ROLE OF PESTICIDES IN FOOD SECURITY

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BRIEF ABOUT IPFT

- **Institute of Pesticide Formulation Technology (IPFT) was Established in May, 1991 under the Department of Chemicals & Petrochemicals, Ministry of Chemicals & Fertilizers as an autonomous institution.**
- **IPFT has established a healthy rapport with the pesticides industries and has been able to successfully transfer technology for safer, efficient and environment friendly formulations.**
- **IPFT consists of three major Divisions –**
  - **Formulation Division**
  - **Bioscience Division**
  - **Analytical Division**
- **The Institute carries out In-House, Grants-in-Aid and Industry Sponsored Projects.**
- **Recognized by CIB/RC for the generation of data for registration.**
- **Accredited as per ISO/IEC – 17025 (2005) for the testing of Pesticide and CWC Related Chemicals.**
- **BIS Recognized/Certified for Pesticide Testing as per IS Specifications.**
- **Website : www.ipft.gov.in**

INTRODUCTION

- **Agriculture is the backbone of the Indian economy.**
- **Ensuring food security for more than 1.21 bn Indian populations with diminishing cultivable land resource is a Herculean task.**
- **This necessitates –**
  - **Use of high yielding variety of seeds,**
  - **Balance use of fertilisers,**
  - **Judicious use of quality pesticides,**
  - **Education to farmers and**
  - **Use of modern farming techniques.**
- **The production of Indian pesticides industry has almost remained stable at 82000 - 85,000 MT during FY 09 - 10.**
- **India is one of the most dynamic generic pesticide manufactures in the world with approximately 60 technical grade pesticides being manufactured indigenously by around 125 producers consisting of large and medium scale enterprises (including 10 MNCs) and more than 500 pesticide formulators spread over the country.**

- **Per hectare consumption of pesticide is low in India at 600 grams when compared to the world average of 3000 grams.**

- **Low consumption can be attributed to –**
  - **Fragmented land holdings,**
  - **Lower level of irrigation,**
  - **Dependence on monsoons,**
  - **Low awareness among farmers about the benefits of usage of pesticides**

- **India, being a tropical country, the consumption pattern is also more skewed towards insecticides which accounted for 52% of the total pesticide consumption in FY10.**

- **Rice is the highest pesticides consuming crop in India followed by cotton.**

History of Pesticides – Indian Perspective

- The use of modern pesticides started in the beginning of the 20th century.
- Till 1947, the farmers were doing subsistence farming and most of them followed traditional practices to minimize the menace of insect pests and diseases.
- During 1960s, the total pesticide market in India was less than Rs. 50 crore annually.
- In 1970s the size of Indian pesticide industry was approximately Rs. 100 crore.
- The decade 1970 – 80 saw a significant change in pesticide market, with a number of new products and the market grew to almost Rs. 400 crore annually.
- In 1981 – 90, a large scale expansion of pesticide industry took place in the country. By the end of decade the total market was almost 1500 crore.
- 1991 – 2000 was a decade of considerable growth of export business. By the end of 2000, the domestic pesticide market grew to Rs. 2500 crore and export market to almost 1000 crore.
- The decade (2001 – 2010) was marked with the introduction of a number of new pesticides, large scale expansion of bio-pesticides and introduction of GM crops. The present domestic pesticide market is about 75000 crore and export is worth Rs. 3800 crore.

PESTICIDE CONSUMPTION IN INDIA

- **Pesticides are the last input in the agricultural process but are important for the sustainable development of agriculture and food security.**

- **Despite the fact that judicious use of pesticides can prevent crop losses and provide economic benefits to the farmers, pesticide consumption in India is limited to about 25% of the arable land.**

- **As on 17/06/2011, 230 pesticides are registered with CIB under the Insecticide Act 1968.**

- **It takes more than Rs. 500 crore investment and 5 to 10 years time to introduce a new molecule for use in the field. It is a cumbersome process involving –**
  - **Synthesis**
  - **Characterization**
  - **Development**
  - **Formulation**
  - **Dat Generation**
  - **Registration**

- **In developed countries the usage of pesticides is 20 times more than India; their crop yields are much higher than ours.**

- **The pesticide consumption (kg/ha) in different countries is as follows.**

Country	*Consumption (kg/ha)*
Japan	11.00
Netherlands	09.40
Republic of Korea	06.60
France	04.60
Italy	04.17
Germany	02.50
Austria	02.40
USA	02.25
Pakistan	01.30
India	00.57

Consumption of Pesticides by States of India

- **The consumption of pesticides shows a large variation across the states of the country.**
- **The consumption in 2009 – 10 is shown below.**

States	*Consumption (MT)*	*States*	*Consumption (MT)*
UP	9563	Karnataka	1647
Punjab	5810	Orissa	1588
Maharashtra	4639	AP	1015
Haryana	4070	Bihar	828
Rajasthan	3527	MP	645
Gujarat	2750	Kerala	631
TN	2335	HP	328

Crop-wise Usage of Pesticides

Crop	*% Usage*	
	2001-02	*2006-07*
Cotton	35	27
Paddy	23	29
Wheat	08	08
Vegetables	08	09
Fruits	06	06
Pulses & Oilseeds	07	09
Chillies	04	04
Others	10	09

PESTICIDE AND FOOD SECURITY

- **Judicious use of pesticides can improve land fertility and ensure food security for the Indian population despite diminishing cultivable land resources.**
- **The country approximately loses 18 per cent of the crop yield worth Rs 900 billion due to pest attack each year.**
- **Of the 40,000 different types of insects about 1,000 have been listed as potential pests of economic plants, 500 pests have caused serious damage at some time or the other and 70 have been causing damage more often.**
- **Therefore, pesticides have been recognised as essential in increasing the agricultural production by preventing crop losses before and after harvesting.**
- **The use of pesticides helps reduce the crop losses, provide economic benefits to farmers, reduce soil erosion and therefore, ensure food safety.**
- **Pesticide ban threatens world food security.**

Major Classes of Pesticides

- **Insecticides (kill insects)**
  - **Organochlorines (DDT, methoxychlor, aldrin, dieldrin, endrin, heptachlor, kepone, lindane, chlordane)**
  - **Organophosphates (Malathion, parathion, guthion, diazinon, TPN, TOCP)**
  - **Carbamates (Sevin (carbaryl), Baygon (propoxur), Temik (aldicarb))**
  - **Synthetic Pyrethroids (based on pyrethrums – from chrysanthemum flowers)**

- **Herbicides (kill plants) (Silvex, 2,4-D, 2,4,5-T)**
- **Fungicides (kill fungus) (Sulfur, copper sulfate, Hexachlorobenzene, Pentachlorophenol, Dithiocarbamates)**
- **Rodenticides (kill rodents) (Phosphorous, Thallium, Zinc phosphide)**

- **Acaricides, Avicides, Bactericides etc.**

PESTICIDE FORMULATIONS

Important Definitions

- **Active Ingredient (Ai)** - the actual chemical in the product mixture that controls the pest.

- **Inert Ingredient** - other materials added with the AI when the product is formulated such as water, emulsifiers, solvents, dry carrier material stabilizers, dye, surfactants

- **Adjuvant** - product added to spray tank to assist pesticide in its application.

- **The primary objectives of Formulation Technology are to optimize the biological activity of the pesticide, and to give a product which is safe and convenient for use.**

- **However, because of the wide variety of pesticide active ingredients which are available, many different types of formulations have been developed depending mainly on the Physico-chemicals properties of the active ingredient.**

- **In the past, most formulations were based on simple solutions in water (SL), Emulsifiable Concentrates in a petroleum based solvent (EC), or dust (DP) and Wettable Powders (WP).**

- **The presence of petroleum based solvents in EC formulations and dusty powders in DP and WP formulations can lead to safety hazards in use and a negative impact on the environment.**

- **Most governments and regulatory authorities are therefore, demanding formulations which are user and environment friendly in nature.**

- **There is also growing concern on the pesticide residues in food crops.**

- **These demands and concerns for the environmental contamination and food safety have put up increasing pressure on the development of improved formulations and adjuvant technologies.**

TYPES OF FORMULATIONS

- Formulations are classified as Dry or solid Formulations and Liquid Formulations on the basis of their physical state in the container at the time of purchase.

- A formulation can contain more than one active ingredient and many have to be further diluted with an appropriate carrier (e.g., water) prior to use.

SOLID FORMULATIONS

- **Solid formulations can be divided into two types: ready-to-use; and concentrates, which must be mixed with water to be applied as a spray.**

- **Three of the solid formulations (dusts, granules, and pellets) are ready-to-use, and three (wettable powders, dry flowables, and soluble powders) are intended to be mixed with water before use.**

LIQUID FORMULATIONS

SOLUTION

- Active Ingredient either liquid or dry substance
- Truly dissolves in water just like sugar or whiskey in water
- Usually transparent

SUSPENSION

- Solid particles suspended in a liquid like hot chocolate
- Active Ingredient (high %)
- impregnated onto Dry Carrier and mixed with an
- Emulsifier (slick, soapy)

EMULSION

- One liquid dispersed within another liquid
- like milk
- Ai is dissolved in oil (oil/ai droplet) and mixed with an emulsifier
- Ai/Oil mixture is suspended in water forming a white emulsion

NEWER TECHNOLOGIES

AEROSOLS

- Ready-to-use
- Little active ingredient
- High drift potential
- Require highly specialized equipment
- Difficult to confine
- Respiratory protection needed

MICROENCAPSULATION

- High toxicity Ai in encased formulation

NANOTECHNOLOGY

SELECTION OF FORMULATION

- **Evaluate advantages and disadvantages**
- **Right application equipment**
- **Can the formulation be applied when and where it is needed?**
- **Will the formulation reach the target pest and be there long enough?**

IMPROVISATION IN PESTICIDE USE

- Many of the harmful effects from applying chemical pesticides are observed not so much from pesticide use but its misuse.
- This includes over application, repeated application and poor application technology.
- It was suggested therefore, that rather than focussing on new technologies such as biological control and IPM, it might be more effective to make sure that pesticides are used properly.
- This includes the improvement of application technology and sprayers, especially for low-income farmers. The condition and quality of the sprayer, and especially the nozzle, are very important.
- If the application technology is poor, farmers tend to apply far too much pesticide.
- Developments of newer molecules which could be easily biodegradable, target-specific with very low mammalian toxicity.

- **Whether to go for bio-based products or for using synthetic chemicals for protecting the crops.**

- **A new horizon of analytical chemistry was evolved as pesticide residue analysis to judge the residue level of these harmful chemicals in food grains.**

- **Researches were carried out to develop safer molecules which could undergo photodegradation, microbial degradation as well as chemical degradation leaving very less amount of residues in the environment.**

- **The prime motto for this development is to give protection to the crops along with safety to the natural enemies of different pests as a whole safety to environment.**

FUTURE CHALLENGES

i) To develop more and more new molecules having
   - Low mammalian toxicity
   - Less soluble in water
   - Less leaching potential

ii) More discoveries in macromolecular pesticides

iii) More innovations required for new neo-nicotinoids

iv) More biotechnological innovations to be directed in transgenic plants

v) Innovative application technology

vi) Minimization of residue load in ecosystem

vii) Research on bio-control agents

viii) Research on bio-pesticides

ix) Better pesticide residue monitoring mechanisms

CONCLUDING REMARKS

- **Close Collaboration between Industry and R&D Institutions**
- **Govt. support to the Industry and R&D**
- **Urgent need for fast track mechanism for introducing new pesticide technology**
- **Registration Process**

India

Thank You