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D04693

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.154/4
11 May 1973

ORIGINAL: ENGLISH

Workshop on Pesticides

Vienna, Austria, 28 May - 1 June 1973

THE MANUFACTURE OF PESTICIDES IN DEVELOPING COUNTRIES[1/]

by

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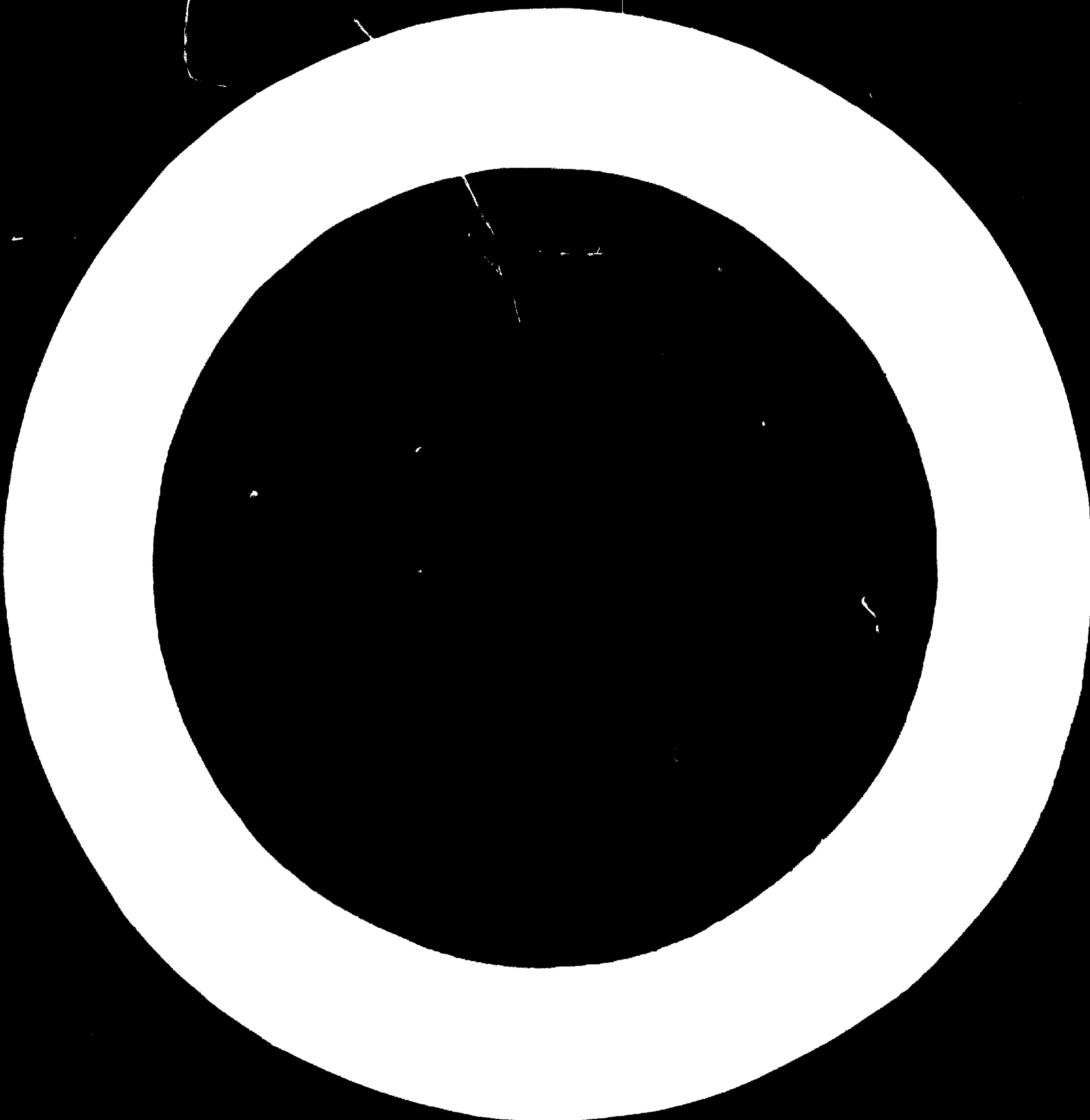


1)

The world sales of pesticides in 1970 are estimated to have been about $3,000m at manufacturers' prices. The USA accounted for the biggest share (45%) followed by West Europe (24%), East Europe (13%) and Japan (8%).

Sales in developing countries were about [illegible] of the total. But in the last decade significant advances have been made in introducing new high yielding, fertilizer responsive varieties of food crops. This has led to an intensified awareness of the value of pesticides as an integral part of the package of improved agricultural practices; bigger and better crops are at risk from the depredations of pests and diseases. The 1969 Provisional Indicative World Plan anticipates that, in Asia alone, the area of high yielding varieties will increase at an average annual rate of 12% to 74m hectares by 1985.

These developments have resulted in a significant growth in local fertilizer manufacture and the successful implementation of seed multiplication schemes. Now that pesticide consumption is increasing and is expected to increase at 10% per annum in the next decade, developing countries are becoming increasingly interested in establishing indigenous pesticide manufacture. This paper highlights some of the major problems associated with such a policy.

2)

These problems are basically those of reconciling two sets of objectives. The developing country, when deciding to establish pesticide manufacture is guided by considerations that are in some respects different from those of a pesticide company deciding on its preferred location for manufacture. It is important therefore to describe clearly these two sets of motives that impinge upon the decision of whether pesticides are to be manufactured in a developing country or not.

3)

The motives of a developing country are made up of a complex of elements; the relative importance of each will vary according to the country concerned and the economic pressures at any one moment in time. In general they can be encompassed within the following five needs:-

1 The need to maintain the growth in food production at around 3% per annum to accommodate the growth in population. The more sophisticated urban dweller and the food processing industry also require food of higher quality.

2 The need to conserve foreign exchange reserves and to allocate these reserves to industries that have the biggest impact upon the country's economy.

3 The need to expand manufacturing capacity to increase the GNP per head and reduce urban unemployment and under employment.

4 The need to establish an export industry which is less dependent on primary products.

5 The need to satisfy the aspirations and ambitions of an increasing number of trained engineers, chemists, biologists and agronomists.

Those of us who have close associations with the problems that face developing countries must accept that, from their point of view, these motives and objectives are genuine, honest and valid and must be understood to be so.

4)

But these motives do not necessarily coincide with the motives and objectives of the chemical industry in the developed countries. These are also equally valid, genuine and - dare I say it - honest. The decision of chemical companies as regards type, scale and location of pesticide manufacture is guided by the complementary needs for a reasonable reward for past investment and risk, and for accumulating sufficient income to finance future investment.

It is not often appreciated outside the industry that pesticide companies, particularly when research based, cannot be considered in isolation from their parent chemical industry - they are umbilically tied with the manufacture of other chemicals.

Most of the pesticides discovered since 1945 have been derived from products of the chemical industry, either by the normal screening process or by synthesising analogues to the primary screened chemicals which have shown biological activity. The chemical complex to which the pesticide business is attached therefore provides a reservoir of material which can be tested for biological activity. As we shall see later, the size of this reservoir is an important feature of the pesticide research process. Furthermore, the choice of raw materials and chemical processes is often influenced by the structure and the accumulated know-how peculiar to the company concerned. After all the majority of chemicals or their analogues that have shown biological activity have been derived from processes with which the parent chemical company is already acquainted.

5)

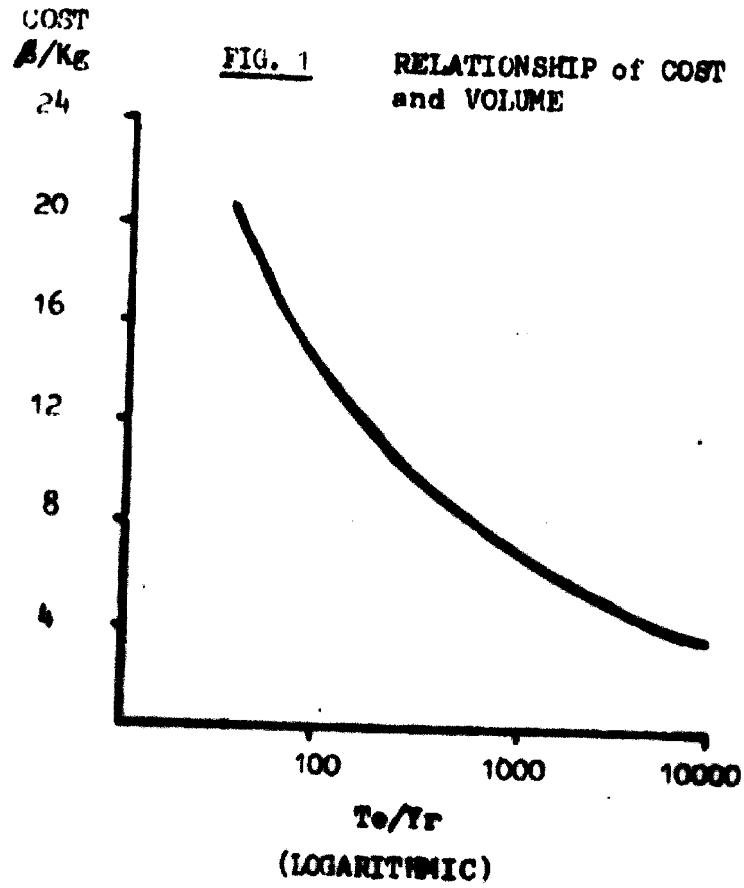
The attitudes of pesticide companies towards manufacturing their products in developing countries are governed to a large extent by the high costs associated with the discovery and manufacture of crop protection chemicals.

Pesticide research has always been an expensive and risky operation but in the last ten years with the tightening up of registration requirements and the continual filling of gaps in desirable biological effects, these costs have increased dramatically in the last few years. A recent survey

(Ernst and Ernst Trade Association) showed that the total cost of discovering each pesticide introduced to the market in [illegible] was $[illegible].1m; these costs had increased by 60% since [illegible]. Nearly 7,000 compounds were tested for each one that was ultimately sold on the market. The high cost of discovering that one compound was largely made up of the abortive effort on the remaining 7,000 odd compounds. The time interval from discovery to marketing was 6.5 years and the total R & D cost on all the new products introduced to the market in 1970 by the 33 companies was approximately [illegible]% of the total value of the 1970 sales. A detailed review of the accumulation of research costs of pesticides is also provided by John and Blair, CHEMTECH. November 1972.

To this high cost of discovering pesticides must be added the considerable expenditure required to develop the most appropriate process for the manufacture of a pesticide. The flow charts in Appendix A, which describe the likely routes for producing the three insecticides Parathion, Carbaryl and Pirimicarb are examples showing that the more recent sophisticated pesticides are complex organic chemicals that require expensive raw materials and up to five separate production stages. In the case of Parathion there are four major stages of production. The main cost determinant, p - Nitrophenol which is attached to the thiophosphate moiety is relatively inexpensive. The cost of Parathion to the cultivator is therefore reasonable. Pirimicarb on the other hand contains a very sophisticated group which requires a long synthesis from basic raw materials. It is therefore more expensive than Carbaryl and Parathion. It has been estimated that, largely due to the complexity of the chemicals concerned and the number of production stages necessary, the total fixed and working capital requirements of a number of recent pesticides can be as high as $3,000/ton/year compared for example with about $300/ton/year for a polythene plant. Much of the process research work is therefore aimed at reconciling these tendancies towards high manufacturing costs with a need to market the product at a tolerable price to the farmer; process yields must be satisfactory, production routes using cheaper chemicals must be sought for and the economies of scale must match potential demand. A commonly occurring volume/cost curve is illustrated in Fig. 1.

FIG. 1 RELATIONSHIP of COST and VOLUME



The high costs and risks of research and manufacture extend well into the marketing phase. During the early stages of developing a product it is extremely difficult to anticipate the likely demand. The price at which the pesticide can be marketed is largely a matter of conjecture until process research is well advanced and until the most likely volume sales have been estimated confidently; it is difficult to define and measure the complementarity and antagonisms between the pesticide and others already on the market, or soon to be launched. Fig. 2. on page 8 describes the performance of 47 new pesticides introduced to the West Europe market since 1960. Only 12 had achieved sales of over $2.5m at manufacturers' prices by 1970.

FIG. 2

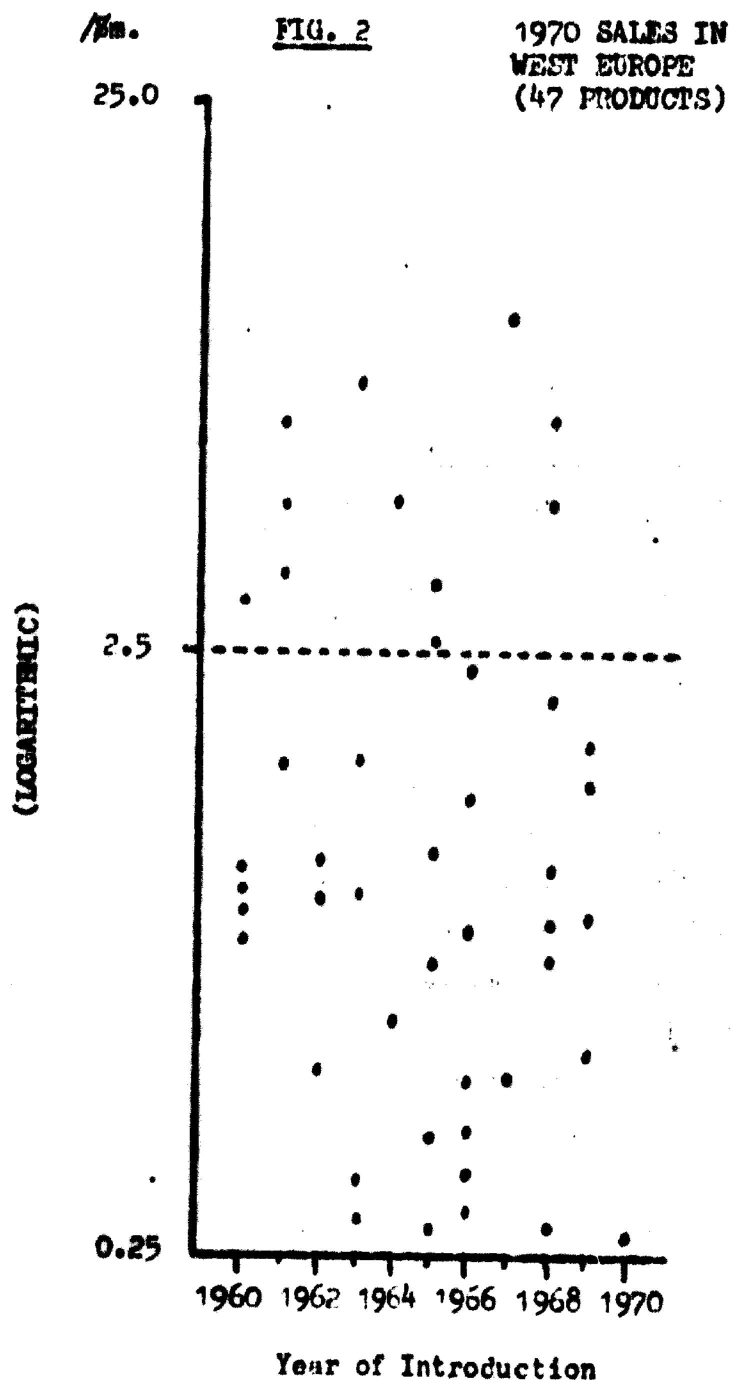
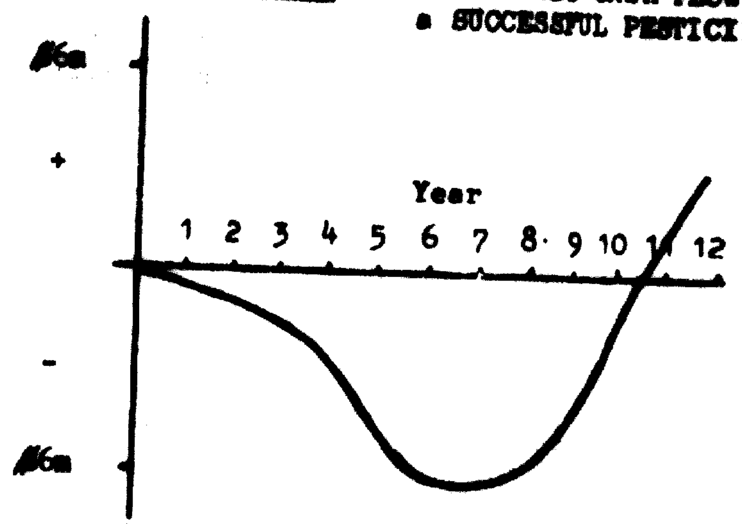

$m.
1970 SALES IN
WEST EUROPE
(47 PRODUCTS)
25.0
2.5
0.25
(LOGARITHMIC)
1960
1962
1964
1966
1968
1970
Year of Introduction

Fig. 3 describes a typical discounted cash flow diagram for a pesticide that has been successful at all stages in its development and has not been subjected as yet to competition from another pesticide with similar effects.

FIG. 3 DISCOUNTED CASH FLOW of a SUCCESSFUL PESTICIDE



Against this background of large investments in research and plant, and the high risks inherent in the pesticide business, chemical companies will naturally wish to protect and manage their discoveries for as long as possible and thus obtain a reasonable reward for past investment and funds for future research.

The manufacture of any one pesticide, being rarely scale neutral, is normally concentrated in one plant. There is a reluctance to consider establishing satellite units until the original plant is near to producing at full capacity and demand is continuing to grow. But in practice this point is often moving forward. Process research results in greater plant efficiencies and in many cases an increase in total capacity can be obtained by increasing the capacity of only one part of the original complex. Thus as the market for a pesticide expands to the more price sensitive sectors, a fall in price can be matched by a fall in costs.

The financial viability of a product is also enhanced when the company maintains control of its marketing for as long as possible. It can determine its own pricing policy that takes full account of the cash flow pattern, risks of obsolescence and biological resistance and its volume/cost relationship.

These requirements for a successful pesticide project militate against a company favourably considering proposals to set up satellite production units in developing countries, particularly when one of the conditions of so doing is that the satellite plant be allowed to export.

6)
Few developing countries have the necessary raw materials and resources to develop an indigenous pesticide industry. Those that do enjoy a nascent chemical industry can only produce the older 'first generation' pesticides such as BHC, DDT and hormone weed killers. Table I lists a selection of developing countries and indicates their current production of HCl and H_2SO_4. Details of current chlorine capacities are only available for India (200,000te) but eight countries, four of which are in South America have plans to expand chlorine production by 473,000 tons, (Information Chimie). Although the quanities of chlorine, caustic soda, etc. required for pesticide manufacture are not very great, it is of interest to place the above figures in their correct perspective. The totals represent only 53% of HCl capacity and 75% of H_2SO_4 capacity in, for example, Japan.

	'000Te 100% HCl		'000Te 100% H_2SO_4 (1971)
India	96.0	(1970)	1291
Brazil	54.0	(1969)	797
Peru	26.8	(1968)	
Korea	17.5	(1970)	440
Iran*	7.2	(1969)	
Chile	2.8	(1970)	457
Egypt	2.6	(1970)	210
Algeria	0.6	(1968)	
Mexico			1335
Morocco			370
Philippines			220
Argentina			157
TOTAL	209.5		5277

* Concentration not known.

Source : Statistical Year Book 1971.

A few of the countries listed above, noteably Brazil and India, are now reaching a stage where at least part of the raw materials required for the manufacture of some sophisticated chemicals may be available within the country. Others may reach this position in the next ten years or so. But against the background of high costs and risks which characterise pesticide manufacture in the developed countries there remain a number of other problems which have to be resolved before pesticide companies will confidently select a developing country as a preferred location for manufacture.

Earlier in this paper emphasis was placed on the chemical complexity of the more recent products. This complexity requires the full availability of a large number of fine chemicals in close proximity to the manufacturing plant. If such chemicals have to be imported, manufacturers would have to be assured that transient foreign exchange difficulties will not affect supplies and that the costs of importing raw materials, particularly the cost-determinants, do not result in a product that is uncompetitive in the world market.

7)
It can of course be argued that the internal costs of pesticide manufacture in a developing country are not as critical to that country as they would be to a chemical complex dependent on export market, as long as the production is directed at a local captive market. This may indeed be so. But if this demand falls short of the manufacturing plant capacity - and many processes are not scale neutral - a series of cost escalating pressures begin to operate. A decrease in the overall or seasonal plant occupancy from say, 80% to 40% may add 30% to the cost per unit produced. Volume sales therefore will be further reduced unless subsidies, export rebates, etc. are introduced; these added costs may result in the total costs becoming appreciably higher than what was considered tolerable in the original proposal to manufacture.

There is also the danger that the need to maintain a high occupancy will lead a developing country that, for example has already established an insecticide plant, to place barriers against importing other insecticides which may be more effective against some pests than the indigenously produced product. The overall cost/benefit ratio of insecticides in that country therefore will be less than satisfactory thus adding a further hidden cost. The whole problem of the relative importance of the cost/benefit of pesticide use and the cost/benefit of pesticide manufacture in developing countries with limited foreign exchange reserves deserves more attention than has hitherto been the case. It can be argued that the growth in GNP can be more effectively achieved by increasing the use of imported pesticides than by establishing a manufacturing plant.

Furthermore, in the more industrialised developing countries with a large, but unexploited, potential for pesticide use, a policy that inhibits the realisation of that potential with as wide a spectrum of products as possible will tend to delay the accumulation of sufficient resources to finance a local research based pesticide industry.

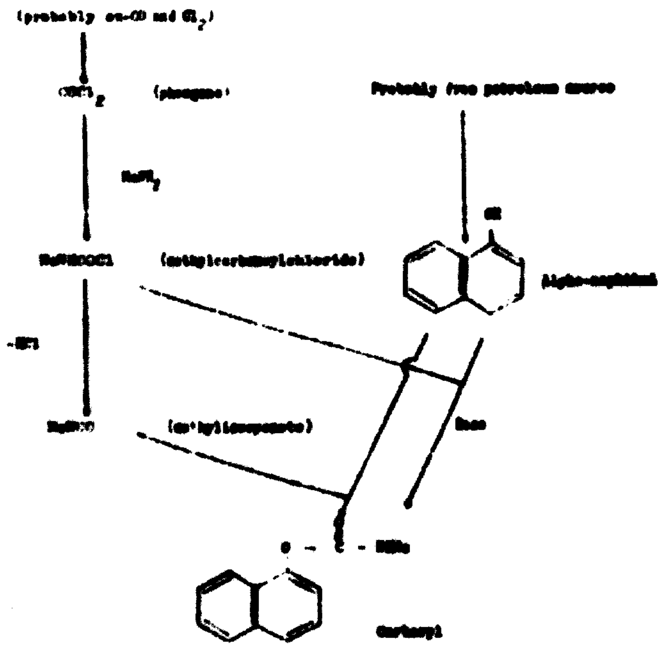
8)

This paper has highlighted some of the major problems that are currently associated with the manufacture of pesticides in developing countries. It has emphasised that a discussion of these problems must embrace a study of many facets of the countries' economy and not confined to the present and future demand for pesticides. Central to this study must be an intensive examination of the future trends in the growth of the chemical industry, particularly in those developing countries which enjoy a large potential for crop protection products.

In this respect, international agencies of U.N.O. in co-operation with pesticide manufacturers and representatives of developing countries have an important role in preparing detailed feasibility studies that accommodate the two main sets of aims and objectives described in the paper and which take into account the rapid progress that many developing countries are making in the industrialisation of their economy.

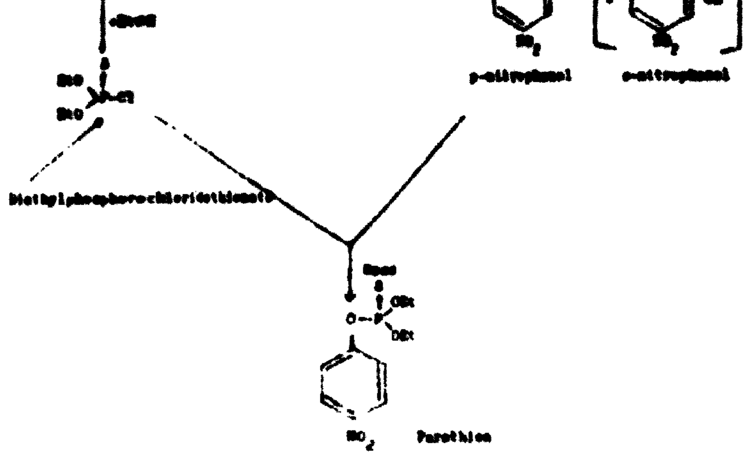
APPENDIX A

SYNTHESIS OF CARBARYL

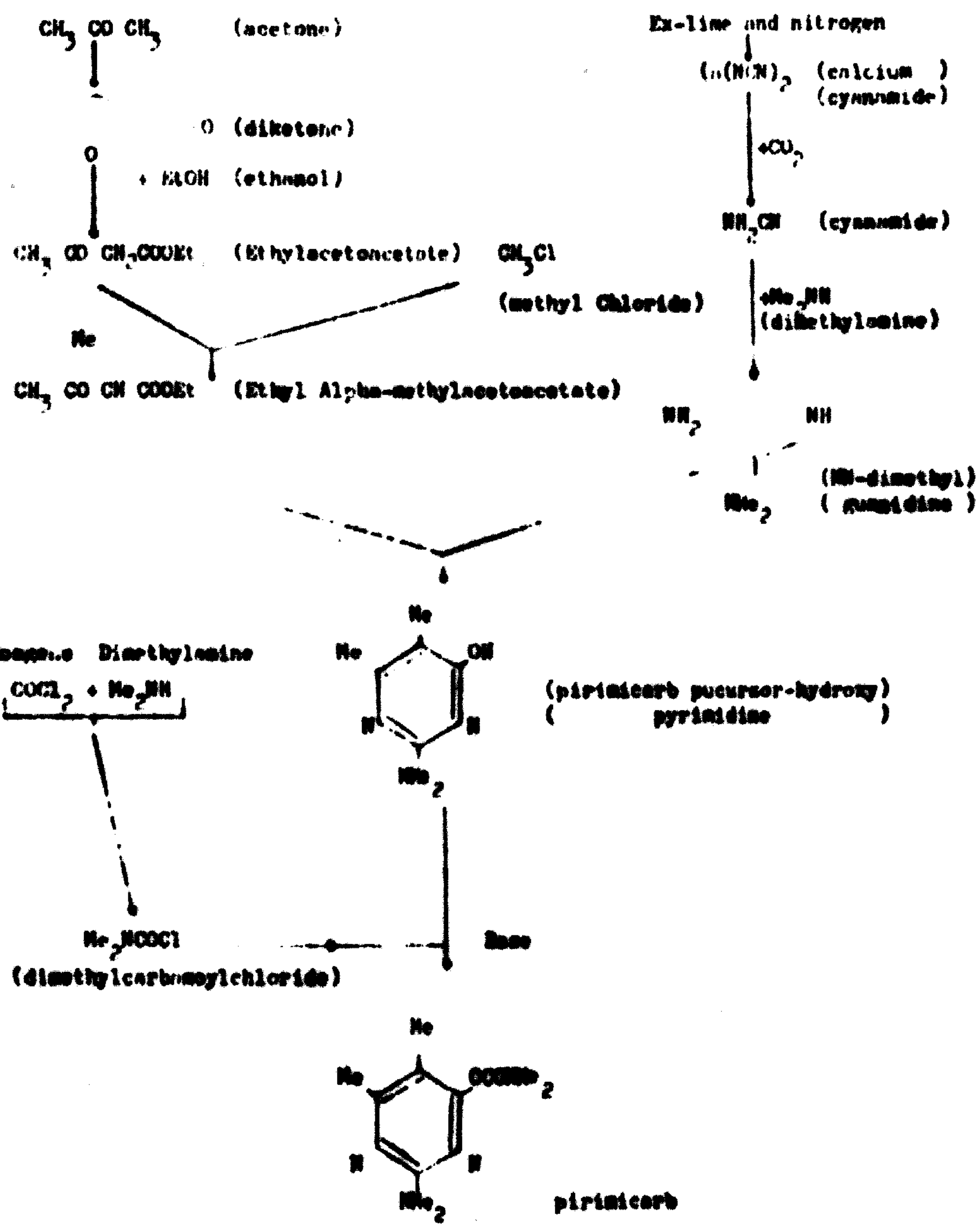


In many cases the alkyl carbamoyl chloride or alkyl isocyanate is not actually isolated but is made and reacted 'in situ'
eg

SYNTHESIS OF PARATHION



SYNTHESIS OF PIRIMICARB



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