TRAINING MANUAL

INTEGRATED PEST MANAGEMENT

FOR BANANA FARMERS

The Agribusiness Project – Agribusiness Support Fund

Integrated Pest Management Training Manual for Banana Farmers – The Agribusiness Project

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This manual is a live document which can be changed as the project progresses. Any suggestions for further improvement are most welcome. Project staff is particularly encouraged to identify areas for further improvement.

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AN OVERVIEW OF BANANA CROP IN PAKISTAN

The Banana is very famous and a major fruit crop of Pakistan. It is grown on 34,800 hectares with production of 154,800 tons. It is mainly grown in Sindh province where the soil and climatic conditions are favorable for its successful cultivation. The total share of Sindh province alone in its cultivation is 87 per cent. Major districts in Sindh where banana is grown are Thatta, Hyderabad, Badin, Mirpurkhas, Tando Allahyar, Matiari, Tando Muhammad Khan, Sangar, Naushero Feroz, and Nawabshah. However, its cultivation has extended to northern parts of Sindh particularly district Khairpur.. Ninety five per cent of area is under Basrai variety (Cavendish dwarf), and the remaining under William Hybrid. Recent introductions include variety Grand Naine (G-9) while the work is underway to introduce high yielding Chinese varieties viz. B-10, W-11, and Pishang.

GROWTH CYCLE OF BANANA

Scientifically classified in the genus Musa, bananas are fast-growing giant herbs from the same family as lilies and orchids. They are the largest plants on Earth without a woody stem like that of a tree trunk. A cultivated banana plant does not grow from a seed, but rather from a bulb-like structure called a corm. The “trunk” of the plant, called the “pseudo stem,” rises from the corm and is made of sheaths of overlapping leaves tightly wrapped around each other like celery stalks. Emerging from the center of the pseudo stem, 4-15 frond-like leaves unfurl at a rate of one per week in optimal conditions as the plant grows.

The leaves extend upward and outward, forming broad glossy blades up to 9 feet (2.7 m) long and 2 feet (0.6 m) wide. Once the plant has produced a certain number of leaves, the flowering stem, called the “inflorescence,” also grows up through the pseudo stem. At first, it is a large tapered purplish bud. As the bud opens, groups of tubular white flowers are revealed. Both male and female flowers are present, and the fruit (technically a berry) develop from the females without pollination. As the young bananas grow, they resemble

slender green “fingers.” A cluster of mature fruit becomes a “hand,” and under the weight of the bananas the stem bends down toward the ground. As bananas ripen, they turn from green to yellow or red depending on the variety. A single banana plant can produce 100-300 individual fruits, and can reach a height of more than 30 feet (9m)

CLIMATE AND TEMPERATURE REQUIREMENTS

The banana cultivated in humid tropic of south East Asia is mainly grown between 30^{o} S and N on equator. A mean temperature of about 27°C is optimal for growth. Minimum temperature for adequate growth is about 16°C, below which growth is checked and shooting delayed. Temperatures below 8°C for long periods cause serious damage. Maximum temperature for adequate growth is about 38°C, depending on humidity and the radiation intensity. Bananas are day-neutral in their response to day length.

HUMIDITY AND WIND VELOCITY REQUIREMENTS

A humidity of at least 60 percent or more is preferable. Strong winds, greater than 4 m/sec, area major cause of crop loss due to the pseudo stems being blown down. Under high wind conditions windbreaks are desirable in order to banana plant from damages caused by high wind velocity. Wind velocity in lower Sindh is a great problem, as much as 15-20% plus losses are observed. In order to save banana from high wind velocities windbreaks are often planted around banana fields to provide some protection from cold and wind.

FERTILIZERS REQUIREMENTS

According to DR. KAZI SLUEMAN MEMON:

8 bags of UREA per acre (184 kg N/acre)

4 bags of DAP per acre (92 kg P/acre)

8 bags of SOP acre (200 kg k/acre)

Plus 200 mounds of farmyard manure are required in order to full fill the nutritional requirement. Other sources can be used to apply NPK are

CAN (Calcium ammonium nitrate, 26% nitrogen)

SOP (Sulphate of potash, 50% potash)

SSP (single superphosphate, 14-18 % phosphorus)

PESTS AND DISEASES OF BANANA CROP

PEST AND DISEASE INCIDENCE:

Black Sigatoka disease is considered the most economically important disease of banana worldwide, causing typical yield losses up to 50%. The fungus grows on the leaves producing dark spots and causes the fruits to ripen prematurely. Banana Xanthomonas Wilt (BXW) attacks almost all varieties of Musa, destroying the fruits and devastating the crop. It was first identified in Ethiopia in the 1970s, but spread rapidly to other parts of the Great Lakes region after reaching Uganda in 2001. Fusarium wilt has had a huge impact on the world banana trade and is found in every banana/plantain producing area. It is spread through corms used for planting.

The major banana and plantain pests are the burrowing nematode and the banana weevil. Nematode species attack the plant's roots, resulting in whole plant toppling or reduced yield. The banana weevil, Cosmopolites sordidus, attacks the plant's underground corm, weakening the plant and causing stem breakage.

BANANA BUNCHY TOP VIRUS

BBTV is widespread in tropical and subtropical Asia. In almost all these countries except for the islands located in Micronesia, banana plants were found to be infected with BBTV. The existence of BBTV was newly confirmed by ELISA (enzyme linked immuno sorbet assay).

A single vector transmits BBTV semi-persistently; the honeydew that the aphid produce attracts the banana black aphid, and the black ants, which live mutually with black aphid. Black aphid appears in the months of September to December. Sometimes the damage caused by BBTV disease is over looked due to the apparent losses due to Fusarium wilt and Sigatoka diseases, and banana plants are considered to be free from BBTV.

Previously, the disease problem was not serious in Pakistan as compared to other parts of the world such as Australia, Panama, Surinam, Central America, India and Colombia. In December

1988, some unknown disease was reported from the Thatta district at Gorabari and Mirpur Sakro. It received public attention in April 1989 when the disease had damaged more than 50 per cent of the banana crop in that area. Now the disease has spread in the districts of Thatta, Hyderabad, Tharparkar and Nawabshah and covered more than 90 per cent of the area in individual fields. In 2001 the disease appeared with low intensity in Karachi, Mirpurkhas and Sukkur and other districts. About 50-60 per cent of the crop has been damaged. The disease has now spread over more than 50 per cent of the total area

IMPORTANCE OF INSECT PEST IN AGRICULTURE

Without insects, our lives would be vastly different. Insects pollinate many of our fruits, flowers, and vegetables. We would not have much of the produce that we enjoy and rely on without the pollinating services of insects, not to mention honey, beeswax, silk, and other useful products that insects provide.

Insects feed on a seemingly endless array of foods. Many insects are omnivorous, meaning that they can eat a variety of foods including plants, fungi, dead animals, decaying organic matter, and nearly anything they encounter in their environment. Still others are specialists in their diet, which means they may rely only on one particular plant or even one specific part of one particular plant to survive.

Many insects are predatory or parasitic, either on plants or on other insects or animals, including people. Such insects are important in nature to help keep

pest populations (insects or weeds) at a tolerable level. We call this the balance of nature. Predatory and parasitic insects are very valuable when they attack other animals or plants that we consider to be pests.

INTRODUCTION TO INTEGRATED PEST MANAGEMENT

Integrated pest management (**IPM**), also known as **Integrated Pest Control** (**IPC**) is a broad-based approach that integrates practices for economic control of pests. IPM aims to suppress pest populations below the economic injury level (EIL). The UN's Food and Agriculture Organization defines IPM as "the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment.

IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. Entomologists and ecologists have urged the adoption of IPM pest control since the 1970s. IPM allows for safer pest control. This includes managing insects, plant pathogens and weeds

PRINCIPLES OF IPM

Following are the key principles of Integrated Pest Management (IPM) to promote best crop management practices among progressive famers of Banana.

- **Grow a healthy crop**.
  The focus is on cultural practices aimed at keeping the crop healthy. Selection of varieties that are resistant or tolerant to pests is an important aspect. Attention to soil, nutrient and water management is part of growing a healthy crop. Many IPM programs therefore adopt a holistic approach and consider a wider range of agro-ecological parameters related to crop production.

- **Manage the agro-ecosystem** in such a way that pests remain below economic damaging levels, rather than attempt to eradicate the pest. Prevention of pest build up and encouragement of natural mortality of

the pest is the first line of defense to protect the crop. Non-chemical practices are used to make the field and the crop inhospitable to the insect pest species and hospitable to their natural enemies, and to prevent conditions favorable to the buildup of weeds and diseases.

- Decisions to apply external inputs as supplementary controls are made locally, are based on monitoring of pest incidence and are site-specific. External inputs may include predators or parasites (bio-control), labor to remove the pest manually, pest attracting lures, pest traps, or pesticides. The choice of external input varies for each situation. Pesticides are generally used if economically viable non-chemical pest control inputs are not available or failed to control the pest. They are applied only when field monitoring shows that a pest population has reached a level that is likely to cause significant economic damage and the use of pesticides is cost-effective in terms of having a positive effect on net farm profits. Selection of products and application techniques should aim to minimize adverse effects on non-target species, people and the environment.

PEST MONITORING & SCOUTING IN BANANA

Following steps are involved for effective and comprehensive monitoring and scouting of Pests:

- **Scouting procedure**
  - ➢ The document title
  - ➢ Date and Name Field
  - ➢ A Map Key
  - ➢ More Fields
  - ➢ The document title
  - ➢ Date and Name Field
  - ➢ A Map Key
  - ➢ More Fields

- **Monitoring**
  - ✓ Monitoring Traps for banana aphids by using Yellow and Blue Sticky Traps.
  - ✓ Magnifiers & Scopes

- ✓ Magnifying Glasses/Loupes
- ✓ Stereoscopes
- ✓ Weekly scouting and disease records
- ✓ Scouting and record keeping

METHODS/TOOLS OF IPM (BIOLOGICAL, CULTURAL, CHEMICAL, MECHANICAL CONTROL)

There is a wide variety of techniques that can be applied under IPM approaches. Applicability of individual techniques depends on various factors, including the crop, the cropping system, the pest problems, the climate, the agro-ecological conditions, etc. Generally, IPM involves a combination of techniques. Some examples of such techniques:

Cultural practices that can help prevent build up of pests

- Crop rotation
- Inter-cropping,
- Field sanitation and seed bed sanitation,
- Use of pest-resistant crop varieties,
- Managing sowing, planting or harvesting dates
- Water/irrigation management,
- Soil and nutrient management (including mulching, zero/low tillage, fertilizer management)
- Practices to enhance the buildup of naturally existing predator populations
- Hand-picking of pests or hand-weeding
- Use of traps or trap crops
- Post harvest loss prevention

Biological inputs

- Biological control through release of predators, parasites or pathogens
- Biological control through fish, ducks, geese, goats, etc.
- Release of sterile male insects
- Bio-pesticides
- Biological preparations (e.g. name extract)

Chemical inputs

- Chemicals that disrupt insect behavior (e.g.: pheromones)
- Growth-regulators
- Conventional pesticides

S #	METHODS-IPM	PRACTICES
1	**MECHANICAL**	Trapping and collecting; mowing, chopping, crushing, and grinding plant residues, pests, and other forms; hand pulling and picking
2	**CULTURAL**	Use resistant varieties; rotate crops; chop stalks and dispose of refuse after harvest; tillage approaches; times for planting and harvesting; pruning and thinning with some crops; fertilizing based on crop needs; sanitation; water and runoff control; using trap crops
3	**BIOLOGICAL**	Using natural predators, such as beneficial insects; using parasites, such as bacteria; using genetically engineered crops; releasing sterile or incompatible pests
4	**PHYSICAL**	Using high and low temperatures; irradiation, particularly with seed and food grains; light traps
5	**CHEMICAL**	Poisons; growth regulators; attractants and repellants; sterilants
6	**REGULATION**	Quarantines; government-sponsored eradication and suppression programs

PROPOSED PEST SPECIFIC PESTICIDES FOR INTEGRTAED PEST MANAGEMENT (IPM)

Pesticides can be classified or grouped in many different ways. Following are the key pesticides used for IPM.

S #	PESTICIDES	PEST CONTROLLED
1	**Insecticide**	INSECTS
2	**Miticide**	MITES
3	**Acaricide**	TICKS and SPIDERS
4	**Molluscicides**	SNAILS and SLUGS
5	**Fungicide**	FUNGI
6	**Avicide**	BIRDS
7	**RODENTICIDE**	Rodents
8	**Nematicide**	Nematodes
9	**Bactericide**	Bacteria
10	**Herbicide**	Weeds
11	**Piscicide**	Fishes
12	**Predicide**	Predatory Animals

Fungicides used for diseases of Banana crops

S#	Diseases	Recommended Fungicides	Dose /100 litre of water	Time of Application	Name of the company/ Distributor
1	Sigatoka Leaf Spot	Copper Oxychloride 50 WP	500 fm	May-June	Generic

CHEMICAL CONTROL IN IPM

USE OF BIOPESTICIDES

ORGANIC PESTICIDES-PLANTS PARTS

Bio pesticide are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals. For example, canola oil and baking soda have pesticidal applications and are considered bio-pesticides.

At the end of 2001, there were approximately 195 registered bio-pesticide active ingredients and 780 products.

Bio-pesticides fall into three major classes

- ✓ Microbial pesticides
- ✓ Plant-incorporated-protectants (PIPS)
- ✓ Biochemical pesticides

There are two levels of benefit for pesticide use

- Primary
- Secondary

- **Controlling pests and plant disease vectors**
  - Improved crop/livestock yields
  - Improved crop/livestock quality
  - Invasive species controlled
- **Controlling human/livestock disease vectors and nuisance organisms**
  - Human lives saved and suffering reduced
  - Animal lives saved and suffering reduced
  - Diseases contained geographically

IMPORTANT PEST OF BANANA

Banana is highly vulnerable to numerous kinds of pests, which ultimately damages the yield of the fruit crop. Following are the key pest attack on banana fruit:

Major Pests of Banana

1. Aphid — *Pentalonianigronervosa Cock*
2. Scale Insects — *Aspidiotus destructor, Parlatoriacrypta*
3. Mealy bug
4. Caterpillars
5. Fruit Fly — *Spodopteralitura*

MEALY BUGS: Scientific name: *Pseudococcus elisae*

Also called "mealy bugs," they comprise many species that cause considerable damage to the plant aerial portion and its roots. These insects are identified by the presence of glands that secrete a whitish dusty or cottony wax. (OIRSA, 2000, cited by Osorno, M. and Mejía G) Once the eggs hatch, nymphs stay in the capsules for a short time and then move about the plants. Nymphs extract the sap, damaging the plant because of the strong suction exerted on the tissues and the abundant production of sugary oozing that attracts ants and other insects and favors the development of fungi such as Capnodium spp or the Meliolaceae family, that cause black mildew. Growing colonies of this insect can deteriorate and cause cosmetic damage to fruit. (Osorno, M. and Mejia, G)

CATERPILLAR WORM: Scientific name: *Ecphanteria spp*

Adults are white moths ranging in size from 4 to 6 cm. Females lay eggs in groups on the leaves and pseudo-stem. Larvae are reddish brown and eventually migrate to fruit bunches, where they feed and then move to the soil to form the chrysalis. Smaller larvae affect the fruit mostly eating outer part of the skin and leaving streamer-shaped scars. Generally the damage is not of economic importance.

Management recommendations:

Since larvae prefer eating suckers and sprouts, they should be managed appropriately to prevent pest population increases.

Banana Plant suffering from the aphid

BANANA APHID *Pentalonianigro nervosa Cock*

Banana aphid is a minor and frequent pest in northern Queensland where bunchy top does not occur. A more serious pest in south-east Queensland because it is a vector of bunchy top disease.

Direct feeding damage is uncommon. Damage from excessive honeydew and the resultant sooty mould development occurs only rarely and only when populations build up to high levels. The greatest potential damage is due to transmission of bunch top virus. Because of this the aphid is regarded as a serious pest in that area.

Sooty mould fungi that develop on the honey dew secretion of banana aphid

CONTROL OPTION/MANAGEMENT

Chemical control of aphids is not effective for bunchy top control and direct damage is seldom severe enough to warrant treatment.

Biological: Natural predators such as ladybird beetles, hoverflies, earwigs and lacewings usually. Maintain low aphid populations.

Chemical

Spray only if aphid problem is severe. Avoid regular spraying as this will remove beneficial insects and may induce other pest problems.

FRUIT FLY ***Bactocera Spp***

Cultural Control and Sanitary Methods

One of the most effective control techniques against fruit flies in general is to wrap fruit, either in newspaper, a paper bag, or in the case of long/thin fruits, a polythene sleeve. This is a simple physical barrier to oviposition but it has to be applied well before the fruit is attacked. Little information is available on the attack time for most fruits but few Bactrocera spp. attack prior to ripening.

Chemical Control

Although cover sprays of entire crops are sometimes used, the use of bait sprays is both more economical and more environmentally acceptable. A bait spray consists of a suitable insecticide (e.g. malathion) mixed with a protein bait. Both males and females of fruit flies are attracted to protein sources emanating ammonia, and so insecticides can be applied to just a few spots in an orchard and the flies will be attracted to these spots. The protein most widely used is hydrolysed protein, but some supplies of this are acid hydrolysed and so highly phytotoxic. Smith and Nannan (1988) have developed a system using autolysed protein. In Malaysia this has been developed into a very effective commercial product derived from brewery waste.

Male Suppression

The males B. papayae are attracted to methyl eugenol (4-allyl-1,2-dimethoxybenzene), sometimes in very large numbers. On a small scale many farmers use male suppression as a control technique; however, with flies attracted over a few hundred metres the traps may be responsible for increasing the fly level (at least of males) on a crop as much as for reducing it. However, the technique has been used as an eradication technique (male annihilation), in combination with bait (Bateman, 1982).

Field Monitoring

Monitoring is largely carried out by traps (see Early Warning Systems) set in areas of infestation. However, there is evidence that some fruit flies have different host preferences in different parts of their range and host fruit surveys should also be considered as part of the monitoring process.

Scale insect: *Aspidiotus destructor*, *Parlatoria crypta*

DAMAGE: Scale insects obtain food by sucking vital fluids from the host plant, causing yellowing and possibly stunted growth of the affected leaves or needles. A heavily infested plant will have extensive leaf yellowing, premature leaf drop, and possibly branch dieback. A plant weakened by a scale population is often more susceptible to damage by a secondary pest that may ultimately kill the plant.

Although sooty mold growth does not damage the plant, it looks unsightly and in large amounts can interfere with photosynthesis, slowing plant growth.

Management/Control

The best defense against severe scale infestations is to monitor landscape plants weekly throughout the year, paying close attention to the undersides of leaves and stems for scale, and avoid over-fertilization. Insects often lay more eggs and survive better on plants that are lush from heavy doses of nitrogen.

CHEMICAL CONTROL

Smothering scale insects by applications of horticultural oil is the easiest and often the most effective means of control. There are numerous types of oils, each with different temperature capabilities. There are some ultra light oils that can be used during the growing season, but it is critical to read the label carefully for guidelines on plant sensitivity and temperature restrictions. Most contact insecticides cannot penetrate the protective covering of the immobile

scale nymphs and adults. Only the crawler stage is susceptible to contact insecticides. Systemic insecticides may provide control of soft scales, but is generally not effective for armored scales.

ROLE OF BIOLOGICAL CONTROL OF INSECT PEST, IMPORTANT BENEFICIAL INSECTS (PARASITOIDS AND PREDATORS) AUGMENTATION AND CONSERVATION IN THE FIELD.

AUGMENTATION

In order to promote biological control practices it is imperative to enhance and augment the desired population of benenficial insects (Predator and Parasitoides) through the purchase and release of commercially available beneficial species. However, there has been relatively little research on releasing natural enemies in gardens and landscapes. Releases are unlikely to provide satisfactory pest control in most situations. Some marketed natural enemies are not effective. Praying mantids, often sold as egg cases, make fascinating pets. But mantids are cannibalistic and feed indiscriminately on pest and beneficial species. Releasing mantids does not control pests.

Only a few natural enemies can be effectively augmented in gardens and landscapes. These include entomophagous nematodes, predatory mites, and perhaps a few other species. For example, convergent lady beetles (*Hippodamia convergens*) purchased in bulk through mail order and released in very large numbers at intervals can temporarily control aphids; however, lady beetles purchased through retail outlets are unlikely to be sufficient in numbers and quality to provide control.

Successful augmentation generally requires advanced planning, biological expertise, careful monitoring, optimal release timing, patience, and situations where certain levels of pests and damage can be tolerated. Desperate problems where pests or damage are already abundant are not good opportunities for augmentation.

CONSERVATION

Conservation of beneficial predators and parasitoids is key toll to promote biologically control practices. Most pests are attacked by several different types and species of natural enemies, and their conservation is the primary way to successfully use biological control. Ant control, habitat manipulation, and selective pesticide use are key conservation strategies.

PESTICIDES MANAGEMENT

Broad-spectrum pesticides often kill a higher proportion of predators and parasites than of the pest species they are applied to control. In addition to immediately killing natural enemies that are present (contact toxicity), many pesticides are persistent materials that leave residues that kill natural enemies that migrate in after spraying (residual toxicity). Residues often are toxic to natural enemies long after pests are no longer affected. Even if beneficial survive an application, low levels of pesticide residues can interfere with natural enemies' reproduction and their ability to locate and kill pests.

Biological control's importance often becomes apparent when broad-spectrum, persistent pesticides cause secondary pest outbreaks or pest resurgence. A secondary outbreak of a different species occurs when pesticides applied against a target pest kill natural enemies of other species, causing the formerly innocuous species to become pests. An example is the dramatic increase in spider mite populations that sometimes results after applying a carbamate (e.g., carbaryl or Sevin) or organophosphate (malathion) to control caterpillars or other pests.

Eliminate or reduce the use of broad-spectrum, persistent pesticides whenever possible. Carbamates, organophosphates, and pyrethroids are especially toxic to natural enemies. When pesticides are used, apply them in a selective manner. Treat only heavily infested spots instead of entire plants. Choose insecticides that are more specific in the types of invertebrates they kill, such as *Bacillus thuringiensis* (Bt) that kills only caterpillars that eat treated foliage. Rely on insecticides with little or no persistence, including insecticidal soap, horticultural or narrow-range oil, and pyrethrins.

A less-persistent pesticide can result in longer control of the pest in situations where biological control is important because the softer pesticide will not

keep killing natural enemies. One soft pesticide spray plus natural enemies can be effective for longer than the application of one hard spray.

EXAMPLES OF BENEFICIAL INSECTS

S #	COMMON NAME	BENEFITS
1	Bees	Bees play key role in pollination of different plans
2	Butterflies	Butterflies are significant agent of pollination
3	Moths	These insects are highly beneficial in pollination
4	Flies	Flies are important agents of pollination and also play key role in the eco-system
5	Honey bees	Honey bees highly beneficial and produces honey and beeswax
6	Ants	Ants aerates soil
7	Lady bug beetles	It is important predator and prey on harmful insects
8	Mantids	It is important predator and prey on harmful insects
9	lacewings	It is important predator and prey on harmful insects
10	Silkworm moth	These insects cocoons provide silk fiber
11	Honey ants	human food
12	Flying ants	human food
13	Grasshopper	human food

PLANT QUARANTINE

The Pakistan Plant Quarantine Act 1976 and Rules 1967 tare enforced through which the country is protected from the entry and spread of exotic insect pests and disease and trade of plants and plant products is facilitated.

PESTICIDE REGISTRATION

Pesticides are regulated through the agricultural Pesticides Ordinance 1971, The responsibility of registration / permission for import and quality control is executed through the Department of Plant Protection. Due to the efforts of the Department, the prices are not only contained but declined by 30-40% despite devaluation of Pak Rupee.

PERSONAL SAFETY MEASURES FOR HANDLING AND APPLICATION OF PESTICIDES

Personal protection equipment such as respirators, chemical resistant (CR) gloves, CR footwear, coveralls with long sleeves, protective eyewear, CR headgear, CR aprons and a first-aid kit should be available immediately outside the storage area. The first-aid kit should include the following items: adhesive strips, tape, eye pads, gauze bandages and tweezers. The phone number 800-222-1222 for the Poison Control Center should be posted in a prominent location.

It is essential that protective eyewear be worn during mixing/loading. The protective eyewear should consist of safety glasses that provide front, brow and temple protection, goggles or a face shield. Workers should be instructed in the correct procedure for the removal of contaminated clothing. Eye wash stations or portable eye wash bottles should be easily accessed by each person engaged in the operation and should be capable of flushing eyes for a minimum of fifteen minutes. At a minimum, a hose and nozzle should be on hand. Routine wash up facilities, equipped with soap, hand cleanser and single use paper towels should be available near the storage area.

PESTICIDES SPILLS AND OTHER ACCIDENTS

An absorbent material such as re-usable gelling agents, vermiculite, clay, pet litter or activated charcoal should be on hand along with a garbage can and shovel to quickly contain and clean up any spills. All discharges to the environment or spills should be recorded. The records should include the date and time of the incident and the cleanup. The Massachusetts Department of Agricultural Resources must be notified within 48 hours if a pesticide spill leads to pollution.

SITE SECURITY

The storage cabinets should be kept locked and the door to the storage area should contain a weather proof sign warning of the existence and danger of pesticides inside. The door should be kept locked. The sign should be visible at a distance of twenty five feet and can contain a notice such as:

DANGER PESTICIDE STORAGE AREA, ALL UNAUTHORIZED PERSONS KEEP OUT, KEEP DOORS LOCKED WHEN NOT IN USE

The sign should be posted in both English and the language or languages understood by workers if this is not English.

PESTICIDES DISPOSAL

Proper disposal of pesticides and their containers is an important phase of pesticide management. An improperly disposed product can be hazardous to people and the environment. Rinse liquid pesticide containers three times when emptied: fill the containers about one-third full and swish it around. Allow the containers to drain well between each rinse (30 or more seconds). The rinse material should be poured into a spray tank and applied to a registered site. Triple-rinsed containers are considered non-hazardous and should be disposed of according to state recommendations. Never reuse an empty pesticide container. If an empty triple-rinsed container cannot be disposed of immediately, store

it in a safe, locked area. Before throwing out powders or granular pesticide containers, be sure to remove all contents from the containers.

PESTICIDES TRANSPORTATION

Depending on the hazard and the quantities of pesticides and hazardous materials (fertilizers, fuel, etc.) at a minimum the following checklist can be helpful for transporting pesticides:

- Driver is a licensed or certified pesticide applicator
- Inspect vehicle for leaks or other problems
- Pesticide containers secured in place
- Pesticide containers stored in a dry and lockable portion of the vehicle but not in the same compartment of driver
- Binder of pesticide labels and MSDS
- Emergency phone numbers
- First aid kit
- Fire Extinguishers
- Cleaning up supplies for spills (kitty litter, shovel, plastic bags, etc)
- PPE (gloves, goggles, coveralls, etc)
- At least 5 gallons of potable water for emergency eye or skin decontamination
- Obey all traffic laws and use signals