INTEGRATED PEST MANAGEMENT: AN OVERVIEW, ASIA AND THE PACIFIC REGION

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Introduction

More has been written on Integrated Pest Control (IPC) or Integrated Pest Management (IPM) during the past decade than on any other aspect of plant protection science. Definitions, concepts, scope, strategies and practical application of IPM have been described and discussed. Research, extension and training in IPM have been deliberated at different fora.

However, it is not intended here to discuss these aspects. The IPM situation, with reference to the agricultural and rural development setting; socio-economic conditions; agricultural patterns; research and extension status and facilities; institutional and organizational arrangements; and administrative, policy and educational systems in non-industrialized countries, particularly in Asia and the Pacific is reviewed. Problems and future trends are examined. New orientations to IPM are suggested with a view to make the IPM an integral part of socio-economic development, and an effective and stabilizing component of production systems.

The rural setting

In view of the limited wording desired, brief comments only on important aspects are made. Some of the points raised are explained through tables.

Most of the Asia and the Pacific Region is characterized generally by typical humid tropical climate. However, some areas have sub-tropical and temperate climates. It is influenced both by continental and oceanic weathers. The regional diversity in topography, geography and weather is matched by the diversity in crops, cropping patterns, cultivation practices and socio-economic standards.

Asia and the Pacific represents more than half of the world population. About 75% of the populations in several countries live in rural areas. There are about 500 million poor, under-nourished and malnourished people in the Region.

Another characteristic of the Region is its large number of small and marginal subsistence farmers and landless labourers who depend on agriculture. Most of the subsistence farmers are in rainfed areas (Table 1).

Cropping patterns, continuous cropping of some crops and favourable climate, all add to the serious and complex pest, disease and weed problems. Rice dominates the Asian part of the region and 75% of it is grown under rainfed conditions. Tubers, coconut and banana are major source of food and income in the Pacific (Table 2).

Major pest problems

Pests, diseases and weeds (referred as pests) have been identified in most countries. In spite of the diversity in location and cropping patterns, there are several common pests, causing enormous losses to individual farmers and to the economy of the countries. There are many pests which are of regional significance (Table 3).

Pests on irrigated rice, some vegetables, certain high value field crops and most plantation crops have received much attention. Pest problems in rainfed crops are not well understood. Little has been done on forest and timber pests. Post-harvest food losses, particularly at the village level, continue to occur.

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Table 1 Population (FAO: 1978)

(Thousand)

Country	Population		Economically Active Population		
	Total	Agriculture	Total	Agriculture	% in Agriculture
Australia	14,249	882	6,076	376	6.2
Bangladesh	79,900	67,417	27,335	23,064	84.4
Bhutan	1,262	1,181	613	574	93.6
Burma	33,550	17,868	13,560	7,222	53.3
China	880,190	540,577	410,739	165,204	64.6
Fiji	612	254	199	83	41.6
India	660,976	427,304	255,546	165,204	64.6
Indonesia	147,083	88,885	50,344	30,424	60.4
Japan	114,898	14,072	59,136	7,372	12.5
Kampuchea	8,860	6,632	3,445	2,579	74.9
Korea, DPR	17,078	8,125	7,579	3,606	47.6
Korea, Rep	36,735	15,090	13,819	5,676	41.1
Lao	3,546	2,653	1,704	1,275	74.8
Malaysia	13,209	6,395	4,479	2,210	49.3
Mongolia	1,577	811	592	305	51.4
Nepal	13,528	12,560	6,473	6,010	92.8
New Zealand	3,107	303	1,246	121	9.7
Pakistan	77,732	42,351	21,279	11,593	54.5
Papua New Guinea	2,927	2,431	1,468	1,220	83.1
Philippines	46,374	21,902	16,133	7,660	47.5
Sri Lanka	14,871	7,982	5,118	2,747	53.7
Thailand	46,402	35,410	20,938	15,978	76.3
Vietnam	46,455	33,369	21,471	15,423	71.8

Plant protection services

In the Region, there is no uniform organizational pattern for the plant protection services. Plant protection service in some countries is a separate entity and in others, it is a part of the research and/or extension wings under the Agriculture Departments. Plant quarantine service and prevention of post-harvest losses at the farm level are the functions of the plant protection service. Pesticide control, implementation of plant protection, plant quarantine and pesticide laws and related matters are also generally with the plant protection service.

Extension in plant protection is carried out through the general agricultural extension service and/or plant protection service. In some countries, specialists in plant protection are assigned at the district, provincial or regional levels.

Plant protection research is generally carried out by the entomology, plant pathology, weed control and pesticide sections of the departments of agriculture, agricultural universities and research institutes. Research is also carried out by some educational institutions and industrial undertakings (Fig. 1).

Often the lack of coordination of research programmes at the national level does and may lead to duplication of efforts and in individuals pursuing their own research interests.

Table 2 Crop production in Asia and the Pacific (FAO 1978)

Crop	Region		World	
	000 Ha.	000 Mt.	000 Ha.	000 Mt
Rice	129,975	342,328	145,130	376,448
Wheat	70,714	104,329	232,076	441,474
Maize	26,691	52,414	117,767	362,971
Millet	35,302	24,539	55,019	37,699
Sorghum	25,649	24,309	51,911	69,117
Potato	2,540	28,184	18,167	272,975
Pulses	52,203	39,784	82,870	62,008
Roots & Tubers	17,222	166,560	47,220	522,947
Chick Peas	9,623	6,212	10,481	6,889
Soybeans	16,153	14,968	52,859	80,232
Groundnut	11,217	10,835	18,919	18,877
Castor Beans	779	410	1,418	921
Beans Dry	17,488	9,952	29,615	17,224
Sesamum Seed	4,126	1,105	6,332	1,974
Sunflower	320	274	11,147	12,705
Seed Cotton	14,868	11,938	32,980	37,792
Linseed	2,086	585	5,509	2,758
Palm oil	–	2,546,300	–	4,029,816
Cabbages	734	11,536	1,590	32,098
Cauliflower	161	1,542	321	4,283
Sugarcane	6,636	352,150	13,881	781,291
Coffee	738	390	9,250	4,583
Tea	1,205	1,378	1,607	1,833
Tobacco	1,976	3,231	4,419	5,710

Control measures

In most countries, there are no national or approved recommendations for guidance. This has resulted often in the over-use of pesticides and in the introduction and application often of wrong and undesirable chemicals.

Control measures, consisting mainly of the use of pesticides, have been used intensively on rice in limited areas in some countries; vegetables; some fruit crops; plantation crops (rubber, tea, coffee, oil palm); and cotton. Some other crops, such as potato, groundnut, sugarcane and tobacco also receive pesticide treatments on a large scale. Large quantities of pesticides are used against locust plagues and some epiphytotics. In some countries, substantial quantities of pesticides are used for fumigation of imported and exported plant materials.

These conditions consequently affect IPM programmes. Yet fortunately the overall crop acreages receiving pesticide treatments are very insignificant. In most countries, only 2-10% of the total areas needing protection have been covered and in some others about 25-40% of the areas under certain crops receive treatments.

The difficulties in the availability of selective pesticides and on time application considerably affect the overall pest management programmes. Utilization of local raw materials and increased use of

Table 3 Pests, diseases and weeds of major significance in the region

Cereals	Leaf- and planthoppers, brown planthopper, stem borers, gall midge, swarming caterpillars and armyworms in outbreaks, tungro, bacterial leaf blight, blast, sheath blights on rice; stem borers, particularly, pink borer on coarse grains; shoot fly and loose smut on sorghum; stem borers, corn ear worm and downy mildew on maize; ergot on pearl millet; rusts and weeds on wheat.
Pulses	Green caterpillar, hairy caterpillars, pod borers, Prodenia; wilt and blight of chick peas and pigeon peas; powdery mildew of peas.
Oilseeds	Aphids, semilooper, hairy caterpillars; leafspots and rosette of groundnut; rust and wilt in linseed; phyllody in sesame.
Fibres	Jassids, bollworms, blackarm and anthracnose in cotton; semilooper, Diacrisia, Apion and mites and stem rot in jute; blister beetle in kenaf.
Tea and Coffee	Red spider mites and green bug; coffee rust; blister blight and termite on tea.
Sugarcane	Stem and top shoot borers.
Rubber	Leaf blight and bark disease.
Tobacco	Aphid, Prodenia, Heliothis, damping off and powdery mildew.
Coconut	Caterpillars, red palm weevil, rhinoceros beetle, cadang-cadang and similar diseases, leaf miner.
Fruits	Fruitflies, jassids, aphids, caterpillars, mealybugs, leaf miner, powdery mildews, canker, anthracnose, scales, soft rots, viruses, greening and decline of citrus.
Potato	Jassids, cutworms, aphids, early and late blights, viruses (golden nematode and black wart very limited in distribution).
Vegetables	Aphids, jassids, caterpillars, Plutella, bugs, viruses, damping off, powdery mildews, bacterial wilt.
Stored products	Several species of insects, moulds, rodents.
Many crops	Several species of rodents: (*Bandicota bengalensis, Mus musculus, Rattus exulans, R. rattus, R. norvegicus, Rattus rattus mindanensis, R. brevicaudatus, R. jalorensis*) Birds: (*Lonchura* spp. *Passer* spp. *Ploceus* spp.) Weeds: Several monocot and dicot species. Nematodes: Several species Grasshoppers and locusts Heliothis complex Hairy caterpillars; Amsacta, Diacrisia.

botanical pesticides have not received much encouragement.

Other pest management practices—cultural practices, resistant varieties, bio-control agents, have been used and manipulated to some extent. The modern concept of pest management and its field application are gaining ground. Some countries have started IPM programmes in a few crops, particularly rice.

Pest problems associated with high yielding varieties

Introduction and intensified cultivation of high yielding varieties have created new and serious pest problems.

Generally, high yielding crop varieties appear to be more attractive to pests and suffer more severe damage. Pests hitherto unknown or of minor significance have assumed major status. Examples are the brown planthopper and rice gall midge on rice; root grubs on groundnut and shoot fly on sorghum. New biotypes and races of pests are emerging at a faster pace. Intensive use of

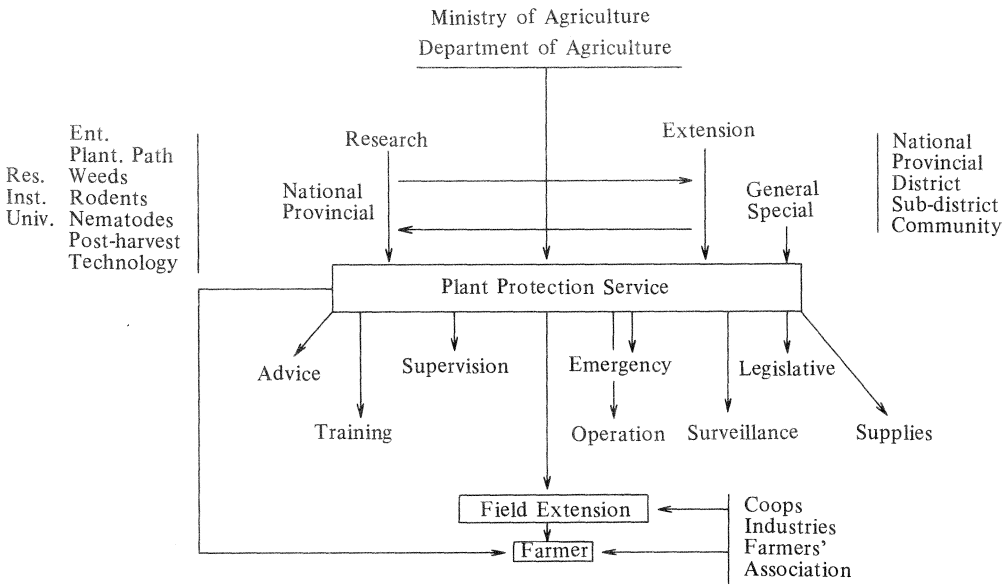

Fig. 1 Plant protection organization (Diagrammatic representation)

pesticides has induced resistance in several insects.

This has created a highly complex situation and is a serious constraint to increasing production in several areas.

Surveys and surveillance

Surveillance, forecasting and monitoring are practised, generally on an *ad hoc* basis. In the Republic of Korea it is in operation for rice. Limited simple surveillance programmes are operational for rice in India, Malaysia and the Philippines. Surveillance programmes have also been found beneficial in some plantation crops.

Trickle-down effects

Benefits of development and breakthroughs in agricultural technology have not reached the majority of small farmers. Where modern technologies and inputs have been introduced, they have not been very useful to small farmers because they were either inappropriate or uneconomical. Several institutions, credit facilities, extension services, information, advisory services, inputs and plant protection measures do not reach most small farmers and seem to become inefficient operationally. Both the delivery and receiving mechanisms are poorly developed, inadequate and inefficient, particularly at the small farm level.

Yet, 75% of farming families are small and poor farmers.

Appropriate technology

Development of appropriate technologies and methods that can be adopted by the small farmer under his farming system is most urgent. New approaches to the traditional methods or their improvement that would fit into the socio-economic setting of the small farmer must be developed. Thus, approaches to research, education, development, training, extension, infrastructure, credit, inputs and other services need to be reoriented and redesigned to meet the special situations of small farmers.

Similar approaches should also be made towards developing rainfed agriculture on which majority of small farmers depend for a living.

Training

Several countries organize training in plant protection and quarantine on an *ad hoc* basis. India and the Philippines have established permanent facilities for providing practical training in different aspects of plant protection. In India, two courses in general plant protection, a 3-month course and a 10-month diploma course, are offered at the Central Plant Protection Training Institute, Hyderabad. Participants from the regional countries receive training at this Institute. Thailand also has recently started short term regional training courses.

Many countries take advantage of training programmes offered through bilateral sources also.

The *ad hoc* training programmes are useful to meet a specific need, but do not provide a continuity. Neither are they well designed nor properly implemented, mostly due to lack of basic facilities.

Also training in plant protection must be practical and should emphasize on-the-field rather than under-the-roof training.

Problems of IPM

Since man started cultivation of crops, pest control has been in practice. Varieties that were not severely attacked and survived in the field were used for the next season. Cultivation practices were modified, where feasible, to reduce pest losses. Natural enemies were encouraged where these were recognized useful. Physical measures to reduce infestations were practised. Where available, treatments including soaking seed in salt water, powders of metallic salts or plant roots and leaves or their extracts were used to prevent and reduce pest infestation.

This was IPM in those days.

It is the same strategy today except that we have more precise knowledge of crops and their enemies. We have better techniques and more information on control factors. We know more about the inter-relationships of crops and pests, pests and their natural enemies and their interactions. We have advanced tremendously in understanding the role of the different control factors and their interrelationships and interactions, particularly pesticides and environment. It is a coordinated approach.

IPM now is a science.

Yet the practical application of IPM, as it is understood today, is limited to a few selected crops in some areas.

The IPM as practised in highly developed and intensified systems and under controlled conditions of agriculture is complex. It involves a great deal of reliable and coordinated information on biology of pests and their natural enemies and their interactions, economic injury levels, climatic conditions, specific pesticides and surveillance and forecasting.

In spite of this kind of information being available, there are serious constraints to IPM programmes over large areas. These are biological, agricultural, socio-economic, educational, infrastructural and human (Table 4).

The problem becomes much more complex under the existing agricultural and socio-economic conditions in most non-industrialized countries. The millions of small farmers with an average of 0.4-2.0 hectare of land holdings, with little assured production inputs, uncertain weather conditions, growing several crops at the same time and with inadequate structural and organizational arrangements and different socio-economic standards will be confounding the approach and the practice of IPM.

Moreover most of the IPM programmes have been developed only for a major insect pest of a crop. But most crops suffer from more than one major insect pest. In addition, there are serious diseases, and weeds which affect crops.

Therefore, the IPM requires a total picture approach involving the agricultural production systems as such (Table 5).

One advantage in these non-industrialized countries is that large quantities of pesticides have not

Table 4 Emerging problems

Escalating Population
Distribution – rural-urban ratio;
500 million poor people
Socio-economic Disparities
Rich-poor gap; tenancy; inputs availability, etc.
Equitable Incomes
Input-Output Ratio
Economics, profits, production increases – No profit increases
Ad-hoc New Introductions
Country location tests
New pest problems
Old ones becoming serious
HYV's – Complex Plant Protection Problems
Intensive use of pesticides
Increased costs
Ecological shifts in pests
Environmental problems
Health hazards
Resistance
Residues
Policy Changes – Shifts in Approach
Prevention of Post-harvest Losses
Drying
Storage
Infestation control
National policy of storage management
Information Gap
Outbreaks
Surveillance
Extension
Research/Extension
Input Gaps
Pesticides (selective)
Biocontrol agents
Plant protection machines
High prices
Timely availability
Quality control
Standardization
Exchange and interchange of information

been used extensively. Still the natural control factors appear to be operating effectively. Farmers rely heavily on varieties, cultural practices and climate. But the main problem is that they are not well informed of the factors triggering pest populations and interactions with and in between the different control factors.

Under these circumstances, the best approach to IPM is to institute a simple surveillance programme, emphasize the cultivation of resistant or tolerant varieties and advise farmers on the role of natural control factors as well as on the cultural and climatic variables that affect pest populations.

Table 5 Farmer - the object reorientation–future trends

IPM – Integral Part of Agricultural and Rural Development

Consideration of Socio-economic Setting

Increased and Stable Productivity

Small Farmer Problems
- Research – development
- Extension
- Minimum inputs technology

Rainfed Agriculture
- Orientation of research
- Integrated approach to farming systems

Appropriate Technology

Institutional Arrangements

Integration – Research/Extension/Development
- Training
- Practical
- On farm – not under roof

Greater Use of Non-Chemical Control Agents
- Resistant varieties
- Interactions of control agents
- Biocontrol agents
- Cropping patterns
- Cultural practices
- Linkages with crops

Problem Oriented Programmes
- Field observations – an essential item
- Feed back

Greater Attention to
- Weeds
- Rodents
- Diseases
- Nematodes
- Other pests

Greater Coordination of
- National efforts/policies
- Bilateral
- Multilateral/international

Self Reliant Programmes
- Policy issues
- Participation of beneficiaries in programming/implementation
- Technical Cooperation among Developing Countries (TCDS)

Also farmers must know what pesticides to use and how and when. This is very important.

While research and laboratory experimentation are necessary, for a well coordinated IPM programme, the basic approach to begin with should be to tackle the problem at the field level and develop progressively. More emphasis should be placed on field observations. The farming families and communities should be involved in the planning and operation of IPM.

Therefore simple techniques coupled with adequate practical education with infrastructural support must be the basis for IPM. As we gain experience and obtain feed back from the field, the emerging problems can be solved through research and through improvement of methods and techniques.

Trends and orientation in plant protection

IPM is in different stages of growth in different countries. However, there are many common problems and similarities between them and from these emerge certain common trends for the Region.

IPM, including plant quarantine, is, and must be considered as an integral part of general agricultural development. Its development and application should not be viewed in isolation.

In most countries, the benefits of plant protection measures, generally have not reached the majority of small farmers and have not been applied to many crops in rainfed areas. Greater attention, therefore, must be given to these two important sectors.

The application of IPM inlcuding the cropping patterns and systems, cultural practices and biocontrol agents, must be emphasized. Greater attention should be given to microbial agents.

However, its success would depend on its appropriateness to the local situations and the management of pesticides.

Establishment of thresholds (economic thresholds, treatment thresholds and control thresholds) should take into consideration the cost-benefit relationship. It is advisable to develop flexible thresholds.

Rapid introduction and expansion of high yielding varieties, without much local adaptability trials in respect to pests, have created serious pest problems and severely affected the production programmes. The policy of large scale introductions of high yielding varieties, therefore, should be carefully reviewed.

The future trends in pesticide usage will be greatly influenced by the growing concern for greater protection of environment including human and animal health, wildlife, pest resistance and pesticide residues. To a large extent, the success of IPM depends on the wise use of pesticides in combination and/or in conjunction with other control factors.

The region is rich in some of the botanicals. Therefore, interest in the development of phytochemicals as pesticides must be revived and should receive urgent attention of governments, international organizations and the pesticide industry.

The current approaches to research, training, education, development and extension should be re-oriented to be more applicable to the local needs and situations.

Regular, well planned and meaningful training programme, particularly at grassroot level, should receive the highest priority in all the plant protection programmes. Emphasis must be on on-the-field training rather than under-the-roof training.

Simple and practical surveillance programmes need to be developed as an essential part of IPM.

Greater attention is required in most countries to measures to prevent and reduce losses at the farm level, including storage, pest infestation and rodent damage. This should include the improvement of indigenous methods of storage, storage structures and pest control methods. Post-harvest management of produce is as important as pre-harvest protection of crops.

Forest and timber protection must receive greater attention in the Region.

Regional cooperation in solving common IPM problems should be fostered through national and

international action programmes. The Asia and Pacific Plant Protection Commission should be further strengthened and the needed resources must be made available. It should play a greater and key role in policy and programme development coordination and implementation of regional activities (Fig. 2).

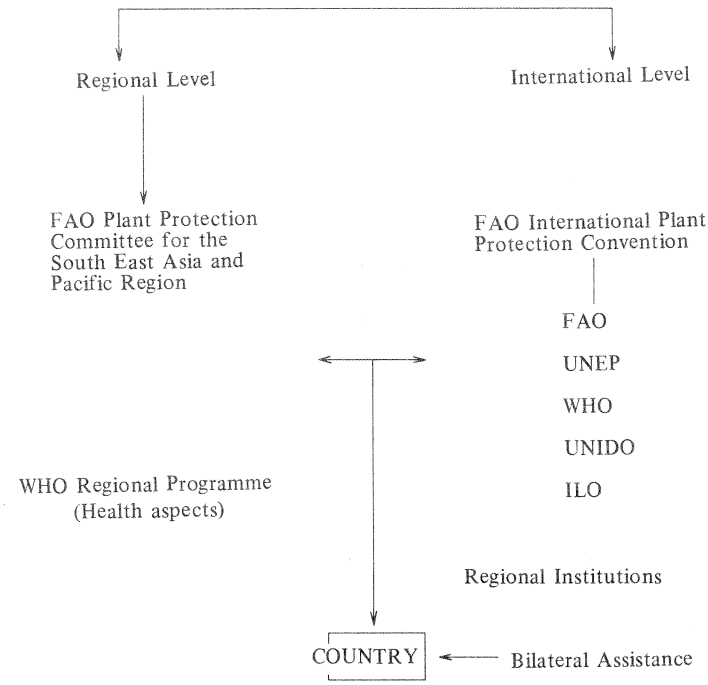

Fig. 2 International cooperation in plant protection