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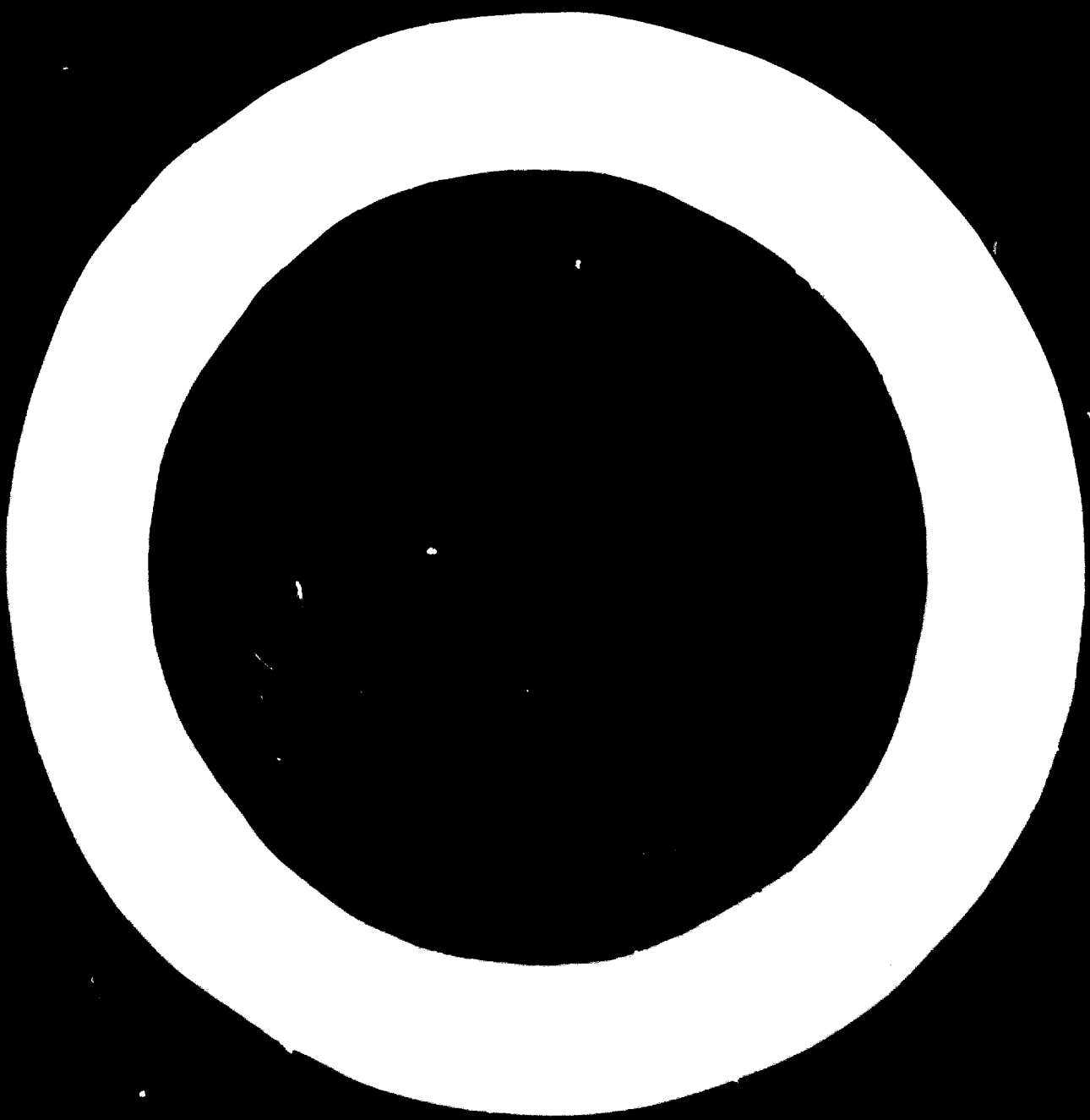
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

PESTICIDES

Report of a Workshop

Vienna
28 May–1 June 1973



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EXPLANATORY NOTES

Reference to " dollars" ($) indicates US dollars.

Reference to "tons" indicates metric tons.

The following abbreviation has been used in this document:

ULV ultra-low volume

INTRODUCTION

The Workshop on pesticides was held at Vienna from 28 May to 1 June 1973. It was organized by the United Nations Industrial Development Organization (UNIDO).

The purpose of the Workshop was to:

(a) Provide a forum for the exchange of views and information on recent developments and trends in the production and use of pesticides;

(b) Recommend guidelines and strategies to UNIDO for the effective promotion of pesticide industries in developing countries;

(c) Recommend a scheme of co-operation between UNIDO and leading pesticide industries in assisting developing countries that seek know-how and potential investors in this field;

(d) Strengthen co-operation between the United Nations agencies, primarily UNIDO, the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO) and the United Nations Environment Programme (UNEP), that have an interest in the promotion of pesticide industries and the proper, safe and effective use of pesticides.

CONCLUSIONS AND RECOMMENDATIONS

As a result of its deliberations, the Workshop made the following recommendations.

Production of technical pesticides

The continuous shift in the requirement of different classes of pesticides now noticeable in developing countries necessitates the use of a variety of products with specific end-uses. This poses a problem in terms of local production plans as the specific demand in a country may be too small for a viable manufacturing unit. It was recommended that in such circumstances UNIDO should investigate the economic feasibility of regional production units.

There is widespread interest among developing countries in products for which the patents have expired. Among them are malathion fenitrothion, rotenone, dithiocarbomates, 2,4-D and systemic phosphate insecticides. UNIDO should help in obtaining suitable technologies to promote new production of these products in developing countries. UNIDO should endeavour to evaluate the comparative merits of each technology in the context of the chemical industry of a country and the foreseeable consumption.

The developing countries must give appropriate consideration to the following important factors:

- Observed trends in the production and consumption of existing products
- Care and circumspection in restricting the use of cheap and highly active pesticides with low human toxicity such as DDT and BHC
- The desirability of installing multipurpose plants which could produce a number of related chemical pesticides to benefit agriculture and thus contribute to the economic viability of new ventures through a built-in flexibility of operations

Although international organizations, and particularly the United Nations, recognize the importance of increased agricultural production, including efficient crop protection, and the importance of preserving the environment, funds are not becoming available for co-operative programmes to identify and promote the development of such pesticides which have less harmful effects on the environment, particularly as replacements of some chlorinated products. It is

therefore recommended that in co-operation with the industry, UNIDO and FAO approach UNDP and UNEP with a proposal for a co-operative research programme for the identification and production of pesticides particularly suitable for use in developing countries.

Formulation and training

Developing countries visualize an enlarged and active role for UNIDO in the transfer of formulation techniques as well as the training of personnel.

There was general agreement that the lack of adequate expertise had hitherto hindered progress. UNIDO should therefore establish prototype centres on an individual country or regional basis for training personnel in multipurpose formulation projects that use locally available fillers, solvents etc. Apart from providing training for operators who will later find careers in the pesticide industry, the centres should provide training in quality control and raw-material evaluation. Both short- and long-term training programmes would be the objectives, and, as a means of updating knowledge, UNIDO should seek the co-operation of international leaders in pesticide manufacture in the development of suitable training programmes in pesticide formulation. Developing countries should include projects in their country programme. The facilities and co-operation offered by Romania in this connexion were considered useful. Close co-operation between UNIDO and FAO in this field is very important.

It was recommended that UNIDO should immediately initiate an effort to create a mobile team of formulation experts to provide on-the-spot advice and assistance to developing countries.

Personnel

The technical competence of personnel and the availability of adequate laboratory and field testing facilities are connected. In countries where personnel and related facilities are inadequate, Governments should provide for strengthening them in their agricultural development planning and if necessary, request appropriate financial assistance from multinational or bilateral sources. FAO has already assisted a number of Governments in this respect and is ready to assist further provided that a suitable financial basis can be arranged.

Co-operation

The sharing of experience by developing countries was highlighted in the discussions of the Workshop. The experience already gained by some developing countries could be helpful in promoting the growth of the pesticide industry in other countries that were encountering similar problems. It was recommended that co-operation among developing countries should be intensified through the efforts of UNIDO and FAO on a regional or other basis.

UNIDO should provide Governments with necessary assistance on technical and commercial matters and organizing regional meetings.

UNIDO should undertake in co-operation with FAO market studies and analyses for guidance in the potential regional development of the pesticide industry.

Planned development

Developing countries should start with simple control procedures such as seed treatment, rodent baits, spraying and dusting and move towards more sophisticated means of protection as the basic chemical production grows and the local capability increases. The economic viability of each step of development must constantly be borne in mind.

I. ORGANIZATION OF THE WORKSHOP

The Workshop was attended by 11 experts from Brazil, Egypt, Hungary, India, Indonesia, Iran, Mexico and Romania, UNIDO consultants, representatives of UNIDO, FAO, UNEP, the UNIDO/Romania Joint Centre, the UNCTAD/GATT International Trade Centre, the Industrial Development Centre for Arab States (IDCAS) and the Groupement International des Associations Nationales de Fabricants de Pesticides (GIFAP).

K. Szabo (UNIDO) was Officer-in-Charge of the Workshop. B. Shah (India) was elected Chairman. K. H. Abdollahi (Iran) was the Rapporteur.

II. PESTICIDES AND MODERN PEST MANAGEMENT

The following findings are based on the discussion of modern pest management in the Workshop.

The use of pesticides in pest management developed very rapidly during the period following the Second World War. Problems resulting from the indiscriminate use of pesticides and the exclusive reliance upon them in the 1950s and 1960s included disturbance of the ecosystem, the emergence of resistant species of some pests, and the presence of pesticide residues in non-target organisms.

Although the methods of pest control were adaptable, the most effective use of pesticides could be obtained from a systems approach of modern management. The important management principles of strategy and selectivity should be applied in pest management with both selective and broad-spectrum pesticides.

The strategy for the control of a given pest must be based on the consideration of the following factors: the efficacy of the pesticide on the target pest, the effect on other organisms, toxicity, and its final effect on the soil, water and atmosphere. The selectivity of pest management was aided by new pest-detection methods that permitted application of pesticides only to the infested area of a crop that was the host or reservoir for pest breeding. The basic requirement for effective pest management was the development of systems that were operationally and economically feasible with the available personnel and selected products.

The pesticide industry had impressive growth rates during the last two decades. Many active ingredients were discovered and developed by the chemical industry. About 900 products were currently marketed.

III. FUTURE TRENDS IN PESTICIDE PRODUCTION AND USE

Attention was directed to the following points in the discussion of future trends in the use and production of pesticides.

The past performance of an industry was usually a reliable indicator of future trends. In the comparatively young pesticide industry, however, account must also be taken of the pace of new research and development programmes, changing and more stringent governmental regulations, and the different end-uses of products that resulted from improved agricultural practices. The forecast of future trends was further complicated by the diverse nature of the data available from different sources. However, official data together with information from industry and private surveys of consultants and specialists gave a reasonable consensus of trends and forecast.

In industrialized countries, the early consumption pattern showed an emphasis on the use of insecticides. Herbicides and fungicides, however, had since increased in importance. Manual labour was becoming increasingly scarce and expensive. The pesticide market was dominated by herbicides. In developing countries with cheap labour available, the demand for herbicides was not significant.

Although the changing consumption pattern could be observed in some developing countries, insecticides were usually employed for the control of agricultural pests and insect-borne diseases in developing countries. Dichlorodiphenyl trichloroethane (DDT) had been the preferred agent for combating malaria. A world-wide ban on its use would increase the cost of public-health measures, and replacement compounds were expected to be more expensive and dangerous to handle. The controlled use of DDT and other chlorinated insecticides was therefore unlikely to diminish in developing countries unless supplies were completely cut off from countries which depended on imports.

The role of research and development in the progress of the pesticide industry needed no emphasis, but there were signs that new work might taper off because of the increasing costs and the governmental requirements for further toxicological data on new products. The costs for developing

narrow-spectrum products with a relatively small market would increase production costs appreciably. It could become difficult for farmers to purchase these products. International companies might therefore reduce the research and development budgets for pesticide programmes. A joint research and development effort among companies was regarded as unrealistic.

In developing countries, insecticides of vegetable origin such as alkaloids, pyrethrins and rotenone, could assume a greater role. The difficulty of obtaining uniform product supplies at reasonable prices must be overcome.

Other possible future developments would be biological control by parasites and predators of particular species only, repellents, sex attractants and behaviour control agents. However, all of these control agents had their limitations, and their use must carefully be evaluated.

As it was unlikely in the near future that the developing countries would use all the products available in developed countries, priority must be given to the optimal use of current resources. Emphasis must be placed on the development of formulation capacities and application know-how. Well-established formulation techniques for wettable powders, granules and emulsions would continue to be required for a range of products. On-the-job training programmes for operators and technicians from developing countries would be valuable for the up-dating of formulation methods.

The basis for the selection of pesticides for use in developing countries could be different from the considerations applicable in industrialized countries because of the differential costs of land, labour and inputs. The relative cost of pesticides in developing countries with regard to the total production cost might reach 40 per cent in comparison to 5 per cent in industrialized countries. Thus, technical, economic and legislative factors must have their individual roles in the choice of the most acceptable pesticide in a given context. The type of pesticides required in one country could be different from the type needed in another country producing the same crop.

During the discussion on the question of the choice of pesticides for use in developing countries, attention was directed to the following points:

(a) The advantage of broad-spectrum pesticides must be balanced against other factors such as persistence in soil or on crops, relative costs and toxicity;

(b) In determining the current and future potential uses, consideration must be given to the potential resistance due to the previous use pattern. The rate of the development of resistance was now known to be related to the extent and intensity of product use. As resistance was an often observed phenomenon, continuous observation and data collection were essential;

(c) The extent of technical supervision available was an important factor as a given pesticide used in a plantation crop under well-administered and controlled schemes could give satisfactory results, whereas the same products could not be used safely and effectively in small individual holdings lacking technical support;

(d) The known side effects on parasites and predators must be taken into account;

(e) The present concern about the environment emphasized the need for continuous collection of data, but, unfortunately, the data were scanty for some of the older pesticides. The toxicity to non-target organisms was yet to be precisely categorized, although some general guidelines were available as a result of individual observation and research. In the future, some norms would have to be established. It was hoped that hazards to applicators and third parties would also be considered in the norms;

(f) While the use of pesticides for crop protection had been the primary interest in industrialized countries, the non-agricultural uses of pesticides were of equal importance to developing countries where insect-borne diseases such as malaria were still a problem;

(g) Agricultural products earned valuable foreign exchange for developing countries. Frequently, these earnings were vital for the national economy. Export crops, therefore, must receive priority in the plans for pest control. Consultation with overseas buyers on the choice of pesticides could often prevent subsequent adverse reactions to high residue levels. FAO/WHO Expert Committees had already codified some data on residue tolerance levels for 50 compounds on a wide variety of crops. Close consultation with these international committees by developing countries could help them benefit from the various programmes that had been instituted.

IV. MANUFACTURE AND FORMULATION OF PESTICIDES

The historical development of formulation technology closely paralleled the discovery of new compounds and their successful field applications. Initially, formulation was the simple blending of dusts, wettable powders and liquid concentrates. With the progress and continuous change in preferred new types of products, the formulation methodology was itself undergoing change. While the old established formulation lines were still popular in most developing countries and would continue to be so, the current view was that the production of formulations must be regarded as an independent operation with its own problems in relation to equipment, quality control of raw materials, and the standardization of products. A rapidly changing market both in qualitative and quantitative aspects rendered a scientific approach necessary as in any other branch of industrial management.

Although the location of formulation plants in close proximity to the market area would reduce transport costs, other economic factors also played a role in determining the over-all viability of the project. Among them were the optimum use of capacity, the costs of unused overheads, and the acquisition of complex machinery. Simple grinding equipment that was generally suitable for minerals could no longer suffice for all pesticide formulations. A more sophisticated approach was required to supply the new demand for products with specific physical, chemical and biological qualities. Product obsolescence was to some degree built into the pesticide industry, because of the fast growth of the chemical industry.

The current trends indicated that as the industry developed, new types of formulations would be needed instead of the conventional products. For instance, a widening interest in ultra-low volume (ULV) application techniques could affect the viability of units dependent on formulations of low concentration. Concern with environmental problems would lead to new measures for the safety of individuals who handle and use pesticides. Some of the old formulations might not conform to these new requirements.

Most developing countries had already accumulated some experience with simple formulation techniques, but as applications became complex, there was

a need for quick improvement and diversification. Developing countries generally lacked technically trained personnel with plant management experience and qualified staff to carry out market surveys and product evaluation. The modernization of formulation technology in developing countries was therefore a difficult task.

Regional centres for training in research and development could alleviate the manpower shortage. The centres could be promoted with the active collaboration of industry, UNIDO, FAO and WHO. Romania had proposed the creation of a training and research centre for studying and evaluating pesticide formulation techniques with the following broad goals:[1]

(a) Installation of a prototype formulation plant in accordance with internationally acceptable standards;

(b) Provision of theoretical and practical training facilities;

(c) Collection and dissemination of information on formulation methods and techniques;

(d) Chemical and biological testing of active ingredients, fillers and adjuvants;

(e) Biological and toxicological evaluation of experimental formulations.

1/ "Report of the Meeting for the identification and development of fertilizer and pesticide industries in the developing countries served by ECE" (ID/WG.127/7).

V. PESTICIDES AND THE ENVIRONMENT

Experts in both developing and industrialized countries were concerned about the total environment and the effects of pesticides on it. As there was yet no global approach to environmental problems, the attitudes and regulations varied from country to country.

In some developing countries, high priority was given to the battle against pest infestation of crops and insect-borne human diseases, and pesticides were important agents in control programmes. Some compromise seemed to be inevitable in the use of established products, while research and development work on new, acceptable products progressed.

Although all uses of DDT had been banned in some industrialized countries, DDT had some applications for which no comparable alternatives had yet been found. The tropical diseases mentioned below illustrate some of the public-health problems that were prevalent in developing countries.

Malaria

The eradication of malaria had been one of the most successful global public-health programmes. Almost all national campaigns in Africa, Asia and Latin America had relied on DDT. According to the Director General of WHO, the withdrawal of this insecticide would tragically expose vast populations to resurgent malaria; its availability for anti-malaria campaigns was therefore vitally important for large areas of the world. No biological control procedure was yet available to replace or supplement insecticides in malaria control. Preliminary experiments with carnivorous fish had evoked interest in Iran and the Union of Soviet Socialist Republics. Operational techniques of genetic control were still in an early stage of development.

Onchocerciasis

An estimated 20 million persons in Africa and Latin America suffered from onchocerciasis, which was transmitted by the black fly. WHO was evaluating biodegradable substitutes for DDT to be applied from aircraft. Biological and genetic procedures for the control of the black fly were not foreseeable developments.

Filariasis

Filariasis was spreading rapidly in many tropical countries. Compounds such as fenthion and chlorpyrifos had shown promise in its control, but alternative products were needed to counteract the possible development of resistance. As a minimum of seven years of uninterrupted vector control was necessary to prevent the transmission of the disease, the application of acceptable new compounds must be steady and methodical.

Yellow fever and dengue haemorrhagic fever

The control of the urban vector was based on larvicides. The ULV application of compounds such as malathion had proved useful. More effective alternatives would be needed if resistance developed. Genetic control of aëdes mosquitoes was being studied by WHO in India but practical wide-scale techniques of application would take years to develop.

Trypanosomiasis

DDT and dieldrin had been used successfully for about a decade to control the tsetse fly in Africa. WHO considered it urgent to develop a biodegradable compound with the desired residual activity which would not affect non-target organisms. Again practical genetic control methods were not foreseeable.

Chagas disease

Some 30 million persons suffered from chagas disease, mainly in the rural areas of Latin America. Biological and genetic methods seemed not to be promising for control of the vector. The evaluation of control measures was hampered by inadequate ecological information; a good technique for assessing the degree of infestation had yet to be perfected.

Typhus

Where resistance to DDT has developed in the body louse, malathion had been substituted effectively for it. Some resistance to malathion had, however, been reported from Burundi. Effective alternatives would have to be devised.

Plague

Biological control of plague was not considered to be feasible. Until recently, DDT was the preferred agent for control of the rat flea. Resistance to DDT required the use of other compounds. Recent outbreaks of plague indicated that foci were being scattered throughout the world, so it would be realistic to expect recrudescence of the disease that would affect many people unless flea control measures were initiated at an early stage.

VI. COUNTRY AND REGIONAL INFORMATION

Brazil

Agricultural growth in Brazil is quite pronounced. It increased 6 per cent in 1969, 9 per cent in 1970 and 11.4 per cent in 1971. As a result, the market for imported and locally produced pesticides has grown steadily. The consumption of pesticides increased from 16,000 tons in 1963 to 68,000 tons in 1972, with only 28 per cent of the cultivated area receiving pesticide treatment.

To promote the use of pesticides, the Government extends a series of facilities such as assistance to farmers in the way of minimum prices, crop-term credits, tax rebates and duty-free imports to manufacturers, economic and technical support of research on new products in co-operation with international organizations. The pesticide industry provides guidance on the use of products and the development of indigenous production. Progress on the latter is, however, slow and not completely satisfactory. Manufacturers abroad have not responded to the potential market in Brazil.

The value of pesticide imports increased three- to fourfold between 1963 and 1972. The tonnage of imports and local production in 1972 was as follows:

	Imports	Local production
Insectioides	24,896	14,025
Fungicides	20,054	4,250
Herbicides	4,750	nil

Domestic production, which totalled 18,275 tons in 1972 was confined to DDT, BHC, ethyl and methyl parathion and maneb. Bridging the gap between local manufacture and the country's demand is an important objective of the Government, although it is realized that not all the chemical inputs are available locally and that there is a shortage of technically trained personnel. The organic petrochemical industry is, however, growing at a very fast rate. The following factors are significant indications of the trend:

(a) DDT and BHC represent about 80 per cent of the local production with additional DDT imported for public-health applications, that is, to combat malaria;

(b) The demand for fungicides has increased rapidly (400 per cent in tonnage between 1963 and 1972). Copper oxychloride is the dominant fungicide;

(c) The sale of organophosphate compounds increased from 10 per cent of the total in 1963 to 20 per cent in 1972;

(d) The sale of herbicides increased from 1.8 per cent of the total market in 1963 to 6.9 per cent in 1972:

(e) Although more than 20 herbicides are imported, 38 per cent of the total was 2,4-D. The value of the estimated annual sales for the projected local manufacture of 2,4-D is $1.3 million.

Egypt

Egypt is one of the larger consumers of pesticides among developing countries. The annual consumption of 20,000 tons has a sale value of £E15 million. Imports account for the bulk of technical pesticides, while DDT, 2,4-D and zinc phosphide are manufactured locally. The manufacture of DDT began in 1957 in connexion with the malaria eradication programme as was the case in some other countries.

The high cost of foreign technology and research, coupled with the absence of basic chemical manufacture, has inhibited local production of more sophisticated pesticides. The fears of product obsolesence and environmental effects have added further negative effects on the diversification of production.

Regardless of these consideration, however, the industry is going ahead with viable diversification of the production. New formulations are being developed such as emulsion concentrates of single and combinations of pesticides based on DDT, lindane and sulphur powders, methyl-parathion, malathion and endrin. A granulating unit was installed in 1965 which can now produce sevin, DDT and lindane. In view of the safety hazards, the formulation technology needs, however, updating periodically. Newer plant designs are needed that incorporate safety principles and modern standards. The role of UNIDO in the transfer of know-how and assistance in training programmes and in the development of feasible projects in therefore considered to be vital.

Hungary

Since 1947 there has been a sharp increase in demand for synthetic pesticides in Hungary following the application of improved agricultural techniques and the subsequent need for new products for crop protection. In 1960, 50 products were used on 3 million hectares of land. The number used on 7 million hectares of treated land area increased to 300 in 1972. Mechanized planting,

weeding and harvesting led to a large increase in demand for herbicides. On the basis of current projections (4,684 tons in 1970 and 6,360 tons in 1971), the forecast for 1980 ,300 tons of herbicides. At the same time, the demand for all other types of pesticides is placed at about 28,200 tons. The total market in 1980 would, therefore, be 44,500 tons, which is almost double the 1971 volume.

The introduction of more expensive and relatively more active systemic fungicides, as well as prohibition of the use of the lower-priced organochlorine compounds, has resulted in a cost increase during recent years. The country's crop pattern - tobacco, maize, tomatoes, fruits and vegetables - and the realization of higher yields compensated for the increased costs of pesticides.

From the point of view of indigenous manufacture, the country is seeking assistance abroad wherever needed. Meanwhile, great efforts are expended by the chemical industry on the local production of raw materials and intermediates for the production of active ingredients. It is hoped that by 1980 the import component will be reduced by one half or one third of the current ratio (in 1967 imports accounted for 22 per cent of the total consumption and in 1973 for 40 per cent).

Hungary desires close co-operation with other countries in both the formulation and the manufacture of technical products. It can now export fungicides (benomyl and BMC), herbicides (atrazine, simazine propazine, prometryne, ametryne, trifluralin, propachlor, 2,4-D paraquat, propanil and 2,4,5-T) and insecticides (prophos, trichlorfon, dichlorvos and DNOC).

India

The use of pesticides in India is connected with the cultivation of the fertilizer-responsive, high-yielding varieties of wheat and rice. Although pesticides have been used for more than 25 years, the improved agricultural strategy based on new techniques and increased physical inputs has operated for less than 10 years. It includes wheat, rice and maize and the increased application of fertilizers and pesticides on cash crops such as cotton and oil seeds. The result was that consumption of technical grades of pesticides increased from 11,000 tons in 1963-1964 to 30,000 tons in 1971-1972. An increase to 77,000 tons in 1978-1979 is forecast for pesticide consumption.

The manufacture and use of pesticides are stressed by the National Plan, with provision for an adequate supply of foreign exchange where necessary. This is supported by improved agricultural education and ancillary developments such as the establishment of commodity research and development stations and the creation of agricultural universities patterned on the lines of Land Grant Foundations in the United States of America. The actual impetus for the use of pesticides arose as a direct consequence of the growth of the chemical industry. Some 42 basic pesticides (20 insecticides, 13 fungicides, 3 rodenticides, 3 herbicides and 3 other types) are manufactured today, using imported or Indian technology with extensive efforts in marketing. In 1971-1972, India's production reached 24,000 tons of active ingredients, from which 53,000 tons of formulations were prepared with a market value of $55 million. By 1974-1975, a market value of $100 million is expected with chlorinated insecticides, BHC and DDT continuing to provide basic applications, particularly in public health.

It is realized that further sophistication of agricultural applications may require a large number of additional products, but India has been endeavouring to limit the total number of indigenous products to as small a group as possible and to import a small volume of materials until a viable production can be created within the over-all plans for the chemical industry.

At present there is an imbalance in the output of various categories. The total production shows the following distribution: insecticides 61 per cent, fungicides 35 per cent, and herbicides, rodenticides and other groups 1 per cent each. It is becoming evident that a much larger potential would lie in weed and nematocide control, and new manufacturing proposals are expected to take this into account. Thus, the pattern of pesticide production and use in India in the next 10 years might follow the same lines as in most of the industrialized countries. Seed treatment, rat control, weed control and intensive treatment on surface and soil pests over a total area of 100 million hectares is expected to produce a potential market worth $121 million in five years. Along with the propagation of products and applications through field publicity and demonstrations monitored by Government agencies and leading pesticide manufacturers, consideration is being given to developing new products such as synergists and products of botanical origin derived from pyrethrum flowers, tobacco waste and derris.

India's potential in a regional co-operation of pesticide industries could include the export of the following pesticides: BHC, calcium cyanide, copper oxychloride, DDT preparations, zinc phosphide, ethyl hydroxy coumarin, sulphur preparations and zineb.

Indonesia

The Government fully realizes the need for intensification of agriculture through an increase in the area under irrigation and the use of fertilizers, new seeds and pesticides. Export crops are an important component of the national economy: seven products - rubber, copra, coffee, tea, tobacco, palm oil and palm kernel oil yielded 2.2 million tons for export in 1966. Rubber and copra provided 80 per cent of the total. Increased yields have followed the application of new techniques, including those involving the use of pesticides.

The consumption of insecticides constituted 85 per cent of the total demand, herbicides 10 per cent, fungicides 4 per cent and rodenticides and miscellaneous products 10 per cent. Organochlorine compounds constituted 75 per cent of the insecticide consumption and organophosphorus compounds 15 per cent.

The local pesticide production is inadequate and is mainly limited to formulation. In view of the local resources, particularly petroleum and natural gas, serious consideration is being given to indigenous manufacture of pesticides. Investments in herbicides and insecticides for rice have attracted attention, although the availability of capital, technology and manpower currently poses a problem.

As the manufacture of pesticides is essentially a chemical industry, the growth of the chemical industry must precede the manufacture of pesticides. Plans for petrochemicals have been under discussion through ECAFE and the World Bank, and any progress in these plans will influence the growth of the pesticide industry. Meanwhile, the agricultural potential promises an outlet for the chemical industry, as the farmer has realized the importance of pesticides.

An integrated development programme should emerge soon. The co-operation of both developed and developing countries, and of international bodies can accelerate Indonesia's plans, especially in areas where there is a need for

sharing experience in this complex industry. Regional planning under the sponsorship of United Nations bodies such as UNIDO may be desirable with a view to accelerating the transfer of technology and to promoting faster growth of the pesticide industry.

Iran

Following the intensification of efforts by the Government to promote agricultural productivity through the cultivation of high-yield seeds and the spread of irrigation, impetus has been given to the pesticide industry with growing demand, including the demand for pesticides for household use. Both domestic and imported formulations are marketed. Imported formulations have the advantage in the market, enjoying the support of well-known companies and brand names.

The consumption of pesticide formulations rose from 2,483 tons in 1966 to about 5,600 tons in 1971 with the imported component decreasing to 36 per cent from 80 per cent in 1966. More than 70 per cent of the consumption is for agriculture, although household applications are increasing.

Indigenous formulation capacity is estimated at 8,000 tons per annum. The capacity is not fully utilized because imported products are readily available, an aspect considered harmful by local industry. With the gradual improvement of local facilities and the improvement in the quality of products, there is scope and need for measures to protect the indigenous manufacturer through adjustments in tariff and import policies.

Long-term assessment indicates that the demand will continue to grow, and by 1977 agriculture alone will require about 18,000 tons of formulated materials, with an active ingredient content of about 7,000 tons. This may lead to the local manufacture of technical products.

Mexico

The current and potential use of pesticides is related to cotton cultivation, which is responsible for $320 million of the total agricultural production. About 20 products, including DDT, BHC, toxaphene, DDVP, parathion (methyl and ethyl), 2,4-D and a number of fungicides and nematocides, are made locally; other products are imported. In 1971, a total of 126 products were

still imported despite increased indigenous manufacture. Dust and liquid formulations are made from both locally manufactured and imported pesticides. The leading world pesticide producers are represented in Mexico and participate in the development of products and sales with the appropriate staff.

In co-operation with international institutions, work is in progress on the development of new varieties of maize, wheat and barley. Other traditional crops such as rice, cotton and sugar receive constant attention with the objective of maximizing quality and output. As Mexico earns about $500 million per annum from agricultural exports, the importance of competitive yields cannot be overemphasized.

One immediate problem with the use of pesticides is the constantly increasing cost of products and technical services. As the profit on cash crops is subject to market competition from other countries, there could only be a limitation on the future demand in that context. Nevertheless the Government is eager to advance the effective use of pesticides through educational measures to publicize the importance of plant protection. Emphasis would be placed on areas which have not received adequate attention, such as the forest and timber industry. At the same time, local production would be encouraged as far as possible.

In 1970, $215 million was invested in the manufacture of pesticides, half for technical products and half for formulation industries. The investment was 3 per cent of the total investments in the chemical industry. As the consumption growth rate is about 7 per cent per annum, steadily increasing investments are required through collaboration with the leading manufacturing companies (wherever practical), joint or independent ventures and outright purchased technology. The manufacture of formulated products remains in the hands of the private sector, while government-owned companies take great interest in the production of technical materials.

Mexico is following a liberal policy to encourage the use of old and new products as long as these benefit the farmer. A balance is sought between reliance on imports and on local production, but the choice is sometimes difficult in view of the small demand for safe, new products which would make local manufacture uneconomic, and the high costs of imported technology. In this connexion, projects serving a number of countries in the same region would be worthy of investigation under the guidance of UNIDO.

Romania

In Romania, the general developments in agriculture and in the use of pesticides in particular have followed the pattern encountered elsewhere in the world. The modernization of agriculture and the application of adquate inputs to boost output for domestic consumption and export led to a demand for pesticides, imported or local. As the growth of domestic production is a function of the availability of chemical raw materials, inorganic and synthetic organic chemicals became the basis for the industry.

The growth index of the chemical industry reached 10,600 in 1971 in comparison to 100 in 1938. The output covered a wide range of chemical raw materials, including chlorine, alkalis, mineral acids, organic solvents, amines and complex derivatives. The installation of petrochemical units added a new orientation towards products like pesticides. Much of Romania's chemical output hinged on the successful implementation of petrochemical plans.

The decade 1960-1970 was significant in that a number of fertilizer projects were completed and an increase in agricultural output was achieved with new demands for pesticides. Until 1970, organochlorine compounds comprised more than 80 per cent of the production, but their share has now dropped to less than 70 per cent because of government restrictions on their use.

The trend is expected to continue, with a larger share of the market accruing to other products: organophosphorus compounds, fungicides and herbicides. Significant increases are expected in the use of herbicides as observed in more developed economies. Romania expects to produce about 38,000 tons of pesticides in 1975 and 63,000 tons in 1980. The percentage share of different classes is expected to be as follows:

	1975	1980
Insecticide	47	33
Fungicide	35	35
Herbicide	17	30
Other	1	2

Romania's current plans envisage co-operation among countries to supplement one another's capabilities in selected areas and the installation of economic multiproduct units, with the main objective of broadening the range

of available products to meet the threat of all major pests, provide for exports and at the same time minimize hazards from undesirable secondary effects.

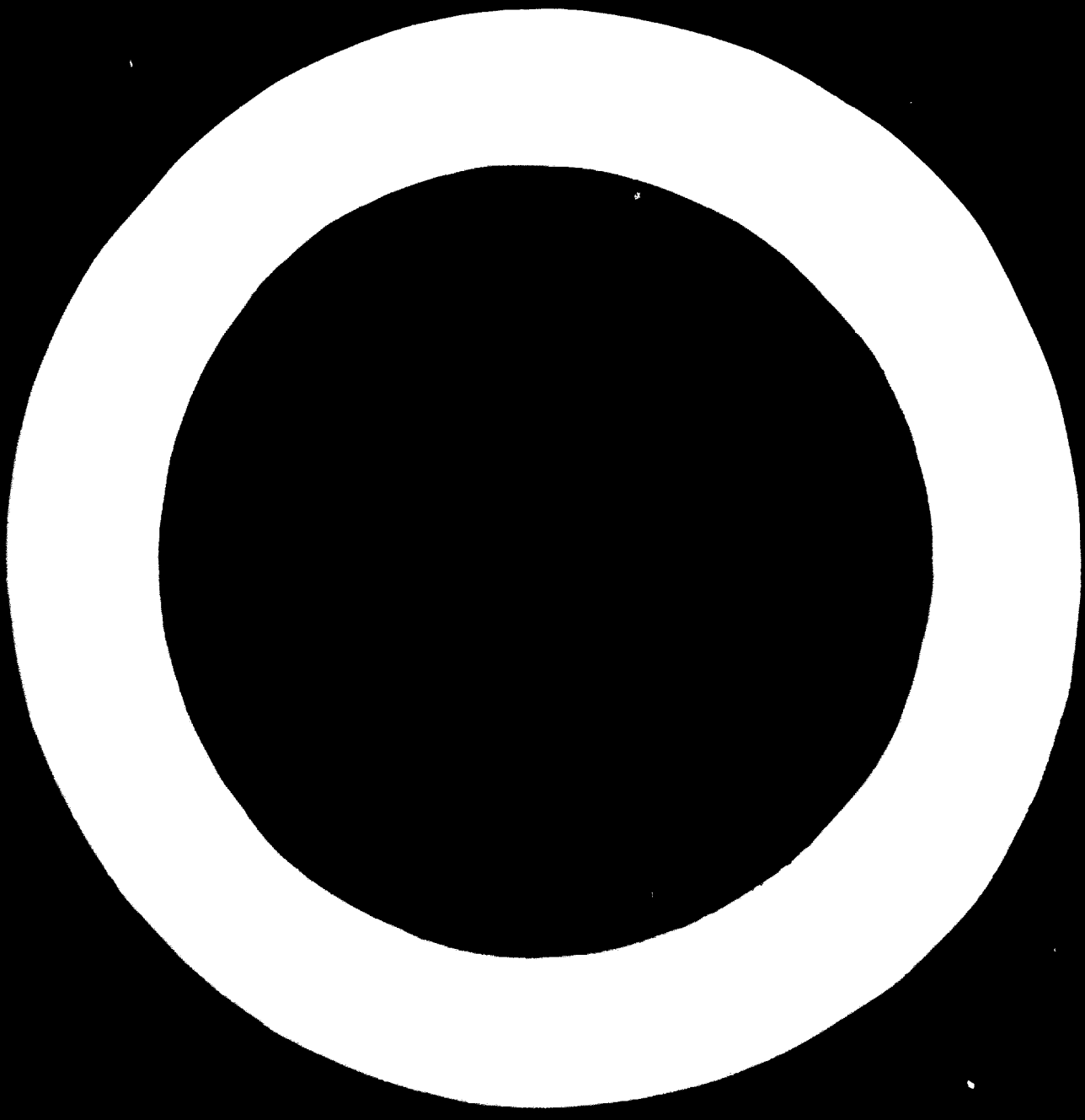
Industrial Development Centre for Arab States (IDCAS)

The agricultural sector is of importance to the economy of Algeria, Egypt, Iraq, Lebanon, the Libyan Arab Republic, Morocco, Sudan, the Syrian Arab Republic and Tunisia, and to a lesser degree in Jordan, Saudi Arabia and Yemen. Another group of countries comprising Bahrain, Democratic Yemen, Kuwait, Oman, Qatar and the United Arab Emirates currently produces fertilizers and could also be potential manufacturers of pesticides.

In the strict sense, there is no pesticide industry in the Arab countries, if formulation and packaging based on imported concentrates are excluded. There is no definitive move towards primary manufacture because of the small consumption and the lack of know-how. The development of petrochemical basis, however, is a possibility in the context of some joint Arab projects; in the meantime imported products will continue to be used.

The pattern of current production and consumption in different countries is not uniform; some countries have no significant production, while others have formulation and packaging units. The "agricultural group" of countries and Kuwait accounted for about 56,000 tons of pesticide consumption in 1970 (as formulations), which could increase to 88,000 tons by 1980, comprising DDT, hexachlorocyclohexane, aldrin, endrin, toxaphene, organophosphorus and sulphur compounds, fungicides, herbicides and fumigants.

Despite the absence of primary technical pesticides from local sources, the consumption of formulations is expected to grow at the rate of 5 per cent annually. The sales value of pesticides will probably increase from $26 million in 1970 to $44 million in 1980.

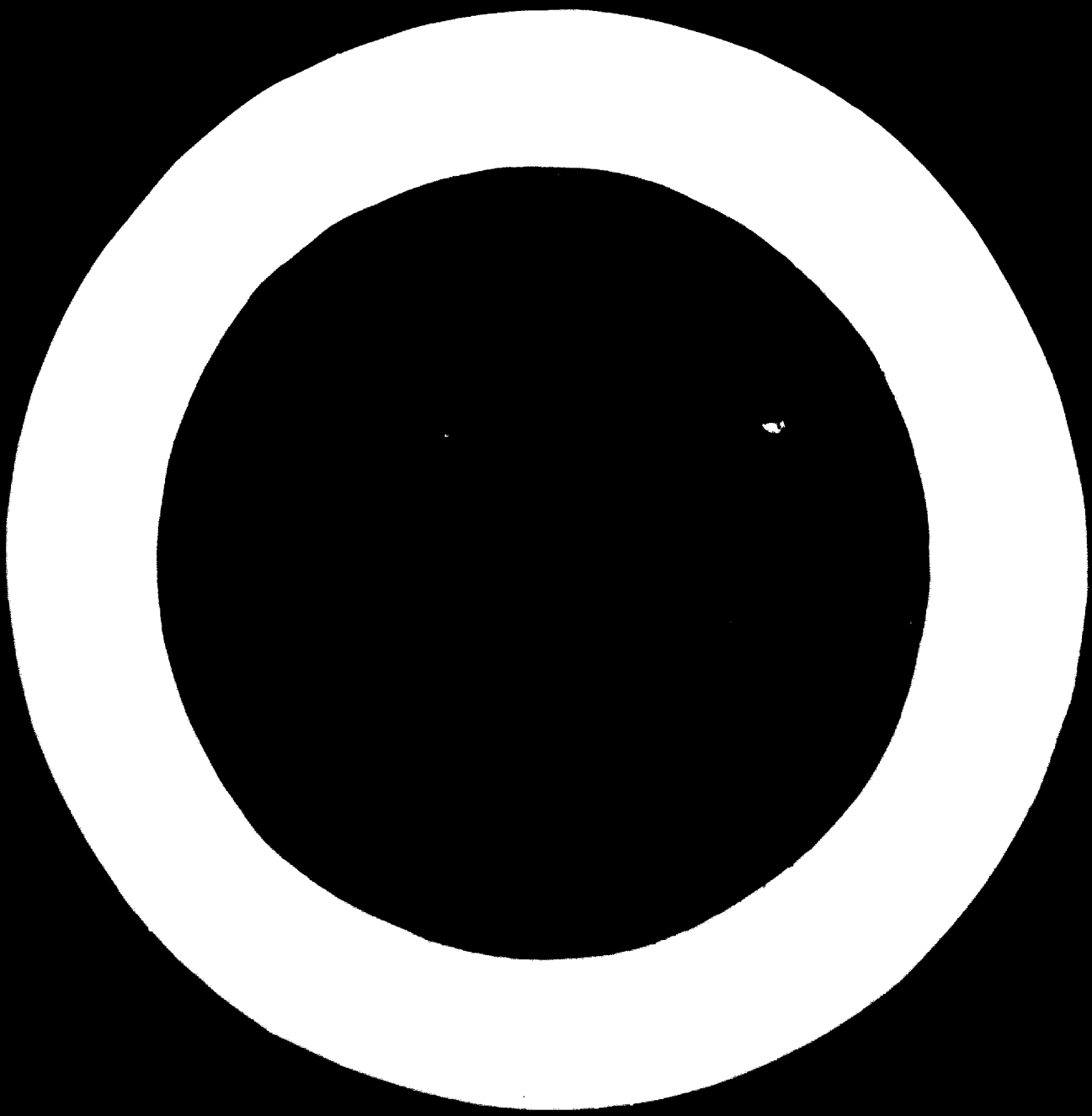


Annex

LIST OF PAPERS SUBMITTED TO THE WORKSHOP[a/]

ID/WG.154/1	Agenda
ID/WG.154/2	List of participants
ID/WG.154/3	The formulation of pesticides in developing countries C. F. Kohll, Food and Agriculture Organization of the United Nations
ID/WG.154/4	The manufacture of pesticides in developing countries C. J. Lewis, Food and Agriculture Organization of the United Nations
ID/WG.154/5 and Corr. 1 and ID/WG.154/5 Add. 1	India's potential in a regional co-operation of pesticide industries in South-East Asia V. S. Bhatia, India
ID/WG.154/6	The pesticide industry in India: Status, goals and problems P. K. Narayanaswamy, India
ID/WG.154/7	Brazilian pesticide outlook H. Teixeira Alves, Brazil
ID/WG.154/8	Present status and contemplated development of pesticide production in India B. Shah, India
ID/WG.154/9	Pesticides: Current and foreseeable trends in production and use R. A. E. Galley, United Kingdom of Great Britain and Northern Ireland
ID/WG.154/10	The present and future status of the pesticide industry in the Arab States G. M. Rouayheb, Egypt
ID/WG.154/11	Technical, economic and legislative factors in determining the choice of pesticides for use in developing countries Food and Agriculture Organization of the United Nations
ID/WG.154/12	Feasibility study of a multipurpose pesticide plant in North-East Brazil P. Barragat, Brazil
ID/WG.154/13	Pesticides in Mexico A. Sisto Velasco, Mexico
ID/WG.154/14	The role of pesticides in modern pest management practices J. R. Brazzel, United States of America

a/ A limited number of copies of the papers are available from UNIDO upon request.



ID/WG.154/15	Patterns and problems of DDT formulation, storage and use in developing countries M. Sobelman, United States of America
ID/WG.154/16	A note on the market for pyrethrum R. Wilson, United Kingdom of Great Britain and Northern Ireland
ID/WG.154/17 and Add.1	Provisional list of documents
ID/WG.154/18	Pesticide production and problems in Brazil Waldemar F. Almeida, Brazil
ID/WG.154/19	Present status and contemplated development of pesticides in Egypt I. A. Kamel, Egypt
ID/WG.154/20	Present status and contemplated development of pesticide production in Hungary Katalin Görög, Hungary
ID/WG.154/21	The pesticide industry in Iran K. Hakim Abdollahi, Iran
ID/WG.154/22	UNIDO training centre for formulation and biological screening of pesticides I. Marinescu, Romania
ID/WG.154/23	Main factors determining the development and trends of pesticide production in Romania A. Staicu, Romania
ID/WG.154/24	Guidelines for the development of pesticide industries in developing countries S. Danusaputro, Indonesia
ID/WG.154/25	Pesticide use in Mexico R. Munguia Barcena, Mexico
ID/WG.154/26	The Pesticide industry as a component of the agricultural sector - Importance of measures to promote pesticide consumption in developing countries A. J. Martley, Switzerland

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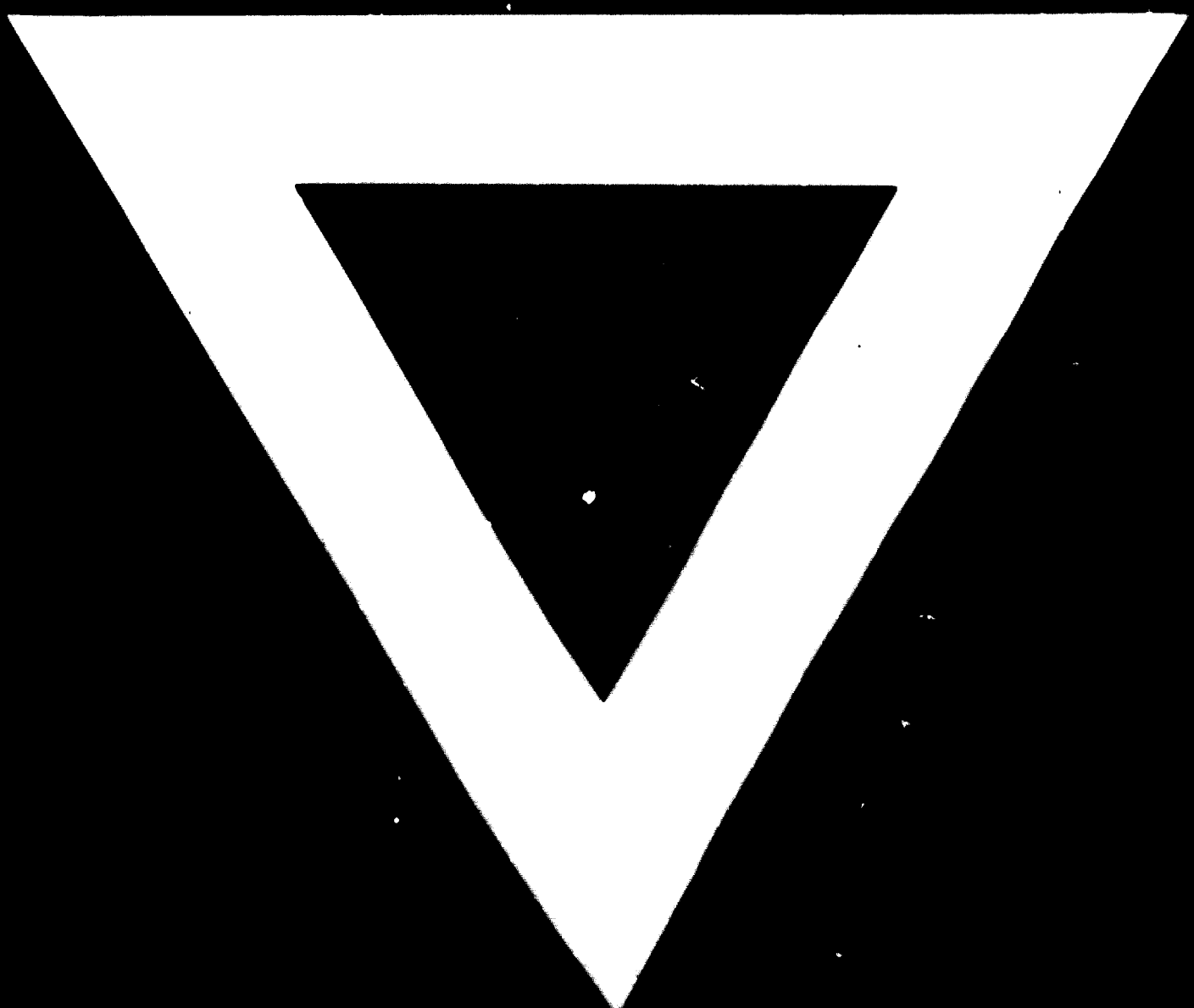

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