UNIT 18 IMPLEMENTATION OF IPM– PROCEDURES AND PRACTICES

Structure

18.1 INTRODUCTION

"Things at first hard and rough, are by use made tender and gentle"

Ben Johnson

Out of one hundred phytophagous (plant-eating) insects having potential of becoming pest, only one species assumes the pest status of economic importance. The remaining ninety-nine percent also exist but are kept at level which is not of much economic importance by various (i) biotic factors (like-unsuitable plants, parasites, predators, insect-attacking microorganisms) and (ii) abiotic factors (namely temperature, humidity, sunshine, wind velocity, topography). The key to Integrated Pest Management (IPM) is the concept of sustainable development, which has two components: environmental and economic. The environmental issue focuses on critical resource bases that may be either non-replenishable or slowly replenishable. An example of this is the soil resource upon which all agriculture is based.

IPM can protect the crops fully, better than by use of chemical pesticides alone. Ecological foundations are protected for sustainable and efficient agriculture by adopting IPM. IPM will also help in poverty alleviation of farmers. Therefore, IPM approach should be practised by farmers. The IPM technology has to be disseminated to cover as many villages as possible. Pest situation is changing from time to time and region to region alongwith the changes in cropping pattern. The agricultural extension

functionaries must be fully conversant with these pest problems and fully equipped with IPM strategies against these pests, so that they can help farmers in most appropriate way to prevent crop losses and thereby get higher yields and maximum return income.

Although IPM has been accepted in principle as the most attractive option for the protection of agricultural crops from the ravages of insect and non-insect pests, yet implementation at the farmers' level has been rather limited. Pesticides remain as key means of intervention and as an essential component of IPM strategies. Even though it may be impossible to avoid chemical pesticides altogether, dependence can be reduced by integrating non-chemical methods in pest management. This would reduce the costs considerably apart from offering protection in an ecologically sound manner.

Effective implementation of IPM is very important to make it a success. Various approaches, procedures and practices for IPM implementation are described in this Unit. Achievements of IPM implementation are also discussed in the Unit.

Objectives

After studying this unit you will be able to:

- explain various strategies and considerations for effective IPM implementation,
- discuss different approaches to agricultural extension,
- explain the concept of Farmer Field School,
- describe ideal format for an IPM module and
- explain IPM modules for rice, mustard and pulses.

18.2 IPM IMPLEMENTATION–PROCEDURES

The strategic aspects of IPM implementation are discussed below:

18.2.1 Infrastructure Development

ICAR established the NCIPM in February 1988 to cater to the emerging plant protection needs of agriculture in the country. Its major thrust areas are to develop and promote IPM technologies for major crops, to develop information base on all aspects of pest management, to establish linkages and collaborative programmes in areas of IPM with other national and international institutes and to extend technical consultancies.

IPM is a knowledge-based technology, hence there should be co-ordination between research institutes and farmers. The farmers need to be trained adequately in the techniques for better adoption. In India, the technology development of IPM is carried out by 29 SAUs (State Agricultural Universities), one Central Agricultural University and National Institutes, Crop Research Institutes, National Research Centres and a network of All India Coordinated Crop Improvement Projects, besides traditional Universities. Information and synthesis of IPM modules, their evaluation on fields and socio-economic impact analysis is being carried out at National Centre for Integrated Pest Management (NCIPM), New Delhi to cater to the plant protection needs of the whole country.

18.2.2 Human Resource Development (HRD)

Making farmer a confident manager and decision-maker free from dependence on a constant stream of pest control instructions is an essential prerequisite to achieve the goal of IPM. The new approach includes farmers' participation. To achieve this goal season-long training, farmers' field schools (FFS) have been started. You will study about FFS in detail further in this Unit. About 1,50,000 IPM demonstrations and 3,000 season long training programmes are planned during the IX plan. Similarly, about 30,000 farmers' field schools are proposed to be setup. So far about 50,000 rice growing farmers have been trained in rice IPM by 50 IPM trainers in the country.

18.2.3 Policy Support

Sustainable agriculture policies require:

i) promotion of domestic supply of crops in agriculture instead of export-oriented cash crops which consume a lot of chemical pesticides,

ii) shift from monoculture to crop diversity,
iii) encouragement of small farmers instead of commercial land holders simultaneously the phasing out of hazardous chemicals and emphasis on biological control agents need to be strengthened,
iv) Increase in funds for research and education on IPM.

18.2.4 Pest Monitoring

Monitoring of exotic pests and diseases through strict quarantine (enforced isolation) laws to check their spread and forecasting of pests through surveillance should be implemented. To promote this, Central Surveillance Stations, Central Biological Control Stations and Central Plant Protection Stations were merged and reorganized as Central IPM Centres (CIPMCs). About 30 CIPMCs are operational as on today.

18.2.5 Commercialization of Biocontrol Agents and Biopesticides

There shall be a determined effort to increasingly use the natural and rapidly biodegradable and renewable organic materials in IPM. A target to release 9000 million bioagents is fixed for the IX plan. Apart from this, the Registration Committee has decided to promote use of biopesticides, the most popular one, Bt (*Bacillus thuringiensis*) for use in agriculture and allowed their commercialization in order to promote IPM programme. Besides neem based pesticides, other plant origin pesticides have been registered. About 65 commercial neem-based insecticides (Unit 13) are currently available in the country and some are in the pipeline. The most exploited parasitoid (a parasite that kills the host) world over is *Trichogramma*. It is an internal egg parasitoid on several lepidopteran (moth and butterfly) eggs.

18.2.6 Registration and Quality control of Pesticides

About 170 commercial insecticides have been registered so far and about 40 are widely used. The Government has already banned 23 pesticides and has restricted the use of several others (See Annexure I to VI given at the end of Unit 12). The Central Government was giving about 580 million rupees as subsidy for distribution of pesticides under various crop schemes. In order to promote IPM, it has been proposed that this expenditure should be reduced substantially and the saving should be diverted to IPM. Apart from this, the registration procedures for biopesticides and botanicals have been simplified.

18.2.7 IPM Publicity

To promote and implement IPM, linkages with National and International agencies, State Agricultural Universities (SAUs), Non-Governmental Organizations (NGOs), Krishi Vigyan Kendras (KVKs) and private sector have to be strengthened. The joint efforts of Department of Agriculture of Centre and States with technology support from ICAR and SAUs will bring wider areas under the IPM network.

To sustain momentum in IPM implementation, there is a need to create greater awareness among the general public

18.2.8 Marketing

Key elements to improve marketing of IPM concepts should include:

i) Focusing on economics.
ii) Emphasizing incentives, including monetary and other incentives (e.g., IPM producer of the year).
iii) Improving communication to clearly define IPM programmes.
iv) Characterizing intended user groups.
v) Dispelling the idea that IPM adoption is going to increase risk of significant losses due to pest damage.
vi) Maintaining funding for research and education.
vii) Understanding producer expectations.
viii)Promoting privatization of consultant enterprises that utilize an IPM approach and strengthening their partnership with academia. Most producers and urbanites

already obtain the majority of their information from secondary providers as opposed to academia.

ix) Minimizing the influence of regulatory policies on IPM implementation, development and refinement. This would allow for a complete set of tools to choose from in constructing IPM programmes.

SAQ 1

How quality control of pesticides and commercialization of biocontrol agents is imperative in IPM implementation?

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18.3 CONSIDERATIONS FOR EFFECTIVE IPM PROGRAMME DEVELOPMENT

Scouting/monitoring is fundamental to decision-making in IPM system. It does not operate, however, exclusive of other tools available in IPM programmes. Many proactive, long-range tools for management (e.g. variety selection or crop rotation) can provide overall reductions in pest populations and cause scouting/monitoring to be less time-consuming. By definition, **IPM is information intensive and site specific.** Even within a state or region, variables such as soil type, location, market opportunities, or climatic differences will affect the design of an IPM programme for a specific crop. The following are considerations for implementing an effective IPM programme.

i) Identify and **define the roles of all persons involved**, including farm-ranch managers, crop consultants, pesticide applicators, warehouse managers, distributors and other personnel. This is particularly important when using contractors or private pesticide applicators.

ii) Set **realistic management objectives** for individual components, including yield goals, quality controls and potential economic returns.

iii) Develop conceptual **short and long-range management alternatives** to help manage the commodity and pests within that commodity. Many of the effective management tools such as crop rotation and variety selection are long-range in nature.

iv) Establish an **understanding of marketing alternatives and consumer attitudes.** Marketing is a critical component that directly influences the contribution of pest management decisions; of critical importance is the development and use of dynamic economic attitudes and management restrictions. The changing demographics of today's society and consumer concerns about production practices will alter marketing challenges and opportunities.

v) Establish **quality-control monitoring programmes** for components of IPM systems including production, storage and processing; this should include monitoring the quality of the commodity, extent of pest infestation, environmental parameters and biological control agents within the system.

vi) If pesticide applications are judged to be profitable according to decision guidelines, choose the most **selective pesticide** and apply it at **proper dosages** with appropriate **safety equipment** to reduce hazards to workers. Provide worker safety training to increase efficiency and reduce potential liability.

vii) Maintain **complete records** to document profitability, implement quality control of pesticides, maintain **food safety records** and fulfill legal requirements related to pesticide applications. Accurate records allow the managers to chart pest population densities and develop an understanding of historical trends related to abiotic and/or biotic factors in that given environment.

The **implementation of IPM must be flexible**, so that it can be tailored to individual situations. Managers can thereby develop appropriate packages that fit the specific needs of their operation in light of economics, availability, environment, socioeconomics and other important factors within that location.

Implementation of **area-wide IPM programmes** would allow large-scale use of *enhancement practices* (resistant plants, biological control, cultural practices, genetic control, mating disruption, trapping, etc.) that would accentuate natural control of pests and more prudent use of *intervention practices* (pesticides, early harvest, tillage, etc.) when pest populations exceed economic thresholds.

As IPM programmes are complex, so they should be constructed within the framework of practical farm operations. Specific criteria should be met and questions answered before widespread use of IPM practices can be implemented. These criteria include:

i) *A clear definition of IPM* by the administration.
ii) *Incentives to use IPM* or the perception that economic benefits of the programme justify the increased demands on management.
iii) *Sustained funding and resources for IPM* programmes at the implementation level with teams of scientists, growers, consultants and industry representatives.
iv) *Increased knowledge of practical means* for using IPM alternatives and support and the growing industry of consultants that will deliver the services.
v) *Decreased impact of an EPA regulatory process* that is burdensome, time-consuming, expensive and unclear while educating the agency about the need for a full toolbox of chemicals to choose from in developing and refining IPM programmes.

18.4 APPROACHES TO AGRICULTURAL EXTENSION

Three basic models of agricultural extension are: **technology transfer, farmer first**, and the **participatory model**.

Technology transfer

Technology transfer typically involves a top-down approach where scientists determine research priorities, generate innovations they believe are good for farmers and provide the results to extension agents. Information about the innovation, including its likely benefits, is then passed to individual farmers on the assumption that this will encourage them to adopt the new technologies and practices extended for quite sound reasons. The research-driven nature of the top-down process can result in products that do not fulfill a genuine need.

The farmer first

The **farmer first model** contrasts strongly with the **technology transfer model**. It acknowledges that farmers often have sound local knowledge and good reasons for their behaviour, which may not be understood by scientists. Farmer experience with experimentation and evaluation provides a basis on which scientists can learn from and with farmers to set research priorities. The main objective of the farmer first approach is to empower farmers to learn and create better situations for themselves rather than being passive recipients of new technology. Researchers do not drive the research, development and extension process; they interact with and assist farmers. The process is "bottom-up" with emphasis on bringing about changes that farmers want.

An important limitation of the farmer first approach is that significant off-farm, structural forces, which inevitably shape farmer priorities and decision-making, can be overlooked. For instance, private sector infrastructure of the marketing of a new

technology can have a significant influence on on-farm IPM, as can changes in relevant government regulations or consumer demand.

Participatory model

Stakeholders are individuals and groups of individuals who have a vested interest in a particular issue or cause. Their expectations are built on past experiences, assumptions and beliefs. Within pest management there are numerous stakeholders who can include e.g. shareholders, managers, employees, suppliers, customers and communities who are all linked to a commercial pesticide company.

The third extension model is the **participatory model** based on cooperation and participation. It arises from the recognition by many agricultural researchers, extension personnel, and farmers of the need to view ill-defined agricultural problems as a complex human activity system. The emphasis of this approach is on involving key stakeholders in a cooperative and flexible process that facilitates the implementation of activities to achieve practical improvements. Many participatory techniques exist, including rapid rural appraisal, participatory rural appraisal, focus groups, and structured workshops. The common themes of these approaches are qualitative data gathering, active participation of those having an interest in the outcomes, and responsiveness to both on-farm and off-farm decision makers.

The participatory approach is especially appropriate when dealing with bundles of technologies rather than single innovations. IPM clearly falls into this category as "a good example of the increasing complexity of recent technology development efforts". IPM is not a concrete entity. It is a site-specific management strategy that, to be successful, requires social scientists, including extension officers, to become more involved in the design, implementation, become more actively involved in developing and facilitating effective co-operation and participation.

A participatory approach to IPM, which involves the cooperation of key players throughout the IPM research, development and implementation process, is likely to be far more effective than technology transfer or farmer first approaches. In the past, a major constraint to effective IPM implementation has been the linear technology transfer paradigm. What is required for long-term IPM success is a high quality interaction between key players. This is most likely to be achieved where key players have common goals, work together as a team, and enhance each other's activities.

SAQ 2

Which model of agricultural extension is considered the best for IPM and why?

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18.5 PROMOTING IPM–DEVELOPING A PARTICIPATORY APPROACH TO IPM IMPLEMENTATION

The range of options and best strategy for developing a high quality, participatory approach to IPM for a particular farming system will depend on the management, political, institutional, and other conditions that prevail. Ultimately, the success of a participatory approach will be judged on the extent to which it is able to achieve better outcomes and impact by linking and enhancing **four types of activities**:

Problem specification activities

Problem specification activities involve farmer survey, pest surveys, collection of regional data, the facilitation of problem specification and planning workshops, and project and activity monitoring.

Research activities

Research activities are focused on the specific biological and technical issues associated with a particular pest management problem, including longer-term studies into the population ecology of pest and beneficial species and damage relationships.

Implementation activities

Implementation activities include applied research projects, such as short-term trials of different methods and practices, as well as farmer experimentation and practice, which may or may not involve research scientists.

Communication, extension and training activities

Communication, extension and training activities include the more conventional activities, such as farm visits and demonstration plots, as well as more novel activities, such as farmers' fields schools and computer training and decision support systems.

18.6 COMMUNITY BASED IPM APPROACH–FARMER FIELD SCHOOL (FFS)

Agro-ecosystem analysis is an approach which can be gainfully employed by group of farmers for decision making in IPM

The training approach, which has been used to help farmers learn about IPM is called the Farmer Field School (FFS). The concept of the farmer field school (FFS) as an extension activity was initially developed by FAO, validated by Indonesians and subsequently by India and other countries. FFS gives small farmers practical experience in agroecosystem analysis, providing the tools they need to practice IPM in their own fields. FFS also provides a natural starting point for farmer innovation covering the whole range of issues relating to crop management and plant health. The success of FFS has opened up a new approach to the development of sustainable, small scale agricultural system. The approach places farmers at the center of the IPM, empowering them as the key pest management decision maker.

Quality in FFS will be achieved by motivating farmers to participate actively in experiments and other field studies. Women should be educated in special FFS organized exclusively for women, if need arises.

The central lesson of programme implementation over the past decade is that the complex ecological and social context of IPM argues for a sustained effort combining elements of technological development, adult education, local organisation, alliance building and lobbying. Scientific excellence and adherence to ecological principles provide a strong technical basis for IPM development, and the application of participatory, non-formal adult education methods represent a real advance over models based on information dissemination and the delivery of simple messages. But these in themselves are not enough. The long-term development of a sustainable small-scale agriculture also requires strong farmer groups and the linkages between these groups and the wider community.

From this perspective, IPM Farmers' Fields Schools are not an end in themselves, but rather a good starting point for the development of a sustainable agricultural system in a given locality. The FFS provides a first experience with experimentation based on ecological principles, participatory training and non-formal education methods. Once this foundation has been laid, farmers are better able to act on their own initiatives, and to sharpen their observation, research and communicative skills. Thus the Farmer Field School sets in motion a longer-term process, in which opportunities are created for local leadership to emerge and for new, locally devised strategies to be tested.

18.6.1 Main Features of FFS

i) A season long crop-linked schedule and curriculum stressing analysis and decision making.
ii) Thoroughly trained facilitators working full time on the programme.
iii) A field lab/training plot for learning activities and on going farmers' experimentation.
iv) Follow-up and horizontal communication activities run by farmer participants.
v) IPM certification for successful members.

18.6.2 IPM Kit

For regular field visits, pest monitoring and agro-ecosystem analysis, an insect net and certain items including stationery are needed for participants of FFS. Often, these are placed in a bag which constitute IPM Kit. The details of these accessories and their uses are given in Table-18.

Table-18.1: IPM Kit for the Participants of Farmer Field School (FFS)

Item	*Quantity (approx.)*	*Purpose*
Watch glass (7 mm diameter)	1	Observing insects
Drawing sheets	6	Agro-ecosystem analysis and sketching
Plastic vials with lid (7.5x2.5cm)	5	Collecting insects
Pencil/ball pen	1	Recording/noting
Dissecting needles	2	Segregating insects
Note Book	1	Recording/noting
Drawing colors (Sketch pens)	6	Drawing agro-ecosystem and pest damage with appropriate color
Cellotape	1	Gluing the sheets on boards or other objects
Polythene bags (30x20) cm.	10	Collecting and studying pest and natural enemies
Rubber bands	20	Binding polybags
Camel hair brushes (5no.)	2	Handling insects and drawing
Muslin cloth (1 Meter)	5	Insectarium erection in field
IPM kit Bag	1	Keeping the kit articles

Insectarium is a place where living insects are kept, bred and studied.

18.6.3 Present Status of FFS in India

The concept of Indonesian IPM programme has been widely accepted by the Government of India. This has re-oriented the organizational set up of Plant Protection. Presently, Directorate of Plant Protection, Quarantine and Storage, Government of India, located at Faridabad has established 26 Central Integrated Pest Management Centers (CIPMCs) to cater the need of Indian farmers and catalyze the FFS. About 220 FFS have already been set up and season long training programmes are sponsored by FAO for the Master trainers. IPM in rice, vegetables and cotton have already been initiated. These FFS are equipped with IPM kits likewise in Indonesia. Tamil Nadu Agricultural University has launched IPM in the State in a big way and similar efforts by other rice growing states are needed.

The field data of IPM farmers' field schools in India have proved beyond doubt 50-100% reduction in pesticide use in rice alongwith 6-42% yield increase in rice, as well as 30-51% pesticide use reduction in cotton alongwith 20-26% increase in cotton yield as compared to the non-IPM fields. As a result of the IPM programme there has been significant reduction in pesticide consumption in the country from 61,357 metric tons of technical grade in 1994-95 to 46,195 metric tons technical grade in 1999-00.

SAQ 3

How FFS empowers farmers as decision makers of pest management?

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18.7 IPM PRACTICES

Rice crop is an excellent example to explain IPM. In it, the number of pesticide applications has been reduced to 0.8 per cent per season in case of IPM trained farmers as compared to 2.4 per cent per season with untrained farmers. Hence, rice crop is used as an example to explain the IPM practices starting from study of components to implementation based on agro-ecosystem analysis. This, with little modifications may be replicated on various crops. Also, there is a need to orient all IPM strategies towards bio-control agents, rather than treating bio-control agents just as a potential tool of Integrated Pest Management. Thus, other methods of pest control will not only conserve and encourage natural enemies but also protect environment from devastation.

18.7.1 Government Policy on IPM

The Government of India has adopted IPM as the cardinal principle in plant protection. So far it has banned 23 pesticides, 6 more are likely to be banned shortly, 7 have been refused registration and 10 have been restricted for their use in the country. At present our country has more than 356 bio-control labs. Government of India is helping states to promote pesticide testing labs for monitoring the quality of pesticides.

The focus of the Government approach towards popularizing IPM is on the following nine areas:

i) Training and Demonstration.
ii) Empowerment of farmers.
iii) Comprehensive training of Subject Matter Specialists.
iv) On the field training of village level and other extension functionaries.
v) Promoting the use of biocides and botanical pesticides.
vi) Coordinating the management and supply of other inputs.
vii) Conservation of farmer friendly insects.
viii) Augmentation by field-release of bio-agents, establishment of bio-control laboratories.
ix) Banning/discouraging the use of persistent pesticides like DDT, BHC etc.

18.7.2 IPM Training

The IPM training has two components, first the training of Master Trainers and other extension functionaries, and second, the training of farmers. IPM is an intensive knowledge based approach. Promotion of this approach at village level greatly depends on the availability of trained extension functionaries/ farmers. In order to provide complete knowledge and intensive field training on IPM to the trainers, including the study of agro-ecosystem analysis throughout the crop season, crop based **season-long trainers training** (SLT) programme for subject matter specialists was introduced. During these SLT programmes greater thrust is on field exercises like agro-ecosystem analysis, participatory action research, special topics and how to organize farmer field school in villages, etc. These SLT programmes are run by national and international resource persons and are organized mostly by the Directorate of Plant Protection, Quarantine and Storage, Ministry of Agriculture, Government of India, in different states.

India is a large country having large number of master trainers, subject matter specialists and other plant protection functionaries. It would take many years to achieve the goal of training all of them through only long-term SLT programmes. Keeping this in view short term training courses on IPM in rice, cotton, vegetables, pulses and oilseeds, etc. are designed and organized by the National Plant Protection Training Institute (NPPTI), Hyderabad, for rapid dissemination of IPM approach. The institute provides the state of the art technical know-how on various components of IPM.

The NPPTI organizes regular and short duration training programmes, workshops, seminars on IPM and varied aspects of allied components. Some of the important programmes organized by the institute are as under.

A.	**Regular Courses**	**Duration**
i)	Postgraduate Diploma Course in Plant Protection	10 months
ii)	Pesticide Formulation Analysis	3 months
iii)	Pesticide Residue Analysis	3 months

B. Short Duration Courses

Duration of short-term programmes varies from 3-19 days.

i) IPM in rice
ii) IPM in cotton
iii) IPM in pulses and oilseeds
iv) IPM in vegetables
v) Pest surveillance
vi) Biological control of crop pests
vii) Integrated Weed Management in major field crops
viii) Rodent Pest Management
ix) Disease Management in major crops
x) Mass production techniques in biological control
xi) Safe and judicious use of pesticides
xii) Pesticide application techniques and maintenance of plant protection equipment
xiii) Refresher course on Instrumental Analysis of Pesticide Formulations
xiv) Neem, an eco-friendly pest management tool
xv) Audio-visual Aids and Communication Techniques.

SAQ 4

Which institution in India is playing a major role in dissemination of IPM approach and how?

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18.8 IPM MODULE

" Observation more than books, experience rather than persons, are the prime educators"

A.B. Alcott

What is an IPM Module

The information about pests of a specific crop, pest monitoring, main IPM strategies to be followed for management of pests of a crop is an **IPM module** for the specific crop.

18.8.1 Basic Format of a Module

An IPM module is carefully developed by the experts for every crop. It should include the following information.

A) Major Pests

Pests of National and Regional Significance that include:

Insect Pests, Diseases, Weeds, Rodents, Nematodes

B) Pest Monitoring

i) Agro–Ecosystem Analysis (AESA)

AESA is an approach, which can be gainfully employed by extension functionaries and farmers to analyze field situations with regard to pests, soil conditions, plant health, the influence of climatic factors and their interrelationship for growing healthy crop. Such a critical analysis of the field situations will help in taking appropriate decision on management practices. The basic components of AESA are:

a) Plant health at different stages
b) Built -in-compensation abilities of the plants
c) Pest and defender population dynamics
d) Soil conditions
e) Climatic factors
f) Farmers' past experience

ii) Survey/Field Scouting (You have studied about this aspect in detail in Unit 7 of this course).

C) Economic Threshold Levels (ETLs) -Stage wise. (You have studied about this aspect in detail in Block 1 and Block 2).

D) IPM Strategies

i) Cultural Practices (Including Resistant/Tolerant Varieties)
ii) Mechanical Practices
iii) Biological Control Practices
iv) Chemical Control Measures
v) Weed Management Practices
vi) Nematode Management Practices
vii) Rodent Management Practices
viii) Crop Stage/Pest vis-à-vis practices

You have studied about these strategies in detail in Blocks 3 and 4.

E) Safety Parameters

F) Do's and Don'ts in particular crop pest management

18.8.2 IPM Modules for Rice, Mustard and Pulses

A) Rice

i) Cultivation of resistant cultivars like Vajram, Chaitanya, Nagarjuna, Pratibha, Manasarovar and other high yielding varieties/cultures like Badava, Mahsuri and IET 7251.
ii) Deep ploughing and raking of bunds to kill soil dwelling pest stages and grasshopper egg pods.
iii) Altering planting time, preponing or postponing depending upon pests in the area.
iv) Clipping of seedling tips at the time of transplanting to destroy stem borer and Hispa eggs.
v) Dipping seedlings in chlorpyriphos for protection against stem borer and plant hoppers.
vi) Formation of alleyways in the field for proper air circulation.
vii) Synchronous planting for avoiding food availability to pests for long period.
viii) Balanced use of fertilizers with emphasis on recommended nitrogen dose.
ix) Field sanitation-removal of excess nurseries and weeds from field.
x) Water management-draining of water from field at certain intervals.

xi) Conservation of natural enemies through need-based and selective use of pesticides. Need for pesticides should be determined through regular monitoring and economic threshold level.

B) Mustard

i) Early sowing of less susceptible cultivars to discourage aphid incidence.
ii) Seed treatment to manage incidence of painted bug.
iii) Deep ploughing after harvesting to kill soil inhabiting stages of mustard fly.
iv) Occasional flooding of the field to drown larvae and pupae of mustard sawfly.
v) Regular monitoring of pest incidence and application of selective pesticides if population reaches ETL.
vi) Avoid pesticide use during flowering stage of the crops to protect honeybees. Otherwise apply pesticides, which are safer to bees during evening hours.
vii) Destroy alternate hosts of aphids such as bathua, *Chenopodium album* and other weeds.
viii) Do not delay threshing for longer period after harvest to discourage painted bug.
ix) Burn crop residues after threshing to kill painted bug population.

C) Pulses

i) Cultivation of resistant cultivars: Cultivars such as ICC 506, ICCV-7, ICC-6663, PDE-1, PDE-5, N-37 and GI-1002 of chickpea and ICPL-1, ICPL-2, ICPL-87-1, and Abhay of pigeonpea have shown resistance against podborer, *Heliothis armigera*. Likewise pigeonpea varieties-MA-2, PDE-88-2E, PDE 898-23, ICP-8102-56 and ICP-7946 are resistant to stem fly, *Melanagromyza obtuse*.
ii) Intercropping of pulses with cereals reduces infestation of aphids, leafhoppers, foliage beetles and flower thrips.
iii) Ensure optimum use of fertilizers.
iv) Crop rotation: Crops sharing same pest fauna such as pigeon pea and chickpea should not be grown in a rotation.
v) Conserve natural enemies of pests by resorting to need based application and dictated by ET. Prefer plant origin pesticides such as neem and karanj. These have been found very effective against pests of pulses. Similarly Bt and NPV formulations can also be applied as these do not harm non-target organisms.

In this way pest management packages can be formulated against key pests of other crops also. The adoption of IPM packages will help to reduce dependence on pesticides and pests can be managed in an eco-friendly and sustainable manner.

18.9 ACHIEVEMENTS OF IPM IMPLEMENTATION

Several attempts have been made during the last two decades to implement IPM in different regions of the world. Maximum efforts have been done on cotton, which receives highest amount of pesticides around the globe. In South and North America, many successful attempts have been made for IPM implementation on cotton. In Asian countries, except China, practically very little efforts have been done in this direction. Moreover, the cotton ecosystems are in the crisis phase in these regions, due to excessive use of pesticides. In case of paddy, however, success of IPM implementation is the best example in the tropical developing countries. Both these crops i.e. rice and cotton provide excellent examples for understanding the progress and problems in IPM implementation.

18.9.1 Paddy

Rice is the staple food of at least half of the world's population and is grown in approximately 148 million hectares of land globally. Nearly 90 per cent of this area falls in the Asian region. Major pests attacking the crop in Asia are brown

planthopper, green leafhopper, hispa, stem borer, gall midge, white-backed planthopper, leaf folder and foliage feeding caterpillars.

Major efforts in implementing IPM in irrigated paddy have been carried out in Asia by the United Nation's Food and Agriculture Organization (FAO) through the Inter Country Program for the development and application of Integrated Pest Control in rice in South and South-East Asia. This programme remains one of the best examples of IPM implementation in the tropical region.

In India, the first IPM programme in paddy was started at Cuttack in 1975 covering an area of about 1000 ha in 10 villages. As a result of implementation of a number of cultural practices and ETL based applications of insecticides, the number of applications was reduced from 3-4 to unusually one. Subsequently, an operational research project (ORP) was instituted on integrated control of paddy pests at 6 locations in 5 provinces. This resulted in a reduction in the number of sprays and increased yield of the crop. Economic threshold levels have now been established for all the major pests at several locations in the country. A system of crop surveillance and forecasting for major paddy pests is in operation in several countries including China, India, Indonesia, Malaysia, Republic of Korea, Pakistan, Philippines and Thailand. However, judging from the current low percentage adoption, it appears that there is much scope for increased IPM in almost all the paddy growing areas. This may result in substantial savings to national treasuries as a result of elimination of pesticide subsidies.

18.9.2 Cotton

Cotton is widely grown throughout the tropics, subtropics and warm temperate zones in small to large scale farms under rain-fed and irrigated conditions. In India, about 10.9 per cent area is under this crop. While in many countries, the lint yield varies from 820 to 1623 kg/ha, in India the average yield is at 277 kg/ha which is less than half of the world average (590 kg/ha).

Cotton ecosystem, throughout the world, includes a wide variety of arthropods. The number of species found on the crop may range from a few hundreds to more than a thousand. The major pests in the Asian region include the pink bollworm, spotted bollworm, American bollworm, aphids, jassids, whitefly, thrips, leaffolder and tobacco caterpillar.

The cotton production systems of the world illustrate well the ecological and environmental problems associated with intensive insecticide use. For the purpose of simplicity, the cotton ecosystem may be divided conceptually into three levels:

i) the **physiological level**,
ii) the **population level**, and
iii) the **economic or decision level**.

This simplistic ecosystem is inhabited by two primary groups of organisms: plants and insects and of course many other organisms such as plant pathogens, spiders, etc.

Only sketchy information is available regarding the pest management practices in the main cotton producing Asian countries viz., China, India and Pakistan. In India, the Indian Council of Agricultural Research (ICAR), sponsored a village level IPM project to test and demonstrate the efficacy, practicability and economics of IPM in cotton in Punjab during 1975. Later on, operational research projects (ORPs) on integrated control of cotton pests were started in several states which were executed by State Agricultural Universities.

From 1994-95, Farmers' Field Schools (FFS) have been started in Andhra Pradesh, Karnataka, Maharashtra, Punjab, U.P. and several other states on the pattern of such

schools in Indonesia. The yield increase in paddy and cotton in IPM-areas varied from 6-42 per cent and 21-27 per cent, respectively, as compared to non-IPM area. There was reduction in pesticide consumption to the tune of 50-100 per cent and 35-50 per cent in paddy and cotton, respectively in IPM areas.

Some successful IPM programmes being implemented for different crops in various countries are listed in Table 18.2.

Table 18.2: Successful IPM initiatives in different countries for various crops.

Crop	IPM Components	Pesticide reduction	Savings and other benefits
Rice (Indonesia)	Parasitoid conservation, plant resistance, need based pesticide use, pesticide subsidy abolished	50% number of applications from 4 (1986) to 0.8 (1991). Pesticide production decline by 75%	Subsidy abolition benefit of 67-100 million/yr. Net profit up by 12% .
Cotton (Egypt)	Pheromones for key pest scouting, pest thresholds used	70% reduction nationally, application from 8 to 2-4	35 million/yr reduction in import cost of pesticides
Sugarcane (Pakistan)	Release of parasitoids, avoiding post-harvest burning to conserve beneficials	Aerial application avoided, chemical application effectively removed	Net farmer income up by 9.15% per yr
Soybean (Brazil)	Scouting, natural enemies, need based pesticides especially NPV biopesticide	Reduction in annual applications from 9 to 12	Superior crop yield
Mango (Pakistan)	Shelters for predators, traps for fruit flies, reduced chemical treatment for hoppers	Pesticides eliminated for all pests except hoppers where application restricted to part of the tree. Application reduced from 5 to 1	14 fold reduction in cost of chemical control. Reduced outbreaks of scale insects
Cabbage (Taiwan)	Exotic parasitoids, timing of planting, need-based biopesticide	Spray frequency halved	Substantial reduction in cost.
Banana (Costa Rica)	Economic thresholds developed for moth pests. Fruit bagged for thrips control	Complete removal of pesticide use after several years	Removal of pesticide cost and environmental and health benefits

18.10 SUMMARY

- Farmers are very much used to the application of chemical pesticides. They use pesticides repeatedly on schedule basis and they have been doing this for many years. This practice has to change. It is not easy to change this practice.
- It is necessary to convince the farmer about benefits of IPM.
- A critical analysis on adoption of IPM by farmers shows that knowledge base with farmers on pests and natural enemies is not adequate. Unless organized training and practical demonstrations with active participation of farmers are organized/imparted, adoption of IPM properly, with correct perspective and on large scale is difficult. Therefore the Government of India has adopted the IPM-demonstrations and FFS approach in the country, which is proving. to be very effective.

- The approach of agro-ecosystem analysis using participatory learning and action tools and techniques has been adopted in the IPM and non-IPM fields. This is completely in participatory mode.
- Farmer is the central focus in FFS. Farmers learn to make field management decisions. Major thrust has been given since 1994 to promote IPM approach through FFS on a large scale throughout the country.
- Centre and State Governments are continuing their efforts in organizing a number of field based crop oriented training programmes to train the extension functionaries and farmers on IPM in rice, cotton, vegetables etc. As a result, spectacular achievements have been made during these years. So far, 28459 agricultural extension officers and 2,03,032 farmers have been trained through establishment of 6733 farmers field schools from 25 States and UTs, thereby making a sound foundation for further expansion of IPM activities in the country.
- National Plant Protection Training Institute (NPPTI), Hyderabad organizes regular and short duration training programmes and workshops on IPM.
- An ideal IPM module carries information about pests of a crop, pest monitoring, IPM strategies for pests. IPM modules for various crops are running successfully in our country.
- IPM programmes have been successfully implemented in paddy & cotton. The problems that arise in implementation are also being solved.

18.11 TERMINAL QUESTIONS

1. What are the different approaches to agricultural extension?

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2. Discuss the present status of FFS in India.

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3. Describe the main considerations for effective implementation of IPM programmes.

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18.12 ANSWERS

Self Assessment Questions

1. Refer Sec. 18.2
2. Refer Sec. 18.4
3. Refer Sec. 18.6
4. Refer Sec. 18.7.2

Terminal Questions

1. Refer Sec. 18.4
2. Refer Sec. 18.6
3. Refer Sec. 18.3