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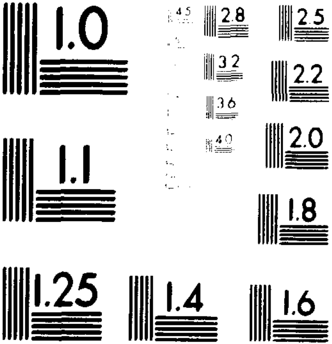

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Thailand.

EXPERT ASSISTANCE IN ESTABLISHING PESTICIDES PLANTS

UC/THA/83/116

THAILAND

Terminal report*

Prepared for the Government of Thailand
by the United Nations Industrial Development Organization

Based on the work of Gerald L. Baldit,
Expert in Pesticide Manufacturing Technology

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EXPLANATORY NOTES

A. Abbreviations and Acronyms

a.e.	Acid equivalent
a.i.	Active ingredient
ARSAP	Agricultural Requisites Scheme for Asia and Pacific
ASEAN	Association of South-East Asian Nations
฿	Baht
BoI	Board of Investment
Btu	British thermal unit = 0.252 kilocalories
ca.	circa, approximately
cif	cost, insurance and freight
CIPAC	Collaborative International Pesticides Analytical Committee
Cont.	Continued
Dept.	Department
e.c.	emulsifiable concentrate
e.g.	exempli gratia = for example
ESCAP	Economic and social Committee for Asia and the Pacific
FAO	Food and Agriculture Organization (of the United Nations)
g	gramme(s)
GERDAT	Groupement d'Etudes et de Recherches pour le Developpement de l"Agronomie Tropicale
i.e.	id est - that is
IRAT	Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières
kg	kilogramme(s)
km	kilometre(s)
kWh	kilowatt-hour
LD_{50}	dose required to kill 50% of test animals
l	litre(s)
mg	milligramme(s)
max.	maximum
min.	minimum
ml	millilitre(s)
MoA	Ministry of Agriculture and Cooperatives
MoF	Ministry of Finance
MoI	Ministry of Industry
MPH	Ministry of Public Health
NESDB	National Economic and Social Development Board

pg	page(s)
PTT	Petroleum Authority of Thailand
rai	0.16 hectares or 0.395 acres
Ref.	Reference(s)
RENPAF	Regional Network for the Production, Marketing and Control of Pesticides in Asia and the Far East
t	tonne(s) = 1,000 kg (solids) or 1,000 l (liquids)
tech.	technical
tpa	tonne(s) per annum
TIS	Thai Industrial Standards
TOT	Telephone Organization of Thailand
UNIDO	United Nations Industrial Development Organization
ULV	Ultra Low volume
viz	videlicet = namely
WHO	World Health Organization (of the United Nations)
w.p.	wettable powder

B. Currency

During the period of the project the value of the local currency was 23 ± 0.1 baht to 1 U.S. Dollar

Note: Common names for pesticides as recommended by the International Standardization Organization have been used throughout this report whenever possible.

ABSTRACT

Title:	Expert in Pesticide Manufacture Technology
Number:	UC/THA/83/116
Purpose:	To help stimulate government and private sectors to establish pesticide factories and related industries.

Duration of Mission: 6 months from 27 February 1984

Over 10,000 tonnes (as 100% ingredient) formulated and unformulated pesticides with a cif value of nearly 1,300 million baht (US $56 million) were imported into Thailand in 1983. The way these products are used, the future usage trends and constraints on the development of pesticide usage have been studied together with the production facilities currently available.

There is ample capacity (installed and planned) for the formulation and packing of pesticides. Many of the formulating factories operate under conditions well below accepted standards and the quality of products is not always up to international standards. These defects can be put right by amendments to and stricter enforcement of existing legislation on registration and quality control and on environmental pollution and industrial hygiene in factories formulating pesticides. Changes in the system of tariffs and taxes would give more incentives to the industry to invest capital in improvements to plant and working conditions. Only the herbicide paraquat is, at present, manufactured. There is no scope for the manufacture of 2,4-D and dalapon, the only other two herbicides used on a large scale. Resistance problems make forecasting of insecticide and acaricide usage difficult. There may be a case of erecting a plant to manufacture dimethoate and malathion and which could later manufacture monocrotophos. The manufacture of fungicides, particularly copper oxychloride, the dithiocarbamates - mancozeb maneb, propineb and zineb - and the formulation of a sulphur wettable powder from sulphur reclaimed from waste hydrogen sulphide gas is technically feasible. The economic viability of these manufacturing projects, even with maximum board of Investment promotional privileges is border line but there could be some saving in foreign currency.

Note: Key words underlined.

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INTRODUCTION

In a document prepared by the Thai representatives for a meeting of RENPAF due to be held in Bangkok in November 1981 (but postponed) it was suggested that, among others, an Expert in Pesticide Production Technology be made available for six months for an advisory and feasibility study. In January 1983 the official Government request from the Ministry of Industry was submitted to UNIDO by the United Nations Resident Representative in Bangkok enclosing the following background information:

"The National Committee on Fertilizer and Pesticide Industry Development was appointed by the Cabinet on October 28, 1975. The Sub-Committee on Pesticide Industry Development was subsequently appointed by the National Committee on Fertilizer and Pesticide Industry Development on August 18, 1981. The objectives of the Sub-Committee are to encourage the establishment of pesticide plants in the country in order to substitute for chemical importation and to lay down the implementation guidelines relating to the chemical production for pesticide sector. The Sub-Committee is also concerned with the international cooperation in collecting data or information relating to production, marketing and controlling of pesticides in Asia and Far-East, and promoting the establishment of the ASEAN Pesticide Manufacture Centre.

The Sub-Committee realises the important role which pesticides play in increasing the agricultural production. Increasing production means that farmers would be able to earn more and to live better lives. This would result in improving the standard of living for farmers and the economy of the country as a whole, which is one of the goals of the fifth Five-year Economic and Social Development Plan.

Since a pesticide industry requires high technology, the assistance in the form of an expert from an industrially developed country therefore is urgently needed".

A UNIDO Project Proposal No. UC/THA/83/116 with a UNIDO input of US $46,000 was submitted in may 1983 and approved in June 1983. This was subsequently slightly amended to restrict the study to Thailand only. The text of the final Job Description is given in Appendix I.

The expert was accordingly recruited for a six months mission with effect from 27 February 1984. After briefing in Vienna he arrived in Bangkok on 1 March 1984 where he remained unitl returning to Vienna for debriefing at the end of the mission.

He was accomodated at the Ministry of Industry in an office next to the Director, Office of Basic Industry Development. Three counterparts (a Chemical Engineer, an Economist and an Administrative Officer) were assigned to the project and a secretary was provided. Although no formal training took place, the expert took every opportunity to discuss with the counterparts, and others, problems of the pesticides industry in general and the specific aspects of this project in particular.

It is also relevant to record that in September 1983 the Ministry of Industry appointed the French Engineery Company KREBS & CIE., S.A. (assigned by the French non-profit making agricultural research institutes GERDAT and IRAT) to study Thai agriculture, prepare feasiblity studies and make recommendations regarding basic manufacture of pesticides for use in Thailand and for export to other countries, at a cost of 2,525,000 baht (ca. US $110,000).

At the request of the Ministry of Industry, the expert carried out a critical review of the draft Krebs report in preparation for the presentation by Krebs, which the expert also attended in the role of consultant to the Ministry. A summary of the Krebs recommendations is given in Appendix VIII.

I. RECOMMENDATIONS

Recommendation	Action by:
1. The formulation and distribution of pesticides should be left in the hands of the private sector	MoI
2. The Government should consider a private sector company already experienced in handling dangerous chemicals to produce for sale to formulators and packers Technical dimethoate and malathion (perhaps monocrotophos later) 1000 tpa dithiocarbamate wettable powders 2000 tpa copper oxychloride 50% Cu w.p. 1000 tpa dicofol (possibly) 750 tpa	MoI
3. As an alternative to copper oxychloride, the use of tank-mix Bordeaux mixture which the farmer can make up from locally produced copper sulphate solution and hydrated lime could be encouraged.	MoA
4. The production of sulphur wettable powder from sulphur reclaimed from a claus unit should be encouraged.	MoI
5. The production of aromatic hydrocarbons should be given consideration.	PTT
6. The local production of surface active agents mainly for the detergent and dyeing industries but also used in pesticide formulation should be encouraged.	MoI
7. The Ministerial Decree requiring formulators to report production quantities regularly should be enforced.	MoA MoI
8. Inspection of pesticide producing factories should be stepped up and industrial hygiene regulations enforced.	MoI
9. The Import Tariff system should be amended to encourage more private investment in pesticide manufacture and formulation.	MoF

		Action by:
10.	The permitted descriptions of imported pesticides should be tightened to prevent ambiguous declarations of active ingredient content.	MoA
11.	The Poisonous Articles Acts should be amended so that:	MoA
	a) All agricultural pesticides require registering	MoI
	b) the toxicity categories conform to WHO recommendations;	MPH
	c) the sale of very toxic pesticides is restricted to authorized users;	
	d) applications for registration give full details of physical properties in accordance with FAO Standards;	
	e) batch numbers are stamped on all containers.	
12.	The Quality Control section of the Dept. of Agriculture should be strengthened.	MoA & MoI
13.	A UNIDO Expert in the analysis of pesticides should be appointed, to train technical staff.	MoA & MoI UNIDO
14.	Satellite laboratories for the quality control of pesticides should be set up at Regional Plant Protection Offices.	MoA & MoI
15.	The technical service effort put into the training of farmers in the safe and efficient application of pesticides and in new techniques should be strengthened.	MoA
16.	The Thai farmer should be further encouraged to increase production. The system of price guarantees and lower interest rates on borrowings to purchase pesticides and fertilizers should be enlarged.	MoA MoF
17.	The quantities of pesticidal active ingredients locally produced should be added, as an Appendix to the annual list of pesticide imports.	MoA
18.	The Ministry of Industry should assume responsibility for coordinating actions on these recommendations.	MoI

II. GENERAL PRINCIPLES

The information contained in this report is based upon discussions with many people in the International, Public and Private Sectors (listed in Appendix II) and on visits to pesticide formulating and other factories (listed in Appendix III).

The main criteria for the establishment of a viable pesticides industry in a developing country are taken to be:

1. The farmer will have available to him the pesticides he requires at the correct time, of quality equal to or better than that of imported pesticides and at a price no higher than the imported products.
2. There should be a saving in foreign exchange.
3. There should be maximum use of local raw materials and manufacturing equipment.

As the industry is not labour intensive, one should not regard it as a means of greatly reducing unemployment although there will undoubtedly be some spin-off in this direction.

The following extract from a paper by Matthews (Ref. 8) is relevant:

"Active ingredient manufacture

The manufacture of active ingredients has really little to do with the pesticide industry itself, though many observers see it as a key operation. The fact of the matter is, that pesticide active ingredient production is simply a branch of the fine chemical industry. Their production is often totally unrelated to agricultural conditions in the countries where they are produced. For example, Bayer in West Germany produces a long list of patented and commodity insecticides, not 5% of which are used in the German market".

The above remarks refer mainly to pesticide production in developed countries where the large multi-national companies spend a considerable amount of money on research and development work into new pesticides (figures of up to US $30 million per new chemical have been cited). The situation in developing countries is somewhat different in that

a) little fundamental research into new chemicals is carried out;
b) there is often no integrated chemical industry
c) small chemical plants erected in a developing country using know-how from a multi-national do not necessarily have to bear a proportion of the research and development costs.

On the other hand, to put up a plant in a developing country on the expectation of large export sales is risky financially unless one can be sure that neighbouring countries will buy the products from that plant. Since most of the ASEAN countries seem to be thinking along the same lines and there is no coordinated policy on basic pesticide manufacture, one must conclude that the economics of any plant erected in Thailand must be based upon a large proportion (at least 80%) of the production being for home consumption.

It is not proposed, in this report, to discuss, in detail, the agriculture of Thailand. This has been amply covered elsewhere (Ref. 1,2,5). Suffice it to say that, given proper incentives, the Thai farmer could make Thailand the major food producing country of South-East Asia and thus raise his standard of living.

There are three major constraints to the development of a viable pesticides industry in Thailand:

1. Although crop yields per hectare are below World averages. there is little incentive for the farmer to improve these by using more fertilizers and pesticides because when he does this, the price he obtains per unit of crop drops, so that, in the end, he has worked harder but his standard of living has not risen.
2. There is pressure to keep down the price of basic foodstuffs, thus reducing the price received by the farmer for his crops.
3. The present import tariff system gives no incentive to anyone to deploy capital to improve local formulation facilities or carry out basic manufacture.

Farmer Incentives

The farmer represents 80% of the adult Thai population and some of them have to borrow at high rates of interest, in order to buy fertilizers and pesticides. What is required is a mechanism to facilitate the already existing system of minimum prices, guaranteed by the Government which will work rapidly for the benefit of the farmer, including special low interest rates, together with some form of cooperative system which will give a group of farmers sufficient power to enable them to organize their own finance and distribution.

The Thai Japan Co-operative (T.J.C.) Chemical Co., Ltd. was founded in 1970 as a Joint Business Venture between the Agricultural Co-operative Federation of Thailand (ACFT) with 51% of the capital and Zen-Noh) National Federation of Agricultural Co-operative Associations of Japan) with 49% of the capital. The aim of the company is to promote nation-wide crop production improvement by making pesticides, fertilizers and application machinery readily available to farmers and also promote international trade in agricultural products. However, as only about 10-12% of Thai farmers (selected by the Co-operative Promotion Dept. of the Ministry of Agriculture and Co-operatives) are members, T.J.C. admits that it has not been wholly successful in meeting its objectives.

Industry Incentives

The present import tariff system (sea Chapter V) whereby ready formulated pesticides and technical active ingredients pay only 5.5% duty (Note 1) whereas solvents, emulsifiers, organic chemicals and other basic raw materials for the manufacture and formulation of pesticides carry duties as high as 33% is grossly unfair and a general dis-incentive for anyone wishing to invest in the pesticide industry in Thailand. In order to overcome this situation and still ensure that locally made products are up to international standards, the following measures should be taken, step by step:

i) The Department of Agriculture should expand its quality control organization for checking locally formulated products to ensure that they are fully up to the declared chemical and physical specifications and that no adulteration has taken place between point of manufacture and sale to the farmer (See Chapter IV).

ii) When this has been effectively established, the duty tariffs on imported pesticides should be amended so that the technical active ingredients <u>and</u> the adjuvants required for their formulation come in <u>duty free</u> (unless they are available from local sources), whereas the duty on similar imported ready formulated products should be increased. The duty on other ready-formulated products which, for

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Note 1: The duty rates quoted are those in operation mid. 1984 good technical reasons, cannot be formulated in Thailand, should remain as it is, except that the first formulator who can demonstrate that he can formulate such a product satisfactorily and to the appropriate chemical and physical specifications should be given special privileges over other formulators and importers.

iii) Basic manufacturers of pesticides should be granted maximum promotional privileges by the BoI under the Investment Promotion Act, 1977. (See Chapter VI)

iv) Not withstanding the above, any importer who can demonstrate that he can import in quantity at least 20% of the previous year's locally formulated product at a lower price than the local formulator is charging shall be entitled to bring that quantity in at the 5.5% duty rate. This will ensure that the price the farmer pays for his pesticides is not inflated by local formulation.

III. USAGE OF PESTICIDES IN THAILAND

A. Agriculture

There is no adequate system for collecting and presenting data on the usage of pesticides by farmers or on the sales to farmers by dealers. Private sector sources have put the annual cost to farmers at between 1.5 and 2.0 thousand million baht. Because of the complicated system of credits, which can vary from crop to crop, it is almost impossible to find out how much a farmer really pays for his pesticides but it is estimated that mark-up on imported formulated products from cif to farmer is about 40% for commodities and up to 70% for specialities with an average of about 50%.

The most reliable statistics being produced are those giving quantities and values of imports (including public health products) which are prepared by the Dept. of Agriculture in co-operation with the Dept. of Customs (Ref. 4). However, even these contain some errors, often due to difficulty in interpreting inaccurate or ambiguous declarations by importers. Take, for instance, the heading "Copper Oxychloride" in the 1983 statistics. Not only are cuprous oxide (Copper Nordex and Copper Sandoz) and copper sulphate included, but the "Formulation" is variously declared as 85% w.p. 62% w.p., 50% w.p., 50% Cu and 35% Cu. Since application rates are linked to copper content, a clear declaration of the copper (Cu) content is essential. Similarly, 2,4-D acid equivalent would be more useful. One important omission in the statistics and which is very relevant to this particular project, is the quantity of paraquat manufactured from imported 4,4'-bipyridyl. The latter chemical is not classified as a pesticide but is listed in Chapter 29.35 of the Customs statistics under 'other heterocyclic compounds'.

If basic manufacture of pesticides in Thailand is to be encouraged and if the Import Statistics are to continue to play their current very useful role, it is essential that some mechanism be introduced to ensure that the quantities of locally produced basic products are shown.

B. Public Health

Malaria Control

Although WHO are trying to phase out the use of DDT, the Ministry of Public Health have mosquito control programmes using DDT, mainly in the South, East and in the West along the Burmese frontier. They are also experimenting with fenitrothion in a joint project with Japan.

Mosquitoes in Thailand do not appear to show any resistance to DDT, and the continued Public Health use of this insecticide is strongly endorsed, since DDT has never been shown to have an adverse effect on human beings (on the contrary, it has saved many hundreds of thousands of lives) and the way it is used for mosquito control cannot cause a build-up of residues in the soil and vegetation.

Rodent Control

This is an ever increasing problem, particularly in rice growing areas. A considerable amount of zinc phosphide is used because it is relatively cheap but the use of other (e.g. coumatetralyl and brodifacoum) baits is increasing as these are less toxic to human beings and pets.

C. Import Statistics

It is not proposed to repeat all the details of past imports as these have been adequately reported by Staring, Krebs and Stangel (Ref. 1, 2,3). The 1983 imports of pesticides, including the quantity of formulated products made from imported technical materials (estimated by the Ministry of Industry) are summarized in Table I.

Table I

SUMMARY OF PESTICIDE IMPORTS IN 1983

	Tonnes Technical Product Imported	Estimated Tonnes Formulated Product made from Technical	Tonnes Formulated Product Imported	Estimated Total Tonnes Formulated Product Available	CIF Value Baht Million
Insecticides	2,110	6,630	4,130	10,760	632
Fungicides	--	--	3,890	3,890	156
Herbicides	1,520	6,100*	4,620*	10,720*	500*
	3,630	12,730	12,640	25,370	1,288

*Note: Corrected for paraquat manufacture from imported 4,4'-bipyridyl

Source: Dept. of Agriculture (Ref. 4)

The major products imported 1981-1983, calculated as 100% a.i. are given in Appendix IV. The total quantity of pesticides imported into Thailand in 1983 (both formulated and technical), claculated as 100% a.i. was 10,676 tonnes. This compares with a total of 8,616 in the 1982 and 10,498 tonnes in 1981.

Since the amount of stock carried over from one year to the next is not known, it is not possible to detect any significant trend in these figures.

D. Future Usage

The effective use of pesticides depends on many factors including the accurate identification of pests, the correct choice of product, proper timing of application and sufficient understanding of safety precautions to protect the applicator, the consumer and the environment.

There are many conflicting views on the future trends of pesticide usage in Thailand although there is general agreement that there is an enormous potential for agricultural expansion which, subject to the constraints mentioned in Chapter II, should mean a large increase in demand for pesticides.

The introduction on modern application techniques, such as ULV spraying, could reduce the wastage of products due to spray run-off and thereby reduce the quantity of a.i. applied per hectare. However, the small hand-held ULV sprayers are battery powered which means additional expense in the frequent replacement of batteries. Thus without a highly competent technical service organization which has the full confidence of the farmer and which is capable of providing convincing proof that any new technique is worthwhile, the farmer will be reluctant to accept the new technology. Therefore, special effort must be directed towards encouraging adoption of new techniques. The Departments of Agriculture and Agricultural Extension are trying hard to provide the technical service required by suffer from a shortage of well trained personnel. It is therefore considered essential that sufficient funds be made available to enable the MoA to increase technical service effort. This is an area in which FAO assistance might be available as it is sprobably a more important Government function that investing in large pesticide manufacturing, formulation and marketing projects which are often better suited to the private sector.

If the current MoA/FAO programmes for integrated control measures are successful and the farmer can be persuaded to use these new methods, insecticide usage could possibly decrease. The current product mix is sure to change but Krebs (Ref. 2), who had a team of biologists studying Thai agriculture, were unable to be very precise.

The use of fungicides, always the poor relation of the pesticides industry, should start increasing within the next five years or so, as farmers become more aware of the value of preventative spraying to reduce crop losses due to fungus attack.

Most respondents were agreed that because of increasing labour costs the use of herbicides is increasing rapidly and that this trend would be maintained for many years, particularly in maize, where at present, little herbicide is used, and rice where broadcast seeding as against transplanting is being incouraged.

IV. THE POISONOUS ARTICLE ACTS 1967 and 1973

General Comments

Unofficial translations of these two Acts and of Ministerial Decree No. 3 (1974) have been made by Napompeth (Ref. 5) and have been commented on by Staring and Krebs (Ref. 1,2). Although these Acts go a long way towards protecting the use, the consumer and the environment, the Government officials concerned appreciate that further amendments are necessary. One of the weaknesses of these Acts is that they are administered by three different Ministries, viz Agriculture and Cooperatives for agricultural pesticides, Public Health for public health and household pesticides and Industry for other poisonous articles. As a result, the effort available for policing the quality of the numerous products involved is diluted. Since pesticides used in Agriculture and in Public Health are very similar in chemical and physical properties, it would appear appropriate for the control and policing of such properties to be the responsibility of one organization, with a well equipped and well-manned laboratory and trained samplers, which could be quite independent of either Ministry; for example, this could be the Thai Industrial Standards Office who would then be responsible for issuing Thai Standards for Pesticides. Since any change from the present system could be difficult to legislate for at this stage, for the purpose of this report it has been assumed that the present system will continue and any recommendations made will refer to the input of the Ministry of Agriculture and cooperatives. Within the scope of this project comments will be made on two aspects - the list of products which require to be registered and the chemical and physical requirements of pesticides.

List of Products

The Acts divide poisonous articles into two categories, - 'ordinary poisonous' and 'highly poisonous', - but do not specify how the two categories are differentiated. the Ministry of Agricultrue and Cooperatives has, at various times, issued lists of pesticidal active ingredients and it is understood that "highly poisonous" refers to chemicals (not formulated products) having an acute oral LD_{50} of less than 50 mg/kg and that "ordinary poisonous" refers to other chemicals which the Poisonous Article Control Board considers poisonous. The numbers of pesticidal active ingredients in each category (as at mid 1984) are given in Table II. In 1983, 22 (out of a total of 99) Insecticides, 23 (out of a total of 60) Fungicides and 13 (out of a total of 35) Herbicides, which are not on the list, were imported.

Table II

NUMBER OF PESTICIDES LISTED AS POISONOUS (MID 1984)

	Ordinary Poisonous	Highly Poisonous	Total
Insecticides	64	46	110
Fungicides	39	4	43
Herbicides	36	2	38
Others	8	4	12
	147	56	203

Since only products on this list need be registered, it may be implied that chemicals not on the list are "non-poisonous". Although this may have been true when the lists were originally compiled, this is not necessarily true now and it is possible for a highly toxic new chemical to be imported and sold with no restriction. It could take many months before the authorities become aware of this and even longer before the chemical is added to the list.

This is obviously a very unsatisfactory state of affairs and it is recommended that all agricultural pesticides should pass through the registration procedure and that it should be an offence to sell a pesticide which has not been registered.

Furthermore, the categories of pesticides should be enlarged to conform with the 1975 WHO recommendations (See Appendix XIII).

In this connection it is interesting to note that paraquat, which, if ingested, can prove fatal, is listed as "ordinaroy poisonous" and not "highly poisonous".

Another aspect which gives cause for concern is that anyone (even a child) can go into a shop selling pesticides and buy the most toxic products with no restriction. If the categories of pesticides were amended to comply with WHO recommendations, it should be possible to introduce a clause in the Poisonous Article Acts to make dealers segregate the more toxic products from the less toxic ones and to limit the sale of the more toxic products to authorized users (i.e. farmers).

Quality Control

Under Section 12.3 of the Poisonous Article Act 1967, as amended by the 1973 Act, applicants for registration of poisonous articles must, among other things, declare the active ingredient content and give some "detail on properties" of the product to be registered. It is unclear how applicants interpret the words "detail on properties" but officials of the Agricultural Toxic Substances division of the MoA say that they are unable to pay such attention to this very important question of physical properties. As a result, the Pesticide Formulation Analysis Sub-Division of the Agricultural Toxic Substances Division of The Dept. of Agriculture only reports officially on the a.i. content of samples submitted to it. The number of such samples (mainly accompanying requests for registration but some may also be taken by Inspectors from factories, dealers premises or farms) averages 120 per month and the failure rate is quite low. However, the Chief of the Pesticide Formulation Analysis Sub-Division has been carrying out her own research into the physical properties of the pesticide samples submitted. Unfortunately, resources permit only about 100 samples a year to be examined in this way, but the results obtained in the past two years are sufficiently bad to give cause for grave concern. Some 80% of all samples were below the FAO Standards for Suspensibility or Emulsion Stability and about 30% were very bad. It is therefore considered essential that the Poisonous Article Acts be amended so as to require specific information on the physical properties of formulated products at the time of registration. Physical properties should conform to FAO Specifications where these exist. Where no FAO specification exists, the requirements for physical properties should be based on those of an FAO Specification for a product with similar physical and biological properties.

Physical data requested should include as a minimum:

1. For Emulsifiable Concentrates
   a. Emulsion stability
   b. Flash point (min.)

2. For Water Soluble Concentrates
   a. Stability of dilution in Standard Hard Water
   b. Flash point (min.)

3. For Wettable Powders
   a. Suspensibility or particle size in the sub-sieve range
   b. Sieve test (wet)

c. Wettability

d. Foam retention (max.)

e. Moisture (max.)

4. <u>For Dusts</u>

a. Apparent density (range)

b. Packed (tapped) density (range)

c. Sieve test (dry)

d. Moisture (max.)

5. <u>For Granules</u>

a. Sieve test (dry)

b. Moisture (max.)

In all cases references to the methods of analysis to be used (preferably CIPAC) should be given.

Importers of Formulated Products should be required to submit an analytical certificate with each consignment. Such a certificate should give actual analytical figures obtained on a representative sample of the consignment and not merely state that the consignment conforms to specifications.

Similarly, local formulators should be obliged to maintain a quality control laboratory and analyse each batch produced for active ingredient content and physical properties. The results of these analysis should be available for inspection by MoA Inspectors.

Furthermore, the containers of all Formulated Pesticide products offered for sale to farmers should bear a code number which can be readily identified with a particular importation or formulated batch.

The MoA has powers under Section 44 of the 1967 Act to withdraw from sale any products found to be sub-standard pending a court ruling on the matter. In such cases, the product in question should be sampled officially in the presence of the manufacturer/formulator/repacker or his agent. The official sample should be divided into three equal sealed portions - one for the manufacturer, one for MoA analysis and one retained as a referee sample in case of dispute over analytical figures. The Courts should be encouraged to deal severely with manufacturers and others who repeatedly offer sub-standard products for sale.

It may be noted here that the Consumer Protection Board also has powers, under the Consumer Protection Act 1979, to take action against people selling "goods which may be harmful to the consumers".

It is appreciated that the Pesticide Formulation Analysis Sub-Division as at present constituted, with a staff of 5 (including the Chief), would not be able to undertake all the extra analytical work involved. The Sub-Division should be capable of analysing, for active ingredient content and physical properties, at least 2,500 samples a year.

This would require, in addition to the Chief, a staff of at least four graduate chemists each with two assistants of vocational school level plus a number of samplers. In order that these people can be efficiently trained in all the analytical techniques required, in the management of their work, in correct sampling techniques and in establishing a set of Thai Specifications for pesticides, the Government should request urgent UNIDO assistance in the form of an expert in pesticide formulation analysis appointed for a 12-month period. A Draft Job Description is given in Appendix V.

Once this nucleus has been properly trained and has become a viable operational unit, small satellite units, capable of sampling pesticides in shops and stores and, as a minimum checking on their physical properties, should be set up in each of the six Regional Plant Protection Offices.

It is relevant to note at this stage that the current Five Year Plan (Ref. 9 pg. 104) calls for improvement and expansion of the national standard system and quality control. Although this may have been aimed principally at the manufacturing industries, there is no reason why Pesticides should not be included.

V. IMPORT TARIFFS

The Dept. of Customs, which classifies imports according to the Brussels Tariff Momenclature, levies Import Duty and Business Tax on imported goods. Import duties were increased by 10% in November 1983. At the same time Business Tax rates were revised as follows:

Old Rate	New Rate
1.5%	1.5%
3 %	5 %
7 %	9 %

The method of calculating the actual amount to be paid to the Deparment of Customs before goods are released is complicated, taking into account a national mark-up ('rate of standard profit') and municipal tax.

Duty rates, mark-ups, and business tax rates for some of the products required in the pesticides industry are given in Appendix VI. Examples of calculating the amounts to be paid to the Customs are given in Appendix VII.

As has been mentioned in Chapter II, the present rates of duty do not offer much incentive for local formulation or manufacture. Take, for example, a typical dimethoate 40% e.c. formulation containing, say:

Dimethoate tech. 95%	42%
Xylene	38%
Cyclohexanone	15%
Surface active agent (nonionic)	3.5%
Surface active agent (anionic)	1.5%

Typical prices of the above raw materials as paid by local formulators are:

	Baht/tonne
Dimethoate tech. 95%	88,000
Xylene	14,825
Cyclohexanone	32,000
Surface active agent (nonionic)	66,000
Surface active agent (anionic)	32,250

Using these figures one can calculate that the cost of the raw materials to formulate one tonne dimethoate 40% e.c. is 50,187 baht. This compares with 53,267 baht/t taxes paid for the imported formulated product in 1983. The difference of 3,080 baht (6.1%) cannot give anyone much incentive to set up a formulating factory with good quality control, and where the health and safety of workers and anti-pollution measures are considered important, and the regulations governing them strictly adhered to.

A similar arguement can be applied to the raw materials for basic manufacture unless maximum BoI privileges (See Chapter VI) are obtained.

It may be noted here that the Ministry of Finance has the power to reduce the import duty on chemicals destined for a particular outlet. For example, in July 1970, the rate of duty on alkylbenzene sulphonic acid and sulphonates used in the detergent industry was reduced from 30% to 10% in order to keep down household detergent prices. Similar powers could be used to assist the pesticides industry and the farmer.

VI. THE BOARD OF INVESTMENT

In 1960, the Office of the Board of Investment was formed and given overall responsibility for investment promotion. The Board's powers were enlarged under the Investment Promotion Act, 1977. The most important incentives under the Act, as they relate to the pesticide manufacturing project are:

1. Exemption or 50% reductions of import duties and business taxes on imported machinery.
2. Reduction of import duties and business taxes of up to 90% on imported raw materials (only after first 6 months of operation).
3. Exemption of corporate income taxes from 3 to 8 years with permission to carry forward losses and deduct them as expenses for up to 5 years.
4. Exemption of up to 5 years on withholding tax on goodwill, royalties or fees remitted abroad.
5. Exclusion from taxable income of dividends derived from promoted enterprises during the income tax holiday.
6. Special additional tax allowances for enterprises in the Investment Promotion Zones.
7. Protection measures by the imposition of import bans or surcharges on imported products.

Current BoI policy is to favour projects which are:

a. Export oriented;
b. based on local resources;
c. labour intensive;
d. located outside Bangkok.

In discussions with the BoI, the manufacture of copper oxychloride, the dithiocarbamate fungicides and organo-phosphorus insecticides were cited as possible investment projects. The Consultant to the Project Development Division was of the opinion that, as they would bring in new technology, these projects would stand a very good chance of getting maximum support, provided they were sited outside Bangkok, even though they would not be labour intensive and exports could not be guaranteed because of the lack of a co-ordinated policy within ASEAN on pesticide manufacture.

VII. FORMULATION FACILITIES

A. Capacities

The estimated formulation capacities (actual and planned for start-up within the next two years) are given in Table III. These figures are only estimates becuase it is virtually impossible to state precisely the capacity of batch units used for making many different products. Much will depend on the time taken to make a particular batch, the amount of unproductive time for cleaning out between batches of different products and hold-ups due to bottlenecks in filling lines etc. The figures given in Table III differ from those given in a report by the NESDB (Ref. 6 pg 144) in that the NESDB list is based upon requests (up to end 1981) for licenses to produce specified pesticides, whereas Table III is based on information received from plant managers and from the expert's own assessments based upon sizes of installed mixing vessels etc. Although the amount of fine grinding capacity is relatively small, in view of the difficulty of fine grinding organic pesticides in the hot and humid atmosphere of Thailand and of the high cost of electricity, it is doubtful whether the installation of more grinding capacity could be justified economically. It is far easier and cheaper to import a finely ground dust concentrate and blend this with locally available fillers (and surface active agents, if required). The resulting mixture can be passed through a simple locally-made disintegrating mill to ensure a homogeneous mix. The figures given in Table III are probably very conservative and, in most cases, production capacities could be increased by better medium-term planning and, if necessary, working two or three shifts. However, with the exception of the I.C.I. Asiatic paraquat plant, which is working at nearly 100% capacity on three shifts and the various granule plants which are working at 60-70% capacity, most of the factories visited reported that they were working to only about 25% capacity.

Items 6 of Ministrial Decree No. 3 (1974) issued in accordance with the Poisonous Article Act 1967 requires formulators to report every four months the amount of poisonous articles they manufacture. Unfortunately, most formulators are ignoring this requirement and since the Dept. of Agriculture does not have sufficient staff to collate such information even if it were produced, no action is taken against the offending formulators. No official pesticide production figures are therefore available. it is recommended that the requirements of the above mentioned Decree be enforced.

One must conclude that there is ample formulation capacity in Thailand to meet the country's requirements for many year, even if some of the factories operating unsafely were to close. The operating conditions in some of the factories must be improved (See Chapter VII/B).

Table III

ESTIMATED AGRICULTURAL PESTICIDE FORMULATION CAPACITIES (Actual and Planned) Mid 1984

(based on 250 working days a year, single shift unless stated otherwise)

TONNES PER ANNUM

	INSECTICIDES & FUNGICIDES			HERBICIDES	
	LIQUIDS	POWDERS	GRANULES	LIQUIDS	GRANULES
I.C.I. Asiatic	--	--	--	5,000 1)	--
Du Pont	1,000	--	--	--	--
Zuellig	1,000	--	5,000	--	--
Shell	5,000	--	7,000	--	--
Union Carbide	100	600 2)	--	--	--
Bayer	3,500	--	2,000	--	--
PATO	3,500	500	3,000	--	1,500
Hoechst	1,000	--	1,500	--	2,000
Chia Tai	400	500	2,500	--	--
Agro-Chemical Ind.	1,500	--	--	2,000 1)	1,250
Sharp	3,500	250	4,500	--	9,000
T.J.C.	2,500	2,500 2)	1,400	--	1,100
Ladda	3,000 3)	5,500 2)	5,000	2,500	--
Seri	500	--	--	500	600
TOTAL	26,500	9,850	31,900	10,000	15,450
PLANNED ADDITIONAL FORMULATING CAPACITY (to 1986)					
Chia Tai	1,250	--	--	--	--
May & Baker	--	--	--	500	2,000
Metro	1,250	600	1,250	--	--
Ladda	--	--	--	--	5,000
Ag-gro	10,500	3,750	5,000	3,000	--
	13,000	4,350	6,250	3,500	7,000

NOTE: 1) Three-shift working on paraquat 2) Have fine grinding capability
3) Including 500 tpa flowables

B. Industrial Hygiene

Most of the factories visited had the appearance of having been recently cleaned up, but from general observation it is clear that the attention paid to health and safety of workers and to general pollution control varies from excellent (in the case of the big multi-national companies) to very poor. It must be emphasised that, when incorrectly handled, pesticides can be very dangerous to human and livestock. Even though this adds significantly to the capital cost, all factories producing and packing pesticides must have proper facilities, as required under Section 39 of the Factory Act 1969 (and amendments), for extracting and trapping dust and vapours at charging and discharging points, collecting and treating contaminated liquid and solid waste and the safe disposal of contaminated drums and other containers. Workers should always be provided with overalls, working shoes and head covering into which they should change before starting work, leaving their own clothing in special lockers. Other protective clothing, e.g. gloves, dust masks, should be provided as necessary. After work, workers should take a shower before changing back into their own clothes. Dirty overalls should be laundered daily. The Ministry of Industry has Inspectors who have powers under Section 36 of the Factory Act to enter all industrial premises to report on working conditions. Visits to pesticide formulation factories, which are probably handling chemicals more toxic than in any other industry in Thailand, should be made frequently. The management of factories which consistently ignore accepted standards of industrial hygiene and pollution control should be dealt with severely. Sections 47 and 48 of the Factory Act might be considered somewhat lenient in this respect.

C. Quality Control

The standard of quality control varies from excellent to poor. In some factories visited the quality control facilities, although present, did not appear to be used. As stated in Chapter IV, if the Thai pesticides industry is to develop as a useful aid to the farmer and not be just another industrial project, complete quality control systems (active ingredient and physical properties) must be installed and used in every formulation factory. Under the Poisonous Articles Acts 1967 and 1973, there is provision for Authorized Officials to visit factories and stores and take samples for analysis. This provision should be enforced as soon as the Dept. of Agriculture Quality Control Sub-Division is able to cope with the increased workload.

VIII. RAW MATERIAL AVAILABILITY

A. Chemicals

The Government lays great stress on the use of Thailand's available natural resources in establishing manufacturing projects. Unfortunately, the number of chemicals available currently is small and it will be at least 1992 before the proposed Petrochemicals Complex will produce the building blocks required for the manufacture of fine chemicals (of which pesticides are only a small part).

The only locally produced raw materials available for use in the manufacture and formulation of pesticides in Thailand and for which prices are given in Appendix IX are:

Carbon bisulphide
Caustic soda liquor (50%)
Chlorine
Copper scrap
Ethyl Alcohol
Hydrochloric acid (35%)
Kaolin (china clay)
Lime hydrated
Methyl Alcohol
Sand (for granules)
Sodium Chloride (80-85%)
Solphuric acid (98%)
Zinc chloride (53% liquor and flake)

There is an urgent need for local xylene for the formulation of emulsifiable concentrates. At present it is imported by Shell from Singapore and elsewhere and carries an import duty of 16.5%. Furthermore, because of shipping delays in 1983, there was no xylene available in the Kingdom for over one week. Had this shortage occurred at the height of the formulation season, this could have had very serious repercussions on the availability of pesticides to farmers. El-Halfawy (Ref. 7) recommends the establishment of an aromatics plant as top priority in the Petrochemicals Project, but the PTT say that until the first stage of the olefins project is under way (1988) they are unlikely to commence a feasibility for an aromatics complex. They are also of the opinion that such a complex is better suited to the private sectors.

The Kao Industrial Co. (Thailand) Ltd., who are large shampoo manufacturers, produce sodium dodecylbenzene sulphonate from imported dodecylbenzene which they sulphonate with sulphur trioxide made from imported sulphur. The calcium salt is widely used as the anionic emulsifier component in e.c. formulations and could be produced by Kao. The sodium salt, if dried, could be used as a wetting agent in w.p. formulations. Here again, El-halfawy refers to the possibility of producing linear alkyl benzenes, such as dodecylbenzene on the proposed Petrochemicals Complex.

Since large quantities of imported surface active agents are used, mainly in the detergent and dyeing industries, their production in Thailand should be encouraged.

(N.B.) It is also reported that Metro have requested BoI permission to erect an alkylbenzene sulphonates plant.

D. Packages

There appears to be no problem with regard to the supply of suitable small packages at a reasonable price. With the exception of small cardboard boxes, the standard seems to be good. There are plenty of good quality new and reconditioned second-hand 200-litre drums available for the bulk trade.

IX. PROSPECTS FOR LOCAL MANUFACTURE OF PESTICIDES

A. Introduction

The local manufacture of pesticides which, at present, carry a very low import tariff burden of 5.5% with very few restrictions on importation, can only be economically viable if the project receives the full support of BoI promotional privileges. Current formulators of pesticides do not receive these privileges and it is therefore most unlikely that the original Government concept of a large complex which would not only manufacture a number of active ingredients but would also formulate, pack and market a whole range of pesticides for home and export would be treated any differently.

Unfortunately, as far as basic manufacture is concerend, Thailand is lagging behind other ASEAN countries such as Malaysia, the Philippines and Indonesia. Thus, with the possible exception of fungicides which are not yet produced with ASEAN, the case for exports must be subordinated to that based on home consumption.

A view must also be taken on the role the Government should play in pesticide manufacture. This poses a number of interesting questions which must be answered before decisions on the Government's involvement in the industry can be taken.

1. Should the Government become actively engaged in the Pesticides Industry which after all, is only a small, though highly technology-oriented part of the fine chemicals industry?
2. Should the Government embark upon projects which although unattractive to the private sector, would have socio-economic value and result in savings in foreign currency?
3. Should the Government subsidise an industry which will bring in new technology?
4. Will production of pesticides by a Government agency give the farmer better service and value than he is now getting?
5. Would Government resources be better employed elsewhere, e.g.
   a) in better farmer training on when and how to use pesticides
   b) in better enforcement of laws relating to industrial safety, hygiene and pollution control
   c) in enforcing quality standards?

The last question has already been dealt with in Chapter III and IV.

The answers to the other four questions are largely political. All that can be done in this report is to indicate possible courses of action. The decision-making must lie with Government although the author is in no doubt that any Government involvement should be restricted to the basic manufacture of active ingredients for sale to existing formulators. The latter already possess efficient sales and technical service forces who understand the needs of Thai agriculture and who can maintain a flow of pesticides through dealers to farmers.

The cases for manufacturing insecticides, fungicides and herbicides are dealth with in the Sections that follow.

B. Insecticides (including acaricides)

No insecticides are at present manufactured in Thailand. Indonesia is erecting a plant for making DDT (for public health use) and is well advanced in the planning of plants to produce BPMC, carbaryl, carbofuran, diazinon, isoprocarb, phenthoate and methomyl for agricultural use.

Should Thailand follow suit and, if so, which products should be made? Probably the main difficulty in forecasting future insecticide usage in Thailand is the very rapid rate at which resistance of the pest to a particular chemical can build up. This is partly due to the climatic conditions which favour rapid reproduction but also to the mis-use by farmers who will often underdose, either because (a) they cannot afford the full treatment or (b) instead of applying, say 100 ml. every five days they apply 20 ml. every day. Often, however, if there is a heavy infestation just before harvest, a crop, particularly vegetables, will receive a large overdose, giving problems with toxic residues as well as killing beneficial insects. For these reasons, the basic manufacture of one or two insecticides might be considered very risky financially, especially as none of the major raw materials are likely to be available in Thailand for many years.

Krebs (Ref. 2) recommend the manufacture in Thailand of dicofol (750 tpa) and dimethoate (plus, possibly malathion) (1,000 tpa). Seri Agricultural Chemicals are carrying out a feasibility study on the manufacture of carbofuran (600 tpa) and monocrotophos (280 tpa) but the results were not available at the time this report was written.

Organo-chlorine compounds

Generally speaking, these are being phased out of agricultural use world-wide because of environmental problems caused by their persistence. The major import into Thailand is DDT (460 t 75% w.p. valued at ฿ 18 million for mosquito control in 1983).

Dicofol, of which about 100 tonnes (as 100% a.i.) were imported in 1983, is a well established non-systemic acaricide, with low mammalian toxicity (the acute oral LD_{50} for rats is about 750 mg/kg). Residues in the soil decrease rapidly, but traces may remain for over one year.

Since the raw materials for its production (95% by value imported) at current World prices amount to nearly ฿ 103,000 per tonne 100% a.i. compared with the average 1983 import price for tech. dicofol 83% of ฿86,000 per tonne (฿ 103,600 per tonne 100% a.i.), the viability of producing dicofol in Thailand could well rest upon the price at which, say, Indonesia is prepared to sell "off-specification" DDT (i.e. 'soft' DDT which, although conforming to WHO Specifications, has an insufficiently high para-para isomer content to enable it to be finely ground in the formulation of a 75% DDT w.p. to WHO Specifications for mosquito control). No other organo-chlorine compound should be considered for manufacture in Thailand.

Organo-phosphorus compounds

In spite of problems associated with some of the more toxic compounds, respondents in both the public and private sectors agree that the use of organo-phosphorus insecticides (currently about 2,000 tpa as 100% a.i.) will continue for many years although the actual products used may well change. A multi-purpose plant capable of making most of the compounds at present in use, and in particular malathion, dimethoate and monocrotophos, would be the ideal solution. Unfortunately, they are not all chemically related and the manufacturing know-how is spread over a nubmer of companies who compete with each other and are unlikely to co-operate in a mixed technology venture.

A large European manufacturer (Cheminova) which supplies many of the multi-nationals with organo-phosphorus compounds or intermediates for their manufacture is of the opinion that a 2,000 tpa plant to produce two or three chemically related products (e.g. malathion, diazinon, fenitrothion) would be feasible but not anything smaller or more multi-purpose.

At the investigation of UNIDO and the Egyptian Government, a 300 tpa pilot plant is being built in Egypt using technology from Aragonesas, Spain and Foster Wheeler engineering to produce malathion and dimethoate and to study the concept of multi-purpose organo-phosphorus plants. Unfortunately, Aragonesas do not have the technology for producing monocrotophos, although it is chemically related to dimethoate.

UNIDO/Vienna also suggested contacting Hindustan Insecticides of India who were uanble to assist but suggested approaching Rallis for dimethoate, Excel Industries for malathion and National Organic Chemical Industries for monocrotophos.

None of these approaches would appear to offer any advantage over the Krebs proposal for a 1,000 tpa dimethoate/malathion plant with an investment of 95 million baht (US $4.1 million). If such a plant were erected, it is quite likely that technology for manufacturing monocrotophos, probalby with only small additions to the equipment, could be obtained later.

Carbamates

Carbaryl is the most widely used of the carbamate insecticides but, since its synthesis involves the highly toxic alpha-naphthol and methyl isocyanate, it is not considered to be a suitable candidate for manufacture in Thailand. None of the other carbamates, with the possible exception of carbofuran whose manufacture is already being considered by Seri, would appear to be a suitable candidate for local manufacture.

The Pyrethroids

The manufacture of this group of compounds is not recommended. Not only are the pyrethroids still covered by patents, but their synthesis involves some very complicated chemistry. New routes and compounds are still being developed. Furthermore, there is some doubt about the insect resistance situation.

C. Fungicides

No fungicides are produced in any of the ASEAN countries, which makes the possibility of production in Thailand more attractive.

The usage of fungicides in Thailand (about 2,400 tpa as 100% a.i.) is still small compared to that of insecticides and herbicides. Nevertheless, respondents feel that the market will start growing in the next five years or so - particularly for the less toxic products. For this reason, copper oxychloride, the dithiocarbamates and sulphur have been singled out of further study.

Krebs' (Ref. 2) recommendations follow similar lines except that they have opted for a Bordeaux Mixture 20% Cu w.p. instead of the more familiar copper oxychloride.

Copper oxychloride

In 1983 over 800 tonnes of formulated copper fungicides (mainly oxychloride) were imported. This is equivalent to 340 t copper metal. The value was 21.5 million baht cif.

All the raw materials (with the exception of a small quantities of surface active agents) required for the manufacture of copper oxychloride wettable powder are available in Thailand (although, since copper scrap is also imported for brass manufacture, it should probably be regarded as an import) and it was decided to study the economics of its manufacture on a 1,000 tpa (500 tpa Cu) scale, more deeply. Data for a cost study were obtained from two European sources (Norddeutsche Affinerie of West Germany and Villaran of Spain). An approach to Chemolimpex of Hungary produced no response.

The German process was chosen for the cost study because:

a) the process is simpler
b) the cost (in Thailand) of raw materials and utilities per tonne finished product is lower
c) the licence fee is lower

The data and assumptions on which the study was based are given in Appendices XI and XII.

The total investment (fixed capital) assuming it to be an extension of existing facilities) is estimated to be ฿ 46.3 million (at 1984 prices), of which 21% would be in foreign currency.

Since there appears to be

a) no systematic collection or guarantee of availability of copper scrap in Thailand

b) The TOT do not appear to have consolidated records of their disposal of scrap copper wire and

c) copper scrap is imported, indicating that there is insufficient arising, at present locally,

it was decided to use an average import price of ฿ 35,000 per tonne copper and not ฿ 29,000 per tonne which was the price for copper scrap in Bangkok in July 1984.

Using this figure, it can be seen that the total direct cost (excluding financing charges) of manufacturing copper oxychloride 50% Cu w.p. is just under ฿ 30,000 per tonne packed in 25 kg bags. Thus, to get a 15% return on capital (1% above the assumed borrowing rate of 14%) one would have to sell to repackers/distributors at ฿ 26,000 per tonne landed, duty and taxes paid (฿ 24,000 cif) for material originating from southern Africa or ฿ 40,000 per tonne for West German material carrying well-known trade names. (1st. quarter 1984 import statistics, unpublished).

Prior to 1983, most of the copper fungicides used in Thailand originated from Western Europe. However, in 1983, over 60% of the copper oxychloride originated from southern Africa. This new, and cheaper, source cannot be ignored, so the possibility of selling locally produced copper oxychloride at a large premium is not considered very realistic. The most that one can say is that an investment of nearly ฿ 10 million in foreign currency plus a further ฿ 36.5 million in local currency could save the Kingdom about ฿ 4,250 per tonne in foreign currency (or, say, ฿ 4.25 million a year if the plant's capacity were fully utilized).

The situation could change, however, if more copper scrap becomes available locally, as might happen in a few years' time as the TOT improves its network and replaces existing telephone lines.

Since copper accounts for about 60% of the operating costs, the viability of a copper oxychloride project will depend very greatly upon the skill with which copper scrap can be purchased. A purchase contract for local scrap would have to be very carefully negotiated not only with regard to the price but also regarding regularity and continuity of supply.

From the above, it is considered very doubtful whether any established private sector company would risk investing over ฿ 46 million (US $2 million) in such a project but they might be interested in a joint venture with Government, particularly if it could be linked with other pesticide manufacture, e.g. dicofol, dimethoate, dithiocarbamates and wettable sulphur.

Another possibility which could save a lot of foreign currency and which might appeal to Provincial MoA extension services is to get the farmers who now use copper oxychloride to go over to tank-mix Bordeaux mixture.

It should be possible to set up small stations at, say, Plant Protection Service Units, who would make up a stock copper sulphate solution in a plastic tank by dissolving copper scrap in sulphuric acid (battery acid). This solution could then be sold to the farmer in re-fillable plastic jerry-cans. The farmer would then dilute it with water, add a slurry of hydrated lime and produce freshly-made Bordeaux mixture. The product made this way has a gelatinous consistancy and adheres extremely well to foliage under heavy rainfall conditions.

This suggestion has the advantage of requiring very little equipment and uses readily available raw materials of local origin.

A typical formula would be:

a) Stock copper sulphate solution (25%)

For 100 litres

Copper scrap	6.25 kg (equivalent to 25 kg copper sulphate pentahydate)
Battery acid (33% H_2SO_4)	16 litres
Water	to 100 litres

The density of this solution should be 1.15 g/ml. It must be neutral to litmus.

b) Bordeaux Mixture #

1) For high volume spraying

Stock copper sulphate solution	4 litres
Hydrate lime	1.25 kg
Water	to 100 litres

Derived from formula given in the entry under 'Bordeaux mixture' in 'The Pesticide Manual' published by The British Crop Protection Council.

2) For low volume spraying

Stock copper sulphate solution	16 litres
Hydrated lime	2 kg.
Water	to 100 litres

The Dithiocarbamates

Some 900 tonnes formulated dithiocarbamates (zineb, maneb, propineb and mancozeb) with a cif value of 40.5 million baht were imported in 1983. As these products have a very broad spectrum of activity and are relatively non-toxic, their manufacture in Thailand would appear to be very appropriate. Usually, the main constraint in developing countries is the need to import and transport by road over long distances the highly flammable carbon bisulphate (CS_2), particularly when the temperature in the sun often reaches the boiling point of CS_2. However, Thailand has an active rayon industry which has been making its own CS_2 for the past 14 years from imported sulphur and local charcoal using an electro-thermal process. Thus the manufacture of dithiocarbamates on the site of the Thai Rayon Factory was deemed technically feasible and enquiries were made on a number of potential licensees (Rohm & Haas, Du Pont, Pennwalt and AKZO) for data to enable a cost study to be made on a plant to produce 2,000 tpa formulated products. The provisional product split was:

Zineb 80% w.p.	1,100 tpa
mancozeb 80% w.p.	500 tpa
maneb 80% w.p.	200 tpa
propineb 70% w.p.	200 tpa

Rohm and Haas and Du Pont replied that they were unable to supply technology for this small scale. No replies were received from AKZO or Pennwalt in time for inclusion of data in this report. Should data arrive before the author's departure, an Addendum to this report will be issued. This aspect should be looked at more closely by the Government in collaboration with a private company e.g. Thai Rayon.

In the meantime, Krebs (ref. 2) have recommended the erection of a 500 tpa technical zineb plant with an estimated investment of 102 million baht (US $4.4 million).

Sulphur

Since nearly 1,000 tonnes sulphur as 80% w.p. were imported in 1983, with a cif value of over 14 million baht, the possibility of formulating sulphur produced a by-product from another industry was considered. As considerable quantities of sulphur have to be imported for the manufacture of sulphuric acid and rayon, the possibility of diverting the relatively small amount used in the pesticides industry from the sulphur recovery units at petroleum refineries was not considered feasible. However, in the manufacture of rayon a lot of hydrogen sulphide (H_2S) is produced. Until recently this H_2S has been vented to atmosphere but the Company has been ordered to stop this pollution. It has accordingly invested in a Claus unit which, at present, recovers some 300 tpa sulphur in the form of a very fine wet paste. If an organophosphorus were also erected on the site of the rayon factory, more sulphur could be recovered. This could be mixed with surface active agents and dried in a spray drier or fluid bed drier. It has therefore been suggested to the management of the Birla Group, who own the Thai Rayon Factory and who wish to diversity, that they should examine the possiblity of producing an 80% S. w.p. for sale to formulators and re-packers already in the pesticides field. If such a plant could produce 600 tpa sulphur 80% w.p. there could be an annual saving in foreign currency of between 5.5 and 6 million baht. (Based on 1983 import prices less cost of surface active agents).

D. Herbicides

This is one group of pesticides where the rate of growth is far exceeding that of insecticides or fungicides. The main products used are paraquat, 2,4-D sodium salt and dalapon.

ICI Asiatic and Chia Thai between them could produce 1,700 tpa paraquat ion (2,340 tpa paraquat dichloride) by the quaternization of 4,4'-bipyridyl with methyl chloride and would probably expand their capacity if the demand exceeded this figure.

MCPA (not used in Thailand) and 2,4-D are produced in the Philippines; paraquat and dalapon are produced in Malaysia.

As it is not clear how the use of herbicides will develop, it is concluded that there can be no case for the basic manufacture of any other herbicides in Thailand at present. If, in a few years' time, the use of 2,4-D switches from the present favoured (and cheap) sodium salt to an ester, then the esterification of imported 2,4-D acid might be undertaken.

The result of the Seri feasiblity study into the manufacture of glyphosate (210 tpa) was not available at the time of writing this report.

E. Conclusions

Even if the basic manufacture of active ingredients such as dimethoate, dicofol, copper oxychloride and the dithiocarbamate fungicides were carried out on an existing factory site where personnel are experienced in handling dangerous chemicals and skilled management and other infrastructure are already available and can be costed in at a small proportion of their total cost, it is unlikely that the products could be manufactured at a cost competitive with that of good imported products. This is mainly due to the fact that plants making the imported products have already been well depreciated but also to the high cost of improted raw materials which would account for a large proportion of the operating costs in Thailand.

Nevertheless, because there could be some savings in foreign exchange and also because it would give Thailand experience in fine chemical manufacture, it is recommended that the Government should try and work out a joint venture with a private sector company. The capital investment would have to be kept to a minimum (without reducing health and safety measures) and very careful control on the price and quality of imported raw materials would have to be maintained. A Consultant skilled in purchasing contracts with good specifications and delivery clauses.

It is not considered feasible for the Government alone to set up basic manufacture on a green-field site.

X. ACKNOWLEDGEMENTS

The Expert would like to express his sincere thanks for the very valuable assistance given to him by those persons and organizations mentioned in Appendix II and also by the many other people in the Ministry of Industry, Ministry of Agriculture and Cooperatives and UNDP Offices.

APPENDIX I

JOB DESCRIPTION

Post Title	:	Expert in Pesticide Manufacture Technology
Duration	:	Six months
Date required	:	As soon as possible
Duty Station	:	Bangkok/Thailand with possible travel within the country
Purpose of Project	:	To help in stimulating Government and private sectors establishing pesticide factories and its related industries.
Duties	:	The expert will perform the following duties: - to study the available natural resources necessary to use in pesticide manufacture and its related industries in Thailand; - to conduct a feasiblity study of short and long term investments of pesticide manufacture factories and its related industries in Thailand; - provide recommendations to the Thai Government concerning the pesticide manufacture technology including financial support and manpower needed for pesticide manufacture and its related industries; - advise to the Thai Government on pesticide business in the conneciton with foreign firms in order to gain assistance necessary in the establishment of pesticide factories and its related industries in thailand
Qualifications	:	Chemist or Chemical Engineer with wide experience in the pesticide manufacture technology and related industries.
Language	:	English

APPENDIX II

PERSONS AND ORGANISATIONS CONTACTED

A. International

UNDP

Mr. Charles H. Larsimont, Deputy Regional Representative

Mr. Mohammed A. Siddiqui, Senior Industrial Field Adviser, UNIDO

Mr. Tadashi Kondo, Assistant to " " " "

Dr. Mohammed El-Halfawy, UNIDO Consultant, Chemical & Petrochemical Industries

Mr. Y. Melamed, FAO Consultant)

B. Public Sector

MINISTRY OF INDUSTRY

Dr. Ing Djakkrit Puranasamriddhi, Deputy Permanent Secretary (to mid. March 1984)

Mr. Chaiwai Sangruji, Deputy Permanent Secretary (from mid. March 1984)

Mr. Trakarn Chairat, Direcror, Office of Basic Industry Development

Mr. Narong Techawattanakarn, (Chemical Engineer), Office of Basic Industry Development, Designated Counterpart

Mrs. Orntipa Krittaphol, (Economist), Office of Basic Industry Development, Designated Counterpart

Miss Visavarunee Onsuwan, (Administration Officer), Office of Basic Industry Development, Designated Counterpart

Mr. Piyavut Napataloung (Mechanical Engineer), Office of Basic Industry Development

Mr. Jirawit Techawatanawana (Industrial Engineer), Office of Basic Industry Development

MINISTRY OF AGRICULTURE AND COOPERATIVES

Dr. Riksh Syamanonda, Deputy Director General

Mr. Montri Rumakom, Director, Entomology & Zoology Division

Mr. Adul Worawisitthumrong, Director, Agric. Toxic Substances Division

Mrs. Nuansri Tayaputch " " " "

Mrs. Chirapan Sriplakich " " " "

Mrs. Supranee Impithuska " " " "

Mr. Boonchob Bhatraruji, Director, Pesticide Registration Divison

Mr. Patanan Sangkatawat, Director, Pesticide Regulatory Section Agric. Regulatory Division

APPENDIX II Cont'd.

Mr. Preecha Chupanish, Pesticides Regulatory Section Agric. Regulatory Div.

Mr. Prayoon Sricharoen, " " " " " "

Mr. Paitoon Pisuthsin, " " " " " "

Dept. of Agriculture

Miss Anong Chandrasrikul, Director, Plant Pathology & Microbiology Div.

Mrs. Cha-um Premasthira, Plant & Weed Div.

Mr. Tawee Sangton, Plant & Weed Div.

Mr. Prasan Vongsaroj, Plant & Weed Div.

Dr. Somchai Khomvilai, Plant & Weed Div.

Dept. of Agricultural Extension

Mr. Udom Dechamani, Director, Plant Protection Service Div.

Mr. Proyong Jeungyusook, Chief, Plant Protection Sub Div., Chiang Mai

Mr. Saard Pongsuwan, Plant Protection Unit I, Chiang Mai

MINISTRY OF PUBLIC HEALTH

Dr. Pakdee Pothisiri, Tech, Director, Food and Drug Administration

OFFICE OF THE PRIME MINISTER

Board of Investment

Mr. George D. Hooker, Consultant, Project Development Div.

Mr. Chokdee Kaosang, " " "

Consumer Protection Board

Mr. Thamrong Chamdermphadejsuk, Director

KASETSART UNIVERSITY

National Biological Control Research Centre

Dr. Banpot Napompeth, Director

Dept. of Entomology

Dr. Sutham Areekul, Professor of Entomology

PETROLEUM AUTHORITY OF THAILAND

Mr. Viset Choopiban, Director, Policy and Planning Dept.

APPENDIX II cont'd

C. Private Sector (Agro-chemical) - Thailand

Chia Tai Seeds & Agricultural Co., Ltd.

Dr. Tianchai Thongsinthusak, Manager, Quality Control & Research Div.

Mr. Decha Gurdsapsri, Plant Office Manager

Dr. Visute Suckowong, Ag. Chem. Division Manager

Agro Chemical Industry Co., Ltd. (part of Chia Tai Group)

Mr. Chin Liang Lin, Vice President

T.J.C. Chemical Co., Ltd.

Mr. Pholchai Onsanit, General Manager

Mr. Bunthit Jinathitra, Production Manager

Mr. Kunioke Someya, Factory Manager

ICI Asiatic (Agriculture) Co., Ltd.

Mr. Bruce Pointer, Managing Director

Mr. Chuer Pavasant, Marketing Director

Mr. Parkpoom Jarnyaharn, Factory Manager

Du Pont (Thailand) Ltd.

Mr. Chalat Sripicharn, General Marketing Manager and President of the Thai Pesticides Association

Mrs. Malin Smakkamai, Plant Manager

The Shell Co., of Thailand Ltd.

Mr. Tanong Pongpanich, Agrochemicals Manager and Secretary of the Thai Pesticides Association

Mr. Chaovalit Mahatumaratana, Chemicals Plant Manager

Cyanamid Thailand Limited

Dr. Verachart Chaicumpa, Manager, Agricultural Products

Dr. Somchai Theveethivarak, Sales Supervisor

Pato Chemical Ind. Co., Ltd.

Mr. Tu Ming Chieh, Managing Director

Mr. Takeo Nakahara, Production Engineer

APPENDIX II Cont'd.

Pitsulin Co., Ltd.

Mr. Pitoon Khawtephawan, Managing Director

Hoechst Thai Limited

Mr. Andrew McDowell, Manager, Plant Protection Divison

Mr. Johannes Schmidt, Division Manager, Production

Mr. Kasem Phaerakkakit, Manager, Agro Chemical Plant

Monsanto Thailand Limited

Mr. Bovorn Rasmidatta, Country Manager, Agric. Products

Ciba-Geigy Services Ltd.

Mr. J.P. Schmier, Agro Regional Manager

Mr. C.J. Hare, Regional Technical Manager

Rohm and Haas Southeast Asia, Inc.

Mr. Niyom Juntakool, Resident Manager

Union Carbide Thailand Ltd.

Mr. Premsak, Manufacturing Manager, Agricultural Products Divison

Bayer Thai Co., Ltd.

Mr. Michael Kessner, Manager Agrochemicals Division

Mr. Suthep Tangkachavana, Marketing Manager

Mr. Gernot Erdmann , Plant Management

The Seri Agricultural Chemicals and Industries Co., Ltd.

Mr. Serm Sawangnetr, Tech. Manager and Asst. Sales Manager

Metro Co., Ltd. (Srikung Watana)

Mr. Bancha Vudhiyarangsit, Asst. General Manager

South-East Agricultural Promotion Co., Ltd. (part of Chia Tai Group)

Mr. Pakorn Worasawate, General Manager

FMC (Thailand) Ltd.

Mr. Michael Blackburn, Country Manager

Dr. Suriyant Boonnarkka, Marketing Manager

F.E. Zuelling (Bangkok) Ltd.

Mr. Virach Chantrasmi, Asst. Manager, Agro Division

FBC (Thai Pesticides) Ltd. - (A subsidiary of Schering AG)

Mr. R.D. Kennett, Area Manager, South East Asia

Union Carbide Thailand Ltd.

Mr. Sakorn Wongprasert, Sales Manager, Agric. Products Divison

Dow Chemical Thailand Ltd.

Mr. Kosol Lertchanaruangrith, Agric. Field Services Manager

May & Baker Ltd. (Part of the Rhone Poulenc Group)

Mr. Uthai Lophansri, Agrochemical Division Manager

Mr. Pradit Piramarn, Agrochemical Marketing Manager

Ladda Co., Ltd.

Mr. Pichai Manichote, Managing Director

Ag-gro (Thailand) Co., Ltd.

Mr. Pravit Chiruppapa, Managing Director

Yip In Tsoi & Jacks Ltd.

Mr. Prasitsak Phanpheng, Agro-Chemical Section Manager

Kijkasetr Chemical Ltd. (Dealer)

Mr. Thawat Cherdsathirakul, Director

D. Others

Birla Group of Industries

Mr. C. Radha Krishnan, Vice President Projects

Mr. K.C. Joshi, Vice President Production, Thai Rayon Co., Ltd.

Kao Industrial Co. (Thailand) Ltd. (Detergent Manufacturers)

Mr. Prakorn Rotdilokpanich, Reaction Section Manager

APPENDIX II Cont'd

The East Asiatic Company (Thailand) Ltd. (Chemical Traders)

Mr. L. Rasmussen, General Manager, Chemicals

Mr. Kamol Sasivongphakdi, Manager, Clearance Division

Sindhu Pulsirivong & Associates (Consulting Engineer)

Mr. Sindhu Pulsirivong, Director

Bangkok Thanakit (Sack Manufacturers)

Mr. Pongkasem

Dow Chemical Thailand Ltd.

Mr. Chai Tandhonskul, Designed Products

Krebs & Cie., France (Engineering Contractors)

Mr. Daniel Caignan, Chief Engineer, Organic Chemicals Dept.

Mr. Bernanrd Espiaube, Engineer, " " "

Institut de Recherches Agronomiques Tropicales, Montpellier, France (Consultants to Krebs)

Mr. Jacques Deuse, Head, Pesticides Dept.

Mr. Michel Grenouillat, Pesticides Expert

Franco-Pacific Co., Ltd. (Local agent for Krebs)

Mr. Guy Machet, Director

Imperial Chemical Industries plc, Plant Proteciton Division/England

Mr. A.B. Higgins, Area Marketing Manager, SE Asia

Ciba Geigy Ltd., Agrochemicals Division, Switzerland

Mr. S.A. Schiess, Area Marketing Manager, SE Asia

Dr. F.E. Pfister, Head, Agro-Production Group

Mr. O.E. Schenk, Country Manager (Production) SE Asia

APPENDIX III

FACTORIES VISITED

Agrochemical Industry Co., Ltd., Kanchanaburi (part of Chia Tai Group)

T.J.C. Chemical Co., Ltd., Bangpoo

ICI Asiatic (Agriculture) Co., Ltd., Bangpoo Industrial Estate

Du Pont (Thailand) Ltd. Bangpoo Industrial Estate

F.E. Zuellig (Bangkok) Ltd., Tanyaburi

Thai Rayon Co., Ltd. Angthong

The Shell Co., of Thailand Ltd., Chongnonsri, Bangkok

Union Carbide Thailand Ltd., Nonthaburi, Bangkok

Bayer Thai Co., Ltd., Phrapra Daeng and Bangpoo Industrial Estate

Pato Chemical Ind. Co., Ltd., Minburi

Hoechst Thai Limited, Nava Nakorn

Chia Tai Seeds & Agriculture Co., Ltd., Omnoi

Sharp Formulators Co., Ltd., Krathum Baen

Ladda Co., Ltd., Nakornpathom

Saha Paisan Industries, Mahachai Katumban, Samut Sakorn

APPENDIX IV

MAJOR PRODUCTS IMPORTED, 1981 - 1983
(Calculated as 100% Active Ingredient)

		1981	1982	1983
1.	INSECTICIDES			
a)	Organo-phosphorus		(T o n n e s)	
	Dimethoate	443	177	316
	Ethyl parathion	1	1	81
	Fenitrothion	30	110	26
	Malathion	138	88	176
	Methamidophos	83	102	109
	Methyl parathion	308	20	617
	Monocrotophos	440	516	302
	Others	405	323	376
		1,848	1,337	2,003
b)	Organo-chlorine			
	DDT	315	18	345
	Dicofol	35	78	110
	Endosulfan	115	63	32
	Toxaphene	288	51	--
	Others	190	74	106
		943	284	593
c)	Carbamate			
	BPMC	131	97	74
	Carbaryl	151	26	210
	Carbofuran	216	166	97
	Isoprocarb ('Etrofolan')	138	117	51
	Methomyl	164	148	172
	Others	58	61	67
		858	615	671
d)	Pyrethroid			
	Cypermethrin	23	23	9
	Fenvalerate	13	5	8
	Permethrin	3	2	4
	Others	2	2	3
		41	32	24

APPENDIX IV Cont'd

	1981	1982	1983
		(T o n n e s)	
e) **Miscellaneous**			
Methyl bromide	512	540	--
Paradichlorobenzene	209	103	165
Zinc Phosphide	--	40	13
Others	50	285	46
	771	968	224
TOTAL INSECTICIDES (as 100% a.i.)	4,461	3,236	3,515
cif value - baht million	792	692	632
2. **FUNGICIDES**			
Captafol	102	36	40
Captan	239	145	9
Copper Compounds (as Cu) (mainly oxychloride)	236	279	340
Mancozeb (+ 'Vendozeb')	185	135	180
Maneb	66	57	55
Propineb	58	96	101
Sulphur	208	194	955
Zineb	575	263	556
Others	110	271	145
TOTAL FUNGICIDES (as 100% a.i.)	1,779	1,476	2,381
cif value baht million	149	133	156

APPENDIX IV Cont'd

	1981	1982	1983
		(T o n n e s)	
3. **HERBICIDES**			
Alachlor	39	42	100
Ametryne	284	430	45
Atrazine	83	451	172
Bromacil	55	74	101
Butachlor	85	41	60
2,4–D a.e. (mainly sodium salt)	1,046	1,032	1,650
Dalapon–sodium	906	401	957
Diuron	415	77	128
Glyphosate	—	59	32
Paraquat dichloride	1,178	1,013	1,300*
Thiobencarb (benzthiocarb)	50	52	68
Others	117	231	167
TOTAL HERBICIDES (as 100% a.i.)	4,258	3,903	4,780
cif value baht millions	461	466	500*
GRAND TOTAL ALL PESTICIDES	10,498	8,615	10,676
cif value Baht millions	1,402	1,291	1,288

*Corrected for local manufacture from 4,4'-bipyridyl

Source: Dept. of Agriculture (Ref. 4)

APPENDIX V

DRAFT JOB DESCRIPTION

Post Title	:	Expert in Pesticide Formulation Analysis
Duration	:	12 months
Date required	:	As soon as possible
Duty Station	:	Bangkok
Purpose of Project	:	To assist in establishing a viable pesticide formulation analysis section of the Dept. of Agriculture.
Duties	:	To assess the usefulness of analytical equipment available in the Dept. of Agriculture and make recommendations for improvements. To train counterpart personnel in sampling and modern analytical technique for active ingredient content and physical properties of pesticides. To assist in producing Thai Standards for pesticides. To devise procedures for the routine sampling of pesticides imported into or produced in Thailand so as to make maximum use of available personnel and equipment.
Qualifications	:	Analytical Chemist with wide experience of modern techniques preferably gained in the pesticides industry and of laboratory management.
Language	:	English

APPENDIX VI

EXAMPLES OF DUTIES AND BUSINESS TAX RATES

(Mid 1984)

Product	Tariff Chapter No.	Duty %	Mark-up %	Business Tax %	Total Payable % (Note 2)
Sulphur	28.02	11	8.5	1.5	13.04
Phosphorus pentasulphide	28.15				
Manganese sulphate	28.38				
Xylene	29.01				
Acetone	29.13	16.5	8.5	1.5	18.63
Cyclohexanone	29.13				
Diethyl maleate	29.14				
Monochloro acetic acid	29.14				
Monomethylamine	28.22				
Ethylene diamine	29.22				
Surface active agents	34.02	33	11	9	47.33
Pesticides (Note 1)	38.11	5.5	11.5	1.5	7.39
Copper scrap	74.04	5.5	7.0	1.5	7.33

Notes: 1) formulated packed for retail sales; also technical and formulated packed in bulk for repacking if specially enumerated by Director of Customs

2) Reduced by 90% with BoI privileges

Source: Wisuthachinda D. (Ref. 10) as up-dated November 1983

APPENDIX VII

CALCULATION OF IMPORT DUTY AND TAXES FOR PESTICIDES

cif value		100.00
Duty @ 5.5%		5.50
Business & Municipal tax (a)		1.89
total payable		7.39

(a) Calculation of taxes

Value duty paid	105.50
National mark-up @ 11.5%	12.13
Value for business tax	117.63
Business tax @1.5%	1.76
Less 2% discount for cash	0.04
	1.72
Plus 10% municipal tax	0.17
Total taxes	1.89

APPENDIX VIII

KREBS FEASIBILITY STUDY ON THE ESTABLISHMENT OF A PESTICIDES PLANT IN THE KINGDOM OF THAILAND

The major recommendations are for a fully developed complex with a total area of 14.3 hectares located in the Eastern Seaboard Development Zone at Map Ta Phut to manufacture, formulate and pack the following products (quantities have been rounded):-

	1st. Year	10th. Year
Active Ingredients	tpa as 100% a.i.	
Dicofol tech. 80%	500	750
Dimethoate tech. 95%	500	1,000
Zineb tech 95%	250	500
Bordeaux Mixture 20% Cu w.p.	500 = 2,500 tpa product	1,000 = 5,500 tpa product
Formulations	tpa as formulated product	
Ground Tuba (derris) root	100	100
Sulphur flowable 85%	1,200	1,750
Microencapsulated methyl parathion 24%	1,000	1,000
Insecticides & fungicide wettable powders	450	770
Liquid herbicides	5,000	8,200
Liquid insecticides	2,500	4,000
Granular herbicides	2,600	4,200
Granular insecticides and fungicides	3,700	6,000
Rodenticides	1,000	1,000

The complex, which would become operational at the beginning of year 5, would eventually employ 228 people and would involve a total investment (at 1984 prices) of 1,167 million baht (US $50.6 million) of which 66% would be in foreign currency.

APPENDIX IX

RAW MATERIALS PRICES (Mid 1984)

A. Local

	B/tonne
Carbon bisulphide	10,000 (at Thai Rayon factory)
Caustic soda liquor (50%)	6,000
Chlorine	10,000 (20 t tanker)
Copper scrap	29,000*
Ethyl alcohol (as 100%)	15,900 (excise duty not paid)
Hydrochloric acid (35%)	2,300
Kaolin (china clay)	2,000 to 4,000
Lime, hydrated	1,300
Methyl alcohol	9,470
Sand (for granules)	500 to 550
Sodium chloride (80-85%)	1,000
Sulphuric acid (98%)	4,000
Zinc chloride (53% liquor)	6,000
Zinc chloride (flake)	14,000
25 kg polypropylene sacks with polyethylene liner	7,500 per thousand

B. Imported

Copper scrap	32,000 to 37,000 cif
Cyclohexanone	32,000 (duty/taxes paid) = 26,830 (cif)
Ethylene diamine - Dow, USA	82,100 cif
AKZO, Netherlands	49,380 cif
Xylene	14,825 (duty & Taxes paid) =12,255 (cif)
Sulphur	2,500 (duty & taxes paid delivered Angthong) = 1,945 (cif)

Note: *The price of copper fluctuates constantly and is regulated by the price of wire bars on the London and New York Metal Exchanges.

APPENDIX X

COST OF CIVIL WORKS

Roads : 18-20 cm thick, concrete	฿ 650 / m^2
Industrial Offices	฿ 3,500 / m^2
Warehouses: Concrete floor on piles, brick walls, cement asbestos roof	฿ 2,500 / m^2
Plant building: 2 storeys, total height 10 m, iron grating between floors, cement asbestos roof, open sides	฿ 1,500 / m^2
Perimeter fencing: 20 cm brick + 1.8 m chain link	฿ 750 / m
2 m high all brick	1,200 / m

Design charges: 4-5% of cost of buildings and equipment

Supervision of construction: 2½% of cost of buildings and erection of equipment

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Source: Sindhu Pulsirivong & Associates

APPENDIX XI

BASIC ASSUMPTIONS AND OTHER DATA USED FOR COSTING PURPOSES

1. Site

The plant will be erected to the site of an existing factory proficient in suing toxic chemicals, so that the existing management, engineering, laboratory and their infrastructure facilities can be utilized at minimum cost.

2. Investment

The investment will be treated as if it were private investment to extend existing facilities with full BoI priviliges. The investor would use local builders and contractors of his own choosing thus avoiding the expensive and protracted bidding procedures required for Government ventures.

3. Time Scale

The plant will be fully operational within two years of decision making. In the 3rd. year it will produce and sell 60% of its capacity, thereafter 100%.

4. Cost of Utilities

a) Electricity: ฿ 1.75 per kWh
b) Natural gas: US $3.65 = ฿ 84 per million Btu
c) Water : ฿ 6 per m^3

5. Building and Supervision

See Appendix X

6. Erection Costs

15% of Equipment

7. Spare Parts

8% of Equipment

8. Salaries and Wages (Note 1)

Chemist	฿ 20,000 per month
Foreman	฿ 7,000 per month
Operators	฿ 5,000 per month

Note 1: A Thai factory manager possessing the right qualifications to run a large pesticides factory successfully would expect a salary of ฿ 60,000 per month gross. An ex-patriate would cost about ฿ 200,000 per month gross. (Source: Hoechst and Bayer)

Labourers: ฿ 2,500 per month

Add 30% for fringe benefits

9. Repairs and Maintenance

Buildings	1½%
Equipment	3 %

10. Administrative Overheads (Contribution to General Works Expenses)

80% of direct salaries, wages and fringe benefits

11. Stock Molding

Imported specialities	3 months
Imported commodities (e.g. copper)	2 weeks
Local raw materials	2 weeks
Finished product	2 months

12. Insurance

1% of equipment, buildings and stocks

13. Sales Charges

1% of sales

14. Depreciation

Buildings	5%
Equipment (erected)	10%
Licen es (including training and pre-start up costs)	10%

15. Financing Charges

14% per annum

16. Raw Materials Prices

See Appendix IX

17. Travel costs

Europe-Bangkok:	For foreign personnel	฿ 16,500 return
	For Thai personnel	17,500 return

APPENDIX XI Cont'd

18. Subsistence Costs

For foreign personnel in Bangkok	฿ 2,000 per day
For Thai personnel in Europe	฿ 1,000 per day

19. Transport Costs (freight)

a) Road: Internal: ฿ 1 per tonne kilometer (6 tonne truckload)

b) Sea : Ex Europe: US $1,400 to 2,800 per tonne (container load)

Ex USA : US $2,200 per tonne from Eastern Seaboard

US $1,800 per tonne from Western Seaboard

20. Landing Charges and Documentation

฿ 170 per tonne

21. Duty and Taxes

See Appendix VI

APPENDIX XII

MANUFACTURE OF COPPER OXYCHLORIDE 50% Cu WETTABLE POWDER

(Process and Costs)

1. Quantity: 1,000 tpa or 4 tonnes per day

2. Know-how: Norddeutsche Affinerie AG, Federal Republic of Germany

3. Introduction:

Copper oxychloride is the approved common name for basic cupric chloride. It has been assigned the formula

$3\ Cu\ (OP)_2\ CuCl_2$ Mol. wt. 457.1

Copper content 59.6%

It is insoluble in water but soluble, with decomposition, in dilute acids. It is also soluble in ammonium hydroxicde solution. It is strongly corrosive to iron and galvanised iron. Copper oxychloride is used in agriculture as a protectant fungicide for many disease-crop situations. It is of low toxicity to mammals (acute oral LD_{50} for male rats is 1,440 mg/kg). No toxicity to honey has been reported. It is usually sold as a wettable powder containing 50% copper equivalent.

4. Outline of Process

Copper scrap, in the form of wire or small piecess, is dissolved in hydrochloric acid and the resulting solution of cupric chloride is oxidized in the presence of excess copper by blowing air throught it. Because of the exothermic nature of the reaction, the reaction vessels must be cooled with water. The precipitated copper oxychloride is filtered and washed. Inert materials and surface active agents are mixed in and the resulting paste dried in a spray or fluid bed drier. The dried powder which does not normally require further grinding, is packed into 25 kg plastic sacks.

The process is continuous. The reaction operation including charging and packing can be completed in 24 hours.

The chemical reactions may be written thus:

$$Cu + 2HCL \longrightarrow CuCl_2 + H_2$$

$$CuCl_2 + 3Cu + 1\tfrac{1}{2}O_2 + 3H_2O \longrightarrow 3Cu(OH)_2 .CuCl_2$$

APPENDIX XII Cont'd

5. Safety and Hygiene

Hydrochloric acid is corrosive and must not be allowed to come into contact with the skin. Rubber gloves, apron, boots and safety goggles must be worn when handling it.

6. Effluent

The process produces no waste water. The filter liquid is re-cycled. A small amount of gas is given off during the reaction and drying processes. The amounts of harmful components in this gas are within the environmental standard limits inforced in Germany. There is also a small amount of solid waste due to insoluble materials in copper scrap.

7. Specifications

Conforms to FAO Specifications

8. Analytical Method

See CIPAC Handbook (1970) Vol I, pg. 226-249

9. Plant Requirements

These have not been specified but glass fibre-polyester/resin vessels and pipework are used in similar processes and would probably be available locally.

10. Size of Buildings

Process: A two-storey open sided building having an area of 300 m^2 and total height, to eaves, of 10 m

Drying and packing: A single storey, closed room with floor area of 100 m^2

Storage: A single storey, closed building with floor area of 300 m^2 Copper, being a very valuable material, should be kept in a special, locked cage inside the store.

Roads: 85 m 10 m

Estimated cost: ₿ 2 million

11. Raw Material Requirements

	Per tonne product	per day
Scrap copper	500 kg	2 t
Hydrochloric acid (35%)	412 kg	1.6 t
Surface active agent	45 kg	180 kg
Kaolin	100 kg	400 kg

Estimated cost: ฿ 21,295 per tonne product, including 25 kg bags (based on scrap copper at ฿ 35,000 per tonne)

12. Specifications of Raw Materials

Copper: Good quality copper scrap (e.g. No. 1 berries), essentially free from arsenic, lead and other harmful impurities

HCl : Normal commercial grade, essentially free from arsenic, lead and other harmful impurities

Surface active agents: To be advised

Kaolin: A good, fine commercial grade, all passing a 300 mesh sieve and free from quartz.

13. Utilities Requirements

	per tonne finished product	per day
Electricity	225 kWh	900 kWh
Natural gas	80 m^3 = 2,8 million Btu	11.2 million Btu
Compressed air (6 bar)	75 m^3	300 m^3
Cooling water	30 m^3 (will depend on inlet temperature)	ca. 120

Estimated cost: ฿810 per tonne product

14. Manpower Requirements

1 Foreman

2 Day operators

4 Shift operators (might be shared with another plant)

3 Labourers

½ Analytical chemist

Estimated cost: ฿ 772 per tonne product

15. Capital Cost

The cost including machinery, equipment, pipework, electrics, metering and control equipment and steel structure is estimated at between 3 and 3.5 million Deutsch Marks(say 25 million baht). Much of this (say 70%) could be made in Thailand, which might reduce the equipment cost.

16. Licence Fee

U.S. Dollars 300,000 (6.9 million baht)
Services of licenser's engineers (2 weeks at beginning of erection, 4 weeks at end and 4 weeks for start-up) could be made available at DM 1,200 per day per engineer plus travel and subsistence costs.
Estimated cost: ฿855,000

17. Training of Thai Personnel

Training at the licenser's Hamburg plant could be provided. Licensee to pay expenses. The estimated cost (assuming 3 months for a foreman and 1 month for a chemist) is ฿ 155,000 plus their salaries and wages (say ฿ 110,000)

18. Costings

a) Investment

			฿,000
Equipment	(70% L)	25,000	
Buildings & Roads	(100% L)	2,000	
Erection	(100% L)	3,750	
Design & Supervision	(100% L)	1,360	
Land (1 rai)	(100% L)	80	
Sapre parts	(70% L)	2,000	
Licence fee	(100% F)	6,900	
Pre-start up & Commissioning	(22% L)	855	
Training	(22% L)	155	
		42,100	
Contingencies @ 10%		4,210	
TOTAL INVESTMENT	(79% L)		46,310

(Note: L = Local Currency, F = Foreign Currency)

b)	Operating Expenses (for 1,000 tonnes)			฿,000
i)	Raw Materials			
	Copper 500 t @ 35,000	(100% F)	17,500	
	HCL (35%) 411 t @ 2,300	(100% L)	945	
	Surface Active Agent 45 t @ 50,000	(100% F)	2,250	
	Kaolin 100 t @ 3,000	(100% L)	300	
	Bags 40,000 @ 7.5	(100% L)	300	
	Total Raw Materials			21,295 (71.7%)
ii)	Utilities (100% L)			
	Electricity: 225,000 kWH @ 1.75		395	
	Gas: 80,000 m^3 = 2,800 million Btu @ 84/million		235	
	Water: 30,000 m^3 @ 6		180	
	Total Utilities			810 (2.7%)
iii)	Salaries & Wages (100% L)			
	½ Chemist @ 120,000		60	
	1 Foreman @ 84,000		84	
	6 Operators @ 60,000		360	
	3 Labourers @ 30,000		90	
	Fringe benefits		178	
	Total Salaries & Wages			772 (2.6%)
iv)	Repairs & Maintenance (100% L)			
	Buildings		30	
	Equipment		750	
	Total Repairs & Maintenance			780 (2.6%)
v)	Overheads (100% L)			
	Administration		618	
	Insurance		635	
	Selling costs (say)		300	
	Depreciation		4,510	
	Total Overheads			6,063 (20,4%)
	TOTAL OPERATING EXPENSES (33.5% L)			29,720

(It should be noted that copper represents 59% of the cost)

APPENDIX XIII

WHO CLASSIFICATION OF PESTICIDES

	LD_{50} to rat - mg/kg body weight			
	Oral		Dermal	
Category	Solids	Liquids	Solids	Liquids
Ia. Extremely hazardous	5 or less	20 or less	10 or less	40 or less
Ib. Highly hazardous	5 to 50	20 to 200	10 to 100	40 to 400
II. Moderately hazardous	50 to 500	200 to 2000	100 to 1000	400 to 4000
III. Slightly hazardous	over 500	over 2000	over 1000	over 4000

Note: The LD_{50} figures refer to the product or formulation and not to the active ingredient.

APPENDIX XIV

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APPENDIX XV

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EXPERT ASSISTANCE IN ESTABLISHING PESTICIDES PLANTS

UC/THA/83/116

THAILAND

Terminal report*

Addendum

Prepared for the Government of Thailand
by the United Nations Industrial Development Organization

Based on the work of Gerald L. Baldit
Expert in Pesticide Manufacturing Technology

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Manufacture of Dithiocarbamate Fungicides

In Chapter IX page 24 of the Expert's Terminal Report it is stated that evaluation data were still awaited from Pennwalt and AKZO. Pennwalt have now replied that they do not wish promote dithiocarbamate production in Thailand and AKZO say their process is too old but they are studying new technology which will not, however, be on stream for 'several years'.

In view of these disappointing responses and because it is felt that this subject must be explored further, the Expert has resorted to using rather old (1976) data based on a 10,000 tpa plant with adjustments for scale and inflation.

Processes and costings for a plant to manufacture
1,200 tpa zineb w.p.
600 tpa mancozeb w.p.
200 tpa maneb w.p.
with an investment of 180 million baht (US $7.8 million), of which at least 34% would be in local currency, are given in the Appendix. Insufficient data are available to include propineb at this stage, but the process is similar to that for zineb except that propylene diamine must be substituted for ethylene diamine.

The figures, which should only be taken as a guide, show orders of magnitude but are not very encouraging.

Even if the plant were working to maximum capacity, it would be impossible to compete with Bulgarian zineb which, from the Expert's experience, can be of very good quality. Only mancozeb would appear to be attractive. There would, of course, be some savings in foreign exchange due to the use of local raw materials but since even these, in most cases, are derived from imported products, this could be a false argument.

Unfortunately, of the other ASEAN countries, only the Philippines uses any appreciable quantity of dithiocarbamates (about 600 tpa a.i. over the past four years - Ref. 2) so the possibility of greatly increasing the size of the plant seems remote.

However, as these figures are very approximate - a decrease of 20% in the capital expenditure would make a lot of difference -, it is recommended that the Ministry of Industry takes further steps in conjunction with a private sector company, to try and obtain suitable technology and carry out an up-to-date cost study.

APPENDIX

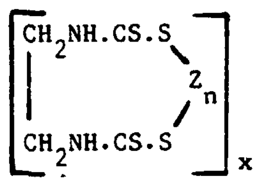
Process and Costings to Manufacture 2,000 tpa Dithiocarbamate Fungicides

1. Products to be made

Zineb 80% w.p.	1,200 tpa (max)
Maneb 80% w.p.	200 tpa (")
Mancozeb 80% w.p.	600 tpa (")

2. Introduction

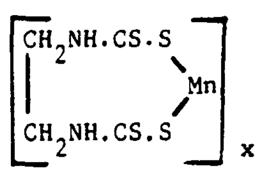
Zineb is the approved ISO common name for polymeric zinc ethylene-1, 2-bisdithiocarbamate.



The technical product is a light coloured solid, slightly soluble in water, insoluble in most organic solvents. The formulated wettable powder is stable under normal conditions of storage.

Zineb is a protective fungicide. Its acute oral LD_{50} to rats is over 5,200 mg/kg.

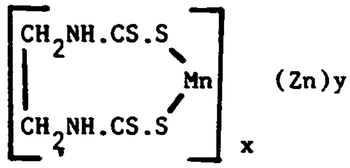
Maneb is the approved ISO common name for polymeric manganese ethylene-1,2-bisdithiocarbamate.



The technical product is a light coloured solid, slightly soluble in water, insoluble in most organic solvents. The formulated wettable powder is stable under normal conditions of storage, but can decompose (often rapidly) on exposure to moisture with the formation of polymeric ethylenethiuram monosulphide.

Maneb is a protective fungicide. Its acute oral LD_{50} for rats is 6,750 mg/kg.

Mancozeb is the approved ISO common name for a complex of a zinc salt and maneb and contains ca. 20% manganese and ca. 2.5% zinc.



The technical product is a greyish-yellow powder practically insoluble in water and most organic solvents. the formulated product is stable under normal storage conditions.

Mancozeb is a protective fungicide with an acute oral LD_{50} to rats of over 8,000 mg/kg.

3. Outline of Processes

ZINEB

1. Ethylene diamine, carbon bisulphide (CS_2) and sodium hydroxide are reacted in aqueous solution in an atmosphere of nitrogen to form sodium ethylenebisdithiocarbamate.
2. This is reacted with zinc chloride solution with the precipitation of zineb.
3. The zineb is filtered and washed.
4. The filter cake is transferred to a reconstitution tank where water, surfactants and stabilising agents are mixed in.
5. The constituted slurry is dried and packed into bulk packages.

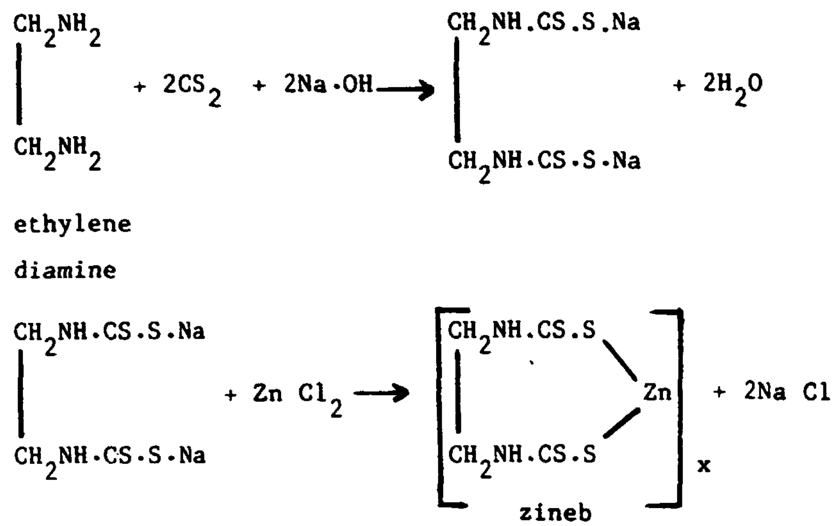
MANEB

The process is similar to that for zineb except that manganese sulphate is used instead of zinc chloride. After drying, the product is cooled in an inert atmosphere before being packed out.

MANCOZEB

As for maneb except that both zinc chloride and manganese sulphate are used.

The zineb reaction may be represented thus:



The reactions for maneb and mancozeb are similar.

4. Safety and Hygiene

   1. Carbon bisulphide will ignite spontaneously in contact with air. It must always be transferred and stored under water or inert gas.
   2. Ethylene diamine can cause eye injury and skin burns.
   3. Sodium hydroxide is caustic. Rubber gloves, apron, boots and safety eyeshields must be worn.
   4. Maneb is combustible at elevated temperatures.

5. Effluent Treatment

   1. Gaseous products from the maneb and zineb production are vented through a 50 metre high stack.
   2. Aqueous wash waters contain traces of thiocarbamates, ethylene thiourea, heavy metals, sulphur compounds, sodium sulphate (ca. 6.5%) and sulphite (ca. 20 ppm). These are precipitated and filtered off.

6. Specifications

   Should conform to FAO Specifications.

7. Analytical Methods

   See CIPAC Handbook.

8. Plant Requirements

   These cannot be specified. Most of the reaction vessels are of stainless steel with some liquor hold tanks of reinforced plastic.

9. Size of Buildings

Process: A two-storey open sided building having an area of 500 m^2 and height of 10 m to eaves

Drying and Packing: A single storey closed room with floor area of 200 m^2

Storage: A single storey closed building with floor area of 600 m^2

Roads : 170 m by 10 m wide

10. Raw Material Requirements per Tonne Formulated Product

	Zineb	Maneb	Mancozeb
	t	t	t
Carbon bisulphide (L)	0.518	0.675	0.545
Ethylene diamine (I)	0.204	0.263	0.248
Caustic soda (50%) (L)	0.542	0.650	0.616
HCL (35%) (L)	0.016	--	0.015
Manganese sulphate (I)	--	0.725	0.630
Zinc chloride (53%) (L)	1.649	--	0.157
Kaolin (L)	0.055	--	0.058
Surface active agents etc. (I)	0.050	0.113	0.050
25 kg sacks (L)	40	40	40

Note: L = Local I = Imported

11. Specifications of Raw Materials

Normal commercial quality

12. Utilities Requirements per Tonne Finished Product

	Zineb	Maneb	Mancozeb
Electricity	118 kWh	250 kWh	220 kWh
Water	76 m^3	168 m^3	153 m^3
Steam @ 7 bar	1.4 t	2.5 t	2.3 t
Nitrogen	1.2 Nm^3	1.7 Nm^3	1.5 Nm^3
Chilling	45 k cal	47 k cal	45 k cal

13. Manpower Requirements

4 Shift foreman

12 Shift operators

8 Shift labourers

½ Chemist

14. Capital Cost

80 million baht of which 60% would be in foreign currency.

15. Licence Fees

70 million baht plus cost of licensor's engineers for supervision of erection and start-up (say) 1.2 million baht.

16. Training

It is assumed that the licenser will give some training in his own works to Thai personnel. 400,000 baht has been allowed for.

17. Costings

L = Local currency F = Foreign currency

a) Investment

	฿,000	
Equipment (40% L)	80,000	
Civil (100% L)	5,000	
Erection (100% L)	12,000	
Design & Supervision (100% L)	4,000	
Land (100% L)	100	
Spare parts (40% L)	6,400	
Licence fee (100% F)	70,000	
Pre-start up and commissioning (22% L)	1,200	
Training (22% L)	400	
Total (34% L)		180,000

b) Operating Expenses (Baht per tonne formulated Product)

(i) Raw Materials

Chemical	Cost/t	Zineb	Maneb	Mancozeb
Carbon bisulphide	10,000	5,180	6,750	5,450
Ethylene diamine	51,000	10,404	13,413	12,648
Caustic soda (50%)	6,000	3,252	3,900	3,696
HCl (35%)	2,300	37	--	35
Manganese sulphate	17,000	--	12,325	10,710
Zinc chloride (53%)	6,000	9,894	--	942
Kaolin	4,000	220	--	232
Surface active agents etc.	50,000	2,500	5,665	2,500
25 kg sacks	7.5 each	300	300	300
Total raw material Costs ฿/t	--	31,787 (40.6% Imported)	42,353 (74.1% Imported)	36,513 (70.8% Imported)

ii) Utilities

	Zineb	Maneb	Mancozeb
Electricity @ 1.75 kWh	207	438	385
Water @ 6/m^3	456	1,008	918
Steam @ 400/t	560	1,000	920
Nitrogen	2	3	3
Chilling @ 1.5/100 kcal	68	71	68
Total utilities costs ฿/t	1,293	2,520	2,294

iii) Salaries & Wages

	฿,000
½ Chemist @ 120,000	60
4 foremen @ 84,000	336
12 operators @ 60,000	720
8 labourers @ 30,000	240
Fringe benefits	407
	1,963 or ฿ 982/t

iv) Repairs & Maintenance

Buildings	75
Equipment	2,400
	2,475 or ฿ 1,238/t

v) **Overheads**

	฿,000
Administration	1,570
Insurance	152
Selling costs (say)	500
Depreciation	17,750
	19,972 or ฿ 9,986/t

vi) Summary of operating Costs (baht/tonne formulated product, packed in bulk, ex works)

	Zineb	Maneb	Mancozeb
Raw materials	31,787	42,353	36,513
Utilities	1,293	2,520	2,294
Salaries & Wages	982	982	982
Repairs & Maintenance	1,238	1,238	1,238
Depreciation	8,875	8,875	8,875
Other overheads	1,111	1,111	1,111
Total operating cost ฿/t	45,286	57,079	51,013
Approximate 1983 import prices c.i.f.	21,000-29,000 from Bulgaria 27,000-37,000 from W. Europe	47,700 from W. Europe	41,800-55,900 from W. Europe