such as soil treatment were taken, and previous history of *Pythium* or *Rhizoctonia*.
- The base and stalk of each crop should be routinely checked, especially in areas with poor water drainage.

Treatment options:

- Remove and bury any infected plant matter. Soil will have to be treated, or new soil should be used for the next season.
- Sulfur dust (consult label for entry intervals)
- Ridomil Gold – follow REI = 48 hours, PHI = 14 days
- Dithane M-45 or F-45 – follow REI = 24 hours, PHI = 3 days

INTEGRATED PEST MANAGEMENT PLAN FOR YAM

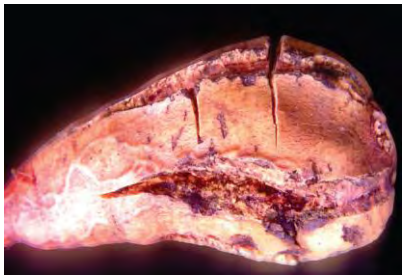
A. Principal pests

1. Nematodes (root-knot and reniform)
2. White grub
3. Storage rot (blue and green mold, botryodiplodia rot, fusarium rot, watery rot)
4. Root borer

B. IPM plan for yellow yam:

1. Nematodes

Identification: Nematodes are very small, worm-like pests ranging from 0.5 to 1.0 mm in length. They can survive in many different types of habitat and feed on a wide variety of crops. Nematodes have spear-like mouthparts that allow them to feed on cells of a plant. High nematode populations can cause significant root damage resulting in stunted growth and low yield. Top-heavy plants may also fall over due to the lack of supporting roots.



Root-knot nematode caused root cracking

Roots of plant toppled by burrowing nematodes

http://www.ctahr.hawaii.edu/adap/ASCC_LandGrant/Dr_Brooks/BrochureNo9.pdf
http://www.spc.int/PPS/PDF%20PALs/PAL%2005%20Banana%20Burrowing%20Nematode.pdf

Pre-planting:

- Avoid planting in fields where sweet potato or yam was cultivated prior to the current growing season.
- Use resistant varieties if possible.
- Transplants should be free of nematodes.
    - Propagative material can be immersed in hot water (50^{o} C for 15-60 minutes) to kill any nematodes present.
- Incorporate organic soil amendments into the soil to ensure high water and nutrient holding capacity of the soil, and activity of natural enemies.
    - Incorporate Neem or Jatropha seed cakes as an organic soil amendment.

Planting and growth:

- Optimize plant health by correctly managing irrigation, fertilization and by controlling other pests.
- At all times, avoid transferring soil between fields by cleaning off shoes and tools.
- In some cases the incorporation of chitin-containing materials (such as crushed crab and prawn shells) into the soil has been known to reduce nematode levels.
- Covering the soil with plant material helps moderate soil temperatures, prevent erosion, and gradually add organic matter to soil.
- When roots have been destroyed by feeding nematodes, plants are more likely to fall over. Fruiting plants should be propped to prevent toppling due to the weight of the bunch or strong winds.

Post-harvest:

- Remove and bury any remnant plant matter.

Crop rotation:

- Crop rotation is one of the most effective measures against nematodes. Do not rotate with sweet potato, yams, or most vegetable crops. Cereal crops are a good crop rotation option.
- If feasible, rotations with nematode-suppressive crops such as mustard, rapeseed, or Jatropha, which are later mixed into the soil, reduce nematode populations substantially.

- Green manures such as castor bean, velvet bean, pearl millet, and forage sorghum are also effective in reducing nematode populations.

Monitoring and treatment decision:

- Soil testing to determine what species of pathogenic nematodes are present is recommended if nematode symptoms are present. Close inspection of roots at harvest should occur to determine whether an infestation occurred and how severe it was. Growers should also watch for above-ground symptoms and make decisions on future growing seasons as necessary.
- Prevention is the safest and most effective long-term option for nematode control. The above-mentioned cultural practices should be followed, in addition to the use of green manures or organic soil amendments.

Control options (to be recommended in the order listed; follow label directions):

- Nematode-suppressive green manure/fallow crops
  - African or French marigolds (grown then incorporated into soil)
  - Jatropha
  - Castor bean, velvetbean, forage sorghum
- Organic soil amendments (Neem or Jatropha seed cakes mixed into soil)

2. White grub

Identification: White grubs are the larvae of scarab beetles such as Japanese or May/June beetles and have tan or brown head capsules, curved bodies and six legs. They may reach up to an inch in length. They are white or whitish cream in color. Grubs cause damage to yam by feeding, carving broad, shallow areas on the root.

White grubs in soil.

Close-up of white grub.

White grub damage.

Pre-planting:

- Avoid planting in fields that were previously used for pastureland.

Planting and growth:

- Ensure plant health through proper irrigation and fertilization.

Post-harvest:

- Remove all tubers, debris and small pieces of root from the field.

Crop rotation:

- Do not rotate with pastureland or sweet potato.

Monitoring and treatment decision:

- Monitor vegetative growth for signs of adults or adult damage (notches on leaf edges) and record infestation levels of harvested sweet potatoes. Preventative treatments are most effective, especially biological controls which can give good long-term control with as little as one application.

Control options (to be recommended in the order listed; follow label directions):

- Pheromone traps
- Milky spore (*Bacillus popilliae*) powder
    - Apply according to label directions just before a rain, or gently water in for 15 minutes after application. Must be ingested by grubs to work; apply at about mid-season, when soil temperatures are warm and an actively feeding grub population is present. Does not provide immediate knockdown but is increasingly effective with each growing season. One treatment controls grub populations for 10-20 years or longer.
- Admire FC (imidacloprid 21.4%); follow REI = 24 hours, PHI = 7 days

3. Storage Rot (Blue/green mold and water rot)

Identification: Blue and green mold is associated with cut or damaged surfaces. In some cases the rot will occur within the tuber with no visible external symptoms. Rotted tissue is pale to dark brown and may be firm or soft. Botryodiplodia rot affected tissue is either dark brown or black, with a distinct brown line between diseased and healthy tissue. The rotted tissue may be soft and water-soaked, or firm and dry, depending on the temperature and the presence of secondary decay organisms. After several months of storage the rotted tubers become shriveled mummies. Fusarium rot symptoms are dry, off-coloured tissues bordered by a brown margin. The yam surface may become covered with thick white mold.

Blue and green mold

Botryodiplodia

Fusarium rot

Post-harvest handling:

- Gentle handling should be practiced to avoid injury to tubers. Any damaged tubers should be disposed of. Tubers should be properly cured before storage. Proper curing involves holding yams at 29 to 32° C and high relative humidity (90 to 95%) for 4 to 5 days to allow skins to thicken and new tissue to form under injured areas of the tuber. Outdoors, tubers can be piled in a partially shaded area. Grass or straw should be placed on top of the pile, with a canvas or burlap tarp or woven grass mat placed over the entire pile, for 4 to 5 days. Do not wash tubers before curing. After curing, tubers can be coated with lime, chalk or wood ashes to fight off infection.

Storage:

- Storage should take place in well-ventilated boxes at an ideal temperature of around 55° F; higher temperatures promote storage rot and tubers stored at these temperatures should be consumed within a few weeks of harvest. The storage facility and boxes should be thoroughly cleaned after each use. If high storage temperatures and humidity are high and curing does not control storage rot, a fungicide dust or spray can be applied.

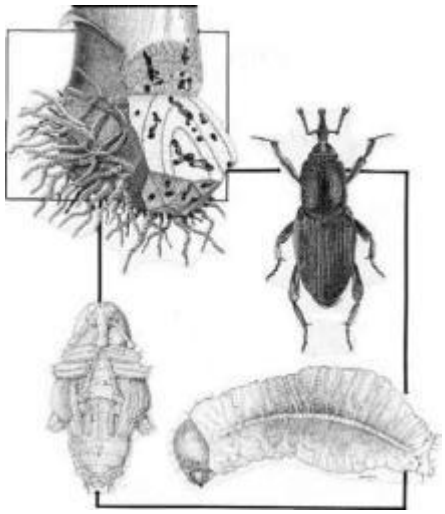
Control options (to be recommended in the order listed; follow label directions):

- Curing of yams
- Well-ventilated storage boxes and optimum storage temperature (55° F)
- Thorough cleaning of storage facility and storage boxes after each season
- Lime, chalk or wood ashes dusted on stored tubers
- Ridomil Gold (follow REI = 48 hours, PHI = 14 days)
- Dithane M-45 or F-45 (follow REI = 24 hours, PHI = 3 days)

4. Banana root borer (*Cosmopolites sordidus*)

Identification: The adult weevil is dark brown to grey black, shining, about 11 mm long. It is similar in general appearance to the billbugs (*Sphenophorus*), but lacks the depressions on the pronotum. All

tibiae are armed with hook-like extensions which enable the beetle to hold tightly to plant tissue. The larva is typical of the weevil subfamily Calendrinae, the body white and the head capsule dark reddish brown. The last two abdominal segments are modified into a plate-like structure giving a "chopped off" appearance in lateral view. The eighth abdominal segment bears a large elongate spiracle, but all other abdominal spiracles are minute and indistinct. Most damage is done by the extensive tunneling of the larvae in the corm, thus weakening the plant and causing blow-down by even slight winds. The adult weevil feeds and breeds at night.



Adult Banana Root Borer and Larvae
http://edis.ifas.ufl.edu/in706
http://entnemdept.ufl.edu/creatures/fruit/borers/banana_root_borer06.jpg

Pre-planting:

- Field sanitation and hot water treatments of corms have been used to manage root borers. Peeling the rhizomes free of lesions and immersing in a hot water bath at 54oC for 10 minutes is practical and effective in controlling this pest.
- Plant-clumps or mats should be cleaned of plant debris.

Planting and growth:

- At planting, rhizomes or corms should be completely covered with soil to prevent eggs from being laid on their exposed surface.
- Transportation of planting material from infested fields to uninfested ones should be avoided to prevent rapid dispersal of this pest to uninfested areas.

Post-harvest:

- Destroy crop residues

Monitoring and treatment decision:

- Adults are attracted to freshly cut pseudostems (trunks) and corms, and population estimates can easily be made using traps consisting of these plant parts.

Control Options (to be recommended in the order listed; follow the label directions):

- Harvested plants should be removed from the field weekly to eliminate hiding places for adults. Stumps should be removed and the corms cut into 4 to 8 pieces and allowed to dry. This practice prevents larval development in the harvested plants.
- Admire 2 FC (consult label for entry intervals)

INTEGRATED PEST MANAGEMENT PLAN FOR LIVESTOCK

A. Principal pests of Livestock:

1. Ectoparasites (mites, earworms, lice, flies)
2. Stomach worms, Intestinal worms, Tapeworms

B. IPM Strategy for Livestock:

1. Ectoparasites (mites, earworms, lice, flies)

- Keep animals outdoors as much as possible to increase sun exposure
- Avoid close confinement
- Ensure ample space for livestock to reduce stressful environments
- Quarantine and check new animals brought into the herd
- Minimize contact between different herds
- Increased sanitation
    - Removal of all spilled feeds and manure.
    - Waste can either be spread directly on surrounding fields or stored under plastic to reduce fly breeding potential.
    - Elimination of moisture resulting from improper drainage and water sources is also important.
- Pests can be easily transported on worker clothing and farming equipment
    - Regular cleaning is recommended

Treatment options:

- Cultural Controls:
- Apply a thin coat of vegetable oil to suffocate insects
- Scrub with iodine, repeat one a week
- Garlic powder can be used as a topical treatment and incorporated into feed
- Rub 2 to 3 handfuls of sulfur along the animal's spine

Chemical Controls (**Note:** consult labels for limitations for beef and dairy cattle):

- Valbazen
- Ectoban
- Ear worms: Sevin 85 PM

2. Stomach worms, Intestinal worms, Tapeworms, Roundworms

IPM Strategy:

- Livestock nutrition is very important in allowing animals to overcome internal parasites
    - In particular, sufficient amounts phosphorus
- The feeding of bypass proteins can help reduce weight loss among livestock
    - Bypass proteins include, forage that contains tannins, fish meal

- Grazing practices should be regulated to allow grass to regenerate and the soil to maintain good health.
    - Forage should never be eaten to the ground. It should be in a vegetative state.
    - The majority of worm larvae are located only on the bottom inch of grass
    - This will reduce the level of parasites in the soil and on plants.
    - Sheep tend to graze lower on grass than cattle and thus must be monitored more closely
    - Grass should also not be allowed to grow too long, lengths between two and four inches will allow more sunlight to enter and kill the parasite larvae.
- Maintain dung beetle populations
- Do NOT spread manure in the grazing fields as fertilizer, this will spread parasite larvae
    - Larvae are rarely found on vegetation more than 12 inches from a manure pile
- Feeders and water receptacles should be cleaned and elevated to reduce manure contamination
- Leaving the grazing field fallow for one year will cause all worm larvae to die

Note: Sheep and Cattle do not share the same parasites

Treatment Options:

Cultural Controls:

- Several studies have shown that the use of diatomaceous earth has reduced larvae count
- The feeding of garlic can reduce internal parasite counts

Chemical Controls:

- Stomach worms, intestinal worms, tapeworms: Albendazole

Note: Studies have shown that Ivermectin can kill dung beetle larvae for up to 45 days. After de-worming with this product it is recommended to quarantine the animals in an enclosed area until the majority of Ivermectin containing manure is excreted.

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