FINAL ACTION FORM

UGANDA CROP PROTECTION
PESTICIDE EVALUATION REPORT & SAFER USE ACTION PLAN
(PERSUAP)
for

Field Crop Production and Commodity Protection Programs of USAID/Uganda

PROGRAM/ACTIVITY DATA:
Country/Region: Uganda
Program/Activity Title: SO 7 — Expanded Sustainable Economic Opportunities for Rural Sector Growth

Funding Begin: FY 2004 **Funding End:** FY 2008

PERSUAP Prepared By: James Litsinger, Integrated Production and Pest Management Specialist

Approval Final Action Form Prepared by: Jody Stallings, MEO, USAID/Uganda

Current Date: December 5, 2005

SUMMARY OF FINDINGS:

This final action form summarizes the findings of the PERSUAP which address the pesticide safer use and handling issues for field crop production and commodity protection activities of USAID/ Uganda by 1) expanding rural economic opportunities in the agricultural sector by increasing food and cash crop productivity and marketing programs; 2) by increasing economic opportunities for rural communities in selected regions of southwestern and western Uganda; and 3) Title II programs to enhance food security of vulnerable households and transform agriculture, covered with its Strategic Objective Seven (Expanded sustainable economic opportunities for rural sector growth). The PERSUAP was funded by APEP and PRIME/West.

A **Negative Determination with conditions** is recommended on the basis of the completion by USAID/Uganda of a PERSUAP for pesticide use by APEP, PRIME/West, and Pl-480 Title II partners, addressing USAID's Pesticide Procedures, pursuant to 22 CFR 216.3 (b)(1)(i)(a - l). The **conditions** are addressed in the findings and recommendations summarized below.

Specifically, the conditions are that the risk reduction measures outlined in Section 5 in this document will be followed, per the actions outlined in the Safer Use Action Plan in Section 6. Among the conditions are that the PERSUAP has approved of 45 pesticides including some recommended replacements for those disallowed (14 insecticides, 14 fungicides, 8 herbicides, 4 seed protectants/fumigants, 2 rodenticides, 1 each for a bird repellant, molluscicide, and nematicide). Twenty one pesticides are not recommended (are disallowed) as being too hazardous to those applying them or to the environment. Before any other product other than those mentioned in the summary list above is used, an amended PERSUAP will need to be submitted and approved.

For any commodities, pests, and pesticide products being considered under the programs of SO7, but not covered in and recommended by this PERSUAP, a **Deferral** is recommended. That is, for pesticides NOT listed in Table of Approved Pesticides (Table 3 in the 2005 Uganda Crop PERSUAP), and inconsistent with the plan for introducing replacement pesticides**,** an *amended PERSUAP*, specific to the pesticides used in the program implicated, shall be prepared before any pesticide is used, directly or indirectly, for pest management with other crop/pest/pesticide combinations. The amended PERSUAP must be approved by the REO and BEO before any pesticide not listed in the present PERSUAP is used.

The following are recommended actions that USAID partners should follow in order to alleviate adverse impact on the environment as well as humans. Section 6, the Safer Use Action Plan, lays out the proposed approach to addressing and implementing the recommendations

1. Use of hazardous and high-toxicity pesticides

Due to the use of knapsack sprayers by small-scale farmers and being unaccustomed to wearing protective equipment, only pesticides which meet USEPA and USAID standards of minimum mammalian toxicity ("least toxic"), yet still effective, should be recommended. Table 1 below presents those pesticides for *immediate removal and replacement* in USAID partner programs: all USEPA toxicity class I and RUP pesticide products. Table 2 lists pesticides to be *removed from USAID-influenced programs by April 30, 2008* -- all pesticides which fall into USEPA toxicity class I or II that are identified in this PERSUAP. Finally, Table 3 lists those pesticides which are *permissible* in USAID-sponsored or influenced programs. Summary lists are provided below. The full tables are to be found in the Annex to this Final Action Form, and in the Crop PERSUAP itself.

Section 6 of the PERSUAP, the Safer Use Action Plan, includes the steps necessary to provide for replacement pesticides in Uganda (Table 4). The suggested replacement pesticides for those disapproved in Uganda, and the timetable for replacement are offered in Table 5. In addition, Table 7 identifies those pesticides which are USEPA-registered and acceptable for small-holder use, but not registered in Uganda, therefore replacement products and crop protection practices are recommended in that table.

Thus pesticides or their formulations which are classified in USEPA toxicity classes I and II should be replaced with the following exceptions:

- Allowed are stored product pesticides aluminum phosphide (Phosdrin, Phostoxin) fumigant and pirimiphos-methyl + permethrin (Actellic, Actellic Super), the former would be used only by professional fumigators at their facilities while the latter can be used only by staff trained in seed protection methods and who have the necessary protective equipment.
- Methyl anthranilate (Bird Shield) which is a bird repellant derived from an extract of concord grapes thus is safe for humans, eye irritation comes from the solvent and carrier used in the formulation, and is allowed if farmers use goggles.
- The herbicide glyphosate acid which is rated toxicity class II (due to eye irritation), but rated III slightly toxic (by inhalation) or IV likely not to be hazardous (by oral/dermal contamination), if farmers were given training to wear goggles, glyphosate could be safely applied by knapsack sprayer; glyphosate is being tested by safer application methods which would reduce exposure during application such as Weed Wipe gravity flow and VLV sprayer which uses the wind to drift the product into weedy areas, exposure to glyphosate using the Weed Wipe and VLV sprayers would only be during loading the sprayer, farmers could be trained to use gloves.
- Carbaryl is approved in formulations less than 50% concentration.
- Malathion is not approved as a wettable powder but only in emulsifiable concentration formulations.

Following are the products submitted in this Final Action Form for approval for actions as identified, respectively:

1. Products for *immediate removal and replacement* in USAID partner programs: all USEPA toxicity class I and RUP pesticide products (Table 1).

Insecticide
Lambda-cyhalothrin

Herbicide
Paraquat

Rodenticides
Coumatetralyl
Coumachlor

2. Pesticides to be *removed from USAID-influenced programs by April 30, 2008* -- all pesticides which fall in USEPA toxicity class I or II that are listed here (Table 2):

Insecticides	Nematicide
Carbofuran	Ethoprop
Carbosulfan	
Chlorpyrifos	Bactericide seed dressing
beta-Cyfluthrin	Bronopol
Deltamethrin	
Diazinon	Herbicide
Dimethoate	Bromoxynl
Fenitrothion	
Fenvalerate also Esfenvalerate	
Fipronil	
Pirimiphos ethyl	
Profenofos	

Table 3. Pesticides *permissible* in USAID sponsored or influenced programs. Suggested replacement pesticides are included.

Insecticides	Fungicides
Acephate	Benomyl
Acetamiprid	Cymoxanil
Aluminum phosphide	Dimethomorph
Azadirachtin	Dithianon
Bacillus thuringiensis (Bt)	Fosetyl aluminum
Carbaryl 3/	Kresoxim-methyl
Fumigant/seed protectant	Mancozeb
Imidacloprid	Metalaxyl
Indoxacarb	Propineb
Malathion	Sulfur
Malathion 4/	Tebuconazole
Methoxychlor	Thiophanate methyl
Methoxy-fenozide	Thiram
NPVirus	
Permethrin	Bird repellent
Petroleum oil	Methyl anthranilate
Pirimiphos-methyl	
Spinosad	Molluscicide (snails)
Thiamethoxam	Metaldehyde
Herbicides	Nematicide
Diuron	Dazomet
Glyphosate acid	
Glyphosate salt	Rodenticide
Haloxyfop-R methyl	Bromadiolone
Iodosulfuron-methyl-sodium	Warfarin
Metolachlor	
Propanil	
Thiobencarb	

2. Protective clothing not used by farmers

According to field visits and briefings by many resource staff, outside of demonstration plot activities, few farmers normally use even the bare minimum of appropriate pesticide protection clothing and equipment. Farmers generally mix chemicals (where the pesticide is most toxic) without rubber gloves, a bucket of water to wash off spills, or goggles and spray while walking through the spray path without rubber boots, goggles, rubber gloves, a plastic sheet between the sprayer and the back, and with only every-day clothing. This behavior is common among farmers even though they generally believe that pesticides pose danger to their health. Most knew to bathe after spraying but few changed clothes after spraying. This is a recurrent problem needing immediate attention. In extension demonstration exercises, sessions should be held to see what farmers could devise using local and cheap materials such as plastic bags etc. to come up with an acceptable compromise to the fully protected suits seen in the extension bulletins. The key times are during mixing and when walking through the spray path. Rubber boots and a water repellant apron of sorts (a water repellant apron, improvised plastic sheeting tied around the waist or raincoat to protect the front of the legs and abdomen (to be worn over long pants), and goggles should be first priority. Those that apply pesticides should be encouraged to wash their clothes after each day's spraying.

Recommendations:

Most farmers are aware of needed protective clothing. The problem needs a fresh look by a consultant to be hired by the partners to make recommendations on better training methods that might be utilized to increase adoption rates. It is suggested that the problem should be posed to the farmer groups in extension sessions. Let the farmers suggest solutions in terms of protective equipment they could purchase or devise using local and cheap materials such as plastic bags etc. to come up with an acceptable compromise to the fully protected suits seen in the extension bulletins. The key danger times are during mixing and when walking through the spray path. Eye and feet protection are the greatest priority. Goggles, long pants, and rubber boots are most needed. Perhaps farmers can improvise an acceptable water repellant apron made of plastic sheeting tied around the waist or raincoat to protect the front of the legs. Those that apply pesticides should be encouraged to wash their clothes after each day's spraying.

3. Most pesticide labels are incomplete

Labels on pesticide containers can provide much information to the farmer on how to best use the product safely and effectively. Observing pesticides on the shelves of stockists revealed that there is a great variation in the information provided on labels. The Ugandan regulations state that the labels should follow FAO standards but it was noted that often much necessary information was lacking. Pests controlled as stated on labels should be those occurring in Uganda. The label should also provide information on poisoning symptoms with information to physicians on antidotes and first aid treatment. Dosage information should be in units that farmers understand (tablespoons per 15-20 liter sprayer). Since there are numerous local languages English no doubt should be the language of choice although some labels were noted to be entirely in Luganda. Others were noted not to give the dosage. Some did not even state the product was hazardous.

Recommendations:

The partners should meet with the ACB technical committee to review the extent of this problem. If the ACB agrees it could review the content on current pesticide labels and make suggestions on the minimum standard set of information needed for registration. It is suggested that information on pre-harvest interval (PHI) and return entry intervals (REI) be adopted as useful guidelines as to the timing of the last possible applications to minimize residues on food and the number of hours or days that it is safe for field workers to re-enter fields after spraying. As all products are required to register every three years this new requirement could be made at this juncture.

4. High turnover rate of stockists

The training of stockists in both Kampala and rural areas is being undertaken by many organizations including MAAIF, Makerere University, AT Uganda, Sasakawa Global 2000, as well as various projects. There are also plans by the ACB to expand this training to more rural towns as part of the stockist registration process. This is a great effort and much needed. Often the owners of the shops are trained but the hired staff in the shops are not. Discussions with stockists in Kampala and in rural areas during field trips revealed a general lack of how to read a pesticide label and provide pest control advice to farmers who seek their help. The high turnover rate among rank and file stockists does not allow all of them to be trained in formal courses.

Recommendations:

It would be useful if a well illustrated booklet designed for self learning could be developed and distributed to stockists and their staff who could have a ready reference to learn from in-between customers. The booklet would contain information on how to read pesticide labels as well as general information about safe pesticide use and first aid practices. Videos that have been developed perhaps could be shown in more venues in order that the shop staff can avail of the information they desperately need. In addition, if MAAIF could be encouraged to assemble the recommended pest control practices in summary form for major crops that also could be useful to stockists when advising farmers. This same booklet could also be used by extension workers.

5. Amelioration of pesticide odor as an occupational health hazard of stockists

Interviews and visits to stockists revealed that many complained of headaches, nausea, and high blood pressure from sitting in small shops for up to 12 hours per day breathing the ever-present odor of pesticides. Some staff take remedies to offset the ill effects and are clearly concerned about their health. One took prescription medicine from Mulago Hospital at great cost.

Recommendations:

Less odor was noticed in shops that displayed pesticides in shelving cases constructed with sliding glass door fronts. In addition some shops had electric fans which helped fresh air enter. Some stockists exhibit empty containers of pesticides for customers to examine before purchase. The technical committee of the ACB could be encouraged to find ways to minimize the health hazard of stockists.

6. Pesticide usage should be in the context of IPM programs

Pesticides are often seen as a first choice in pest control whereas following IPM their use should be the last choice when all else fails. In addition the decision to use pesticide is based on the presence of the pest and not on decision protocols such as action thresholds currently being used for cotton using the pegboard. As it is now for most crops, recommendations imply that as soon as the pest is seen, a pesticide should be used. As a result more applications are probably given than would be necessary if decision guides were developed based on field verification or trials. Pest control recommendations include many non-pesticide practices and pesticide usage should also be seen as a last resort.

Recommendations:

Monitoring programs need to be developed along with action thresholds as methods to quantify pest abundance as a guideline to initiate pesticide usage for more crops than cotton. Cotton is an excellent model for developing guidelines for pesticide usage in an IPM context. Pest control recommendations should include many non-pesticide practices first and pesticide usage only as a last resort. As a first start relevant literature from other countries could be sourced and field tested in verification field trials such as on-farm demonstrations with farmers as partners.

7. The list of approved pesticides in the Registrar of Pesticide Office should be computerized and made more widely accessible

In looking up the list of registered pesticides in Uganda in the MAAIF Registrar Office it was noticed that the list is actually a series of lists, some on computer and others on paper in scattered files. As a result it is possible that some pesticides reported are actually registered in Uganda, but were missed in the search. Much work and expense go into registering pesticides, and pesticide dealers and projects using pesticides should be able to readily obtain a list of registered products. Even other government agency staff were requesting such a list.

Recommendations:

The partners should request the Office of the Registrar of Pesticides to make the list of registered pesticides more available to those who have legitimate needs to know if a particular pesticide is registered. If there were one computerized list in alphabetical order this could greatly facilitate wholesalers, project staff as well as GoU agencies who need to look up pesticides. Perhaps the list could be put on a website for all to access in a convenient manner without having to visit the Entebbe office at a great savings of time.

8. Farmers often use the wrong pesticide product such as an insecticide to control a disease

From discussion with extension staff and farmers it is apparent that there are multiple sources of recommended practices which often differ, resulting in confusion among farmers. In addition, farmers think brand names are different pesticide. Farmers also believe pesticides control a wider range of pests than they do. Sometimes insecticides are applied to control fungal diseases. Some farmers use an aphid insecticide to control stalk borer not knowing that insecticides differ in efficacy for different pest groups. These problems arise because MAAIF has not published current standardized recommendations. Those in the past are out of date.

Recommendations:

In most countries there are standardized recommendations that are developed and updated regularly following a procedure of meetings among researchers and extension staff where results are published in booklets for use by extension workers and others. Confusion can be minimized by listing the brand names for each pesticide and the most efficacious products for each target pest. The first meetings occur within commodity groups by those who are actively researching and testing new technologies. Recommended practices are then decided upon as is now done in the National Variety Release Committee, but would be expanded for all production practices for each crop including IPM and recommended pesticides. A second series of meetings would occur between research and extension entities where the research teams present the latest recommended practices for feedback by extension. Some of this work has already been done but occurs in scattered sources such as the pest control guide for cotton. After agreeing on a set of recommended practices, booklets would be published that would be given to extension workers and be available for sale to farmers and the general public. The booklets could be updated from time to time and even put on a Webpage.

9. Pesticide disposal of containers and obsolete product needs to be strengthened

Many people interviewed expressed concern that pesticide containers are often found scattered around fields or near farmers' homes. Sometimes containers are reused by the farmers. Both unsound disposal and reuse of containers pose hazardous situations. There were conflicting recommendations given by people interviewed as to the best solution for reducing pesticide hazard from improper container disposal. If the containers are burned, products from burning can be more hazardous than the pesticide itself. The ACB technical committee is working with the Bureau of Standards to come up with containers that would be less attractive for reuse by farmers which is a good strategy. Disposal of obsolete pesticides in the incinerator at the Veterinary School in Makerere University probably does not heat up the pesticide enough to vaporize with no visible smoke. The MAAIF is looking into a chemical disposal facility run by the UPDF but again it is not known if temperatures are enough to prevent dangerous smoke and fully vaporize the chemicals.

Recommendations:

The ACB technical committee could look into deciding on the best practices of container detoxification and disposal. The UPDF site is being looked into as a way of disposing of used containers. The USEPA recommends that solid containers should be tripple rinsed, crushed, and buried. Paper containers should be buried, and not burned. Burning is dangerous as the temperatures obtained by wood fires are not hot enough to prevent poisonous smoke from occurring. There is no place to safely dispose of obsolete pesticides. It is suggested that arrangements with a cement plant be pursued to determine if pesticides and other hazardous chemicals could be incinerated in this manner. The temperature of 2000^{o}F of the cement plant flame fully vaporizes pesticides. A metal tank can be constructed next to the burning area in the cement plant and fitted with a mixing blade and a pump to take the pesticide and kerosene mixture right to the flame by copper pipe. A nozzle fitted on the end would send the mixture as a fine mist to be readily vaporized. Unless the temperatures are of the order of 2000^{o}F the resulting smoke will pose health problems. Perhaps the ACB Technical Committee could visit the several cement companies in Uganda. Other noxious chemicals could also be disposed in the same manner. It is far cheaper to add on an incineration capability to a cement plant than to export it to another country or build a specialized incineration plant within the country. There is the added danger if the pesticides were exported that the trucks would have an accident spilling the concentrated product. The cement plant incineration could be utilized for more than pesticides and could include most organic chemical waste from schools, businesses, and the public.

10. Rotate pesticide chemical groups to minimize pesticide resistance

Repeated pesticide use presents risks for development of pesticide resistance where mortality rates decline. When this occurs it is often difficult to find substitutes. The danger is greatest in areas where year-round cultivation of vegetables, cotton, or Irish potatoes occurs. Technicians need to match pest abundance within a season with pesticide response for each location. Under heavy pest pressure and in the absence of genetically resistant varieties, repeated spraying often is necessary. As cross resistance is common, fungicides, insecticides, herbicides, and acaricides need to be rotated by chemical family to reduce the risk of pesticide resistance. Glyphosate resistance is now common in the U.S. Farmers need to have knowledge of the general families of pesticides for rotation must occur between families and not just brand names. Farmers generally do not know that different brand names are often the same chemical. Fungicides on Irish potatoes, insecticides on cotton, and herbicides such as glyphosate may require calendar-based schedules both to improve the degree of control as well as lower the risk of crop failure.

Recommendations:

Pesticide manufacturers and researchers worldwide have developed systems of rotation of pesticide families on cotton and other crops to minimize the development of pesticide resistance. In order to work, a strict rotational schedule needs to be followed by all farmers in an area for each growing season. It is recommended that such systems be enacted for cotton insect pests, diseases of Irish potato, and herbicides such as glyphosate.

11. Adulteration

Conversations with pesticide wholesalers, stockists, project staff and chemists revealed that adulteration occurs commonly in certain pesticide products. Farmers have even approached the Government Chemist with stories of products not working and reports of phytotoxicity with usage. APEP paid for some cotton pesticides to be tested to determine if the stated active ingredient content was within the range set by the Bureau of Standards. Three of the five samples were significantly below the stated percentage formulation. Adulteration hurts the pesticide industry and creates distrust among farmer clients.

Recommendations:

The pesticide regulations identify the Government Chemist as the person with legal authority for monitoring pesticide content in the retail market. The Government Chemist has already had success that led to the prosecution of Lake Victoria fishermen using pesticide instead of nets. Soon it is expected that MAAIF inspectors will be gazetted so that they legally can take samples of suspected adulterated product. If an arrangement were worked out with a local consumer oriented NGO who would act as witness along with the inspectors to the taking of samples and delivering them intact to the laboratory, this could be presented as evidence of impartiality in court. All it would take would be a few convictions to stop this practice.

12. Protecting biological reserves such as national parks from pesticide incursion

It has been observed that due to the pressure to expand agricultural lands, cotton and other crops where pesticides are used are being grown along the borders of national parks, rivers, and other protected areas. Nearness of these fields poses hazards to the wild nature of these biodiversity centers. Pesticide can enter protected areas by a number of means with drift posing the most imminent threat. As well, insecticides and fungicides bind with soil in the treated field upon contact from drift or washing off of plants. Later, this pesticide contaminated soil could erode and run into streams and thence into parks. Herbicides, being more water soluble, have a history of leaching into underground aquifers particularly in sandy soils. They are carried downward by rainwater seeping into the soil. Farmers may improperly dispose of pesticide containers and rainwater can leach pesticides into groundwater. The same can be said when farmers wash their sprayers and throw rinseate onto the ground or worse, directly into bodies of water. Guidelines need to be drawn up to mitigate potential contamination of centers of biodiversity in Uganda from nearby agricultural activities.

Recommendations:

Following NEMA guidelines there is a need to develop an environmental plan to deal with location of project demonstrations and farmers' fields for each type of crop in relation to protected areas to minimize environmental impact. Both the APEP and PRIME/West projects have initiated a mitigation plan to minimize encroachment based on their activities. APEP has no direct control over location of fields by farmers but could work with ginneries to influence farmers to be conscious of the location of fields due to potential negative publicity that could result if the source of contamination were more publicized internationally and thus seriously affect the export market. PRIME/West recommended an environmental management systems (EMS) consultant be hired.

The ginneries can be encouraged to contribute to the Uganda Wildlife Authority to hire community conservation wardens to monitor sensitive areas. Rwenzori Coffee Company that procures organic Arabica is now giving money to help protect QE Park in order to strengthen monitoring activities. A link could be established with NEMA at local level with District Environmental Officers. An environmental NGO could be hired to work as a go-between with both wildlife authorities and forestry services and the local villagers. Arrangements would be made on the part of villagers in terms of a plan giving villagers managing rights to a pre-described area within the park border in return for their agreeing to work with the wardens to police the borders to prevent encroachment by others.

Guidelines for herbicides causing significant phytotoxicity have been developed in the U.S. based on studies as spray drift has on occasion ruined neighbor's crops leading to lawsuits. These guidelines could also apply to other pesticides. On USEPA approved labels, herbicide should not be applied within 100 m of an ecological reserve or any body of water as it can spread by drift. This range could apply to all pesticides. Pesticides should also not be used in areas where the water table is less than 3 m from the ground level as a precaution. Rinseate from cleaning spray equipment and clothing should not enter surface or ground water.

The environmental plan should be developed by the local villagers in PRIME/West and APEP project areas in biological reserves who in turn have been given training on how to conduct such a plan by the District Environmental Officers. As this would be a new activity and expansion of the Environmental Officer's job, both projects should organize training for the Officers initially in a few key areas to

work out the details and curriculum. This may be done by the staff of the projects themselves or contracted out to an NGO or similar organization.

13. More feedback and adoption rates needed in training programs

On-farm demonstration is the extension method of choice among all partners for training farmers and extension workers. Using this method, project staff train extension workers, who in turn train farmer leaders or key farmers who in turn demonstrate new crop production to farmer groups. Some projects in turn expect the trained farmers to train an additional 15-25 farmers as farmer-to-farmer training. Such training methods are used for all the crops covered in the PERSUAP. Training is crop oriented and begins with sessions held before sowing. In most programs the on-farm demonstrations are continued for three seasons with the same crop and afterwards the farmers are said to graduate. A recent adoption survey was conducted by DANIDA with the Ugandan National Farmers' Federation and found an average of 35% adoption. Is this good enough?

Recommendations:

In farmer training programs in other countries, more feedback mechanisms are designed into the activities. For example, before training begins, training needs assessment surveys are undertaken for each commodity both to learn what technologies farmers already know but more importantly what technologies farmers should but don't know. Training activities are then focused on the key concepts that farmers should know. This reduces the training load and makes the training more interesting to farmers. At the same time before each training activity, a short quiz is frequently given on questions relating to the main extension messages of the current demonstration. After the extension activities, the same quiz is given to measure understanding. This still does not mean that farmers would adopt the practices but at least tells if they understood the information. After each season small adoption surveys might be carried out with a small sample of 20 or so farmers and extension workers to measure adoption rates. This is another measure of the benefit of the extension activity. In general, more adoption usually follows demonstrations where farmers are not lectured to but follow exercises where they take observations in the field and then discuss the implications of those observations and draw conclusions. One activity would be for farmers to assess the pest populations in the field and then make decisions themselves on whether and what corrective measure to undertake.

14. The provisions made for monitoring the use and effectiveness of the pesticides

Some sort of appropriate monitoring and evaluation is needed of the mitigation program for the PERSUAP, particularly the issues mentioned in the Safer Use Action Plan.

Recommendations:

The key to monitoring and evaluation will be the interaction of the MEO with the partners on the one hand and the Senior Regional Environmental Officer on the other. The MEO should set up a committee of the partner members that would meet at least once a year to review progress in implementing the recommendations outlined in the PERSUAP particularly in the Safer Use Action Plan. Each partner may identify personnel who would have this duty and would act as monitors. The MEO would undertake visits to project sites as follow-up to see progress first hand. Minutes of the meetings would be communicated with the Senior Regional Environmental Officer and others as deemed appropriate.

As many of the concerns do not directly imply changes in procedures of the partners themselves but to GoU agencies, partners can only make suggestions. This was done in the IDEA PERSUAP and resulted in some results that benefited GoU as well as the projects themselves.

CLEARANCE:
Mission Director: _____/s/_____ Date: _11/09/05_____
Margot Ellis

CONCURRENCE:
Bureau Environnemental Office_____/s/_____ Date: __12/22/06_____
Brian Hirsch Approved: ____X_____
Disapproved: _____

File No: 36Uganda3 SO7 Crop PERSUAP (AID/AFR/W)

Mission Environmental Officer: _____/s/_____ Date:__10/12/05_
Jody Stallings, MEO

SO 7 Team Leader: _____/s/_____ Date:_10/26/05
Paul Crawford

Regional Environmental Officer: _____/revised and cleared/ Date:_Dec. 08, 2005
Walter I. Knausenberger

Monitoring and Evaluation: As required by ADS 204.5.4, the SO 7 team and project activity implementing partners will "actively monitor and evaluate whether the environmental features designed for the activity resulting from the 22 CFR 216 process are being implemented effectively and whether there are new or unforeseen consequences arising during implementation that were not identified and reviewed in accordance with 22 CFR 216." The SO team shall specify: who will monitor, how they will monitor, and how they will determine if there are "new or unforeseen circumstances."

If additional activities not described in this document are added to this program, an amended environmental examination must be prepared and approved before any funds can be obligated.

APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED: (Type Name under Signature Line)

CLEARANCE:
Mission Director: _____ Date: 11/9/05
Margot Ellis

CONCURRENCE:
Bureau Environmental Office _____ Date: 12/22/06
Brian Hirsch
Approved: X
Disapproved: _____

Filename: ____ (USAID/W BEO)

CLEARANCE:
General Counsel (Africa Bureau): _____ Date: _____
Tanya Nunn

ADDITIONAL CLEARANCES: (Add as appropriate; type name under signature line)

Mission Environmental Officer: _____ Date: 12OCT05
Jody Stallings

SO 7 Team Leader: _____ Date Oct 26, 2005
Paul Crawford

Sr. Regional Environmental Officer: _____/ revised & cleared /_____ Date: 9/23/2005
Walter I. Knausenberger

Recommendations:

Table 1. Products for *immediate removal and replacement* in USAID partner programs: all USEPA toxicity class I and RUP pesticide products

Pesticide	Brand	Formulation [1]/	WHO toxicity class	USEPA toxicity class	USEPA RUP	Registered USEPA	Registered Uganda
Insecticide							
lambda Cyhalothrin	Ambush CY Ambush Super	10% EC	II	I	Yes	Yes	Yes
Herbicide							
Paraquat	Gramoxone	60% WG	II	I	Yes	Yes	Yes
Rodenticide							
Coumatetralyl	Racumin	Pelleted bait	Ib	I	[2]/	No	Yes
Coumachlor	Tomorin	Pelleted bait	Ia	I	[2]/	No	Yes

[1]/ RUP = restricted use pesticide, EC = emulsifiable concentrate,
WG – wettable granules, [2]/ No RUP listing if not registered by USEPA

Table 2. Pesticides to be *removed from USAID-influenced programs by April 30, 2008* -- all pesticides which fall in USEPA toxicity class I or II that are listed here

Pesticide	Brand	Formulation [1]/	WHO toxicity class	USEPA toxicity class	USEPA RUP	Registered USEPA	Registered Uganda
Insecticide							
Carbofuran	Furadan	5% G	Ia	II	Yes	Yes	Yes
Carbosulfan	Marshall	2.5 EC	II	II	[2]/	No	Yes
Chlorpyrifos	Dursban	48% EC	II	II	Yes	Yes	Yes
beta-Cyfluthrin	Bulldock	2.5% EC	II	II	[2]/	No	Yes
Deltamethrin	Keshet Decitab	2.5% EC 0.5g/tablet	II	II	Yes	Yes	Yes

Diazinon	Diazol	60% EC	II	II-III	Yes	Yes	Yes
Dimethoate	Rogan	40% EC	II	II	No	Yes	Yes
Fenitrothion	Fenpaz	50% EC	II	II	Yes	Yes	Yes
Fenvalerate also Esfenvalerate	Fenfill	20% EC	II	II	Yes	Yes	Yes
Fipronil	Regent	20% EC	II	II	No	Yes	Yes
Pirimiphos ethyl	Primicid	20% EC	Ib	II	[2]/	No	No
Profenofos	Polytrin-K	40% EC	II	II	Yes	Yes	Yes
Nematicide							
Ethoprop	Mocap	10G	Ia	II	Some	Yes	No
Fungicide							
Anilazine	Dyrene	40% WP	IV	II	No	Yes	No
Copper oxychloride	Cupravit	50% WP	III	II	No	Yes	Yes
Bactericide seed dressing							
Bronopol	Bronocot	80% SP	II	II	[2]/	No	No
Herbicide							
Bromoxynil	Buctril	45% EC	II	II	No	Yes	No

[1]/ G = granules, EC = emulsifiable concentrate, WP = wettable powder, SP = soluble powder
[2]/ No RUP listing if not registered by USEPA

Table 3. Pesticides *permissible* in USAID sponsored or influenced programs. Suggested replacement pesticides are included

Pesticide	Brand	Formulation	WHO toxicity class	USEPA toxicity class	USEPA RUP	Regis-tered USEPA	Regis-tered Uganda
Insecticide							
Acephate	Orthene, Lancer	75% WP	III	III	No	Yes	Yes
Acetamiprid	Assail	70% WP	III	III	No	Yes	No
Azadirachtin	Neemol	4% EC	IV	III	No	Yes	Yes
Bacillus thuringiensis (Bt)	Xentari	10.3%DF	IV	III	No	Yes	No
Carbaryl [3]/	Sevin	< 50% Dust, WP	II	II-III	No	Yes	Yes
Imidacloprid	Gaucho	17.4% F	II	III	No	Yes	Yes
Indoxacarb	Steward	14.5% SC		III	No	Yes	No

Malathion [4]/	Malathion	WP	III	II-III	No	Yes	Yes
Methoxychlor	Marlate	25% EC	IV	IV	No	Yes	No
Methoxy-fenozide	Intrepid	22.6% F	III	III	No	Yes	No
NPVirus	Heliokill	0.6% LC		IV	No	Yes	No
Petroleum oil	Summer oil, white oil, horticultural oil	98% oil	IV	IV	No	Yes	No
Spinosad	Tracer	22.8% SC	IV	IV	No	Yes	No
Thiamethoxam	Cruiser	350 FS	III	III	No	Yes	[1]/
Fumigant/seed protectant							
Aluminum phosphide	Phostoxin	Tablet	[1]/	I	Yes	Yes	Yes
Malathion	Malathion	WP	III	II-III	No	Yes	Yes
Pirimiphos-methyl	Actellic	16% EC	II	II	No	Yes	Yes
Permethrin	Actellic	3% EC	II	II	Yes	Yes	Yes
Thiram	Thiram	65% WP	III	III	No	Yes	No
Fungicide							
Benomyl	Benlate	50% WP	IV	IV	No	Yes	Yes
Cymoxanil	Milraz	76% WP	III	III	No	Yes	[1]/
Dimethomorph	Acrobat	MZ	IV	III	No	Yes	Yes
Dithianon	Delan	75% WP	III	III	[2]/	No	No
Fosetyl aluminum	Aliette	80% WDG	IV	III	No	Yes	No
Kresoxim-methyl	Stroby	50% WG	Not rated	III	No	Yes	No
Mancozeb	Dithane	M 45% WP	IV	IV	No	Yes	Yes
Metalaxyl	Ridomil	7.5% WP	III	III	No	Yes	Yes
Propineb	Milraz	76% WP	IV	III	No	Yes	[1]/
Sulfur	Thiovit	80% WP	IV	III	No	Yes	Yes
Tebuconazole	Folicur	25% EC	IV	III	No	Yes	No
Thiophanate methyl	Topsin M	50% WP	IV	IV	No	Yes	Yes
Herbicide							
Diuron	Diurex	80%DF	IV	III	No	Yes	Yes
Glyphosate acid	Roundup, Touchdown Total	48% EC	IV	II-IV	No	Yes	Yes
Glyphosate salt	Touchdown	28% EC	IV	IV	No	Yes	Yes
Haloxyfop-R methyl	Gallant Super	52% EC	II	III	[2]/	No	No
Iodosulfuron-methyl-sodium	Hussar	50%EC	Not rated		[2]/	No	No

Metolachlor	Dual	960EC	III	III	No	Yes	Yes
Propanil	Rical	23%EC	III	III	No	Yes	No
Thiobencarb	Rical	11%EC	II	III	No	Yes	Yes
Bird repellent							
Methyl anthranilate	Bird shield	26.4% SC	IV	II	No	Yes	No
Molluscicide (snails)							
Metaldehyde	Mesurol	Pellets 3.5%	III	III	No	Yes	No
Nematicide							
Dazomet	Basamid	99%G	III	III	No	Yes	No
Rodenticide							
Bromadiolone	Ratoxin	Ready to use bait 0.005%	Ia	III	No	Yes	Yes
Warfarin	Ratatox	Ready to use bait 0.025%	Ib	III	No	Yes	Yes

[1]/ Being field tested for registration, [2]/ No RUP listing if not registered by USEPA
[3]/ Approved only in WP formulation, [4]/ Approved in concentrations below 50%

UGANDA CROP
PESTICIDE EVALUATION REPORT & SAFER USE ACTION PLAN
(PERSUAP)

for

Field Crop Production and Commodity Protection Programs

Supported in Uganda by

USAID/Uganda Strategic Objective 7 – Support for Economic Growth

(APEP and PRIME/West)

(Title II partners ACDI/VOCA, Africare, Catholic Relief Services,

Save the Children/USA, World Vision)

at the request of

the US Agency for International Development/Uganda
Kampala, Uganda

James Litsinger, Consultant to APEP

Production and Pest Management Specialist

Kampala, Uganda

December 5, 2005

ACRONYMS

$	US dollar
ACB	Agriculture Chemicals Board
ACDI	Agricultural Cooperative Development International
ADC	Agribusiness Development Centre
AIDS	Acquired Immune Deficiency Syndrome
BAT	British American Tobacco
Bt	*Bacillus thuringiensis* (biological insecticide)
APEP	Agricultural Productivity Enhancement Program, USAID Project in Uganda
CDO	Cotton Development Organisation
ASPPG	Agricultural Sector Pesticide Procedures Guide
CAB	Commonwealth Agricultural Bureau
CBNRM	Community-based natural resource management
CFR	Code of Federal Regulations
CGIAR	Central Group for International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIP	International Potato Center
cm	Centimeter
CORI	Coffee Research Institute Kituza
CRS	Catholic Relief Services
CRSP	Collaborative Research Support Program
DAI	Development Alternatives International Inc.
D	day/days
DAP	Development Activity Program
DANIDA	Danish International Development Agency
DF	dispersible flowable
E	East
EA	Environmental Assessment
EC	emulsifiable concentrate
EC_{50}	Molar concentration that causes 50% mortality
EMS	Environmental Management Systems
EU	European Union
FAO	Food and Agricultural Organisation (UN)
FHIA	Honduran Agricultural Research Foundation
FORRI	Forestry Resources Research Institute
FY	fiscal year
g	Gram
G	Granule
GMO	Genetically Modified Organism
GoU	Government of Uganda
GUP	General Use Pesticide
ha	Hectare
HCH	Lindane insecticide
HIV	Human Immunodeficiency Virus
ICRAF	World Agroforestry Centre
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDEA	Investment in Developing Export Agriculture
IEE	Initial Environmental Evaluation
IFDC	International Fertilizer Development Center
IITA	International Institute of Tropical Agriculture
IMF	International Monetary Fund
IPICS	International Programme in the Chemical Sciences
IPM	Integrated Pest Management
ISO	International Standards Organisation

K	Potassium
KARI	Kawanda Agricultural Research Institute
Kg	Kilogram
L	Liter
LC_{50}	Lethal concentration to cause 50% mortality
LD_{50}	Lethal dosage to cause 50% mortality
m	Meter
M	Million
µ	Micron
MAAIF	Ministry of Agriculture, Animal Industry, and Fisheries, Uganda
MEO	USAID Mission Environmental Officer
Mg	Milligram
ml	Milliliter
MPS	Dutch firm that issues environmental compliance certifications
MTCS	Medium-Term Competitiveness Strategy
N	North
N	Nitrogen
NAADS	National Agricultural Advisory Services
NAARI	Namulonge Agricultural and Animal Research Institute
NARO	National Agricultural Research Organisation
nd	no date
NEAP	National Environmental Action Plan
NEMA	National Environmental Management Authority
NGO	Non Governmental Organization
NPV	Nuclear Polyhedrosis Virus
NRI	Natural Resources Institute UK
P	Phosphorous
PAMP	Pesticide Action and Mitigation Plan
PAN	Pesticide Action Network
PEAP	Poverty Eradication Action Plan
PERSUAP	Pesticide Evaluation Report and Safer Use Action Plan
PHI	Pre-harvest Interval
PIR	project intermediate result
PL-480	US public law 480 allows food aid to be sold to raise money for development projects
PMA	Programme for Modernisation of Agriculture
PRIME/West	Productive Resource Investment for Managing the Environment-Western Uganda, USAID Project
QE	Queen Elizabeth
Reg.	Regulation
REI	Re-entry interval
RUP	Restricted Use Pesticide
S	South
SAARI	Serere Agricultural and Animal Research Institute
SC	Save the Children/USA
USh	Uganda Shilling
SG 2000	Sasakawa Global 2000
SO	Strategic Objective
SP	soluble powder
SPEED	Support for Private Enterprise and Development
t	Metric ton
TOT	training of trainers
UCDA	Uganda Coffee Development Authority
UGTL	Ugandan Grain Traders Ltd.
UN	United Nations

UNFFE	Uganda National Farmers' Federation
UPDF	Uganda People's Defense Force
US	United States
USAID	United States Agency for International Development
USEPA	US Environmental Protection Agency
UWA	Uganda Wildlife Authority
VOCA	Volunteers in Overseas Cooperative Assistance
VLV	Very low volume
W	West
WFP	World Food Programme (UN)
WG	wettable granule
WHO	World Health Organisation
WP	wettable powder
WTO	World Trade Organization
WV	World Vision
Yr	year/years

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List of Tables

[Note: all 22 commodities in Section 3.2 include a table of pests and the respective present pest management practices in Uganda]

Annexes

EXECUTIVE SUMMARY

In accordance with U.S. Federal Regulation 22 CFR 216.3(b), USAID's Pesticide Procedure, all USAID funded projects that use pesticides, or influence pesticide use, need to file an appropriate analytical documentation for approval to promote safer use of pesticides. USAID has developed a format through which this is carried out based on a Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP), in this case for crop and commodity protection related activities supported by USAID/Uganda. A PERSUAP is designed to provide the technical, analytical, and mitigative information to be able to fulfill the requirements set out in federal regulations. The present PERSUAP covers programs conducted on behalf of USAID/Uganda by seven contractors and grantees: the Agricultural Productivity Enhancement Program (APEP)(Chemonics, prime contractor), the Productive Resource Investment for Managing the Environment-Western Uganda (PRIME/West) program (DAI, prime contractor), and the five Title II Food Aid PVO grantees ACDI/VOCA, Africare, Catholic Relief Services, Save the Children/USA, and World Vision, which are undertaking agricultural and environmental activities. The report provides background information in the first three sections. Section 3 provides detailes breakdown by commoditiy as to pest problems encountered in Uganda, and Section 4 provides and analysis which complies with federal regulations for the pesticide evaluation component while Section 5 lists 13 concerns and recommendations related to pesticide use as a result of the consultancy. The PERSUAP proposes of 45 pesticides as acceptable and least toxic options for crop protection needs in Uganda programs influenced by USAID, including some recommended replacements for those disallowed (14 insecticides, 14 fungicides, 8 herbicides, 4 seed protectants/fumigants, 2 rodenticides, 1 each for a bird repellant, molluscicide, and nematicide). Twenty one pesticides were disallowed as being too hazardous to those applying them or to the environment. Section 6 outlines the monitoring program for follow-up. The Final Action Form is a separate summary document detailing the essential issues and recommendations, for approval by the Africa Bureau Environmental Officer.

1. INTRODUCTION

Two of USAID's primary contractors in Uganda – Chemonics and Development Alternatives International Inc.(DAI) – through the respective Agricultural Productivity Enhancement Program (APEP) and Productive Resource Investment for Managing the Environment-Western Uganda (PRIME/West) Program, manage agricultural and environmental projects. In addition, PL-480 Title II Monetization Program partners ACDI/VOCA (FY 2002-2006), Africare (FY 2002-2006), Catholic Relief Services (FY 2002-2006), Save the Children/USA (FY 2004-2008), and World Vision (FY 2004-2008) have undertaken agricultural programs to improve food security and rural livelihood throughout Uganda. Vegetable cooking oil and hard red winter wheat are imported and monetized to support these partners' activities. U.S. federal environmental regulations require USAID-funded projects to complete an Initial Environmental Evaluation (IEE) of its programs. The IEEs were completed, with a deferral on the pesticide components, until more specific pesticide usage could be detailed and a PERSUAP produced

A technical review of pesticide usage must be carried out before the Amended IEE can be written. This technical review is composed of two parts as the name suggests: Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP). The results are recommendations which adoption will be monitored under the direction of USAID's Mission Environmental Officer (MEO). The proforma for a PERSUAP was developed by the agency's environmental staff which began with the Investment in Developing Export Agriculture (IDEA) project, the predecessor of APEP. The purpose of the PERSUAP is to provide guidelines for the development of IEEs by project staff or their hired consultants. Several iterations led to the current makeup of a PERSUAP, the first of which began in 1999 as 'USAID/Uganda Agricultural Sector Pesticide Procedures Guide (ASPPG) (Schaefers, et al. 1999)' a review of 13 projects in the Strategic Objective 1 (SO1) program "Increasing Rural Household Income". The ASPPG set about to develop the background information and guidelines to develop the pesticide procedures for the IEEs. The ASPPG morphed into the Pesticide Action and

Mitigation Plan (PAMP) (USAID 1999) which was later renamed as a PERSUAP. Since the IDEA project PERSUAP, others have been completed in Uganda for dairy and malaria control projects.

The IDEA PERSUAP mostly covered exported flowers and vegetables. Some beneficial results that occurred as a result are that both the Uganda Flower Exporters' Association (UFEA) and wholesalers have lobbied the pesticide regulatory office to allow importation of safer, but unregistered pesticides on a trial basis and have been given a restricted use import permit for these products with the stipulation that these pesticides will not be re-sold. If the products perform well, then registration procedures would follow. As a result of the IDEA project the flower growers have become highly organized and two more pesticide wholesalers that cater to the floriculture industry have appeared to supply the newer pesticides. The need for nematicides, which are highly toxic, has been minimized in greenhouses by adoption of soilless culture using coconut coir. Steam sterilization pipes are being constructed underground so beds can be treated without using methyl bromide fumigant which is in the process of being banned in most countries in accordance with the international Montreal Protocol on Substances that Deplete the Ozone Layer' first signed in 1987. Floriculture and some vegetable exporters have constructed concrete holding tanks to capture pesticide rinseate during cleaning operations, preventing contamination of Lake Victoria. There is a strong effort to minimize pesticide application to greenhouses by working with a private integrated pest management (IPM) company that mass produces biocontrol organisms to be released. The Real IPM Company has a contract with UFEA through APEP funding and has identified indigenous predatory mites which are now being cultured with the assistance of the industry and to be released in test greenhouses against spider mite. The Kenyan company has had success there but in order to satisfy quarantine worries, has focused on indigenous predators. The new industry also creates employment in Uganda and saves foreign exchange.

The APEP and Title II partner projects covered in this PERSUAP work with the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) to strengthen production and markets for agricultural commodities. PRIME/West is an environmental project working mostly with the Uganda Wildlife Authority (UWA) but has agricultural and forestry components such as plantation crops, field crops, fruits, spices, and fuelwood. As all of these commodities are threatened by pest problems, it is anticipated that as the projects become successful in carrying out their objectives, pesticide usage should increase due to the very low levels at present and the concomitant low productivity. The various projects' goals are consistent with Government of Uganda's (GoU) Poverty Eradication Action Plan (PEAP), Programme for Modernisation of Agriculture (PMA), and the Medium-Term Competitiveness Strategy (MTCS). The projects fall under USAID's objective of 'expanded sustainable economic opportunities for rural sector growth' within SO7.

2. BACKGROUND AND PROGRAM DESCRIPTION

2.1 Scope and Aim of the Report

The PERSUAP is expected to provide guidelines for safer pesticide use to reduce damage, in both field and storage, caused by weeds, arthropod and vertebrate pests, diseases, nematodes, and snails. The term 'pest' in this document is generic, referring not just to insects. Likewise, 'pesticides' is a generic term.

Crops in Uganda are infested and damaged by pests to varying degrees, often causing economic loss. The damage from weeds is potentially serious to all crops. Arthropods and plant diseases and nematodes can be particularly injurious to cotton, coffee, upland rice, maize, cassava, grain legumes, banana, Irish potato, and sweet potato. If uncontrolled, or not controlled effectively, economic crop loss can occur, posing serious obstacles to the achievement of the objectives of USAID and GoU programs. It is expected that pesticide usage would be imbedded within integrated pest management (IPM) programs which stress alternative practices to pesticides as well as safety and decision guidelines for their effective usage. The USAID sponsored IPM-Collaborative Research Support Program (CRSP) in collaboration with Makerere University and the MAAIFs research arm via

regional experiment stations of the National Agricultural Research Organisation (NARO) has been particularly active in developing sustainable pest control methods. Unfortunately farmers have had a history of either opting completely on a pesticide based strategy or the contrary of not using any purchased pesticides at all, depending on the commodity and climatic region. Farmers have developed indigenous methods of pest control that have varying degrees of success. In the absence of standardized GoU pest control recommendations, there is often confusion on the part of farmers on what to do. Farmers are then vulnerable to input suppliers who have commercially vested interests in encouraging pesticide dependence. Farmers are ill informed about sustainable methods of pest control due to weak extension programs and a lack of appropriate technologies. GoU has now embarked on a basket funded extension program NAADS (National Agricultural Advisory Services) to privatize services as a bold means of overcoming current weaknesses. Dependence solely on pesticides can lead to pesticide resistance, secondary pest outbreaks, and increased hazards to humans and the environment. A review of the Ugandan pesticide regulatory apparatus will be made to ensure that pesticide use will follow GoU regulations.

The approval of the use of pesticides was deferred in the respective programs' Initial Environmental Evaluations (IEEs) pending completion of a PERSUAP for crop production and commodity storage. This deferral is consistent with USAID's Environmental Procedures, specifically the provisions governing pesticide procurement or use (Reg. 216, 22 Code of Federal Regulations [CFR] Part 216.3(b)(1).) (See Appendix E-2 in USAID Washington 1996).

The USAID Environmental Procedures §216.3(b)(1)(i) through (l) (as provided by USAID Environmental Procedures: text of CFR Title 22, Part 216, Reg. 216) (USAID Environmental Guidelines for Small-Scale Activities in Africa 2003), indicate that when a project includes assistance via use of pesticides registered for the same or similar uses by the US Environmental Protection Agency (USEPA) without restriction, the IEE for the project shall include a separate section evaluating the economic, social and environmental risks and benefits of the planned pesticide use to determine whether the use may result in significant environmental impact.

By USAIDs definition 'use' is broad to include direct or actual use or procurement, including the handling, transport, storage, mixing, loading, application and disposal of pesticides. Recommending pesticides in training programs or in published bulletins is considered also to need a PERSUAP. Indirect uses also fall under its purview such as providing fuel for transporting pesticides and technical assistance to pesticide management operations. Use is said to occur if training curriculum include information on safer pesticide use even if it does not involve actual application of pesticide. It also applies if pesticide procurement is facilitated by credit or loans. USAID also strongly encourages including instruction in IPM and alternatives to pesticides in any training on pesticide use. Under this approach, pesticides are considered a tool of 'last resort' and pesticide choice should as far as feasible be the 'least toxic' choices. Support to pesticide research and pesticide regulatory activities is not considered use.

The PERSUAP is an instrument used in the preparation of an IEE. The recommendations from the PERSUAP will be summarized along with formulating an action plan for their mitigation by the partners in a separate document, the Final Action Form. Both of these two documents will be used to amend the IEEs by the partners. The rationale for a PERSUAP–type environmental review is to avoid straightaway use of the broader and more expensive Environmental Assessment (EA), as normally an IEE would indicate a probable result of 'Categorical Exclusions and Negative Determinations with or without Conditions' that does not indicate an EA is warranted. Thus an EA would only be carried out if the IEE concluded that it were necessary. Normally it would not be required and pesticides in the development programs would be used under tight management spelled out as mitigative procedures and conservation practices under the guidance of trained and experienced staff members and review of the Mission Environmental Officer (MEO).

2.2 Country Background

Although not a large country by African standards, Uganda is among the continent's richest countries with respect to its natural environment. Bodies of water, most notably Lake Victoria, cover 20% of the area (Figure 1). Seven of Africa's bio-geographic regions and some 90 vegetation communities are represented as it occupies a transition zone between East African savannas to the moist tropical forests of the Congo Basin. Uganda's highly diverse landscape includes rift valleys, highlands and mountain ranges, papyrus swamps, acacia savannas, and an extensive network of interconnected rivers and lakes.

Population pressure has recently increased sharply, now more than four times higher than in 1950, trebling every 30 years. By 2025 the total is projected to be 55 million. Cropland has increased dramatically over the past decade by almost 20% with farmers seeking more fertile soils. Forest and woodland cover has declined from 45% in 1890 to 20% today. Agricultural conversion has played a major role in this process. Soils in general are free of mineral deficiencies/toxicities and pH is generally favorable and its volcanic origin makes for excellent texture. A bimodal rainfall (1.0 to 2 m annually) extends the growing season favorable for double cropping. Along the Lake Victoria crescent there is no distinct dry season. Even upland rice can be cultivated twice a year. In the north, rains are favorable for a single crop of sorghum or millet. Along some of the volcanic peaks, rains can be year round to favor coffee, tea, cocoa, and banana production.

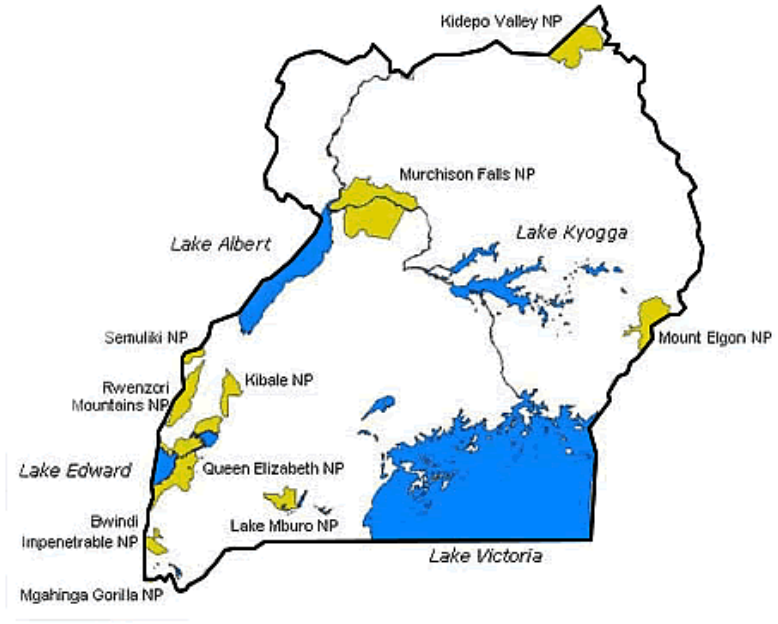

Figure 1. Map of Uganda showing bodies of water and biodiversity conservation areas.

Despite the favorable natural resource base, there is a large yield gap between what farmers now achieve and what can be achieved as determined by research trials. Maize yields are now 1.5 t/ha (potential of 4-5 and 7-9 t/ha for open pollinated and hybrids respectively), sunflower (1 t/ha), and banana 5 t/ha (potential over 30 t/ha). Agriculture accounts for 60% GDP and 98% of export earnings for the 90% of Ugandans that live in rural areas. The agricultural sector is comprised of 99% small scale farmers. Farm sizes average 2.5 ha per family equaling 4.5 M ha total of which 4.1 M ha is devoted to food and non-traditional cash crops production and livestock grazing while 0.4 M ha are devoted to traditional cash crops (coffee, tea, cotton, tobacco, and sugarcane). Non traditional crops include cocoa, vanilla, floriculture. Food crops are dominated by bananas, cassava, sweet potato, maize, sorghum, finger millet, beans, Irish potato, sesame, and groundnuts.

During the colonial period and into the 1970s, Ugandan farmers relied to a large extent on traditional cash crops (coffee, cotton, tea, tobacco) to generate incomes and export earnings. There was thus an over-reliance on a few crops for rural incomes and export earnings. To illustrate this, in 1978, coffee alone accounted for 95% of all of Uganda's export earnings. With an emphasis on export crops, high levels of poverty in the rural areas occurred and the national balance of payments deficit overburdened the economy. Uganda needs to increase incomes, particularly rural incomes, and increase exports to generate much needed foreign exchange.

The development of food crop agriculture needs to be considered as a pivotal poverty reduction strategy in Africa despite the sector's erratic performance. Land tenure systems have failed to encourage investment in the land resource base and there is evidence that soils are being degraded as population pressure increases, particularly as migration occurs into more marginal areas. There is a lack of credit in Uganda due to lack of land titles as most land is communally used. Credit is given to men if at all, but women do most of the agricultural work. The observed low productivity is mostly a consequence of poor agronomic practices rather than environmental limitations. Inputs such as fertilizers and pesticides are expensive due to the great distances Uganda is from the suppliers. Transportation costs are high. Inputs come by ship to Kenya and overland by truck to Uganda. There are no government subsidies on pesticides. Suppliers are limited however and pesticide costs in the rural areas are sometimes double those in Kampala. Few farmers, for example, apply pesticides. Inorganic fertilizer is not taxed as is pesticides but few farmers apply fertilizer either from organic or inorganic sources. Few farmers have draught animals and thus prepare the land by hand tools. Farming has become all the more difficult as the HIV/AIDS incidence is decimating rural labor. Weeds can become overwhelming.

Due to the limited arable land there will be a need for productivity increases on the existing lands, including increased pesticide usage. Small farmers are slowly increasing pesticide usage but they are poorly informed about the proper selection and are inadequately trained and equipped for the correct and safe application of these products.

There are environmental concerns. The fast growing population puts more pressure on the agricultural sector as demand for food increases. This implies further encroachment on land, increased irrigation, and agrochemical usage. With its extensive wetlands and lakes there is a risk that uncontrolled pesticide usage will contaminate economically important resources such as Lake Victoria. In 1999 the lucrative export market for fish to Europe was stopped due to endosulfan residues found in fish.

Agricultural research is carried out by the MAAIF regional research stations under NARO, the National Agricultural Research Organisation. The three largest stations include Kawanda Agricultural Research Institute (KARI) (horticulture and post harvest) and Namulonge Agricultural and Animal Research Institute (NAARI) (root crops) both outside Kampala as well as Serere Agricultural and Animal Research Institute (SAARI) (dryland crops) in the northern zone of lower rainfall. There is also the Kituza Coffee Research Institute (CORI) also near Kampala and a few smaller ones elsewhere. Also important is the Crop Science Department of Makerere University which has support from the USAID IPM-CRSP.

Extension however is carried out by a wide range of institutions and local entities. The traditional extension service under MAAIF in Entebbe was decentralized. Farmers mostly depend upon their neighbors or agricultural suppliers for advice and technical assistance. There is no national compilation of recommended production practices and the many sources of advice (chemical companies/stockists, agricultural extension service, various NGOs, private plantations and estates, and various projects) result in inconsistent messages confusing farmers.

Currently GoU is devolving the extension service with a view to make it self supporting and demand driven. NAADS funds local communities and farmer organizations to enable them to contract extension workers to deliver the technical services farmers determine they require. The various

commodity organizations such as Cotton Development Organisation (CDO) and British American Tobacco (BAT) hire their own extension workers, as do chemical companies, NGOs, and farmer organizations such as the Uganda National Farmers' Federation (UNFFE) which has over 200,000 members.

The Uganda Wildlife Authority (UWA), Ministry of Tourism, Trade and Industry, established in 1996 by the Uganda Wildlife Statute, merged the Uganda National Parks and the Game Department. UWA is in charge of management of 10 National Parks, 12 Wildlife Reserves, 14 Wildlife Sanctuaries, and provides guidance for 5 Community Wildlife Areas. UWA's mission is to conserve and sustainably manage the wildlife and Protected Areas of Uganda in partnership with neighboring communities and stakeholders for the benefit of the people of Uganda and the global community.

The mandate of the Forestry Resources Research Institute (FORRI) under MAAIF covers all aspects of natural and plantation forest management and conservation, forest products and utilization, and agroforestry. The goal of FORRI is to generate appropriate technologies for increasing the productivity and supply of forest products on a sustainable basis. The institute also strives to strengthen and develop national forestry research capacity through personnel training, physical facilities improvement, management, networking and collaborative work.

NEMA, the National Environmental Management Authority, is responsible for monitoring, planning and coordination of environmental matters, implementation is the responsibility of relevant line ministries. Environment liaison units within each line ministry are responsible for integrating environmental concerns into their sectoral plans, and implementing environmental activities within the mandate of the Ministry of Water Lands and Environment.

2.3 USAIDs Strategic Objectives and Partner Programs

There is a compelling need for an integrated approach to land use development in Uganda that can simultaneously strengthen environmental conservation, promote growth in rural productivity, incomes, and increase agricultural productivity and exports. Addressing these needs is USAIDs SO7 which merges environmental and economic growth under a single objective with the overarching goal of reducing mass poverty. SO7 directly aligns USAID assistance with Uganda's development goals.

2.3.1 APEP

The Agricultural Productivity Enhancement Program (APEP) aims to expand rural economic opportunities in the agricultural sector by increasing food and cash crop productivity and marketing. APEP builds on sector successes with added emphasis on creating economies of scale that catalyze transformation of agriculture from low input/low output, subsistence farming to commercially competitive agriculture. APEP addresses targeted commodities and related systems; production-to-market transactions; improvements in input distribution, technology transfer, and producer organizations; and development of competitive agricultural and rural enterprises.

APEP works through three project intermediate results (PIRs). These are: Increased Enterprise Efficiencies; Increased On-Farm Productivity; and, Improved Enabling Environment. It has broad geographic coverage in Uganda with commodity chain support to the following commodity sub-sectors: cotton, coffee, grains & oilseeds, vanilla & spices, and, matooke banana. Cassava and sweet potato cuttings will be provided to resettlement areas in the North. The floriculture sub-sector involves strategic and policy interaction at the industry level and does not involve production issues.

APEP has a somewhat different role regarding use of pesticides than its predecessor project IDEA. In IDEA project the staff directly purchased and used pesticides and made recommendations on pesticide use among other cultural practices. APEP does not directly purchase pesticides as this is done via ginneries or CDO in the case of cotton. APEP does jointly make pest control recommendations with NARO, the research arm of MAAIF, or the CDO, a GoU body, in publishing some production bulletins and training aids which include the use of pesticides (APEP 2004a, APEP 2004b). APEP gives advice on obtaining good quality pesticides from suppliers that employ agronomists and test

their materials in order to avoid adulteration, common in Uganda. APEP staff gives IPM advice for on-farm demonstrations (IPM control practices including the role of natural enemies and other non-pesticide measures, pesticide decision making protocols, correct timing, safe handling practices). APEP sponsored training programs that emphasize safe and effective usage (what protective clothing to wear, how to measure and mix pesticides, apply correctly, clean sprayers, as well as safe disposal of empty pesticide containers). Training programs do state which pesticides are recommended. Fumigation of stored products or seed treatment is done by contract with private profession pest control operators who use protective equipment.

2.3.2 PRIME/West

The Productive Resources Investment for Managing the Environment (PRIME/West) Project falls within USAID/Uganda SO7, Expanded Sustainable Economic Opportunities for Rural Sector Growth. The project's objective is to conserve biodiversity by reducing threats to forest, woodland and aquatic ecosystems through increased economic opportunities and conflict resolution for rural communities in selected regions of southwestern and western Uganda. The project seeks to conserve critical habitat and species in the two landscapes that comprise the Ugandan portion of the Albertine Rift Valley.

The project operates under the following premises:

- Increased local, district and national capacity to use threat and asset-based landscape analysis and planning techniques will enhance decision making with regard to the trade-offs between biodiversity conservation and economic development, leading to the improved management of biodiversity and other natural resources;
- Establishing communal property and management regimes by defined groups in defined areas/critical ecosystems with rights of inclusion and exclusion will result in fewer threats/conflicts and increased biodiversity; and
- Providing economic alternatives to unsustainable natural resource uses will contribute to reducing environmental degradation and will help conserve these critical ecosystems.

From a geographic perspective, PRIME/West implements activities within the Greater Virunga Landscape and the Murchison Falls-Toro-Semliki Landscape. PRIME/West focuses its activities on reducing the following two threats to biodiversity in these landscapes:

- Habitat loss/degradation/fragmentation; and
- Over-utilization of natural resources.

To maximize SO7 results, DAI uses three approaches that will systematically seek to bring biodiversity conservation/ natural resource management and economic development together into a practical and sustainable model. These approaches are:

- Landscape Analysis;
- Community-based natural resource management (CBNRM); and
- Competitiveness.

The potential impact of PRIME/West lies not only in the soundness or application of these individual approaches but in their creative combinations to yield sustainable solutions in participation with local partners. Thus, landscape principles will drive the analyses and inform program participants as to the productive potential – both economic and ecological - of the land. The CBNRM approach will provide communities with use-rights of the natural resources concerned, along with the ability to decide on when and how to use those resources. The competitiveness approach will turn economic and environmentally sustainable solutions and secure tenure and use rights into action within the private sector.

The PRIME/W activity directly supports two key sub-PIRs:

* Enabling environment for biodiversity conservation and improved livelihoods strengthened; and

* Threats to forest, woodland and aquatic ecosystem (lakes and wetlands) biodiversity decreased.

PRIME/West is evaluating a number of crops and commodities for use in buffer zones around parks and conservation areas to encourage farmers and their neighbors to respect the boundaries. Fuelwood species are being evaluated and project trained staff will use pesticides to protect the nurseries before distribution to farmers. PRIME/West will evaluate a number of new or renovated crops such as robusta coffee, tea, Irish potatoes, and fuelwood (*Eucalyptus, Grevillea, Albizia*) that will use pesticides on the evaluation trials. All pesticide usage will be carried out by project staff and not farmers.

2.3.3 PL-480 Title II Partners

The five Title II partner's objectives fall within GoUs goals of the PEAP and transforming subsistence agriculture to commercial agriculture (PMA). Rural food insecurity leads to malnutrition and low resistance to diseases and finally to low life expectancy in rural areas. Food insecurity is attributed primarily to utilization of inefficient and laborious agricultural cultivation implements, poor agronomic practices, poor seed quality, lack of price incentives, pest problems, erratic rainfall in some areas, poor infrastructure, lack of education, and poorly funded and organized extension systems. The HIV/AIDS epidemic has also created a further strain on family income-generation and food security due to an increased number of orphans and loss of productive family members. Title II partners' activities address these issues.

All of the partners are working with the most marginalized farm communities thus farm sizes are small. Pest control technologies are focused on introducing pest resistant varieties and adoption of organic farming practices with use of petroleum based pesticides being shunned. The model is to expand the home vegetable garden technologies to field agriculture. This model utilizes more labor-intensive technologies such as hand picking insect pests from plants, but as farmers gain success and want to expand farm area, labor saving practices such as synthetic pesticides and inorganic fertilizers will come more into play as farming changes from a subsistence to a commercial enterprise. A farm over one acre cannot generate enough compost to fertilize fields and herbicides will be needed for weeding. As yield potential increases, insecticides and fungicides will become more economically attractive. Title II partner extension agents will likewise need to receive more training in pest identification and pesticide control methods as many are currently weak in these areas.

2.3.3.1 ACDI/VOCA

ACDI/VOCA has targeted 120,000 beneficiaries in 20 districts throughout Uganda. It has piggybacked onto APEPs program by identifying the most promising farmer groups and strengthening them into marketing associations. The farmer groups receive assistance through: i) increased access to rural financial services for inputs, production, and marketing, ii) demand driven agricultural extension services, iii) increased supply of agricultural inputs, iv) increased local and regional market access, and v) improved nutritional practices at the household level. A training component supports the achievement of these sub-objectives. Agricultural production is stimulated through credit facilitation for inputs and contracting for extension assistance following GoUs decentralization program. Farmers are given agribusiness and management skills as well as information on IPM and the safe and efficient use of pesticides. Conservation programs focus on promoting environmental awareness and minimizing land degradation. Farmers are supported by postharvest handling of marketable commodities to both store food reserves and sell. Some 250 agricultural extension agents are being trained in many topics including IPM and the safe and effective use of pesticides.

2.3.3.2 Africare

Africare is on Phase 2 of its Uganda Food Security Initiative with farmers in five districts (Kabale, Ntungamo, Rukungiri, Kanungu, and Kisoro). Its staff undertakes extension services to encourage farmers to improve agricultural production in Irish potatoes, sweet potatoes, apples, climbing beans, and livestock. Africare has a policy to not recommend commercial pesticides but exposure comes from their partners: NARO, International Center for Tropical Agriculture (CIAT) based in Colombia,

the International Potato Center (CIP) based in Peru, the World Agroforestry Centre (ICRAF) based in Kenya, and FORRI during varietal testing. Agroforestry work, to produce fuelwood, centers on *Albizia, Grevillea* and *Eucalyptus*. Seeds are boiled to reduce fungal disease at planting in the nursery (no pesticide seed dressing). A number of tree species are introduced to minimize pest problems and vulnerability from monoculture. Africare staff work with farmers to encourage soil erosion control by planting Napier grass on contour vegetative strips harvested to feed milking goats. Working with CIP, improved varieties of Irish potato and sweet potato have been identified. The former possess disease resistance while the latter are high in vitamin A. Farmers undertake training via farm demonstrations and are working with CIP testing the Farmer Field School extension method.

2.3.3.3 Catholic Relief Services (CRS)

CRS hires extension staff working with Internally Displaced People (IDP) residing in camps in Gulu. Agriculture remains the backbone of the region's economic well-being and the 18- year conflict has constricted agriculture in the region, restricting farming activities to areas around the protected camps and towns where UPDF could offer protection to people from the rebels. The Development Activity Program (DAP) in its effort to improve the food security and overall livelihood for the targeted beneficiaries focuses its efforts on ensuring access to farmland, seeds/planting material, and agricultural extension services. The conflict has compelled most farming households to focus on food security crops (finger millet, groundnuts, sorghum, maize, rice, beans, cassava and sweet potato). Farmers are being trained in modern farming and agronomic practices, conducting on-farm variety trials, demonstrations, multiplication as well as dissemination of improved crop varieties in order to enhance productivity. CRS works with the research staff of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the International Institute of Tropical Agriculture (IITA) posted in Kampala to select new germplasm. Often the certified seed they purchase is treated with fungicide. In 2004, 31 demonstration sites were established stressing: timeliness and quality of land preparation, weeding, and appropriate spacing. Over 2,000 farmer groups have been formed into marketing agencies in order to receive higher prices. CRS hires its own extension workers who in turn train key farmers who in turn each train four farmers. Farmers cannot raise draught animals due to theft thus CRS pays for large areas to be plowed by tractors. Farmers are given vouchers to purchase improved seed at seed fairs from previous cooperators. No synthetic pesticides are used now. Some farmers use biorational products for stored seed in small containers: ground up neem leaves and ground chili. Seeds are dried in the sun before storage and groundnut is stored in the shell to prevent pest entry. Wood ash is sometimes used on vegetable crops but often is phytotoxic. Some farmers have some sprayers for vegetables but these are not supported under the project. In the next phase of the project there may be more involvement with pesticides as they try to raise yields.

2.3.3.4 Save the Children/USA (SC)

SC works with about 25 farmer production and marketing associations comprising 5,500 farmers in Nakasongola District which focus on agricultural production, storage, and marketing. Its project on Enhancing Food Security through Poverty Alleviation distributes food to marginalized families and AIDS victims. Food is distributed monthly among 25 distribution centers, mostly at GoU health centers. There are two distribution sites per location. One is for the most vulnerable householders who have confirmed AIDS and the other for the poorest of the poor. Before food is distributed SC workers check the health of the children and give the mothers nutrition and AIDs information (counseling and sensitization). In 2004 100 t (corn-soybean blend meal, dry lentil beans, and soybean oil) were delivered and distributed to over 100,000 beneficiaries. SC also has an agricultural improvement program and employs 7 agricultural officers who supervise 250 extension officers who in turn train key farmers. Extension workers give messages to cooperating farmers during key periods of the crop cycle. They also sponsor field days to show neighboring farmers new technologies. Sustainable agricultural practices are followed based on the Kulika Charitable Trust's Training Program including non-chemical IPM management practices for field and storage. Market linkages between input suppliers and small business that supply farmers are being established.

2.3.3.5 World Vision (WV)

WV conducts its Livelihood Security Project in N. Uganda in Gulu and Kitgum. The overall goal is to improve livelihood security for 25,000 households by increasing incomes and improving food security, health and nutritional status of vulnerable groups. Workers distribute supplemental food rations to over 6,000 beneficiaries on a monthly basis from the most vulnerable households. WV offers nutrition and community health training including monitoring the progress of pregnant mothers and their children after delivery. The program further strengthens research-extension-farmer linkages by training model farmers who in turn disseminate new crop technologies to their neighbors. WV collaborates with international centers to obtain new germplasm for major food crops such as rice, groundnuts, soybeans, sunflower, and cassava. Farmers receive in-kind loan packages of seeds. WV promotes adoption of organic farming that excludes synthetic inputs such as commercial pesticides and inorganic fertilizers. They rely instead on composting, use of farmyard manure, fertility trenches, and biorational pest control methods. Their extension agents set up organic farming demonstration centers in each sub-county. They are promoting agroforestry and establish a tree nursery in each parish with an annual output of 5,000 seedlings per nursery (*Calliandra sp., Leucaena leucocephala, L. divesifolia, Azadirachta indica, Moringa oleifera, Sesbania sesban, Cassia siamea, Markehamia excelsa*, and various fruit trees).

2.4 Study Methodology

The consultant reviewed the scope of work including the desired format of the PERSUAP and reviewed the findings of previous PERSUAPs. After mobilization Jan 17 and arrival Jan 19, 2005, the consultant received an orientation by the team leaders of both APEP and PRIME/West and met the MEO of USAID. A work plan was submitted to the MEO Jan 24 and follow-up reports were submitted Feb 2 and 11. On Feb 9, after consulting with the regional environmental director of USAID, coverage was extended to the five Title II partners' programs. The consultant's main task was debriefing key informants in all relevant disciplines. This began with project commodity staff of APEP and meeting consultants of PRIME/West and the five Title II partners to determine the pests and current control measures of the commodities to be covered by the PERSUAP. A final list of commodities was soon developed.

Current pest control knowledge, attitudes, and practices of farmers was ascertained by interviewing secondary sources as well as undertaking field visits to Mbarara, Nakasongola, Kisalize, Kaliro, and Iganga. Wholesalers and retailers as well as open markets were surveyed in Kampala and Nakasongola to assess availability of pesticides and protective equipment and clothing. The MAAIF registrar of pesticides was interviewed to determine the current state of registered pesticides, importation, and registration practices and capacity. Key personnel in research and extension were met at the National Agricultural Research Organisation (NARO) of MAAIF as well as Makerere University. Research reports were scanned from the University of California Davis library (CAB Silver Platter), IPM-CRSP Annual Reports (www.ag.vt.edu/ipmcrsp/index.asp), from Makerere University (African Crop Science Journal, Proceedings of the African Crop Science Conferences), and NARO (Uganda Journal of Agricultural Sciences). Extension agents from GoU and NGO and private entities were interviewed. Other entities involving health, the environment, and training were solicited. A list of people contacted is presented (Annex 1). A seminar to 36 stakeholders was given Feb 22 at the APEP office (Annex 2). A follow-up neting was held with the REO and key stakeholders in July 2005.

The status of pesticides available in Uganda, use by farmers, and in partner recommendations to farmers was reviewed in terms of USEPA <www.USEPA.gov> and GoU compliance. Information as to toxicity class and nontarget hazard was referenced in technical manuals reviewed in the U.S. as well as the Farm Chemicals Handbook 2004, WHO toxicity data from the website of the International Programme on Chemical Safety (The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 2004 <www.who.int/ipcs/publications/pesticides _hazard/en/>). USEPA registration status was determined by formulation via <www.kellysolutions.com>. Pesticide efficacy information was derived from labels available through <www.greenbook.net> and

<www.cdms.com>. A list of registered pesticides and the laws in Uganda regarding pesticide regulation were provided by Plant Protection Services of MAAIF in Entebbe. Feedback was received from USAID and partners who reviewed the recommendations of the first draft before a final work plan was developed.

3. PESTICIDE AND PEST MANAGEMENT

3.1 Pesticide Management Situation in Uganda

3.1.1 Pesticide importation and distribution

There are no agricultural pesticides manufactured, nor formulated, in Uganda. Suppliers of imported pesticides come mainly from India, China, Taiwan, Israel, Europe or branch offices of international companies in Kenya. The market is dominated by generic companies which manufacture pesticides that have gone off patent (> 20 years) (Annex 3). Over 300 products are registered in Uganda. Many active ingredients have been on the world market for 30-50 years. These are less expensive but are more hazardous and include organo-phosphates, carbamates, and synthetic pyrethroids. There were some newer pesticides (eg. Polo, Tordon, Milraz) but these were much more expensive and mostly aimed at the floriculture industry or vegetable exporters. New products are used primarily by the flower industry or larger farms. Surprisingly however one shop had a large selection of biologicals and botanicals imported from India (*Beauveria*, *Metarrhizium*, neem, etc.). Many products offered were in small sizes, some as small as 50 ml much in demand by farmers but most were 1 liter or kg packings.

There are less than ten large wholesalers who distribute to small scale stockists (dealers), mostly in Kampala but also in the interior. Nakivubo, a section near the main market in Kampala, is the site of some 50 or more small shops that sell either agricultural, public health, or veterinary supplies. Some have a sideline as pesticide applicators in homes or fumigation services, some have their own vegetable farms, while others raise livestock. Business is thriving in Kampala for agricultural pesticides. Due to the ignorance of the farmers there are new brand names being introduced each year, most of which are the same as existing pesticides, but as the farmer thinks they are a new product he is willing to give it a try.

Aside from chemicals, a wide selection of sprayers either lever operated knapsack, mister blowers, or compression sprayers are displayed (Annex 4). All knapsack sprayers were plastic and capacities ranged from 1 liter hand sprayers to 20 liter level-operated knapsacks. Suppliers came from India, Brazil or Europe, the latter having the best quality (metal nozzles). There was a wide variation in prices of knapsacks from USh 20,000 (plastic nozzles) to USh 200,000 illustrating the differences in quality (1715 Ugandan Shilling = 1US$). Spare parts may or may not be available locally. An expensive mister blower for sale had no spares as only some suppliers sell spare parts. The most common protective equipment for sale was rubber boots and gloves, goggles, and nose masks. However the filter is not designed for use with pesticides but rather to filter dust, pollen, and spray paint. No overalls were seen in the popular markets although the larger wholesalers did list them.

There is an abundant supply of pesticides in Kampala but once in the rural areas the number of products greatly diminishes. There are stockists in the rural areas maintaining store sites, but much pesticide is sold in public markets sometimes in unlabeled containers such as beverage bottles. This is in part due to the inability of farmers to purchase a liter or even a half liter, as they want an amount for one sprayerload. Some dealers are selling smaller packings of 50-250 ml or g at the insistence of the pesticide regulatory office. Monsanto plans to offer glyphosate 60% WG in single dosage sachets for the weed wipe applicator.

Some wholesalers hire agronomists who undertake field demonstrations in the districts each year validating their products. They work directly with farmers and test their material against a control and

make visual observations to determine benefit. If the crop looks better they say the product works. A placard is placed in the demonstration field with the name of the local stockist for all to see. Promotion aside from demonstrations and training seminars is via distributing calendars, caps, t-shirts, leaflets, and banners as well as radio, newspaper, and linking with other organizations. Evergreen has the endorsement of the UNFFE which will promote its products to its members.

Private vendors do not cover the country. In order to increase input supply, stockists are sponsored by commodity organizations such as the CDO and BAT for collaborating farmers. In both cases pesticides are subsidized. Subsidies, however, will soon be phased out. In the rural areas, such as surveyed in Nakasongola, pesticides are less available and twice the cost (Baliddawa 1993, Annex 3).

Large wholesalers sponsor rural stockists. They keep track of the sales, and if they fall, stockists are targeted for training and promotional activities. Wholesaler staff conduct seminars tailored to the audience. Senior stockists may get a PowerPoint presentation during a pre-season review of products, their uses, how to calculate dosages, and safety tips. Flip charts are used for less formally educated staff. A number of projects including APEP, ACDI/VOCA, Danish International Development Agency (DANIDA), Sasakawa Global (SG) 2000, and Technology International have assisted in establishing more rural outlets. DANIDA through the UNFFE has stimulated agribusiness ventures in various districts. Pesticides are purchased wholesale and sold more cheaply than in commercial outlets. DANIDA stopped supporting this project but still some of the UNFFE outlets remain as viable businesses. Some are trying to link up with NGOs to obtain credit so farmers can afford to purchase their products. Both SG 2000 and Technology International promote the development of village stockists and the entry of farmers' associations into input dealing. Their programs provide training in the handling of agricultural inputs and in managerial issues. They also help find ways for input dealers to gain inventory credit from banks and wholesalers. By bringing prospective dealers together with agribusiness companies, they help input delivery networks proliferate. Monsanto is hooked up with DeKalb seed thus promotes hybrid maize and sunflower.

3.1.2 Stockist training and skills

Technical knowledge of stockists is highly variable. Many farmers know what product they want to buy as most pesticides have been on the market for decades. Often only when a new pesticide is being offered are instructions needed. Other farmers depend on the information provided by the stockist due to weak extension services. The stockist often gives recommendations based on farmers' descriptions of pest problems and if the stockist is also a farmer the knowledge can be very good.

Casual interviews were undertaken of stockists in Kampala. Curiously most felt that they were quite knowledgeable but in reality all needed more information. These were employees of the owners and most had never had much training. Owners are often away so that farmers generally have to deal with them rather than the more knowledgeable owners. Stockists knew the uses of most pesticides they sold but some did not (an acaricide was thought to be a foliar fertilizer). Most stockists had great difficulty in interpreting pesticide labels. Few knew the meaning of hazard color codes (yellow was thought to represent sunshine and thus stood for a safe product, or can bring brightness meaning a good product) (it actually designates toxicity class II products). Some thought yellow was more toxic than red. 'Other ingredients' stated on the label was thought to mean other pesticides. The 'X' sign to designate hazard was misunderstood. A number of the icons were not known. The icon for locking up pesticide in the home was rarely understood (some answers -- kills bees and snakes, it is a herbicide, it is showing how to spray). Most did not know the inflammable icon (one thought was a tsetse fly). One thought the water/fish icon stood for cotton. The icon for not to dispose in water was thought to be a sign for use on cotton and the wearing gloves icon was said to mean one has to measure pesticide. None knew to triple rinse empty glass or metal container before destroying.

Most stockists in Kampala said that at least someone in the shop received training from the annual MAAIF/Makerere University stockist training program. None of those interviewed could accurately read a label. The course (Nov 2003) in Makerere was 2 weeks long and was on pesticide handling and fumigation methods. The stockist visited in Nakasongola was trained by SG 2000.

When asked what additional training they would like, the subjects of marketing and a refresher course were mentioned. Dealers sometimes had technical questions such as what caused the drying up of tomato plants in large patches (this could have been from using an adulterated product). None belongs to a dealer association although they said once such an organization existed. Some said the reason for disbandonment was mismanagement.

3.1.3 Pesticide regulation

Pesticide regulation began in its current form in 1989 with the passage of The Control of Agricultural Chemicals Statute No. 8 which established the Agricultural Chemicals Board (ACB) and in 1990 with the Pesticides Regulatory Services within MAAIF's offices in Entebbe. The ACB is composed of 13 standing members from wide backgrounds including the chiefs of agriculture, veterinary science, medicine, forestry, the environment, but also members from the chemical industry, a farmer representative, and a public advocate. A technical committee of 8 members advises the ACB representing entomology, plant pathology, ecology, agronomy, chemistry, forestry, and veterinary science.

The pesticide registration unit is supervised by the Commissioner for Plant Protection, the Pesticide Registrar, and some 20 Inspectors. Laws to regulate pesticide use were passed in 1993 (Agricultural Chemicals [Registration and Control] Regulations, Statutory Instruments No. 85) which were based on FAO's International Code of Conduct on the Distribution and Use of Pesticides. New pesticides that are registered are promulgated in The Uganda Gazette by GoU and the latest was in April 6, 2001. An unpromulgated list is available covering the intervening years.

The ACB provides technical advice to the Commissioner regarding pesticide regulation, sets policies, and updates statutes if needed. The ACB is the legal body regarding pesticide regulation and approves all pesticides registered. All pesticide wholesalers, stockists, fumigators, and commercial applicators must register with the ACB as well. Stockists must specialize in either agricultural or animal products and cannot sell both. Shops that sell pesticides cannot sell food. Shops are licensed and inspected yearly by MAAIF inspectors. However the inspectors do not have legal powers as do inspectors from the National Drug Authority as the pesticides regulatory office is not an Authority. In 1999 there were only two inspectors who had not been given their official identification clearances from GoU. At present there are 20 that have clearances. The inspectors can now cover the country as the ACB has introduced legislation to give inspectors legal authority. The duty of the inspectors is to visit all stockists selling pesticides to ensure that a license has been issued and they follow safety regulations. Inspectors also can take samples of pesticides that are suspected of being adulterated.

The Government Chemist in the Ministry of Internal Affairs (MIA) plays a role in inspection to verify via analysis the content of products sold to the public and can control adulteration. The Government Chemist is the legal authority to analyze pesticides. The laboratory documented pesticide residues in fish in Lake Victoria which resulted in the conviction of fishermen who were found with pesticide bottles in their boats.

The analytical unit has made some recent improvements. Several labs have been consolidated within the Ministry into one unit covering all its drug, foresenic, and pesticide functions thus there is sharing of equipment and a concentration of workers to equipment to troubleshoot and enjoy an economy of scale. There are six staff. As more Ugandan products are exported into UK there is a growing awareness of the need to upgrade the laboratory to accepted standards of ISO 17025. GoU via MAAIF and MIA hired a consultant to access the capacity and capabilities of the laboratory. The consultant concluded (Cox 2005) that the laboratory is not yet ISO accredited and in its present form there is not possibility of achieving this status except by financial investment, effort, and professional development. Conclusions were that 1) the staff are technically competent but lack experience in the demands and practice of pesticide multi-residue analysis, 2) the laboratory is not air-conditioned and without a generator to stabilize electricity, and 3) the two gas chromatographs obtained in 1999 are behind in maintenance. A budget of $360,000 would be required to upgrade the lab. However the

Government Chemist can analyze pesticides sold in the market to control adulteration as well as analyze market produce for pesticide residues.

To be registered a pesticide must be sponsored by a company with a local address in Uganda for tax purposes. The company supplies technical information on the product including its chemistry, efficacy, toxicity, and registration data in other countries. The labels used on the pesticide container must be approved and should follow international guidelines. The Government Chemist believes that their lab should vet each pesticide during its registration process to verify the active ingredient and concentration stated on the label as is done in Tanzania. It normally takes three years to register a product. Efficacy trials are required and are conducted by NARO staff at their stations over three seasons. It costs $1,200 for each product which is up from $333 in 1999. The first three years the cost of registration is $300 and for every 3-year period afterwards $150.

Fertilizers are imported without restriction, registration is not needed, and there are no taxes or fees. Pesticide subsidies were removed in 1986 as a part of an IMF Structural Adjustment Facility which abolished parastatal marketing monopolies and lowered taxes and tariffs. Imported pesticides are levied a 2% import tax and 4% of the value of the shipment is withheld for income tax purposes.

Stockists selling pesticide in Uganda must obtain a license from ACB which is renewed annually. New regulations introduced by the ACB require that prospective dealers must be interviewed by the ACB Technical Committee to show they have technical competence regarding pesticide storage and safe handling practices. Fumigators and professional pesticide applicators must also pass the interview process. Those with limited information are encouraged to take a two week training program offered jointly by MAAIF and Makerere University each year. This has been ongoing for two years. For those selling pesticides in Kampala there is a city ‘stockists tax’, the amount depends on the size of the stock and is a tax that all businesses pay. Small Container Village shops pay about $1 per year.

The dealers complain that it takes too long to register a product and the field trials could be carried out in 1.5 years in the high rainfall areas favoring double cropping. Registration is crop neutral, that is, registration means that products can be used on any commodity. USEPA and EU countries for example require registration by pest for each commodity.

All bulk pesticide importation is by ship landing in Mombasa with limited shipments by air. Prior to import a stockist is required to apply for and obtain a letter of no objection from the ACB. A copy of the letter is forwarded to the customs department of the Uganda Revenue Authority who then allows the pesticide entry. The pesticide can be sold in registered stockist outlets. In order to avoid the red tape and expense to import, pesticides are often smuggled via Kenya as well as from Rwanda and the People’s Republic of the Congo. This is known from the MAAIF inspectors who find these products in stores.

Adulteration is a big problem in Uganda which is a concern of the wholesalers as well as all legitimate dealers. Pesticide adulterers have even approached the staff of the Government Chemist who wanted confirmation of the appearance of fake mancozeb fungicide! Their product consisted of soybean flour and yellow chalk. Later a farmer came to the laboratory later saying he sprayed Dithane45 (mancozeb) fungicide and his tomato plants dried up and died. It is likely he bought the adulterated product. Gramoxone herbicide is often adulterated as it does not turn white when water is added and the Roundup herbicide label is often faked.

APEP solicited the help of the Uganda Cotton Ginners and Exporters Association to lobby the pesticide industry to police adulteration. APEP had five samples analyzed in the Makerere University Chemistry Department. All were below specification but only three significantly:

Brand	Pesticide	Expected concen-tration	Observed concen-tration	Significantly lower
Fenfill	Fenvalerate	200 g/liter	103 g/liter	Yes

Fenkill	Fenvalerate	200 g/liter	174	No
Contra Z (mixture)	Chlorpyrifos	500 g/160 ml	349	Yes
	Cypermethrin	50 g/160 ml	38	Yes
Lancer	Acephate	75% w/w	60%	No

In addition KARI tested several formulations and brands of malathion dust in storage weevil bioassay tests and found great differences in mortality indicating that some products were highly diluted. Until an analytical laboratory is given legal status by GoU it will be hard to prosecute adulterers.

Some products state on the label that they have a five year shelf life but the law in Uganda is two years from the date of manufacture. A small number of pesticides observed in the market were outdated. Discussion with pesticide dealers in regard to what they do with outdated products resulted in a variety of answers. Some dealers say they return the products to the wholesalers. Wholesalers store them long term in their warehouses. However metal warehouses heat up in the summer leading to chemical deterioration. If there is a large supply of outdated product, wholesalers can pay to have them analyzed and if the product is at the specified concentration, they can legally sell them. Otherwise some are incinerated at the Veterinary School in Makerere facility where pharmaceuticals and cadavers are disposed. The incinerator fire, however, is not hot enough for proper pesticide incineration as smoke emerges. At times the byproducts of incinerated pesticide are more toxic than the parent material. This is of concern as the facility is in the middle of the city!

There are some reports of large stocks of obsolete pesticide awaiting disposal in stockist and GoU warehouses (Byakola and Kabuye 2000). Some containers were seen to be corroded as well as the iron-walled warehouse itself. FAO in 1999 estimated 214 tons of obsolete pesticides were on hand in Uganda. A more recent figure is not known.

A number of people interviewed say that pesticides are disposed illegally in the environment, even in Lake Victoria. There is a better way as there are several cement plants in Uganda which reach temperature that can safely vaporize pesticides. A metal tank could be constructed with a stirring blade and a pump. Pesticides would be mixed with kerosene and pumped via a copper pipe with a nozzle directed into the flame where the pesticide solution would be instantly converted to CO_2 and H_2O.

There currently is no published information on pesticide poisonings and usage in Uganda. Thus there are several initiatives being put forth by the ACB Technical Committee to establish a National Pesticide Information System to address this gap. FAO is interested as well as Makerere University. This database would include listing all registered pesticides cross referenced by brand name. A poison control center would be established where the public including physicians can phone to access first aid and toxicology information in poisoning cases. Information on pesticide importation and usage per crop per district would be compiled by MAAIF staff.

The pesticide regulation has had a very beneficial effect in Uganda. The number of highly toxic pesticides once widely available has been severely reduced. Very few toxicity class I products are in the marketplace. In no case were food items seen for sale in the shops. The Technical Board is very active as is the ACB which has new legislation waiting for GoU gazetting. This includes giving the inspectors and the Government Chemist legal powers.

All proprietors interviewed in the Container Village displayed their ACB issued license. All had said their shop was visited annually by MAAIF inspectors who made an inspection of the premises and gave recommendations. However in no shop could the owner show a fire extinguisher as required. Mostly veterinary products are sold separately from agricultural pesticides as the law dictates but there were some exceptions found, but they usually had the products separated in the store. Almost all of the products seen were in proper containers. But some plastic containers were of very thin plastic prone to crack. No torn packages were seen with product spillage. In the pesticide regulations all it states is that a container of pesticide should have a label that is approved by the ACB and conforms to

FAO standards (p 18 of Regs). Some wettable powders were repacked into 1 kg plastic bags: diazinon (white colored powder), mancozeb (yellow), copper oxychloride (green) without identification labeling, instructions, or hazard warnings. In rural areas it is common for farmers to join and purchase a liter or kg of a product and then divide it up using unlabeled local containers.

Most of the products have a local label giving the name of the local supplier. The common language of the label is normally English. Some products had labels written in Swahili and Indian languages and clearly were not local. Some products had labels written entirely in Luganga. The problem in Uganda is that there are many local languages and Luganda is not understood by all groups.

Most labels gave inadequate information, failing to give sufficient information required for effective and safe use. Deficiencies were noticed regarding: that the product is poisonous, how to store it properly, safety information, proper disposal, first aid instructions, and information for medical staff. International hazard and safe use icons were present on about half of the labels inspected. Normally they ringed around the bottom of the label and formed a sequence ending with an icon of a farmer spraying. Some icons were so small that they could not be discerned even on 1 liter bottles and certainly not on smaller packings. Icons are used to denote toxicity, use of protective equipment, proper storage, and proper disposal. Only a few labels gave the pre-harvest interval (PHI) while no label gave the re-entry interval (REI). Some products provided a supplementary leaflet that gave more information than could fit on the label. Instructions to medical staff were present on about half of the labels. This included antidotes and first aid care. Instruction for disposal of empty paper or plastic pesticide containers was to burn (wrong) rather than bury (correct). On one label on an aluminum container instructions were to cut open with machete and burn (should have said to triple rinse, crush, and bury)

3.1.4 Pesticide usage

There is not much published information on pesticide usage in Uganda either from importation statistics or on a crop basis as GoU statistics derived from surveys. From the information at hand, it is evident that usage is highly variable depending on the crop and the size of the farm. GoU was once the largest importer of pesticides in Uganda until the early 1990s when the economy was liberalized. Now the private sector is the leading importer. With the decline of subsidies, pesticide usage is slowly increasing to former times. Pesticide prices are high as they are unsubsidized and taxed and transportation costs are high as manufacturers are overseas. Crop prices and yields are generally low and with credit programs almost absent, farmers have little economic incentive to use pesticides particularly on subsistence crops. Highest usage is by large farms and commercial estates growing cash crops (cotton, cowpeas, groundnut, tomato, Irish potato and sweet potato). Moderate amounts are evident on the other crops covered in this report. Fungicide usage is high on Irish potato and tomato. Insecticide usage is high on cotton and legumes. There are exceptions however. The IPM CRSP documented 47 pesticide sprays on a sweet pepper crop over a five month period by a ‘small scale’ farmer. Herbicides can be used during land preparation on almost any crop due to the paucity of draught animals and lack of capacity for thorough tillage. A number of cultures in Uganda do not use livestock for draught purposes although they raise cattle. Small scale farmers weed by hand tools and normally do not undertake any control measures for other pest groups.

Small farmers tend to use the least expensive pesticides (generics) and select the smallest packings (100-250 ml/g containers). Among insecticides, USEPA Class II products are mostly used (synthetic pyrethroids, chlorpyrifos, and dimethoate). The most toxic class I products are not commonly used but some are present notably carbofuran G on banana. Absent are the ‘Dirty Dozen’, aldicarb, phosphamidon, and monocrotophos. However also notably absent are malathion, carbaryl, petroleum oil, and other safer products. Fungicides which tend to be less toxic are mostly mancozeb (class III) and copper-based products (class II). Herbicides are mainly glyphosate (class II) and paraquat (class I).

Title II partners have a policy against using synthetic petroleum based pesticides but instead recommend indigenous materials made into insecticide concoctions based on mixtures of cow urine,

chili peppers, wood ash, crushed neem tree leaves, and soap. Chili fruit and neem leaves are dried and ground into a powder. Interesting however is that cotton farmers were hesitant to use OMO® laundry detergent to spray aphids as they do not believe soap can kill aphids despite being recommended. OMO® is said to clog nozzles and produce too much froth. Jireh® brand liquid soap is better but is only available in Kampala.

3.1.5 Pest recognition and pesticide decision making

Based on conversations with farmers and key informants, farmers have local names for only some pests and many of these are generalized. This is indicative of cultures who have not had much need to identify different pest groups and indirectly supporting the notion that they have not dealt with these organisms in terms of developing control measures. But as they move into more business oriented farming they will find that higher yields and profits can accrue from their control and thus need to use more specific names. Small-scale farmers have names for many weeds, some insect pests but few diseases. Recognition is mainly based on size, the larger the pest the more it is known. Names of insect pests often translate as 'worm' or 'bug'. Common pests such as aphids and thrips often are not given specific names. In cotton, untrained farmers confuse some natural enemies such as ladybeetles as pests and spray when they see them. Those for diseases are generally based on symptoms and often associated with weather changes. Near Mbarara, diseases of tomato were called 'bright' and their prevalence was associated with weather. It is not clear if farmers recognize them as living organisms.

Not only farmers but also extension workers need to be trained more in pest identification. In one site farmers soaked banana corms in cow urine overnight before planting to rid them of ants which were considered pests. In this case they are more likely predators of banana weevil which made the holes.

Most farmers spray by crop growth stage in a prophylactic manner. Others spray when they see a pest. Only on cotton, with the pegboard, is there a protocol to determine when to spray.

3.1.6 Pesticide application knowledge and use of protective clothing

According to the British Journal of Industrial Medicine, developing countries use only 20% of all agricultural pesticides but account for 99% of deaths related to pesticide poisoning worldwide. Africa accounts for only 4-5% of the world's pesticide trade but has greater problems in enforcing regulations and dealing with a mostly illiterate farmer population that does not know how to use pesticides properly or normally wears sufficient protective equipment.

Pesticide selection appears to be a problem for small scale farmers. Due to lack of knowledge, farmers often spray a leaf disease with an insecticide, or an insect with a fungicide. Hardly any small farmer would know that an insecticide would not kill all pest groups equally and that there are some products better for larvae than aphids (e.g. not dimethoate or malathion for maize stalk borer). Lack of ability to understand pesticide families prevent adoption of insecticide resistance management on cotton.

Farmers generally underdose to save money but this is a sign that they do not understand the non-linear dosage-mortality relationship. There is a critical mortality threshold for pesticides below which no control occurs. For organo-phosphorous insecticides is usually around 0.3-0.4 kg active ingredient/ha. When mixing, farmers use a tablespoon or plastic cup that sometimes comes with the product, as dosage as stated on pesticide labels is usually in tablespoons per 20 liters. As there is a wide range in knapsack sprayer volumes from 15-20 liters, farmers not using 20 liters (the standard on labels) would have to make a calculation for 15 liter capacity (most common in Uganda). This no doubt is not always done correctly so farmers with a 15 liter sprayer could overdose up to 25%. On one label dosage was given as 1000 ml product per 500-1000 liters!

In applying herbicides farmers do not use the proper nozzle and often do not wash out their sprayer afterwards, thus may cause phytotoxicity if they spray an insecticide next. Most farmers apply the pesticide themselves but there are communities where they can hire locals who specialize in spraying. These people have their own sprayers and get paid $1-2 for a half day plus food. The result is that the farmer receives training while the private spray crew does not. Farmers who have sprayers tend to rent

them out. Spray volume and thus crop coverage can be low particularly when water is scarce (eg. from a bore hole well), but more if farmers are near a stream. Not all farmers use the wind to direct the pesticide away from the body and into the crop.

There are other unsafe practices. Farmers typically place the pesticide first into the sprayer and then add water (the industry recommends to first fill the sprayer ½ full before adding the product) to minimize splashing pesticide. Farmers correctly use a stick to stir the pesticide in the tank. But few farmers would use gloves while measuring, important as they are handling concentrated product.

Most farmers know pesticides are poisonous despite the fact that the Luganda word for pesticide translates as 'medicine' and not 'poison'. Currently there are large protests against DDT being used in homes to control malaria. Thus farmers seem to care about the health dangers of pesticides. Farmers know pesticides enter the body via the skin as well as mouth and nose and eyes. Despite knowledge of the hazards of pesticides, farmers do not wear sufficient protective equipment. Only 10% or so have rubber boots. Most wear long pants but few wear gloves, or face or nose protection. Very few would have full body overalls which are probably unrealistic. Some have special clothes that are used while spraying and only some take a bath immediately afterwards. It is said farmers might accept protective clothing if the project paid for it, but few however would probably wear it. As a result of unprotected bodies many testimonials were given by farmers that they often felt ill after spraying.

Thus despite the efforts of government agencies, chemical companies, NGOs, and agricultural projects that have been stressing use of protective clothing for years in their many training programs, there are few signs of adoption. Most farmers do not wear purchased protective clothing which is all imported. There is little evidence of locally improvised clothing. APEP is teaching farmers to place a plastic bag over their shoulders under the knapsack sprayer to prevent dripping product from wetting the shirt and to use plastic bags as gloves. Wholesalers have distributed protective clothing to farmers such as cloth face masks during its demonstrations. In Container Village there were no full body overalls for sale. One would have to go to the wholesalers. Rubber overalls are too hot for most farmers to bear even if they were provided free of charge. Tea pickers will wear a plucking apron that is waterproof and covers to the knee.

3.1.7 Occupational health issues

Pesticides pose health problems to those that handle them during the supply chain from stores to farms. Some of the pesticide stockists shops in Kampala are converted metal shipping containers (hence the name 'Container Village') while the majority are small wooden constructed shops. The average store was 3-4 m wide and 5-6 m deep and pesticides are displayed openly on shelves with up to six staff seated behind counters. The odor of pesticides permeates each shop to the chagrin of the staff. A few stores had glass encased shelves or ventilators with noticeably less odor.

All staff interviewed complained of the pesticide odor and were concerned about their health. They blamed the odor on headaches, stomachaches, and high blood pressure. Most did not know what to do about it and were resigned to stay there because of the employment. One asked if there was a product that they could use to reduce the pesticide in the air. One said he drinks milk to overcome the health hazards from the odor. Another said she went to Mulago Hospital where she was advised to take a tablet each day, but since 6 tablets cost $17 she takes only one per week. Another said he drinks tea to overcome the effect of pesticides. It was noticed in shops that displayed pesticides in glass enclosed shelves or used fans that the odor was less. Some had empty pesticide containers to show customers to minimize exposure.

Pesticide poisonings are not systematically recorded in Uganda but Morton et al. (1993) cited 270,000 cases of acute poisoning annually with 1% fatal. These figures are repeated in NEMA reports but are uncorroborated (hospitals do not identify pesticide poisoning which is grouped as part of a larger category) and no doubt vastly overestimated due to the low rate of pesticide usage. However farmers' ignorance of the dangers of pesticide usage place many in jeopardy. Organophosphate insecticides constitute the most hazardous group due to low prices and farmers' prediliction to use them. The most

popular group of pesticides, however, is the synthetic pyrethroid insecticides. Even insecticides are often generically called 'Ambush', a popular synthetic pyrethroid. Paraquat, a frequently used herbicide, has been linked with skin damage and impotence among males (Aryamanya Mugisha 1999). Consumers purchased smoked birds killed in rice paddies with lindane-laced termites as bait. Unlabeled containers such as a soda bottles and plastic bags invite accidents. There have been numerous cases of accidental ingestion of pesticide dressed seeds. Few farmers will bury or crush empty pesticide containers. In the rural areas it is common for farmers to wash out a pesticide container and then reuse it for salt or other food item, especially the plastic ones. According to Dr. Kizito of Makerere his grandmother stored pesticides in her bedroom which may have contributed to her early death. A child in his village consumed Furadan stored at home and died.

As women's role is to tend the home gardens, it is not uncommon for women to spray, even when pregnant. One lady who applies pesticide herself to her vegetable garden that if she feels dizzy after application she takes a tablet called "Dez" which revives her. She said this was a common practice. In the PAN-E-AFRICA Pesticide Watch newsletter of Jan 2003 an article by a mother expressed her concerns for women, especially pregnant women, entering tomato fields that have recently been sprayed. Children are also noted to apply pesticides in the field.

There is no agency monitoring pesticide residues on vegetables in the marketplace but the IPM CRSP project monitored pesticide residues on tomatoes which they reported as being 'rather high'. This occurs as tomatoes are sprayed on the day of harvest for cosmetic reasons. Farmers believe that spraying tomatoes with insecticide before harvest gives a strong hard and shiny skin which is more marketable. In a survey undertaken by the IPM CRSP in the Kampala marketplace, 58% of the public were indifferent regarding the presence of pesticide residues on tomatoes and would buy the produce anyway! Some 25% perceived fruit with residues to be of higher quality. Some farmers harvest cowpea leaves as a vegetable and pick right after the field was sprayed.

A survey carried out by the Occupational Health Commission among field level extension and health workers found inadequate knowledge and skills to deal with pesticide poisonings, only 3 of 54 medical staff achieved adequate scores. This finding may in part be due to the little attention given to pesticide poisoning in continuing education for public health workers. The Commission recommends organizing toxicology training workshops for medical personnel and refresher courses for agriculture extension agents and farmers.

3.1.8 Pesticides and the environment

Uganda is a country laced by rivers and lakes (Figure 1). Such aquatic features act as a sink for eroded material and effluent, and great care should be taken when using pesticides adjacent to, or on hillsides leading to, such aquatic environments. Due to declining soil fertility, farmers are occupying more marginal lands, usually by converting wetlands, particularly during drought epochs. Encroachment into swamplands by farmers began in the early 1950s, and placing agricultural lands close to ground and surface water will increase the hazards of pesticide contamination. Marshes are often connected to lakes in Uganda and water ebbs and flows between them. Winds cause surges during the seasonal trade winds that fill in the wetland marshes surrounding the larger lakes.

Clearing of the wetlands causes floods, as runoff is not slowed down. Wetland marshes and swamps filter soil and nutrients that accumulate from natural erosive events and act in cleaning up the environment but its capacity can be quickly overloaded by high pesticide contamination rates. Nutrients emanating from the marshlands are important food sources in the food chain of lakes responsible for sustaining the fish population, important for both food and cash income. Papyrus, commonly found in wetlands, is used for thatch, mats, and floats for fishing, and being of organic origin, can 'soak up' pesticides. No studies on residues in ground water were encountered nor could the effect of pesticide drift as a mode of environmental contamination be quantified.

There have been reports of pesticides used in agriculture being detected in Ugandan waterways (IDEA PERSUAP). Since then new evidence has emerged from a study supported by the International

Programme in the Chemical Sciences (IPICS) at the Chemistry Department entitled 'Characterization of Pesticide Residues in Biota, Water and Sediments of Lake Victoria'. Waterways flow into Lake Victoria where residents of Kampala get their water as well as into the Nile. The water table along the shore of Lake Victoria is very high and during rainy seasons can be within several meters of the surface. Waterways can more likely become contaminated from pesticides applied in the air as is done in the large lowland rice farms from drift or by farmers washing pesticide sprayers in or near waterways. The IPICS study is still ongoing and seeks to build capacity for such environmental monitoring activities in Uganda through exchange of researchers and students. The PhD chemistry student who participated in this study is now on a 4-month study tour in the University of Florida where his samples will be verified. The data so far comes from monitoring lake sediment in three locations along the edge of Lake Victoria:

Location	Residues detected
Napoleon Gulf	Chlorfenvinphos, γ-HCH, Δ-HCH, endosulfan sulfate,
Murchison Bay	Chlorfenvinphos, α-HCH, Δ-HCH, pp-DDT, pyrethrins
Thurstone Bay	Chlorfenvinphos, endosulfan sulfate, β-endosulfan, α-HCH, γ-HCH, chlorpyriphos

Fish (Nile perch, tilapia, and mud fish) were also sampled in the same places plus Waiya Bay. Detected were γ-HCH, pp-DDT, and endosulfan sulfate. Pesticide residues were only detected in mature fish and not young fish.

HCH isomers are from Lindane, a chlorinated hydrocarbon soil insecticide which is no longer available in Uganda but was once extensively used. There are a number of suspected sources for the insecticides detected based on discussions with local experts. The first is that fishermen have used pesticides to kill fish. Fishermen were arrested in Uganda in 1999 with endosulfan and chlorpyrifos in their fishing boats. Endosulfan is banned from a number of countries because of its propensity to accumulate in fish. It is still a popular insecticide in Uganda. As a result of this, Lake Victoria fish were banned from EU for a long period causing great economic hardship. The second is that it is suspected that pesticide stockists disposed of expired pesticides directly into the lake. The third is from farmers washing their sprayers in rivers and lakes that drain into Lake Victoria. Farmers with some exceptions know not to wash a sprayer directly in a body of water such as a stream and generally wash it near their house near the local water supply. The fourth is from direct agricultural field usage. This could be from pesticides that entered the waterway either directly or combined with soil (more likely) from field runoff after rains or from pesticide spray drift. A fifth source of pesticides is from atomospheric contamination as found in Lake Malawi (Karlsson et al. 2000). This is a world-wide phenomenom whereby pesticide drift from all countries enters the earth's atomsphere and circulates, constantly falling (especiall during rain) and being deposited into bodies of water such as Lake Victoria where it bioaccumulates in organic matter.

The floriculture industry which is expanding is located along the shores of Lake Victoria as growers pump water from it to irrigate their greenhouse crops. As a result of the IDEA project PERSUAP effluent from washing sprayers from the floriculture spray teams, which spray almost daily, was likely entering Lake Victoria as well as sources of well water. Recommendations were made from these companies to construct concrete holding tanks to capture this effluent as is commonly done in the US by farmers who apply pesticides by tractor in large volume tanks. It is reported that the floriculture industry has complied with this recommendation. The industry as a whole is under scrutiny of the MPS Certificate program of EU to follow a code of good practices. Inspectors from Europe come to the growers sites. There is strong economic motivation for suppliers to comply to international environmental regulations.

Build up of residues in the soil is more likely to happen in plantation agriculture on crops such as coffee and tea where greater frequency of usage potentially occurs. While it is true that soil residues

decline much faster in tropical climates this is not true for metals such as copper (component of some fungicides) which would build up over time and never degrade. There is danger that high concentrations of heavy metals such as copper could become toxic over time from overuse. As little as 1 g of mercury can contaminate a lake 1 acre in size rendering fish uneatable.

Another area of concern is the buffer areas near to Queen Elizabeth National Park (QE Park) in W Uganda which are sometimes planted to cotton and thus threatened by pesticide toxicity. 'The National Environmental Statute 1995' Statute No. 4 is that which established NEMA. Its regulations that cover agricultural chemicals used near rivers or National Parks are as follows (Part VII):'no person shall, in relation to a river or lake carry out any of the following activities: deposit any substance in a lake or river or in, on or under its bed if that substance would or is likely to have adverse effects on the environment.' The act of spraying an agricultural chemical could be argued as 'depositing' where the drift or runoff enters the river or lake. Similar wording occurs with respect to wetlands and protected areas.

QE Park is a combination of a Park, National Forest Reserve, and wetlands lies within the Albertine Rift which has been designated by Conservation International as one of the 34 'hot spots' (threatened critical environments noted for biodiversity). The Park buffer area has about 300 people/km^2 (excluding water surfaces) which is quite high and encroachment potentially is high by bush meat hunters, villagers procuring fuelwood and hardwood, and by farmers planting crops inside the park boundaries. APEP staff during inspections noted discarded pesticide containers in a watermelon field inside the park. A cotton ginnery was recently inside of the park but has since moved out.

APEP was noted in Jan 2005 to have several cotton demonstration plots within 100 m the edge of the Park and streams in both Kasese and Bushenyi Districts (53 of the 950 plots are within 5 km as determined by GPS). Farmers also have planted cotton right on the park border, some inside the park itself, and some on river banks. Guidelines need to be drawn up to control this potential problem that would result in pesticides/fertilizers polluting the centers of biodiversity in Uganda (by spray drift, washing sprayers, by pesticide entering park rivers via erosion runoff).

Areas adjacent to parks should employ economic crops that are not food for forest animals yet could produce income for neighboring villagers. Such crops should not require high levels of pesticides. Nurseries will be established under the PRIME/West project to support community based planting programs for fast growing fuelwood trees. Fuelwood species would be planted in the village land. Nurseries may have pests that would dictate pesticide application and should be sited away from the parks. The project is interested in introducing high value crops in order to attract local villagers to adopt the technologies. Crops being considered are tea, Irish potatoes, organic arabica coffee, and artemesia (a plant possessing antimalaria properties - like quinine). Most likely tea, and potatoes will be sprayed with pesticides so guidelines need to be established.

Cotton promoted by APEP is not a good buffer zone crop. According to the UWA, elephants are attracted to fields to feed on the green pods. However, it is far better than other crops such as maize that attracts elephants, buffalo, monkeys, baboons, etc. Deep ditches dug to keep them out are not maintained and quickly silt up. Thorny hedge barriers are easily penetrated by people or elephants. Such hedges are effective when properly grown. However, some people do not want the hedge to be continuous so that they can hunt, and then this allows some animals to come in. APEP will soon to have sunflower demonstration plots near Murchison Falls. Both the APEP and PRIME/West projects have initiated a mitigation plan to minimize the encroachment in meetings held in Feb 2005. APEP has no direct control over location of fields by farmers but could work with ginneries to influence them that bad publicity could result if this were more publicized internationally to seriously affect the export market.

Uganda's environmental policy framework is largely defined by the National Environmental Action Plan (NEAP) whose goal is to achieve sustainable social and economic development that maintains or enhances environmental quality and resource productivity. A key feature calls for participation by

interested groups at national, district and local levels in integrating environmental concerns into all development policies, plans, and activities. The decentralization law (1993) directs the Districts to establish a District Environmental Committee and the sub-Districts to establish Local Environmental Committees. Both the District and sub-Districts' committees are required to appoint environmental officers.

The National Environment Statute was enacted in 1995 that provided the legislative mandate for policy initiatives identified in the NEAP. The Statute established NEMA which is the central coordinating body for the NEAP. NEMA's mandated functions blend policy formulation and strategy development, cross-sectoral policy and program coordination, public education and awareness building, regulatory standards development and enforcement, and environmental monitoring and reporting. NEMA has a staff of some 50 people whose essential function is oversight. Law requires the user to report and monitor environmental pollution. For example the Rwenzori tea estates and the Tilda rice farm have to provide evidence that their use of pesticides is not contaminating the environment.

There are no GoU guidelines for the above issues. While the expansion of APEP technology is beyond the manageable control of the project, the potential impact from hundreds of hectares of cotton production near QE Park and other protected areas could be sizeable. Following NEMA guidelines there is a need to develop an environmental plan to deal with location of crop fields and demonstration plots regarding their safe distances to biodiversity areas, width of buffer zones, and the characterization of likely environmental impacts.

PRIME/West recommended an environmental management systems (EMS) consultant be hired to make a plan and draw up guidelines. Cotton ginneries can be encouraged to contribute to the UWA in order to hire four community conservation wardens to monitor the area to note problems. Rwenzori Coffee Corporation which produces organic Arabica is now supporting QE Park in order to monitor environmental issues. A link should be established with NEMA at local level with District Environmental Officers who report to the district. An environmental NGO could be hired to work with the local villagers to give them managing rights to the forest buffer zone and influence farmers not to plant environmentally sensitive crops next to protected areas.

3.2 Pests and Pest Management Overview in Uganda

3.2.1 Maize

Maize is the most popular cereal crop in the wetter zones of Uganda as a food and increasingly as a cash crop. White grain types are preferred and an increasing market is opening up for export of surplus production. Under the long rainfall period of the Lake Victoria crescent, two crops can be grown per year. Double cropping is however done as a monoculture rather than the traditional maize and dry bean intercrop. Export oriented production demands planting larger fields and applying profit minded production methods. Uganda Grain Traders Ltd. (UGTL) was set up to buy maize directly from farmers and supplies grain to the World Food Programme as well as exports to neighboring countries. Good crop management dictates that maize should be planted early, at the beginning of the rains when pest numbers generally are low and at the optimal plant stand for the fertility regime to ensure vigorous growth. Land preparation by draught animal or tractor is very important to achieve this objective. Crop rotation following a non-cereal crop also lessens pest pressure. A central pillar of pest management is to grow a healthy crop to strengthen the crop's ability to tolerate pest damage and this means application of inorganic fertilizer in the case of field crops. Due to labor constraints and often a lack of draught animals, weeds remain a pivotal constraint with the only economical method of control being herbicides. Delayed weed removal is the primary cause of maize yield loss in smallholder agriculture. The drudgery of weed management could probably be reduced if the initial weed control removal is restricted to the in-row weeds, followed by elimination of inter-row weeds before competition sets in. Inter-row weeds optimally must be removed within four weeks after crop emergence. Herbicides can save labor and time to increase the net benefits to farmers by up to 80% (Maina et al. 2001). When this is combined with herbicides' ability to alleviate seasonal, HIV/AIDS

afflicted and gender-based labor constraints, their potential contribution to a more successful and economically sustainable farming system is substantial. Despite these potential benefits, a recent survey found that only 3% of maize producing households were using herbicides as a means of weed control. Low adoption levels were found to be related to low capital, inadequate knowledge systems, poor access to credit, and gender issues (particularly intra-household income flows).

Maize is constantly threatened by the potential outbreak of multiple foliar diseases. For optimal maize yields, attention must first be placed on selecting a variety that is resistant and tolerant to the major leaf diseases. Fortunately there is excellent collaboration with CIMMYT in bringing in new germplasm and new varieties are being developed continuously. Several maize diseases were important in the 1980s (maize streak virus and grey leaf spot) which have now been minimized by resistant varieties. The Longe 1 variety is tolerant to maize streak while Kenyan hybrids H614, H626, and H625 should be avoided in the mid altitudes (1000-1700 m) due to susceptibility to streak virus. The virus is vectored by a leafhopper but intercropping tempers the disease incidence. Grey leaf spot is spread by infected plant residue (Asea et al. 2002) thus crop rotation is important. Several other minor leaf diseases also occur. Minimal insecticide usage as well as selective materials conserve beneficial arthropods for natural insect pest control. A project to introduce larval (*Cotesia flavipes*) and pupal (*Xanthopimpla stemmata*) parasitoids against stalk borers has produced good results against *Chilo partellus* the main species (Matama-Kauma et al. 2001). If the crop cannot be planted early to escape stalk borers then carbaryl granules placed in the funnels (whorls) have been found effective (Kalule et al. 1998). Termites are more important in dry seasons in dryland areas and have been found to be controlled by encouraging ant nesting (*Lepisiota* spp. and *Myrmicaria* spp.) with fish bone meal (Sekamatte et al. 2001b, 2002). Farmers mix a concoction of dried chili, cow urine, neem, and wood ash to apply to the mounds. Farmers have also found that excavation of the tops of mounds significantly disturbs termites.

Maize Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Grass and broad leaf weeds (pre-emergent control)	Compete for water and nutrients	Thorough land preparation, hand weeding, pre-emergent spray if previous crop was weedy	Metolachlor (Dual) Diuron (Diurex)
Grass and broad leaf weeds (post-emergent control)	Compete for water and nutrients	Thorough land preparation, hand weeding, post-emergent spray if previous crop was weedy	Diuron (Diurex)
Perennial weeds	Compete for water and nutrients	Pre-plant or pre-emergent spray or post plant weed wipe	Glyphosate acid (Roundup)
Soil insect pests (millipedes, white grubs)	Damage roots, cause plants to lodge	Deep plowing, insecticide seed treatment	Imidacloprid (Gaucho)
Cutworms/ armyworms	Sever seedlings, defoliate and reduce photosynthetic surface area	Early planting, deep plowing, apply insecticide poisoned bait when larvae first seen in economic numbers	Carbaryl (Sevin)
Termites *Pseudacan-thotermes Macrotermes, Microtermes Odontotermes*	Attack roots and stems of young seedlings and mature plants, Plants lodge	Deep plowing, dig out queen, grinding fish bones and placing dry meal underground to attract ants that reduce termites, insecticide seed treatment	Imidacloprid (Gaucho)
Aphids/ thrips	Remove plant sap to stunt the plant	Rainfall as physical control, early planting can avoid population buildup, fertility management to	Acephate (Lancer) Imidacloprid (Gaucho) Malathion

		ensure tolerance, apply insecticide when 25% of plants (in silk or heads)	(Malathion)
Leafhopper vector of maize leaf streak *Cicadulina*	Transmits maize leaf streak virus	Resistant/ tolerant variety	
Leaf beetles	Defoliation to decrease photosynthesis	Fertility management, scout field edges, apply if incidence of damage exceeds 30% plants	Carbaryl WP (Sevin)
African armyworm *Spodoptera exempta*	Occasional outbreaks occur to cause severe defoliation	Insecticide when necessary	Carbaryl WP (Sevin)
Stalk borers *Chilo partellus Sesamia calamistis* *Eldana saccharina* *Busseola fusca*	Tunnel stalks to inhibit nutrient and water flow, feeding causes ears to break off	Early planting, fertility management, insecticide at first sign of feeding injury, spot treat infected plant and its neighbors only (not the whole field)	Carbaryl Granules (Sevin) Chlorpyrifos (Dursban) beta Cyfluthrin (Bulldock 25 EC)
Earworm *Heliocoverpa armigera*	Feed on grains in ear	Early planting	None
Damping off, seedling blight *Rhizoctonia*	Cause seedling to wither	Certified seed, crop residue thoroughly decomposed, purchased seeds come with a fungicide seed treatment	Thiram (Thiram)
Maize streak virus	Reduce photosynthetic area	Resistant/ tolerant variety Intercrop	None
Grey leaf spot *Cercospora zeae-maydis*	Reduce photosynthetic area	Resistant/ tolerant variety	None
Northern leaf blight *Exserohilum turcicum*	Reduce photosynthetic area	Resistant/ tolerant variety	None
Leaf rust *Puccinia* sp.	Reduce photosynthetic area	Resistant/ tolerant variety	None
Leaf blight *Stenocarpella macrospora*	Reduce photosynthetic area	Resistant/ tolerant variety	None
Downy mildew *Perenoschleros-pora sorghi*	Stunting, narrow leaves, death	Resistant/ tolerant variety	None

3.2.2 Upland Rice

Both upland and irrigated lowland rice are cultivated in Uganda. Encroachment into wetlands from lowland rice production has compromised environmental concerns. New wetland rice areas can only come from encroachment into swampy areas, and NEMA's environmental policies now dictate that expansion can only come from upland rice. Yields are low (1.4 t/ha) in upland rice, thus the nation depends on imported rice, but tariffs (increased from 35 to 70%) protect the local rice industry. This will probably raise the local price of rice. Upland rice is concentrated in acidic soils in N & E Uganda. But in favorable rainfall areas, two crops can be grown per year. Dramatic improvements in upland rice culture have occurred over the past five years. Three varieties have been tested by APEP which can respond to improved management. These come from crosses made in WARDA (Suparica 1, Gold) and a national variety NARIC 3. The best by far is Gold which is a cross of African *Oryza sativa glabberima* and Asian *Oryza sativa indica* subspecies combining excellent drought and disease resistance from *O. s. glabberima* and high tillering from *O.s. indica*. The seeds are being sold by two private seed companies - Naseco Ltd and FICA - supported by APEP. Yields can reach 4-5 t/ha with

two applications of fertilizer, but normally average 2-3 t/ha. APEP is targeting 25,000 acres in the first wet season 2005 and an additional 25,000; farmers will be given kits for testing new practices on 200 m^2 plots. Improved management calls for two applications of inorganic fertilizer, the first at 15 days after emergence with NPK and the second after weeding at 45 days with N. In acid soils, application of lime (1 t/ha) is recommended every 3 years. Diammonium phosphate (DAP) should not be used as it increases soil acidity. Often rice is followed with cowpea as a green manure. With the success of Gold, farmers will not be motivated to continue their practice of slash and burn agriculture through cutting down the neighboring forest as their needs will be met on existing fields. In some years drought as long as two months occurs, but Gold variety can withstand this normally severe stress. A number of insect pests attack rice, none seriously. Increased seeding rates compensate from soil and seed arthropod pests. Grasshoppers became a new pest problem after rice area increased. Damage is severe when swarms of quela birds attack the grains. Some farmers grow a trap crop of maize or sorghum but the birds quickly devour it and then the rice. Farmers normally move to the fields during grain filling to scare the birds using all family members including children. Use of bird repellant frees children enabling them to attend school instead of scaring birds. The repellent is being tested now on rice and sunflower. Rats also concentrate on fields near bushy areas causing localized but severe damage.

Rice Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds (grasses, sedges, broadleaves)	Compete for nutrients	Thorough land preparation, post-emergence herbicide usage (at 2-leaf stage) preferably on moist soil, followed by hand weeding	Propanil + thiobencarb (Rical or Satunil 34%EC)
African mole cricket *Gryllotalpa*	Remove roots	Increase seeding rate, wood ash (20 kg mixed with 30 kg seed)	Cypermethrin (Ambush CY) lambda Cyhalothrin (Ambush Super)
Termites *Macrotermes*	Remove roots	Increase seeding rate, wood ash (20 kg mixed with 30 kg seed)	Cypermethrin (Ambush CY) lambda Cyhalothrin (Ambush Super)
Crazy ant	Remove roots during first 15 d during drought period	Increase seeding rate, wood ash (20 kg mixed with 30 kg seed)	Cypermethrin (Ambush CY) lambda Cyhalothrin (Ambush Super)
Grape colaspis beetle *Colaspis brunnea*	Larvae feed on roots destroying nutrient uptake and causing seedling death	Increase seeding rate	Cypermethrin (Ambush CY 6% EC) lambda Cyhalothrin (Ambush Super 4000 EC)
Leaf miner fly	Defoliates and removes photosynthetic area	Insecticide spray	Cypermethrin (Ambush CY) lambda Cyhalothrin (Ambush Super)
Stem borers *Chilo partellus, Sesamia, Busseola*	Wilt tillers by tunneling or wilt panicle	Insecticide spray	Cypermethrin (Ambush CY) lambda Cyhalothrin (Ambush Super)
Green grasshopper	Causes unfilled grains	Insecticide spray	Cypermethrin (Ambush CY) lambda Cyhalothrin (Ambush Super)
Grasshopper	Defoliates	Hand collected as food	Cypermethrin

		Insecticide spray	(Ambush CY 6% EC) lambda Cyhalothrin ((Ambush Super)
Stink bug *Nezara*	Unfilled or damaged grains	Insecticide spray	Cypermethrin (Ambush CY 6% EC) lambda Cyhalothrin (Ambush Super)
Rice blast *Pyricularia oryzae*	Removes photosynthetic tissue, infects grains	Resistant variety Gold	None
Smut *Ustilago*	Infects grains	Resistant variety Gold	None
Birds	Swarm into crop at grain filling and remove grains	Family labor at the time of grain filling stay in field to scare off birds, trap cropping with maize or sorghum, bird repellant	Methyl anthranilate repellant (Bird Shield)(3 applications 5 days apart)
Rats	Cut tillers, feed on grains	Remove brush and weedy areas that are nesting sites around field, rodenticide mixed with rice grain bait	Bromadiolone (Ratoxin) Coumachlor (Tomorin) Coumatetralyl (Racumin)

3.2.3 Barley

Barley is a new crop for Uganda which is being sought by the local breweries. UGTL purchases directly from farmers and has started a barley program in Kapchorwa to supply Uganda Breweries Ltd. and the crop is being tested in a few fields by APEP. There are few pests and none yet severe. It is expected that if the plantings are successful, diseases in particular will adapt to the crop as well as insects such as aphids. In 2005 3,000 t of barley are expected to be produced.

Barley Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Broadleaved weeds	Compete for water and nutrients	Crop rotation thorough land preparation, post-emergence herbicide	Bromoxynil (Buctril) Iodosulfuron-methyl-sodium (Hussar)
Leaf rust	Reduce photosynthesis	Tolerant/resistant varieties Fungicide	Tebuconazole (Folicur)

3.2.4 Sorghum

Sorghum replaces maize as the major food crop in the drier areas of Uganda. Increasingly it is also a cash crop as an ingredient in beer. Over the last season, 1,800 t of sorghum were used by breweries. Crop improvement has been achieved with introduction of improved cultural practices such as new varieties selected from ICRISAT introductions as well as inorganic fertilizers. Traditional land preparation is with hand tools. Pest problems are less than occur with maize. Small-scale farmers typically have few resources for the management of weeds and soil fertility. Weed composition varies with soil properties and crops compete with weeds for available nutrients. The traditional farmer practice is hand weeding using hoes. Striga weed can be lessened by antagonistic plants and crop rotation. Profits were higher when weeding was done with oxen instead of hand labor, especially for the SAARI weeder. Grain yields increased and labor inputs decreased when oxen-drawn weeders were used (Obuo et al. 2001). Farmers were generally satisfied with the use of oxen-drawn equipment

but the need to sow the crop in rows was perceived as time-consuming. Fungal leaf diseases are controlled by resistant varieties while insect pests are tolerated as little pesticide use occurs on traditional sorghum. As farmers adopt improved management being proposed by the PL 480 partners yields will increase and it will be economical at a later time to practice higher levels of pest control, probably first with herbicides and then insecticides. Fungicide usage is not anticipated.

Sorghum Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds	Compete for nutrients and water	Crop rotation, thorough land preparation, hand weeding, inter-row cultivation, herbicide	Glyphosate acid (Roundup)
Striga	Parasitic on crop roots	Crop rotation, intercrop *Celosia argentia* or leguminous crop	
Shootfly *Atherigona soccata*	Larvae tunnel in tillers of seedlings causing deadhearts	Early planting, increase seeding rate, inorganic fertilizer	
Armyworm *Spodoptera exempta*	Occasional outbreaks occur to cause severe defoliation	Insecticide	Carbaryl WP (Sevin)
Stalk borers *Chilo partellus Sesamia calamistis Eldana saccharina Busseola fusca*	Larvae tunnel into the stalk hindering movement of nutrients	Early planting, fertility management, treat at first sign of feeding injury, spot treat infected plant and its neighbors only (not the whole field)	Carbaryl G (Sevin) Chlorpyrifos (Dursban) beta Cyfluthrin (Bulldock 25 EC)
Aphid *Melanaphis sacchari*	Remove sap and sooty mold	Early planting	Soap spray
Sorghum midge *Contarinia sorghi*	Larvae feed within grain	Early planting, insecticide treatments when 20 to 30 percent of the field has begun to bloom and a mean of 1 midge per head is found	Spinosad (Tracer)
Downy mildew, *Perono-sclerospora sorghi*	Stunting, narrow leaves, death	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane) Benomyl (Benlate SP)
Leaf blight *Exserohilum turcicum*	Reduce photosynthetic area	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane M45) Benomyl (Benlate 50SP)
Leaf spot *Cercospora sorghi*	Reduce photosynthetic area	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane) Benomyl (Benlate SP)
Anthracnose *Colleto-trichum graminicola*	Reduce photosynthetic area	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane) Benomyl (Benlate SP)
Head smut *Ustilago sorghi*	Putrifies the grain	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane)

			Benomyl (Benlate SP)
Birds	Remove seed	Early planting, bird repellant, (3 applications 5 days apart)	Methyl anthranilate repellant (Bird Shield)

3.2.5 Finger millet

Finger millet (*Eleusine coracana*), is a staple and food security crop in the driest zones of Uganda where PL-480 partners are working. It is often intercropped with pigeon pea or other grain legumes. Finger millet is appreciated for its nutritional value, tolerance to water deficits and good storage qualities. However, production requires copious labor, particularly for weed control. There is a need to develop weed management strategies that are profitable. Two weedings are normally needed two or four weeks after sowing. *Digitaria scalarum* was difficult to control and was judged to be the most serious weed (Nyende et al. 2001). New varieties are selected from ICRISAT such as Seremi 1 and 2 resistant to blast. Pests are similar to those of sorghum including a range of fungal diseases and three species of stalk borers. Birds attack the crop during grain filling.

Millet Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds	Compete for nutrients and water	Crop rotation, thorough land preparation, hand weeding, inter-row cultivation herbicide	Glyphosate acid (Roundup)
Shootfly *Atherigona soccata*	Larvae tunnel in tillers of seedlings causing deadhearts	Early planting, increase seeding rate, inorganic fertilizer	
Armyworm *Spodoptera exempta*	Occasional outbreaks occur to cause severe defoliation	Insecticide spray	Carbaryl WP (Sevin)
Sorghum midge *Contarinia sorghi*	Larvae feed within seed	Early planting, insecticide spray	Spinosad (Tracer)
Stalk borers *Chilo partellus Sesamia calamistis* *Eldana saccharina* *Busseola fusca*	Larvae tunnel into the stalk destroying movement of nutrients	Early planting, fertility management, treat at first sign of feeding injury, spot treat infected plant and its neighbors only (not the whole field)	Carbaryl G (Sevin) Chlorpyrifos (Dursban) beta Cyfluthrin (Bulldock 25 EC)
Damping off *Sclerotium rolfsii*	Cause death of seedlings	Overseeding, fungicide seed treatment	Thiram (Thiram)
Bacterial blight *Acidovorax avenae* ssp. *avenae*	Attack the roots, wilt plant, eventual death	Crop rotation, seed sterilization, rogueing	
Blast *Pyricularia grisea*	Reduce photosynthetic area	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane WP) Benomyl (Benlate SP)
leaf spot *Cylindrosporium*	Reduce photosynthetic area	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane WP) Benomyl (Benlate SP)
Tar spot *Phyllachora eleusine*	Reduce photosynthetic area	Resistant/ tolerant variety,	Mancozeb (Dithane WP)

		fungicide	Benomyl (Benlate SP)
Birds	Remove grains	Early planting, bird repellant(3 applications 5 days apart)	Methyl anthranilate repellant (Bird Shield)

3.2.6 Sunflower

Sunflower has been cultivated for many years and fields the size of 1 acre are common. It is an important crop in the northern areas. Seedcake which is a by-product of the oil extraction is an important livestock feed. Sunflower is rotated with legumes and cereals as a cultural practice to minimize pests. New varieties (hybrids) come from South Africa as do modern cultural practices. The traditional open-pollinated varieties yield about 1 t/ha but new hybrids can triple that and have higher oil content as well. Fields are normally plowed twice to minimize weeds and provide a good seedbed. Fields are prepared by hand hoes. Conservation tillage is recommended. Early planting is recommended to ensure dry weather at maturity. Soil should be wet at the time of planting to ensure good germination. Stand should be thinned 10-15 days after crop emergence. Sunflower responds well to fertilizer and N is the limiting element. P is placed in planting furrows and N is applied a month later. Herbicide is used as a pre-plant application followed by hoe weeding 2-3 weeks after germination. If not done during the first 6-8 weeks, up to half the yield can be lost. Cutworms are important if the field was a grassy fallow before. A homemade poisoned bait based on rice bran can be concocted and placed in the furrow for their control. A number of soil borne diseases can be minimized by crop rotation and removal of contaminated crop trash.

Sunflower Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds	Compete with crop for nutrients and water	Through plowing, followed by two hand weedings 2-3 and 4-5 weeks after emergence	Glyphosate spray on weed regrowth
Cutworms *Spodoptera, Agrotis*	Feed at base of seedlings severing them	Poison bait of rice bran	Carbaryl (Sevin SP)
Bollworm *Heliocoverpa Armigera*	Larvae do not feed on seeds but cause entry for soft rot diseases	None	
Stem rot *Sclerotium Rhizoctonia*	Kill seedlings (damping off)	Crop rotation, removal of crop residue, seed treatment	Thiram (Thiram)
Sclerotinia head rot	Flower head undergoes necrosis	None	
Birds	Feed on seed	Scare tactics, tying bright reflector streamers, do not plant 400 m within marshes, plant a buffer strip between wooded areas	Methyl anthranilate repellant (3 applications 7 days apart)
Rats, squirrels	Remove seed during planting	None	

3.2.7 Sesame

This dryland crop has been traditionally grown for decades in the N and E regions and is commonly known as simsim. It may have originated in nearby Ethiopia. Upon ripening the sesame capsule splits releasing the seed. Because of this characteristic, sesame has been grown in small plots and harvested

by hand. Sesame is often intercropped with groundnuts, pigeon pea, maize, and sorghum. Sesame is getting a good price now $0.50/kg. The seed contains about 50% edible oil and 25% protein and is fried and made into a paste for soup or cooking oil, confectionery, and livestock feed. 40% of farmers grow sesame for food only and 42% for both food and cash. Yields are low (average 150 kg/acre) due to broadcast seeding, low yielding cultivars, weed competition and poor soil fertility. Traditional farmers tend to overseed as the seeds are tiny and hard to see, they sow more than is needed. But with new technologies being spread by APEP, row planting, improved varieties, proper planting time, optimal plant densities, thinning the stand at 2 weeks after emergence, and along with early weeding, yields can reach 500 kg/acre. Fallow periods are short, reducing the time for fertility buildup, and no fertilizer is being used. The practice of leaving fallow periods to increase fertility leads to greater weed problems. Only weeds have emerged as a sufficient pest group where pesticides would be used. Herbicides are considered uneconomic, expensive, and farmers lack knowledge on how to use them. Herbicides are also not readily available. Sesame grows slowly at first and is sensitive to competition with weeds thus early weeding is necessary. At least two weedings are required, one about a month and the second before flowering. One should avoid weeding during flowering as it causes flowers to drop. Insects and diseases are constraints due to lack of control measures. There are few pests since acreage now is low. Two varieties have been released by NARO, one a small seeded Sesim 1 and a larger seeded Sesim 2, the latter seems to yield better. The more drought tolerant varieties are branched and deeper rooted.

Sesame Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds (broadleaves and perennial grasses)	Compete for nutrients and water	Crop rotation Good land preparation Post emergent herbicide Hand weedings (2)	Glyphosate (Roundup)
Gall midge Asphondylia sesami	Feed on flower	Insecticide spray	Dimethoate (Tafgor 40% EC)
Webworm Antigastra catalaunalis	Feed on capsule	Insecticide spray	Carbaryl (Sevin SP)
Leaf miner	Defoliation	Insecticide spray	Dimethoate (Tafgor EC)
Verticilium wilt	Kills plant	None	
Cercospora leaf spot	Reduce photosynthetic area	Fungicide spray	Mancozeb (Dithane M45)
Virus	Distorts flowers and leaves	Rogueing	

3.2.8 Sweet potato

Uganda is the second worldwide in sweet potato production after China. Sweet potato production ranks after matooke and cassava and is said to be a poor man's crop. It is a food security crop, especially in areas where cassava is affected by mealybug and matooke by black sigatoka, and now banana bacterial wilt. It is early maturing. Sweet potato is also a cash crop cultivated mostly by women. NARO has new varieties but their distribution is limited as farmers still grow land races which are susceptible to viruses. The PL-480 projects are training farmers to cultivate sweet potato first stressing traditional methods and slowly improving practices. Farmers sometimes plant a varietal mixture due to few sources of planting material/risk aversion. It is often intercropped with cassava, maize or beans and is more commonly planted in both rainy seasons in the Lake Victoria crescent. Farmers know sweet potato is drought tolerant/ early maturing thus will be planted last. This often subjects the crop to pest buildup as early planting or early maturing cultivars normally escape damage. A complex of 3 weevil species attack the vines and eventually the tubers and by a butterfly which is a defoliator particularly devastating to young plants. The butterfly larva causes webbing and leaf mining and is controlled by handpicking. Other farmers use ash sprinkled on the leaves for control. The butterfly is often naturally controlled in the rainy season by a fungal disease *Beauveria*. Recently millipedes have been found feeding on the tubers underground. There are some 5 species

that occur. The rice bran poisoned bait could be buried with seed pieces as a control of these soil pests. Several diseases are also important. Sweet potato virus is a complex and is transmitted by infected planting materials and by both whitefly (chlorotic stunt crinivirus) and aphid (sweet potato feathery mottle potyvirus). If the plant has only one of the viruses there is no symptom, but if both are present there is stunting, leaf distortion, and low yield. Rogueing as a control measure must include total removal and destruction of plant material or else the disease will re-establish. Piecemeal harvesting prolongs the life of the diseased plants. Resistant varieties are the main control and NARO is collaborating with CIP to introduce new ones. A virus free certified planting material scheme is needed. Another disease is *Alternaria*. Weeds are more prevalent in exhausted soils and are controlled by hand. As a result of the pacification in the northern border areas, GoU is initiating a resettlement program for returning internally displaced persons (IDPs) and refugees. APEP was requested to establish a nursery for staple food crops cassava and sweet potato for one year to be a supply for NGOs working in the resettlement program. A 200 acre block will provide planting material to the settlers. Cultural methods form the basis of control of the sweet potato weevil. The weevil does not fly thus selecting a planting site free of its host provides escape. The danger is that the planting material may harbor the weevil eggs and larvae, thus selecting only the ends minimizes this possibility. As a precaution, the planting material can be soaked for 10 minutes in carbaryl insecticide in drums before planting. The concentration is the same for a spray tank mix. This will be done by APEP staff using rubber gloves. Those planting the slips also will use gloves. The land will be tilled by tractor. And herbicide (glyphosate) used. Any weed problems will be removed by hand.

Sweet Potato Pests and their Present Management in Uganda

Pest	Damage	Control measures	Pesticide
Sweet potato weevils *Cylas brunneus, C. Puncticollis* Striped sweet potato weevil *Blosyrus* sp.	Larvae tunnel into the stems to block nutrient flow and eventually enter the tubers destroying them and rendering them unmarketable	Select a planting site free of sweet potato for a 1 km radius, select planting slips from the tips <30 cm from the ends, soak the slips in insecticide	Carbaryl (Sevin)
Butterfly *Acraea acerata*	Defoliation	Early planting, hand picking, insecticide spray	Carbaryl (Sevin)
Hornworms *Herse convolvuli Hippotion celerio*	Defoliation	Hand picking, insecticide spray	Carbaryl (Sevin)
Armyworm *Spodoptera*	Defoliation	Hand picking, insecticide spray	Carbaryl (Sevin)
Cutworm *Agrotis*	Feeds at the base of the plant	Poison bait of rice bran	Carbaryl (Sevin SP)
Whitefly Bemesia tabaci	Removes plant sap, vectors virus disease	Tolerant/ resistant variety	
Aphid	Removes plant sap, vectors virus disease	Tolerant/ resistant variety	
Millipedes	Feed on the tubers	Cutworm poisoned bait	Carbaryl (Sevin SP)
Rats *Ratus*	Feed on tubers	Clean culture	
Sweet potato virus Chlorotic stunt crinivirus	Vectored by whitefly. Causes stunting of plant	Tolerant/ resistant varieties	
Sweet potato virus Feathery mottle potyvirus	Vectored by aphid	Tolerant/ resistant varieties	
Alternaria diesase	Causes black lesions on the stems and can kill the vines	Tolerant/ resistant varieties	

3.2.9 Irish potato

Potato is an important cash and food crop grown in the E and W highlands. It does best >1800 m, which is typified by cool, wet weather. It produces a high yield in a short growing season. Consumption in areas that produce potato is 100 kg/capita/yr. Decline in yield forces farmers to more marginal lands which in many cases are erosion prone. Constraints identified by farmers were lack of markets, unmarketable tuber sizes, delayed maturity, prolonged dormancy, storage rot, and high seed price. Where production targets urban markets, especially for processing purposes, market preference becomes key in W Uganda. Introducing new varieties can increase yield from 7 to 12 t/ha. Research is supported by the NARO station in Kabale. In absence of a certified seed system, securing a reliable seed supply of the farmer's most preferred variety is a key problem. Desired characteristics are early maturity, high yielding potential, earliness to sprout, resistance to late blight, production of big tubers, and palatability. The high preference for Victoria and Sangema varieties is attributed to their early maturity, while Rutuku and Victoria have especially high demand in urban markets because of their good processing qualities. Thus, varietal development must consider farmer selection criteria, otherwise the improved varieties will not be adopted. In the case of the W highlands, the most common varieties were Rutuku (60%), Victoria (30%), Sangema (7%) and Kisoro (3%). These are materials released by the National Potato Programme based at Kalengyere. A national Seed Potato Producers Association provides disease free seed. Potato can be planted for three seasons before needing new disease free source. It is recommended that farmers choose seed pieces 60 mm diameter and apply 80 kg NPK as a single dosage. Sowing distances are 70 x 30 cm = 47,000 plants/ha on ridges. Farmers however do not normally use fertilizer as they believe that it kills the soil. Farmers do not use ridging as they believe it is a waste of time. They also believe the seeding rate is too high. The major problems are diseases as is the case in most countries worldwide. Early planting escapes most pest problems including fungal diseases but this is not always possible. Late blight is the most serious pest in the tropical highlands due to the climate. Widespread phenyl amide (metalaxyl) resistance is based on lack of rotation fungicide families (Wagoire et al. 2001). There are resistant sources to late blight and bacterial wilt, but farmers prefer Victoria which is susceptible to late blight and use fungicides due to its high market demand. Protection of seed pieces in storage is another key preventative method.

Irish Potato Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds	Compete with crop for nutrients	Hand weeding	Glyphosate (Roundup)
Late blight *Phytophthora infestans*	Reduces photosynthesis in leaves, eventually can cause death of plant	Early planting, tolerant/resistant variety Rutuku fungicides, rotate chemical family to prevent resistance	Mancozeb (Dithane M-45) Metalaxyl + mancozeb (Ridomil MZ) Copper oxychloride (Cupravit) Sulfur (Thiovit) Propineb 58%+ cymoxanil 4.8% (Milraz)
Bacterial wilt *Ralstonia solana-cearum*	Constricts the base of plant at ground level blocking nutrient uptake causing death of plant	Resistant variety Cruza, crop rotation, use organic matter	None
Virus complex of diseases (leaf roll)	Reduce photosynthesis, kill plant	Rogue, control aphid vector with insecticide	Dimethoate (Tafgor EC) Soap (Omo)
Nematodes	Reduce nutrient uptake in roots	Crop rotation, use organic matter	None
Potato tuber moth	Attack stored potato seed	Insecticide dust	Pirimiphos methyl (Actellic)

Storage disease, seed pieces	Transmit late blight and wilt	Soak seed pieces in fungicide before storage and before planting, construct storage area that is aerated	Mancozeb (Dithane M-45) Metalaxyl + mancozeb (Ridomil MZ)
Aphids	Remove plant sap	Soap Dimethoate	Dimethoate (Tafgor 40% EC)
Cutworms	Sever sprouts below ground level	Rice bran bait laced with carbaryl	Carbaryl (Sevin SP)
Millipede	Feed on the tubers	Cutworm poisoned bait	Carbaryl (Sevin SP)
Snails	Remove leaf area	Molluscicide bait	Metaldehyde pellets

3.2.10 Cassava

Cassava is another staple crop and serves well in providing food security. It is a staple in E. and parts of N. Uganda, the drier zones. Farmers generally plant several varieties, choosing some for eating quality of the leaves and others for the tubers with both early and late maturity classes. Several pest epidemics have affected cassava in the past 25 years. First came the green mite and mealybug in the 1990s followed by African cassava mosaic virus which developed into a local strain. East African cassava mosaic virus is transmitted by a whitefly. These results indicate that cassava mosaic virus, whether in single or mixed infections, reduces root yield and numbers of tuberous roots produced and that losses are substantially increased following mixed infection (Owor et al. 2004). Whitefly adults collected from within the pandemic area were infective, whereas those collected ahead of the pandemic were not (Colvin et al. 2004). The transmission rate of African cassava mosaic virus from plants with dual infections was significantly less than that of East African cassava mosaic virus-Uganda, which may explain the latter's predominance within the pandemic. A new disease, cassava brown streak virus, is threatening production. Some reional initiatives are underway using biotechnology to address some of the major cassava diseases. Now whiteflies themselves threaten the crop. The green mite and mealybug were controlled throughout Africa by the introduction of natural enemies (predatory mites in the case of green mite and parasitoids in the case of mealybugs). But in the drier areas, the predators are not as effective and a new predatory mite has been released that is more adapted. In general the natural enemies keep mites below 20 per leaf. IITA is providing new germplasm to NARO for testing and has assisted in getting mosaic virus resistant varieties. Resistant varieties to mosaic virus have been developed to deal with this disease. FS4 is resistant but susceptible to mealybug. In Gulu the PL-480 partners in IDP camps report that cassava is often stolen from the fields but since production is increasing this loss is diminishing. They have resistant varieties to mosaic such as TME14 which is early maturing, good taste and good flour.

Cassava Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds	Compete for nutrients	Thorough land preparation, hand weeding, herbicide	Glyphosate (Roundup)
Nematodos *Meloidogyne arenaria, M. hapla, M. incognita M. javanica*	Injures roots to reduce nutrient uptake, reduces sprouting on planting pieces	Crop rotation	
Termite *Macrotermes*	Feed on tubers underground	Dig up nest and kill queen	
Green mite *Mononychellus tanajo*a	Suck plant sap drying up plant	*Typhlodromus aripo* predator	
Mealybug	Removes plant sap	*Epidinocarsis lopezi*	

Phenacoccus manihoti		parasitoid	
Whitefly *Bemesia tabaci*	Transmits mosaic virus, direct damage by removing plant sap	Resistant/ tolerant variety	
Millipedes	Feed on tubers, causing entry points for secondary infections	None economical	
African cassava mosaic virus	Twisted leaves, reduced plant growth, small tubers	Resistant variety TME 14, Nase 1-12	
Cercospora leaf spot	Brown lesions that dry up	Tolerant/ resistant variety	
Bacterial wilt *Xanthomonas campestris*	Putrifies the base of the plant which dries and wilts	Rogueing	
Anthracnose *Colletotrichum gloesporioides* f sp. *manihotis*	Angular spots on leaves reduce photosynthetic surface area	Resistant/ tolerant variety	

3.2.11 Matooke Banana (East African Highland Banana)

Matooke banana is the traditional staple carbohydrate for most Ugandans in the wetter zones. It is steamed and mashed without any spices. Matooke is produced in river valleys in the deeper soil and higher rainfall areas. It may be intercropped sparsely with coffee, maize, beans, and some vegetables. Farmers use very little purchased inputs. In drier zones mulch is placed around the banana pseudostems to reduce moisture loss. The crop is normally not fertilized but the leaves are pruned and used as a mulch. Crop residue is often spread in plantations to increase mulch load. Desuckering is done leaving a mother plant and 1-2 suckers. Excess suckers are used to establish new plantings. Weeds are controlled by hand until the plantation shades the inter-row areas. Pseudostems are chopped as mulch for moisture retention as well as weed control. Crop rotation is practiced and new areas are selected for planting. Disease pressure is much reduced in the highlands. Leaf diseases are tolerated and no fungicides are used. Panama wilt *(Fusarium oxysporum)* that attacks other banana species does not attack matooke. But banana bacterial wilt, a new disease that originated in Ethiopia, is now spreading rapidly (since 2001). It is transmitted plant to plant by insects such as bees feeding on the plant sap welling up from open wounds of scars left when bracts from the male flower fall. The plant is susceptible for <1 hour. There are no resistant varieties and a quarantine program has been set up. It is now present in the main W. banana belt.

Banana Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds (perennial grasses and broadleaves)	Compete for nutrients and water	Mulching, mechanical removal, hand weeding, crop rotation, herbicide	Glyphosate (Roundup) Paraquat (Gramoxone)
Banana burrowing nematode *Radopholus similis* Other nematodes *Helicotylen-chus multicinctus* *Pratylenchus goodeyi*	Destroys root system and blocks uptake of water and nutrients	Select less infested planting material eg. tissue culture, use clean fields for new plantings (crop rotation), hot treatment of planting material or insecticide after planting, all planting material is trimmed to remove roots before planting, place compost or other organic matter in planting hole to encourage beneficial micro-	Ethoprop (Mopcap) placed into holes dug around the plant

		organisms, nematicide granules	
Banana weevil *Cosmopolites sordidus*	Larvae and adults tunnel into the corm destroying nutrient uptake	Tolerant variety FHIA 01, use planting material from low infested area after monitoring adult populations with pheromone traps or split pseudostems, trim sucker or corm to remove eggs/larvae Preplant insecticide dip, insecticide granules placed into holes dug around the plant four times a year, trap with split pseudostems treated with insecticide, bolster tolerance with good fertility management, chop up pseudostem residue	1) Preplant corm dip: Chlorpyrifos (Dursban) 2) Pseudostem traps with Pirimiphos ethyl EC (Primicid) Chlorpyrifos EC (Dursban)
Banana bacterial wilt *Xanthomonas campestris*	Causes early ripening and eventual death of plant transmitted by insects feeding on cut male flowers or open wounds made when bracts fall	Quarantine, bag banana bunch to prevent insects feeding on sap, remove male bud	None
Banana streak virus	Weakens plant, less photosynthetic area	Remove infected plants, clean planting materials	None
Black Sigatoka *Mycosphaerella fijensis*	Removes photosynthetic area	Resitant cultivars (FHIA), reduce plant density, weeding, good drainage, maintain soil fertility/good vigor, remove infected leaves	None Fungicide spraying not recommended/ not economic
Leaf Speckle *Periconiella sapintumicola*	Removes photosynthetic area	None	None
Fruit spot	Affects fruit quality	None	None
Monkeys	Remove fruit, destroy market quality of fruit	Where possible avoid planting next to forest habitats, family labor to scare away	None

2.3.12 Dry bush beans and climbing beans

Bush beans (*Phaseolus vulgaris*) are the most important legume crop as food and cash. They can be grown as dry bush beans in drier areas or climbing varieties in mountainous or wetter areas. Climbing bean is a vegetable as the green beans are marketed. They are grown on trellises or poles. They are an important protein supplement to prevalent starchy crops such as matooke, cassava and sweet potatoes. Neither seed size nor color was found to have a significant impact on either green bean or dry bean prices. Variation in market prices is more a function of market location and month of sale than of seed characteristics. Production constraints of beans center around fungal, bacterial, viral, insect pests and soil fertility problems. Both dry bush beans and climbing beans share a common pest complex. As bees are present during pollination, selecting insecticides that are not highly toxic to bees should be followed and sprays scheduled when bees are not active. Early plantings mostly escape pest damage. Nematodes suppress nodulation and thus reduce natural N fixation as well as damage roots that bring nutrients and water. The PL-480 partners are assisting farmers to increase production, first by

encouraging traditional methods with a plan to introduce more modern methods including pesticides over time. Rodents are more of a pest on climbing beans.

Bean Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Perennial grassy weeds	Compete for nutrients	Thorough land preparation, hand weeding, herbicide if weeds dense in previous crop	Glyphosate (Roundup)
Damping off, seedling blight *Rhizoctonia*	Kill off seedlings	Certified seed, crop residue thoroughly decomposed, fungicide seed treatment	Thiram (Thiram)
Cutworms *Agrotis segetum*	Larvae feed on roots and base of stem killing seedlings	Early planting, deep plowing, apply insecticide poisoned bait when larvae first seen in economic numbers	Carbaryl (Sevin)
Beanfly *Ophiomyia phaseoli*	Larvae tunnel into leaves and down petiole to the stem, cut flow of nutrients	Hilling up, early planting, Seed treatment on late plantings	Imidacloprid (Gaucho)
Aphids *Aphis fabae*	Remove plant sap, vector virus disease	Early planting, fertility management, insecticide if > 20% plants infested and at least 1 in 10 plants heavily infested	Liquid soap or OMO® Summer petroleum oil
Thrips *Megalurothrips sjosetedti*	Feed on developing flowers to prevent pod formation	Early planting, fertility management, inspect flowers and insecticide only when 10 seen/flower	Sulfur (Thiovit)
Defoliating worms	Remove photo-synthetic tissue	Early planting, fertility management, insecticide only if >30% leaf loss until flowering stage, during flowering stage treat when > 3 worms per plant seen	Carbaryl (Sevin) Bt (Xentari)
Leaf beetles *Ootheca bennigseni*	Remove photo-synthetic tissue	Early planting, fertility management, insecticide only if >30% leaf loss until flowering stage, during flowering stage treat when > 3 beetles per plant seen	Carbaryl (Sevin)
White fly *Bemesia tabaci*	Remove plant sap	Not economically important	
Pod borer *Maruca testulalis*	Feed on developing flowers and seeds	Insecticide when 3 larvae/20 plants	Acephate (Lancer) Spinosad (Tracer)
Bollworm *Heliocoverpa armigera*	Feed on flowers and young pods and seeds in pods	Insecticide	Acephate (Lancer) Spinosad

			(Tracer)
Blister beetles *Mylabris*	Feed on flowers	Collect with nets when seen	
Seed bugs *Nezara viridula* *Clavigralla tomentosicollis* *C. horida* *Riptortus dentipes* *Anoplocnemis curvipes*	Feed directly on seed, introduce secondary infestions	Insecticide when 2 bugs/20 plants	Carbaryl (Sevin)
Bean common mosaic necrosis potyvirus (BCMNV)	Reduce plant growth	Resistant/ tolerant variety or roguing	
Floury leaf spot *Mycosphaerella phaseoli*	Reduce photo-sythentic areas	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane M-45) Benomyl (Benlate)
Angular leaf spot *Phaseoisariopsis griseola*	Reduce photo-sythentic areas	Resistant/ tolerant variety	
Bean rust *Uromyces appendiculatus*	Reduce photo-sythentic areas	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane M-45) Benomyl (Benlate)
Powdery mildew	Reduce photo-sythentic areas	Resistant/ tolerant variety, fungicide	Mancozeb (Dithane M-45) Benomyl (Benlate)
White mold *Ramularia phaseoli*	Reduce photo-sythentic areas	Resistant/ tolerant variety	
Bacterial blight *Xanthomonas campestris* pv. *phaseoli*	Cause whole plant to wilt	Resistant/ tolerant variety	
Fusarium wilt *F. oxysporum* f.sp. *phaseoli*	Cause whole plant to wilt	Resistant/ tolerant variety	
Nematodes *Meliodyne incognita*	Feed within roots reducing nutrient uptake, opening up wounds for Xanthomonas and Fusarium	Crop rotation	
Rats	Feed on stems	Remove brushy areas around the field, Ready-to-use bait	Warfarin

3.2.13 Soybean

Soybean is a crop introduced in the 1940s. Seed is not inoculated so its ability to fix N is limited. This season, UGTL is also growing soybean to meet the local and regional demand. With the increased interest in fish farming, Uganda should increase soybean production to over 30,000 t per year because there is increased demand. Shatter resistant cultivars have been released by NARO and the PL-480 partners are encouraging farmers to grow soybean. Diseases are more important than insect pests. Unprotected soybean normally suffers higher rust severities (>75%) and lower yields (1 t/ha) compared to the rust-protected soybean, with rust severities <70% and yields of >1 t/ha. Crop yield can increase to up to 27, 33 and 39% with the application of fungicides (Kawuki et al. 2001).

Soybean Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticides
Nematodes *Meliodyne incognita*	Injures roots preventing nutrient uptake	Crop rotation, increase crop tolerance by good management and fertility	
Insect defoliators	Removes photosynthetic tissue	Insecticide	Carbaryl (Sevin)
Thrips *Megalurothrips sjosetedti*	Prevents flower and pod formation	Insecticide	Petroleum oil Sulfur (Thiovit)
Pod borers *Maruca Heliocoverpa*	Reduces bean production, reduces bean quality	Insecticide	Acephate (Lancer)
Stink bug *Nezara viridula*	Fees on seed introducing fungi to degrade quality	Insecticide	Carbaryl (Sevin)
Soybean rust *Phakopsora pachyrhizi*	Reduces photosynthesis, kills leaves	Tolerant/resistant varieties foliar fungicide	Mancozeb (Dithane) Tebuconazole (Folicur),
Leaf spots Cercospora	Reduces photosynthesis	Tolerant/resistant varieties foliar fungicide	Mancozeb (Dithane)

2.3.14 Groundnut

Groundnut is a staple in Uganda, usually eaten as a sauce paste with greens and matooke. It is a source of fat in the diet and protein as well as being a cash crop. Sometimes it is intercropped with cassava. Rosette is the most important pest followed by Cercospora leaf spot and in Gulu the first rainy season has greater incidence. Rosette can be controlled by planting resistant varieties such as Igola 2 and Serenut 4. Control methods also are intercropping, early planting, and applying ash as an insecticide. Leafminer is more important in the second wet season. High use of insecticides leads to greater leafminer as parasitoids are killed off. Some five species of millipedes feed on the pods underground.

Groundnut Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Damping off *Scerotium rolfsii*	Death of seedlings	Crop rotation, fungicide seed treatment	Thiram (Thiram)
Bacterial wilt *Ralstonia solacearum*	Death of plants	Resistant/ tolerant variety	
Rosette virus disease	Severe stunting, reduced pod density	Early planting, close spacing, high plant density,rogueing, Resistant/ tolerant variety	
Peanut clump virus (PCV) Peanut mottle virus (PMV)	Severe stunting, reduced pod density	Resistant/ tolerant variety	
Verticillium wilt *V. dahliae*	Stunting, reduced pod density	Resistant/ tolerant variety	
Cercospora leaf spot *Cercospora arachidicola*	Reduces photosynthetic surface area	Tolerant variety Fungicide	Benomyl (Benlate) Mancozeb

Cercosporidium personatum			(Dithane M45)
Rust *Puccinia arachidis*	Reduces photosynthetic surface area	Resistant/ tolerant variety	Benomyl (Benlate) Mancozeb (Dithane)
Pod rot *Pythium myriotylum, Fusarium solani*	Putrifies nuts in pods	Fungicide seed treatment	Thiram (Thiram)
Dry rot Macrosphomina phaseolina	Putrifies nuts in pods		
Cowpea aphid *Aphis craccivora*	Vector of rosette	Resistant variety	
Thrips *M. sjostedti* *Thrips palmi* *Caliothrips indicus* *Frankliniella schultzi*	Reduces flower formation	Insecticide	Sulfur (Thiovit) Neem Petroleum oil
Leaf miner *Aproanema modicella*	Reduces photosynthetic surface area	Insecticide	Neem Methoxychlor
Millipedes 5 species	Feed on pods and nuts underground		

2.3.15 Coffee

Coffee is the major cash crop in Uganda both in terms of foreign exchange and employment creation. Most (90%) production comes from robusta, the balance from arabica type. Coffee is native to Uganda but commercial production began in the 1920s, peaking in the early 1970s only to fall off due to civil strife and low prices. The Uganda Coffee Development Authority (UCDA) began in 1991 to reverse the low production, but still yields are low due to declining soil fertility, poor management, old trees, coffee wilt disease and a history of low prices. Now that prices are increasing there is an impetus by APEP and others to increase productivity but farmers generally have not adopted better management techniques including use of fertilizer and proper pruning. Also quality suffers from not picking ripe cherries. Shade trees generally are not used. Main pests are weeds, coffee wilt disease, coffee berry disease, coffee berry borer, coffee leaqf rust and mealybugs. Arabica has more pest problems than Robusta. Coffee plantations should be kept weed free. Most farmers cannot mulch as mulching material is not easy to come by. During the wet season cutting weeds (slashing) is recommended instead of hoeing as regrowth occurs. Hoeing in the dry season uproots the weeds to kill them off.

Coffee Wilt is slowly spreading from the Congo border area and is the most serious coffee pest in Robusta. Wilt differs from *Armillaria* in that the plant remains firmly rooted whereas *Armillaria* infected plant is easily pushed over. In wilt if the bark is peeled off black/brown or violet streaks or bands are observed. Wilt disease is transmitted in the soil into the plant from wounds caused by nematodes in roots or mechanical damage. Spores are spread by infected soil, water, or wind. Leaf rust in Arabica is currently being treated with up to 5 fungicide applications per year. Although several different and effective fungicides for control of coffee berry disease are known, their use in the field has been inconsistent. Numerous studies suggest that fungicide applications early in the season are effective only in those seasons when both flowering was early and the rainy season finished early. The key appeared to be protection of the immature crop throughout the rainy season. In years when flowering was normal or late, and the rainy period extended longer into the season, early season fungicide applications were ineffective and coffee berry disease became worse during the season. Numerous fungicides have been evaluated for control. Many farmers are unaware of the fact that higher yields are possible. There is a large yield gap between farmers and research plots (eg. 0.2

vs >3 t/ha). Farmers lack expertise in input usage and pesticide safe practices. In farmer driven research this becomes a problem when farmers, and often extension agents serving them, are unaware of the problem. A common set of practices is urgently needed so that farmers receive a single message. IPM technologies are needed to be developed involving pest identification, scouting methods, and decision criteria for curative methods including pesticides. A major problem is to make available sprayers that can reach the whole coffee plant, the knapsack sprayer is very limited as to the height it can cover and is dangerous to spray above 2 m as the drift will fall on the applicator.

Coffee Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds (grasses, broadleaves, sedges)	Competes with crop for nutrients and moisture	Intercropping particularly young coffee, slashing weeds in the wet season and hoeing in the dry season, mulch, herbicide on regrowth of weeds	Glyphosate (Roundup) Paraquat (Gramoxone)
Lace bug	Removes plant sap	Insecticide	Fenitrothion (Dudu Sumi 50%)
Antesia bug	Removes plant sap	Insecticide	Fenitrothion (Dudu Sumi 50%)
Stem borer C*erambycid*	Tunnels into stems weakening them, introducing secondary infections	Insecticie	Diazinon (Diazol 60% EC)
Leaf miner *Leucoptera*	Defoliation in nursery stage causing leaves to be shed	Insecticide when larvae are noted in mines	Fenitrothion (Dudu Sumi 50%)
Leaf skeletonizer *Epiplema dohertyi*	Defoliation	Insecticide	Fenitrothion (Dudu Sumi 50%)
Tailed caterpillar *Epicampoptera andersoni*	Defoliation	Hand removal Insecticide	Fenitrothion (Dudu Sumi 50%)
Termites *Macrotermes*	Destroy internal trunk and crown	Hand dig out nest to kill queen, insecticide poured into nest, use composted instead of fresh mulch	Chlorpyrifos (Dursban) Fenitrothion (Dudu Sumi 50%)
Green scale *Coccus alpinus*	Remove plant sap to weaken plant feeding on leaf veins or shoots	Prune off badly affected branches, remove unwanted suckers, band tree with insecticide to keep off tending ants	Chlorpyrifos (Dursban) Deltamethrin
Brown scale *Saissetia coffeae*	Remove plant sap to weaken plant feeding on shoots, leaves or berries	Prune affected branches and leave on ground for parasites to emerge, strengthen plant to tolerate damage by fertilizer, insecticide banding as above	Chlorpyrifos (Dursban) Deltamethrin (Keshet 2.5 EC)
White waxy scale *Gascardia brevicauda*	Removes plant sap from leaves attached to leaf veins	Prune off infested brances, insecticide banding as above (waxy covering protects against sprays)	Chlorpyrifos (Dursban) Deltamethrin (Keshet 2.5 EC)
Common coffee mealybug *Planococcus kenyae*	Removes plant sap from flower buds, berries, shoots, and leaves, sooty mold	Remove unwanted suckers, insecticide banding directly controls pest	Chlorpyrifos (Dursban) Deltamethrin (Keshet 2.5 EC)

	fungus blocks photosynthesis		
Coffee root mealybug *Planococcus ireneus*	Feeds underground, removes plant sap from roots stunting them, can cause death of tree	Often associated with low fertility acid soils, apply manure or NPK, replace highly damaged trees, remove soil from base of plant and apply insecticide granules or sprays	Chlorpyrifos (Dursban) Carbosulfan (Marshall)
Coffee berry borer beetle *Hypothenemus hampei*	Adults feed on berries to reduce quality and larvae develop within berries destroying them (not common above 1500m)	Heavy shade discourages its parasites thus prune shade trees as well as coffee tree, regularly harvest red berries fortnightly, place cloth on ground during harvest to catch infested fruit as well as pick over ripe fruit and bury in ground	
Coffee ant *Macromischoidesaculeatus*	Bite harvesters	Spot treat nests with insecticide	Fenitrothion (Dudu Sumi 50% EC)
Tailor ant *Cecophylla longinoda*	Bite harvesters	Spot treat nests with insecticidee, band tree with insecticide as above	Chlorpyrifos (Dursban) Deltamethrin (Dudu Striker 2.5 EC)
Coffee leaf rust *Hemileia vastatrix*	Causes premature leaf fall	Resistant clone, good crop management is a preventative measure, should the disease occur apply fungicide	Copper oxychloride (Sulcop 50 DF) Anilazine (Dyrene WP) Dithianon (Delan) Mancozeb (Dithane M-45) Fluazinam (Altima 50%SC)
Red blister rust *Cercospora coffeicola*	Attack the berries to cause spots or blisters reducing quality	Resistant clone, application of fungicide not economical	
Root rot, collar crack *Armillaria mellea*	Infects root system to eventually damage vascular system to wilt tree	Problem more in areas of cleared forest thus ring barking trees 2-3 years before felling in land clearing, infected trees should be removed completely of all roots and surrounding trees treated with fungicide(replanting delayed for 2 years), dig a trench 2 feet wide between infected tree and healthy trees to prevent root to root contact	Copper oxychloride (Sulcop 50 DF)
Fusarium bark disease *Fusarium stilboides*	Infests tree at ground level to damage vascular system causing wilt and death	Mulch should not touch tree, entry from wounds caused by bruising tree when weeding or herbicide contact	

Coffee wilt *Fusarium xylarioides*	Infection blocks the vascular system blocking water and nutrient trans-portation causing wilt symptom and killing the shootberries ripen prematurely	Combination of quarantine and sanitation: plant new fields with certified disease free planting material, competely destroy infected plants, do not use coffee husks from infected areas as mulch, sterilize tools by heat, do not burn infected wood, do not harvest berries from infected tree	
Coffee berry disease *Colleto-trichum coffeanum*	Reduces quality of berries	Fungicide	Cuprous oxide (Nordox) Anilazine (Dyrene WP) Dithianon (Delan) Benomyl (Benlate) Thiophanate-methyl (Topsin) Chlorothalonil (Daconil 75% WP)
Stored beans Coffee Berry Borer Lesser coffee bean borer (*Araecerus fasciculatus*)	Destroys beans	Fumigate	Aluminum phosphide (Phostoxin)

3.2.16 Cotton

With pressure for the WTO to help Africa export more cotton in the world market by reducing subsidies worldwide, cotton stands to become a more profitable crop in the near future. It was grown successfully during the colonial and pre-Amin era where production reached 500,000 bales per year. Production fell dramatically during the period of civil strife. It is now making a rebound and currently is grown by over 250,000 families. The former IDEA project, in concert with the microcredit program SPEED, supported a number of ginners by introducing newer yield enhancing technologies. APEP is receiving technical IPM assistance from the UK through NRI that has extensive experience in Asia and W. Africa. Yields have increased two fold with low input technology and three fold with high input technology. Pest control accounts for about half of the total costs of production for most Ugandan farmers. Cotton has in many countries fallen into the so-called pesticide treadmill where due to the severity of insect pests in particular that repeated use of insecticides rapidly led to resistance. That is less likely to happen in Uganda or at least be held off for a while due to the cropping system which is mainly small scattered fields rather than large commercial estates with 1,000 ha fields sprayed by aircraft. Also the technology of insect control has reduced the number of applications from 6-7 to 3-4. But a strategy to prevent resistance should be ever present.

As with most crops weeds and particularly perennial grasses are important constraints. A weed-free seedbed is desired through twice plowing or use of minimum tillage with glyphosate. The later is preferred for soil conservation. Glyphosate kills all weeds on contact and works best when weeds are actively growing. Two applications are sometimes needed and the farmer should get a special herbicide nozzle that produces a flat pattern. The herbicide saves labor and gives better control of perennial grasses. For high yields weeds should be contained at planting, during early growth (first 2 weeks) and even up to flowering. Crop rotation is the first step followed by thorough land preparation. A pre-plant herbicide may still be required if rains cause weeds to regenerate. A post-plant, pre-emergence application may be necessary. Timely weeding is stressed. The first post-emergence

weeding should be at 2 weeks, if delayed to 4 weeks, 30-65% loss can result. If labor is short the farmer should concentrate on removing weeds nearest the crop. Additional weeding may be required 4, 6, and 8 weeks after emergence but not after 10 weeks. As water is often limiting for spraying, low volume sprayers are being tested. The Weed Wipe applicator is being slated for post-planting weed control which does not involve spraying. The product is mixed with water and placed in the end of the handle and gravity takes the solution down to a mop like sponge at the bottom. The farmer walks quickly and spreads the herbicide directly onto weeds. The most promising sprayer for both pre-emergence herbicides and insecticides is the Very Low Volume (VLV) battery operated sprayer which uses 5 liters water to spray 1 acre with existing pesticides. APEP has distributed 6,000 units with battery, spacer and new nozzle for bigger drops with less potential for drift. It is also quicker: 90 min vs 10 h/ha. Gallant Super a new selective grass herbicide by DOW is being tested on older cotton and is not phytotoxic. To prevent resistance, a rotational schedule of alternating insecticide families should be adopted area wide by farmers. The keys to a high yield start with planting within three weeks of the desired planting date for the location and basally applying the first fertilizer dosage and thinning at two weeks after emergence. As crop management from good agronomy and soil fertility the crop becomes more susceptible to insect pests. IPM practices are being followed in cotton. The key insect pest is the bollworm which attacks the developing bolls ruining the lint. It is one of the most difficult insect pests to control particularly when it reaches the 4th and 5th larval stage. At that point it is virtually impossible to kill. The key to bollworm control is application when the larvae are young. This means at least weekly field vigilance. A peg board scouting method based on sequential sampling has been developed in which the more pests the fewer samples needed.

Scouting '5/5/5 method' (walk across 5 rows, walk 5 paces along that row, examine the 5th plant) is used. Overuse of insecticide can lead to secondary pest outbreaks as happened with *Cryptophlebia leucotreta* in the early 1970s. Uganda also appears to be more open to the introduction of GMO germplasm than some neighboring countries and if allowed for cotton could lead to a great reduction in pesticides. Spraying insect pests only when their numbers threaten economic damage reduces insecticide frequency from the earlier prophylactic six applications to 3-4. Conservation of beneficial arthropods is an important IPM principle. At least 30 beneficials are noted in Uganda cotton. Reduced sprays allow more to live. Using soap as the first spray for aphids is important as it allows buildup of natural enemies early in the crop. If liquid detergent is not available then the OMO® laundry soap can be used. It should first be softened and dispersed in a separate bowl before placing in the sprayer.

Cotton Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds	Compete for nutrients and water	Crop rotation, deep plowing, pre-plant or post-plant:pre-emergent or post-emergent herbicides	Glyphosate (Roundup) Haloxyfop-methyl (Gallant Super) Diuron (Diurex) Metolachlor (Dual)
Cotton aphid *Aphis gossypii*	Early season pest, removes sap causing the leaves to crinkle and curve downwards, growth stunted	20 ml liquid laundry detergent mixed in 15 l tank when 5 damaged plants (4 top leaves crinkled for plant to be damaged)(do not spray more than once a week)or insecticide spray or seed dressing	Soap Dimethoate (Rogan) Thiamethoxam (Cruiser) Acetamapri (Assail) Profenofos (Polytrin-K)
Leafhoppers/ jassids *Jacobiella* sp.	Feeding introduces toxin which cuts down photosynthesis and	BPA tolerant varieties (hairy leaves), seed dressing insecticide	Thiamethoxam (Cruiser) Profenofos

	hopperburn		(Polytrin-K)
Whitefly	Removes plant sap	Seed dressing insecticide	Thiamethoxam (Cruiser)
Lygus bugs *Taylorilygus vosseleri*	Early season pest, feed on developing leaf and fruit buds	Insecticide when 5 plants with fresh damage (feed at nite therefore cannot see them thus shot holes in top 4 leaves)	Dimethoate (Rogan) Chlorpyrifos (Dursban) Profenofos (Polytrin-K)
African bollworm *Helicoverpa armigera*	Mid season pest, removal of buds, flowers, young fruit, bores into boll (one larva can damage 9-15 bolls)	Intercrop with sorghum, 3 plants infested with larvae or fresh damage to squares Insecticide spray when young larvae	Fenvalerate (Fenkill 2%) Deltamethrin (Keshet) Cypermethrin (Debush EC) lambda-Cyhalothrin (Ambush Super)
Spiny bollworms *Earias insulana E. biplaga*	Mid season pest, feeds on flowers and young bolls	Insecticide	Fenvalerate (Fenkill 2%) Deltamethrin (Keshet) Cypermethrin (Debush EC) lambda-Cyhalothrin (Ambush Super)
Pink bollworm, *Pectinopora gossypiella*	Develop internally in a boll	Closed season	Fenvalerate (Fenkill 2%) Deltamethrin (Keshet) Cypermethrin (Debush CY EC) lambda-Cyhalothrin (Ambush Super)
False codling moth *Crypto-phlebia leucotreta*	Develop internally in a boll	Insecticide	Fenvalerate (Fenkill 2%) Deltamethrin (Keshet) Cypermethrin (Debush EC) lambda-Cyhalothrin (Ambush Super)
Cotton stainer *Dysdercus haemor-rhoidalis*	Late season as suck seeds, Pierce bolls to discolor the lint, also entry for secondary fungi to impact quality	3 infested plants Insecticide	Fenvalerate (Fenkill 2%) Deltamethrin (Keshet) Cypermethrin (Debush CY 5% EC) lambda-cyhalothrin (Ambush Super)
Cotton mosquito bug *Helopeltis*	Feeds on outer surface of bolls scarring them	Insecticide	Fenvalerate (Fenkill 2%) Deltamethrin

			(Keshet) Cypermethrin (Debush CY EC) lambda-cyhalothrin (Ambush Super)
Spider mite *Tetranychus* sp.	Remove plant sap mottling leaves	Not economical to control	
Bacterial blight *Xanthomonas campestris* pv. *malvacearum*	Leaves die, blights shoot tip, attacks boll	Crop rotation (at least one year) PBA cultivars with some resistance Seed treatment with bacteriocide Remove trash	Copper oxychloride (Cupravit) Bronopol (Bronocot)
Fusarium wilt *Fusarium oxysporum* f.sp. *vasifectum*	Plant wilts	Certified seed, Seed treatment with fungicide	Copper oxychloride (Cupravit)

3.2.17 Vanilla

Production of vanilla has allowed the farmers to reduce risks associated with a single crop. Vanilla is an extremely effective tool to attack rural poverty, since vines must be pollinated by hand, a time-consuming process that favors small-scale growers over large commercial farms. Formerly IDEA, now APEP staff have promoted vanilla in 60 demonstration sites over the last eight years in 18 districts. At present farmers sell green beans, an unfinished product to specialized curers. Vanilla is normally interplanted among coffee and banana, thus does not involve tillage. Vanilla is planted by inserting cuttings into holes supplied with manure, weeding, mulching and looping, pollinating and harvesting use family labor. Vanilla begins to flower and fruit after 2-3 years and is productive until 10-12 yrs. About 10 curers are exporting vanilla. Fortunately this crop is virtually pest free as long as composted mulch is placed at the base of the plants. The mulch is made from cut grass and should first be dried to prevent termite damage before placing in the vanilla plots. No serious pests occur but root rot is always a threat which has severely affected production in Madagascar. A butterfly, capsid bug and aphid can be tolerated without resorting to insecticides. Mosaic virus is of minor occurrence and if detected the vines are removed. *Fusarium* root rot is also a soil-borne disease requiring replanting on clean sites.

Vanilla Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Butterfly	Defoliate	None	None
Capsid bug	Feeds on bean	None	None
Aphid	Removes plant sap	None	None
Root rot, tip dieback *Fusarium oxysporum* f. sp. *vanillae*	Death of plant	Crop rotation, fungicide	Fosetyl aluminum (Aliette)
Mosaic virus	Kills plant	Rougeing	None

3.2.18 Cardamom

Production of cardamom has allowed the farmers to reduce risks associated with a single crop. At present they sell uncured fruits, an unfinished product. Cardamom has been planted in a number of organic farms and appears to do well and is slated to be planted on vanilla farms to diversify enterprises and ameliorate risk from price fluctuations. A private company, a combination of grower and marketing outlet, wants to expand production for export. Cardamom can fit into the local

cropping systems under shade of coffee or banana. Other than weeds and thrips, no pests have been indicated. Since it is a new crop for Uganda, the pest spectrum will increase with time.

Pest	Damage	Control measure	Pesticide
Weeds	Compete with plant for nutrients and water	Hand hoeing	Glyphosate (Roundup)
Thrips	Suck on immature capsules		Soap Neemoil

3.2.19 Tea

Uganda has a good climate and good soils for tea and was introduced from Kenya in 1935. It grows at 1100-1800 m and is taken up by smallholders as well as large plantations. There are various regions where tea is grown including the W, central, and near Kampala. The Rwebitaba research station is dedicated to tea but fell to dysfunction in the 1970s when civil strife occurred. There is a lack of financial commitment to support the station or research in general. Only recently have the estates been privatized and revived or new plantings carried out. The station has not been revived and there is little extension support for this crop. There are a number of large privately owned estates near Fort Portal and the Bushenyi Districts of up to 5,000 acres. There are also large grower-owned estates. National production used to be 22,000 t and is now around 35,000 t. Small growers typically have ½ to ¾ acre in tea and use family labor. There are mid sized operations of 10-50 acres which hire labor as do the large estates. The major constraint is management skills. Farmers tend to pluck coarser leaves instead of the finer leaves. Plucking cycles should be every 7-8 d but due to labor problems this can be extended to 14-15 d. They mistakenly believe if they select fine leaves they will in the long run earn less. This perception has to be changed. If the shorter cycle is kept then good quality leaves are about 65% and the reverse if the longer cycle. Tea is also highly perishable and should be brought to the processing center within 8 hours. Shareholder farmers in tea cooperatives are given inputs and when receiving fertilizer are more apt to apply it to bananas and vegetables. If they are given herbicide they will sell it. Thus it is better to have a large tractor driven tank with the proper mixture and then driven to each shareholder to load directly into the sprayer. Shareholder shares are based on production not quality. Fertilizer dosage should be gauged to last a year's production as it should replace nutrients taken up in the harvest. In addition fertilizer requirement depends on the crop age. Farmers cannot calculate these dosages. The Plantation Labor Act was in effect until 1972 and stated the protective equipment that the plantations should provide their workers when applying pesticides. It also included medical insurance. The major pests are weeds which control costs reach about half of production cost. Hand hoeing actually makes the weed situation worse. Trampling of the pluckers does offer some control but generally herbicides are used. Because tea plants are pruned they cannot shade out weeds. Farmers do not use the proper flat nozzle for weed control. Glyphosate and paraquat are the two most popular products. Glyphosate 60% WG is the most effective formulation. If the 48% EC is used best to apply 2.5 liters in 400 liters water per acre. There are very few insect pests or diseases. No blister blight, no black rot.

Tea Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds (particularly couch grass)	Compete for water and nutrients, interfere with pluckers	Herbicide sprays	Glyphosate (Roundup) Paraquat (Gramoxone)
Termites	Feed on trunk weakening the plant	Dig up the nest and destroy the queen	
Hairy caterpillar	Defoliate primarily nurseries	None	
White grub	Severe young tea	Burn wood over the nursery area	
Charcoal rot	Reduce photosynthetic	Not economical	

	area		
General fungi occurring after hail damage	Reduce photosynthetic area	Fungicide within 48 hours	Mancozeb (Dithane)
Nematodes	Infect nurseries and are transferred to field	Burn wood over the area of the seedbed, plastic sheets for 2 wks before planting	

3.2.20 Apples

ICRAF is assisting NARO in testing a wide range of fruits including apple in the highlands of Kabale. Extensive training courses are being undertaken to teach the farmers to cultivate this new crop. Apple varieties from Kenya and South Africa are being tested using several root stocks including Bitter Felder. The most promising apples are Anna and Golden Dorset but about twenty varieties are being tested in the station. Weeds are not important and of the various diseases and insect pests, none is serious to date but as time goes on and the area to apples is increased the major apple pests of Southern Africa and Kenya are sure to follow.

Apple Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Weeds	Compete with plant for nutrients and water	Hand hoeing, herbicide	Glyphosate (Roundup)
Powdery mildew *Podosphaera leucotrica*	Reduce photosynthetic area	Tolerant/ resistant variety, fungicide spray	Mancozeb (Dithane M-45) Metalaxyl (Ridomil) Copper oxychloride (Cupravit) Sulfur (Thiovit) Propineb + Cymoxanil (Milraz)
Anthracnose canker *Colletotrichum gloeosporioides*	Blocks the flow of nutrients	Tolerant/ resistant variety, fungicide spray	Mancozeb (Dithane M-45) Metalaxyl (Ridomil) Copper oxychloride (Cupravit) Sulfur (Thiovit) Propineb + Cymoxanil (Milraz)
Foot rot *Alternaria*	Rots the root system and base of plant to eventually cause death	Crop rotation	
Aphids	Remove plant sap	Insecticide	Dimethoate (Tafgor EC)
Leaf caterpillars	Remove leaf area to reduce photosynthesis	Insecticide	Dimethoate (Tafgor EC)
Fruit boring caterpillar	Reduce quality of fruit	Insecticide	Dimethoate (Tafgor EC)
Moles	Reduce root area, can cause death of sapling	Rodenticide ready to use bait	Warfarin

3.2.21 Fuelwood

The leading fuelwood species and most preferred by communities and institutions in W Uganda are *Eucalyptus*. It is preferred because it is fast growing and has excellent coppicing ability. The other species that could be promoted for wood production include *Maesopsis eminii*, *Albizia chinensis, Grevillea robusta* and *Acacia mearnsii*. Fast growing shrub species such as *Calliandra calothyrsus, Sesbania sesban* and *Leucaena* spp. can be promoted for fuelwood. The common pests and diseases are not of major importance. Nurseries will be established to support community based planting programs for fast growing trees that would be used by people living next to protected areas such as QE Park in W Uganda as part of the PRIME/West project. Villagers bordering on the park now enter and illegally remove fuelwood. Fuelwood species would be planted in the buffer zones between villages and parks. A number of species are being evaluated as fuelwood and the project is charged with setting up production nurseries. Only the nurseries will be involved in the PERSUAP. The main species are *Myzopsis, Albizia, Grevillea*, and *Eucalyptus*. There are a range of pests mostly diseases, nematodes, and some insect pests.

Fuelwood Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Nematodes	Reduces nutrient uptake from roots	Crop rotation Nematicide	Carbofuran (Furadan G)
Powdery mildew	Reduce photosynthetic area	Fungicide spray	Mancozeb (Dithane M-45) Metalaxyl (Ridomil) Copper oxychloride (Cupravit, Cobox) Sulfur (Thiovit) Propineb + Cymoxanil (Milraz) Benomyl (Benlate)
Anthracnose	Blocks the flow of nutrients	Fungicide spray	Mancozeb (Dithane M-45) Metalaxyl (Ridomil) Copper oxychloride (Cupravit, Cobox) Sulfur (Thiovit) Propineb + Cymoxanil (Milraz) Benomyl (Benlate)
Damping off Foot rot *Alternaria*	Rots the root system and base of plant to eventually cause death	Crop rotation Use of compost, Fungicide	Benomyl (Benlate) Copper oxychloride (Cupravit, Cobox)
Termites	Destroy the vascular system of the plant and may lead to death	Insecticide	Fipronil (Regent G)
Defoliating Worms	Reduce photosynthesis	Insecticide	Chlorpyrifos (Dursban) Cypermethrin (Dipemethrine) Fenitrothion (Fenpaz) Lambda cyhalothrin (Ambush CY) Dimethoate (Rogan) Malathion (Malathion)

3.2.22 Stored grain

Seeds of food grains (maize, sorghum, rice, dry beans, groundnuts) need to be stored by small scale farmers for market or until the next planting season. Coffee farmers often store their beans before processing or sale. More maize farmers are organizing into producer groups to store grain until more favorable prices occur. This means longer storage times. Stored grain is under threat from a wide

array of pests such as insects, rodents, fungi, and aflatoxin which reduce quality and germination. Many of these pests attack the crop in the field before harvest thus the first step in reducing pest damage is to harvest the crop at physiological maturity. Most maize farmers harvest 4 weeks too late. Studies have shown that harvesting no later than 2 weeks after optimal time is the most effective at reducing pest incidence. Farmers employ a number of means to dry grain to 14% moisture in maize to make an unfavorable breeding site for stored product insects before it is stored. A few maize farmers build cribs to store cobs before shelling and bagging. Seed should be sieved before bagging which removes not only dust and other impurities but also insect pests. If grain is to be stored at home, farmers may add a number of botanically based products such as neem leaves to protect the grain. These home remedies however have only limited effects so that if grain is to be stored for more than 3 months an insecticide or fumigant must be used. It is also a practice often quoted, but seldom practiced.

At the farm level, farmers who have been trained to use protective equipment can apply pirimiphos-methyl (Actellic) onto grain to be stored as home-saved seed until the next planting season. In areas where the larger grain borer is present permethrin needs to be added which is commercially available as Actellic Super. The larger grain borer entered Africa in 1981 and Uganda in 1997 from Latin America. It is located in E Uganda near the Kenyan and Tanzanian borders thus it is close to Kampala. All seed should be treated with permethrin as its distribution is now widespread. The larger grain borer is more destructive than the normal stored grain pests and can reduce weight of stored maize up to 40% in 6 months. Fumigation is warranted if the seed is to be stored for long periods or is infested. Fumigation only controls infested seed and does not offer residual control. The spray offers residual control but has no effect on insects already inside the seed. After fumigation the seed may be treated with pirimiphos methyl and permethrin, depending on the storage conditions. Often fumigation is enough in a relatively pest free storage area. Aluminum phosphide is used by commercial seed companies to disinfest grain just before it is exported or sold to WFP, or for long term storage in large warehouses. Aluminum phosphide is highly dangerous and should only be used by contracted fumigators (for indoors or outdoors) or by project staff (outdoors only) that had the training. Fumigation should not be done directly by farmers. It is sun dried too. At times contractors fumigate the products in the warehouses upon receiving by contracting the work out to professional fumigators (Phostoxin). They do not return to the warehouse for 7 days as the warehouse is divided into chambers and the treated side can be left alone.

Stored Grain Pests and their Present Management in Uganda

Pest	Damage	Control measure	Pesticide
Stored product insect pests	Destroy grain	Timely harvest, sun drying, sanitation, purchased seeds come with a seed treatment, varieties with closed husks Small lots use Actellic, large lots in warehouses fumigate with aluminum phosphide	Permethrin + pirimiphos-methyl (Actellic Super) Aluminum phosphide (Phostoxin)

3.3 IPM Status in Uganda

There is great awareness of an IPM approach to pest control among the research staff of the two main research institutions, NARO and Makerere University, both of whom are actively generating a wealth of new technologies. As a result non-pesticide technologies have been introduced for most crops. The presence of the USAID-sponsored IPM-CRSP and the contribution of a dozen international researchers stationed in Uganda from the CGIAR centers also contribute. NRI has been active with cotton IPM in collaboration with IDEA, APEP, and NARO. More research staff are active and have published many reports in Ugandan journals. Uganda is the hub of the African Crop Science Society

which holds biennial conferences that contain numerous relevant papers on IPM. Each proceeding is over 1,000 pages. The Society also publishes the African Crop Science Journal that comes out regularly. NARO issues the Uganda Journal of Agricultural Sciences whose volume 9 came out in September 2004.

As a result, many new developments in IPM have occurred since the 1999 IDEA PERSUAP. Recommendations of alternative practices have led to a reduction of pesticide applications. Taking cotton as an example of new IPM technologies, i) the varieties being recommended have resistance against leafhopper and bacterial wilt, ii) a number of cultural practices are recommended to minimize weed pressure and pink bollworm, iii) use of soap as a selective insecticide to spare natural enemies that will become important during the flowering stage, and iv) a crop monitoring protocol (the pegboard method) for insecticide decision making.

Weed control is receiving much research attention from APEP staff in the form of new herbicides and application methods. Weed control is now highly dependent on broad spectrum herbicides to replace laborious tillage practices using hand tools. The high rainfall in the more favorable growing areas keeps weeds flourishing. If weeds are hoed up during the rainy period they re-root so successfully that actually more weeds develop as a result of hoe weeding than if the field were left alone. Animal power for tillage implements is lacking in most of the country thus fields are prepared laboriously by hand. It takes hundreds of hours to prepare 1 ha for planting which in turn prevents early planting, an important IPM tool to escape pest incidence. Farmers then fall into a dependence on broad spectrum herbicides such as glyphosate. There is a danger that glyphosate resistance will develop in the future. Minimum tillage methods such as permanent furrows also depend on herbicide.

In Asia by contrast, under similar high rainfall areas, farmers do not use herbicide on maize, relying solely on animal traction. They use inorganic fertilizer and sow in the same fields. Farmers can thoroughly prepare their fields (2 plowings and 3 harrowings) which provide good initial weed control and is followed up by inter-row cultivation. As a result, weed populations decline over time. In Uganda, with larger farms and fallow rotation, farmers clear new lands each year that were idle and start out with high weed incidence. Crop rotation can still occur in permanent agriculture but the important fact regarding weed control is that the land is plowed each year.

IPM research is developing some labor saving technologies particularly for herbicide usage based on glyphosate. Glyphosate is the best herbicide for Uganda conditions because of its activity of killing the roots when weeds are in their growing stage. Only the laborious hand pulling of weeds compares in efficacy as the more rapid hoe weeding as was mentioned is often useless. Glyphosate is too hazardous as applied by knapsack sprayer according to USEPA toxicity ratings to be used by small scale farmers who do not wear goggles. A hand-held Weed Wipe applicator is now in production in Zambia where glyphosate is mixed and poured in the handle where it descends in tubes to a sponge mop. Thus glyphosate is not sprayed but is wiped onto weeds. Thorough coverage is not needed as a weed dies if glyphosate even touches a few leaves. This applicator is particularly good for inter-row weeding after the crop has emerged because the herbicide can be precision placed without hazards of pesticide drift. It also could be used for pre-plant weed control. The Weed Wipe applicator is just coming to market and has not been field tested under Uganda conditions to see if the plastic applicator can hold up under farmer use. The hazards to the applicator are less as applied by weed wipe than by sprayer as predominantly dermal exposure would occur. Glyphosate is safer than most pesticides by dermal exposure. The farmer would only be required to use rubber gloves and goggles when mixing and wear rubber boots and long pants, rather than wearing a full body protection as would be needed when using the knapsack sprayer.

A second applicator is being developed for cotton, the VLV battery powered sprayer for any liquid herbicide. When the VLV sprayer has been fitted with a larger aperture nozzle and has a battery spacer. Larger droplets are formed than with a conventional spinning disc which do not easily drift in the face of the applicator when wind gusts. In fact VLV spraying requires wind to direct the herbicide into the weeds when used at pre-plant. This application method is attractive as it uses less water (5

liters per acre vs 150-200 liters) and take less time to apply (45 minutes vs 5 hours/acre). As farmers often hire pesticide application crews, they can be trained to use VLV sprayers and to wear protective clothing, in this case full protective clothing.

The chemical industry has in recent decades produced many selective insecticides, fungicides, and herbicides which are safer to use and are often more sustainable. But as these are under patent by the discovering pesticide companies they are higher priced, usually two to three times more than the generics. Markets are opening up through efforts such as being initiated by APEP for farmers to grow cash crops, but agricultural credit, even through microcredit schemes, has high interest rates (>25%). Microcredit NGO's avail of the 18% current bank rates and turnaround and ask farmers to pay 25-30%. This is not a favorable environment for small farmer loans. Small farmers, with less capital, prefer the cheaper pesticides and use hardly any fertilizer.

Most research time is now focused toward new control technologies rather than testing IPM systems in the field. This step should have preceded the on-farm demonstrations that are now in vogue. Genetic resistance is receiving much attention through introduction on new germplasm. One would like to see more biologically based pesticides (Bt, *Beauveria, Trichoderma*) tested more as a means of reducing pesticide hazard. One would also like to see more yield loss trials to determine pest status and economic analyses of IPM technologies. Still to be developed, however, are decision tools such as action thresholds for insecticides (only available on maize and cotton).

More research is needed in developing insecticide and fungicide decision protocols for the major crops. There seems to be little effort in doing this at the present time thus more applications result than otherwise. This is not only more expensive but it results in lower natural enemy densities.

More surveys of farmers' indigenous pest control methods should be undertaken to obtain clues on new technologies. Traditional farmers' practices of using dead animals, meat bones and sugarcane husks attracted predatory ants to control termites. The traditional pesticides such as cow urine, dried chili pepper should be field tested in replicated trials. Traditional practices are incorporated into IPM technologies such as hand picking pests and sterilizing nursery bed areas by building a fire.

Several factors have kept IPM technologies from becoming more available to farmers. Results are dispersed in the various journals or project reports that have not been well distributed. Much of the technology is there, but needs to be coordinated in more useful ways. MAAIF should standardize recommended practices for growing each crop into a booklet. Included would be the recommended varieties and their characteristics including degrees of resistance to particular pests. Planting methods would be described as well as fertilizer and pest control. Each major pest would be listed along with control measures including the best pesticides and non-pesticidal control measures. APEP and NAADS have developed some training guides that include much of this information.

There is no national IPM policy within the MAAIF stating that pesticides should be the last rather than the first choice among pest control technologies. IPM components have been developed for single pests. Most recommendations state the pesticides to be used against each pest but give no guidance on when to apply. Pesticide decision protocols are lacking in most crops with the exception of cotton. These can first be gleaned from the literature for each pest group and field tested to fine tune them. More yield loss studies will also be needed and can be done in the same trials to determine pest status.

IPM implies integration of practices at three levels. The first is within each pest control discipline such as insect pest control or disease control employing resistant varieties, cultural practices, biocontrol methods, and pesticides. Further integration of practices is needed to be tested between the various pest control methods and finally within the local farming system. Needed is an applied research effort to test suites of control measures at the farming system level. Built into this must be the recognition that pest pressure varies with each season depending on rainfall, etc., so there has to

be some flexibility in the package of recommendations, but still kept in a simple manner so illiterate farmers can make observations and respective decisions.

3.4 Training and Extension Programs and Methods in Uganda

PRIME/West is still in the development stages of testing new commodities and has not conducted extension or training programs for its agricultural component. Other partners have very active extensive/training programs. APEP offers training for pesticide stockists as well as extension officers and farmers. ACDI/VOCA has offered similar training in the past for stockists but now conducts only on-farm technology demonstrations as well as marketing and agribusiness skills training.

APEP is engaged in two types of training. One for pesticide handlers and one for crop production by training of trainers (TOT). For pesticide handling there is a three-tiered training program for stockists. The first tier is directed at technical staff such as extension agents which is handled in a seminar room in a lecture format aided by PowerPoint visuals. Two sessions of training were undertaken in Kampala and at Busitema involving 57 individuals drawn from commercial pesticide distributors. Facilitators came from the industry arm, Crop Life Middle East and Global Crop Protection Services. 177 new stockists were identified and trained in 2004 in conjunction with the International Fertilizer Development Center (IFDC).

The second is a training program for rural stockists that is carried out in rural settings regarding safe pesticide storage and handling practices. The third is participation in the MAAIF/Makerere annual stockist training program where staff are lecturers. Participants are taught how to read a label of pesticides with different hazard levels.

By far the greatest involvement of APEP is ToT (training of trainers) for the on-farm demonstrations which are used as the main extension method for all technologies. Meetings are held throughout the crop cycle. APEP trains the trainers who act as area coordinators and in turn train extension agents. The extension agents identify one lead farmer for 15-25 collaborating farmers and hold periodic meetings. The same training format occurs in all crops where the farmers cultivate the crop from seeding to harvest under the guidance of the lead farmer. The cotton on-farm demonstration is a three day course that was developed in conjunction with NRI. The training method combines discussion with field demonstrations. The objective is to create a critical mass of farmer trainers for each area. Trainees state their expectations before training begins and break up into small groups with each listing the constraints to cotton production. These are summarized in a plenary session and ranked. A similar session follows whereby solutions are offered for each major constraint and opposite each constraint is the responsible institution. Trainees are encouraged to see what they could do to alleviate constraints.

The trainer emphasizes that of all the problems facing the industry the greatest of all is the perception that the crop does not pay sufficiently well. But if the crop is not profitable, then why? The profit triangle is next analyzed with 1) price, 2) yield, and 3) production costs included. Unit costs are highlighted as the key. Then the participants are asked to think of very successful cotton farmers and what practices they follow that have made them successful.

Using analogies, group discussion, and field demonstrations, participants are taken through the main steps to profitable cotton production. IPM is introduced with an analogy of how people cope with malaria by undertaking a series of steps to control it and not by one method alone. Trainers are shown how to calibrate sprayers and use them in a safe manner. Protective clothing is emphasized but if farmers have none they are encouraged to improvise (eg. with a plastic bag draped over the back to prevent leaking sprayers from wetting clothes and use of plastic bags as improvised gloves while mixing). Cleaning the sprayer for herbicides is stressed as is the use of the correct nozzle. The need for on-farm demonstration is stressed and that farmers would be the best persons to show fellow farmers the methods. The trainees are then expected to train farmers to be on-farm demonstration leaders.

A coffee demonstration area consists of five coffee trees to be compared to the rest of the surrounding trees. Technologies stressed are:

1. Application of fertilizer at the time of weeding (placed in a groove ringing the tree and covered)
2. Pruning
3. Picking (individual red cherries vs whole branch stripped)
4. Pest control

The groups meet once a week with the following obligations stated for the lead farmer:

1. Unconditionally commit an agreed acreage of land for demonstration purposes
2. Identify and supervise 15 or more collaborating farmers including farm visits
3. Receive and use agro-inputs specifically for demonstration purposes
4. Apply recommended practices and input application rates in a timely manner
5. Provide labor for all activities
6. Mobilize farmers to attend all field sessions
7. Carry out all specified field sessions with other farmers
8. Maintain an accurate and complete lead farmer record book that is provided
9. Promptly report any crop growth, weather, or pest abnormalities to the area coordinators

Obligations of the collaborating farmers:

1. Attend all field sessions
2. Educate other farmers on adopted technology
3. Encourage other farmers to attend field sessions
4. Adopt similar technology on their fields
5. Sign in the lead farmer's record book on attendance of each field session

Record books are given to each participating farmer. Most site coordinators are extension officers who each organize 6-10 on-farm demonstrations and regularly visit and attend sessions. They are paid $35 per month when they have completed their reports. APEP and its SAF awardees follow up with the site coordinators and keeps them motivated. As a general observation, farmers are very motivated to learn and pay attention during sessions. There are sessions aside from the on-farm demonstration meetings as well. The key is that APEP trainers are very knowledgeable and have good motivational skills.

Technologies for other crops where pest control is included include:

- Sunflower and maize – minimum tillage using glyphosate herbicide on permanent ridges
- Upland rice – Satunil and Rical herbicides are promoted as labor saving technologies
- Cotton – glyphosate for pre-planting weed control of cotton is emphasized as are a range of insecticides where usage is based on the peg board guide.

Some results from training:

Crop	Demonstrations in 2004 (number)	Farmers participating in 2004 (number)
Cotton	6,280	121,000
Upland rice	850	9,600
Maize	290	4,200
Sunflower	1,200	4,000

The five Title II partners undertake similar on-farm demonstrations as their principal training vehicle. The method involves the partners hiring their own technical staff who in turn train locally hired extension workers. Each extension staff organizes 5-10 groups of 15-25 farmers each and identifies a lead farmer who is trained to conduct on-farm demonstrations. The lead farmer is responsible in organizing each demonstration and calling the farmers to regular meetings. The subject matter involves agronomic techniques in growing the crop over a season. Follow-up demonstrations are held for 1-2 more seasons and then the group graduates and new groups are formed. In some cases trained farmers are expected to train other farmers.

UNFFE, supported by DANIDA, feels the need to do extension because the existing extension service cannot reach out to all farmers. They hire two staff per district. These are usually former extension workers, diploma holders, or farmers with experience. These in turn train Extension Link Farmers (lead farmers) to give on-farm demonstrations or farmer-to-farmer extension. The participants determine the topics.

The larger pesticide wholesalers hold training programs for distributors. Generally one session is held each year per region at the beginning of the growing season. All stockists in that region are invited to the one day training which mostly focuses on new products, especially the dosage needed as many labels do not state this clearly. They also provide training on pesticide safety and advise farmers to wear long thick pants and shirt, rubber boots, rubber gloves, cap, goggles, and nose mask. For cotton they have their own recommendations based on their trials and products. The farmers are taught to monitor the crop first for aphids within the first three weeks and apply dimethoate, then in the boll stage two more sprays when bollworms noted with the mixture of deltamethrin + chlorpyrifos. The Cotton Development Organisation, they say, recommends cheaper products with less efficacy and no order to the sprays.

NARO and Makerere University are testing their own version of the farmer field school method. Most training programs, however, do not include training needs assessment nor evaluation or feedback. Training programs in other countries are generally initiated with a general survey to determine what farmers know and what they do not know so training curricula can be focused on the latter. Elsewhere training programs also incorporate a short quiz before each session with the same quiz given afterwards to measure learning of current lessons.

DANIDA undertook an evaluation of their sponsored trainings by the UNFFE and found that farmers adopted on average 35% of the knowledge presented in their training sessions (DANIDA 2003). With a paucity of adoption surveys, it is difficult to measure efficacy of the on-farm demonstration method in changing farmer knowledge and behavior. Clearly there are successes, but perhaps there are better extension methods. The FAO Farmer Field School method has high success rates but is more expensive to operate in the short run. In the long run however it may be the more preferred option.

4. PESTICIDE EVALUATION REPORT

This section contains information addressing the twelve criteria requested by USAID for a pesticide IEE, as outlined in the Agency's Pesticide Procedures [22CFR §216.3 (b)(l) (i) a-l] for funded projects based on the background information presented in sections 2 and 3.

a.) Factor a: The USEPA registration status of the requested pesticide, and the registration status in Uganda

The registration status for the requested pesticides by USAID partners is presented along with suggested replacements in Annex 5. Additional information is given for each pesticide as to its mode of action and chemical group, useful in pesticide resistant management programs. Each pesticide is classified as either a general use pesticide (GUP) or restricted use pesticide (RUP). RUP classifications are for products that are too hazardous either to the applicator or to nontarget organisms or the environment. Both the WHO and USEPA toxicity ratings are presented but more importance is given to the USEPA rating based on formulation. Information is provided on the

restricted entry interval (REI) or the number of days that should pass before it is safe for workers to re-enter a treated field. The pre-harvest interval (PHI) is given as well for a range of crops. The PHI is the period of time that it is safe after the last application before harvest to minimize residues on food. This is particularly mandated for insecticides and fungicides. Herbicides are generally applied early in the season thus have little relevance for PHI. Registration status in Uganda was verified for each product by the current MAAIF registrar as well as the current USEPA database <www.kellysolutions.com>. Some products are registered with USEPA but are not marketed in the U.S. as registration is soley for the purpose of establishing residue levels for imported produce. An overall evaluation is given for each pesticide on its use in IPM programs. Those that are considered undesirable, will be disallowed and replacements given.

b.) Factor b: Basis for selection of the requested pesticide;

The pesticides were suggested for use by the APEP and PRIME/West partners following recommendations from GoU research and extension officers. Efficacy is the primary criterion. There are no standardized pest control recommendations based on comparisons of a range of pesticide products for each pest x crop combination. Registration by GoU requires testing against one standard on a particular crop. Efficacy information provided by the pesticide technical representative weighs heavily. Often however these may be representatives from generic companies who sell a wide range of products and may not have specific data. Such data may be highly biased as well. Most companies select only the best data and it may be that in 20 trials results were not favorable on 18. On-farm demonstrations and limited trials have been conducted by extension and project workers to further provide a basis for efficacy. Often however yield is not taken, nor are pests censused. Farmers' perceptions of the best products no doubt influence research and extension workers' decisions. Other factors that weigh in are cost, availability, formulation, safety, and registration status. In rural areas where stockists are not prevalent, availability outweighs cost in decision making among farmers. However the basis receiving much weight in the PERSUAP is the information on the USEPA approved label for efficacy against a particular pest on a specific crop as well as toxicity class and registration status. As USEPA requires efficacy data by pest x crop combinations, more assurance that the pesticide would be effective is based on field trials conducted in many locations by the primary manufacturer rather than a generic company.

c.) Factor c: Extent to which the proposed pesticide use is part of an integrated pest management program;

At the research level, IPM is being rigorously promoted at NARO stations and by Makerere University projects. Broad collaboration with international centers with active programs in varietal evaluation stress pest resistance over a full spectrum of crops. USAID partners likewise are promoting IPM practices in their many demonstrations and through their direct hire extension agents. A model IPM program has been developed by a collaborative effort between NARO, APEP, and NRI on cotton where pesticide usage has been minimized. Still due to the weak extension services and lack of reasonably priced pesticides in rural areas, most farmers under-apply pesticides. Consequently yields are low. First priority is for farmers to adopt modern varieties and optimally manage them from an agronomic perspective with IPM as a secondary tier to protect the resulting higher yielding potential. The strategy of most Title II partners is to work with farmers to stress agronomic improvements based on adoption of better varieties, agronomic practices, and using indigenous pest control practices avoiding synthetic petroleum-based pesticides. This is a viable strategy given that their target is the most marginalized farm communities. Organic fertilizer and indigenous pesticides based on cow urine, wood ash, and chili pepper, developed for home gardens and extended to field crops, will prove to be too labor intensive as agriculture fields increase in size, particularly as farmers increasingly adopt animal draught power. Needed on most crops is an applied research effort to develop application decision tools as has been done for cotton and was done for a number of crops under the IDEA project. Pesticide usage will increase when recommendations stress a few well timed applications rather than expecting farmers to apply blanket protection from seeding to harvest. Initiating applied research trials to evaluate pesticide scouting programs and decision tools for the common pests are needed as well as more and better training of extension agents.

d.) Factor d: Proposed method or methods of application, including availability of appropriate application and safety equipment;

As yield levels increase from adoption of better agronomic practices more farmers will be able to afford knapsack sprayers, the most preferred pesticide application equipment. A wide variety of knapsack sprayers of varying quality and prices is available in the Kampala market. Lack of draught power, either because of a shortage of livestock or people with no habit for using draught animals, has meant that herbicides have been more needed to minimize choking weed densities so common on lands prepared by hand tools, particularly in the wetter zones. Hoe weeding during the rainy season actually exacerbates weed problems. Inter-row cultivators are rarely used by those that have draught animals. Methods to make herbicide usage more affordable and effective are being developed by APEP staff, including the Weed Wipe applicator and the battery powered VLV applicator. Both of these sprayers should be highly attractive to cash-strapped farmers in reduced labor cost. Both of these applicators are safer to use than knapsack sprayers where farmers walk into the spray path. Most farmers, despite being trained to wear protective equipment, do not comply. Training has emphasized using a complete complement of protective equipment including a body suit, face mask, and cumbersome and ill-fitting rubber gloves. A new strategy should be developed where extension services stress usage of a few basic pieces of protective clothing and then working into more complete coverage after the first few have been adopted. Communities could be encouraged to form professional spray teams that would be hired. These could be more efficiently trained to wear protective equipment. Herbicide application could be a useful test case in testing this approach. Eyes are particularly sensitive to glyphosate thus wearing goggles is a must. In addition, wearing rubber boots and long pants would complement this giving the highest priority protection. Goggles are readily available and inexpensive (<$US2) as are rubber boots (<$US5).

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

A list of pesticides both currently recommended and suggested by the PERSUAP is presented in the following tables with the acute and chronic toxicological hazards. Table 1 gives the values used in those toxicity ratings.

Table 1. Descriptive toxicity categories for currently used and suggested pesticides.

Descriptive term	Mammalian /avian acute oral (LD_{50}) (mg/kg body wt)	Mammalian dermal (LD_{50}) (mg/kg body wt)	Mammalian inhalation (LC_{50}) (mg/liter air)	Aquatic invertebrate/fish (LC_{50} or EC_{50}) (ppm or mg/liter water)	Honey bee acute oral (LD_{50})
Very highly toxic (VHT)	<10			< 0.1	
Highly toxic (HT)	10-50	< 200	< 0.05	0.11-1.0	< 2 µg/bee
Moderately toxic (MT)	51-500	201-2000	0.051-0.50	1.1-10.0	2.1-11 µg/bee
Slightly toxic (ST)	501-2000	2001-5000	0.51-2.0	10.1-100	
Relatively non-toxic (RNT)	> 2000	> 5000	> 2.0	101-1000	> 11 µg/bee
Practically non-toxic (PNT)				1001-10,000	
Non-toxic (NT)				> 10,000	

Mammalian toxicity includes both man and domestic and wild animals. Acute oral includes not only entry by mouth but also via the eyes and nasal passages (mucous membranes), thus the need to protect ones eyes and nose. Even the ground chili powder being recommended as ‘safe’ pesticides can cause severe eye irritation (tear gas) as can soap. Dermal hazard is more if the skin is moist, thus wearing

too heavy protective equipment may have counteracting effects of causing much sweating. The worst dermal exposure comes from applicators carrying leaking sprayers in which pesticide soaks the back. The applicator's soaking shirt acts as a wick in which pesticide constantly enters the body via the wet skin. This means that it is very important to repair or replace leaking sprayers. Extension services are encouraged to conduct sprayer calibration trainings annually where all the farmers bring their equipment for inspection. Spray drift from herbicides and other pesticides can enter parks and other centers of biodiversity to potentially kill off plants, invertebrates, and microflora. Farm and wild animals are exposed when farmers clean their sprayers and cause puddles filled with pesticide rinseate that invite animals to drink. Washing spray equipment in or near rivers and lakes presents hazards for fish and aquatic life. Rinseate can also enter underground aquifers. Methods of safe disposal of empty pesticide containers should be known by all farmers which if not done carefully threaten humans, farm animals, and wildlife.

f.) Factor f: Effectiveness of the requested pesticide for the proposed use;

The best way to determine efficacy is to conduct field trials testing the top 5-6 products for each pest on each crop. This takes a large applied research effort and could be carried out as farmer-led, on-farm demonstrations with the farmers as co-partners. During the registration process each pesticide is tested in the field over three seasons, but only on one crop. The identity of the crop is not recorded and as national recommendations are lacking that would summarize these data, one has to rely, as a first source, on information provided on the product label. This could be supplemented by information provided by technical representatives of chemical companies as well as published literature or recommendations available from other countries on the Internet. Most farmers unfortunately are not good sources of this kind of information because they do not compare different products at the same time nor leave an untreated check. Not much published literature on pesticide testing is being generated in Uganda so other sources need to be sought, particularly on less well known crops. Considerable information does flow from neighboring Kenya. All of those products recommended have been cross checked from information provided by labels and from USEPA sites. Still more local testing is needed to ensure that the most effective pesticides are being recommended. The problems of product adulteration are also a concern of the pesticide industry and need to be addressed.

g.) Factor g: Compatibility of the proposed pesticide with target and non-target ecosystems;

All but the biologically based pesticides being recommended are broad spectrum in effect, thus will have negative impacts on beneficial arthropods in the case of insect and mite pests. Fungicides directed at plant diseases will reduce densities of beneficial pathogens that kill insects and mites as well as weeds. Insecticides will also kill herbivorous arthropods feeding on weeds. A number of crops are pollinated by bees that are not only sensitive when flying but also can carry contaminated pollen and nectar to the hive potentially killing off the whole colony. Rodenticide baits can also be eaten by domestic and wild animals with serious repercussions as they affect all mammals. This is why rodenticides are highly toxic to man. Ways of placing the bait in the field can minimize the negative effects. Use of bamboo tubes only allows small rodents and not dogs or cats from finding the food. Wax encased bait is better than loose rice grain which will attract more nontarget organisms. The most selective pesticides are azadiractin, Bt, NPV, petroleum oil, soap, and sulfur. Seed treatment materials are more protected from the environment covered by soil. Granular insecticides and nematicides such as carbofuran if broadcast onto the soil cause great hazards to birds which inadvertently feed on them not knowing their hazards. This is one reason why carbofuran is not recommended. Toxicity class III and IV are less hazardous than class I and II which, with a few exceptions, are not being recommended

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

With the exception of fumigation and some seed treatments, all pesticides will be used directly by farmers or hired spray teams. The hesitancy of farmers to wear complete protective clothing is in part due to the warm largely subtropical climate, making it uncomfortable to wear body suits, rubber gloves, and face masks. Along the high rainfall Lake Victoria crescent, there are two rainy seasons. The frequent rainfall will reduce the residual life of pesticide applied to the crop. However once the

pesticide has dried on the leaf, adjuvants in the pesticide formulations will help pesticide residues to resist rainfall. The high rainfall also increases humidity which encourages fungal diseases and thus more fungicide applications. In the drier zones, sourcing water for spraying is a problem. Some of the developments in new low volume sprayers address this issue. Uganda is one of the world's centers of biodiversity and QE Park is a combination of a Park, National Forest Reserve, and wetlands, has been designated by Conservation International as one of the 34 threatened 'hot spots' <www.biodiversityhotspots.org> (red areas on figure 2). The Albertine Rift is part of the eastern Montane biodiversity hot spot, and QE park is part of the Albertine Rift.

Figure 2. Eastern Afromontane biodiversity hot spot stretches from Saudi Arabia in the north to Zimbabwe in the south.

Though geographically disparate, the mountains comprising this hotspot have remarkably similar flora. The Albertine Rift <www.albertinerift.org> (running south from Lake Albert along eastern Uganda to the southern end of Lake Tanganyika) harbors more endemic mammals, birds, and amphibians than any other region in Africa. The geological turmoil that created the mountains of this hotspot has also yielded some of the world's most extraordinary lakes. Due to these large lakes, a vast amount of freshwater fish diversity can be found in the Eastern Afromontane region, which is home to 617 endemic fish species. As in many tropical areas, the main threat to this region is the expansion of agriculture, especially large crop plantations for crops like bananas, beans, and tea. Another relatively new threat, which coincides with the increasing population, is the growing bush meat market. This is especially problematic in the Albertine Rift. The country is trying to expand its tourism industry which feature over 40 preserves. With the population expanding, some agriculture areas juxtapose parklands. PRIME/West's main mandate is to develop management plans with neighboring communities to protect these areas. Cotton, vegetables, fruits, and other commodities that are often protected by pesticides are often next to parkland. Measures need to be worked out to minimize the negative impacts this can have. Uganda is a country laced by rivers and lakes. Much of the country lies "between the lakes," an area receiving abundant rainfall. Such aquatic features act as a sink for eroded soil and effluent, and great care should be taken when using pesticides adjacent to, or on hillsides leading to, such aquatic environments. Waterways can more likely become contaminated from pesticides applied in the air as was done in the tsetse fly campaigns decades ago and is now done in the large lowland rice farms from drift. Other sources could be farmers washing pesticide sprayers in or near waterways or illegal pesticide disposal. Contamination could also come from direct agricultural field usage. This could be from pesticides that entered the waterway either directly or combined with soil (more likely) from field runoff after rains or from pesticide spray drift.

i.) Factor i: Availability and effectiveness of other pesticides or non-chemical control methods;

As part of the PERSUAP a number of replacement pesticides have been recommended, most of which however currently are not in the marketplace nor registered in Uganda. As there are now several large importers in Uganda presently they could be encouraged to import trial amounts. A system has been put in place since the IDEA PERSUAP which allows for importation and testing of new products that was developed for the floriculture industry but can be used generally. The suggested replacement pesticides were chosen with highest efficacy and least hazard in mind. There still are several weaknesses such as nematicides and bactericides. For the latter there is no suggested replacement for copper oxychloride and bronopol. This is due mainly to the general lack of products worldwide, not just in Uganda. Only one safe nematicide could be found (dazomet = Basimid). Nematicides are generally highly toxic and encouraging new products are being tested which are biologically based. More testing will be needed before they can be recommended for importation. Non-chemical methods have been documented for the various crops pest by pest in section 3.2. Genetic resistance plays a large role and credit is due for Uganda to foster such close relationships with the various international centers to ensure that the latest genetic materials are being tested. Cultural controls also play a vital role. One central one is early planting which can generally be stated as a vital escape mechanism. However for this to be carried out, farmers need to quickly prepare their land, and thus need draught animals for tillage and interrow cultivation. This can go a long way in reducing the need for herbicides. Glyphosate resistance is problem in areas of the world where this herbicide is overused. Fertility management can also support the crops' ability to tolerate infestations. A complement of organic and inorganic sources is important. More biologically based pest control measures will be developed with time to complement control methods.

j.) Factor j: Requesting country's ability to regulate or control the distribution, storage, use and disposal of the requested pesticide;

The MAAIF Pesticide Registration Office runs an active program and over the past four years has registered 54 insecticides, 4 fumigants, and 21 herbicide products. This regulatory body has prevented the world's most hazardous products being registered in Uganda, following FAO guidelines. None of the so-called dirty dozen products were seen for sale as well as the highly hazardous class I methamidophos, aldicarb, or monocrotophos, etc. The Registrar is supported by the Commissioner for Crop Protection and now has a larger body of inspectors. The registration process is very strict. Not only pesticide products are registered but also wholesalers, stockists, and private application companies must register and renew registration annually. Pesticide products must be field tested over three seasons and renewed every three years thereafter. Importation requires permits, copies of which are sent to border towns for customs officers. Some smuggling does go on along the Kenyan and Congo borders. Inspectors are active in Kampala but not in the rural areas. Adulteration is a serious problem. However MAAIF inspectors do not have police powers as do pharmaceuticals and enforcement cannot be carried out even though analyses have shown dilutions. Storage facilities of distributors are inspected in Kampala. Due to smuggling and the paucity of importation records, statistics on pesticide importation are lacking. There is no record keeping on pesticide use by crop. The Agricultural Secretariat used to compile this data but this policy board is no longer active. Extension agents could undertake surveys to derive this data as is common in other countries but there is no mandate to do so. Likewise there are no statistics kept in public health hospitals on the incidence of pesticide poisonings. An adequate disposal site is lacking and currently the only facility is the incinerator at the veterinary school of Makerere which is used to burn animal cadavers and is not hot enough to vaporize pesticides. Cement plants have the capacity and there are two in Uganda. The regulatory office is pursuing the UPDF to see if it has a suitable disposal site.

k.) Factor k: Provisions made for training of users and applicators;

With the exception of PRIME/West which is newly started, all partners run extensive training programs for farmers, farmer leaders, extension workers, and stockists. These training programs are amplified by training that is being undertaken by other institutions such as MAAIF, Makerere University, other NGOs, pesticide wholesalers, etc. For farmers, farmer leaders, and district extension workers, the training is crop based with farmers being organized into groups led by a farmer leader.

District level extension workers may be hired by projects, farmer groups, or private companies. Extension workers are now being taken off the GoU payroll and linked with any of these entities as a part of a transfer to a farmer driven system under NAADS. The success of this devolution of extension workers to clients depends on farmer groups having sufficient profits from farming that they can hire them and the individual competency of each extension worker in assisting the group to raise yields and income. Less competent extension workers will be out of a job, thus overall numbers will fall, whose positions must be filled with new recruits.

The method for training farmers and farmer leaders is the on-farm demonstration where farmer groups are led, step by step in growing the crop during the season from planting to harvest and increasingly into postharvest activities and even marketing. Many successful farmer groups are even at the stage of joining other groups to form larger farmer organizations. Generally it was seen there is a strong will among farm communities to be successful. The key to success first is having the presence and commitment of a knowledgeable extension worker who visits the communities regularly during the season. Secondly, there must be well developed lesson plans to transmit the technical knowledge during training sessions. There are two types of knowledge that farmers must assimilate in order to rise above their current level. One is that knowledge of practical skills that can be learned by seeing someone do it or by observation. This would be to learn how to plant in rows, measuring distances between rows, make a planting rope, how to recognize a pest in the field, and how to conduct scouting based on a pegboard. More difficult to learn however is the set of knowledge that requires analysis and decision making and what to do if conditions changed in the field different from what occurred during the demonstrations. On-farm demonstration is adequate for the former if repeated over several sessions but not good on the latter. The FAO farmer field school method teaches farmers how to make decisions and gives them skills to develop their own technologies when new pests appear. Part of the farmer field school method teaches farmers how to conduct their own applied research and analyze data. CIP has particular skills in the farmer field school method and should be encouraged by Africare to initiate training to serve as a model for other projects. One has to see a properly run farmer field school group to appreciate its benefits. Cost should not be a limiting factor in its adoption if there are no other appropriate training methods for farmers. Cost sharing by the farmers themselves has been conducted in other countries which follows the NAADS approach and could possibly be accommodated in Uganda as a result. In addition partners should introduce farmer driven research into trained farmer groups. This not only can be used as a learning tool but also can increase our knowledge of the performance of IPM technologies. These could be testing various pesticides, action thresholds, monitoring and scouting schemes, fertilizer rates, varieties, etc.

It behooves each project to undertake periodic evaluations of the on-farm demonstration methods in terms of adoption surveys. The only one reviewed conducted by DANIDA in UNFFE programs shows farmers are not assimilating many of the technologies. The far majority of trainers in on-farm demonstrations have not been trained in learning theory and how to make and evaluate a training curriculum. Desired knowledge to transmit is broken down into learning concepts and lessons are drawn up on how to transmit these concepts in ways farmers can adopt them. Trainers now are mainly technical people sharing their knowledge using lecture and demonstration. Agricultural extension is a discipline in its own right and has made improvements in how to present learning concepts in ways farmers can best adopt them.

An outside consultant with a background in agricultural extension theory and practice should be engaged to make a review of the on-farm demonstration programs and make recommendations on improving training skills and conducting evaluations. Training needs assessment surveys should be conducted to find out what technologies to focus on during training. It has been shown that training farmers in skills they already possess reduces interest. By focusing on what they do not know increases attendance. Data should be taken on attendance and published in project reports as should results of quizzes and adoption evaluations. Commonly used evaluations are short quizzes before and after training sessions. This would tell the trainers immediately if their training session were successful. If not, the presentation should be changed and more time spent on less understood concepts. Concepts are best presented with analogies or short exercises conducted by the farmers. The

trainer should act as a facilitator as farmers learn best from other farmers thus discussions should be undertaken where farmers themselves come up with the answers. If they are merely told or just see it done by others it does not stick in their mind as well. There are two steps to learning. One is understanding the information such as why it is important to wear goggles while spraying and the second is to actually adopt wearing goggles. One of the greatest obstacles faced in IPM is for farmers to wear adequate protective clothing. They could probably tell you what clothing to wear but still they do not wear it. This is a problem that needs to be solved by better training methods. The current training methods are not effective enough.

The current training methods for stockist managers are probably effective enough, although adoption surveys should be conducted to measure this. This group of stockists can learn by lecture formats while the rank and file stockists whose turnover is probably high need a different approach. The rank and file stockists are those that are the salespersons and contact the farmers directly. They can learn on their own from reading if given good quality pamphlets and manuals. For them more training sessions are needed with handouts so they can learn on their own. There are several good pamphlets and manuals that have been developed and these should be made more widely available.

5. SUMMARY OF CONCERNS AND RECOMMENDATIONS

As a result of the Pesticide Evaluation Report the following issues emerged which are now discussed one by one followed by recommendations to deal with them. In section 6 an action plan on how to carry this out is presented.

5.1. Use of hazardous and high-toxicity pesticides

Due to the use of knapsack sprayers by small-scale farmers and being unaccustomed to wearing protective equipment, only pesticides which meet USEPA and USAID standards of minimum mammalian toxicity should be recommended. Thus pesticides or their formulations which are classified in USEPA toxicity classes I and II should be replaced with the following exceptions:

- Allowed are stored product pesticides aluminum phosphide (Phosdrin) fumigant and pirimiphos-methyl + permethrin (Actellic), the former would be used only by professional fumigators at their facilities while the latter can be used only by staff trained in seed protection methods and who have the necessary protective equipment.
- Methyl anthranilate (Bird Shield) which is a bird repellant derived from an extract of concord grapes thus is safe for humans, eye irritation comes from the solvent and carrier used in the formulation, and is allowed if farmers use goggles.
- The herbicide glyphosate acid which is rated toxicity class II (due to eye irritation), but rated III slightly toxic (by inhalation) or IV likely not to be hazardous (by oral/dermal contamination), if farmers were given training to wear goggles, glyphosate could be safely applied by knapsack sprayer; glyphosate is being tested by safer application methods which would reduce exposure during application such as Weed Wipe gravity flow and VLV sprayer which uses the wind to drift the product into weedy areas, exposure to glyphosate using the Weed Wipe and VLV sprayers would only be during loading the sprayer, farmers could be trained to use gloves.
- Carbaryl is approved in formulations less than 50% concentration.
- Malathion is not approved as a wettable powder but only in emulsifiable concentration formulations.

Recommendations:

Table 1. Products for *immediate removal and replacement* in USAID partner programs: all USEPA toxicity class I and RUP pesticide products

Pesticide	Brand	Formulation [1]/	WHO toxicity class	USEPA toxicity class	USEPA RUP	Regis-tered USEPA	Regis-tered Uganda
Insecticide							
lambda Cyhalothrin	Ambush CY Ambush Super	10% EC	II	I	Yes	Yes	Yes
Herbicide							
Paraquat	Gramoxone	60% WG	II	I	Yes	Yes	Yes
Rodenticide							
Coumatetralyl	Racumin	Pelleted bait	Ib	I	[2]/	No	Yes
Coumachlor	Tomorin	Pelleted bait	Ia	I	[2]/	No	Yes

[1]/ RUP = restricted use pesticide, EC = emulsifiable concentrate,
WG – wettable granules, [2]/ No RUP listing if not registered by USEPA

Table 2. Pesticides to be *removed from USAID-influenced programs by April 30, 2008* -- all pesticides which fall in USEPA toxicity class I or II that are listed here

Pesticide	Brand	Formulation [1]/	WHO toxicity class	USEPA toxicity class	USEP A RUP	Regis-tered USEPA	Regis-tered Uganda
Insecticide							
Carbofuran	Furadan	5% G	Ia	II	Yes	Yes	Yes
Carbosulfan	Marshall	2.5 EC	II	II	[2]/	No	Yes
Chlorpyrifos	Dursban	48% EC	II	II	Yes	Yes	Yes
beta-Cyfluthrin	Bulldock	2.5% EC	II	II	[2]/	No	Yes
Deltamethrin	Keshet Decitab	2.5% EC 0.5g/tablet	II	II	Yes	Yes	Yes

Diazinon	Diazol	60% EC	II	II-III	Yes	Yes	Yes
Dimethoate	Rogan	40% EC	II	II	No	Yes	Yes
Fenitrothion	Fenpaz	50% EC	II	II	Yes	Yes	Yes
Fenvalerate also Esfenvalerate	Fenfill	20% EC	II	II	Yes	Yes	Yes
Fipronil	Regent	20% EC	II	II	No	Yes	Yes
Pirimiphos ethyl	Primicid	20% EC	Ib	II	[2]/	No	No
Profenofos	Polytrin-K	40% EC	II	II	Yes	Yes	Yes
Nematicide							
Ethoprop	Mocap	10G	Ia	II	Some	Yes	No
Fungicide							
Anilazine	Dyrene	40% WP	IV	II	No	Yes	No
Copper oxychloride	Cupravit	50% WP	III	II	No	Yes	Yes
Bactericide seed dressing							
Bronopol	Bronocot	80% SP	II	II	[2]/	No	No
Herbicide							
Bromoxynil	Buctril	45% EC	II	II	No	Yes	No

[1]/ G = granules, EC = emulsifiable concentrate, WP = wettable powder, SP = soluble powder
[2]/ No RUP listing if not registered by USEPA

Table 3. Pesticides *permissible* in USAID sponsored or influenced programs. Suggested replacement pesticides are included

Pesticide	Brand	Formulation	WHO toxicity class	USEPA toxicity class	USEPA RUP	Regis-tered USEPA	Regis-tered Uganda
Insecticide							
Acephate	Orthene, Lancer	75% WP	III	III	No	Yes	Yes
Acetamiprid	Assail	70% WP	III	III	No	Yes	No
Azadirachtin	Neemol	4% EC	IV	III	No	Yes	Yes
Bacillus thuringiensis (Bt)	Xentari	10.3%DF	IV	III	No	Yes	No
Carbaryl [3]/	Sevin	< 50% Dust, WP	II	II-III	No	Yes	Yes
Imidacloprid	Gaucho	17.4% F	II	III	No	Yes	Yes
Indoxacarb	Steward	14.5% SC		III	No	Yes	No

Malathion [4]/	Malathion	WP	III	II-III	No	Yes	Yes
Methoxychlor	Marlate	25% EC	IV	IV	No	Yes	No
Methoxy-fenozide	Intrepid	22.6% F	III	III	No	Yes	No
NPVirus	Heliokill	0.6% LC		IV	No	Yes	No
Petroleum oil	Summer oil, white oil, horticultural oil	98% oil	IV	IV	No	Yes	No
Spinosad	Tracer	22.8% SC	IV	IV	No	Yes	No
Thiamethoxam	Cruiser	350 FS	III	III	No	Yes	[1]/
Fumigant/seed protectant							
Aluminum phosphide	Phostoxin	Tablet	[1]/	I	Yes	Yes	Yes
Malathion	Malathion	WP	III	II-III	No	Yes	Yes
Pirimiphos-methyl	Actellic	16% EC	II	II	No	Yes	Yes
Permethrin	Actellic	3% EC	II	II	Yes	Yes	Yes
Thiram	Thiram	65% WP	III	III	No	Yes	No
Fungicide							
Benomyl	Benlate	50% WP	IV	IV	No	Yes	Yes
Cymoxanil	Milraz	76% WP	III	III	No	Yes	[1]/
Dimethomorph	Acrobat	MZ	IV	III	No	Yes	Yes
Dithianon	Delan	75% WP	III	III	[2]/	No	No
Fosetyl aluminum	Aliette	80% WDG	IV	III	No	Yes	No
Kresoxim-methyl	Stroby	50% WG	Not rated	III	No	Yes	No
Mancozeb	Dithane	M 45% WP	IV	IV	No	Yes	Yes
Metalaxyl	Ridomil	7.5% WP	III	III	No	Yes	Yes
Propineb	Milraz	76% WP	IV	III	No	Yes	[1]/
Sulfur	Thiovit	80% WP	IV	III	No	Yes	Yes
Tebuconazole	Folicur	25% EC	IV	III	No	Yes	No
Thiophanate methyl	Topsin M	50% WP	IV	IV	No	Yes	Yes
Herbicide							
Diuron	Diurex	80%DF	IV	III	No	Yes	Yes
Glyphosate acid	Roundup, Touchdown Total	48% EC	IV	II-IV	No	Yes	Yes
Glyphosate salt	Touchdown	28% EC	IV	IV	No	Yes	Yes
Haloxyfop-R methyl	Gallant Super	52% EC	II	III	[2]/	No	No
Iodosulfuron-methyl-sodium	Hussar	50%EC	Not rated		[2]/	No	No

Metolachlor	Dual	960EC	III	III	No	Yes	Yes
Propanil	Rical	23%EC	III	III	No	Yes	No
Thiobencarb	Rical	11%EC	II	III	No	Yes	Yes
Bird repellent							
Methyl anthranilate	Bird shield	26.4% SC	IV	II	No	Yes	No
Molluscicide (snails)							
Metaldehyde	Mesurol	Pellets 3.5%	III	III	No	Yes	No
Nematicide							
Dazomet	Basamid	99%G	III	III	No	Yes	No
Rodenticide							
Bromadiolone	Ratoxin	Ready to use bait 0.005%	Ia	III	No	Yes	Yes
Warfarin	Ratatox	Ready to use bait 0.025%	Ib	III	No	Yes	Yes

[1]/ Being field tested for registration, [2]/ No RUP listing if not registered by USEPA
[3]/ Approved only in WP formulation, [4]/ Approved in concentrations below 50%

5.2 Protective clothing not used by farmers

According to field visits and briefings by many resource staff, outside of demonstration plot activities, few farmers normally use even the bare minimum of appropriate pesticide protection clothing and equipment. Farmers generally mix chemicals (where the pesticide is most toxic) without rubber gloves, a bucket of water to wash off spills, or goggles and spray while walking through the spray path without rubber boots, goggles, rubber gloves, a plastic sheet between the sprayer and the back, and with only every-day clothing. This behavior is common among farmers even though they generally believe that pesticides pose danger to their health. Most knew to bathe after spraying but few changed clothes after spraying. This is a recurrent problem needing immediate attention. In extension demonstration exercises, sessions should be held to see what farmers could devise using local and cheap materials such as plastic bags etc. to come up with an acceptable compromise to the fully protected suits seen in the extension bulletins. The key times are during mixing and when walking through the spray path. Rubber boots and a water repellant apron of sorts (a water repellant apron, improvised plastic sheeting tied around the waist or raincoat to protect the front of the legs and abdomen (to be worn over long pants), and goggles should be first priority. Those that apply pesticides should be encouraged to wash their clothes after each day's spraying.

Recommendations:

Most farmers are aware of needed protective clothing. The problem needs a fresh look by a consultant to be hired by the partners to make recommendations on better training methods that might be utilized to increase adoption rates. It is suggested that the problem should be posed to the farmer groups in extension sessions. Let the farmers suggest solutions in terms of protective equipment they could purchase or devise using local and cheap materials such as plastic bags etc. to come up with an acceptable compromise to the fully protected suits seen in the extension bulletins. The key danger times are during mixing and when walking through the spray path. Eye and feet protection are the greatest priority. Goggles, long pants, and rubber boots are most needed. Perhaps farmers can improvise an acceptable water repellant apron made of plastic sheeting tied around the waist or raincoat to protect the front of the legs. Those that apply pesticides should be encouraged to wash their clothes after each day's spraying.

5.3 Most pesticide labels are incomplete

Labels on pesticide containers can provide much information to the farmer on how to best use the product safely and effectively. Observing pesticides on the shelves of stockists revealed that there is a great variation in the information provided on labels. The Ugandan regulations state that the labels should follow FAO standards but it was noted that often much necessary information was lacking. Pests controlled as stated on labels should be those occurring in Uganda. The label should also provide information on poisoning symptoms with information to physicians on antidotes and first aid treatment. Dosage information should be in units that farmers understand (tablespoons per 15 or 20 liter sprayer). Since there are numerous local languages English no doubt should be the language of choice although some labels were noted to be entirely in Luganda. Others were noted not to give the dosage. Some did not even state the product was hazardous.

Recommendations:

The partners should meet with the ACB technical committee to review the extent of this problem. If the ACB agrees it could review the content on current pesticide labels and make suggestions on the minimum standard set of information needed for registration. It is suggested that information on pre-harvest interval (PHI) and return entry intervals (REI) be adopted as useful guidelines as to the timing of the last possible applications to minimize residues on food and the number of hours or days that it

is safe for field workers to re-enter fields after spraying. As all products are required to register every three years this new requirement could be made at this juncture.

5.4 High turnover rate of stockists

The training of stockists in both Kampala and rural areas is being undertaken by many organizations including MAAIF, Makerere University, AT Uganda, Sasakawa Global 2000, as well as various projects. There are also plans by the ACB to expand this training to more rural towns as part of the stockist registration process. This is a great effort and much needed. Often the owners of the shops are trained but the hired staff in the shops are not. Discussions with stockists in Kampala and in rural areas during field trips revealed a general lack of how to read a pesticide label and provide pest control advice to farmers who seek their help. The high turnover rate among rank and file stockists does not allow all of them to be trained in formal courses.

Recommendations:

It would be useful if a well illustrated booklet designed for self learning could be developed and dispersed to stockists and their staff who could have a ready reference to learn from in-between customers. The booklet would contain information on how to read pesticide labels as well as general information about safe pesticide use and first aid practices. Videos that have been developed perhaps could be shown in more venues in order that the shop staff can avail of the information they desperately need. In addition if MAAIF could be encouraged to assemble the recommended pest control practices in summary form for major crops in a summary form that also could be useful to stockists when advising farmers. This same booklet could also be used by extension workers.

5.5 Amelioration of pesticide odor as an occupational health hazard of stockists

Interviews and visits to stockists revealed that many complained of headaches, nausea, and high blood pressure from sitting in small shops for up to 12 hours per day breathing the ever-present odor of pesticides. Some staff take remedies to offset the ill effects and are clearly concerned about their health. One took prescription medicine from Mulago Hospital at great cost.

Recommendations:

Less odor was noticed in shops that displayed pesticides in shelving cases constructed with sliding glass door fronts. In addition some shops had electric fans which helped fresh air enter. Some stockists exhibit empty containers of pesticides for customers to examine before purchase. The technical committee of the ACB could be encouraged to find ways to minimize the health hazard of stockists.

5.6 Pesticide usage should be in the context of IPM programs

Pesticides are often seen as a first choice in pest control whereas following IPM their use should be the last choice when all else fails. In addition the decision to use pesticide is based on the presence of the pest and not on decision protocols such as action thresholds currently being used for cotton using the pegboard. As it is now for most crops, recommendations imply that as soon as the pest is seen, a pesticide should be used. As a result more applications are probably given than would be necessary if decision guides were developed based on field verification or trials. Pest control recommendations include many non-pesticide practices and pesticide usage should also be seen as a last resort.
Recommendations:

Monitoring programs need to be developed along with action thresholds as methods to quantify pest abundance as a guideline to initiate pesticide usage for more crops than cotton. Cotton is an excellent model for developing guidelines for pesticide usage in an IPM context. Pest control recommendations should include many non-pesticide practices first and pesticide usage only as a last resort. As a first

start relevant literature from other countries could be sourced and field tested in verification field trials such as on-farm demonstrations with farmers as partners.

5.7 The list of approved pesticides in the Registrar of Pesticide Office should be computerized and made more widely accessible

In looking up the list of registered pesticides in Uganda in the MAAIF Registrar Office it was noticed that the list is actually a series of lists, some on computer and others on paper in scattered files. As a result it is possible that some pesticides reported are actually registered in Uganda, but were missed in the search. Much work and expense go into registering pesticides, and pesticide dealers and projects using pesticides should be able to readily obtain a list of registered products. Even other government agency staff were requesting such a list.

Recommendations:

The partners should request the Office of the Registrar of Pesticides to make the list of registered pesticides more available to those who have legitimate needs to know if a particular pesticide is registered. If there were one computerized list in alphabetical order this could greatly facilitate wholesalers, project staff as well as GoU agencies who need to look up pesticides. Perhaps the list could be put on a website for all to access in a convenient manner without having to visit the Entebbe office at a great savings of time.

5.8 Farmers often use the wrong pesticide product such as an insecticide to control a disease

From discussion with extension staff and farmers it is apparent that there are multiple sources of recommended practices which often differ, resulting in confusion among farmers. In addition, farmers think brand names are different pesticide. Farmers also believe pesticides control a wider range of pests than they do. Sometimes insecticides are applied to control fungal diseases. Some farmers use an aphid insecticide to control stalk borer not knowing that insecticides differ in efficacy for different pest groups. These problems arise because MAAIF has not published current standardized recommendations. Those in the past are out of date.

Recommendations:

In most countries there are standardized recommendations that are developed and updated regularly following a procedure of meetings among researchers and extension staff where results are published in booklets for use by extension workers and others. Confusion can be minimized by listing the brand names for each pesticide and the most efficacious products for each target pest. The first meetings occur within commodity groups by those who are actively researching and testing new technologies. Recommended practices are then decided upon as is now done in the National Variety Release Committee, but would be expanded for all production practices for each crop including IPM and recommended pesticides. A second series of meetings would occur between research and extension entities where the research teams present the latest recommended practices for feedback by extension. Some of this work has already been done but occurs in scattered sources such as the pest control guide for cotton. After agreeing on a set of recommended practices, booklets would be published that would be given to extension workers and be available for sale to farmers and the general public. The booklets could be updated from time to time and even put on a Webpage.

5.9 Pesticide disposal of containers and obsolete product needs to be strengthened

Many people interviewed expressed concern that pesticide containers are often found scattered around fields or near farmers' homes. Sometimes containers are reused by the farmers. Both unsound disposal and reuse of containers pose hazardous situations. There were conflicting recommendations given by people interviewed as to the best solution for reducing pesticide hazard from improper

container disposal. If the containers are burned, products from burning can be more hazardous than the pesticide itself. The ACB technical committee is working with the Bureau of Standards to come up with containers that would be less attractive for reuse by farmers which is a good strategy. Disposal of obsolete pesticides in the incinerator at the Veterinary School in Makerere University probably does not heat up the pesticide enough to vaporize with no visible smoke. The MAAIF is looking into a chemical disposal facility run by the UPDF but again it is not known if temperatures are enough to prevent dangerous smoke and fully vaporize the chemicals.

Recommendations:

The ACB technical committee could look into deciding on the best practices of container detoxification and disposal. The UPDF site is being looked into as a way of disposing of used containers. The USEPA recommends that solid containers should be tripple rinsed, crushed, and buried. Paper containers should be buried, and not burned. Burning is dangerous as the temperatures obtained by wood fires are not hot enough to prevent poisonous smoke from occurring. There is no place to safely dispose obsolete pesticides. It is suggested that arrangements with a cement plant be pursued to determine if pesticides and other hazardous chemicals could be incinerated in this manner. The temperature of 2000^{o}F of the cement plant flame fully vaporizes pesticides. A metal tank can be constructed next to the burning area in the cement plant and fitted with a mixing blade and a pump to take the pesticide and kerosene mixture right to the flame by copper pipe. A nozzle fitted on the end would send the mixture as a fine mist to be readily vaporized. Unless the temperatures are of the order of 2000^{o}F the resulting smoke will pose health problems. Perhaps the ACB Technical Committee could visit the several cement companies in Uganda. Other noxious chemicals could also be disposed in the same manner. It is far cheaper to add on an incineration capability to a cement plant than to export it to another country or build a specialized incineration plant within the country. There is the added danger if the pesticides were exported that the trucks would have an accident spilling the concentrated product. The cement plant incineration could be utilized for more than pesticides and could include most organic chemical waste from schools, businesses, and the public.

5.10 Rotate pesticide chemical groups to minimize pesticide resistance

Repeated pesticide use presents risks for development of pesticide resistance where mortality rates decline. When this occurs it is often difficult to find substitutes. The danger is greatest in areas where year-round cultivation of vegetables, cotton, or Irish potatoes occurs. Technicians need to match pest abundance within a season with pesticide response for each location. Under heavy pest pressure and in the absence of genetically resistant varieties, repeated spraying often is necessary. As cross resistance is common, fungicides, insecticides, herbicides, and acaricides need to be rotated by chemical family to reduce the risk of pesticide resistance. Glyphosate resistance is now common in the U.S. Farmers need to have knowledge of the general families of pesticides for rotation must occur between families and not just brand names. Farmers generally do not know that different brand names are often the same chemical. Fungicides on Irish potatoes, insecticides on cotton, and herbicides such as glyphosate may require calendar-based schedules both to improve the degree of control as well as lower the risk of crop failure.

Recommendations:

Pesticide manufacturers and researchers worldwide have developed systems of rotation of pesticide families on cotton and other crops to minimize the development of pesticide resistance. In order to work, a strict rotational schedule needs to be followed by all farmers in an area for each growing season. It is recommended that such systems be enacted for cotton insect pests, diseases of Irish potato, and herbicides such as glyphosate.

5.11 Adulteration

Conversations with pesticide wholesalers, stockists, project staff and chemists revealed that adulteration occurs commonly in certain pesticide products. Farmers have even approached the Government Chemist with stories of products not working and reports of phytotoxicity with usage. APEP paid for some cotton pesticides to be tested to determine if the stated active ingredient content was within the range set by the Bureau of Standards. Three of the five samples were significantly below the stated percentage formulation. Adulteration hurts the pesticide industry and creates distrust among farmer clients.

Recommendations:

The pesticide regulations identify the Government Chemist as the person with legal authority for monitoring pesticide content in the retail market. The Government Chemist has already had success that led to the prosecution of Lake Victoria fishermen using pesticide instead of nets. Soon it is expected that MAAIF inspectors will be gazetted so that they legally can take samples of suspected adulterated product. If an arrangement were worked out with a local consumer oriented NGO who would act as witness along with the inspectors to the taking of samples and delivering them intact to the laboratory, this could be presented as evidence of impartiality in court. All it would take would be a few convictions to stop this practice.

5.12 Protecting biological reserves such as national parks from pesticide incursion

It has been observed that due to the pressure to expand agricultural lands, cotton and other crops where pesticides are used are being grown along the borders of national parks, rivers, and other protected areas. Nearness of these fields poses hazards to the wild nature of these biodiversity centers. Pesticide can enter protected areas by a number of means with drift posing the most imminent threat. As well, insecticides and fungicides bind with soil in the treated field upon contact from drift or washing off of plants. Later this pesticide contaminated soil could erode and run into streams and thence into parks. Herbicides, being more water soluble, have a history of leaching into underground aquifers particularly in sandy soils. They are carried downward by rainwater seeping into the soil. Farmers may improperly dispose of pesticide containers and rainwater can leach pesticides into groundwater. The same can be said when farmers wash their sprayers and throw rinseate onto the ground or worse directly into bodies of water. Guidelines need to be drawn up to mitigate potential contamination of centers of biodiversity in Uganda from nearby agricultural activities.

Recommendations:

Following NEMA guidelines there is a need to develop an environmental plan to deal with location of project demonstrations and farmers' fields for each type of crop in relation to protected areas to minimize environmental impact. Both the APEP and PRIME/West projects have initiated a mitigation plan to minimize encroachment based on their activities. APEP has no direct control over location of fields by farmers but could work with ginneries to influence farmers to be conscious of the location of fields due to potential negative publicity that could result if the source of contamination were more publicized internationally and thus seriously affect the export market. PRIME/West recommended an environmental management systems (EMS) consultant be hired.

The ginneries can be encouraged to contribute to the Uganda Wildlife Authority to hire community conservation wardens to monitor sensitive areas. Rwenzori Coffee Company that procures organic Arabica is now giving money to help protect QE Park in order to strengthen monitoring activities. A link could be established with NEMA at local level with District Environmental Officers. An environmental NGO could be hired to work as a go-between with both wildlife authorities and forestry services and the local villagers. Arrangements would be made on the part of villagers in terms of a plan giving villagers managing rights to a pre-described area within the park border in return for their agreeing to work with the wardens to police the borders to prevent encroachment by others.

Guidelines for herbicides causing significant phytotoxicity have been developed in the U.S. based on studies as spray drift has on occasion ruined neighbor's crops leading to lawsuits. These guidelines could also apply to other pesticides. On USEPA approved labels, herbicide should not be applied within 100 m of an ecological reserve or any body of water as it can spread by drift. This range could apply to all pesticides. Pesticides should also not be used in areas where the water table is less than 3 m from the ground level as a precaution. Rinseate from cleaning spray equipment and clothing should not enter surface or ground water.

The environmental plan should be developed by the local villagers in PRIME/West and APEP project areas in biological reserves who in turn have been given training on how to conduct such a plan by the District Environmental Officers. As this would be a new activity and expansion of the Environmental Officer's job, both projects should organize training for the Officers initially in a few key areas to work out the details and curriculum. This may be done by the staff of the projects themselves or contracted out to an NGO or similar organization.

5.13 More feedback and adoption rates needed in training programs

On-farm demonstration is the extension method of choice among all partners for training farmers and extension workers. Using this method, project staff train extension workers, who in turn train farmer leaders or key farmers who in turn demonstrate new crop production to farmer groups. Some projects in turn expect the trained farmers to train an additional 15-25 farmers as farmer-to-farmer training. Such training methods are used for all the crops covered in the PERSUAP. Training is crop oriented and begins with sessions held before sowing. In most programs the on-farm demonstrations are continued for three seasons with the same crop and afterwards the farmers are said to graduate. A recent adoption survey was conducted by DANIDA with the Ugandan National Farmers' Federation and found an average of 35% adoption. Is this good enough?

Recommendations:

In farmer training programs in other countries, more feedback mechanisms are designed into the activities. For example, before training begins, training needs assessment surveys are undertaken for each commodity both to learn what technologies farmers already know but more importantly what technologies farmers should but don't know. Training activities are then focused on the key concepts that farmers should know. This reduces the training load and makes the training more interesting to farmers. At the same time before each training activity, a short quiz is frequently given on questions relating to the main extension messages of the current demonstration. After the extension activities, the same quiz is given to measure understanding. This still does not mean that farmers would adopt the practices but at least tells if they understood the information. After each season small adoption surveys might be carried out with a small sample of 20 or so farmers and extension workers to measure adoption rates. This is another measure of the benefit of the extension activity. In general more adoption usually follows demonstrations where farmers are not lectured to but follow exercises where they take observations in the field and then discuss the implications of those observations and draw conclusions. One activity would be for farmers to assess the pest populations in the field and then make decisions themselves on whether and what corrective measure to undertake.

6. SAFER USE ACTION PLAN

6.1 Replace hazardous and highly toxic pesticides

The most hazardous products in toxicity class I or RUP will be removed from programs immediately while the less hazardous class II will be replaced with suggested replacement products by April 30, 2008.

Only carbaryl in formulations less than 50% and malathion in emulsifiable concentration formulations are approved for these two insecticides.

Protection of seed and grain using hazardous pesticides and fumigants would continue to be carried out only by trained professional firms on contract. Farmers could treat their own seed using an emulsifiable concentration formulation of malathion.

Those farmers or professional pesticide applicators needing to use methyl anthranilate to repel birds and glyphosate acid by knapsack, Weed Wipe, or VLV application would be given appropriate training for protective equipment as recommended.

Farmers and project staff treating vegetative planting material such as sweet potato vines and banana corms by immersion in pesticide solution shall be wearing rubber gloves.

Farmers should be trained on how to safely use the recommended rodent poison baits.

Farmers and project staff should be mindful of the dangers pesticides pose to pollinating bees and use only recommended pesticides which have been selected for least toxicity to these beneficial organisms.

Training programs should emphasize that pregnant women nor children should apply pesticides.

Suggested Replacement Pesticides

There are only six insecticides which meet the criteria of registration in USEPA and Uganda and are safe enough for small scale farmers (acephate, azidirachtin, carbaryl, malathion, imidacloprid, and sulfur). There are an equal number of fungicides (benomyl, dimethomorph, mancozeb, metalaxyl, sulfur, thiophanate methyl). There are no nematicides that meet the criteria nor are there any bactericides. Therefore in those cases where no acceptable pesticides are ready for replacement there will have to be time allowed for the registration process in Uganda (in 2008) to achieve more products that meet the stringent criteria. In some cases pesticides will have to be replaced by non-chemical means.

Pesticide wholesalers should be encouraged to import the replacement pesticides if not available in country for field testing in partner programs under the special import arrangement with the MAAIF pesticide regulatory office. Importers would seek registration if the products give good results.

A schedule of the time required to register a replacement pesticide that is currently unregistered and not available in Uganda is given in the following chart and would take 4 years beginning with applying for a special-use import permit and then undergoing field testing to be sure it is effective followed by formal registration. The soonest it could be registered and approved would be in 2008.

Table 4. Steps to providing for replacement pesticides in Uganda

Steps to providing for replacement pesticides in Uganda	Time required (years)	If begun now would be registered
1. Apply for special-use import permit and test in first season	0.5	2008
2. Test in second season	0.5	2008
3. Encourage company to register and NARO tests in first season	0.5	2007
4. NARO tests in second season	0.5	2007
5. NARO tests in third season	0.5	2006
6. Registration process	1.5	2007

Registry period	4	

The following pesticides are suggested as replacements for those disapproved:

Table 5. Suggested replacement pesticides for those disapproved in Uganda

Pest/Pesticide	Suggested pesticide	Representative Brand	USEPA			Uganda	
			Toxicity class	RUP	Reg. US EPA	Registered	Available
Perennial weeds	Glyphosate salts	Touchdown	III	No	Yes	Yes	Yes
Aphids, mealybugs, whiteflies, mites, thrips, small larvae	Petroleum oil	Summer oil, white oil, horticultural oil	IV	No	Yes	No	Yes
Aphids, leafminer, caterpillars, loopers, pod borer, mite, thrips, whitefly, seed bug, mealybug	Azadirachtin	Neemol	III	No	Yes	Yes	Yes
Leafminer, caterpillars, loopers, Leaf beetles Maruca pod borer Pod bugs, Stalk borer	Methoxychlor	Marlate	IV	No	Yes	No	No
Cotton aphid, thrips, leafhoppers Dimethoate	Thiamethoxam (neonicotin-oid class)	Cruiser (seed treatment)	III	No	Yes	NARO	No
Cotton bollworm [Fenvalerate Cypermethrin Deltamethrin Chloryprifos]	Acephate	Orthene	III	No	Yes	Yes	Yes
	Bacillus thuringiensis	Xentari, Dipel	III	No	Yes	No	Yes
	Spinosad	Tracer	IV	No	Yes	No	No
	Methoxy-fenozide (insect growth regulator)	Intrepid	III	No	Yes	No	No
	Indoxacarb	Steward (ovicide)	III	No	Yes	No	No
	Acetamiprid Chloronicotinyl	Assail (ovicide)	III	No	Yes	No	No
	NPVirus	Heliokill	IV	No	Yes	No	No

Toxicity class	Suggested pesticide	Representative	USEPA			Uganda	
			Toxic	RUP	Reg.	Register	Avail

		Brand	ity class		US EPA	ed	able
Termites	Imidacloprid	Confidor/ Gaucho	III	No	Yes	Yes	Yes
Armyworm, cutworm	Spinosad	Tracer	IV	No	Yes	No	Yes
	Cereal bran bait (mix 0.5 litre of molasses with 1 kg of carbaryl and stir into 100 kg wheat or rice bran)	Sevin	III	No	Yes	Yes	Yes
Nematicide	Dazomet	Dazomet	III	No	Yes	No	No
Bactericide	None suggested						
Rodenticide	Warfarin ready to use wax baits	Warfarin	III	No	Yes	Yes	No

Some replacement pesticides are already in some of the steps of being field tested or registered, as in the below example from cotton (Table 6). Those already registered and available in Uganda can be replaced at once, for the most toxic pesticides.

Table 6. Cotton pesticides with a range of alternative pesticides already in various stages of approval and registration in Uganda.

Disallowed Pesticide (generic name)	Crop/Pest	Replacement pesticide	Replacement date
Herbicide			
Paraquat	Coffee Tea Weeds	Glyphosate	Oct 05
Rodenticide			
Coumatetralyl Coumachlor	Upland rice Rats	Warfarin ready to use Bromadiolone ready to use	Oct 05
Insecticides			
Carbofuran	Fuelwood nursery Nematodes	Select new site	Oct 05
Carbosulfan	Coffee Root mealybug	imidacloprid	Apr 08
Chlorpyrifos	Maize Stalk borers	carbaryl	Dec 07
	Sorghum Stalk borers		
	Banana Banana weevil	Pseudostem trapping	Oct 05
	Coffee Termites	imidacloprid	Dec 07
	Coffee Green scale Brown scale Waxy scale Mealybug	azadirachtin malathion	Dec 07

	Coffee Root mealybug	imidacloprid	Dec 07
	Coffee Tailor ant	carbaryl	Dec 07
	Fuelwood Defoliating worms	carbaryl	Dec 07
beta-**cyfluthrin** (Bulldock)	Maize Stalk borers	carbaryl	Oct 05
	Sorghum Stalk borers		
Lambda-**cyhalothrin**	Cotton Bollworm, spiny bollworm, false codling moth, cotton stainer, mosquito bug	Acephate	Oct 05
cypermethrin	Upland rice Mole cricket Termite Crazy ant Grape colaspis	Increase seeding rate or imidachloprid	Oct 05
		acephate	Apr 08
	Upland rice Leaf miner	azadirachtin	Oct 05
	Upland rice Stem borers	Increase seeding rate, optimal N fertilizer	Oct 05
		acephate	Apr 08
	Upland rice Grasshoppers Stink bug	carbaryl	Oct 05
	Cotton Bollworms False codling moth Cotton stainer Mosquito bug	acephate	Apr 08
	Fuelwood Defoliating worms	carbaryl	Oct 05
Deltamethrin	Coffee Green scale Brown scale White waxy scale Coffee mealybug	azadirachtin malathion	Oct 05
	Coffee Tailor ant	carbaryl	Oct 05
	Cotton Bollworm, spiny bollworm, false codling moth, cotton stainer, mosquito bug	acephate	Apr 08
Diazinon	Coffee Cerambycid stem borer	carbaryl	Oct 05
		acephate	Apr 08
Dimethoate	Cotton Aphids, leafhoppers, whitefly Lygus bug	azadirachtin malathion acetamiprid	Jun 07
	Irish potato Aphids,	azadirachtin malathion	Oct 05
	Apples Aphids	azadirachtin malathion	Oct 05

	Sesame Leafminer Gall midge	carbaryl	Jun 07
Fenitrothion	Coffee Lacebug Antesia bug Leaf miner Leaf skeletonizer Tailed caterpillar Coffee ant	carbaryl	Oct 05
		acephate	Apr 08
	Coffee Termites	imidacloprid	Apr 08
	Fuelwood Defoliating worms	carbaryl	Apr 08
Fenvalerate	Cotton Bollworm, spiny bollworm, false codling moth, cotton stainer, mosquito bug	acephate	Apr 08
Fipronil	Fuelwood Termites	imidacloprid	Jun 06
Pirimiphos-ethyl	Banana Banana weevil	Pseudostem trapping	Oct 05
Profenofos	Cotton Aphid Leafhopper Whitefly	azadirachtin malathion	Jun 06
		acephate	Apr 08
Ethoprop	Banana Burrowing nematode	dazomet	Dec 07
Fungicides			
Anilazine	Coffee Leaf rust	mancozeb benomyl dithianon	Oct 05
	Coffee berry disease	benomyl	Oct 05
		fosetyl aluminum	Oct 06
copper oxychloride	Irish potato Late blight	mancozeb	Oct 05
	Coffee Leaf rust Root rot, collar crack Armillaria mellea	mancozeb	Oct 05
		dithianon	Apr 08
		fosetyl aluminum	Oct 06
	Coffee berry disease	benomyl	Oct 05
		dithianon	Apr 08
	Cotton Bacterial blight	Crop rotation	Oct 05
	Fusarium wilt	Crop rotation	Oct 05
		thiram	Apr 08
	Apples Powdery mildew Anthracnose canker	sulfur mancozeb	Oct 05
	Fuelwood Powdery mildew Anthracnose	sulfur mancozeb	Oct 05
	Fuelwood Damping off	benomyl	Oct 05

Fluazinam	Coffee berry disease	benomyl	Oct 05
		dithianon	Apr 08
bronopol	Cotton Bacterial wilt	Crop rotation Imidacloprid	Oct 05 Apr 08
bromoxynil	Barley Weeds	Iodosulfuron-methyl-sodium (Hussar)	Apr 08
		propanil + thiobencarb	Oct 05

The following in Table 7 are USEPA-registered general use pesticides, but are not registered in Uganda, thus technically are not allowed:

Table 7. Pesticides which are USEPA-registered and acceptable for small-holder use, but not registered in Uganda.

Unregistered Pesticide in Uganda	Crop/Pest	Replacement pesticide	Replacement date
Insecticides			
acetamiprid	Cotton Bollworm, spiny bollworm, false codling moth	acephate	Apr 08
Bacillus thuringiensis	Cotton Bollworm, spiny bollworm, false codling moth	acephate	Apr 08
indoxacarb	Cotton Bollworm, spiny bollworm, false codling moth	acephate	Apr 08
methoxychlor	Coffee Leaf miner, Upland rice Leaf miner Sesame Leaf miner Groundnut Leafminer	azadirachtin (Neemol)	Oct 05
	Coffee caterpillars, Tea Hairy caterpillar Apple Leaf caterpillar Fruit boring caterpillar	acephate carbaryl	Oct 05
	Dry bush beans Maruca pod borer Pod bugs, Soybean Maruca pod borer Pod bugs,	acephate carbaryl	Oct 05
	Maize Stalk borer Sorghum Stalk borer	carbaryl	Oct 05

Unregistered Pesticide in Uganda	Crop/Pest	Replacement pesticide	Replacement date
	Maize Leaf beetle Upland rice Grape colaspis Dry bush beans Leaf beetle	acephate carbaryl	Oct 05
NPVirus	Cotton Bollworm	acephate	Oct 05
petroleum oil	Aphids Sorghum Sweet potato Irish potato Dry beans Groundnut Cotton Vanilla Apples	Malathion azadirachtin (Neemol)	Oct 05
	Mealybugs Cassava Coffee	azadirachtin (Neemol) malathion	Oct 05
	White flies Sweet potato Cassava Dry bush beans Cotton	azadirachtin (Neemol) malathion	Oct 05
	Mites Cassava Cotton	sulfur	Oct 05
	Thrips Maize Dry bush beans Groundnut Soybean	sulfur	Oct 05
spinosad	Cotton Bollworm	acephate	Oct 05
thiamethoxam	Cotton Aphid Whitefly Leafhopper	azadirachtin (Neemol) malathion	Oct 05
Fungicides			
Cymoxanil	Irish potato Late blight Apples Antracnose Powdery mildew Fuelwood Antracnose Powdery mildew	mancozeb	Oct 05
thiram	Maize Damping off Finger millet Damping off	thiram	Apr 08

Unregistered Pesticide in Uganda	Crop/Pest	Replacement pesticide	Replacement date
	Sunflower Stem rot Dry beans Seedling blight Groundnut Damping off Pod rot		
Dithianon	Coffee Rust	mancozeb	Oct 05
fosetyl aluminum	Vanilla Root rot, tip dieback Fusarium	fosetyl aluminum	Apr 08
Propineb	Irish potato Late blight Apples Anthracnose Powdery mildew Fuelwood Antracnose Powdery mildew	mancozeb	Oct 05
tebuconazole	Barley Leaf rust Groundnut Leaf rust Soybean Leaf rust	mancozeb	Oct 05
Herbicides			
haloxyfop R methyl	Cotton Weeds	glyphosate	Oct 05
Idosulfuron-methyl	Barley Weeds	glyphosate	Oct 05
Propanil	Rice Weeds	propanil	Apr 08
Other: avicides, molluscicides, nematicides			
methyl anthranilate	Birds Upland rice Finger millet Sorghum	Shouting or scaring birds by family labor	Oct 05
metaldehyde	Irish potato Snails	metaldehyde	Apr 08
dazomet	Banana Nematode Fuelwood Nematode	dazomet	Apr 08

6.2 Protective clothing not used by farmers

A consultant well versed in extension methods and learning theory will be hired to improve the presentation of the concepts of needing to use adequate protective clothing and equipment by farmers. The consultant would develop training exercises to be tested and make follow up visits to evaluate their adoption rates.

The greatest priority would be to protect the eyes with goggles, feet with rubber boots, and legs by long pants and hopefully a water repellant apron or other protective dress.

Partners should hold training sessions each year with farmer groups that apply pesticides where farmers bring their sprayers for inspection for leaks and review methods of calibration and application technique. Farmers would be given information on the appropriate nozzles to use when applying weeds vs other pests and to wash one's sprayer three times after herbicide application. Farmers should be taught how to spray a field using prevailing wind to guide spray material into the crop with minimal exposure to the applicator. Farmers should be taught how to first add water to the sprayer and then pesticide afterwards.

6.3 Most pesticide labels are incomplete

USAID Partners will arrange a meeting with the ACB to review the problem to determine if it is based on lack of enforcement of existing regulations or whether the regulations are not detailed enough to be followed.

6.4 High turnover rate of stockists

So that stockists can be self taught, a well illustrated booklet on safe and effective use of pesticides will be developed with information on pesticides in general, how to read pesticide labels, and first aid and safety practices. There is an ADC publication on safe use of pesticides in the local language which should be given to stockists.

More venues for stockists to view video presentations of similar material will be scheduled in Kampala and in key rural areas.

An extension pamphlet summarizing the recommended pest control practices including listing of pesticides will be developed for distribution to stockists to assist them in recommending pest control measures. This pamphlet would also be useful for extension agents.

6.5 Amelioration of pesticide odor as an occupational health hazard of stockists

Partners should meet with the ACB to alert them to the occupational health problem posed by sitting near to toxic pesticides. Some suggested remedies include 1) requiring glass shelving, fans, and 2) use of empty pesticide containers for display.

6.6 Pesticide usage should be in the context of IPM programs

The partners should encourage MAAIF to issue a policy statement that IPM as the preferred approach to pest control where pesticides are the last choice after other control methods have been exhausted. Furthermore pesticide usage should be based on field monitoring leading to quantifying pest densities so that action thresholds can be used. As it is now, only cotton has such a decision making program.

6.7 The list of approved pesticides in the Registrar of Pesticide Office should be computerized and made more widely accessible

The partners should request the Office of the Pesticide Registration to compile the list of registered products in alphabetical order by common name and make this list more available such as posting it on a GoU website.

6.8 Farmers often use the wrong pesticide product such as an insecticide to control a disease

Partners should encourage MAAIF to publish a standardized set of crop production practices suitable for extension workers listing pesticides by brand names for each pest for major crops.

6.9 Pesticide disposal of containers and obsolete product needs to be strengthened

Partners should emphasize in training programs proper methods to dispose of pesticide containers. Solid containers should be triple rinsed, crushed and buried. Paper containers should be buried, and not burned.

Partners should ask the ACB Technical Committee to look into utilizing cement plants to dispose of outdated or obsolete pesticides.

6.10 Rotate pesticide chemical groups to minimize pesticide resistance

APEP to take the lead and develop preventative plans to avoid the development of pesticide resistance for cotton insects, pre-emergent herbicides, and Irish potato diseases.

Training programs on crops where pesticide resistant management is needed would be taught the various chemical families for pesticides that should be rotated

6.11 Adulteration

APEP to take the lead to encourage MAAIF inspectors to team up with a local consumer advocate NGO to take samples of suspected adulterated products for analysis by the Government Chemist. If the products were below the legal limit allowed by the Bureau of Standards then prosecution should follow to curtail this illegal practice.

6.12 Protecting biological reserves such as national parks from pesticide incursion

Working with NEMA and UWA as well as private or government agricultural entities (cotton ginneries or coffee plantations), both APEP and PRIME/West can develop guidelines to minimize the potential negative impact of pesticide contamination of protected lands such as parks from nearby agricultural fields, either as demonstration plots or farmers' choice to plant there. Such activities include:

- Hiring community conservation wardens to monitor near designated threatened parks
- Linking with District Environmental Officers
- Tapping resources to fund to support mitigation actions from ginneries and coffee plantations
- Hiring an environmental NGO to facilitate communication between local farm communities, project and GoU agencies, and agribusiness entities
- Hiring an environmental management systems consultant to make a management plan that would be approved by the concerned stakeholders. Each distinct farming community would develop its own environmental management plan allowing them certain rights to selected resources in the parks in return for their cooperation
    - A minimum distance of 100 m buffer area is suggested to minimize impact from pesticide spray drift
    - Pesticides should not be used in areas where the water table in within 3 m of the surface
    - Crops that require pesticide treatment should not be planted within 100 m of bodies of water or wetland areas
    - Intensive training of farmers on proper means to wash their sprayers and dispose of pesticide containers after use to minimize contamination of the protected areas
    - Erosion barriers should be constructed to prevent runoff of soil from agricultural fields into wetland areas

6.13 More feedback and adoption rates needed in training programs

The partners should jointly support an outside training consultant who is well versed in different extension methods as well as monitoring tools such as training needs assessment and adoption instruments. The consultant would evaluate current training programs of each partner suggesting introducing monitoring methods with a view of strengthening this component. This may involve several visits that involve interpreting results of suggested adoption surveys by program. In particular the consultant should focus on demonstration activities in the areas of pest identification, monitoring, and use of action thresholds for pesticide application as well as use and adoption of non-pesticidal control methods and farmers' use of protective equipment.

The trainer would also work with partners to incorporate more farmer driven applied research trials that test recommended practices including some suggested by the farmers. Tests should include comparing various pesticides including such as farmers' home remedies of cow urine, etc against a recommended commercial pesticide. Minimum dosage trials would also be appropriate.

6.14 The provisions made for monitoring the use and effectiveness of the pesticides

This section involves the setting up of monitoring and evaluation of the mitigation program for the PERSUAP, particularly the issues mentioned in the Safer Use Action Plan. The key to monitoring and evaluation will be the interaction of the MEO with the partners on the one hand and the Senior Regional Environmental Officer on the other. The MEO should set up a committee of the partner members that would meet at least once a year to review progress in implementing the recommendations outlined in the PERSUAP particularly in the Safer Use Action Plan. Each partner may identify personnel who would have this duty and would act as monitors. The MEO would undertake visits to project sites as follow-up to see progress first hand. Minutes of the meetings would be communicated with the Senior Regional Environmental Officer and others as deemed appropriate. As many of the concerns do not directly imply changes in procedures of the partners themselves but to GoU agencies, partners can only make suggestions. This was done in the IDEA PERSUAP and resulted in some results that benefited GoU as well as the projects themselves.

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ANNEXES

UGANDA CROP PROTECTION
PESTICIDE EVALUATION REPORT & SAFER USE ACTION PLAN
(PERSUAP)

for

Field Crop Production and Commodity Protection Programs

Supported in Uganda by

USAID/Uganda Strategic Objective 7:
Expanded Sustainable Economic Opportunities for Rural Sector Growth

December 2005

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Presenter: James Litsinger, Consultant Moderator: Clive Drew, APEP

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Annex 3. Available pesticides in the market in Uganda, January 2005

Chemical	Brand	Language on label	Origin	Uganda dealer	
Navkivubo Place Kampala					
Small containers					
Cypermethrin	Ago-Cythrin 5%EC	English	Germany/ Singapore	General & Allied	6,00(
	Sicorin 5% EC	English	Uganda	Twiga	3000
	Cyper Lacer 5%	English	India	Nsanja	2000
Alpha cypermethrin	Dudu Alpha 3 EC	English		Bukoola	6,00(
Deltamethrin	Atom 2.5%EC	Swahili/ English	India/ Kenya	none	9,00(
	Dudu Striker 2.5EC	English		Bukoola	3,50(
lambda Cyhalothrin	Ambush Super 4000 EC	English	Switzerland	Twiga	4,00(
Diazinon	Diazol 60% EC	English	Israel	Osho	2,00(
Chlorpyrifos	Dudu Bullet 48% EC	English		Bukoola	5,00(
Fenitrothion	Dudu Sumi 50%	English		Bukoola	6,00(
Dimethoate	Tafgor 40% EC	English	India	Nsanja Family Stores	6,00(
	Ogon 40% EC	English	Kenya	Osho	2,00(
Profenofos + lambda Cyhalothrin	Polytrin 315 EC/ULV	English	Switzerland	Twiga	11,0(
Profenofos 40+ cypermethrin 4	Roket 44% EC	English + 8 Indian languages	India	none	11,0(
Cypermethrin 3.6 + dimethoate 40	Cymethoate 47.6%EC	English		Lipsun	3,00(
Pirimophos methyl 16 g + Permethrin 3 g	Actellic Super 19% EC	English	Switzerland/ Kenya	none	
Carbaryl	Sevin Dudu 75% dust	English	S. Africa		2,50(
Malathion Seed treatment	Blue Cross 2% dust	English	Kenya		1500
Fiponil	Regent 3G	English	Nairobi		6,00(
Alphamethrin	Legend 10%EC	English	Nairobi	Alga	2,00(
Benomyl	Pilarben 50% WP	English		Bukoola	3,00(
Thiophanate methyl 20%+ maneb 50%	Toplite 75% WP	English		Bukoola	4,50(
Mancozeb	Mancofil 80% WP	English	India	Nsanja Family Stores	3,50(
	Oshothane 45% WP	English	Kenya	Osho	2,00(
	Dithane 45 %WP			Murphy	
	Indofil 80%WP	English		Bukoola	2,90(
Mancozeb 640 + metalaxyl 80 g	Master 72%WP	English	India/ Kenya	Osho	3,50(
Mancozeb 560 + metalaxyl 75 g	Agrolaxyl MZ 63.5	English	Germany/ Singapore	General & Allied	2,50(
Carbendazin	Milstin 50%W	English	India		4,00(
Cymoxanil 4.8%+	Milraz P				30,0(

Propineb 58%					
Sulfur + copper oxychloride	Sulcop 50 DF	English	India/ Kenya	Osho	6,00
2,4-D	Agro 2,4-D	English	Germany	General & Allied	12,0
Glyphosate	Round-up Max 680 g	English	Europe	Farm Inputs Care Centre	4,00
Zinc phosphide	Ratol bait	English/ Luganda	India	Alga	1000
Flocoumafen	Storm 50mg/kg Ready to use bait	English	Kenya		30,0
Larger containers					
Malathion	Agro-Malon 57%EC	English	Germany/ Singapore	General & Allied	15,0
	Famathon 57%EC	English	Egypt	Famous Dist	11,0
	Sulmathion 50% EC	English	India	Lipsun	20,0
Carbofuran	Furan 5%G	English	India	United Phosphorous	8,00
	Carbofuran 5%G	Luganda	none	Bukoola	7,00
	Agro Furan 5%G	English	Germany	General & Allied	10,0
	Furacarb 5%G	English	India		8,00
Dichlorvos	DDVP 1000EC	English	Egypt	Greenhouse	15,0
	Doom 100%EC	English	Indeia	United Phosphorous	15,0
Thiodan	Thionex 35%EC	English	Israel	Balton	15,0
Chlorpyrifos	Pyrinex 48%EC	English	Israel	Balton	15,0
Dimethoate	Agro-thoate 40 %EC	English	Germany	General & Allied	12,0
	Agrosate 360 SL	English	Germany	General & Allied	12,0
beta Cyfluthrin	Bulldock 2.5%EC	English/ Swahili	Nairobi	none	
Cypermethrin	Debush CY 5% EC	English/ Swahili	India/ South Africa		15,0
	Ambush CY 6% EC	English/ Swahili	Kenya		10,0
Azadirachtin	Nimbecidine 0.03%	English	India	Bukoola/Stanes	12,0
Paecilomyces lilacinus	Stanes Bio-Nematon	English	India	Bukoola/Stanes	6,70
Trichoderma viride	Bio-Cure-F	English	India	Bukoola/Stanes	6,70
Beauvaria bassiana	Bio-Powder	English	India	Bukoola/Stanes	
Metarhizium anisopliae	Stanes Bio-Magic	English	India	Bukoola/Stanes	
Clofentezine	Polo 50%EC	English	Italy		35,0
Glyphosate	Sweep 41%EC	English	India	United Phosphorous	13,0
	Weedmaster 50%	English		Bukoola	11,0
	Roundup 48% EC	English/ Swahili	Kenya	none	11,0
	Glyweed 41ESL	English	India	Nsanja	6,00
	Mamba 360 SL	English	S. Africa		11,0
2,4-D	Sangshen D				1 lite

Picloram 65 + 2,4-D 240 g	Tordon 101	English	USA/ Kenya	none	40,0
Atrazine	Milzine 500F	English	India		12,0
Propanil	Butanil W 350 g	English, Luganda		Bukoola	13,0
Propanil 230 + thirbencarb 115	Rical 345EC	English	France	Balton	25,0
Paraquat	Gramoxone 276EC	English		Bukoola	12,0
Benlate	Benlate 50%WP	English	France		30,0
Metalaxyl + mancozeb	Ridomil MZ 68% WP	English	Tanzania		7,00
Aluminum phosphide	Quick Phos560 g	English	India	Alga Ltd.	38,0
Mancozeb	Sancozeb 80%WP	English, Afrikan	S. Africa		20,0
	Dithane M45	English	S. Africa		14,5
Propiconazole	Tilt 250 EC	English	Kenya		200,
Glyphosate	Glyphogan 480 EC	English	Israel	Balton	60,0
2,4-D	Wildbees 720SL	English	S. Africa		60,0
Atrazine	Lasso				5 lite
	Duancyper 5EC				500
Nakasongola					
Glyphosate	Weedmaster 50%	English		Bukoola	20,0
	Pinup				liter
Atrazine	Lasso				1 lite
Carbofuran	Furacarb 5%G	English	India		15,0
Fenvalerate	Fenvalerate				500
Malathion	Antiborer Dust				500
Cypermethrin	Ralothrin 5EC				liter
	Dudu Cyper 5EC				
Dimethoate	Tafgor 40% EC	English	India	Nsanja Family Stores	500
Cymoxanil 4.8%+ Propineb 58%	Milraz P				500
Mancozeb	Indofil 80%WP	English		Bukoola	500

Annex 4. Sprayers and protective equipment available in Nakivubo market, Kamapala, Jan. 2005.

1 $ US = 1715 Uganda Shillings

Knapsack sprayers (lever operated)				
Capacity	Brand	Materials	Origin	Price
18 liters	Farmate	Plastic + metal nozzle	Italy	120,000
15 liters	Cooper	Plastic + metal nozzle	UK	200,000
20 liters	Farmate	plastic	China	20,000
16 liters	Farmate	plastic	China	20,000
16 liters		plastic	China	30,000
16 liters	Agrotrade	plastic	Italy	80,000
16 liters	Pompey	Plastic + metal nozzle	Italy	50,000
	Jatco	plastic	Brazil	85,000
15 liters	CP15	plastic	UK	150,000
1 liter		plastic		
16 liters	Green Fox		Italy	
8 liters	Green Fox		Italy	
1 liter	Green Fox		Italy	
Motorized mistblower				
20 l	Mistblower	plastic	India	450,000

Protective equipment		
Protective equipment	Material	Price
Nose and mouth mask	Filter for dust, spray paint	3,000
Safety goggles		3,500
Gloves	Rubber	6,000
	Rubber	3,500
	Rubber	3,000
Plastic trousers		
Plastic shirt		
Gum boots	Rubber	10,000

Annex 5: Registration status of suggested or available pesticides in Uganda [1]

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Insecticides (I)/Acaricides (A)							
Acephate (I) Organo-phosphate Systemic Contact and stomach poison	GUP	EPA III WHO III	24	Green bean (0), Chili pepper, bell pepper (7), Dry bean, peanut (14), lettuce (21)	Yes as Lancer 75% SP	Yes as Orthene Acephate 75SP	Suitable for IPM programs
Acetamiprid (I) Neonicotinoid Contact and systemic/ ovicidal	GUP	EPA III WHO III	12	Leafy vegetables, cole crops, fruiting vegetables, citrus, pome (7), cotton (28)	No	Yes as Assail 70WP	Suitable for IPM programs
Azadiractin (I,A) Botanical Contact poison, antifeedant	GUP	EPA II 4.5% concen-tration EPA III 0.25% concen-tration WHO IV	4	Cabbage, eggplant, peanut, peas, pepper, tomato, bean, soybean, sweet potato, carrot, Irish potato, okra, cucurbit, citrus, lettuce, onion, chickpea, radish(0)	Yes as Nimbecidine	Yes as Neemix, Margosan, Neem	Formulations < 1% suitable for IPM programs, need to register with GoU
Bacillus thuringiensis (Bt) (I) Biological pesticide	GUP	EPA III WHO IV	4	All crops within 4 hours of harvest	No	Yes as Dipel Thuricide	Suitable for IPM programs, need to register with GoU

[1] Restricted Use Pesticides (RUP) can only be applied by a trained, certified applicator. General Use Pesticide (GUP) without restrictions. Products not rated by WHO are too new. REI = minimum number of hours it is safe to return to the field after application (safe re-entry interval), PHI = minimum number of days before harvest it is safe to apply pesticide for least contamination on harvested product (safe pre-harvest interval). REI and PHI data available on most product labels registered in the U.S.

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Stomach poison							
Carbaryl (I) Carbamate Contact and stomach poison	GUP	EPA II (5% dust, 85%WP) EPA III (liquid formu-lations < 50%) WHO III	12	Bean, carrot, maize, cucurbit, okra, peanut, eggplant, soybean, potato, sweet potato, tomato, pepper (0); Cowpea, pea, head cabbage (3), Citrus (5); Leaf cabbage (14); Sorghum, wheat (21)	Yes as Sevin Dudu 75% dust	Yes as Sevin 4L (43%EC)	Formulations < 51% suitable for IPM programs
Carbosulfan (I) Carbamate Contact, stomach poison, systemic	RUP	EPA II WHO II			No	No Registered in other countries Marshal Advantage	Not suitable for IPM programs due to EPA class II toxicity & RUP (high mammalian toxicity and bird mortality)
Chlorpyrifos- ethyl (I) Organo-phosphate Contact, stomach poison	RUP as EC GUP as WG or G	EPA II WHO II	24	Asparagus (1), Alfalfa (7), Cotton (14), Citrus, groundnuts (21), Maize Sorghum, soybean , (28), Sunflower (42), Sweet potato (125)	Yes as Dursban 48EC	Yes as Lorsban 4E, 75WG, 5G	Not suitable for IPM programs due to EPA class II toxicity and RUP (irreversible eye damage)
beta Cyfluthrin (I) Synthetic pyrethroid Contact, stomach poison	GUP	EPA II WHO II	24	Tomato, most cole crops (1), broccoli (3)	Yes as Bulldock 2.5%EC	Not registered for agricultural uses in the US, only public health uses as Tempo and turf and building foundations as Beta cyfluthrin	Not suitable for IPM programs due to EPA class II toxicity & lack of registration for agricultural uses

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
lambda-Cyhalothrin (I) Synthetic pyrethroid Non-systemic contact and stomach poison	RUP	EPA II WHO II	24	Cole crops (1), Tomato (5), Groundnuts (14), Maize, cotton, rice (21) Sorghum, wheat (30), Soybeans (45)	Yes as Ambush Super 4000 Polytrin 315 EC/ULV	Yes as Karate	Not suitable for IPM programs due to EPA class II toxicity & RUP (toxicity to fish and aquatic invertebrates)
Cypermethrin (I) Synthetic pyrethroid Non-systemic Contact and stomach poison	RUP	EPA II WHO II	12	Crucifer (1), Lettuce (5), Onion (7), Cotton (14)	Yes as Ago-Cythrin 5%EC Sicorin 5% EC Cyper Lacer 5% Debush CY 5% EC Ambush CY 6% EC Keshet 25EC	Yes as Cymbush E Fastac Ripcord	Not suitable for IPM programs due to EPA class II toxicity & RUP (toxicity to fish and aquatic invertebrates)
Deltamethrin (I) Synthetic pyrethroid Non-systemic Contact and stomach poison	RUP	EPA I-(17%EC) II (12% Gel) WHO II	12	Cotton (21)	Yes as Atom 2.5%EC Dudu Striker 2.5EC	Yes as Decis 1.5 EC (17%) Decis 1 Gel (12%)	Not suitable for IPM programs due to EPA class II toxicity & RUP (toxicity to fish and aquatic invertebrates)
Diazinon (I,A) Organo-phosphate Non-systemic Contact and stomach action	RUP	EPA II-III WHO II	24	Tomato (1), Apples (21)	Yes as Diazol 60% EC	Yes as Diazinon 4E	Not suitable for IPM programs due to EPA classification as RUP (avian and aquatic toxicity)
Dimethoate (I,A)	GUP	EPA II WHO II	48	Bean, pea, pepper, irish potato (0), Cucurbit (3)	Yes as Tafgor 40% EC Ogon	Yes as	Not suitable for IPM programs due to EPA

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Organo-phosphate Systemic Contact and stomach poison				Head cabbage, lettuce, tomato (7)Maize (14) Citrus (15) Soybean (21) Sorghum (28) Wheat (35)	40% EC Cymethoate 47.6%EC	Dimethoate EC	class II toxicity
Fenitrothion (I) Organo-phosphate Non-systemic Contact and stomach poison	RUP	EPA II-III WHO II			Yes as Dudu Sumi 50%	Yes for forestry as Sumithion but not agriculture	Not suitable for IPM programs due to EPA classification as RUP (potential adverse effects on aquatic & avian species)
Fenvalerate (I) Synthetic pyrethroid Non-systemic Contact and stomach poison	RUP	EPA III WHO II	12	Tomato (1), Climbing beans, cole crops (3), Potato (7), Maize, cotton, sorghum, soybean, apples, dry beans (21), Sunflower (28)	Yes as Fenvalerate EC, Fenkill	Yes as Asana XL	Not suitable for IPM programs due to EPA class II toxicity & RUP (toxicity to fish and aquatic invertebrates)
Fipronil (I) Phenyl pyrazole Contact and stomach poison	RUP	EPA II WHO II	4	Maize (90)	Yes as Regent	Yes as Regent 4SC	Not suitable for IPM programs due to EPA class II toxicity & RUP (toxicity to aquatic invertebrates)
Indoxacarb (I) oxadiazine Ovicide	GUP	EPA III WHO not listed	12	Cotton, groundnuts (14), Soybean (21)	No	Yes as Steward 14.5 % SP	Suitable for use in IPM programs, must register with GoU
Imidacloprid (I)	GUP	EPA III WHO II	12	Potato, eggplant, tomato, chili pepper, pepper, head	Yes Available as	Yes as Provado 1.6 EC (17%)	Suitable for use in IPM programs

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Novel nitroguanidine chemical family Systemic action in root zone Contact and stomach poison				cabbage, leaf cabbage, lettuce (7) Mango (30)	Confidor 20% EC Gaucho 70% EC	foliar spray (EPA III)	
Malathion (I,A) Organo-phosphate Contact, stomach, and respiratory action	GUP	EPA II (as EC)-III (as WP) WHO III	12	Potato (0)Bean, cucurbit, okra (1), Eggplant, garlic, onion, pea, pepper, sweet potato, tomato (3), Head cabbage, leaf cabbage, lettuce, radish, turnip (7), Lettuce (14)	Yes as Malaton 50S (50%EC) Malaton 5P (5% dust) Malathion UV Malaton 5	Yes Malathion 5EC 56% (EPA II) Malathion 25WP EPA III)	WP formulations suitable for use in IPM programs
Methoxychlor (I) Organochloride Contact and stomach poison	GUP	EPA IV WHO IV	12	Irish potato, sweet potato (0), Dry bean, green bean, head cabbage, (3), Maize, peanut, cucurbit, eggplant, radish, soybean, pea, tomato, (7), Carrot, leaf cabbage (14)	No	Yes Marlate 25% EC	Suitable for use in IPM programs, must register with GoU
Methoxy-fenozide (I) Diacylhydra-zine insect growth regulator Upon ingestion prevents molting to adulthood	GUP	EPA IV WHO IV	4	Cotton, apples, (14)	No	Yes as Intrepid 23%F	Suitable for IPM programs, must register with GoU
NPVirus (I)	GUP	EPA IV	4	All crops within 4 hours of	No	Yes as	Suitable for IPM

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Biological insecticide Host ingests virus crystal		WHO IV		harvest		GemSTar for cotton bollworm, Spod-X for armyworm	programs; must register with GoU
Petroleum oil (I,A) Organic hydrocarbons Suffocates insect pest	GUP	EPA IV WHO IV	4	All crops within 4 hours of harvest	No	Yes as Volck Supreme JMS Stylet oil	Suitable for IPM programs; must register with GoU
Pirimiphos ethyl (I) Organo-phosphorous Fumigant, contact	GUP	EPA II WHO Ib			No	No registration cancelled, as Primicid	Not suitable for use in IPM programs due to EPA class II toxicity
Profenofos (I,A) Organo-phosphate Nonsystemic but translaminar Contact and stomach poison Ovicidal	RUP	EPA II WHO II	48	Cotton (14)	Yes in combination with cyper-methrin Politrin 440 EC	Yes Curacron 8E on cottton	Not suitable for use in IPM programs due to EPA class II toxicity and RUP
Spinosad (I) Biological compound from actinomycete fungus	GUP	EPA IV WHO IV	4	Cole crops, tomato (1), Sorghum, apples, Irish potato, sweet potato (7), Barley (21), Pearl millet, maize, cotton, soybeans, dry beans (28)	No	Yes as Tracer, Success, SpinTor	Suitable for IPM programs, must register with GoU

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Contact, stomach poison							
Sulfur (I,A,F) Inorganic element Non-systemic contact and protectant	GUP	EPA III WHO IV	24	All crops within 24 hours of harvest	Yes	Yes as Kumulus DF (80% dispersible granules)	Suitable for IPM programs
Thiamethoxam (I) Neonicotine Seed treatment Systemic contact, stomach poison	GUP	EPA III WHO not rated	12	NA as seed treatment	No	Yes as Cruiser 350 FS seed treatment	Suitable for IPM programs, must register with GoU
Fumigant/stored product							
Aluminum phosphide Fumigant Inhalation toxicity (odorless)	RUP due to acute inhal-ation toxicity	EPA I WHO (not classified)	48	NA as a fumigant	Yes as Quick Phos560 g	Yes as Phostoxin	Suitable only for IPM programs when used by trained operators in fumigation facilities wearing full protective equipment, fumigation of food or nonfood products
Malathion (I,A) Organo-phosphate contact, stomach, and respiratory action	GUP	EPA III (as WP) WHO III		NA as a seed treatment	Yes as Malaton 5P (5% dust)	Yes as Malathion dust	Suitable for IPM programs for nonfood products

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Permethrin (I) Synthetic pyrethroid Non-systemic contact and stomach poison	RUP	EPA II WHO II		NA as a seed treatment	No	Yes as Ambush	Not suitable for IPM programs due to EPA class II toxicity & RUP (toxicity to fish and aquatic invertebrates)
Pirimiphos-methyl (I) Organo- phosphate Contact and fumigant action	GUP	EPA II WHO III		NA as a seed treatment	Yes as Actellic 50cpc	Yes as Actellic 5%EC Actellic 2% dust	Suitable only when used by trained staff for nonfood products
				Nematicide (N)			
Carbofuran (I,A) Carbamate Systemic Contact and stomach poison	RUP	EPA I-II WHO Ib		NA as a pre-plant product	No	Yes as Carbofuran granules	Not suitable for IPM programs due to EPA class I-II toxicity & RUP (high mammalian toxicity and bird mortality)
Dazomet (N,H, F) Thiadiazine Soil fumigant in granular form	GUP	EPA III WHO III	24	NA as a pre-plant product	No	Yes as Basamid G	Suitable for IPM programs, must register with GoA
Ethoprop (N,I) Organo-phosphate Fumigant	RUP	EPA I-II WHO Ib	48	NA as a pre-plant product	No	Yes as Mocap G	Not suitable for IPM programs due to EPA class I-II toxicity & RUP (high dermal toxicity)

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Bacteriocide (B)/Fungicides (F)							
Anilazine (F) Triazine Protective	GUP	EPA II WHO IV			No	Registration cancelled Dyrene	Not suitable for IPM programs due to EPA class II toxicity and cancellation of registration
Benomyl (F) Benzimidazole Systemic Protective/ curative	GUP	EPA IV WHO III	24	Cucurbit, tomato (1), Citrus (2), Carrot (4), Leaf cabbage, mango, papaya, peanut (14), wheat (21), Dry bean (28), Soybean (35)	Yes as Benomyl 50% SP Pilarben 50% SP	Yes as Benlate 50SP	Suitable for IPM programs
Bronopol (B) Alkal halide Protective	GUP	EPA II WHO II			No	No Registered as Bronocot in other countries	Not suitable for IPM programs due to EPA class II toxicity and no EPA registration
Chlorothalonil (F) Nitrile Nonsystemic Protective	GUP	EPA I-II WHO IV	48	Carrot, cabbage (7), Tomato, potato (14), Onion (21)	No Available as Ridomil Gold mixed with metaxyl	Yes as Bravo 500 (40%) Ridomil Bravo 81 Mixed with metaxyl Daconil	Not suitable for IPM programs due to EPA class I and II toxicity
Copper oxychloride (F,B) Inorganic metal	GUP	EPA II-III WHO III	24		Yes as Sulcop 50 DF	Yes as Oxycop50%	Not suitable for IPM programs due to EPA class II toxicity

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Protectant fungicide/ bacteriocide							
Cymoxanil (F) Acetamide Protective and curative foliar	GUP	EPA III WHO III	12	Potato (14)	No Available as Milraz 76% WP mixed with propineb	Yes as Curzate 60DF	Suitable for IPM programs, must register with GoU
Difenoconazole (F) Triazole Systemic with protectant, curative action	GUP	EPA III WHO III	48	Tomato (7) Potato, mango (14)	No Available as Score 25%EC	Score 25%EC Dividend XL RTA (3.2%)	Suitable for IPM programs, must register with GoU
Dimethomorph (F) Morpholine Preventative, curative, locally systemic	GUP	EPA III WHO III	12	Tomato, Irish potato (4)	Yes as Acrobat MZ	Yes as Acrobat MZ	Suitable for IPM programs
Dithianon (F) Quinone Protective, limited curative	GUP	EPA III WHO III			No	Yes as Delan 75%WP but no current label	Not suitable for IPM programs as it causes severe eye irritation
Fenarimol (F) Pyrimidine	GUP	EPA IV WHO IV	12	Apple (30)	No	Yes as Rubigan 12% EC	Suitable for IPM programs, must register with GoU

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Protectant, curative, and eradicating properties							
Fluazinam (F) Dinitro-aniline Protectant	GUP	EPA II WHO nl	48	Potato (14), groundnut (30)	No	Yes as Omega500 F	Not suitable for IPM programs as it is rated toxicity class II by EPA as it can cause severe eye irritation
Fosetyl aluminum (F) Organo-phosphate Protective, curative, systemic	GUP	EPA III WHO IV	12	Banana, cucurbit (1) Cole crops (3) Apple, tomato (14)	No	Yes as Aliette 80% WDG	Suitable for IPM programs, must register with GoU
Kresoxim-methyl (F) Methoxy-acrylate Preventative, curative	GUP	EPA III WHO not listed	12	Apples (30)	No	Stroby 50% WG	Suitable for IPM programs, must register with GoU
Mancozeb (F) Ethylene dithio-carbamate Non-systemic protective	GUP	EPA IV WHO IV	24	Banana, papaya (0) Garlic, potato (3) Tomato, cucurbit (5), Onion, maize (7) Peanut (14) Wheat (26) Maize (40)	Yes as Mancoped Manzine	Yes as Dithane M45 (62%)	Suitable for IPM programs
Metalxyl (F)	GUP	EPA III WHO III	48	Cucurbit, tomato (5), Onion (7), Irish potato (14)	Yes as Ridomil MZ 72 (mixed	Yes as Ridomil MZ72	Suitable for IPM programs

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Acylalanine Systemic with protective and curative properties					with manczeb)	Ridomil Gold EC Ridomil 68WP (mixed with mancozeb)	
Propineb (F) Dithiocarbamate Protective foliar	Never registered with EPA	EPA IV WHO IV			No Available as Milraz P	Not registered with EPA but it in Europe as Antracol	Only in combination with cymoxanil is it suitable for use in IPM programs, must register with GoU
Sulfur (F, I, A) Inorganic element Non-systemic contact and protectant	GUP	EPA III WHO IV	24	Can harvest all crops within 24 hours of application	No	Yes as Kumulus DF (80% dispersible granules)	Suitable for use in IPM programs, must register with GoU
Tebuconazole (F) Conazole Systemic, curative, protective	GUP	EPA III WHO IV	12	Apple (30)	No	Yes as Folicur 25%EC	
Thiophanate methyl (F) Benzimidazole carbamate Systemic, preventative, curative	GUP	EPA IV WHO IV	12	Apples (1), groundnuts, green beans (14), Irish potato (21)	Yes as Topsin 50% WP	Yes as Topsin 50%WP	Suitable for use in IPM programs

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Thiram (F) Dithio-carbamate Contact with protective action	GUP	EPA III WHO III	24	No restrictions as a seed treatment	Yes as Pomarsol	Yes as Thiram 42S (42%) Seed treatment	Suitable for use in IPM programs
Herbicides							
Bromoxynil Nitrile Selective, contact, post-emergent	GUP	EPA II WHO II	24	Garlic (112), Mint (70), Cotton (75)	No	Yes as Buctril 4EC	Not suitable for IPM programs due to EPA toxicity II level
Diuron Substituted urea Pre- & post-emergent, nonselective	GUP	EPA III WHO IV	12		Yes as Diuron EC	Yes as Direx 4L	Suitable for IPM programs
Glyphosate acid Phosphonate Non-selective, post-emergence, translocated	GUP	EPA II-IV WHO IV	12	Banana, citrus, pome fruit (1), Nuts (3), Cotton, sorghum, corn, rice, barley (7), Soybean (14), stone fruit (17), coffee (28)	Yes as Roundup Max 680 EC Sweep 41%EC Weedmaster 50%	Yes as Roundup EC 41% Touchdown Total 36.8%	Suitable for IPM programs if not applied by knapsack sprayers or < 41% formulations
Glyphosate –salts trimesium Phosphonate	GUP	EPA III WHO IV	12	Banana, citrus, pome fruit (1), Nuts (3), Cotton, sorghum, corn, rice, barley (7), Soybean (14), stone fruit (17), coffee (28)	No	Yes as Touch-down 28.3%, Touch-down Hi Tech 52.7%	Suitable for IPM programs, must register with GoU

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Non-selective, post-emergence, translocated							
Haloxyfop- methyl Pyrine Systemic, pre- & post-emergence	GUP	EPA II WHO II			No	No Verdict discontinued by Dow	Not suitable for IPM programs due to EPA rating toxicity II
Iodosulfuron-methyl-sodium Sulfonylurea Selective post-emergent	GUP	EPA no rating WHO no rating			No	No Registered in Australia as Hussar	Product is too new and is not registered by USEPA therefore it is not suitable for use for IPM programs until more toxicological information is available
Metolachlor Acetamide Selective pre-emergent	GUP	EPA III WHO III	24		Yes as Dual	Yes as Dual	Suitable for IPM programs
Paraquat dichloride (H) Dipyridyl Non-selective, contact, post-emergence,	RUP due to acute inhal-ation toxicity	EPA I WHO II			Yes as Paraxone Gramuron	Yes as Gramoxone	Not suitable for IPM programs due to EPA rating as a RUP posing a health hazard
Propanil (H) Anilide	GUP	EPA III WHO III	24		No	Yes as Stampede, Stam	Suitable for use in IPM programs, must register with GoU

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Selective, post-emergence							
Thiobencarb (H) Carbamate Selective, postemergent	GUP	EPA III WHO II	4		Yes as Saturn	Yes as Bolero 8EC	Suitable for IPM programs
Bird Repellent							
Methyl anthranilate Biological pesticide Repellent	GUP	EPA II WHO not listed			No	Yes as Bird Shield	Not suitable for IPM programs due to EPA toxicity II rating because of danger of eye injury from the solvent in the formulation
Molluscidide							
Metaldehyde Carbamate Stomach poison	GUP	EPA II WHO III	12		No	Yes as metaldehyde granules 3.5% pellets	Suitable for use in IPM programs, must register with GoU
Rodenticides							
Bromadiolone coumarin Anticoagulant	GUP	EPA I-III WHO Ia			No Available as Ratoxin, Ratox	Yes as Contrac or Maki 0.005% pelleted bait	Suitable for use in IPM programs, must register with GoU as ready to use bait
Coumatetratyl coumarin	Not regis-tered	EPA I WHO Ib			No Available as Racumin	Not registered by EPA	Not suitable for use in IPM programs due to EPA toxicity class Ib

Chemical	Type	Toxicity class	REI hours	PHI (days)	Registered in Uganda	Registered in U.S.	Suitability for IPM programs
Anticoagulant	with EPA						and not registered by EPA
Coumachlor coumarin Anticoagulant	Not regis-tered with EPA	EPA I WHO Ia			No Available as Tomorin	Not registered by EPA	Not suitable for use in IPM programs due to EPA toxicity class Ia and not registered by EPA
Warfarin coumarin Anticoagulant	GUP	EPA I-III WHO Ib			No Available as Ratatox wax block bait	Yes as Warfotox 0.025%	Suitable for IPM programs, but only in the ready-to-use wax block bait formulation, must register with GoU

Annex 6: Hazards of suggested and replacement pesticides proposed for use in Uganda[2]

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
Insecticides/Acaricides				
Acephate	Acute oral – MT Dermal – ST Inhalation – RNT Prolonged or repeated skin contact may cause irritation	Considered a fetotoxin (can poison the fetus) Some evidence of hormonal effects NOAEL 100 mg/kg (rat) ADI 0.03 mg/kg	HT to bees, beneficial arthropods. MT to birds, aquatic invertebrates. RNT to fish.	Not cont grou wate Brea life
Acetamiprid	Acute oral – MT Dermal – ST Inhalation – MT Non-irritating to skin and eyes, not skin sensitizer	None noted NOAEL 7.1 mg/kg (rat) ADI 0.07 mg/kg	MT to birds, bees ST to fish RNT to aquatic invertebrates	Fair high 425(Brea life
Azadiractin	Acute oral – RNT Dermal – ST Inhalation -- RNT A mild skin irritant	None noted, it is a toothpaste and soap in India	HT to fish. MT to aquatic invertebrates. RNT to bees, beneficial arthropods	Pote soil accu envi expe
Bacillus thuringiensis (Bt)	Acute oral –RNT Dermal – RNT Inhalation – RNT Solvents may irritate the eyes	None noted in mammals NOAEL 4 g/kg (rat) ADI	RNT to bees, fish, birds, mammals, aquatic invertebrates, beneficial arthropods	Pote grou Doe envi

[2] See table 10 for ratings. Dermal toxicity includes entry via eyes and other mucous membranes. Chronic toxicity measured by NOAEL (long term feeding trials with various doses, the maximum dosage that has no adverse health effect is the NOAEL, ADI is the acceptable daily intake. Both are measured in mg of pesticide per kg of body weight of the test animals (rats, dogs). Lower numbers indicate more toxic pesticides. Sources: *Farm Chemicals Handbook*, 2003. Extoxnet Pesticide Information Profiles. Pesticide Action Network of North America Pesticide Database http://ace.orst.edu/info/extoxnet/. The Pesticide Manual by CDS Tomlin (2000). Agricultural Chemicals Books I-IV by WT Thomson (2000-01), Thomson Publications, Fresno CA, The Agrochemical Handbook (1991) Royal Society of Chemistry UK.

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
Carbaryl	Acute oral – ST Dermal – ST Inhalation – RNT Direct contact to eyes or skin can cause burns	Chronic exposure potential effects on the reproductive system and potentially mutagenic and a endocrine disruptor NOAEL 200 mg/kg (rat) ADI 0.01 mg/kg	HT to bees, beneficials, earthworms. MT to fish, aquatic invertebrates, wild and domestic mammals. ST to birds	Not mob to gı dete (solı Half
Carbosulfan	Acute oral– MT Dermal – MT Inhalation– ST Minimally irritating to the eye, slightly irritating to the skin and is a dermal sensitizer	Minimal effects from chronic exposure NOAEL 20 mg/kg (rat) ADI 0.01 mg/kg	HT-VHT to birds, fish, aquatic invertebrates, bees	Not (solı Rap half
Chlorpyrifos ethyl	Acute oral – MT Dermal – RNT Inhalation - MT Causes irreversible eye damage	Chronic exposure results in similar effects as acute poisoning, cholin-esterase depression	VHT to fish, bees, aquatic invertebrates, HT-MT to birds	Not (so1 Slov half
Beta Cyfluthrin	Acute oral – MT Dermal – RNT Inhalation – MT Slight irritatin to eyes	Minimal chronic effects, repeated overexposure may damage liver and kidney NOAEL 125 mg/kg (rat) ADI 0.02 mg/kg	VHT to fish, aquatic invertebrates HT to bees, beneficial arthropods RNT to birds, mammals, earthworms	Littl grou and the s
Lambda cyhalothrin	Acute oral – MT Dermal – ST Inhalation – RNT May cause skin irritation	Endocrine disruption (on 1 of 4 lists) NOAEL 0.5 mg/kg (dog) ADI	HT to fish, bees, beneficial arthropods, aquatic invertebrates	Littl grou and the s
Cypermethrin	Acute oral – MT Dermal – ST Inhalation – RNT Slight skin irritation	Minimal chronic effects Possible human carcinogen NOAEL 7.5 mg/kg (rat) ADI 0.05 mg/kg	HT to fish, bees, beneficial arthropods, aquatic invertebrates RNT to birds	M so da Lc (0. str to
Deltamethrin	Acute oral – MTc	Minimal chronic effects	HT to fish, bees,	De

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
	Dermal – ST Inhalation – RNT Slight skin and eye irritation	NOAEL 12 mg/kg (rat) ADI 0.01 mg/kg	beneficial arthropods, aquatic invertebrates RNT to birds	oc Lc (0. un co
Diazinon	Acute oral – MT Dermal – ST Inhalation – RNT	Not considered carcinogenic Chronic effects are minimal NOEL 0.06 mg/kg (rat) ADI 0.002 mg/kg	VHT to aquatic invertebrates HT to birds, bees, fish	Lc wi we be so mg Ha wa
Dimethoate	Acute oral – MT Dermal – ST Inhalation – ST Contact with the skin may be irritating and dermatitis and dermal sensitization may occur may produce a transient corneal injury	Potential endocrine disruptor, affects reproductive system, teratogenic and mutagenic, possible carcinogen NOAEL 5 mg/kg (rat) ADI 0.002 mg/kg	HT to birds, bees, beneficial arthropods MT to fish, aquatic invertebrates, domestic and wild mammals	Sc an en Lc so
Fenitrothion	Acute oral – MT Dermal – ST Inhalation – ST Mild dermal irritant	Slight effects on the reproductive system noted NOAEL 10 mg/kg (rat) ADI 0.005 mg/kg	HT to birds, bees, beneficial arthropods MT to fish	De soi tha Int (sc
Fenvalerate (es-fenvalerate)	Acute oral – MT Dermal – MT, Inhalation – ST Slightly irritating to skin and eyes	No observable health impact from chronic exposure NOAEL 250 mg/kg (rats) ADI = 0.02 mg/kg	VHT to fish, bees, beneficial arthropods, ST to birds,	Ab Hi 1 r Ha
Fipronil	Acute oral – MT Dermal – MT Inhalation – ST Moderately irritating to skin or eyes	No observable health impact from chronic exposure NOAEL = 0.5 mg/kg ADI = 0.0002 mg/kg	HT-ST to birds HT to fish, aquatic invertebrates, bees HT-RNT to birds	Re of
Indoxacarb	Acute oral – ST Dermal – RNT Inhalation – RNT Dermal sensitizer	No observable health impact from chronic exposure NOAEL = 60 mg/kg (rats) ADI	MT-RNT to birds HT to fish, aquatic invertebrates, bees	Lit the Ha pe
Imidacloprid	Acute oral – MT Dermal – ST Inhalation – STc Mild dermal irritant	May be weakly mutagenic Minimal carcinogenic risk, categorized by EPA as a "Group E" carcinogen NOAEL 100 mg/kg (rat) ADI 0.06 mg/kg	HT to birds, bees, beneficial arthropods MT to fish	Th co soi (5(bir ma in

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
Malathion	Acute oral – ST Dermal – STInhalation – RNT Can cause slight to substantial but temporary eye irritation May cause allergic contact dermatitis	Chronic possibly affecting mammalian reproduction, being mutagenic, carcinogen Potential endocrine disruptor NOAEL 100 mg/kg (rat) ADI 0.02 mg/kg	HT to fish, bees, amphibians, aquatic invertebrates, beneficial arthropods, earthworms	Ma gro cor env wh to l Cal
Methoxychlor	Acute oral – ST Dermal – ST Inhalation – RNT May cause irritation to the eyes, nasal passages, throat and skin	May have estrogenic or reproductive effects NOAEL 300 mg/kg ADI 0.1 mg/kg	VHT to fish, aquatic invertebrates MT to beneficial arthropods ST to birds RNT to bees	Per life bio Ris be (0.
Methoxy-fenozide	Acute oral – RNT Dermal - RNT Inhalation – RNT Slightly irritating to skin	Excessive exposure may hinder blood's ability to transport oxygen NOAEL 10 mg/kg (rats) ADI 0.1 mg/kg	RNT to birds, bees, beneficial arthropods MT to fish, aquatic invertebtates	Lo mg Lo in s
NPVirus	Acute oral – RNT Dermal – RNT Inhalation – RNT May cause slight irritation to eyes and skin	No observable chronic health hazards Exempt from NOAEL and ADI	RNT to birds, bees, fish, beneficial arthropods, aquatic invertebrates	As acc env dri
Petroleum oil	Acute oral – RNT Dermal – RNT Inhalation – RNT May cause eye and skin irritation	None noted	MT to beneficial arthropods, fish, aquatic invertebrates RNT to birds, bees	Bre env acc gro
Pirimiphos-ethyl	Acute oral – HT Dermal – RNT Inhalation - May cause eye irritation	No data on chronic toxicity NOAEL 0.2 mg/kg (dogs) ADI	VHT-HT to birds HT to fish, bees	No cor Hig mg Ha
Profenofos	Acute oral – MT Dermal – ST Inhalation – RNT Causes eye irritation	NOAEL 0.3 mg/kg (rat) ADI 0.01 mg/kg	VHT to fish HT to aquatic invertebrates MT to birds, bees	Ra (ha
Spinosad	Acute oral – RNT Dermal – RNT Inhalation – RNT May cause slight eye irritation	No significant chronic effects noted	HT to aquatic invertebrates, bees RNT to birds ST-MT to fish	Ra env mo slig and cor
Sulfur	Acute oral – RNT Dermal – ST Inhalation – RNT Irritating to the skin, eyes, and mucous	No significant chronic effects noted NOAEL not rated ADI not rated as is natural element	ST to fish RNT to birds, aquatic invertebrates, bees, beneficial arthropods	Sul cor env cor by

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
	membranes			Ele soi
Thiamethoxam	Acute oral – ST Dermal – RNT Inhalation – RNT Non irritating to skin or eyes	Predominantly liver and kidney effects at high dosages Liver tumors at high dosages (mice)NOAEL ADI	VHT to bees ST to birds RNT to fish, aquatic invertebrates	No the occ Ha Sli g/l
Fumigant/stored product				
Aluminum phosphide	Acute oral – VHT Dermal – NA (not absorbed thru skin) Inhalation – VHT	No chronic effects noted	VHT to birds, reptiles, mammals, fish, aquatic invertebrates, beneficials, bees	Eva ope in t
Malathion	Acute oral – ST Dermal – STInhalation – RNT Can cause slight to substantial but temporary eye Irritation May cause allergic contact dermatitis	Chronic effects possibly affecting mammalian reproduction Possibly mutagenic Possibly carcinogen Potential endocrine disruptor	HT to fish, bees, amphibians, aquatic invertebrates, beneficial arthropods, earthworms	Ma gro cor wh to l Cal Do
Permethrin	Acute oral – MT Dermal – ST Inhalation – RNT Causes some eye and skin irritation on contact	Chronic effects on mammalian reproduction Possible mutagen Possible carcinogen Potential endocrine disruptor NOAEL 100 mg/kg (rat) ADI 0.05 mg/kg	HT to fish, aquatic invertebrates, beneficials, bees MT to amphibians RNT to birds	Lo in t life exp cor bin par ins
Pirimiphos-methyl	Acute oral – RNT Dermal – ST Inhalation – RNT Slight irritation to the eyes and skin	Minimal chronic effects expected NOAEL 10 mg/kg (rat) ADI 0.03 mg/kg	HT to birds, fish, MT to bees, aquatic invertebrates	Mo (ha Mi wa sol
Nematicides				
Carbofuran	Acute oral – VHT Dermal – ST Inhalation – HT Skin and eye irritation	Minimal effects from chronic exposure NOAEL 20 mg/kg (rat) ADI 0.002 mg/kg	HT to birds (who eat the granules) MT to fish, bees (RNT in granular form)	Fai sol mg Sm gro lea Ha per
Dazomet	Acute oral – MT Dermal – RNT Inhalation – RNT Non irritating to eyes or skin	When fed high doses test animals exhibited liver and kidney effects NOAEL – 30 mg/kg (rat) ADI -	MT-RNT to birds HT to fish, aquatic invertebrates RNT to bees	Mo 3g/ Ra it u int
Ethoprop	Acute oral – MT Dermal – VHT Inhalation – RNT	Suspected to be carcinogenic NOAEL – 100 mg/kg	VHT-MT to birds MT to fish VHT to aquatic	As to a env

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
	May cause skin and eye irritation	ADI – 0.0003 mg/kg	invertebrates RNT to bees	mo and hal dep
Fungicides/ Bacteriocide				
Anilazine	Acute oral – MT Dermal – ST Inhalation – Skin sensitizer	Suspected developmental toxicant to children NOAEL ADI	ST to birds HT to fish, aquatic invertebrates	De life
Benomyl	Acute oral – RNT Dermal – RNT Inhalation toxicity – RNT Mild eye irritant	Skin irritation may occur in chronically exposed workers Classified as a possible carcinogen NOAEL > 2500 mg/kg (rat) ADI 0.1 mg/kg	HT to fish, earthworms MT to birds, aquatic invertebrates RNT to bees	No gro eas No Sli
Bronopol	Acute oral – MT Dermal – ST Inhalation - RNT May cause eye and skin irritation	No chronic health effects noted NOAEL – 1000mg/kg ADI -	ST to birds, fish MT to aquatic invertebrates	Ra env kno gro
Chloro-thalonil	Acute oral – RNT Dermal – RNTc Inhalation – RNT Can cause allergic reactions	Likely human carcinogen NOAEL 1.8 mg/kg (rat) ADI is 0.03 mg/kg	HT to fish, aquatic invertebrates RNT to bees, birds	Lo loa mo Mi life
Copper oxychloride	Acute oral – ST Dermal – STic Inhalation – RNT May cause substantial but temporary eye injury and cause mild irritation to the skin	Repeated ingestion may result in kidney or liver damage, it is not a carcinogen NOAEL ADI	HT to earthworms MT to fish, aquatic invertebrates RNT to birds, beneficial arthropods, bees	Hig as No wa the
Cymoxanil	Acute oral – ST Dermal – ST Inhalation – RNT	No chronic symptoms known NOAEL 4.1 mg/kg (rat) ADI 0.016 mg/kg	ST to fish, aquatic invertebrates RNT to birds, bees, earthworms	Lo life thr
Difenoco-nazole	Acute oral – RNT Dermal – ST Inhalation – RNT irritating to skin risk of serious but reversible damage to eyes	Not teratogenic or mutagenic NOAEL 1 mg/kg (rat) ADI 0.01 mg/kg	HT to fish, aquatic invertebrates MT to aquatic plants RNT to birds, bees	Str par lea Rel
Dimethomorph	Acute oral – RNT Dermal – RNT Inhalation – RNT Not sensitive to skin or eyes	No known chronic ill effects NOAEL – 200 mg/kg ADI – 0.09 mg/kg	RNT to birds, bees, beneficial arthropods ST to fish, aquatic invertebrates	On wa can cor

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
Dithianon	Acute oral – ST Dermal – RNT Inhalation – RNT Will cause severe eye irritation	Weight loss and damage to liver and kidney from prolonged exposure NOAEL – 20 mg/kg (rats) ADI – 0.01 mg/kg	MT to birds VHT to fish MT to aquatic invertebrates RNT to bees	Sol
Fenarimol	Acute oral – RNT Dermal – RNT Inhalation – RNT Mild eye irritatant	No known chronic ill effects NOAEL – 25 mg/kg (rats) ADI – 0.01 mg/kg	RNT to birds, bees MT to fish VHT to aquatic invertebrates	No wa (13 > 3 tox
Fluazinam	Acute oral – RNT Dermal – ST Inhalation – MT Irritating to eyes, may cause skin irritation	No known chronic ill effects NOAEL – ADI –	ST to birds VHT to fish HT to aquatic invertebrates RNT to bees	No soi sol
Fosetyl aluminum	Acute oral – RNT Dermal – ST Inhalation – ST Irritating to eyes	Contains ingredients that are suspected carcinogens NOAEL – ADI –	RNT to birds, aquatic invertebrates, bees ST to fish	Ext soi (<1 (12 gro
Kresoxim-methyl	Acute oral – RNT Dermal – MT Inhalation – RNT Non irritating to skin and eyes	No chronic health effects have been noted NOAEL – 800 ppm (rats) ADI – 0.4 mg/kg	RNT to birds, bees HT to fish, aquatic invertebrates	De hal
Mancoze**b**	Acute oral – RNT Dermal – RNT Inhalation – RNT May cause mild irritation of nose, throat, eyes and skin	Probable human carcinogen Endocrine disruption (on 4 of 4 lists) Chronic usage may cause sensitization rashes NOAEL 5 mg/kg (rat) ADI 0.03 mg/kg	HT to fish, aquatic invertebrates MT to bees, aquatic plants RNT to birds	Mc cor due Do soi
Metalaxyl	Acute oral – ST Dermal – ST Inhalation – RNT Can cause irritation to the skin, eyes, throat, and nose	No known chronic effects have been documented NOAEL 2.5 mg/kg (rat) ADI 0.03 mg/kg	ST to birds, aquatic invertebrates RNT to bees, fish	Poo hig pos cor sur hal
Propineb	Acute oral – RNT Dermal – RNT Inhalation – ST Not irritating to skin or eyes	Minimal chronic effects NOAEL 50 mg/kg (rat) ADI 0.007 mg/kg	RNT to birds, bees MT to fish, aquatic invertebrates	Is r gro and the

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
Sulfur	Acute oral – RNT Dermal – STInhalation – RNT Irritating to the skin, eyes, and mucous membranes	Generally recognized as safe as it is an essential element for human nutrition	RNT to birds, fish, aquatic invertebrates, bees, livestock and mammals	Not in gr in te sulfu elem crop conta envi
Tebuconazole	Acute oral – RNT Dermal – ST Inhalation – HT Mild irritant to eyes	No known chronic health hazards NOAEL – 300 mg/kg ADI – 0.03 mg/kg	RNT to birds, bees, beneficial arthropods MT to fish ST to aquatic invertebrates	Does envi in so wate grou
Thiophanate methyl	Acute oral – RNT Dermal – RNT Inhalation – ST Mild skin and eye irritant	No known chronic health hazards NOAEL – 160 mg/kg ADI – 0.02 mg/kg	RNT to birds MT to fish ST to aquatic invertebrates	Soil week conta wate
Thiram	Acute oral – RNT Dermal – ST Inhalation – RNT Moderate eye irritant	Prolonged exposure could lead to progressive lung disease NOAEL 1.5 mg/kg (rat) ADI 0.01 mg/kg	HT to fish MT to aquatic inverts ST to birds RNT to bees	Mini grou half Does soil
Herbicides				
Bromoxyanil (mixture of bromoxynil octanoate and b.-potassium)	Acute oral – MT Dermal – ST Inhalation – Mild eye irritant	Class C carcinogen. Considered to be a development toxicant NOAEL – ADI –	HT to birds MT-HT to fish RNT to bees	Does envi of 1(hydr subs
Diruon	Acute oral – RNT Dermal – ST Inhalation – RNT Mild eye irritant	Excessive exposure may inhibit blood from transporting oxygen, caused cancer in som e lab animals NOAEL – 250 mg/kg (rats) ADI – 0.002 mg/kg	RNT to birds, bees MT to fish ST to aquatic invertebrates	Dura mon near resis wate mg/l collo
Glyphosate acid	Acute oral – RNT Dermal – RNT Inhalation – RNT Eye irritant	Minimal chronic effects documented NOAEL 410 mg/kg ADI 1.8 mg/kg	MT to amphibians, aquatic invertebrates, beneficial arthropods and earthworms ST to fish RNT to birds, bees	Haza crop dive High mg/l appr adso Half varia
Glyphosate salts	Acute oral – RNT	Minimal chronic effects	MT to amphibians, aquatic	Haza

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
	Dermal – RNT Inhalation – RNT Eye irritant	documented NOAEL 410 mg/kg ADI 1.8 mg/kg	invertebrates, beneficial arthropods and earthworms ST to fish RNT to birds, bees	crop diver High mg/l appr adso Half varia
Haloxyfop-methyl	Acute oral – MT Dermal – RNT Inhalation – RNT Moderate eye irritant	Repeated oral exposure caused liver toxicity in rats. NOAEL – ADI –	ST to birds MT to aquatic invertebrates HT to fish RNT to bees	Only wate grou and soils
Iodosulfuron-methyl-sodium	Acute oral – RNT Dermal – MT Inhalation – Non irritating to skin & eyes	Chronic data from Australia state that there are not health hazards NOAEL – ADI –	ST to fish	Alm mov repo
Metolachlor	Acute oral – RNT Dermal – RNT Inhalation – ST Mild skin and eye irritant	Benign liver tumors NOAEL – 300 mg/kg (rats) ADI – 0.1 mg/kg	RNT to birds, bees MT to fish ST to aquatic invertebrates	Half does Mod (488 grou
Paraquat dichloride	Acute oral – MT Dermal – ST Inhalation – HT Moderate to severe eye irritation, irritating to skin	Chronic skin contact can lead to rash, ulcers, loss of fingernails Prolonged inhalation can lead to lung damage Chronic contact in the eyes causes conjunctivitis NOAEL 170 mg/kg (rat) ADI 0.004 mg/kg	MT to birds ST to fish RNT to bees	Rapi inact with high g/l)
Propanil	Acute oral – RNT Dermal – RNT Inhalation – ST Not irritating to skin or eyes	No chronic health effects noted to date NOAEL – 400 mg/kg (dogs) ADI – 0.005 mg/kg	MT to birds, fish, aquatic invertebrates	Half degr soil. wate grou degr
Thiobencarb	Acute oral – ST Dermal – ST Inhalation – RNT Irritating to eyes and skin	No chronic health effects noted to date NOAEL – 0.9 mg/kg ADI – 0.009 mg/kg	RNT to birds, bees MT to fish HT to aquatic invertebrates	Not cont solu readi life 2 and
Bird repellant				
Methyl anthranilate	Acute oral – RNT Dermal – RNT Inhalation – RNT The solvent used in the formulation can cause substantial but	As an extract from grapes that has been used in the food industry for over 30 years it has not been identified as a chronic health habit.	RNT to birds, fish, aquatic invertebrates, bees	It biod not an polluta

Pesticide Product (generic name)	Acute toxicity	Chronic toxicity*	Ecotoxicity	cor
	temporary eye injury.	NOAEL – ADI –		
		Molluscicide		
Metaldehyde	Acute oral – MT Dermal – RNT Inhalation – RNT Not irritating to skin or eyes	Two breakdown products occur in concentrations of 0.01% have been listed as carcinogens NOAEL – ADI – 0.025 mg/kg	MT to birds ST to fish, aquatic invertebrates RNT to bees	Rapidl enviro compo Moder (222m ground
		Rodenticides		
Bromadiolone	Acute oral – VHT Dermal – VHT Inhalation – HT Not irritating to skin or eyes	NOAEL – ADI –	MT to birds, fish, aquatic invertebrates RNT to bees	Rapid enviro to soil soil bu contar solubi
Coumachlor	Acute oral – ST Dermal – VHT Inhalation -	No data available NOAEL – ADI –	No data available	Practi (0.5 m
Coumate-tratyl	Acute oral – HT Dermal – HT Inhalation – RNT	No data available NOAEL ADI	ST to aquatic invertebrates, domestic animals (but young pigs especially susceptible) RNT to birds, fish,	Not cc in the Not hi (4-425 solutic
Warfarin	Acute oral – VHT Dermal – MT Inhalation – HT	Chronic exposure to skin cause hematomas to appea ron the arms and legs. Within four days, there were also epistaxis, punctate hemorrhages of palate, bleeding from lower lip Established teratogen Causes organ damage by inhibiting blood coagulation NOAEL ADI	RNT to game birds, poultry, bees, fish, aquatic invertebrates HT to mammals if ingested (young pigs especially susceptible)	Not cc in the Practi mg/10 hazarc