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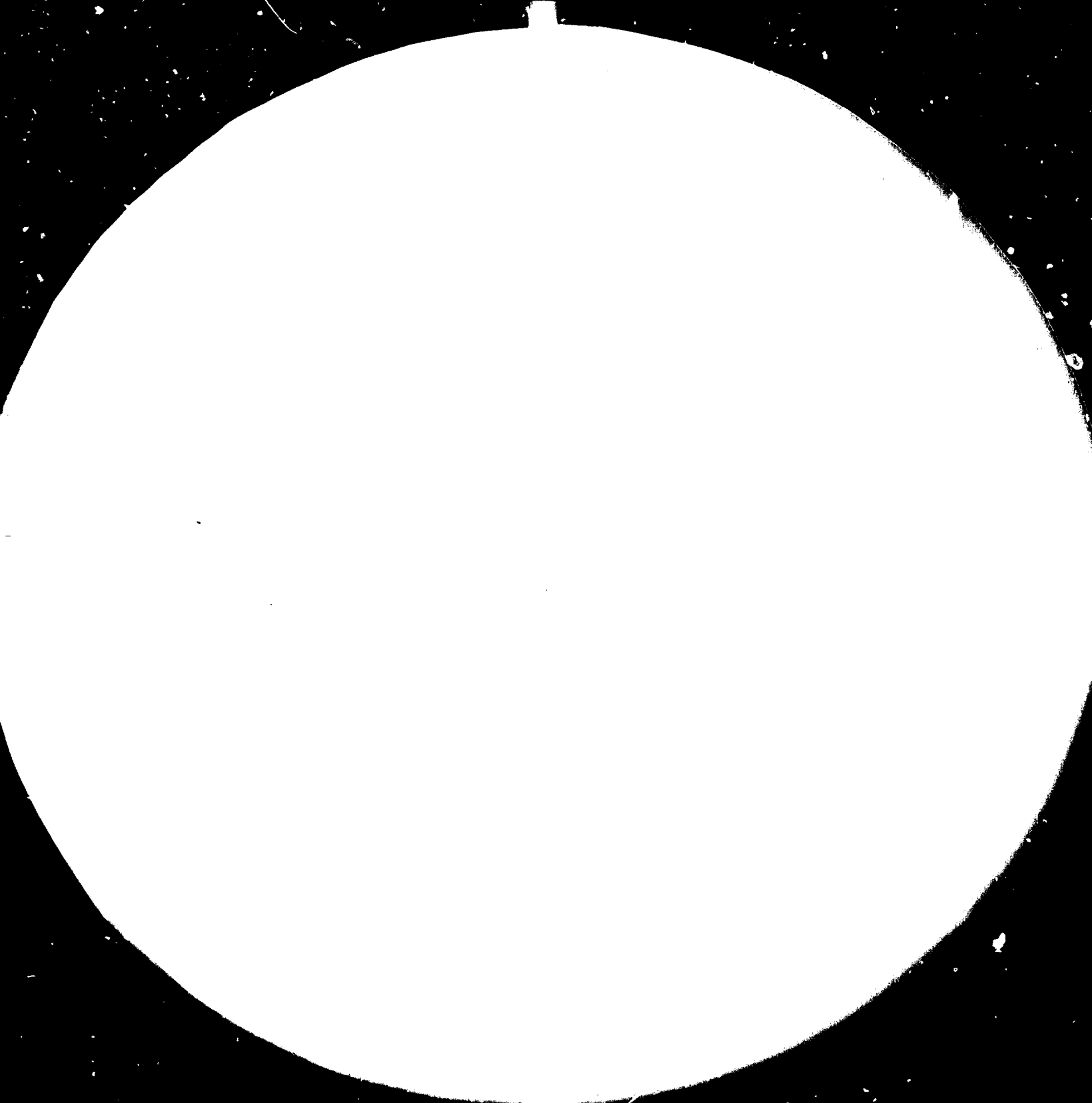

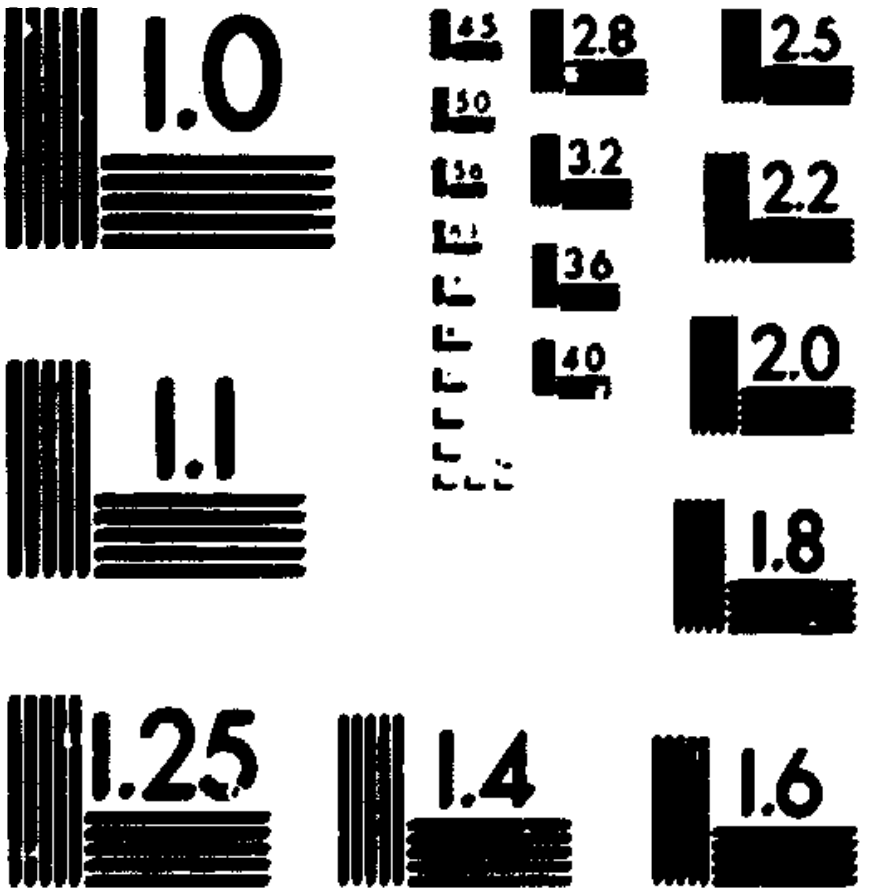

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Regional Network for the Production,
Marketing and Control of pesticides
in Asia and the Far East
DP/RAS/82/006

Regional Workshop on the Formulation
of Pesticides

New Delhi, India 6-10 February 1984

[REPORT*. (Regional workshop on pesticides formulation).]

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*Prepared for the Member Countries of the Network and other participating countries of the Region. This document has been reproduced without formal editing.

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CONTENTS

INTRODUCTION

1. The International Workshop on Pesticide Formulation organized under the auspices of the Regional Network for Production, Marketing and Control of Pesticides in Asia and the Far East was held on February 6-10, 1984 at the India International Centre, New Delhi, India.

2. The Workshop was attended by 10 delegates from 9 participating countries of the Regional Network and the ESCAP Region: Bangladesh, India, Indonesia, Korea, Nepal, Pakistan, Philippines, Sri Lanka and Thailand. The Workshop was also attended by the Regional Network Coordinator and one member each from UNIDO, ESCAP and WHO. The delegates from Afgahnistan was not present. The list of participants is attached as Appendix I of the report.

3. The Workshop was intended to:

   a) Identify specific areas in pesticide formulation technology where developmental efforts are required;

   b) Encourage the utilization by local formulation plants of raw materials available in the region like carriers, solvents and inerts;

   c) Determine the scope of research and development in formulation technology;

   d) Plan specific activities in the field of pesticide formulation, where regional cooperation can be strengthened.

   As a result of the deliberation, a workplan will be prepared for future activities of the Sub-network on Formulation operating under the Regional Network Project.

OPENING OF THE WORKSHOP

4. The Workshop was inaugurated by Mr. Rama Chandra Rath, Honorable Minister of State for Chemicals and Fertilizers, Government of India.

   Quoting the Prime Minister of India, The Minister said that success is to be achieved not through curtailing the use of pesticides but by organizing their proper use through development of safe products. He emphazised the utilization of locally available raw materials and cooperation and inter dependence among the countries of the region. He also acknowledged the role of UNDP and UNIDO in undertaking the first regional cooperation programme to promote development of the pesticide industry and the safe and effective use of pesticides especially in depeloping countries in this part of the world.

5. Mr. M. J. Priestley, the Resident Representative of UNDP, New Delhi, in his introductory address focussed on the assistance provided by UNDP and stressed the importance of pesticides to enchance food production in India and the region.

6. Mr. S. R. Panfil,Senior Inter-Regional Adviser of UNIDO, introduced the objectives and activities of the Regional Network project.

7. Mrs. Cecilia P. Gaston, Regional Network Coordinator, in her welcome address dealt with the purpose of the Workshop.

8. On behalf of the host organization, Dr. Ram S. Hamsagar, Chairman and Managing Director, Hindustan Insecticides Ltd. and National Coordinator of the Network Project, elaborated on the local pesticide formulations and their relevance to the developing economies. He laid special emphasis on the R&D efforts by the developing countries themselves to meet the technology needs of tomorrow's pesticides.

TECHNICAL SESSIONS

9. The workshop consisted of nine Technical Sessions covering the different aspects of pesticide formulation technology. The details of the programme are as per Appendix II.

TECHNICAL SESSIONS

10. Country papers highlighting the current status of the pesticide formulation industry were presented by the respective delegates.

BANGLADESH

11. In 1979 the Government of Bangladesh handed over the pesticide industry to the private sector except the National Pesticide Testing Laboratory, which was set up in 1965. The only technical product being manufactured in the country is DDT.

INDIA

12. The paper presented the latest data on requirements, production and consumption of pesticide formulations. It also gave details of R&D activities relating to development and technology for pesticide formulations currently being undertaken in the country including the activities of the Pesticide Development Programme, India, which is being implemented with assistance from UNDP/UNIDO. The paper also listed out possible areas for future development of formulation industry in India

and offered areas where India can contribute and cooperate with other countries of the region in the field of formulation technology.

INDONESIA

13. The paper highlighted on the increased use of pesticides in recent years mainly because of subsidized supplies through the BIMAS/IMMAS programmes of the Government. The present pesticide formulation production capacity is sufficient to meet the requirements till 1989. Even though many of the raw materials required for formulations are available locally, these have not been fully exploited. The immediate objective for R&D is utilization of locally available raw materials.

KOREA

14. With the advancement of chemistry and technology, pesticide industry in Korea has made significant improvements, especially in the fields of technical synthesis, formulations and quality control.

NEPAL

15. Pesticide industry in the country is comparatively young though the commencement of the use of pesticides goes two decades back. The first pesticide company was started in 1972 in the private sector followed by the pesticide company in the Public Sector in 1977. A Pesticide Board has also been set up governing various aspects of the trade.

PAKISTAN

16. The pesticide industry of the country which is mostly formulation-based has been in the private sector since 1980.

PHILIPPINES

17. The pesticide industry of the country is entirely in the hands of private sector. It is built around 20 companies under the trade organization, Agricultural Pesticides Institute of the Philippines (APIP), which is responsible for 95% of the industry.

SRI LANKA

18. Technical material as well as solvents/adjuvants are not produced locally while certain solid carriers are available locally and are being used in local formulations. Present formulation capacities are adequate to meet the local consumptions of pesticides. The pesticide industry is rapidly growing in Sri Lanka to ensure greater agricultural productivity.

THAILAND

19. The pesticide industry in the country is still in its infancy and hence research in pesticide production and formulation must be encouraged. Obstacles like lack of technology, testing facilities for local raw materials and selection of suitable pesticides for manufacture and marketing of products can be overcome through regional cooperation especially with the technical and financial assistance from UNIDO or UNDP.

PRESENTATION OF TECHNICAL PAPERS

Development of Formulation with Special Reference to Their Uses and Application

20. Starting with the development of indigenous technology in making formulation auxiliaries, especially synergists for insecticides, the technology of making a number of conventional as well as newer pesticide formulations has been developed. Some of the significant achievements include the development of emulsifiable concentrates of carbaryl, photodegradable formulations of DDT, improved DDT emulsifiable concentrates and certain conventional formulations based on the biologically active neem crudes. Of the newer formulation, a significant breakthrough in developing technology for the manufacture of dispersible granules has been achieved. Basic information such as the role of solid carriers in transforming malathion into iso-malathion has also been generated.

Selection of Formulation Adjuvants

21. The proper choice of formulation ingredients is one of the most important and most puzzling problems of pesticide formulation technology. Due to the advances made in recent years in this field, it has become possible to decide on various formulation adjuvants systematically and based on scientific principles. The paper deals with the criteria for selecting different formulation ingredients from a practical point of view. Selection of the following ingredients were discussed:

a) Inert materials required for the preparation of dry formulations
b) Solvents required for liquid formulations
c) Surface active agents

Pesticide Formulation Design

22. Pesticides are effective in minute quantities per unit area. Appropriately designed formulations provide a suitable means of delivering them evenly. The technical material can be formulated in different ways. Possibilities available from the physical properties of the technical material, target pest and application method are some of the determinant factors in designing the formulation type. Proper selection of various inputs and production process are also an integral part of formulation design. Using as example some of the widely used formulations, designing principles were discussed in the context of safe, economic and reliable application of pesticides.

Pesticide Analysis Methods

23. For determination of physico-chemical characteristics of a pesticide, the methods mostly used are gas liquid chromatography (GLC), high pressure liquid chromatography (HPLC), thin layer chromatography (TLC) and spectrophotometry. GCL is the most commonly used method for pesticide analysis as the detectors available have become more selective and sensitive. On the other hand, HPLC, a relatively new technique at present is not widely used because detection systems available are not often sufficiently suitable for pesticide residue analysis. However, it has a useful role to play in the analysis of formulated material. TLC has lost some of its popularity but has great advantage over the other two techniques in being relatively inexpensive and normally does not require sophisticated instrumentation. The principles involved in the use of these techniques, their advantages and limitations in the analysis of pesticides were described and discussed.

Recent Developments in Application Technology

24. The paper deals with the common pest diseases and their remedial measures in various crops, fruit and ornamental trees. Use of low cost ideas on application technology developed indigenously by the author was also discussed in detail.

Key Issues Concerning the Establishment of Plants for the Formulation of Agrochemicals

25. The paper deals with various aspects and problems related to the establishment of formulation plants namely:

1. Economic viability
2. Access to reasonably priced local raw materials and packaging relevant and access to active ingredient

3. Expertise in planning and operation
4. Access to local resources
5. Foreign exchange control and exchange rate problem
6. Access to know-how and service
7. Safety, hygiene and environmental viability
8. Rigid quality control and modes of packaging

26. The economics in locating an agrochemical formulation plant in developing countries was also discussed.

Controlled Release Granules

27. The paper consists of various concepts of encapsulation technology dealing with choice of matrices, solvents and binders. Various concepts relating to encapsulation technology were discussed. The paper also gives a description of micro and macro capsule, hollow fibre monolithic and laminate structure.

Machinery and Its Development for Pesticide Formulation

28. Machinery for processing pesticide formulation needs to be selected after careful study of the toxicant as well as the carrier material. The physical and chemical properties, heat sensitivity, flash point, solvent content, type of solvents, moisture content in carrier material, etc. need to be considered. Further, the optimum size and degree of sophistication desired must be related to output per unit time required, product formulation to be handled and other economic factors. Typical examples were presented for discussion.

Flowable and Wettable Powder Formulations of Fungicides and Herbicides - Techniques of Preparation, Properties and Applications.

29. This paper deals with the need for new formulations, which would be more effective in controlling pests, and at the same time would not cause problems like pesticides drift and residual toxicology. Ways and means for developing effective herbicide formulations were discussed. Different methods for the preparations of Wettable Powders, Flowable and granules were also discussed.

30. Surfactants in Pesticide Formulations:

Surfactants are ampiphilic molecules with a polar hydrophilic head group and hydrophobic tail. They are classified into three major categories depending on the ionic nature of the hydrophilic group- anionic, nonionic and cationic. The ampiphilicity is responsible for the accumulation of surfactant molecules at interaces between two phases. As a primary consequence there is reduction in interfacial energy. A number of secondary properties such as ease of wetting, formation and stabilization of emulsions etc. are important for the application of surfactants.

Among the large variety of surfactant applications, their use in agricultural emulsions including pesticides is an important one. The formation of fine droplets of emulsions is the result of reduction of interfacial tension to extremely low values. Electrostactic repulsions, steric/entropic factors are some of the forces involved in the stabilization of emulsions. The HLB concept is of practical value in the choice of emulsifiers for specific applications. HLB values can be calculated from empirical molecular parameters and can also be experimentally determined.

Apart from the above mentioned molecular aspects techniques for the preparation of emulsions, physiochemical characterization, method for study of stability and other relevant aspects were covered in the talk. Special problems related to pesticide formulations were also dealt with.

31. Bioefficacy Studies on Pesticide Formulations:

Pesticide formulations differ in their bioefficacy to insects and other animals. In general, solutions are more toxic than emulsifiable concentrates which in turn, are more toxic than wettable powder/dispersible powders while the latter are more toxic than dusts. Even the same formulations of a particular pesticides formulated by different formulators differ in their bioefficacy. Such formulations also differ in their residues and shelf life.

32. Problem in Residue Analysis of Pesticides:

The availability of a wide range of pesticides has been responsible for increasedcrop production. Unfortunately, these chemicals can also lead to adverse effects on human health and environment. Once toxicological studies have established the probable degree of hazards of a chemical, residue analysis is required to regulate the usage of the chemicals to the desired level of safety. Accurate residue data are required towards food safety, movement and dissipation of agrochemicals, uptake and effects on wild life, disposal of toxic wastes, occupational safety and pest control efficacy. Residue can be grouped into three main types, namely,

(i) Food and Feed (ii) Environmental (iii) Human tissue. Determination of accurate residue data requires a lot of scientific endeavours and usage of sophisticated equipment.

33. Occupational Health Hazard:

The concepts of toxicity and hazards including statistical studies on pesticide hazards relating to chemical industries were discussed in detail. Recommendations regarding the proper safety in pesticide handling for the formulators and consumers were also discussed.

34. Pesticide Formulation and Engineering aspects:

The technical-grade pesticide is unsuitable for direct application due to its toxic nature. It needs to be formulated to the required concentration of toxic chemical and type for its specific application and use. Important unit operations involved in the manufacture of pesticide formulation, are mixing, particle size reduction, granulation, solid separation material storage conveying, etc. For the successful manufacture of a product of specified quality, the engineering aspects of a chemical plant are as important as the process know-how itself. The principle applies in the case of pesticide formulation plants although only physical processes are involved in its manufacture. Close study and coordination of the various process requirements, state regulations and clientele requirements, are essential considerations from the early stages of process engineering through project execution and actual commissioning of the plant.

Important pesticide formulations were illustrated with brief descriptions. The various equipment units commonly employed to perform the unit operations, product packing, dust control, safety and health were presented. The performance characteristics of the units and criteria for their selection and engineering aspects to be considered were also given. A survey of equipment evailability in India was presented.

35. Packaging of Pesticide Formulation:

Over the past few years, packaging technology has been accepted as a science. The paper gives an account of a number of benefits from the adoption of suitably designed packaging. Also, the requirements for packaging, factors influencing package selection and packaging material, along with the newer trends in packaging of pesticides have been discussed in detail.

CONCLUSIONS AND RECOMMENDATIONS:

36. The Workshop

The Workshop noted with interest the progress of the pesticide formulation industry in the region and the need and possiblity of improving and encouraging the pesticide formulation capabilities; introduce safer pesticide formulations.

Having further noted the availability of the expertise in the region;

Having recognized that the expertise required to satisfy the growing need of the region have not yet reached the desirable level of collective self-reliance;

Having noted that considerable sophistication and knowledge exist in the developed countries especially within their pesticide industry;

Having emphasized that all efforts be made to utilize the knowledge and expertise available in the region with a view to ensure safety, efficiency and economy in the formulation of pesticides;

Recommends that:

The exchange of experience in pesticide formulation among the countries of the region should further be promoted, and in particular, the technological know-how available in the more advanced developing countries should appropriately be adopted whenever possible. Certain special local features of pest problems and novel and effective local solutions developed in the region as brought out in the expert technical papers were of special interest in the significance of local expertise for adoption to the region.

37. While having learned from the presentations that some of the countries in the region have few, if any formulation plants and have to import pesticide formulations and in some cases even carriers in large quantities;

The Workshop identified the needs for and scope of assistance required under these circumstances based on expertise available within the region for setting up of pesticide formulation facilities and development of local carriers for formulations.

38. The countries concerned when seeking assistance regarding the establishment of new formulation capacities should primarily take into consideration the market potential existing in the region and the availability of regional resources such as raw-materials, technology, expertise, consulting services, plant machinery and equipments in the region.

Recommendations

The Workshop

Having noted the existence and exploitation of indigenous raw materials for pesticide formulations;

Having recognized mineral suitability of local production of pesticides;

Recommends that:

Surveys should be carried out in the countries of the region where needed to realistically assess their local requirements, the availability of such suitable raw materials and their quality, and to investigate into the possibilities of utilizing them within the region.

39. Further having noted the need to facilitate mutual trade in chemical products for the manufacture of pesticide formulations, such as intermediates, solvents, surfactants and adjuvants, as well as technical grade active ingredient;

Having recognized the need to provide opportunity for countries which do not possess their own local resources to acquire such raw materials from within the region on preferential terms;

Recommends that Countries of the region take active part in the preparations for the Expert Consultation on Trade and Tariffs which is being convened by RENFAP in Sri Lanka in the second half of this year.

40. The Workshop focussed particular attention on the necessity of developing or strengthening R & D institutions in the region dealing with research on pesticide formulations, quality control and their efficient use in agriculture.

Having noted that certain local techniques if adopted in the region could result in substantial reduction and enhanced safety to applicators;

Having further noted that while there is ready local expertise available on most conventional formulations like dusting Powders, Wettable Powders, Emulsifiable Concentrates, Granules and ULV formulations, the development of newer, safer and more effective and economical formulations for the region needs to be encouraged.

Having recognized the need to encourage and strengthen R & D efforts for development of slow release pesticide formulations, flowables/suspension concentrates, aerosol, micro emulsions etc. to ensure self-reliance of the region in the future;

Having further noted that such would require cooperation with pesticide research laboratories of advanced countries;

Recommends that:

Existing R & D institutions in the region be strengthened by making available to them foreign assistance, inter alia to be provided, through international organizations. Inter-country cooperation in R & D should be facilitated by the respective governments of the region. In this effort, the existing R & D facilities such as those established by the Pesticide Development Programme India (PDPI) be extended to other countries of the region and consider regional work on pesticides formulation development with local raw materials.

41. Having further recognized that local R & D efforts should be directed towards developing technologies for low cost, high quality, pesticide formulations and innovative application techniques to make pesticide economical, safe and simple suiting the local, social, climatic and cultural uniqueness of the region, and

Having noted examples of successful R & D work of this nature particularly the successful use of an electric motor-driven protable sprayer turbine developed locally;

Recommends that:

Efforts be made by the industrial and agricultural institutions to encourage development of new ideas and dissemination of practical results of their innovations.

42. Health hazards and environmental pollution effects of pesticides whether of industrial nature or agricultural use have received particular attention of the Workshop.

The Workshop

Having emphasized the need for adopting a cautious but realistic approach towards solving the identified inherent environmental problems without overreaction to preliminary toxicological indications;

Recommends that:

(i) The awareness of health hazards pollution abatement and precautionary measures be continuously enhanced at all levels of industrial activities and along the chain of pesticide distribution and application. Specialized training programmes should be developed and implemented with particular emphasis on recommended occupational health protection practices and theoretical toxicological aspects if and where relevant.

(ii) The industry take an active role supported by agricultural extension services which also need to be strengthened.

(iii) The pollution control and precautionary measures including effluent treatment from industrial units should be ensured.

43. With regard to the quality of pesticide formulations that well equipped and functioning quality control facilities are of paramount importance. Reliability of the results of analysis has been figured out as the prerequisite to successful quality control measures.

Having noted the need to strengthen existing quality control facilities;

Having recognized the need to develop research on new analytical procedures for identification and determination of undesirable impurities in order to keep abreast with the progress made in this field in the developed countries;

Recommends that:

(i) Exchange of experience relating to new analytical procedures and instrumentation should be promoted as a tool of accelerated specification.

(ii) Simpler and cheaper yet reliable analytical procedures be developed for purposes of quality assurance of pesticide formulation. Some analytical methods have to be developed for possible use by the end users themselves.

44. Having further recognized that there is considerable scope for improving packaging of pesticides in the region;

Having noted that this type and size of packaging containers as well as standardized labelling are important factors in the prevention of accident (poisoning) and ensurance of quality of the products;

Recommends that:

Low cost but effective and safe packaging methods be developed to meet local needs. Proper packaging materials and containers should be used and disposed according to existing standards and regulations. These packaging materials should be locally manufactured on the basis of development work to be undertaken by the pesticide industry in cooperation with the end users.

45. Having recognized the need for setting up specialized facilities for residue analysis; and

Having noted that further work will have to be conducted to establish, strengthen and augment such facilities for residue data generation in the region;

Recommends that:

(i) Governments be advised to initiate research programmes and strengthen the analytical facilities required for residue analysis.

(ii) Regional Network for the Production, Marketing and Control of Pesticides in Asia and the Pacific (RENPAF) should include among its activities a pertinent programme which would promote better understanding of the issues involved and facilitate cooperation of the government institutions entrusted with this task.

46. The Workshop acknowledged the stimulating role of the Regional Network Project and its promotional impact on cooperation among pesticide specialist of Network member countries for the region.

Having recognized the need to upgrade existing formulation facilities identify possible use of indigenous raw materials for pesticide formulations, carry out R & D newer formulations, establish/augment pesticide detecting facilities, develop skills and expertise etc.;

Having emphasized these programmes require long term efforts,

Strongly recommends that:

(i) The recommendations of the Workshop be taken into consideration by the Regional Network for the Production, Marketing and Control of Pesticides in Asia and the Pacific (RENPAF) when deciding on its work programme. It should include a number of new activities, the importance of which have been highlighted by the Workshop.

(ii) The continuation of Regional Network for the Production, Marketing and Control of Pesticides in Asia and the Pacific programme with continued support from international agencies like UNDP/UNIDO/FAO/WHO/ESCAP towards achieving project objectives.

(iii) Having recognized that the pesticide industry play a very active role in the project activities.

Conclusions:

47. The international Workshop on Pesticide Formulation proved to be very valuable in evaluating, understanding and appreciating the local developments and capabilities in the region as revealed by the country papers and expert papers of the region presented at the Workshop.

48. The Workshop helped in identifying areas of regional cooperation and future development as brought out above.

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