TRAINING MANUAL

INTEGRATED PEST MANAGEMENT

FOR CHILI FARMERS

The Agribusiness Project – Agribusiness Support Fund

Integrated Pest Management Training Manual for Chili 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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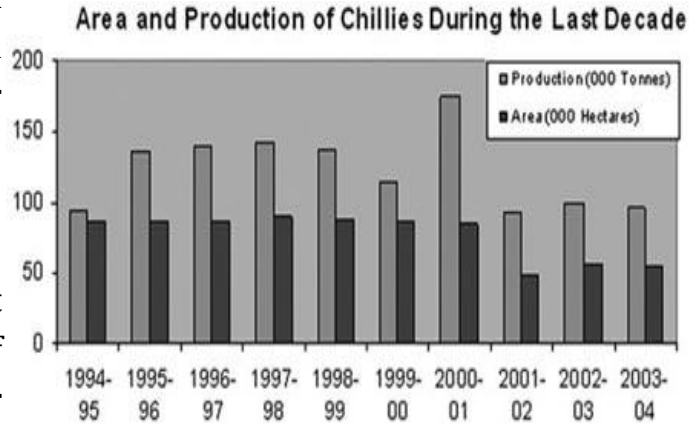
AN OVERVIEW OF CHILI CROP

According to scientist (Khurram Ziaf, Qamer Iqbal & Dr. Muhammad Amjad) chilies crop has greater potential for economic return.



Vegetable and spice crops have great scope. Currently, only six per cent of the total cropped area is under horticultural crops, while vegetables are cultivated on about two per cent. Demand of horticultural products is increasing fast. Chili is gaining importance because of its high cash value.

In Pakistan, only two species viz. Capsicum annum and Capsicum frutescens are known and most of the cultivated varieties belong to the species Capsicum annum. Chili extensively grown for dry chili (powder) is also harvested green. There are many nutritional, medicinal and economic benefits of its production.

Medicinal value: Chilies are valued for their soothing effects on the digestive system, relief from symptoms of cold, sore throats and fever, circulation especially for cold hands and feet and as a hangover remedy. Chilies can act as a heart stimulant, which regulates blood flow and strengthens the arteries, possibly reducing heart attacks. Medicinally, capsaicin is being used to alleviate pain. It is the most recommended topical medication for arthritis.

Chili peppers, especially hotter varieties such as Cayenne and Habanero, can also be used externally as a remedy for painful joints, for frostbite and applied directly to stop bleeding. They stimulate blood flow to the affected area, thus reducing inflammation and discomfort.

Domestic production and economic value: Chilies are grown on an area of 38.4 thousand hectares with production of 90.4 thousand tones, with an average yield of 1.7 tons per hectare with 1.5 per cent share in the GDP. Sindh is the major producer of chilies followed by Punjab and Balochistan.

Pakistan earned Rs. 1.127 billion during 2003-2004 by exporting red chili powder, whereas, export earnings from all fruits were Rs. 5.912 billion during the same period. This reveals the potential of this non-staple crop. Despite its importance the yield has declined from 86.5 (1994-95) to 55.8 thousand tons (2003-04). This decline in yield is due to a number of factors including poor quality seed, mal-cultural practices and diseases like viruses, collar rot and phytophthora root rot.

World market for chilies: India is the largest producer of chilies in the world contributing 25 per cent of the total world production, of which only four per cent is exported because of high domestic consumption. Besides India, other major producers and exporters are China, Pakistan, Morocco, Mexico and Turkey. Major importers of chilies from Pakistan are Gulf States, the US, Canada, Sri Lanka, the UK, Singapore and Germany.

Aflatoxin and chemical residues are two major constraints in the export of chilies to Europe, Japan and the US as buyers expect a high degree of hygiene and sanitation in processing and preparing chilies for export.

Export of red dried chilies from Pakistan has declined from Rs. 1.127 billion (during 2003-2004) to Rs. 846 million after European Union food authorities have detected the presence of aflatoxin (PHDEB).

Off-season production technology to extend production season of the crop for about two to three months is evolved.

Disease-free seeds should be used by treating them with suitable fungicide like thiram or captan. During nursery raising, proper cultural practices should be adopted particularly the maintenance of proper soil moisture to avoid phytophthora root rot and collar rot. While after transplanting, proper insect-pest control measures should be carried out to check the population of sucking insects, which are the vector for viral diseases affecting the chili crop.

To reduce aflatoxin contamination, some precautionary measures should be adopted. These include: picking and drying of fruit with pedicel (fruit stalk), avoid direct contact of fruit with soil, proper drying of fruit and storage of powder at low relative humidity and temperature. Furthermore, agronomic factors that may influence aflatoxin development like stresses, irrigation, cropping pattern, variety, date of planting, date of harvesting and storage conditions, should be studied in detail.

CHILI CULTIVATION SEASON

Chili season begins in September and lasts till the middle of March. It is a simpler crop to cultivate. It adjusts itself in various types of soil and different climatic conditions. It gives quality production when it is cultivated on deep, loomy and fertile soil with balanced moisture content. It is a short span crop. For successful growth of chili crop, proper watering and harvesting is essential.

DISEASES AND PESTS OF CHILI CROP

Following are the major pests of the Chili Crop:

WHITE FLY *(BEMISIA TABACI)*

These tiny insects feed on plant juices, leaving behind a sticky residue or 'honeydew,' which can become a host for sooty mold. Rustle the leaves of infested plants, and clouds of these insects will rise. If you have a serious problem, you may be tempted to reach for a conventional insecticide, but don't bother, as whiteflies have developed resistance to many. The best bet is a horticultural oil, which effectively smothers all stages of this insect. To deal with lower levels, place yellow sticky traps to monitor and suppress infestations.

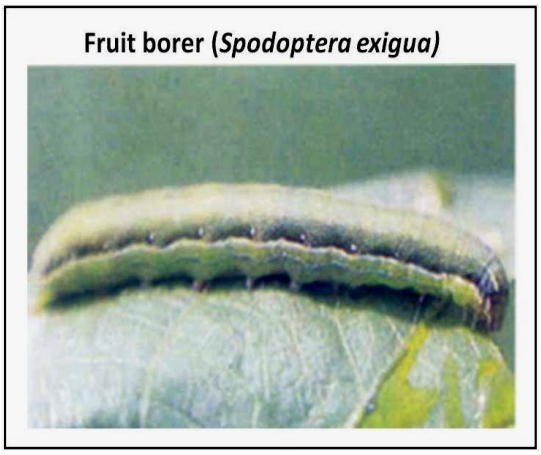
Hosing down plants can be surprisingly effective, especially if you use a bug-blaster, a hose attachment designed to produce an intense multi-directional spray that easily reaches the undersides of leaves. Another tactic is to release natural predators such as ladybugs, lacewings, or whitefly parasites. If the situation is out of control, insecticidal soaps and botanical insecticides and oils can bring populations down to manageable levels, at which point natural predators can maintain them.

CUT WORM *(AGROTISIP SILON)*

These tiny caterpillars that feed on young plant stems at night, frequently felling seedlings by eating right through them at ground level. Prevent damage by placing collars around seedlings. You can make these of paper, cardboard, aluminum foil, or an aluminum pie plate about ten inches long and four high, bent to form a circle or cylinder and stapled. Sink the collars about an inch into soil around individual seedlings, letting three inches show above the ground to deter high-climbers.

BORER *(SPODOPTERA EXIGUA)*

Seasonal occurrence:


Fruit borer (*Spodoptera exigua*)

The highest infestation of this pest is from July to August, although it has been found active throughout the year.

Brief life *cycle:*

SPODOPTERA LITURA eggs were usually round and laid in groups in the lower surface of the leaves. The number of eggs per female varied from 70 to 72 during a 24-h period. The larvae were polyphagous and pentamoulter having six larval instars. The entire life cycle was completed within 50.57±1.30 days during April to May and 40.02±0.54 days during July to August.

Control method:

Spraying carbaryl at 0.05 per cent methyl parathion or fenitrothion at 0.02 per cent concentration at 10 days interval will effectively control these fruit borers.

Spray of Sl NPV @ 500 LE/ha + jaggery 10 g/l + triton x 0.1 ml/l is recommended against S. LITURA. Baiting (rice/wheat bran 1 kg + 100 g jaggery + 50 ml monocrotophos or 25 g methomyl) is also recommended.

IMPORTANCE OF INSECT PEST IN AGRICULTURE

It is world-recognized fact, that 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

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 supression 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

USE OF BIOPESTICIDES

ORGANIC PESTICIDES-PLANTS PARTS

Bio pesticides 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 level's of benefit for pesticide use

- Primary
- Secondary

- **Primary Benefits are direct gains from the use of pesticides**

➢ **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

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.

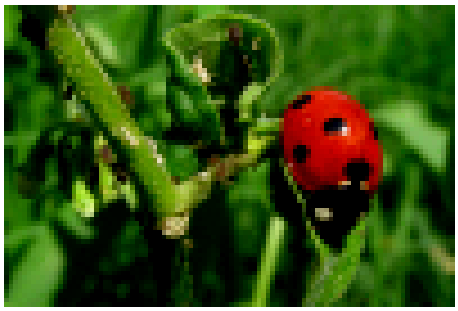
Successful augmentation generally requires advanced planning, biological expertise, careful monitoring, optimal release timing, patience, and situations where certain levels of pests and damage can be tolerated. Desperate problems where pests or damage are already abundant are not good opportunities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

Useful insects on chili plants:

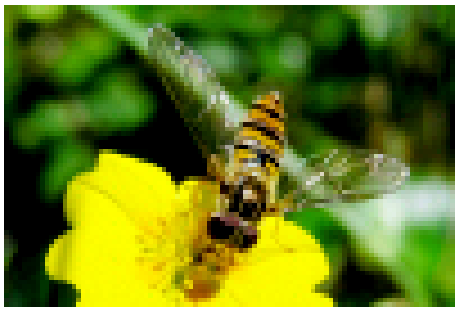
Like all plants, chili also is subject to attack by phytophagous insects or parasites.

A real 'plague' is certainly the aphids but also other insects may be particularly harmful. However, nature provides us with the valuable allies, insect predators such as:

The Ladybug is without doubt the best ally in the fight against aphids, mites and various insects. It has a remarkable voracity. In the adult state can reach to eat up to 100 aphids in a day.



The Hoverflies are excellent pollinators because they feed with nectar, honeydew and pollen. Their larvae are active predators of aphids and other phytophagous insects. Are similar in appearance to wasps, but belong to the Diptera order.



The Crisope are a family of insects of the order Neuroptera. The larvae are nocturnal predators of aphids, mites, eggs and larvae of other insects.

The Anthocorid are predatory insects belonging to the order of Rincoti, they're especially active against mites, aphids, eggs and larvae of other insects.

The Cryptolaemus montrouzieri is a coccinellid, but unlike ladybugs in bright colors, the body has a brown-orange color. The larvae are covered with white waxy substance. Excellent predator of mealybugs, but in the absence of them they also willingly feeds on aphids. The ability of predation is high and leads to a complete elimination of the pest.

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
14	Scarab beetles	These beetles are highly helpful in decomposing carrion (dead flesh), dung, and vegetation

HAZARDS, SAFE AND EFFECTIVE USE OF PESTICIDES

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

Pesticide 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