AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523
BIBLIOGRAPHIC INPUT SHEET

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Batch 97

1. SUBJECT CLASSIFICATION

A. PRIMARY
Food production and nutrition — AH00-0000-0000

B. SECONDARY
Plant protection

2. TITLE AND SUBTITLE
Proceedings of Pesticide Management Seminar-Wrokshop

3. AUTHOR(S)
(101) Pesticide Management Seminar-Workshop, Manila, 1975; Calif. Univ./USAID Pest Management and Related Environmental Protection Project

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1975	290p.	ARC

7. REPRODUCING ORGANIZATION NAME AND ADDRESS
Calif.--Berkeley

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)

9. ABSTRACT

10. CONTROL NUMBER
PN-AAG-301

11. PRICE OF DOCUMENT

12. DESCRIPTORS
Meetings
Pesticides
Philippines

13. PROJECT NUMBER
931093000

14. CONTRACT NUMBER
AID/La-C-1195 GTS

15. TYPE OF TRANSLATION

PESTICIDE MANAGEMENT
SEMINAR-WORKSHOP

Manila, Philippines
10-15 February 1975

Pesticide Management Seminar-Workshop

MANILA, PHILIPPINES
10–13 February 1975

CERTIFICATE

This is to certify that

_____

has participated in the PESTICIDE MANAGEMENT SEMINAR-WORKSHOP organized by the University of California, University of Miami, Oregon State University, United States Agency for International Development and the Government of the Republic of the Philippines.

Given this 13th day of February, 1975.

BERNARDO S. CASTILLO
Chairman, Seminar Management Committee
Director, Bureau of Plant Industry

THOMAS NIBLOCK
Director, USAID
Manila

RAY F. SMITH
Project Director
UC/AID Pest Management & Related Environmental Protection Project
University of California

MANAGEMENT COMMITTEE

PESTICIDE MANAGEMENT SEMINAR-WORKSHOP

Manila, Philippines
February 10-15, 1975

1.	Dir. Bernardo S. Castillo	Chairman,	Bureau of Plant Industry
2.	Dr. Reynaldo Lesaca	Vice Chairman,	National Water and Air Pollution Control Com.
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19.	Dir. Felix Gonzales	"	Bureau of Fisheries
20.	Mr. Simeon A. Estocapio	"	B P I
21.	Mr. Hipolito A. Custodio	Exec. Secretary -	BPI
22.	All Chairman of Sub-Committees	Member	

PESTICIDE MANAGEMENT SEMINAR-WORKSHOP

February 10-15, 1975
Ramon Magsaysay Center
Manila, Philippines

A G E N D A

Monday, February 10, 1975

8:00 - 9:00 a.m.	Registration of Participants
9:00 - 10:30 a.m.	Opening Ceremony (see Program A)
10:30 - 10:45 a.m.	Coffee Break

S E M I N A R

Memorial Hall

PESTICIDES AND THEIR USES

10:45 - 11:00 a.m.	Rationale of Pesticide Use	Mr. Simeon A. Estocapio
11:00 - 11:20 a.m.	World Problems of Pesticides	Dr. Ray F. Smith
11:20 - 11:40 a.m.	Pesticides in Philippine Agriculture	Mr. Renato I. Capinpin
11:40 - 12:00 a.m.	Pesticides in Public Health	Mr. Felipe P. Catangui
12:00 - 12:30 p.m.	Open Forum	
	Moderator:	Dr. Virgil H. Freed
12:30 - 2:00 p.m.	L U N C H	

Monday, February 10, 1975

PESTICIDE CHEMISTRY AND METABOLISM

2:00 - 2:40 p.m.	Chemical Properties and Degradation Patterns of Pesticide Groups	Dr. Edwin Magallona
2:40 - 3:20 p.m.	Formulations of Pesticides	Dr. Virgil H. Freed
3:20 - 3:35 p.m.	Coffee Break	
3:35 - 4:15 p.m.	Pesticide Application	Dr. Wesley E. Yates
4:15 - 5:30 p.m.	Open Forum	
	Moderator:	Dr. Fernando F. Sanchez

Tuesday, February 11, 1975

BIOCHEMICAL AND PHYSIOLOGICAL EFFECTS OF PESTICIDES

9:00 - 9:45 a.m.	Hazards of Pesticides	Dr. Quintin Kintanar, M.D.
9:45 - 10:30 a.m.	Medical Aspects of Pesticide Poisoning	Dr. John E. Davies
10:30 - 10:45 a.m.	Coffee Break	
10:45 - 11:30 a.m.	Diagnosis and Treatment	Dr. John E. Davies
11:30 - 12:30 p.m.	Open Forum	
	Moderator:	Dr. Jacinto J. Dizon
12:30 - 2:00 p.m.	L U N C H	

Tuesday, February 11, 1975

PESTICIDES IN THE ENVIRONMENT

2:00 - 2:40 p.m.	Environmental Pollution caused by Pesticides	Miss Clarita Centeno
2:40 - 3:20 p.m.	Chemodynamics - Chemicals in the Environment: behavior and distribution	Dr. Virgil H. Freed
3:20 - 3:35 p.m.	Coffee Break	
3:35 - 4:30 p.m.	Storage, Handling and Disposal of Pesticides	Dr. Virgil H. Freed and Mr. Renato I. Capinpin
4:30 - 5:30 p.m.	Open Forum	
	Moderator:	Com. Reynaldo Lesaca

Wednesday, February 12, 1975

PESTICIDE MONITORING

9:00 - 9:30 a.m.	Present Status of Pesticide Monitoring in Agriculture	Miss Lydia Crisostomo
9:30 - 10:00 a.m.	Present Status of Pesticide Monitoring in Public Health	Dr. Luzonica Pesigan
10:00 - 10:15 a.m.	Coffee Break	
10:15 - 11:20 a.m.	Pesticide Analysis	Dr. Edwin Magallona
11:20 - 12:00 noon	Open Forum	
	Moderator:	Dr. John E. Davies
12:00 - 2:00 p.m.	L U N C H	

Wednesday, February 12, 1975

ROLE OF PHILIPPINE AGENCIES

2:00 - 2:30 p.m.	Department of Agriculture	Dir. Bernardo S. Castillo
2:30 - 3:00 p.m.	Department of Natural Resources	Dir. Felix Gonzales
3:00 - 3:30 p.m.	Department of Health	Dir. Joaquin Sumpaico
3:30 - 3:45 p.m.	Coffee Break	
3:45 - 4:15 p.m.	Food & Drug Administration	Dr. Luzonica Pesigan
4:15 - 4:45 p.m.	National Water & Air Pollution Control Commission	Com. Reynaldo Lesaca
4:45 - 5:30 p.m.	Open Forum	
	Moderator:	Dr. Ray F. Smith

Thursday, February 13, 1975

PESTICIDE REGULATIONS
IN THE PHILIPPINES

9:00 - 10:00 a.m.	Evaluation of Present Status of Pesticide Regulations	Mr. Hipolito A. Custodio
10:00 - 10:15 a.m.	Coffee Break	
10:15 - 11:30 a.m.	Proposals on Pesticide Regulations:	
	Dept. of Agriculture	Mr. Hipolito A. Custodio
	Pest Control Council of the Philippines	Dr. Dante Benigno
11:30 - 12:00 noon	Open Forum	
	Moderator:	Dr. Wesley Yates
12:00 - 2:00 p.m.	L U N C H	

Thursday, February 13, 1975

RECAPITULATION OF SEMINAR PAPERS
AND ORGANIZATION OF WORKSHOP GROUPS

2:00 - 3:30 p.m.	Agroecological Approach to Pesticide Management	Dr. John E. Davies Dr. Ray F. Smith Dr. Virgil H. Freed
3:30 - 3:45 p.m.	Coffee Break	
3:45 - 5:30 p.m.	Introduction to Workshop and Organization of Workshop Groups	Dr. Ray F. Smith
	Group 1. Pesticide Industry	Mr. Renato I. Capingin
	Group 2. Safe Use of Pesticides	Engr. Celestino Asinas
	Group 3. Regulation and Registration of Pesticides	Mr. Hipolito A. Custodio
	Group 4. Education and Research	Dr. Fernando F. Sanchez

Friday, February 14, 1975

W O R K S H O P

9:00 - 12:00 noon M e e t i n g s :

Group 1	Room
Group 2	Room
Group 3	Room
Group 4	Room

(10:00 - 10:15 a.m.) Coffee Break

12:00 - 2:00 p.m. L U N C H

2:00 - 5:00 p.m. Meetings of Groups (cont'd) (Same Rooms)

(3:00 - 3:15 p.m.) Coffee Break

Saturday, February 15, 1975

GENERAL SESSION

9:00 - 10:30 a.m.	Presentation of Recommendations of Workshop Groups 1 and 2	Group Leaders
10:30 - 10:45 a.m.	Coffee Break	
10:45 - 12:00 noon	Presentation of Recommendations of Workshop Groups 3 and 4	Group Leaders
12:00 - 2:00 p.m.	L U N C H	

CLOSING CEREMONIES

3:00 - 5:00 p.m. (Please see Program B)

RESOURCE SPEAKERS

OPENING PROGRAM

Bernardo S. Castillo, BSA, M.S.	Acting Director Bureau of Plant Industry Manila
Clemente C. Gatmaitan, M.D.	Acting Secretary Department of Health M a n i l a
Abelardo Samonte, Ph.D.	Chancellor University of the Philippines at Los Baños
Renato I. Capinpin, BSA	President Agricultural Pesticide Institute of the Philippines Manager, Agriculture Department Shell Chemical (Phils.) Co. Makati, Rizal
Reynaldo Lesaca, M.D.	Commissioner National Water & Air Pollution Control Commission

SEMINAR-WORKSHOP

Ray F. Smith, Ph.D.	Professor, Dept. of Entomological Sciences Director, UC/AID Pest Management & Related Environmental Protection Project University of California, Berkeley, California
Virgil H. Freed, Ph.D.	Professor Director, Environmental Health Sciences Center Head, Department of Agricultural Chemistry Oregon State University Corvallis, Oregon
John Edward Davies, M.D., M.P.H.	Chairman Department of Epidemiology and Public Health School of Medicine, University of Miami, Florida
Wesley E. Yates, M.S.	Professor Agricultural Engineering Department University of California Davis, California

John P. Hummon, Ph.D.	Acting Director USAID Mission, Manila
Reeshon Feuer, Ph.D.	Crop Production Specialist International Rice Research Institute & Cooperative NFAC-IRRI-USAID Rice Program
Norman Ulsaker, Ph.D.	Chief, Small Farmer Income Program Agricultural Development, USAID, Manila
Simeon A. Estocapio, B.S.A.	Chief, Crop Protection Division Bureau of Plant Industry
Felipe P. Catangui, B.S.A.	Entomology Adviser Department of Health
Edwin Magallona, Ph.D.	Professor, and Head, Pesticide Residue Laboratory UPLB, Los Baños, Laguna
Fernando F. Sanchez, Ph. D.	Professor, Dept. of Entomology, UPLB Director, Rodent Research Center
Quintin Kintanar, M.D.	Science Research Chief Biological Research Center, NIST
Jacinto J. Dizon, M.D.	Chief, Disease Intelligence Center OIC, Bureau of Disease Control Department of Health
Clarita Centeno	Chief, Research & Development Section National Water & Air Pollution Control Commission Manila
Lydia Crisostomo, M.S. Chem.	Chief, Agric. Chemistry Section Laboratory Services Division Bureau of Plant Industry
Luzonica Pesigan, M.D.	Administrator Food & Drug Administration Department of Health
Felix Gonzales	Director Bureau of Fisheries & Aquatic Resources Manila
Joaquin Sumpaico, M.D.	Director Bureau of Research & Laboratories Manila
Hipolito A. Custodio, BSA, M.S.	Chief, Pest Control Section Crop Protection Division Bureau of Plant Industry

Pedro G. Afable	Vice Chairman & Executive Director National Science Development Board
Dante Benigno, BSA, Ph.D.	Asst. Professor, UPLB President, Pest Control Council of the Philippines
Celestino Asinas	Chief, Sanitary Engineer Malaria Eradication Service Center Department of Health

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/OC/1
75-10-2

OPENING ADDRESS

DIRECTOR BERNARDO S. CASTILLO
Bureau of Plant Industry
Manila

Distinguised guests, friends, ladies and gentlemen:

In behalf of the P.P.I.-USAID and the Management Committee, I wish to extend our warm welcome for your presence this morning.

It gives me extreme pleasure to welcome an elite group such as this body to a historic gathering that has been called to participate and to achieve a noble mission.

This first seminar-workshop on pesticide management in the Philippines is an integrated activity of representatives from public health, agriculture, pesticide industry and educational institutions. This is very timely considering the fact that the Philippines is a fast developing country actively involved in the large-scale use of pesticides in our massive agricultural development programs which has created a problem subsequently on the protection of food and maintaining man's health and well-being.

The benefits mankind has derived from the use of pesticides justify the continuance of their use, especially so because of the worldwide runaway population growth. The use of pesticides in agriculture, forestry and public health in the last three decades has greatly increased the quality and production of crops, protected forests from insect depredations, and saved countless of human lives by controlling insect vectors of human diseases like malaria, yellow fever, plague, etc.

While we all appreciate these benefits, we must be aware that there are serious problems associated with the large-scale use of pesticides, specially with their indiscriminate use, e.g. poisoning in food and of the environment from pesticide residues, destruction

of beneficial insects, and development of resistance by agricultural pests to these pesticides.

This seminar-workshop, with an enlightened group of people in attendance, should be able to evolve concrete measures and policies related to pesticide management, quality control, the determination of pesticide residues, and the investigation of environmental contamination. Our immediate aim then is to protect our sources and supplies of food and our environment - land, water, and air - for our own sake and that of the coming generations. This seminar I hope, should not only result in improved pest control to increase crop production and human health but also to the conservation of the supply of pesticides that is now facing the threat of shortages.

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/OC/2
75-10-2

INTRODUCTORY REMARKS

Ray F. Smith
Professor of Entomology
Department of Entomological Sciences
University of California, Berkeley
and
Director, UC/AID Pest Management Project

This Seminar/Workshop is the third in a series in which the University of California/USAID Pest Management project has participated. But this one is different, from the very start, it has every indication that it will be one of the most productive and useful of the series. I believe this results from the fact that here in the Philippines, we can start from a much stronger base than in many other countries. The level of training in pesticide management and the awareness of the needs that exists here in the Philippines has provided increased capability and gives strong motivation to get on with the job of improved pesticide management.

We are now in one of the most critical periods of man's existence on earth. What happens during the next few years must and will provide answers to most vital questions for man and his well being. Can we produce an adequate food supply for the worlds population? Can we do this without irretreivably destroying our environment and its future productive capacity? Can we control or eliminate the diseases of man that continue to erode his health and well-being?

A critical element in a satisfactory and complete answer to these three questions is pest and disease control. We cannot produce an adequate supply of food without improved pest control. We cannot maintain the quality of our environment without a better pest control which is ecologically oriented. We cannot control many of the diseases which plague man without good pest control.

It is for these reasons that plant protection and pest control are placed in a new context today as compared to that prevailing as short a time ago as five years. The worlds expanding human population

requires an increasing supply of food and fiber. To obtain this larger supply will require better protection from diseases, insects, and other pests. Unfortunately, the task of achieving this desired goal of improved production through better pest control has now become more difficult. There have been great increases in food production in some regions of the world. These increase have been achieved through use of improved varieties, cultural methods and to some extent pest control. however, the protection of this new food supply rests on very shaky foundations. For example, we have narrowed the genetic base of our agricultural crops and the ability of these crops to resist new pests or old pests in new form. The resistance in certain insect population has greatly reduced the effectiveness of chemical pesticides in a number of important situations.

Nevertheless, despite a variety of very difficult problems associated with our chemical pesticide, e.g. human intoxications, destruction of beneficial insects, development of resistance, these pesticides still are essential in in the protection of our crops and our health. In fact, the pesticide shortages which have plagued us recently have dramatically demonstrated the essential role of pesticides.

This Seminar/Workshop is to be work session that should result in a functional plan for the improved management of pesticides in the Philippines. We should look forward to improved pest control from the recommendations of this meeting and thus provide increased crop production and improved human health. It also should lead to the conservation of our precious supplies of pesticides.

We, who are representatives of the UC/USAID Pest Management Project, are most pleased to be able to work with you in this Seminar/Workshop. We look forward to an extremely productive session.

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/OC/3
75-10-2

ADDRESS

Hon. Abelardo Samonte
Chancellor, University of the Philippines
at Los Baños

Secretary Gatmaitan, Director Castillo, Commissioner Lesaca, Dr. Smith, Mr. Capinpin, Distinguished Guests, Participants to the Pesticide Management Seminar-Workshop, Ladies and Gentlemen:

It is my pleasure to extend to our guests and participants of this Seminar-Workshop the greetings and best wishes of the faculties and researchers of the University of the Philippines at Los Baños.

We are fortunate to have with us today foreign specialists and practitioners in pesticide management, who will share with us their knowledge and experience so that we may be able to plan our works and dealings with a view on the worldwide problems on pesticide pollution. We are hopeful that during the course of this week-long activities, the inter-change of ideas and experiences will prove to be mutually beneficial.

The holding of this Pesticide Management Seminar-Workshop is indeed very timely. The activated use of pesticide in recent years, specially in our country, has highlighted the use of pesticide in human life and in the environment. It is said by many that the availability of pesticide could lead to a widespread or indiscriminate use.

Pesticide can be very phenomenal in many ways: in agriculture, forestry and public health. In the last 30 years or so, the use of pesticides has greatly contributed to the increased productivity of our farmers. Similarly, Seminars have been held by the millions regarding the control of human diseases like malaria, typhoid, yellow fever and encephalytis.

Pesticides should be required to safeguard agricultural productivity from pest damage. Indeed, crop protection including pesticide management should be given more attention to the development of high-yielding, disease-resistant varieties in worldwide efforts to increase and accelerate food production.

Thus, in the barrios, we are proposing the establishment not only of restricted places for plant breeding but also of regional centers for crop protection. Consequently, pesticide management strategies through sound ecological principles should be developed and applied. This is essential if we are to minimize the hazard commonly associated with pesticide use.

We at the University of the Philippines at Los Baños, Laguna undertook the development of alternative method of pest control to open good possibilities for sound pesticide management program. Development in this area should lead to lesser pesticide use without sacrificing the over-all efficiency of pest control. Nevertheless, we should not also overlook the need to improve our pest control practices. Opportunities for improvement are numerous. For example, mainly true in the disciplinary usage on how to harmonize pesticide use with other methods of control, such as the use of parasites to improve cultural practices, crop varietal resistance to pest and genetic manipulation on pest population.

In the context of recent Philippine events, we have withered out tungro disease, brownhopper and the associated yellow blast disease in rice which are likely in the development of disease resistance. High-yielding rice varieties have been developed in the course of many years of effort and usage. Nonetheless, the educational and training years have found pesticide management neglected. particularly in developing countries.

Technical education and training are needed in any society. It is not only with proper understanding that anyone could really appreciate the positive aspects of pesticide use. The need for effective and economic control of agricultural crop problems in developing countries point to the field of agricultural chemicals. While this maybe so, the need for pesticide research and extension program will insure improvement in kind of pesticides available and the means and manner of using them.

Another avenue that could lead to the improvement of pesticide management is government regulation of pesticide field use. The government should be strict in the sale and use of every toxic pesticide and institute a license program for professional applicator to insure proper usage. Only the relatively safe chemical should be left solely in the hands of farmers and housewives. The dangerous material should be handled only by licensed pesticide specialist who have full appreciation of the need to balance benefit against hazard before using the chemicals.

Pesticide residue should be perennially looked into by the government. The move should be initiated to see to it that foodstuff and animal feed are free from excessive pesticide contamination. Information on food poisoning and levels of human poisoning and contamination should also be helpful in devising appropriate management program.

Coordinated poison control centers should be established in specific areas to help attend to medical emergencies caused by pesticide and to provide the instructions and guidance to occupational workers about proper pesticide management.

We hope that the current interest in pesticide management should lead to the development of a program that will solve or at least minimize the problems associated with the use of pesticide. Government programs and regulations that encourage the development of positive control and strategies through pesticide use along lines of sound ecological principles should lead to the enlightened utilization of pesticide in promoting human welfare through the control of pest.

As head of the University which has long been the center for agriculture, education and research not only in this country but also in Southeast Asia, I wish you all the success in your seminar-workshop. We will do our part in contributing and utilization. Your findings and recommendations will lead to better pesticide management for increased agricultural productivity and for better health and welfare in the rural areas.

Thank you.

A D D R E S S

Dr. John Hummon
Acting Director, USAID, Manila

Mr. Chairman, Director Castillo, Dr. Smith, Director Samonte, Mr. Capinpin, Secretary Gatmaitan, Ladies and Gentlemen:

We are delighted to have you here in our opening of this Pesticide Management Seminar-Workshop. We are also delighted to join the Bureau of Plant Industry in this Seminar-Workshop and we hope that the USAID would continuously be involved, even in a small way, in this kind of seminar. I believe this pesticide management is the third seminar of this type, other seminars being held way back in 1973, in Indonesia and also last summer.

We are happy to introduce to you our representative, Dr. Feuer, who is an expert in this field. I understand that there are 267 invited to this seminar.

You are talking about the final analysis and important factors in relationship to people. We are talking about food production. During the past years, we experienced the energy crisis and its consequent impact in terms of feeding the people throughout the world. The population experts predict that by the year 3000, the world population could be doubled, or even tripled. Hence, we should double our food production. This we owe from the farmers of the world.

Regarding the philosophies which are essential in any food production program to find means to feed mankind, we know that most of our critical listeners will delve on the task of pesticide before we go into the environmental concern. But before we get involved in this, we should look at the question of rats, bats and noxious birds.

The consequence of cutting down the USAID money - they cut that for about 25 to 30 percent of some reason - will be reflected in AID projects. Hence, there may come a time when we will have to do something about rats, bats and noxious birds before we could rid ourselves of trouble. Fortunately, the Ambassador expressed positive support

on what the proposed team had discovered.

It is a serious problem in Latin America; it is a serious problem in Africa; it is a serious problem here in the Philippines. It is estimated that rats in the field saturate 20 percent of the crop yearly. There are lots of birds, lots of insects, including the brownhoppers and greenhoppers. It is therefore important to have a sound pesticide management in this country in order to improve production program.

We have reports from rodent centers. There have been discussions on possible regional pesticide centers which will possibly be in close cooperation with the University of the Philippines at Los Banos. We have interest in them. I know our people in Washington have been talking about the people from the University.

In the Philippines, we have program on rural application, rural irrigation, water supplies and what we called the RDA. All of these are designed to help the small farmers improve their income. Of course, pesticide management is an important element in them.

I think the Philippines has made progress during the last two years in its food production programs, especially the Masagana 99 Program, despite floods and typhoons that swept the country. In such programs, the USAID is involved. We are also working with the Lady's Program of feeding school children besides many other different programs where we are involved. Because the level of malnutrition in the Philippines is high, the production of nutritious food is a major task this country faces.

Therefore, I think it is important that the USAID be involved in the Philippines for three reasons. I think we want to see the Philippines developed economically which will lead to the progress of all the people within the country. Consequently, Philippine progress will have an impact on peoples throughout the Pacific area. Indeed, the progress of nations will have an impact with their co-relation with other nations throughout the world.

Secondly, if you go down to Makati, you find a handsome and beautiful area, even surpassing that in the United States, Europe and other developed areas. This shows that the children in this country have tried to fully develop themselves. Moreover, it shows that they have the potential to develop.

Thirdly, we found out that there is a reason of the close relationship between the Philippines and the United States. Filipinos understand us; conversely, Americans like to think that they understand Filipinos, if not understand them.

In closing, I just want to say that we are very glad to be a part of this seminar-workshop. I see that Dr. Feuer is with your

work group and he maybe called to answer every question you have about USAID. In fact, if you would like to see any of our officer anytime for more question, we are happy to accommodate you.

Thank you very much and we wish you all the success.

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

FM/CC/4
75-10-2

ADDRESS

R. I. Capinpin
President, Agricultural Pesticide
Institute of the Philipuines & Agric. Chemicals Mgr.,
The Shell Chemical Co. (Phil.) Inc.

In behalf of the Agricultural Pesticide Institute of the Philippines, allow me to welcome you to this Pesticide Management Seminar and workshop. This meeting is very timely indeed, and in a way, compliments the current government programmes on food production which recognize the importance of pesticides as an agricultural input. The Bureau of Plant Industry through Director Castillo should be congratulated for organizing this multi-faceted look on the subject of agricultural pesticides.

The urgent need to produce food to meet our growing population brings into increasing public prominence the use of agricultural pesticides as a vital means of boosting crop yields and safeguarding animal health. We, in the field of pesticide, are aware that the products we handle, despite the immense value to the community at large can be the subject of mis-apprehension, prejudice and ignorance. Perhaps this is understandable and even inevitable since the use of agricultural pesticides is a relatively new technology and is expanding rapidly while public awareness is still lagging behind.

Regulatory Policies

A mis-apprehension which I wish to correct is that in the absence of an updated regulatory law on agricultural pesticides, the products are indiscriminately marketed risking the lives of Filipino farmers applying the pesticides as well as the consumers of the farmers produce. This is not so. The country's export-oriented crops such as bananas, pineapple and sugarcane follow strictly the tolerances and other regulations set by the Environmental Protection Agency in the United States as well as the importing countries. On top of these strict standards, the American fruit companies operating in the Philippines follow their own regulatory policies set by their

U.S. offices. At present, almost half of the pesticides imported into the country go to these crop outlets.

For rice and corn, the government supervised credit program set up a technical advisory committee whose responsibility is to screen the different products which can be provided with adequate financing. In the selection, efficacy as well as the hazard posed by each product is considered. On tobacco, the members of APIP, in compliance with the request of the Bureau of Plant Industry, withdrew completely all the DDT formulations from the market and supplied the tobacco growers only with pesticides acceptable to the importing countries. However DDT coming from other sources, not from the trade, continue to find its way to the tobacco plantations. To the European buyers of our leaf tobacco, the local pesticide industry is responsible for the high DDT content of our export tobacco which is enough ground for outright rejection.

I should like to take this opportunity to reaffirm APIP's support to the government's move to regulate the manufacture, distribution and use of agricultural pesticides. We have cooperated with the Bureau of Plant Industry and the Defunct Senate in drafting the Philippine Pesticide Bill, which we trust will now be implemented through a Presidential Decree. APIP would also endorse the active involvement of the Philippine government in the Codex Alimentarius Commission of the joint FAO/WHO Food Standard Programme whose main responsibility is to protect the health of consumers and to ensure fair trade practices in food among nations.

Continue Research Programme

Pesticide research and development has been one of the casualties of sustained attack on the environmental aspects of pest control chemicals. As a result, development costs of pesticides have increased considerably. Yet, chemical companies continue their search for newer compounds to meet the need of modern agriculture and to find the answers to the questions raised by environmentalists. It is not generally known for instance that a pesticide may take from 6-10 years to develop, costing $5-10 million with many thousands of new chemicals being tested every year but very few are considered as marketable products.

Pollution

One of the undersirable side effect of the large scale use of pesticide is the possible contamination of the environment with its residue or metabolite. However, before we get alarmed with this particular problem, let us not lose sight of the fact that pollution with pest control chemicals depends largely on level of pesticide usage and weather conditions which are responsible for the chemical or biodegradation of the pesticides. The pesticide usage in the Philippines, particularly among our rice and corn growers is still very low as borne out by a recent survey. The Filipino farmer in general tends to under-dose or use less pesticide than the recommended dosage. On the other hand, our tropical climate, i.e. bright sun, high

temperature and humidity and rains are all conducive to an accelerated breakdown of pesticides and its matabolite. A sciertific assessment of the problem is in order to establish once and for all the possible level of pollution so that remedial measures can be instituted.

Today the lessons of the mid 60's have been well learned. We are aware of the problems that surround the use of our products through over-use and mis-use in agriculture and in public health. As a consequence, we are making great efforts to see to it that our products are used correctly thru education of the farmers.

What everybody hopes for and what some people indeed demand is a perfect pesticide, deadly to an insect or lots of insects or weeds, harmless to mammals and easily biodegradable. Over the past decade, the discovery of such pesticide has been jubilantly announced again and again by otherwise reliable publications and authorities. But this ideal pesticide is yet to be found in any economically usable form. The country needs food and pesticides are essential to large scale food production. The different pesticides now available in the market, though not as selective as we may desire, when properly used will not harm men and its environment.

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A D D R E S S

HON. CLEMENTE C. GATMAITAN
Secretary, Department of Health

Thank you very much, Director Castillo, for your very kind introduction. For one who has known me only for several years, particularly during nutrition conferences and relief work after typhoons and floods, I am moved by such a lengthy introduction of my humble self.

Councilor Samonte, Commissioner Lesaca, Dr. Hummon, Dr. Smith, Dir. Castillo, Mr. Capingin, Honored and Distinguished Guests, My Friends, Ladies and Gentlemen:

I appreciate very much the opportunity given to me to be with you in this prestigious seminar-workshop on pesticide management, the third of its kind held in three years. According to Dr. Smith, this seminar-workshop is better than the first two past conferences in point of the number of agencies which have participated. For us in the Philippines, there is an added significance in the importance of this seminar, particularly to us in the field of public health.

In our New Society, we are building a train of high-yielding major crops in our development efforts. We aim, among others, to increase agricultural production in order to help ease the th[illegible] of economic crisis.

Because our economy is still predominantly agricultural, one of the main objectives of our government is self-sufficiency in food to support our rapidly growing population. Towards this end, His Excellency, President Ferdinand E. Marcos, has initiated various nationwide food production programs that [illegible] involve both the government and the private sectors. To attain the objectives of these programs, more land will be made available for cultivation and idle land will be utilized. This will inadvertently entail extensive use

of soil conditioners, fertilizers, and pesticides. Pesticides in various forms are used extensively in agriculture. Indeed, their economic importance to an agricultural boom hardly need to be emphasized.

Apart from their use in agriculture, pesticides are of estimable value to public health. Before inventions can be made to superficially fear my remark by extrinsic features, let me expound further.

Our disease control program would not have progressed in this field, were it not for pesticide. There are main stations in our program to eradicate malaria and to control schistosomiasis, filariasis and hemorragic fever, among others.

Moreover, the Department of Health also uses them in disinfecting and fumigating on board of ship as part of its quarantine services.

Of course, pesticides have become common household items. They are used in business establishments, industry and related fields to a limited extent. But I would like to touch a little more on this point.

I beg your indulgence with regards to our experience in the use of pesticide in our disease control program, because my orientation is basically on public health. Anyway, the illustrations I will cite will also have implications for agriculture and industry.

Our malaria control program in the Department of Health started as a pilot project in 1952. It was expanded to encompass the whole country in 1954. In the middle 40's, the liberation year, malaria took a heavy toll of our people, specially among the rural masses. Our malaria workers at that time estimated that we had some 2 million cases and 10,000 deaths a year.

In 1954, when the malaria eradication program was on the way, the number of registered cases reported to the Department of Health was 71,363 or a case rate of 309.9 per 100,000 population. It ranks second among the leading causes of illness at that time. The number of reported deaths was 5,236 or a mortality rate of 22.7 per 100,000. Death-wise it ranked seventh among the leading causes of death during that year.

After only five years and that was in 1959, the number of cases became 6,763 or only 8.6 per 100,000 and ranked as the tenth leading cause of mortality that year. Between 1954 - 1959, morbidity rate decreased 26% while the mortality was reduced by 62%.

But the things I have cited may be for the barrio statistician alone. What has been the impact of this on the agriculture sector? Consider the following:

The review of the available data of food production program shows no rise in rice cultivation areas from 1920 to 1950. The marked rise from 1950 to 1960 was in the later period that malaria eradication was distributed in the Philippines with widespread experience and which started in 1954.

The period of 1960 to 1970 was characterized not only by further expansion of rice cultivation areas but also by large increase in yield per hectare. The control or elimination of malaria in rice cultivation areas plainly saved too often the development and expansion by maintaining healthy working conditions which are favorable, together with permanent settlement of growers and capital investment, in improving production.

What has been indicated regarding the importance of anti-malaria activities in connection with rice cultivation can also be said, to some extent, for cultivated areas as a whole. The 1966 annual report of the International Rice Research Institute mentioned that the annual total cultivated area in 1963 to 1964 in the Philippines was 10 percent larger than in 1954 and 1956. This increase in cultivation follows the track of anti-malaria campaign into stronger areas of developing land yield, especially the 1960 to 1970 years marked by generally high increases in agricultural production. In formerly malarial areas, such economic advantage may be due to a variety of contributory factors. Nevertheless, the reduction of malaria contributed an important share in helping to make available the necessary human resources.

Even in the logging industry, malaria has curious adverse effect. To cite an example, the Firewood Company in Roxas, Palawan had a costly experience with malaria since it started its operations. On February, 1973 alone, 92 out of 99 employees were infected with malaria. For a 548 man-hours per month law, a production percentage loss of 22.2% of the total labor force is affected. Even mines which are located in certain areas are also susceptible to the impact of malaria.

Another disease, the control of which involves pesticide, is schistosomiasis. The disease is one of our country's important disease problems which relates, in large measure, to agriculture. It has been estimated, on the basis of the studies conducted, that the annual loss resulting from death, disabilities and cost of treatment is ₱75,000,000.

In the Philippines, the disease is prevalent in agricultural areas, affecting mostly farmers and their families. It is then easy to realize that it is indeed a major deterrent in agricultural activities.

It was reported that in the municipality of Carmen, Davao del Norte, around 1,000 hectares of irrigable rice fields were abandoned by land owners because the people working in the area invariably become infected with the disease. This situation could well be true in other similar areas.

My friends, I have gone to the extent of citing these statistics in order to project the vital role played by pesticides or insecticides in our present way of lives and in our agricultural system.

The amount of pesticides to be used in the Department of Health is considerable. For malaria, we had used about 900,000 kg. DDT, 75% wettable powder per year at present. This calendar year, our spraying operation will cover about 860,000 households with a population of approximately 4-1/2 million people. Today, the malaria eradication service can consume a total of over 12,000,000 kg. of DDT powder and half a million of dieldrin. I refer to the limited use of dieldrin because of its disadvantages over DDT. At that time, however, dieldrin could be abandoned after only two years of use because of its high toxicity to animal. For our schistosomiasis control program, we use an average of 1,400 kg. of molluscides per year to supplement our agro-engineering measure.

With all this amount of pesticide and knowing them to be toxic one way or another, what is the possible impact of pesticide on man and on his environment? Much has been done to develop effective and efficient pesticide for the benefit of the users of the product. Using pesticides may benefit man and his environment. On the other hand, one may expect that the indescriminate use of pesticides may interfer with man's health. Moreover, it may disture the ecology of the region. However, it should be recognized that health may also be affected indirectly by the impairment of well-being.

The evolution of pesticides, for example, may greatly affect health by causing ignorance. Hence, the present growing concern over the evidently increasing introduction of pesticide with toxic and physiological, even carcinogenic effect in man. The concern over this effect in the environment is worldwide and this is eloquently articulated by Rachel Carson's book entitled The Silent Spring. I am sure many of you here have read that.

In our experiences with the use of pesticides in the public health service, we have not yet come across any report or instant on any serious effect of pesticide in man, even among our handlers.

Our position, therefore, at the present is to continue its use because the advantages far outweight the disadvantages. Even so, we are aware of the hazards and potential ill-effects, particularly chronic or long term one, the widespread use of persistent pesticide may bring. Taking cognizance of the consequences, we have tried to do something about the matter. A few years ago, a committee was formed to undertake a study on the effects of pesticide now in use and to recommend corrective measures. However, we have to admit that not very much have yet been accomplished in that direction. The committee is headed by Director of the Research Laboratory and one of its ranking member is the FDA Administrator, Drn. Luzonica Pesigan. Will you please stand up to be recognized?

Even legislation for regulation and management of pesticide in their use cannot be enacted although it has been proposed many times. It is in this aspect that this seminar-workshop is very much significant and relevent. The expertise, the USAID and the University of California accord our technical men, particularly those in agriculture both in the private and government sectors, will very well give answers to questions we ask and point the way for the rational and expeditious solution of our problems in pesticides. Hopefully, their experience with pesticide, not only in their own countries but also in areas similar to our own could provide us the knowledge that could be obtained only through extensive study and researches. In developing countries like ours, we find such knowledge desirable and very necessary.

In the light of these considerations, we welcome this seminar-workshop and entertain great expectations. We add significance to the mass of knowledge now in application and find the sound basis for future action. This is in consonance with the current emphasis the president with the New Society accords the effort at scientific pursuit. And I quote "In shaping our policies and programs in the field of agriculture, the government is governed by the knowledge and reality, not by superstition and fantasy. We place higher premium in this area on the fruit of research and experiment just as we placed a high value on these things in the management of our financial system in the propagation of arts and development of the critical sciences in our country".

I extend to you all my best wishes for a lively and fruitful discussion.

Thank you and good day.

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MANILA, PHILIPPINES
10-15 February 1975

PM/SP/1
75-10-2

RATIONALE OF PESTICIDE USE

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M a n i l a

Introduction

Nowadays, leaders of the world are tackling the burning problems on how we could produce enough food to avert widespread famine and starvation. And the problems involved are of great magnitude which are further agravated by the fact that some, like droughts, floods and typhoons are beyond the control of man. These occurrences are not however day to day problems unlike that of the problems generated by agricultural pests and diseases. As such, to some extent, these agricultural pests do more damages than any of the natural causes. This is where, this paper deals with and is taking the cue from Dr. Julian Huxley, the noted English Biologist and author of the "Uniqueness of Man" wherein he ably Expounded when he said "Man is created the dominant creature on our planet and is placed in his exalted position to have all other animal creations to serve him for his needs and pleasures and with no share in man's salvation or eternal destiny." And further, he said, "man has the capacity for conceptual thought and has given him distinct qualities over other creations which are that of being able to accumulate knowledge or traditions through transmission of organized experience and the ability to use tools with increasing expertness and dexterity. And because of these qualities the capacity of man for rational thinking have in turn enable him to build enduring civilization."

In the light of the famous biologist words, we have in this age and century a civilization that is dominated by unprecedented progress in science and technology which greatly increased our ability to control our physical environment. The science and technology in agriculture is one of these progressive subjects of studies with no less emphasis on the control of plant pests and diseases. This is in-

evitable but understandable bacause man, since the beginning of recorded history, has been pestered by pests of all sorts in his daily activities not only to his direct personal self but to the plants he raised. In fact, as far back as many hundreds of years before Christ, flies and locusts were known as menaces to man and has to continue waging war against them without let-up in order to survive. In this country, which is essentially an agricultural one, has a great number of agricultural pests and diseases and weeds that are harmful to Philippine Agriculture. And to give a clear understanding about these agricultural menaces, a passing review of some of these agricultural pests are to be presented which, by the mere mention of them, would make everyone ponder with sadness and concern.

Extent of Pest and Disease Problems

From the annual reports of the Bureau of Plant Industry, the infested areas in all crops from 1965 to 1970 mainly with insect pests and diseases are presented in Table 1. It is evident that in 1965 and 1966 the total crop area infested was appreciably much higher than the succeeding years. This is true with the rice crop when considered alone. While there has been substantial improvement in crop protection methods and expansion of treated areas, there was likewise a parallel increase in areas put under more intensive cultivation. This may account for the increase of infested crop areas such as in rice. The susceptibility of some new high-yielding rice varieties recommended for the expanded rice production program to pests and diseases should not be overlooked.

Crop Losses

A quantitative assessment of the extent of crop losses caused by several insect pest species on rice has shown that ricefields protected from insect damage yielded an average of 5.4 tons of unhulled rice while untreated control plots yielded 3.1 tons per hectare.

Studies conducted at the International Rice Research Institute have shown that based on 65 replicated trials over 12 crop seasons (from 1964 to 1970), plots treated with the best insecticidal treatments yielded about two and a half tons more rice per hectare than the unprotected plots (Fig. 1).

Field experiments conducted by the IRRI in collaboration with the Agricultural Productivity Commission at 9 different locations in 7 provinces of the Philippines during the period January to June, 1965 showed a 60 per cent increase in yield over the untreated fields (Fig. 2).

Table 1. Summary of Crop Area Infested by Pests and Diseases

Production Period	Infested Areas in Hectares	
	All Crops	Rice
1965 - 1966	334,393	278,303
1966 - 1967	123,540	87,552
1967 - 1968	125,674	94,476
1968 - 1969	145,670	92,318
1969 - 1970	148,411	108,311

(Data taken from Annual Reports of the Pest and Disease Control Division, Bureau of Plant Industry).

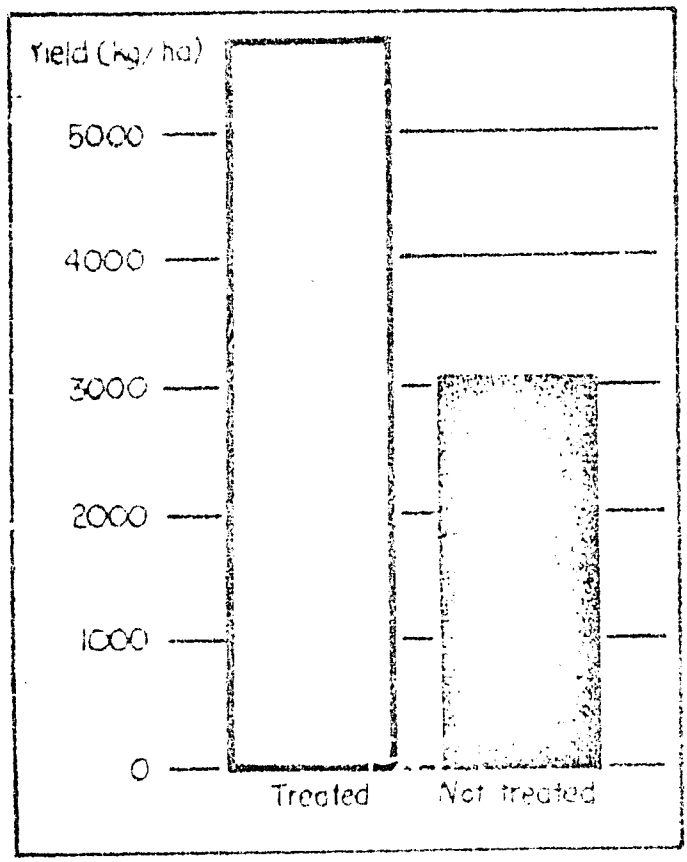
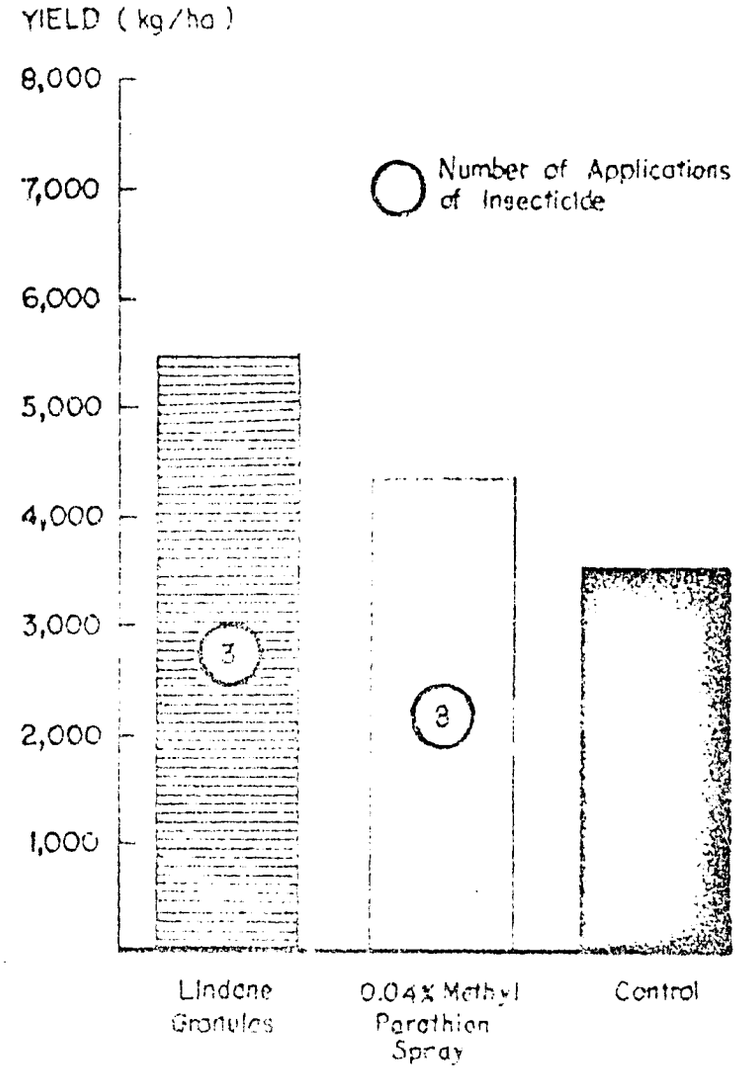


Fig. 1. Effect of insect control on rice yield. Average of the best insecticidal treatments from each of 65 replicated trials over 13 crop seasons (wet and dry). IRRI, 1964-1970.

Fig. 2. Effect of lindane application to the paddy water at 30-day intervals and 0.04% methyl parathion spray every 14 days on the yields of rice. The bars represent the average of experiments conducted in 4 replications at 9 different locations in 5 provinces of the Philippines. January-June 1965.*



*Experiment conducted by William L. Golden et. al., The International Rice Research Institute, in collaboration with the Agricultural Productivity Commission, The Philippines.

Applied research projects conducted jointly by the IRRI and the Bureau of Plant Industry in 16 provinces over five crop seasons (from 1965 to 1967) showed that treated farmers' fields gave an increase of one and a half tons unhulled rice over untreated fields (Table 2).

The damage due to the stem borers in this country may range from 15 to 20 per cent. In ricefields in which no insect control measures are used coupled with the adoption of new rice varieties of moderate susceptibility to the insect, the damage may reach as much as 40 per cent.

Severe infestations with stem borers and planthoppers have caused damage ranging from 40 to 50 per cent.

Rice leaf shield maggot may reduce yields up to 25 per cent or more.

Crop losses over a wide area of the Bicol region from rice blast outbreaks in 1962 varied from 50 to 90 per cent, and in Leyte, West Visayas, damage in 1963 ranged from 30 to 60 per cent.

The normal annual loss due to stem rot is 10 per cent, with losses of 25 to 30 per cent in severely affected areas. Damage on the rice crop from sheath blight range from 25 to 50 per cent. Bacterial leaf blight causes a yield reduction of 30 per cent in severely affected fields.

In severe infection with "tungro", one of the most common and destructive virus diseases of rice in the Philippines, yield reductions of 50 to 90 per cent have been registered.

Crop losses from locust infestation range from 50 to 90 per cent, especially when adult locusts settle on rice at their vegetative growth or early boeting stage.

The common ricefield rat causes an average annual damage to rice of 100 million pesos. Serious infestations, especially prior to harvest could cause from 10 to 40 per cent crop loss.

Weeds can reduce grain yield in transplanted rice by as much as 50 per cent. Higher yield reductions are registered in directly seeded lowland or upland rice.

R a t i o n a l e

Considering, the magnitudes of the problems of food production and the attendant post depradations always associated with them, it is therefore necessary that there is a further need of moulding a national if not global coherent and commodity insect pest control.

Table 2 - Showing the treatments and yields in the different series.

LOCATIONS	SERIES NUMBER	CROP YEAR	SEASON	VARIETY	AVE. PRODUCTION UNTREATED (Cav./Ha.)	TREATED	AVERAGE COST BENEFIT RATI
				A. YIELD DATA			
1. Ilocos Norte							
2. Mt. Province							
3. Pangasinan	I (g-BHC)	1965	Wet	Milfor 6(2)	75.8	92.5	₱ 2.16
4. Tarlac	II (g-BHC)	1966	Dry	Milfor 6(2)	79.9	109.4	3.81
5. Cagayan				Farmer's	76.0	89.0	1.68
6. Isabela	III (g-BHC)	1966	Wet	IR8	103.7	140.8	4.79
7. Bulacan				Farmer's	59.7	83.9	3.13
8. Nueva Ecija	IV (DIAZI-NON)	1967	Dry	IR8	103.1	137.8	4.17
				BPI-76-1	83.7	120.0	4.35
9. Albay	V (DIAZI-NON)	1967	Wet	IR8	92.2	124.8	3.91
10. Camarines Sur							
				BPI-76-1	77.0	100.7	2.84
11. Capiz							
12. Iloilo	VI (DIAZI-NON)	1968	Dry	- DEMONSTRATION/TEACHING PROJECT.			
13. Leyte del Norte				B. BASIS OF COMPUTATION			
14. Lanao del Norte				GAMMA BHC - - - - - - - - - - - - -			₱1.20/kg.
15. Zamboanga del Norte				DIAZINON GRANULE - - - - - - - - -			2.50/kg.
16. Cotabato				P A L A Y - - - - - - - - -			18.00/cav.

Otherwise, their multiplication will tip the balance of survival in their favor and, man, in his present and future state of civilization is existing only on borrowed times. This was aptly stressed by President Marcos when he made his call for a national unity as monitored through the various Media of Communications some few days ago, and exhorted the nations of the world to realize fully the gravity of the global situation to work together in solving the worsening economic crisis which involves in the shortage of food that is of reality to the extent that big nations have already stopped talking about growth but survival. Hence, it is to this end, that the use of chemical pesticides is facilitating a knock-down thrust against the inroads of destructions by the agricultural pests and diseases that underlines the rationale of pesticides usages although, however, there are some who advocate strongly the use of effective biological control in order to avoid the use of pesticides and fungicides. Not to go through with these for the moment and or even for the distant future would be disastrous for the reason that there are still limited materials produced for the purpose. We have to resort to the extensive use of well known commercial agricultural chemicals, therefore.

C o n c l u s i o n

Of all the foregoing, it is evident that the only salvation we have for the present and perhaps for many more years to come, in our effort to raise enough food is to control effectively the various pests and diseases that destroy our crops. And the only answer is for us to use judiciously agricultural pesticides. However, it is equally important to bear in mind of the hazards to man's health and to our domesticated animals attendants to their usages; otherwise, our struggle to save the human race would be in vain. Are we to eat and live only on those which are left by the insects or diseases?

Pesticide Management Seminar - Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/SW/2
75-10-2

WORLD PROBLEMS OF PESTICIDES

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Introduction

The trends and extent of growth for the production and use of pesticides since World War II are reasonably well documented for the industrial countries of North America, Western Europe and Japan. The overall amount of pesticides sold to the developing countries as a group is also reasonably reliable, but the figures for individual countries and even more the uses made of these imported pesticides are not readily and reliably available.

Nearly all pesticide production is limited at least in large part to the industrialized countries of Europe, North America, and Japan. Although much of the parent pesticidal compounds are formulated in final commercial form in the developing countries, and in less frequent cases some steps in the synthesis of the parent compound may be carried out in the developing country, nevertheless, there is very little production that includes all steps of synthesis and final formulation.

Although the rate of growth in pesticides use in developing countries has tended to be higher in recent years than in the developed countries, the small base from which this growth started still results in the total tonnage of use by all developing countries being small in comparison with the countries with highly developed modern agriculture. In 1970, the United States consumed 45 percent of all pesticide production, Western Europe 23 percent, Eastern Europe 13 percent, Japan 8 percent and the developing countries 7 percent with the remainder in Australia and other developed countries.

The relative growth rate between insecticides and other pesticides has been much less in the developed world compared with the developing

world. In the developed world, insecticides have declined in relative position among pesticides from being the dominant class of pesticide before 1960 to representing only about one-third of total pesticide usage currently. This is in spite of large increases in total tonnage of insecticides used. This is primarily the result of the rapid growth in the use of herbicides which now represent the major portion of pesticides used on global basis and are still increasing in use at a more rapid rate than other classes of pesticides. There is strong indication that this trend may accelerate as farmers are increasingly substituting herbicides for tillage because of higher fuel and equipment costs and equipment shortages. In the developing world, insecticides, remain the dominant class of pesticides used and their use is increasing at a rate that would appear to maintain their dominant position for some time to come.

The use pattern by crops for insecticides is fairly well known for the United States and some of the other developed countries, but it is not well documented for the developing countries. In the United States about half of all insecticide usage in agriculture is in cotton. Maize represents about 10 percent of all use; and of the fruit crops, apples is one of the major consumers. In developing countries, it is hard to evaluate end use of imported pesticides because they are used extensively in public health programs in addition to agricultural uses; reliable figures on relative uses by sector and specific crop are not available. Nevertheless, it is clear that in the past, nearly all agricultural use of pesticide use in developing countries has been on cash crops with cotton representing at least half of all use. Plantation crops such as sugarcane and tree crops have been major consumers of pesticides with vegetables, rice and maize when they are raised as cash crops are of lesser but increasing importance. In some developing countries, use of insecticides to protect stored products is also of importance.

Current International Trends Affecting Agricultural Development.

The disappearance of basic food stock reserves has led to a rapid increase in prices for not only basic food commodities but also for industrial crops such as cotton, rubber, etc. Some of these crops receiving high prices have often been marginal in the pesticides use in the past but now with their increased value there is a favorable cost/benefit ratio. Some of the beverage and plantation crops such as cacao and sugar have also been affected similarly although coffee and bananas have not had any major increase in prices thus far. These more favorable prices for the farmer should stimulate both production and demand for inputs such as fertilizer and pesticides. The impact can already be seen in shortages and rapidly escalating prices for these products. This, in turn, may well lead to greater emphasis by developing countries on increased local manufacture of pesticides at last to the extent possible.

General inflation resulting from the high food prices and shortages based on rapidly increasing demand for many basic raw materials, such as petroleum, metals, paper pulp, etc. has become a world-wide problem. It is seriously affecting the balance of payment position of both industrial countries and those developing countries which are not major exporters of raw materials. The balance of payment problems are expected to increase the desire of agricultural product exporting nations to increase their production as a means of easing payment problems, and for the countries who are net importers of agricultural products to expand local production of agricultural products to reduce import requirements. Since both of these current trends could increase pesticide demand substantially, they could have a major impact on the pesticides industry. This is particularly true because pesticides usually produce a high rate of return on money invested by the farmer. The rate of return can be greatest in developing countries where low base productivity permits greater cost-benefit potential.

The basic world wide shortage of many raw materials, which generates much of the inflationary pressure, make it difficult to expand production readily to meet the demand for more pesticides. The shortage and resultant rapid price rise in petroleum products has heavily affected the pesticide industry. Most pesticide manufacture involves petrochemical products either as basic building blocks in manufacture or as solvents or emulsifiers in formulation. In addition, the shortages of plastics, metals, and paper products used in packaging are also affecting pesticide production adversely. In some cases, shortages of transport for either raw materials or finished products have slowed production. All of these factors are depressing supplies of both pesticides and fertilizers which would result in further depression of the growth of agricultural production.

Phenols are also major pesticide intermediates and supplies have been drastically reduced because of the destruction at several major phenol producing factories by explosion and fire.

As a result of all of the various factors listed above, the general trend has been about a 25 percent world wide increase in orders for pesticides during the past season but probably a slightly decreased level of production. Under normal conditions, the pesticide industry keeps current production reserve for field use in the following crop season. This year the increased demand has largely been met by the current production which normally would have been used to build the 1974/75 inventory stocks. This suggests that the short fall in the 1974/75 season will be at least in the order of 25-30 percent. This situation has been aggravated by speculative and panic purchases. Any global shortage could be most severe for the developing countries as they consume less than 10 percent of the world pesticide production, but many now wish to increase their consumption rapidly. As the basic manufacturing of pesticides is conducted outside the developing countries, the prospect for this increased use is not bright.

Another development in the past six months which has eased the supply problem somewhat is the deteriorating price for cotton. Many farmers have greatly reduced or will greatly reduce their planted acreage in the coming growing season. In the United States there may be a 3 million acre reduction in cotton. The shift in other part of the world will come more slowly. These shift will have their greatest influence on the 1976 supply situation. As cotton is the largest consumer of agricultural pesticides this will ease to an extent the anticipated shortages in the coming season. Nevertheless a number of pesticides will remain in short supply.

Current trends in pest control and pesticide usage and their implications.

The growing concern for greater protection of the environment especially in developed countries has had major impact on pest control programs. This is most strongly manifested in the efforts that have been made to restrict or eliminate the use of pesticides that persist in the environment over long periods. This is having a major impact on the use of chlorinated hydrocarbons with the greatest influence on the use and availability of DDT.

Although the effort to restrict DDT and other chlorinated hydrocarbons originated in the United States, it has been taken up rapidly by other industrial countries, furthermore the current trend is that most developing countries follow the pattern set in the industrial world and establish increasingly rigid use restrictions soon after these have been adopted in the United States or Europe. This has had a major impact on both the availability and type of compounds used. This affects the cost of plant protection and other pest control because most of the potential alternatives prove to be much more costly.

Some of the adverse consequences of wide scale use of pesticides have caused some to advocate the elimination of most or even all pesticides. This is foolish because knowledgeable plant protection experts have been unanimous in recognizing that pesticides are essential for agricultural and public health for the present and the future. Nevertheless certain adverse consequences of pesticides, e. g. development of resistance to pesticides, persistence of residues in food, destruction of beneficial organisms, and human intoxication has led to restudy of pesticide use patterns. This trend has produced interest in expanding the integrated control approach to crop protection. In this approach primary reliance in placed on naturally occurring mortality with supplemental manipulation of parasites, predators and pathogens, on resistant varieties, on pesticides, and on cultural practices to keep pests below the levels that cause economic damage. Pesticides are used in compatible ways and are kept to the needed minimum to supplement the other controls.

The expanded interest in integrated pest control has also created the demand for more narrowly specific pesticides which have greatest possible impact on the target pest organisms while at the same time causing minimum effect on other species in the environment. This has led not only to greater interest in developing highly specific pesticides but also in isolating natural compounds which can be used to manipulate pest populations. These include such chemicals as hormones or hormone mimics that can restart the normal development pattern and pheromones that can be used to interrupt or abuse mating and confuse normal behavior. This same trend has created increased interest in artificial rearing of parasites, predators and pathogens and in the genetic manipulation of pest populations.

Although these new trends will result in the development of new compounds, but the continued use of older pesticide compounds will be necessary. Furthermore, these trends are fraught with many problems when it comes to maintaining adequate pest control capability for economical crop protection and production in the future.

<u>Problems in the development of new pesticides, particularly speciality compounds and novel chemicals needed in pest control.</u>

One of the biggest factors which are the difficulty in the development of any new pesticide is the rapidly increasing research and development cost required to bring a new product to the market stage. This cost has reached the level of more than [illegible] million dollars to get a new product on the market and requires an average of [illegible] years to fulfill all the regulatory and [illegible] requirements. Much of this large cost results from the greatly increased regulatory requirements that have generated from a heightened awareness of conservation and the environment. These requirements are often only for the specialized requirements needed to insure an adequate agricultural market of reasonably assured levels of safety.

It is clear that we will be faced with pesticide shortages of the next few years. What can we do? The best conserve of our supply of pesticide like a man in the middle of a desert conserves his one canteen of water. <u>Pesticides must not be wasted</u>. The insurance treatment applied because pests <u>might be present</u> or might do damage is wasted pesticide. To conserve pesticides, they must be applied at the correct dosage in the most effective manner possible and only when necessary. Where possible the integrated control approach should be utilized because it makes maximum use of the naturally occurring mortality, and thus extends the effectiveness of the available pesticides.

Pesticide Management
Seminar-Workshop
MANILA, PHILIPPINES
19-23 February 1979

PM/SI/2
79-10-2

PESTICIDES IN PHILIPPINE AGRICULTURE

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Background

The use of pest control chemicals in Philippine agriculture is not new but general acceptance of this technology, particularly on rice and corn, is still lagging behind.

The era of pesticide usage can be traced to:

	Chemicals used/crops
Pre-Pacific War	Kerosene - soap solution for coconut leafminer control Arsenicals - Lepto infestation and tobacco Nicotine - dust/liquid - vegetables Pyrethrum - general pest control
War time	Pyrethrum dust/emulsion and soap solution for cotton pest control
Post-Pacific War	Beginning of DDT trade for tobacco, mango, rice and other crops. THIP for rice bug, Dalidore for citrus, 2,4-D for rice and sugarcane

There are now 22 chemical companies engaged in the manufacture and/or distribution of agricultural pesticides, which have organized themselves into a trade association now referred to as the Agricultural Pesticide Institute of the Philippines. These agricultural chemical

companies are mostly affiliates of chemical companies in U.S.A. and Europe or distributor of Japanese manufacturers. Because of this set up, our farmers benefit from the results of very expensive research programme being undertaken by each company.

Some of these companies and their respective strength by way of products originally developed, or currently manufactured.

Fungicides	Du Pont Rohm & Haas	
Herbicides	Monsanto Du Pont Elanco Agchem	Dow Warner Barnes (ICI) Ciba Geigy
Insecticides	Bayer Shell Chemicals Hoechst Planters Products Trans World American Cyanamid	Union Carbide Ciba Geigy Pharma Velsicol BASF Interchem

Characteristics of the Philippine Market

1. Small farmers market - small packs

With an average land holding of about 2½ Ha. agricultural pesticides are marketed in pack sizes that farmers can afford to pay and not necessarily what they require. We deal with thousands of farmers to achieve a volume.

2. Education - although the potential user may be aware that he has a pest or disease problem, he is often ignorant of its nature and the measures necessary to control it. As a consequence, we have to undertake education of the farmers and a well informed technical sales backing is therefore essential.

3. Toxicity problems - pesticides are biologically active substances and which can be highly toxic; their use involves the risks of intoxicating the user and the consumer of treated crops. In this connection, government regulatory measures are indeed very useful to the industry.

4. Controversial - in some countries, the "interference with nature" which is caused by new agricultural technique is a controversial subject and "nature lovers" frequently criticize the use of pesticides.

5. Unpredictable business - as a result, substantial amounts of working capital must be invested in stocks.

6. Credit- financing of sales to distributors to ensure availability of stocks when the farmers ask for the product. This again increases amount of working capital.

7. High cost of sales - the cost of selling pesticides is high due to the seasonality of the business and to the widespread scatter of the customers.

Crop Outlets of Pesticides and estimated Extent of Use

Commercial Crops	No.	Area being treated	Pesticide Use
1. Pineapple	27,000	25%	Insecticides Nematocides Herbicides
2. Bananas	250,000	10%	Fungicide Herbicide Insecticide
3. Sugarcane	450,000	50%	Herbicide Insecticide Fungicide
4. Tobacco	84,000	20%	Insecticide
5. Mangoes	1.5 million bearing trees	10%	Insecticide
Food Crops			
1. Rice	3.1 million	15% 25%	Granular Insecticide Liquid Insecticide
	less than	15% 25%	Granular Herbicide Liquid Herbicide
Vegetables (Beans, Cabbage, potatoes)	50,000	10%	Insecticides Fungicides

Prospect of the Agricultural Pesticide Industry

With the government [illegible] and the recognition of pest control [illegible] it is producing more food, it is almost certain that the Agricultural Pesticide Industry is here to stay with sufficient room for expansion. The export crops such as sugarcane, bananas, pineapple, and very soon mangoes, will continue to expand in acreage to meet growing world demand. The growth of the pesticide market, however, will depend on the following:

1. Supply Position - worldwide situation has not firmed up and majority of the pesticides now available in our market are in very short supply resulting from shortages of raw materials and

and also increasing demand. Almost all countries including the more developed ones who have depleted their food reserves have now given emphasis on food production and developing countries like ourselves, compete with them for the necessary supplies.

2. Increase in cost - because of product shortages and increase in demand, pesticides prices have always been on the rise. A situation which is aggravated by inflation which is affecting almost all nations of the world. To make pesticides available to the Filipino farmer, the chemical companies have to meet on-going world prices and terms.

Some of our crops may not be able to absorb these cost increases because of pricing policies. A good example is in the case of chemical herbicide for rice 2,4-D. The gap between the cost of chemical herbicide and manual labour using rotary weeder has narrowed down to a point that more farmers including those provided with financing are now resorting to rotary hand weeder. The use of rotary hand weeder is further encourage with the new system of planting rice in straight rows.

3. Resistant varieties - the full impact of rice varieties resistant to almost all insect pests may be realized in 2-3 years time thereby affecting also the insecticide market. The rice insecticide market can be expected to taper off during the period but no doubt new usages on other crops such as corn, sorghum and soybeans will be developed and new crops such as cotton will be grown in a wider scale.

4. Infrastructure programs - the construction of more irrigation systems and improvement of existing ones and also feeder roads in the rural areas will promote more intensive farming and thereby create the market for agricultural chemicals.

5. General Order No. 47 - this order which will require big corporations to produce rice for their employees will serve as the source of the necessary farm technology and supervision of farmers who do not participate in Masagana 99 rice programme.

<u>Agricultural Pesticides in Masagana 99</u>

Masagana 99 rice production programme is a package consisting of three important components, namely:-

Financing from rural banks and PNB branches to provide necessary funds for inputs such as fertilizer, pesticides and seeds of high yielding rice varieties

Technology - the application of a pattern of cultural practices including the use of pesticides, and

Supervision - government extension agents or production technicians to assist the farmer obtain his financing and guide him in the 16 steps of Masagana 99.

Pre-Masagana 99

Let us look back when the above scenario on Masagana 99 did not exist, particularly on the utilization of pest control chemicals. The promotion of pesticides mainly through the education of farmer, was the responsibility of chemical companies. The government through the Bureau of Plant Industry and the Bureau of Agricultural Extension assists through their extension men while in the case of the Bureau of Plant Industry undertake some actual pest control on pests affecting the whole community such as rats and locusts.

The chemical companies promote their products

a) by use of mass media
b) convincing the farmer by field demonstration
c) organizing farmers meeting
d) sales promotion techniques such as contests and raffles, and
e) employing agricultural graduates who can discuss with the farmer on his problem, particularly on pest control.

To support the sales organization, each company has its own technical department which initiates field trials to confirm dosage rates on particular pest of specific crops and also to serve as a bridge between research and sales. In brief, all efforts by each company are directed towards the farmer who will decide for himself if he is satisfied with a particular product. Although competition was fierce between companies, some brands prevailed in the market over others such as Folidol, as a general purpose spray, Phosdrin for vegetables, Sevin for mangoes. The acceptability of these products or brands was mainly dependent on the farmers demand. Of course, upon the influence of the chemical company. In some instances it was difficult for companies to introduce new product because of the insistence of farmers in using a particular brand. This was a slow process of getting to the farmers but we believe that they were happy with the situation when they can exercise their own judgment in the selection of a particular pesticide.

The Filipino farmer is not as ignorant about pesticides as we may presume. He will ask and use a product which is effective based on his experience and others and also subject to price consideration. He will even mix his own cocktail of insecticides to make his spray more effective and perhaps cheaper. He is easily impressed with instant kill rather than slow acting safe chemicals and last but not least he always remembers his experience in one particular insecticide, particularly if he needs replenishment.

Masagana 99

The first phase of Masagana 99 in 1973 has resulted to a significant increase in pesticide usage on rice. However, the marketing of all chemicals [illegible] a different approach. Chemical companies have to provide their products to production technicians who then [illegible] the usage of pesticides through financing from the bank. The production technician becomes a very important link in promoting a [illegible] product to the farmer, to the extent that whatever the farmer has learned prior to Masagana 99, is completely ignored.

On the basis of areas actually planted, Masagana 99 Phase I should have provided a market potential of about 1,000 metric tons active ingredient of insecticide valued at about P85 million and 500 metric tons a.i. of herbicide worth P21 million, or a total market of about P[illegible] million. During the same period total pesticide market, including sales to commercial crops, i.e. bananas, pineapple, etc. which constitute about 50% of total is only about P100 million. This is an indication that the full potential of the programme for the pesticide industry is not being realized.

Problems of the [illegible] in the chemical pest control

A massive programme such as Masagana 99 involving thousands of people in a wide eastern area is likely to have problems during the implementation. ACPI as an input supplier sits as a member of the management committee which oversees the implementation of the programme. Thus [illegible] problems regarding pesticides availability, pricing, etc. are referred to us for action. It is also ACPI's responsibility to maintain inventory of the necessary pesticides to support the programme and to locate these stocks in the different places where they are needed, following the programme of planting. I would like to mention some of these problems, particularly which have direct bearing to chemical pest control. We trust that when a similar programme is re-designed, these problems and possible solutions are included.

As earlier stated, the production technician is the focal point of all activities with regards to pesticide usage. Naturally we are not familiar with their activities and related problems. To name a few.

1. Inadequate supervision - the technicians on which depend the success of the programme are assigned more farmers than what they can actually handle thus their role as a teacher or as an adviser is not fully complied with. As a consequence the implementation of cultural practices covered by the 16 steps of Masagana 99 is not well supervised.

News stories about complaints of farmer having been asked to buy more pesticides than what they need, is to our observation the result of lack of proper advice on its usage. Furthermore most of the farmers who availed of loan from the bank to buy his pesticide had no choice but to accept a product since a firm plan and budget was prepared for him by the technician. The farmer had no say on what to use.

Another direct result of inadequate supervision is the common practice among the farmers to apply less pesticide than the recommended dosages resulting to poor control of the posts. Our recommendation here is to limit the programme areas, to a size which can be adequately supervised by the existing number of technicians.

2. Farmers adviser need more training on pesticides.

3. System of supervising the farmers - the production technicians tell the farmers what to buy without giving the farmers an opportunity to decide for himself on what particular pesticide to buy. I believe that after three phases of Masagana 99, the farmer has already learned something about pesticide and has the experience to guide him in his choice.

4. Interference on the recommending process - the technicians are often under pressure from interested groups to recommend only products which are available from them but not necessarily the most effective.

5. Production technicians - potential for abuse. Because of the new importance of their role in the financing programme, the production technicians can abuse their role in the following manner:

a) to go into alliance with dealers to push a particular brand for a fee, and
b) to go into business themselves

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/SP/4
75-10-2

PESTICIDES IN PUBLIC HEALTH

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Introduction

After the Second World War, the general trend on Public Health campaign in the Philippines was to encourage and develop programs for the control of vector-borne diseases and the gastro intestinal infections. Both groups of diseases are intimately related to the local environment. However, attempts to control these diseases through significant or rapid improvement of the environment was costly and beyond the financial reach of our country. The only immediate financially feasible alternative for control and good sanitation was the application of pesticide.

Pesticide in public health is mainly used to control insects, snails and rodents which transmit or serve as carriers of human diseases; like malaria, dengue/haemorrhagic fever, Filaria, cholera, el tor, schistosomiasis, plague, etc. The continued use of these chemicals depend on the present rapidly changing situation in the field of vector control. This change is brought about by the ever-increasing occurrence of resistance to insecticides on the one hand and on the other, development of numerous new methods, materials and concepts to meet this problem.

I. MALARIA: DDT in the Philippine Malaria Program

From 1946 to 1950, the Department of Health through the Division of Malaria was undertaking a malaria control program. The control measures being followed were mechanical and naturalistic methods directed against *anopheles flavirostris* the principal malaria vector

which breeds on clear, slow flowing and partly shaded streams. These measures were automatic siphon, sub-soil drainage, clearing of streams and larval control with Paris green.

Malaria in the Philippines is a rural disease and it is found in almost every province at that time. But the campaign was so limited in its scope due to financial reason. Because of this shortcomings, the Department of Health and the World Health Organization (WHO) with the cooperation of the United States Mutual Security Agency (MSA) now Agency for International Development (AID) agreed on February 15, 1952 to establish Malaria Pilot Project to find out whether DDT residual spraying of houses would be an effective and economical method of controlling malaria in the Philippines. After one year of study the results showed the effectiveness of DDT in controlling the disease. Now, taking this as the basis, the Philippine Government started its nation wide malaria control programs using DDT as the main weapon.

The recommended dose of 2gm/M^2 twice a year by the (WHO) which was tried in the Mandaue Pilot Project was adopted as the standard dosage for the whole country. All malarious areas of the country were received total coverage two times a year at an interval of six months. The spraying were done inside houses, dwellings and their sheds, temporary shelters and tents, and any structure where people may sleep, consider or spend some hours of the night.

Safety measures are followed in the handling, preparation of the suspension and spraying are as follows:

1. DDT powder in sack for one load of a spray can are weighted at the Unit Headquarters and placed in plastic bags for use in the field.

2. Before spraying a house, all materials including drinking water, cooking and drinking utensils and food are placed in the corner of the room and covered with mat and plastic sheets.

3. Domestic animals and chickens are placed in a cage outside the house.

4. During the actual spraying of the house, only the spray-man is allowed to stay inside the house.

5. House with a newly born child or sick person is not sprayed until after sometime. Since 1953, there is no record of illness - attributable to DDT resulting directly from the normal spraying operations among either the many thousands of sprayers or the millions of occupants of DDT treated houses.

From 1952 to 1974, the Malaria program consumed 26,480,653 lbs. of DDT and these were sprayed to 19,895,498 total number of houses (Table 1). This anti-malaria efforts have brought about a reduction of malaria from an estimated 2,000,000 cases and 10,000 deaths each year in the 1940's to 40,000 cases and less than 1,000 deaths in 1972. In the same period, malaria used to be the number two disease killer of the country and now reduced to number 14 in the list.

Other Insecticides Used in the Malaria Program

(a) DIELDRIN - In 1958, a pilot project on the possible uses of dieldrin for intradomiciliary spraying against malaria vector species was established in Cagayan Valley. This studies proved to be effective in interrupting malaria transmission. In (1956 - 1959) the program used a total of 1,198,901 lbs. of this insecticide on a nationwide basis. Within a short span of the years, the principal malaria vector of the country (the Anopheles flavirostris) developed resistance to this particular insecticide (Table II). Also, Dieldrin was relatively more toxic than DDT and the people complained of affecting their domesticated animals. As a result, the program reverted back to the use of DDT.

(b) BAYGON - (Propoxur a carbamate insecticide) - The potentialities of this insecticide as a possible substitute for DDT in fighting malaria in this country was tried in several highly endemic localities in Palawan last 1972. Baygon was formulated to 5% suspension with water and sprayed at 2gm/m^2. Although, this insecticide has a long residual effects against the vector species yet it has the same objection from the people as DDT in making the walls of houses untidy. Also, during the actual spraying, sprayman complained some discomfort like headache, nausea, etc. Because of these disadvantages, the field trial was discontinued even before a sufficient epidemiological data could be gathered.

(c) ABATE - An Organo-phosphorus insecticide was used in the Philippine Malaria Program as a larvicide against (Anopheles flavirostris) the principal vector which breeds on the foot hill streams. Also, this was used against An. sinensis and An. literalis both secondary malaria vectors of this country.

Abate (BAYOS) a 44% of pure liquid material was formulated at one cc. to one liter of water (0.066 pm). The interval of application was on a weekly basis with the aid of a spray can. In our larviciding program, we noted the excellent effects of Abate against the larval stages of both Anopheline and culicine groups of mosquitoes. Our consumption of Abate amounted to 312 gallons. The epidemiological assessment of the area under larviciding showed that malaria transmission could be interrupted successfully. However, the operation was several times more

expensive than the ordinary indoor spraying of houses. To compensate the high cost of the operation it is advisable to undertake larviciding in places where population is dense. This larvicide was found to be safe and we never had any complaint from people using the streams for domestic uses.

II. FILARIA

Filaria is one of the major insect borne diseases next to malaria in this country. Although, not a deadly disease it causes monstrous deformities thus rendering the individual a social outcast.

Of the 66 provinces in the Philippines, 48 have been surveyed for filaria. The disease was found endemic in 29 provinces. A total of 282,712 persons coming from 48 provinces have been examined with an overall micro-filaria rate of 3.7%. Filariasis in the Philippines is caused mainly by Wuchereria bancrofti. This is transmitted by Culex pipiens fatigans in big municipalities or in semi-urban areas. The mosquitoes breeds on stagnant water and artificial containers. Whereas, in provinces where abaca (Musa textiles), banana "Saba" (M. sapientum compressa), "Pandan" (Pandanus Sp.) plants are common the vector is Aedes (Finlaya) poicillius. This mosquito breeds on axils of abaca, banana and pandan plants. In the absence of these two vectors, in some places the Anopheles flavirostris the principal malaria vector was found to transmit the bancroftian type of filariasis. Another filaria parasite that is found in the country is the Brugia malayi. It is found in the Southern part of Palawan. The mosquito vector is Mansonia bonneae. It breeds on bodies of fresh water with acquatic plants like Pistia stratiotes and Eichornia crasipes. The larvae of this species attach itself to the roots of these plants under water thus it is difficult to control with larvicide.

Filariasis being a mosquito-borne disease, studies on its transmission, epidemiology, treatment and control follow certain patterns similar to malaria. The method of control using DDT at $2gm/m^2$ at six months interval was found to be effective and showed reduction in adult mosquito density and the vector infection rates.

However, if a country wide control for filariasis is contemplated it is more difficult because Wuchereria and Brugia have a multiplicity of mosquito vectors representing a wide variety of ecological conditions.

III. DENGUE/HAEMORRHAGIC FEVER

This disease is an arthropod borne virus that is transmitted by *Aedes aegypti*. At present, H-fever is being considered as one of the major public health problem of this country. Usually, this disease occurs in epidemic proportion during rainy months, (July-September) and always associated with the fluctuating densities of *Ae. aegypti*.

Last 1966, the Greater Manila area had its worst H-fever epidemic, wherein the total cases amounted to 9,361 with 250 deaths. The hardest to be hit were the poorer sectors of the urban area whose housing conditions appears congested.

Chemical control, in the form of fogging, residual spraying and larviciding is the only immediate measure to relieve the population during epidemic. However, control of the vector *Ae. aegypti* is hampered by its development of resistance to DDT in this country. Because of this prevailing problem, the different cities and municipalities within the Greater Manila area used Mistox-C and Mal-rin for fogging and spraying. These two insecticides with contain DDVP (0,0-dimethyl 2,2-dichlorovinyl phosphate) of different concentration as the active ingredient. The final concentration of the emulsion was 0.5% and observed to be effective against *Ae. aegypti* and other mosquitoes. Consumption of these two chemicals were minimal in quantity due to lack of funds among the different city and municipal health departments.

Abate - As a larvicide was found to have excellent effect on the larval stage of *Ae. aegypti*. The most convenient formulation for *aegypti* control was the 1% sand granules.

IV. SCHISTOSOMIASIS

Schistosomiasis in the Philippines is caused by *Schistosoma japonicum*. It is transmitted by a snail intermediate host called *Oncomelania quadrasi*. The disease is maintained or may be contracted when an infected person or animal deposits his stools with ova in it on the water. Once on the water, the ova will hatch into miracidia. The miracidia will parasitize the *O. quadrasi* and when inside the snail, an enormous multiplication occurs in this intermediate host. After reaching a certain stage of development, the parasites leave the snail as fork-tailed cercariae and live in the aquatic environment. The cercariae can penetrate the intact skin of man and do so when exposure takes place in water containing them.

In the Philippines, there are 23 provinces found to be infected with this disease. The estimated population at risk was 3,374,951 persons with an estimated total cases of 529,070. This disease mainly affect agricultural workers and their families.

Control of snails by means of agro-engineering methods appears to be the most practical way of minimizing the disease. The use of molluscocides is only resorted to as a terminal measure when the distribution of snails still exist in small pockets. The molluscocides commonly used for this purpose are NaPCP (Sodium Pentachlorophenate) and Bayer 73 (Niclosamide). These are formulated at the rate of 5gm/sqm and 0.5gm/sqm, respectively. The application was at monthly interval and found to be effective against quadrasi snails.

V. PREVENTION OF PLAGUE

Plague is a highly infectious disease and has a high mortality rate to human. The causative organism is Pasteurella pestis. It is essentially a disease of rodents usually transmitted by rodents fleas, Xenopsyela cheopis as the intermediate host.

The Bureau of Quarantine is continously guarding our shores from the possible importation of this dangerous disease. All "Open Ports" of our country are being watched as the possible entrance through commercial ships coming from infected countries like India and Vietnam. Quarantine personnel are impowered to fumigate any ship found with high density of fleas on board. For fumigation, the Bureau of Quarantine has been using cyanogas and sulphur (Table III).

For rat control in the Pier area, they used these rodenticides; Sodium flauroacetate "1080" and liphadione - consumption of these chemicals were minimal due to their high toxicity. The Bureau of Quarantine has to be highly commended in their efforts in preventing the occurrence of such a disease in this country.

VI. HOUSEHOLD PEST

1. Common Houseflies:

(a) Musca domestica
(b) Musca sorbens

2. Cockroaches:

(a) Blatta orientalis
(b) Blatella germanica
(c) Periplaneta americana
(d) Periplaneta australasiae

3. Culicine Mosquitoes:

(a) Culex pipiens fatigans
(b) Aedes albopictus
(c) Aedes aegypti

4. F l e a s :

(a) Ctenocephalides canis
(b) Ctenocephalides felis-felis
(c) Ctenocephalides felis-orientis

5. Bedbugs :

(a) Cimex lectularis
(b) Cimex hemipterus

6. A n t s : Most household ants belongs to the family Formicidae.

The control of these insects listed above has long been recognized as vital to the community. Both from the standpoint of being a potential disease carriers and its capacity to annoy. These groups of insects are the most highly exposed to the different preparation of insecticides intended for household consumption. Last year alone the estimated quantity sold throughout the country by the different chemical companies amounted to several million liters not considering the powder forms. Actually, this is an indication that there is a big demand in the market for such products. Because of this, public interest should be guarded from over exposure. The government should establish a research laboratory that will ascertain the toxicity of every preparation being sold to the public. Together with this, health education in the proper usage of these chemicals should be carried out.

Pesticide seems indispensable in the maintenance of Health and comfort at this modern age. However, the use of these chemicals seems start leave because these household pests developed resistance to a wide variety of insecticides used against them in less than two decades.

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Summary

1. Pesticide in public health is mainly used to control insects, snails and rodents which transmits or serve as carriers of human diseases; like malaria, dengue/haemorrhagic fever, Filaria, cholera, el tor, schistosomiasis, plague, etc.

2. Last February 15, 1952, the Philippine Government, the World Health Organization (WHO) and the United States Mutual Security Agency (MSA) now Agency for International Development (AID) agreed to establish the Malaria Pilot Project to find out whether DDT residual spraying of houses could be effective and economical method of controlling malaria.

3. The recommended dose of $2gm/m^2$ twice a year was adapted as the standard dosage for the whole country. The spraying were done inside houses, dwelling and their sheds, temporary shelters and tents, and any structure where people may sleep, assemble or spend some hours of the night.

4. From 1952 to 1974, the malaria program consumed 26,480,653 lbs. of DDT and these were sprayed to 19,895,498 total number of houses. This anti-malaria efforts have brought about a reduction of malaria from an estimated 2,000,000 cases and 10,000 deaths each year in the 1940's to 40,000 cases and less than 1,000 deaths in 1972. In the same period, malaria used to be the number two disease killer of the country and now reduced to number 14 in the list.

5. Dieldrin, although effective in interrupting malaria transmission, however, we stopped using it because the principal vector, Anopheles flavirostris developed resistance to this insecticide.

6. Baygon or Propoxur has long residual effects against the vector, but people objected to its use because it makes the walls of houses untidy. Also, during the actual spraying it has some side effects to the spraymen.

7. Abate when used as a larvicide against the aquatic stages of An. flavirostris, An. mangyanus and An. litoralis showed that malaria transmission could be interrupted successfully. However, the cost of operation was something prohibitive.

8. Filariasis being a mosquito-borne disease the method of control using DDT at 2gm/m at six months interval was found to be effective in reducing the adult mosquito density and the vector infection rates.

9. During H-fever epidemic chemical control, in the form of fogging, residual spraying or larvicidding is the only immediate measure to relieve the population. However, Ae. aegypti has developed resistance to DDT in this country.

10. Abate proved to be an excellent larvicide against the aquatic stage of Ae. aegypti.

11. Schistosomiasis in the Philippines is transmitted by a snail intermediate host (Oncomelania quadrasi) and it is traditionally controlled by means of agro-engineering methods. The use of molluscicides is only resorted to as a terminal measure when distribution of snails still exist in small pockets.

12. To prevent the possible importation of even a single case of plague in our country, the Bureau of Quarantine has been using cyanogas and sulphur to fumigate ships coming from infected areas. For rat control within the river premises they use Sodium fluoroacetate "1080" and lipnadione.

13. Household pests are the most highly exposed group of insects to the different preparations of insecticides intended for domestic uses. Because of this, the government should protect the public from over exposure by establishing a research laboratory and through Health Education campaign.

14. Pesticide is indispensable in the maintenance of health and comfort at this modern age.

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TABLE I

DDT USED, HOUSES SPRAYED & NO. OF PERSONNEL EMPLOYED BY THE MALARIA ERADICATION SERVICE
(Fiscal Year 1953-1974)

Fiscal Year	Houses Sprayed	Insecticide Used			Personnel Employed
		DDT 75% Powder in lbs.	Dieldrin in lbs.	25% Emulsion Concentrate (gal)	
1952 - 1953	149,879	329,734			
1953 - 1954	1,260,694	2,773,527			
1954 - 1955	1,260,478	2,749,142	10,868		
1955 - 1956	1,429,314	2,372,227	351,029		
1956 - 1957	1,520,489	37,393	505,140		5,142
1957 - 1958	426,763	51,953	149,160		3,280
1958 - 1959	486,350	65,872	179,494		11,873
1959 - 1960	687,915 #	836,463			2,124
1960 - 1961	535,162 #	644,991			1,782
1961 - 1962	618,504 #	991,315			1,503
1962 - 1963	574,487 #	1,038,279			2,450
1963 - 1964	978,111 #	1,396,383			3,848
1964 - 1965	1,235,031 #	1,3[illegible]2,518			1,669
1965 - 1966	676,215	896,730			3,916
1966 - 1967	1,048,379 #	1,286,925			3,825
1967 - 1968	923,819 #	1,378,259			3,502
1968 - 1969	1,737,224 #	2,417,306			5,046
1969 - 1970	1,273,412 #	1,591,473		19,925	3,899
1970 - 1971	468,628 #	424,125		136,578	2,883
1971 - 1972	537,627 #	331,150		54,203	2,942
1972 - 1973	543,401 #	721,919		42,171	2,791
1973 - 1974	832,644	1,004,606			1,168
1974 - 1975(½)	537,370	718,472			1,891
TOTAL	19,895,498	26,480,653	1,195,901	252,880	65,534

NOTE: # - Two cycle/year spraying
@ - Total personnel employed exposed or handling insecticide

/ngs

TABLE II - SUSCEPTIBILITY [illegible] OF *A. sinensis* *flavirostris* to DDT and DIELDRIN

Date of Test	Locality	DDT		% Mortality to 4% DDT for 1 hour	Susceptibility status*	Dieldrin		% Mortality to 1.6% DD for 1 hour	Susceptibility status*	Remarks
		LC-50	LC-100			LC-50	LC-100			
June 1959	Malaville, Mindanao, Sec.	0.5	2.5	-	S	-	-	41.0	R	-
July 1959	Malaville, Mindanao, Sec.	-	-	-	-	-	-	35.0	R	-
July 1959	Mindanao, Sec.	0.5	1.0	-	S	1.07	-	57.0	R	-
Sept. 1961	" "	-	2.0	-	S	-	-	55.5	R	-
June 1967	" "	0.44	1.0	100.0	S	-	-	-	-	No test made w/DD
July-[illegible] 1968	" "	[illegible]	1.0	100.0	S	-	-	46.5	R	-
Jul. 1969	" "	0.5	4.0	99.0	S	1.0	-	49.5	R	-
Oct. 1961	Malaville, Cotabato City	-	2.0	-	S	-	-	65.2	I	-
July 1961	Sandoval, Cabina, Lake del Norte	-	1.0	99.0	S	-	-	-	-	
Mar. 1961	Zamboanga, Sulu	0.5	-	-	S	-	-	-	-	74% Mortality to 1% [illegible] test w/DD
[illegible]	[illegible], Princesa Island	0.42	1.0	100.0	S	0.01	0.2	-	S	-
[illegible] 1961	" "	-	1.0	100.0	S	-	-	-	-	-
Apr. 1961	" "	0.9	4.0	100.0	S	0.05	1.2	-	S	-
Oct. 1968	" "	1.0	4.0	100.0	S	-	-	-	S	97% to 0.4% DD
June 1969	" "	-	4.0	100.0	S	-	-	-	-	No test w/ DD
Aug. 1969	Maad, Sarlout, Agros Sec.	0.5	2.0	100.0	S	-	-	-	-	" " "

* - R - Resistance; I - Intermediate; S - Susceptible; Classification in accordance with categories as defined in [illegible] 446, dev/[illegible] 20[illegible]/71 dated May 12, 1964.

TABLE III - CONSUMPTION OF CYANOGAS AND SULPHUR AS FUMIGANTS BY THE BUREAU OF QUARANTINE (1969-1973)*

YEAR	NUMBER OF VESSELS FUMIGATED	CUBIC FEET FUMIGATED	QUANTITY USED OUNCES CYANIDE GAS	RATS RECOVERED	CUBIC FEET FUMIGATED	QUANTITY USED OUNCES SULPHUR	RATS RECOVERED	TONNAGE OF CARGO FUMIGATED
1969	161	7,719,152	2,404	41	2,812,183	8,451	225	24,297
1970	160	6,616,904	19,338	59	1,458,135	4,319	233	7,489
1971	291	30,896,950	111,263	75	2,103,234	6,426	358	314,067
1972	282	31,928,093	124,859	57	2,326,789	6,789	301	401,385
1973	139	28,273,444	98,565	58	965,083	2,890	236	246,377
TOTAL	1,042	105,524,543	356,429	290	9,665,424	28,874	1,353	993,615

*Only for the Port of Manila as compiled by the Bureau of Quarantine.

/ngs 2-5-75

Pesticide Management Seminar - Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/SP/5
75-10-2

CHEMICAL PROPERTIES AND DEGRADATION PATTERNS OF PESTICIDE GROUPS

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INTRODUCTION

There are now about 900 pesticides in 45,000 distinct formulations and the detailed chemistry of these compounds will constitute a massive book in itself. Although it is some consolation that pesticides may be conveniently arranged into groups, it is by no means simple to present the chemistry of each group. This is because, and this point is always worth remembering, the chemistry of a particular compound is distinctly its own. Thus, any grouping of pesticides is intended to serve only as guides to understanding them and allows generalized ideas of the chemistry of the compounds within the group but should not be looked at as rigid compartmentalization of these compounds.

Model Compounds for Pesticide Groups

I. Fungicides

a. Dithiocarbamates -- Nabam

b. Captan and analogs -- Captan

II. Herbicides

a. Phenoxy acids -- 2, 4-D

b. s-Triazines -- Simazine

III. Insecticides

a. Organochlorines -- DDT / Dieldrin

b. Organophosphates -- Parathion / Malathion

c. Carbamates -- Carbaryl / Aldicarb

In view of the limitations of this paper and in an attempt to be relevant to the Philippine setting, it seems most appropriate to discuss pesticide groups using a few model compounds and also discuss only the organic pesticides. It is hoped that through the use of model compounds, group characteristics and dissimilarities may be more clearly illustrated. Since organic compounds constitute the large bulk of the pesticides in the country, a discussion of inorganic compounds would be nothing more than an academic exercise.

A further consideration in this discussion would be the rationale behind the seminar-workshop. Definitely, when talking about pesticide management, the concern is with the why, what, where, and how of pesticide use. Our concern, although primarily man, also extends to the environment and the ecosystem, thus our concern for pesticide degradation. This discussion will therefore focus on two aspects of pesticide use, residues in food and feed which concerns man directly, and those in substrates which affects man indirectly through environmental contamination and ecosystem imbalance.

Table 2

Toxicity Data for Some Organic Pesticides

Pesticides	Rat Acute LD_{50} (mg/kg) Oral	Dermal
A. FUNGICIDES		
Binapacryl	150-350	1,350 (Rb)
Nabam	395	800 (Rb)
Thiram	780	>2,000
Vapam	820	
Dinocap (Karathane)	980	>9,400 (Rb)
(Morestan)	>2,000	>2,000
Zineb	>5,200	>1,000
Captafol (Difolatan	6,200	15,400 (Rb)
Maneb	6,750	>1,000
Captan	9,000	
Benomyl (Benlate)	>10,000	>1,000
Daconyl	>10,000	>10,000
Thiophanate	>15,000	>15,000
B. HERBICIDES		
Paraquat (Gramaxone)	150	80- 480
Diquat	400-440	>500 (Rb)
2,4-D amine	300-1,200	1,500
2,4-D ester	500-1,200	
Diphenamid	1,000	6,320
Atrazine (Gesaprim)	3,080	
Diuron (Karmex)	3,400	
Asulam (Asulox)	>5,000	
Terbacil (Sinbar)	>5,000	
Picloram (Tordon)	8,200	>4,200 (Rb)
C. INSECTICIDES		
1. Organochlorines		
Endrin	5	60
Endosulfan (Thiodan)	30	359
Aldrin	55	>200

Table 2 ..... con't.

Dieldrin	60	>100
DDT	113	2,500
Methoxychlor	6,000	>6,000
Perthane	8,170	-
2. Organophosphates		
Parathion	3.6	6.8
Mevinphos (Phosdrin)	6-7	34 (Rb)
Mephosfolan (Cytrolane)	8.9	9.7
Methylparathion	9-25	300-400 (Rb)
Leptophos (Phosvel)	52.8	>10,000
Triazophos (Hostathion)	82	1,100
Chlorpyrifos (Dursban)	163	202
Diazinon	300-400	455
Fenitrothion (Sumithion)	500	1,300
Acephate (Orthene)	866	
Malathion	1,375	4,100 (Rb)
3. Carbamates		
Aldicarb (Temik)	0.93	5.0 (Rb)
Carbofuran (Furadan)	11	10,500 (Rb)
Methomyl (Lannate)	17	>5,000 (Rb)
Propuxur (Baygon)	95-104	1,000
MTMC (Tsumacide)	286 (m)	6,000 (m)
BPMC (Bassa)	410	
MIPC (Etrofolan, Mipcin)	485	>500
Carbaryl (Sevin)	500	>500
D. RODENTICIDES		
Sodium Fluoroacetate (1080)	0.22	
(Gophacide)	3.7-7.5	
Fluoroacetamide (1081)	15	
Conmafuryl (Fumarin)	25	

1/ The data should be regarded only as useful approximate indices rather than as exact data. Where possible, data were taken from "FARM CHEMICALS HANDBOOK", Meister Publishing Co., Ohio (1974). Data not found in this handbook are supplemented from the following:

1. von Rumker, R. and Horay: Pesticide Manual, Univ. of California-U.S.A.I.D. (1972).

2. Ben-Dyke, R., D.M. Sanderson, and D.N. Noakes: Acute toxicity data for pesticides (1970).

3. Manufacturers' technical data.

2/ Names in parentheses are the most commonly used trade names.

3/ LD_{50} is defined as the dose that kills 50% of a test population. Where there is a choice, data are taken for pure compounds and with female rats. Its means a rabbit is used as the experimental animal while in results a mouse as experimental animal.

II. PESTICIDE CLASSIFICATION AND TOXICOLOGY

A conventional classification scheme for pesticides would be according to the living system that it controls. If the definition of a pesticide in the U.S. Federal Insecticide, Fungicide, and Rodenticide Act is adopted, that is, that a pesticide is " . . . . any substance or mixture intended for preventing, destroying, repelling, or mitigating any insect, rodent, nematode, fungus or weed . . . . . ", then the major pesticide groupings will be 1) insecticides, 2) rodenticides, 3) nematocides, 4) fungicides, and 5) herbicides, respectively.

In order to evaluate the hazards in pesticide use to man and other mammals, Table 2 would be important. Toxicity is expressed in terms of LD_{50} values or the dose, in mg/kg body weight, that kills 50 percent of a test population. On the basis of rat acute oral LD_{50} values, pesticides may be classified as highly toxic (LD_{50} = <50), moderately toxic (LD_{50} = 50-500), and safe (LD_{50} = >500). Therefore, the lower the LD_{50} value, the more toxic is the compound.

Acute oral toxicity values are important for pesticides that may be present in food or feed whereas acute dermal toxicity gives an indication of the hazards due to accidental spillage or contact. Chronic toxicity would be more insidious and important but because

of the paucity of data and complexity of the tests, they are not included in the tabulation. Persistence would be another helpful data but its measurement is subject to so much variability that unless work is done on near-identical conditions, the data will only serve to confuse. Besides, even the so-called non-persistent insecticides have been shown to persist in the soil for a long time at low levels.

Considering the rationale for their use and toxicity to warm-blooded animals, there seems to be little cause for worry with herbicides in food and feed. The most likely problems in their use would be related to environmental contamination and disturbance of the microbial fauna in the soil. Fungicides, although generally of lower toxicity, are sometimes applied directly in fruits, vegetables, or may be applied unintentionally so that the more persistent or those able to penetrate the surface may be residue hazards. Since rodenticides are usually kept separate from crops in the field or in the household with baits, they do not pose a direct hazard to the health of humans except through accidental ingestion.

On the whole, insecticides are the compounds of particular concern. The problem comes about because the target is another animal which competes with man for the crops grown or are present

in domesticated animals. It is seen in Table 2 that among the comparatively safer insecticides are acephate, carbaryl, malathion, methoxychlor, and perthane. The fact that there is a wide divergence between oral, and dermal toxicity for several compounds serves to reaffirm the original point that the chemistry and toxicology of these compounds are distinctly their own and generalizations are full of exceptions.

In view of their potential hazards to health, a brief discussion of insecticide toxicology maybe in order so that these compounds may be placed in the proper perspective in subsequent discussions.

Basic to the understanding of insecticide toxicology is the concept of site of action. This concept presupposes the existence of a site in the animal system wherein the insecticide exerts its action and is responsible for death. As can be seen in Figure 1, there are several barriers which a toxic compound must pass through before it reaches the site of action. Only a small fraction of the initially applied dose will, or need to, reach the site of action. Within the insect system therefore, there is a competition between penetration, intoxication, detoxication, inert storage, and excretion. Predominance of intoxication mechanisms may result in insect death while the reverse situation makes a compound harmless.

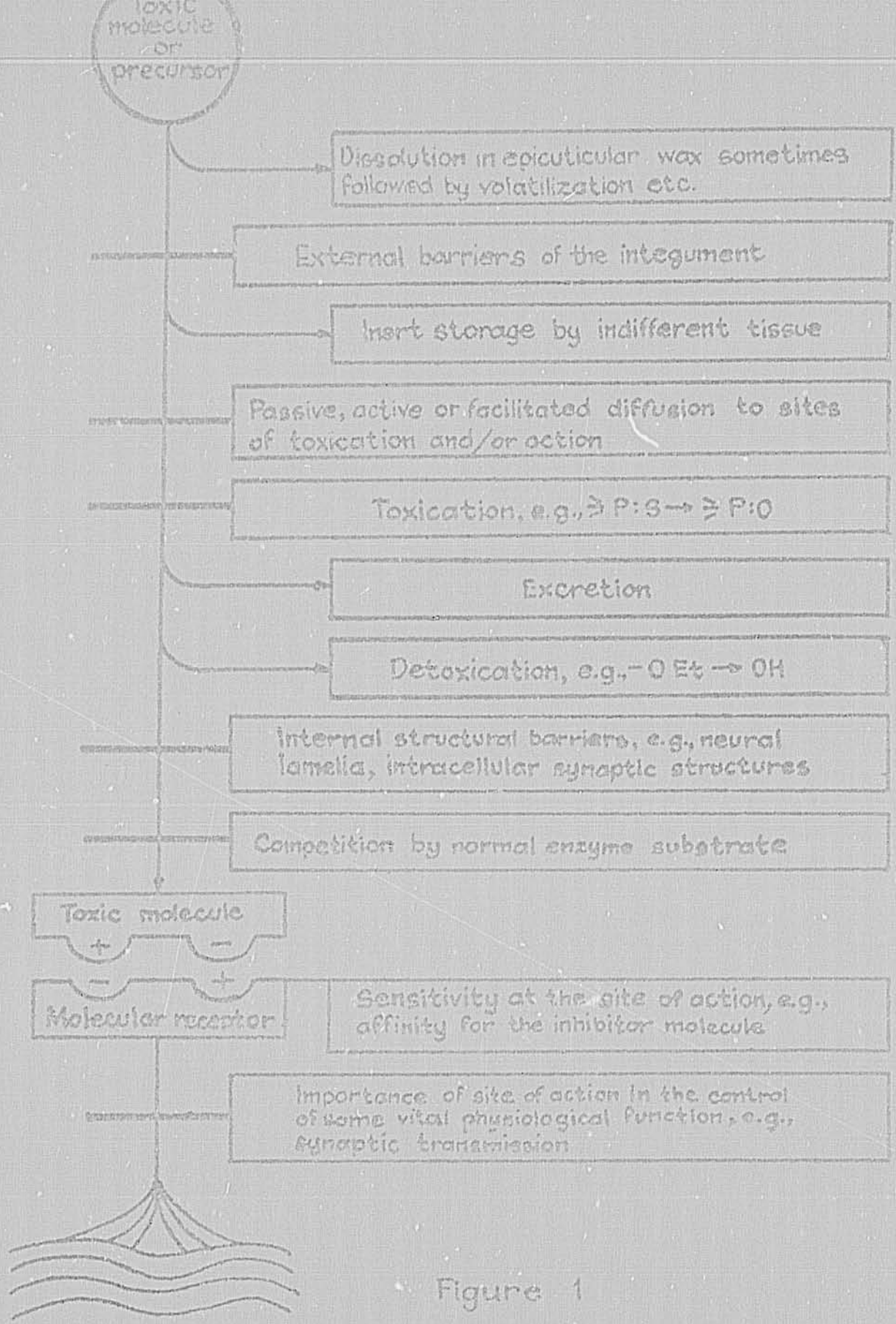


Figure 1

Diagrammatic representation of biochemical and physiological ratelimiting steps and effective barriers in the toxicity of an externally applied insecticide. The vertical arrow represents the successful formation and survival of toxic molecules as far as the molecular receptors of the "site of action." Horizontal arrows represent competing processes of inert storage, detoxication, excretion etc. Horizontal bars represent rate-limiting steps or barriers in the overall process

Insecticides generally exert their toxic action through their effects on the nervous system. The organochlorines belonging to the DDT and lindane groups are believed to act on the peripheral nervous system while the cyclodienes like aldrin, dieldrin, and endrin may act on the ganglia of the central nervous system. In both cases, the precise biochemical lesion responsible for death is unknown. On the other hand, organophosphate and carbamate toxicity is known to result from the inactivation of the enzyme acetylcholinesterase (AChE). This enzyme is responsible for the hydrolysis of acetylcholine, the nerve impulse transmitter which is present in the nerve endings. The difference between the mode of action of the organophosphates and the carbamates is that while the former is an irreversible inhibitor of AChE, the latter is a reversible inhibitor.

Since the system acted upon by insecticides are present in insects as well as in mammals, it is obvious that care must be taken in their use. There are also differences in the physiological processes between insects and mammals leading to differences in insecticide metabolism, e.g., the presence of carboxyesterase in and its absence in insects. These differences have been taken advantage of in designing compounds with selective toxicity. Spe-

cificity for pest species to the exclusion of beneficial insects are more difficult to take advantage of because of species overlaps.

III. COMPARATIVE DEGRADATION CHEMISTRY

The relationship between toxicology and degradation rates may be seen in Figure 2. Point 1 may be taken as the concentration of the initial deposit whose degradation shows a layering effect, that is, the upper layer of molecules will be decomposed ahead of those found in the lower layer. Point 2 may be taken as the minimum level effective for pest control so that region A represents the concentration effective for the pest. Region B is the degradation curve where penetration and reissue takes place while region C is the persistence curve; the distinction between regions B and C is only of academic interest.

A. Substrates of Importance and Factors Responsible For Degradation

The actual shape of the residue curve is influenced by biotic and abiotic factors present or acting on the substrate. Pesticides may undergo substrate transfers in accordance with their chemical and physical characteristics.

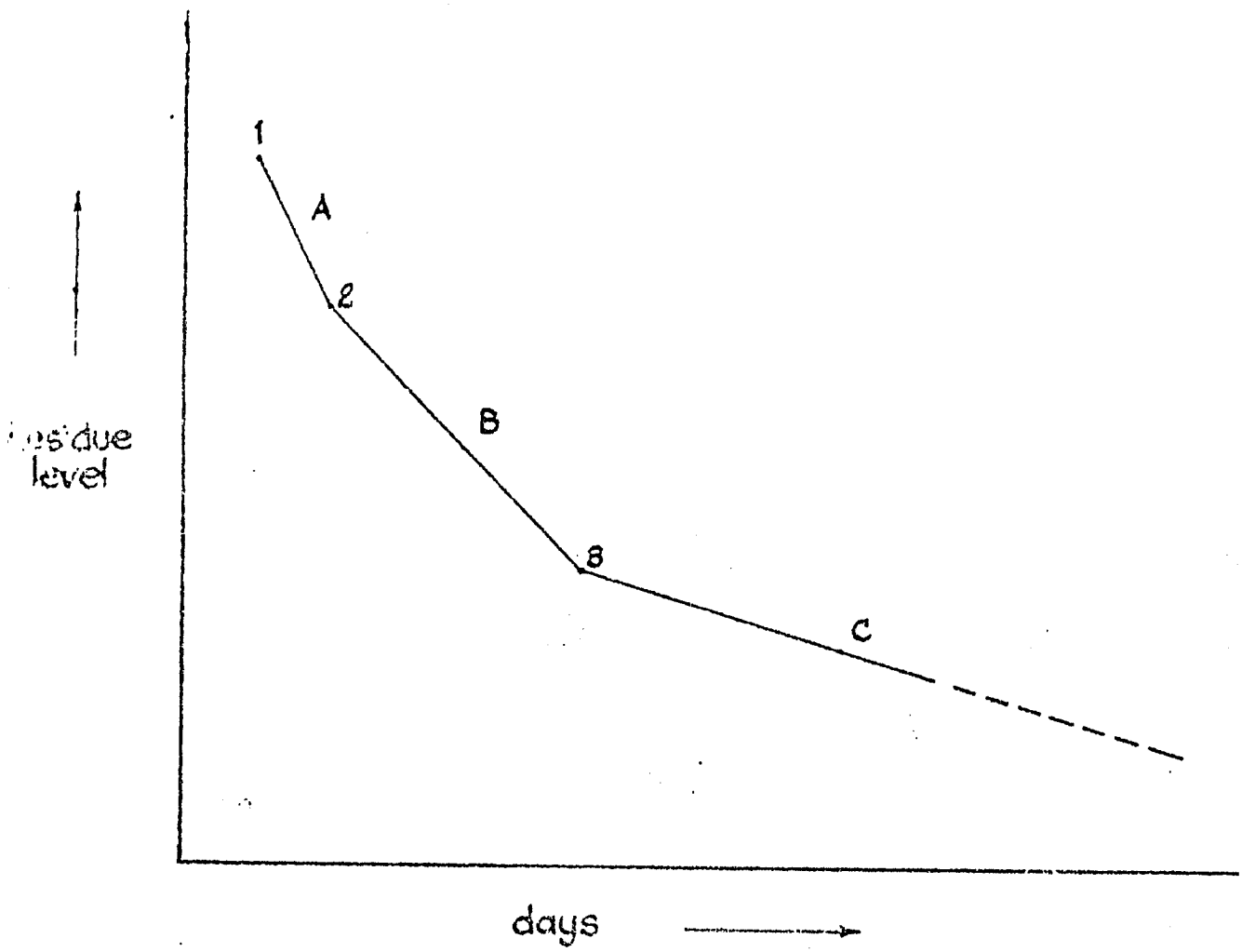


Figure 2

A typical residue curve in plant substrates

It can be seen from Figure 3 that in addition to the plant system the substrates that are important in pesticide decomposition are air, soil, and water. In the plant system, degradation occurs either through the forces acting on the surface or subsurface deposits. Light, heating effect of solar radiation, and hydrolysis due to moisture are the major factors causing degradation. Enzymatic and chemical mechanisms are responsible for the breakdown of subsurface deposits usually into polar molecules which may then react with other indigenous molecules to form conjugates.

The soil is the main matrix of pesticide deposition as a result of direct application, run-off from treated surfaces, drift, sloughing off through moisture or rain action, rainfall to bring down the pesticides which may have codistilled with water, as well as the normal proportion which fails to hit the target plant surface. Microbial degradation is the main pathway of decomposition with chemical and physical reactions also playing a small part.

Pesticides may be present in the water due to soil erosion, direct application, rainfall, and the limited solubility of compounds in this medium. In the water itself, degradation may occur through hydrolytic and photolytic mechanisms. Aquatic organisms and animals feeding on them could concentrate the pesticides and cause

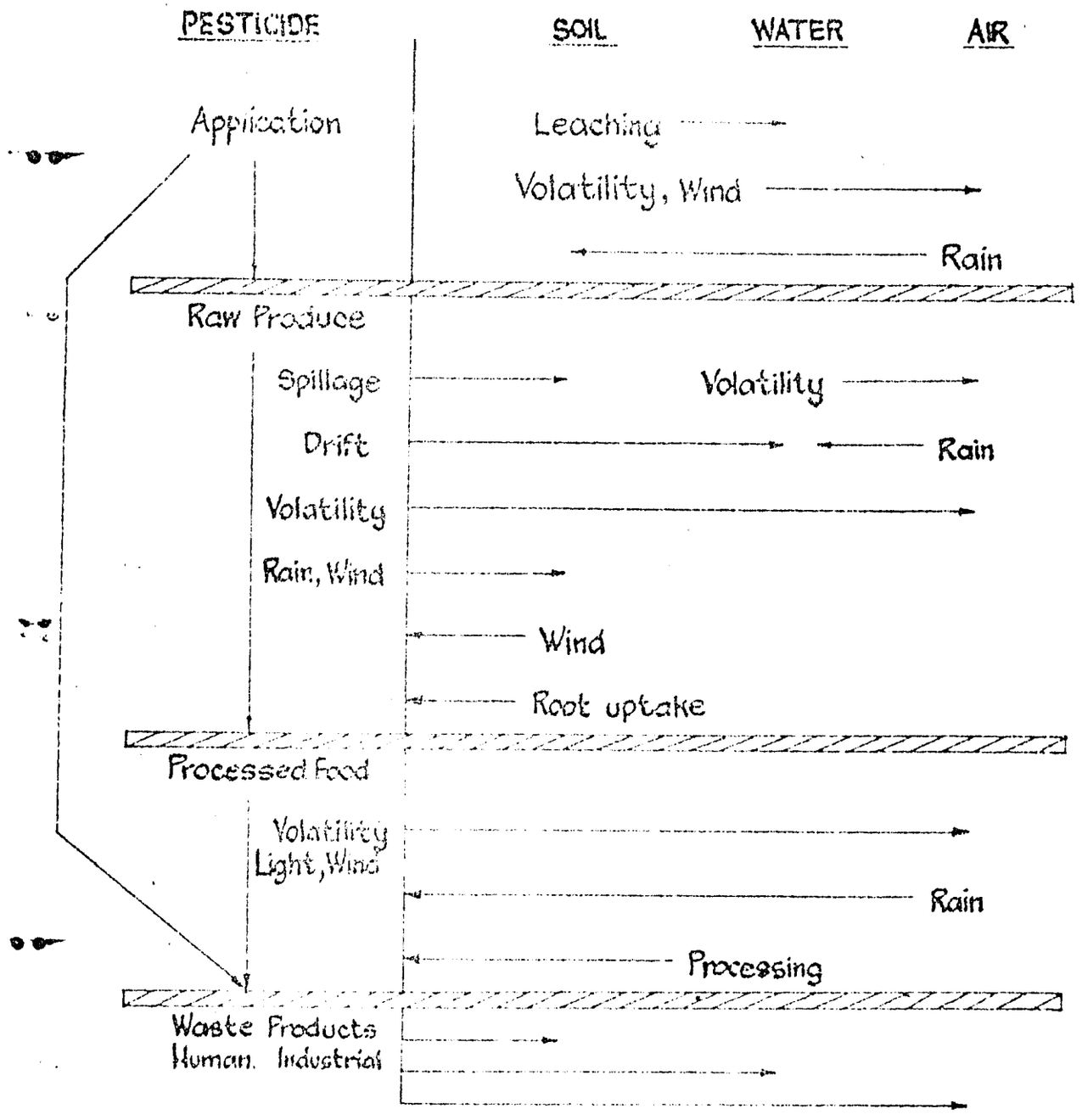


Figure 3

DISTRIBUTION OF PESTICIDES

their decomposition. The settling muds will also reduce pesticide levels in water.

In air, photodecomposition is expected to be the major degradation mechanism with some limited hydrolysis also occuring. The presence of pesticides could be due to volatization, drift during spraying operations, and the continued suspension of very fine deposits in air.

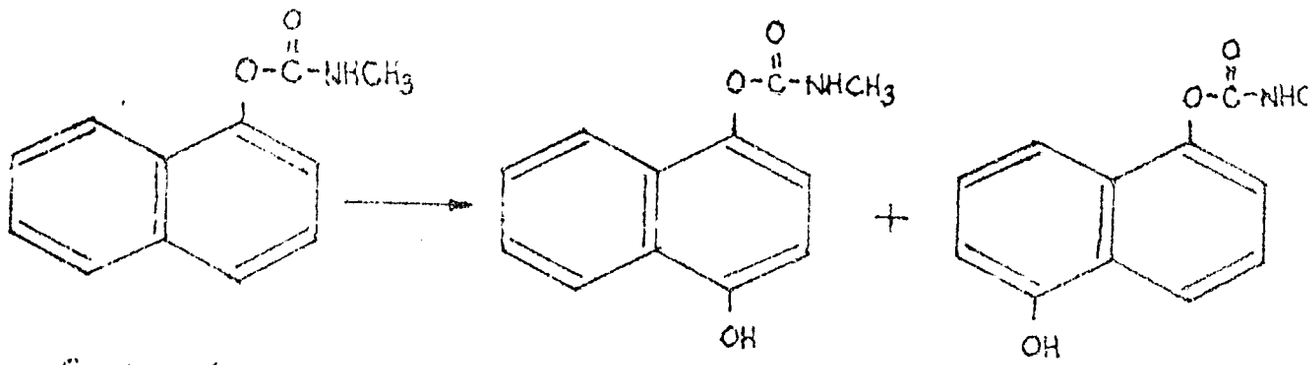
B. Generalized Reaction Mechanisms

Two major types of degradative reactions can be recognized, namely, 1) The biochemical reactions which occur in the presence of an organism or its component, and 2) non-biochemical reactions which takes place in the absence of any effect from living systems. A reaction may however be both biochemical or non-biochemical and the distinction between the two mechanism in a complex matrix like the soil or plant is quite difficult. In Table 3 are given some of the representative reactions of pesticides. Two or more of these reactions are responsible for the total degradation of pesticides in the environment. Some of the reactions may also be activation rather than inactivation reactions. Activation reactions make the

Table 3

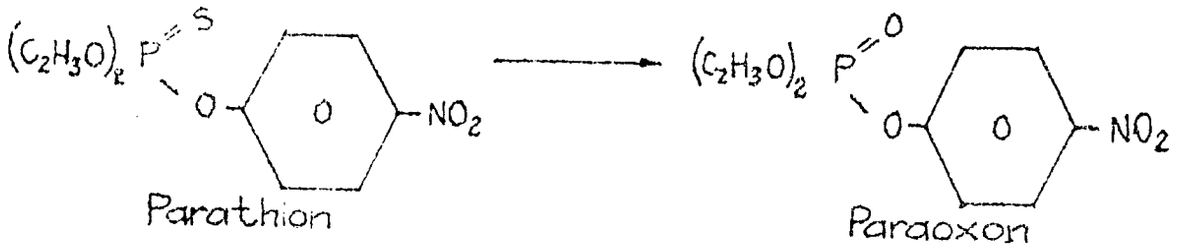
Some Reactions of Pesticides

1. Ring Hydroxylation



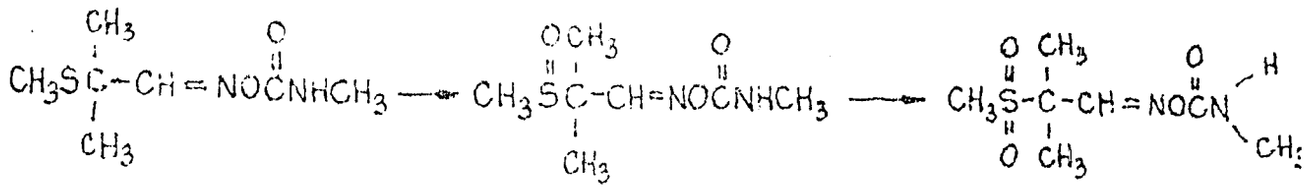
Carbaryl — 4-OH Carbaryl — 5-OH Carbaryl

2. Desulfuration



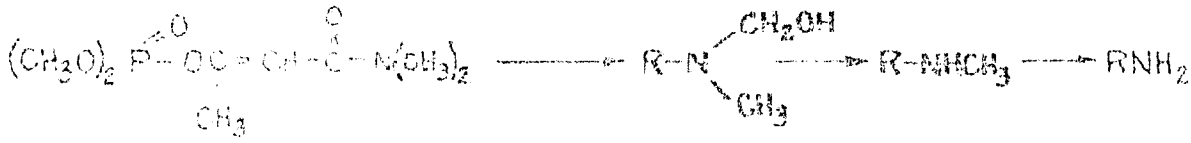
Parathion — Paraoxon

3. Thioether Oxidation



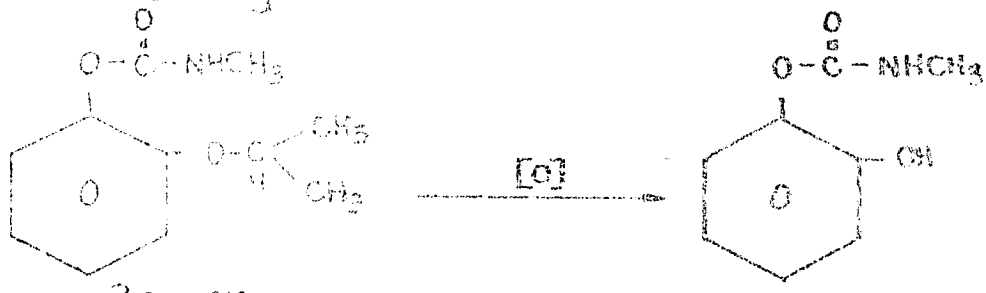
Aldicarb — Aldicarb sulfoxide — Aldicarb sulfone

4. N - Dealkylation



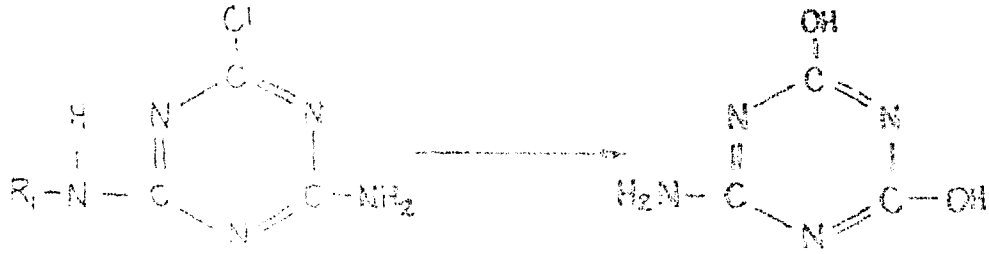
Bidrin

5. O - Dealkylation



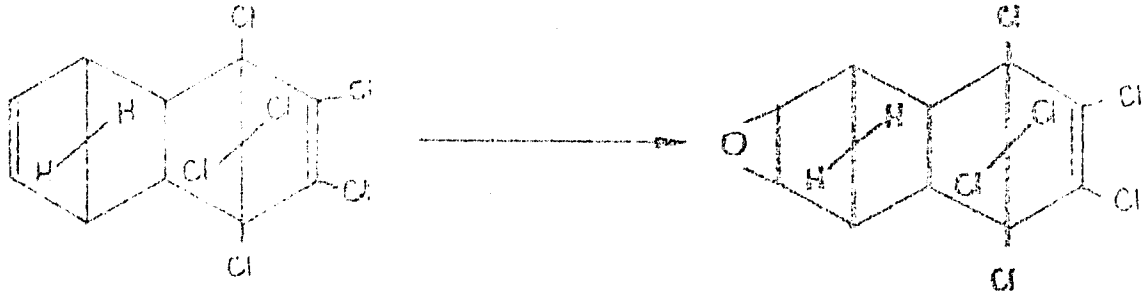
Baygon

6. Deamination



Chloro - s - triazine

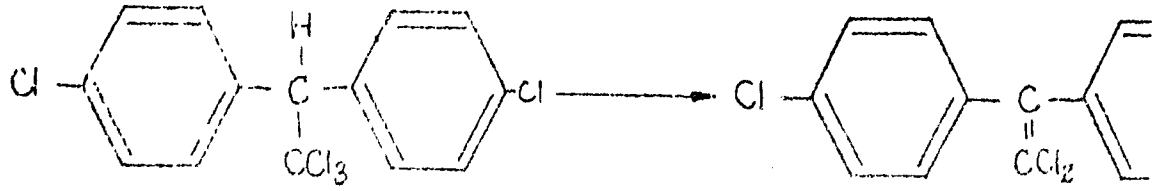
7. Epoxidation



Aldrin

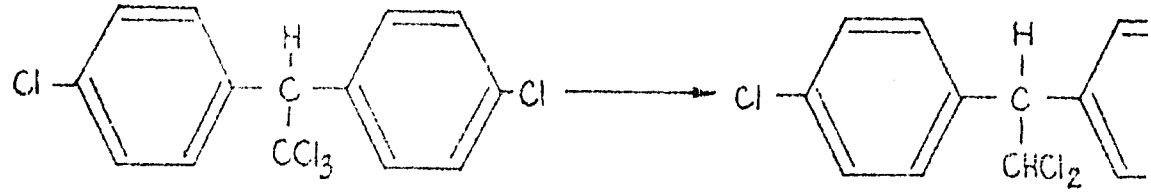
Dieldrin

8. Dehydrohalogenation



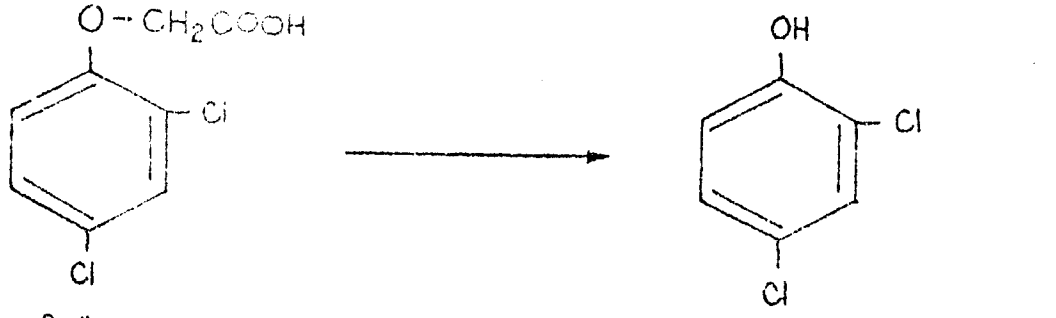
DDT DDE

9. Dehalogenation



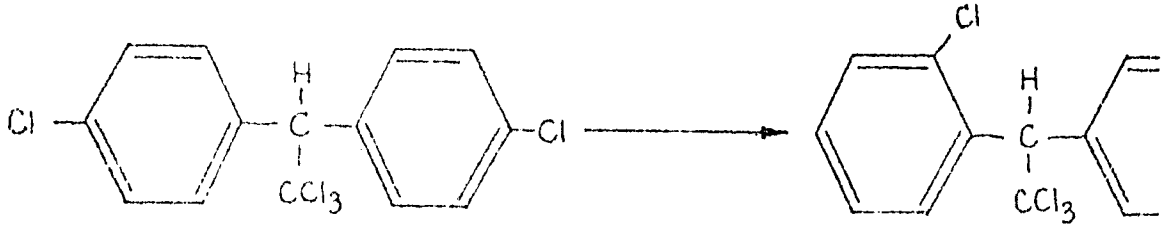
DDT TDE

10. Decarboxylation



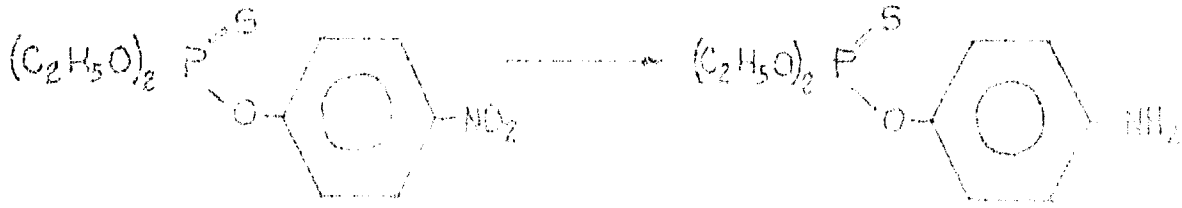
2,4-D 2,4-Dichlorophenol

11. Rearrangement



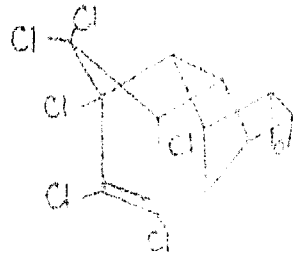
P,P'-DDT o,p'-DDT

12. Reduction

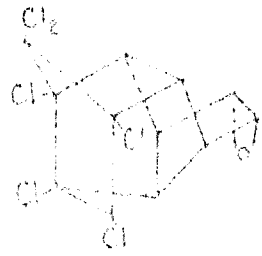


Parathion — Amino parathion

13. Photolysis

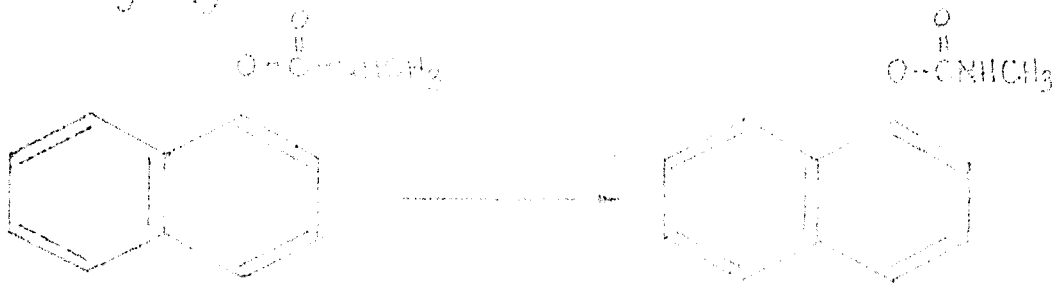


Dieldrin



Photodieldrin

14. Conjugation



4-OH- Carbaryl — O-glucuronide

compounds more toxic. Examples of these reactions are thioether oxidation, sulfur oxidation, N-dealkylation, and some photochemical reactions. The other reactions are generally detoxication reactions.

C. Transformation of Model Compounds

Combinations of reaction in several substrates of model compounds are shown in Figures 4-13.

1. Fungicides

a. Model Group No. 1: Dithiocarbamates

Model compound: Nabam

Related compounds: Maneb, zineb, metham, ziram

Comments on group: These compounds are the most widely used and most versatile of the organic fungicides. The watersoluble analogs, zineb and maneb, have very wide spectra of activity as foliar sprays for fruits, vegetables, and ornamentals for the control of blights, leafspots, blotches, and mildews. The dithiocarbamates are generally of low mammalian toxicity and are unstable in soil.

Nabam Transformation (Figure 4):

Direct microbial degradation and conjugate formation has not been demonstrated unequivocably. However, nabam is quite unstable in agneous solutions. Under slightly acid conditions it is split into ethylenediamine and carbon disulfide with the former possibly being

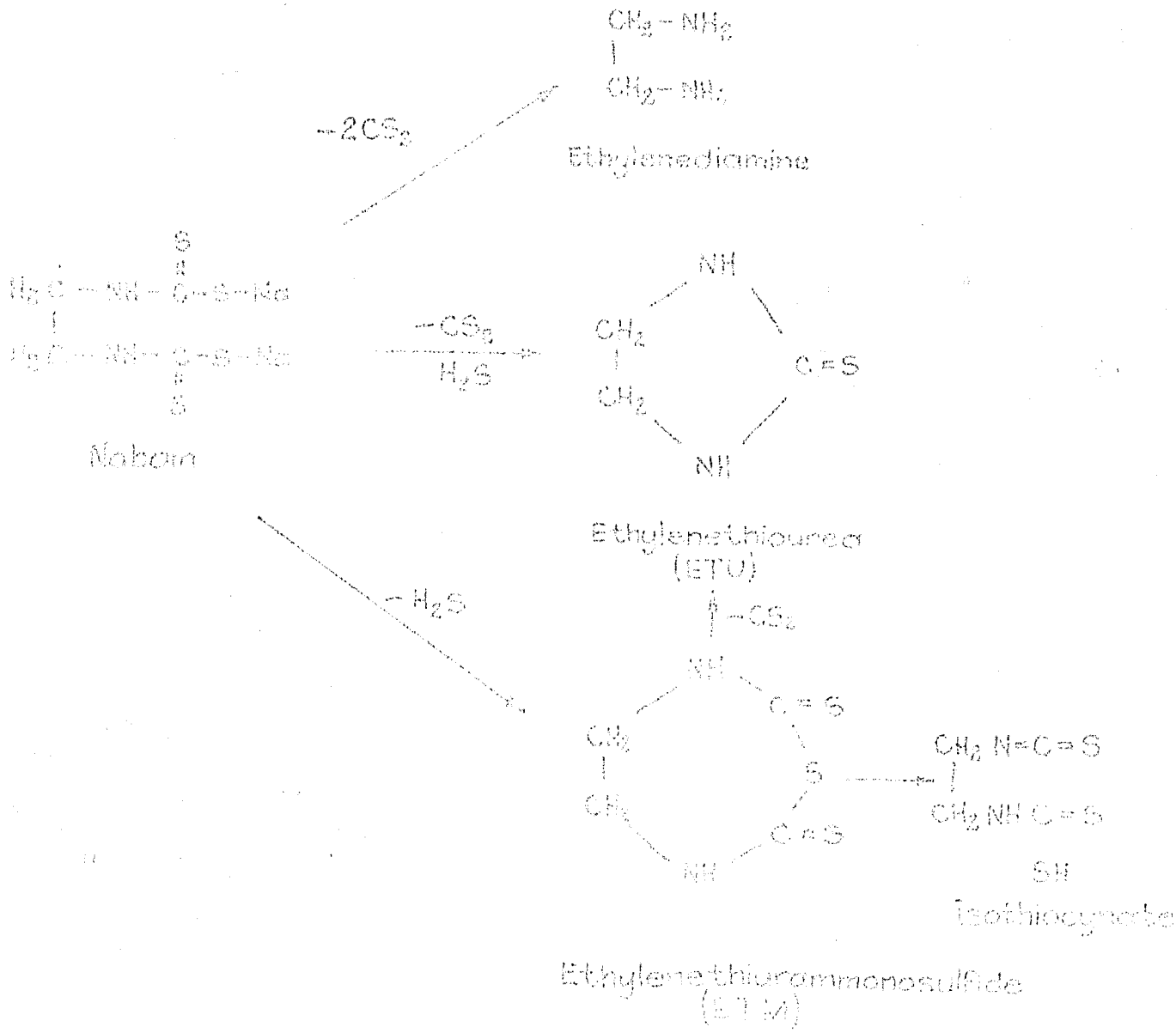


Figure 4

Some Conversions of Nabam

used by a variety of bacteria as a source of nitrogen. Ethylenethiourea (ETU) and ethylenethiurammonosulfide (ETM) appears to be the major products in soil. ETU is stable compound. Polymerization and reaction with heavy metals are also known to occur.

b. Model Group No. 2: Captan and analogs

Model compound: Captan

Related compounds: folpet, difolatan

Comments on Captan: Captan is one of the safest fungicides to plants and mammals. It is widely used for the control of plant diseases such as scab, rots, leafspot, blotch, mildew, blights, and damping off. The biochemical lesion may be due to its reaction with -SH groups within the fungus cells to produce thiophosgene which in turn react with free sulfhydryl, amine, and hydroxyl groups of enzymes.

2. Herbicides

a. Model Group No. 1: Chlorophenoxy acids

Model compound: 2, 4-D

Related compounds: 2, 4, 5-T, MCPA, silvex

Comments on group: Forerunners of modern herbicides, these compounds are cheap and can be translocated in plants. They are selective for broad-leaved weeds in cereals and could be absorbed from soil as pre-emergent herbicides.

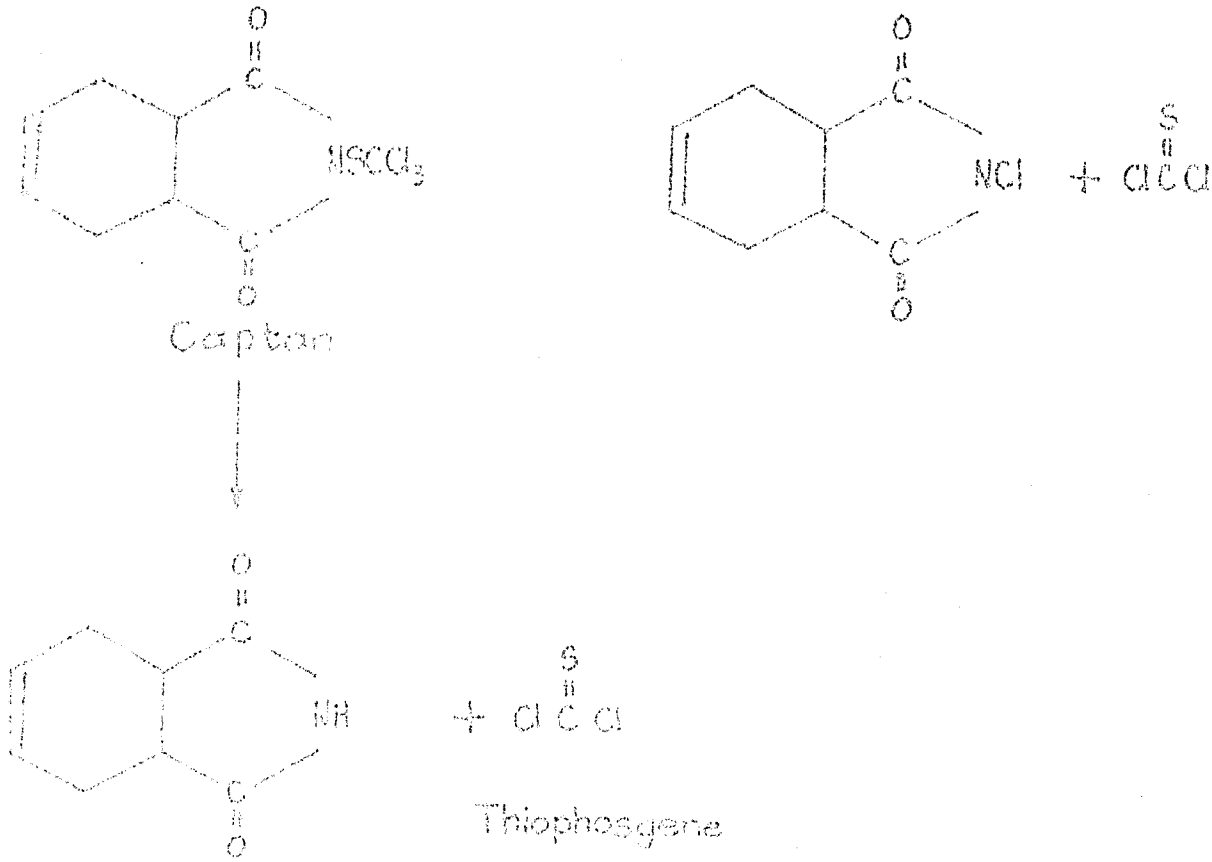


Figure 5

Transformations of Captan in Fungal Cells

a. 2, 4-D transformations (Figure 6):

Degradation is mainly through ring hydroxylation and decarboxylation with the resultant hydroxylated products being available for conjugation. Alternatively, the aromatic ring may be cleaved to give chloromaeonic acid. There is very little metabolism of 2, 4-D in mammals and unaltered herbicides are excreted in the urine and feces.

b. Model Group No. 2: s-Triazines

Model compound: Simazine

Related compounds: Atrazine, ametryne, prometryne.

Comments on group: The triazines have a wide variety of herbicidal action and are valuable as post- and pre-emergent compounds. At low dosages, they kill broad leaved weeds and are soil sterilants at high dosages. They act by inhibiting photosynthesis.

Simazine transformations (Figure 7):

Simazine is the most versatile of the triazine herbicides because of its very low water solubility and high binding energy to colloidal soil particles. In plants and soils, the major route of decomposition is through the substitution of the chlorine at the 2-position with the hydroxyl group; this is true with all 2-chloro-s-triazines. Dealkylation is a minor reaction catalized by several soil microorganisms.

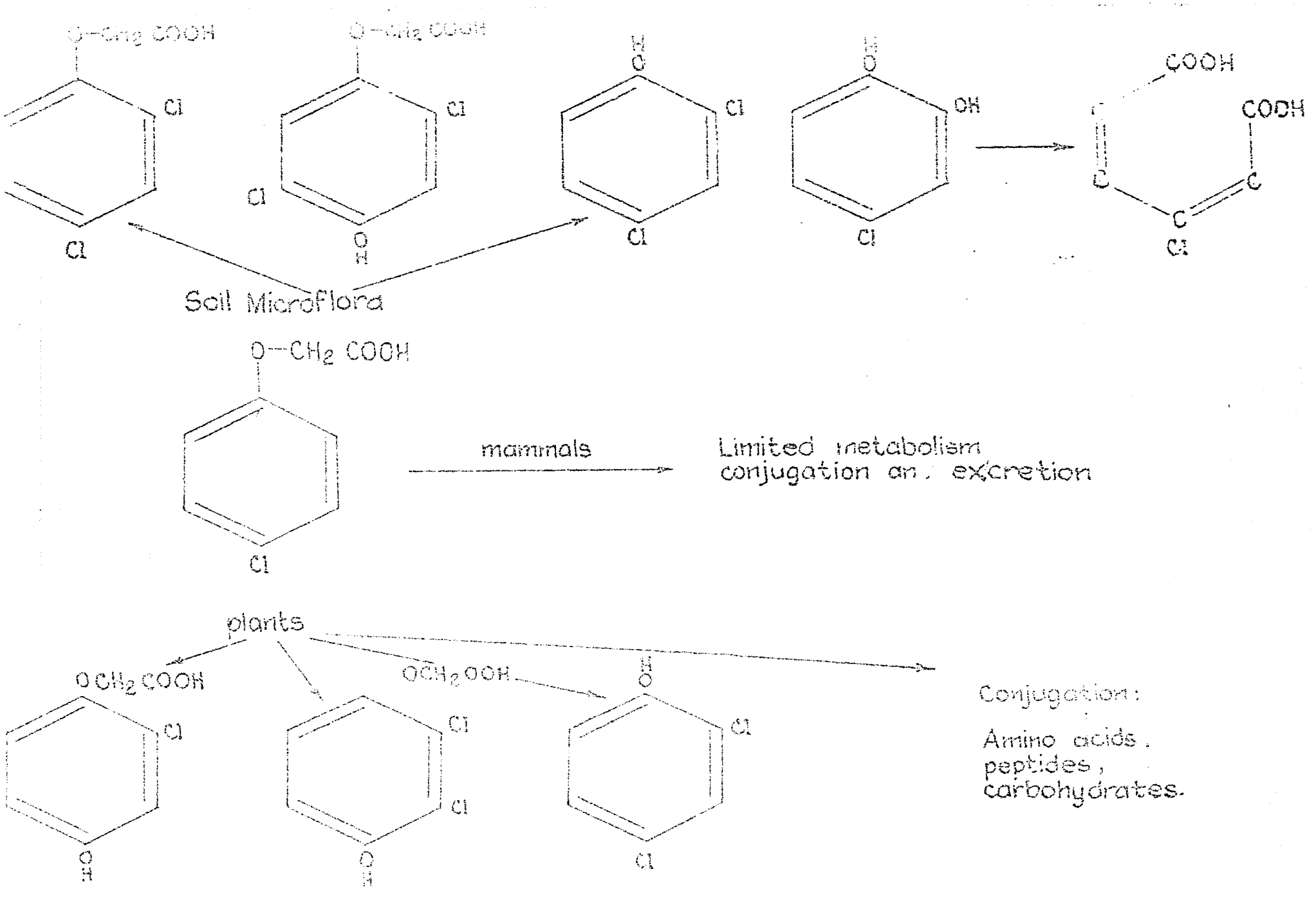


Fig. 5. Metabolism of 2,4-D in plants, mammals, and soil microflora.

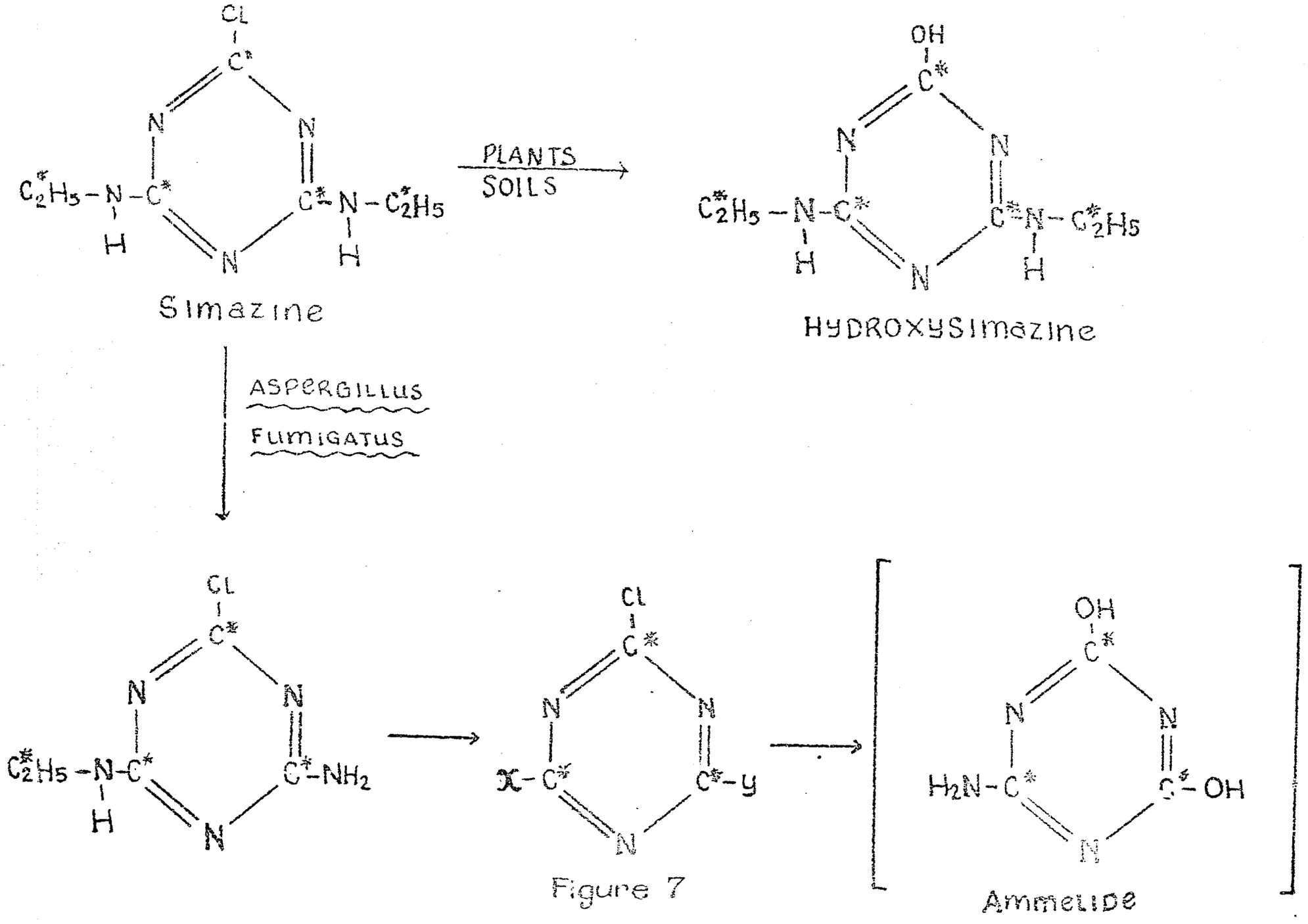


Figure 7

Proposed pathways of simazine decomposition in soils (from KEARNEY *et al.* 1965 b)

3. Insecticides

a. Model Group 1: DDT-type compounds

Model compound: p,p'-DDT

Related compounds: TDE, Perthane, Methoxychlor, Kelthane

DDT transformations (Figure 8):

The main metabolic and environmental transformation product of DDT is DDE. For example and some soil microorganism TDE is the major transformation product. Kelthane is one of the products in insects. DDT persistence in the environment and some of its adverse effects have been attributed to DDE.

b. Model Group 2: Cyclodienes

Model compound: Dieldrin

Related compounds: Aldrin, endrin, telodrin, heptachlor.

Dieldrin transformations (Figure 9):

Dieldrin may be formed through the epoxidation of aldrin in plants, animals, insects, mammals, fishes, and microorganisms. Further metabolism gives rise to a several products, the major metabolites being 6-hydroxydieldrin and water-soluble glucuronides of the hydroxylated type structures. Of particular interest is photodieldrin formed when dieldrin is irradiated with sunlight resulting in the methylene bridge being bonded to an adjacent carbon atom.

Photodieldrin is twice as toxic as dieldrin to houseflies and mosquitoes and about 2-4 times more toxic to mice (LD_{50} = 5 mg/kg).

c. Model Group 3: Parathion group

Model compound: Parathion

Related compounds: Fenitrothion, Chlorthion

Parathion transformations (Figure 10):

Parathion is susceptible to microbial degradation. Under aerobic conditions, the major metabolite is aminoparathion which is further degraded to other compounds. None of this transformation occurs under unaerobic conditions and aminoparathion is the end product. Breakage of the P-O bond to give the nitrophenol occurs quite rapidly.

d. Model Group No. 4: Malathion group

Model compound: Malathion

Related compound: Mevinphos

Malathion transformations (Figure 11):

Malathion is readily degraded by hydrolysis of the P-S or of the carboxyester bonds. In soils this gives rise to the monoacid or to the dimethyl thiophosphoric acid. The primary route of detoxication in mammals is carboxyesterase cleavage of the ester bond whereas in insects, metabolism is to the toxic malaoxon.

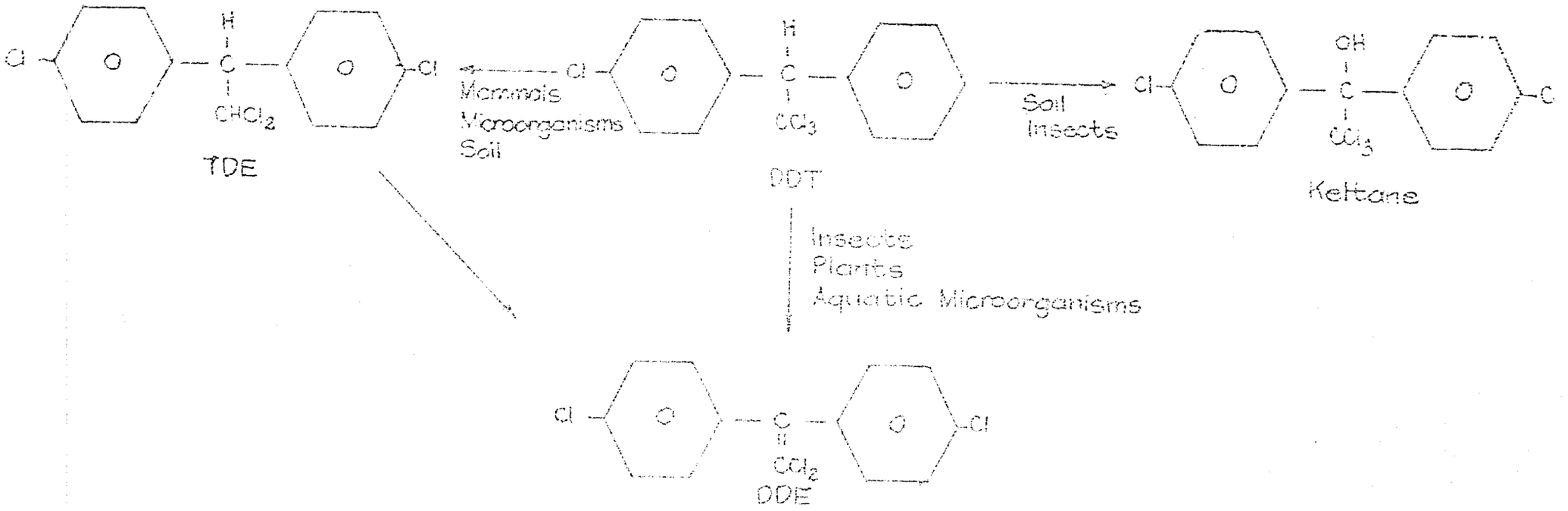


Figure 8

Major Transformation Products of DDT

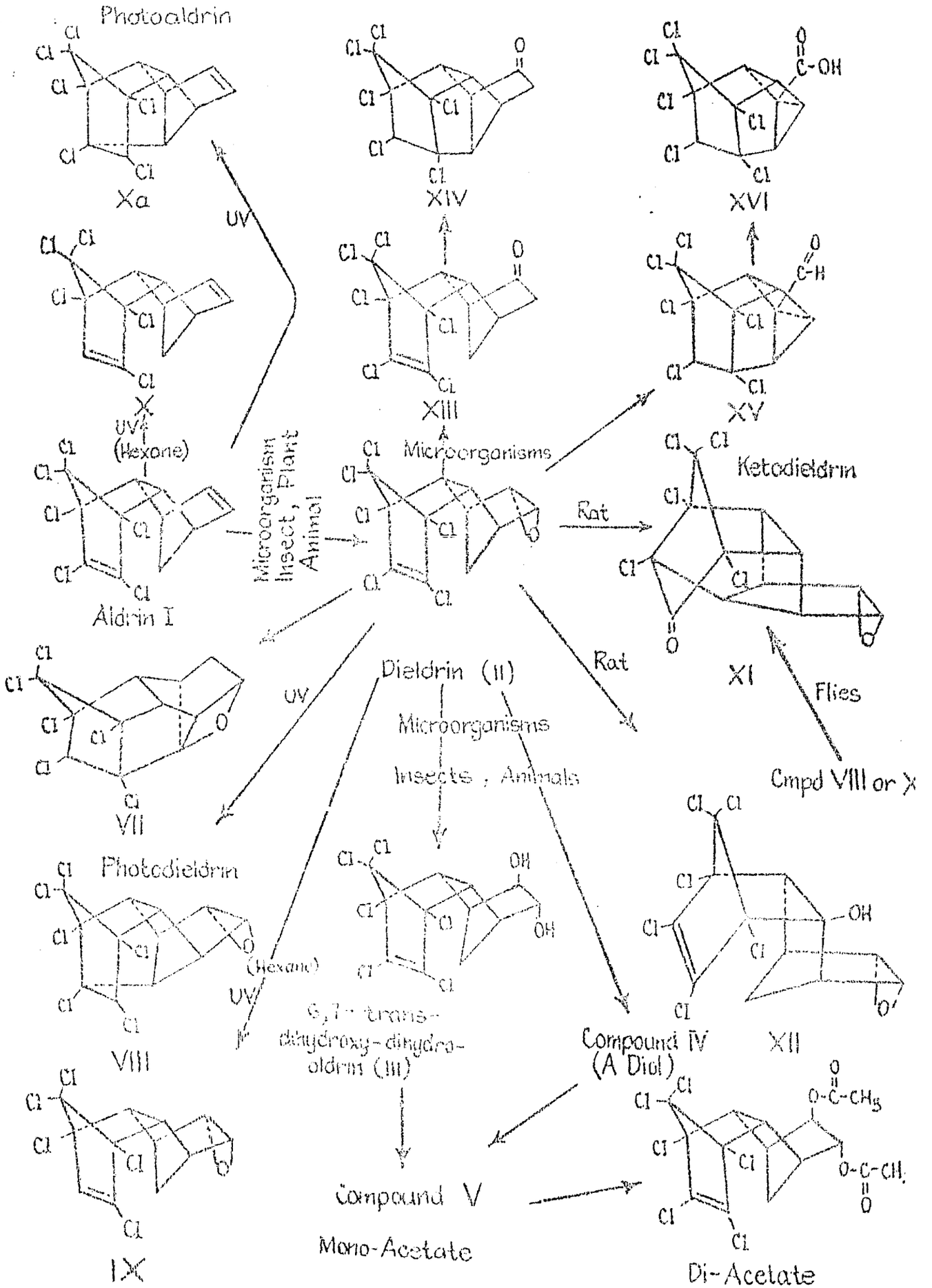
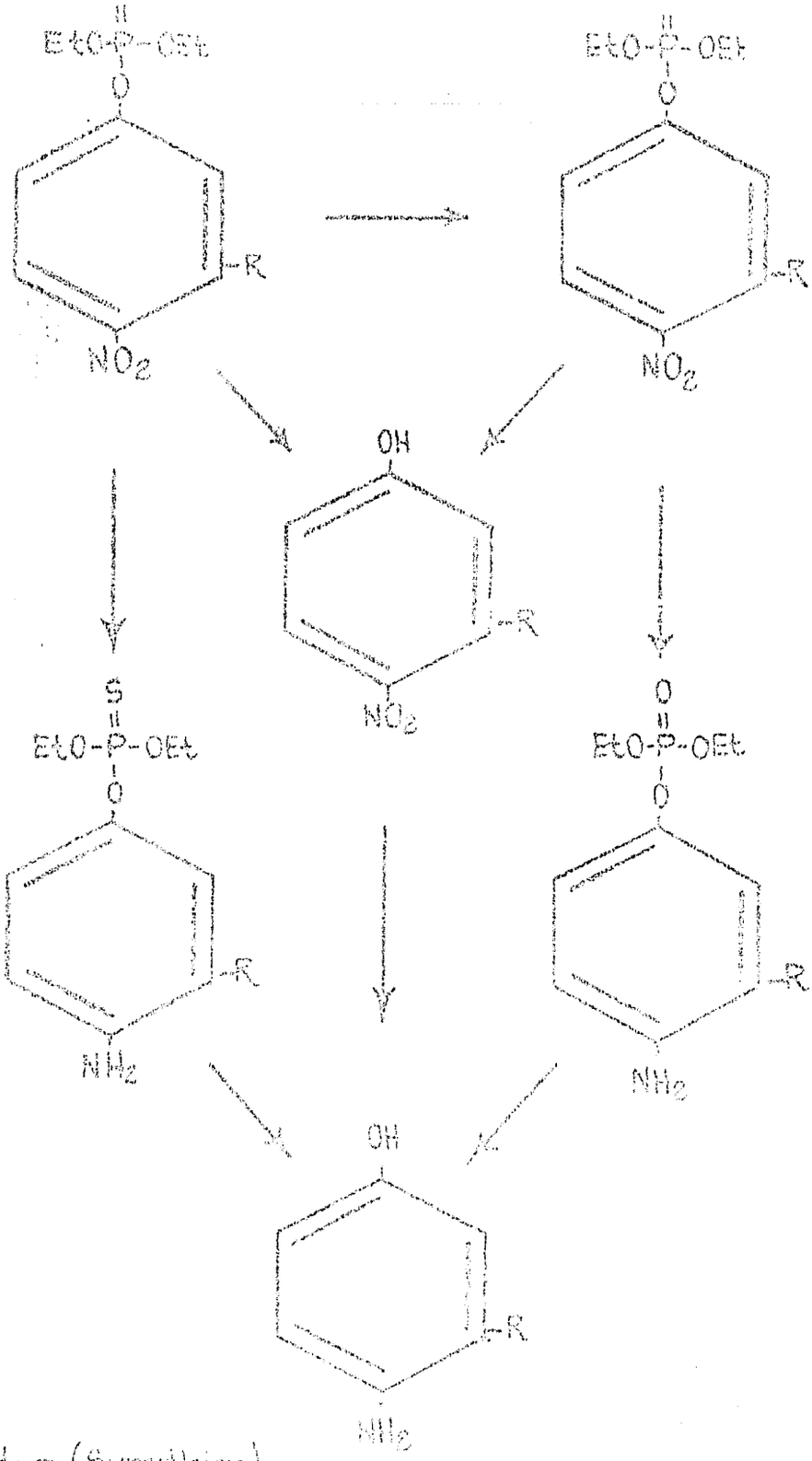


Figure 9

Transformation of Dieldrin



R = CH_3 – (Sumithion)

= Cl (Chlorthion)

= H (Parathion)

Figure 10

Transformations of Parathion-type Insecticides

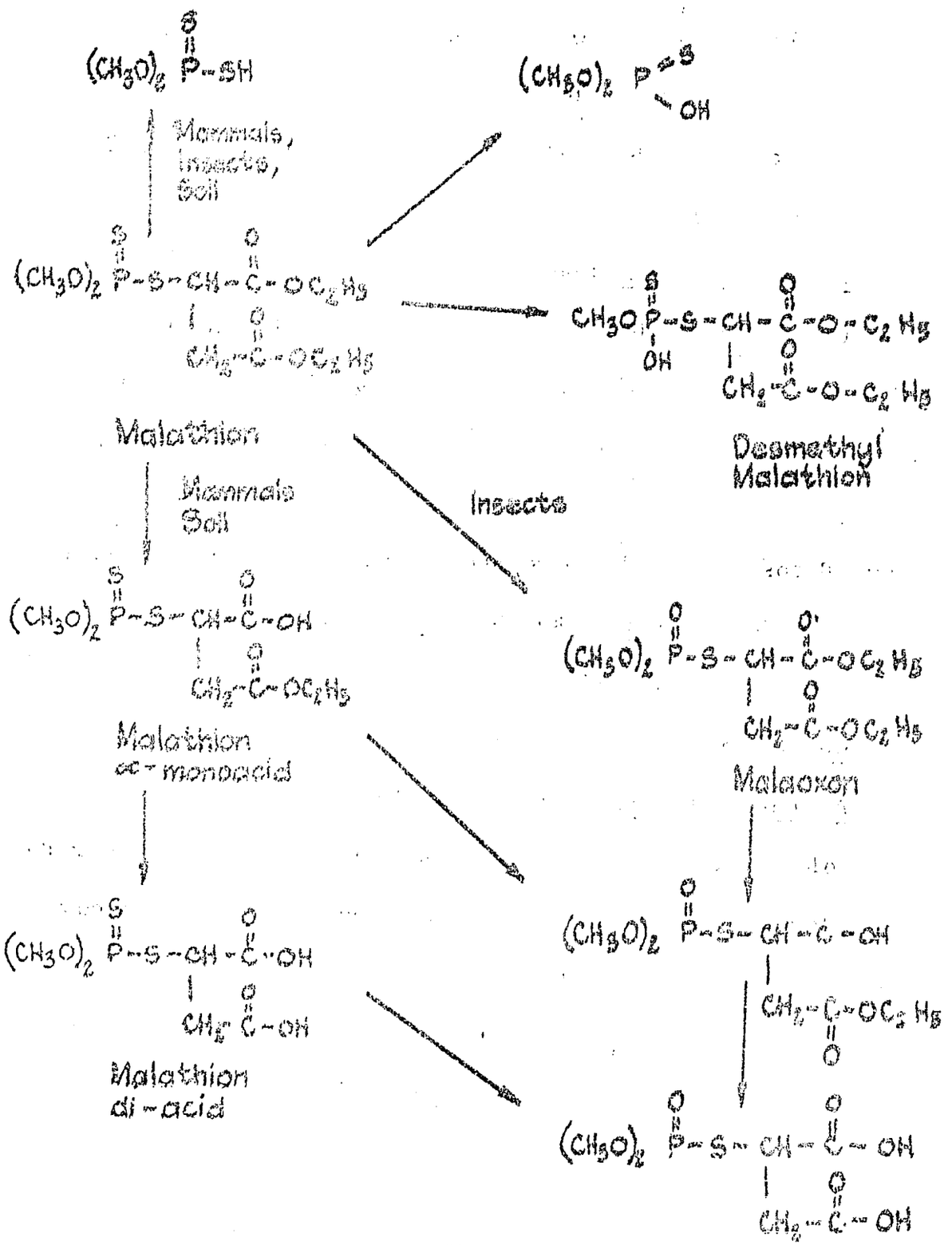


Figure 11

Major Transformations of Malathion

e. Model Group No. 5: Aryl N-methylcarbamates

Model compound: Carbaryl

Related compounds: carbofuran, propoxur, mesurol, MIPC, BPMC, MTMC.

Carbaryl transformations (Figure 12):

Carbaryl is readily 1) hydroxylated at the 4 and 5 positions 2) cleaved at the amide link to give CH_3NH_2, 3) oxidized at the N-methyl group, and 4) hydrolyzed at the carbamate ester link to give 1-naphthol. The resultant hydroxylated materials are then conjugated with glycosides, glucoronides, and sulfates to harmless compounds.

f. Model Group No. 6: Alkyl N-methylcarbamates

Model compound: aldicarb

Related compound: methomyl

Aldicarb transformations (Figure 13):

Aldicarb is sequentially converted to the sulfoxide and then to the sulfone with increased toxicity. These compounds are in turn converted to the oximes and other innocuous polar metabolites.

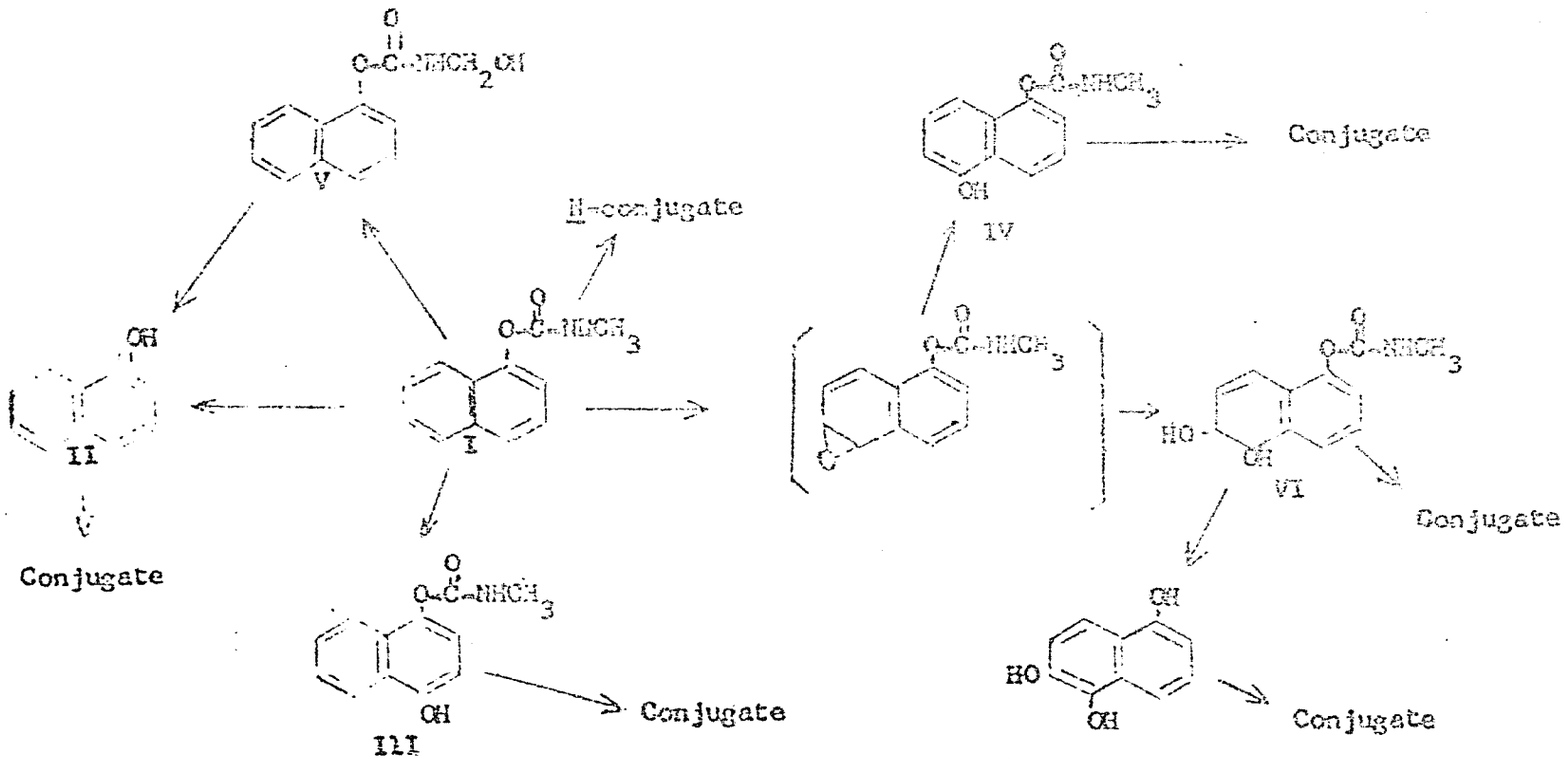
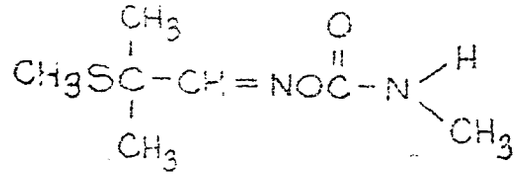
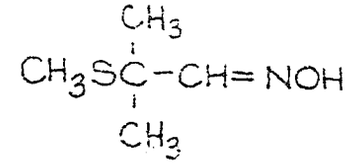


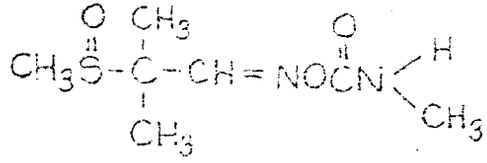
Figure 12

Proposed metabolic pathway for carbaryl in living systems (After Dorough 1970).

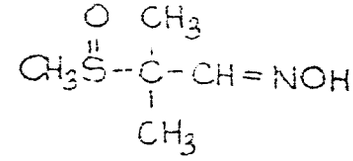


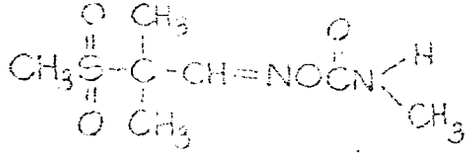
Aldicarb





Sulfoxide





Sulfone

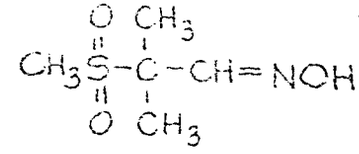


Figure 13

Transformations of Aldicarb.

IV. CONCLUSION

A more detailed discussion of pesticides degradation has been presented here than originally planned but it nonetheless covered only a small part of the whole, illustrating the wide diversity in th chemistry of these compounds. It is however hoped that they will be useful guides to subsequent discussions on the management of these compounds.

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/SP/6
75-10-2

FORMULATION OF PESTICIDES: A CHALLENGE

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Introduction

Over the past half century pesticides have become very important tools in agriculture and public health. The use of these chemicals for control of insects, weeds, fungi, and other pests, has contributed greatly to the increasing supply of quality food. Equally important has been the use of pesticides, particularly insecticides for the control of insect vectors such as the tsetse fly and the mosquito for the protection of human health. Despite very substantial efforts in recent years to find nonchemical means of pest control, pesticides remain one of our main methods of combating these pests. There are a number of promising developments in biological control, the use of pheromones, and attractants, and, of course, the application o integrated control for abating pests. However, there is a consensus of opinion based on in-depth studies by a number of groups that pesticides will remain our principal weapon of pest control for the foreseeable future.

If then pesticides are so important to the protection of our food supply and our health, they deserve to be used in the best possible manner. These chemicals are highly sophisticated tools of technology with biological effects not limited just to a particular pest, but may equally effect a wide variety of non-target organisms. Consequently, efforts to achieve safer more efficient application and utilization of these chemicals are well worth our attention.

Environmental Factors Influencing
Effectiveness of Pesticides

1. Temperature - (height and variation)
2. Rainfall (moisture supply)
3. Light (intensity and quality)
4. Soil

Factors Limiting Effectiveness of Pesticide Application

1. Losses during application
2. Degradation
   - Chemical
   - Biological
   - Photochemical
3. Vaporization
4. "Wash off" with water
5. Adsorption
6. Leaching (in soil)

Beyond this, however, is the prospect of the shortfall of pesticides because of the energy crisis making it all the more important to maximize the efficiency of use. It is the premise in this paper that improving formulation can help to achieve the ends of safety and efficiency.

Background

Few chemicals may be used directly as the technical product for pest control. The technical chemical may be so insoluble that there is no means of applying it. Yet other chemicals are so highly toxic that until they are diluted in the appropriate formulation they cannot be applied in small enough amounts to control pests without undue hazard. Even with proper formulation and application there is considerable waste entailed in the use of pesticides. It has been estimated that in some instances as little as 10% of the chemical applied is all that would be required if it could all be put on the pests. This is due to our inability to target the application directly on the pest. Another factor entailing use of more chemical than actually required to control pests, is the breakdown of the chemical in the environment. Consequently, additional amounts of chemical must be used to achieve and maintain the concentration sufficient to control the pests over a period of time.

Formulations of chemicals may be of various types, also some chemicals may be offered in more than one type of formulation. The formulation usually consists of a diluent such as a dust base or a solvent combined with

other ingredients to afford the correct properties for application. Different formulations are called for depending upon the type and conditions of application, the target organism, and the nature of the pesticide itself. Among the factors which must be considered in formulating are: the method of application, the need for dilution of the active ingredient, safety in handling, reduction of loss through drift, vaporization or degradation, and adherence to the crop or soil being treated.

Let us take a moment to consider some of the common types of formulations now in use.

Dusts

Dusts are formulated for direct use and require no further dilution. The active ingredient content in dust, usually varies from 1 to 10 percent, though higher percentages of active ingredient may at times be used. Because of their bulky nature, dusts are usually prepared locally from dust concentrates by diluting with an appropriate inert material such as attaclay, flour made of husks of nuts, or other materials. The inert ingredient must be selected not only for ease of application, but also compatibility with the pesticidal chemical.

For very obvious reasons dusts are very finely ground. They are easier to apply than the wettable powders or emulsions, usually utilizing much simpler equipment. Compared to some of the other types of formulation they are less apt to be phytotoxic in the case of the insecticides, but are highly susceptible to drift during application. Generally there is less toxic hazard through dermal exposure from dusts, but probably they are equally as hazardous as other formulations through inhalation. Dusts are readily removed from plant surfaces by wind and rain so that their residual life will be shorter than some of the other types of formulations.

Granulars

The formulation of pesticides into larger particles for direct application has been particularly well suited for application of pesticides to soil. They are usually prepared in concentrations similar to those used in dusts, that is from about 1,5 on up. Because of their size, the granular formulations of pesticides do not drift and do not stick to foliage. Like dusts the granulars are formulated utilizing inert carriers such as one of the clays, and appropriate binding agent, and pressed into the size particle desired. Granulars, of course, are unsuitable

for treatment of foliage, and may have the additional disadvantage in some instances of having a lower biological activity because of adsorption on the clay. It is believed that substantial improvement in granular formulations particularly for systemic insecticides could be achieved by using sustained release formulations.

Wettable powders

Wettable powders are essentially the same type of formulation as dusts, except that they contain a wetting agent. A wetting agent is for the purpose of dispersing the powder in water. The concentration of active ingredient of wettable powders will range from about 10 to 75%.

Wettable powders suspended in water will soon begin to settle out unless stirred or agitated.

Some of the physical properties of wettable powders, which are important in application are: their uniformity of distribution, particle size, wettability and suspensibility. These must meet reasonable standards for ease of application and effective results.

Liquid formulations

Liquid formulations, whether a water soluble derivative, or emulsifiable concentrate, are designed for spray application with a suitable carrier liquid. In some instances the formulation is designed for very low volume (ultra low volume) application without further dilution. There are a variety of so called liquid formulation ranging from water soluble materials (amine salt of 2,4-D) to flowable formulations which are finely ground solids dispersed in a suitable liquid vehicle for spray application to emulsifiable concentrates (ethylparathion EC). Recently a number of variations of liquid formulations have been developed. Among one of the more interesting developments has been that of microencapsulated methylparathion in which the chemical is encapsulated in plastic beads. This formulation is designed for spray application. It has lower mammalian toxicity through skin absorption, as well as oral ingestion, and a longer residual life on the plant than the comparable emulsifiable concentrate.

Factors to be Considered for Improved Formulation

In the past, the principal concern in developing a formulation was to put the active ingredient in such a form as to make possible the application. Having achieved this, the next goal in formulating was to ensure stability and shelf life of the formula and only then was consideration

given to modifying the formulation to minimize biological

Evaporation (volatilization) of Chemicals

1. All chemicals tend to vaporize
2. Temperature accelerates

$$\frac{dp}{dt} = AN \frac{X}{RT^2}$$

3. The larger the area, more evaporation
4. Below a certain size of droplet, the rate of evaporation increases

$$\frac{P_2}{P_1} = e^{\frac{2\gamma V}{r(RT)}}$$

DRIFT OF NATURAL-OCCURRING WATER DROPLETS

Description	Size Microns	Drift Height = 5 feet Wind = 10 m.p.h.	Drift Height = 50 feet Wind = 10 m.p.h.
Fog	10		
Mist	100	75 ft.	1/4 1/2 miles 750 ft.
Av. particle size of mist under Niagara Falls	217.3		210 ft.
Drizzle	300	8 ft. 4 in.	83 ft.
Light rain	500	2 ft. 2 in.	21.5 ft.
Moderate rain	800	1 ft. 3 in.	12.5 ft.

*One micron = 1/1000 millimeters or 1/25,000 inch.

effectiveness. Only recently has more attention been given to developing formulations of greater ease of application and enhanced effectiveness. This has come about as we began to more fully appreciate the factors of both the formulation and the environment that could limit the effectiveness. For example, as we learned more about drift occurring during application there was recognition for the need to not only improve application equipment, but also formulations to reduce drift. The addition of thickening agents to increase viscosity of the spray and the use of invert emulsions has gone a long way with some chemicals in reducing this problem.

Degradation is another factor that is important in limiting the effectiveness of a pesticide. The degradation may be a technical such as would occur on a leaf surface or chemical, degradation as for example, hydrolysis

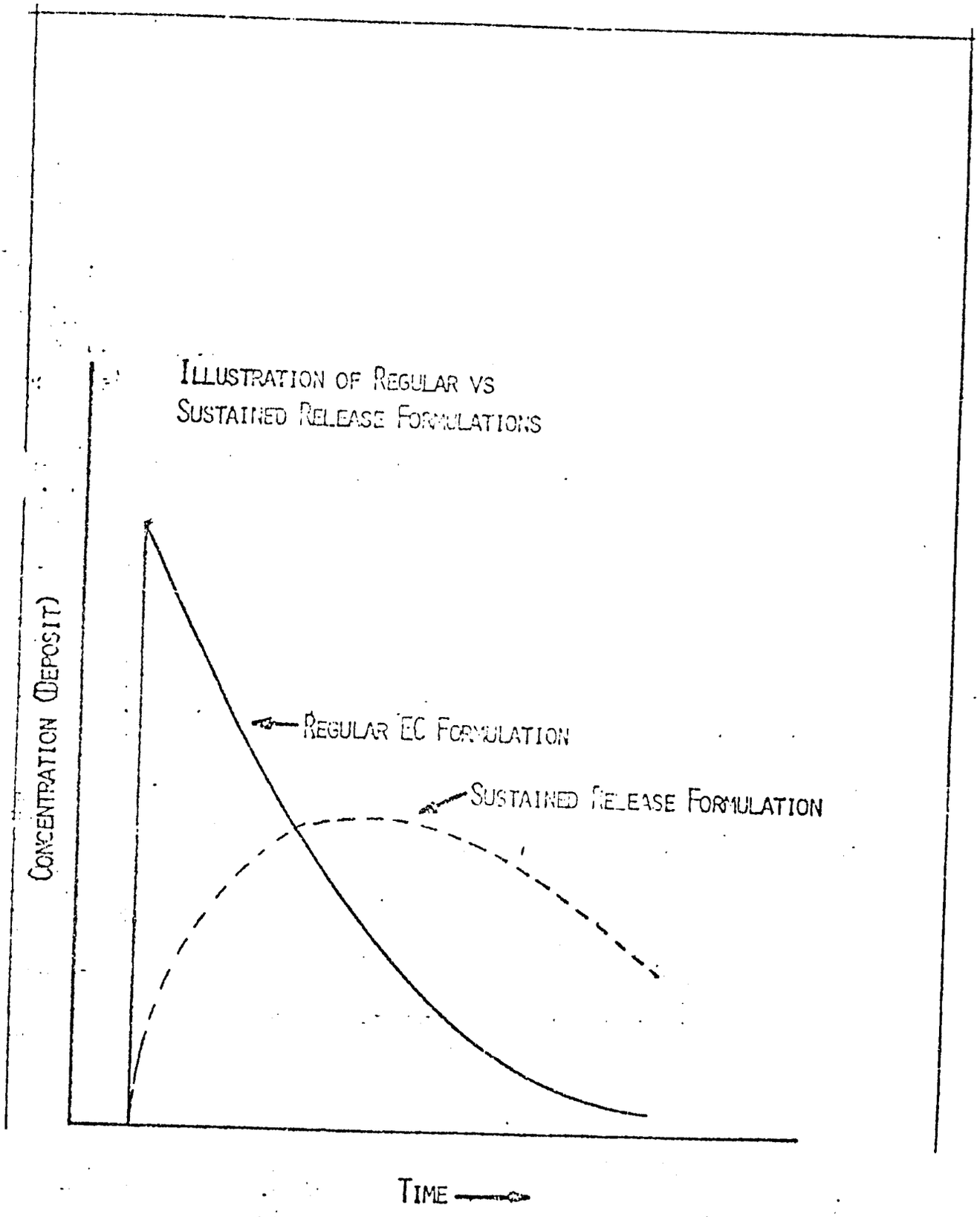


ILLUSTRATION OF REGULAR VS
SUSTAINED RELEASE FORMULATIONS
CONCENTRATION (DEPOSIT)
REGULAR EC FORMULATION
SUSTAINED RELEASE FORMULATION
TIME

or biodegradation as might occur in the soil. Degradation of course, brings about a decrease in the concentration of the pesticide and when the concentration drops below the biological effective level pest control ceases. We have deliberately turned from persistent pesticides or those that do not degrade readily to those that break down more rapidly. To be sure, in order to protect the environment we do want chemicals that degrade, but we would like to slow down the degradation until the pest control has been achieved.

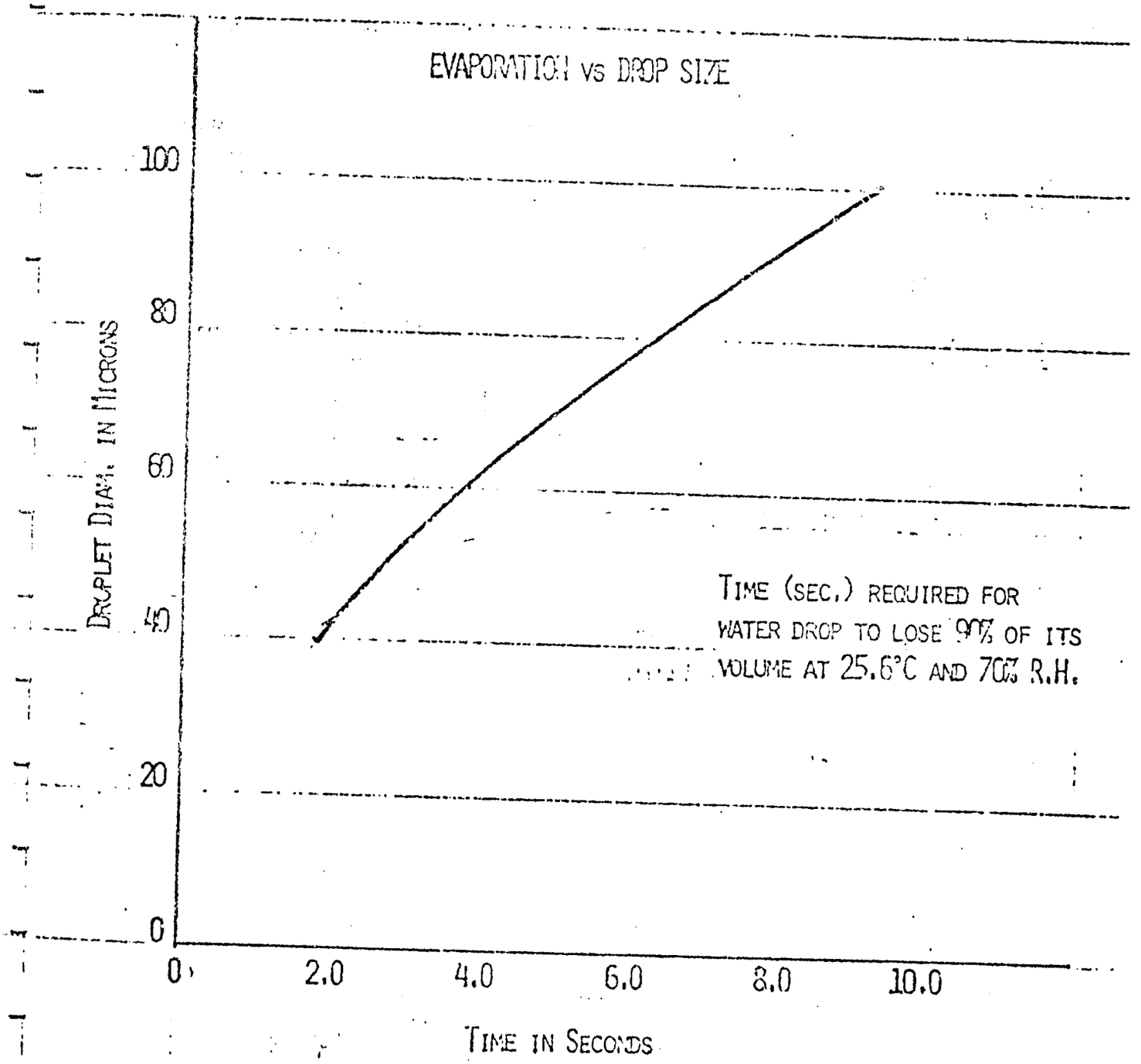
Another route of loss of chemicals, is through vaporization or the change to gaseous form and escape from the treated area. Even though most of the pesticides that we use would be categorized by the organic chemist as being low in volatility, substantial vapor losses are experienced in field applications. The explanation for this is that we have spready a very thin film of chemical over a large area, and even though the percentage loss per square centimeter is low, substantial amounts are going to evaporate when spread out in such a film. Along with the vaporization loss particularly in sub-tropical tropical regions is a "wash off" from the rainfall that occurs during the growing season. These two losses reduce the concentration so rapidly as to require many more pesticide applications during the growing season in order to achieve the required level of pest control.

As you may suspect, the relative importance of these limiting factors would be influenced by environmental conditions. Thus, the ambient temperature influences both vaporization and degradation. Intensity of the light as well as the quality of the light reaching the chemical is important in the photochemical degradation. Rainfall, of course, is a factor not only in the wash off of the deposit on leaves, but also in leaching and encouraging biological breakdown.

The problem for us then is to devise formulations of pesticides to overcome so far as possible these limiting factors. We may accomplish this by using the proper ingredients in the original formulation or for the use of additives at the time the spray is mixed. We are now beginning to have a sufficiently good understanding of the chemistry and dynamics of pesticides in use thus we can begin to think of formulations tailored to the particular conditions of applications and environment in which the pesticide is to be used.

Recent Developments in Pesticide Formulations

One of the earliest problems to be dealt with by


EVAPORATION vs DROP SIZE
DROPLET DIAM. IN MICRONS
100
80
60
40
20
0
0
2.0
4.0
6.0
8.0
10.0
TIME IN SECONDS
TIME (SEC.) REQUIRED FOR WATER DROP TO LOSE 90% OF ITS VOLUME AT 25.6°C AND 70% R.H.

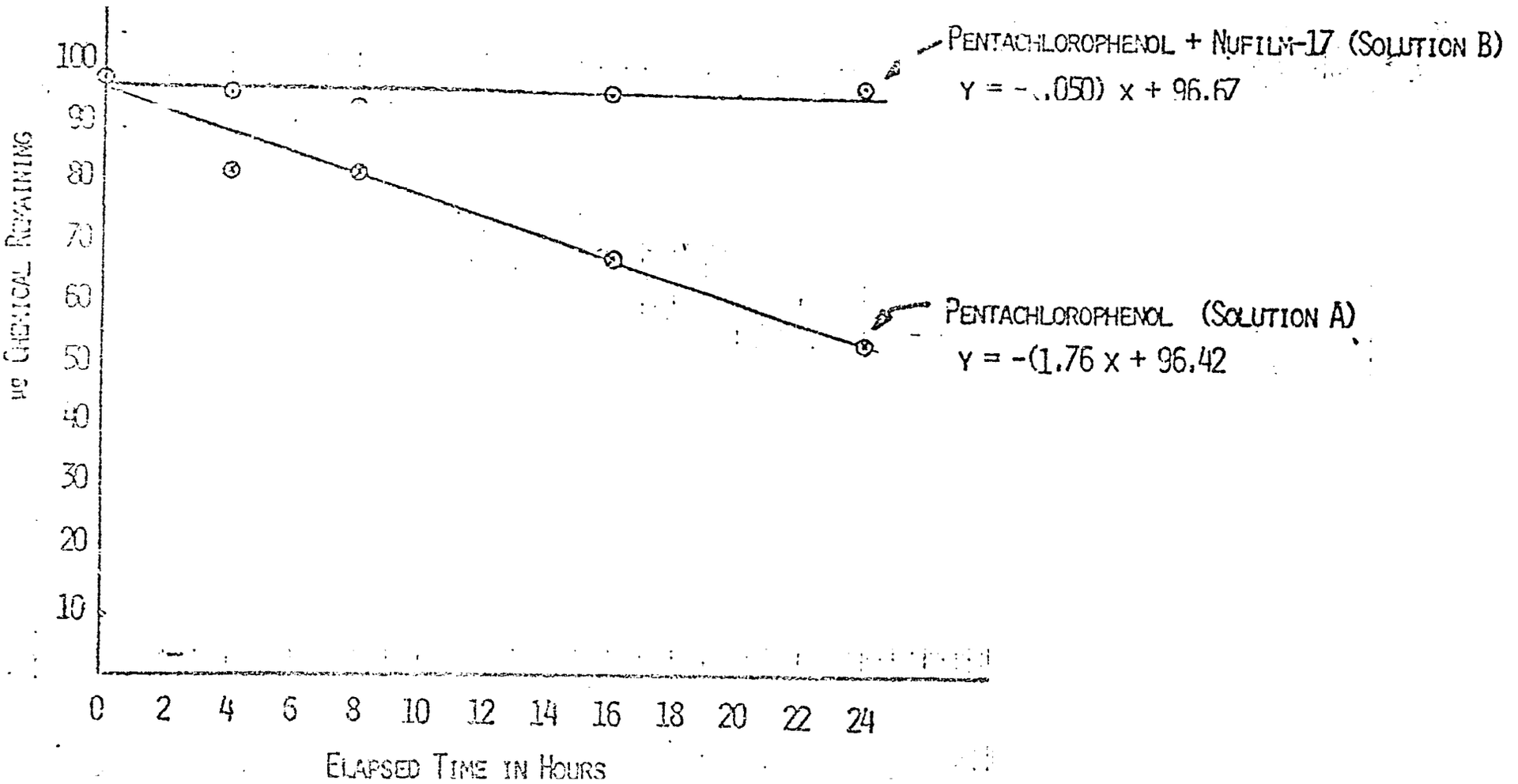
formulation was that of drift. With certain chemicals the drift from the target area posed a real problem.

Some Formulation Additives and Their Function

Agent	Example	Function
Solvents	Petroleum Xylene Ketones	Dissolve and Dilute active agents
Surfactants	Soaps Sulfonates Aryl polyoxy ethylene Alcohols (Anionic, cationic, nonionic)	Emulsifiers Wetting agents
Thickeners	Methyl cellulose Gums Water dispersible Plastics	Increase viscosity & drop size Reduce drift
Clays	Attapulgite Bentonite	Diluents and base for dusts Wettable powders and granulars
Stickers	Glyptal resins Plastics Terpene polymers	Enhance Retention

Engineers worked hard on the problem to develop application equipment to reduce drift. Some small certain modifications of formulation were accomplished the equipment design also changed so that as to reduce the problem. One of the early attempts at formulation to reduce the drift problem was the use of the invert emulsion. The normal emulsion with which we are all familiar is oil in water--that is oil drops are dispersed in a continuous water phase. However, by manipulation of the amount and kind of emulsifier and method of mixing, we can produce the so called invert emulsion or water in oil. This is a much thicker more viscous emulsion producing larger drop sizes. The larger the drop, of course, the less the drift. The next step in attempting to reduce drift, however, was the introduction of agents that would thicken normal sprays. A variety of these agents have been introduced and include such things as methyl cellulose, alginate, vegetable gums, and water dispersible plastics. More recently there has been developed a technique of application which rather

EFFECT OF NUFILM-17 ON VOLATILITY OF PENTACHLOROPHENOL
MICROGRAMS REMAINING V.S. TIME IN HOURS



than discrete spray particles utilizes a foam containing the chemical. Complex glycols and stabilizing agents are used to produce such materials in mechanical sprayers.

An exciting development in pesticide formulation is that of micro-encapsulation. This idea came from the pharmaceutical industry where they were seeking to achieve sustained high concentration of a drug without having to administer frequent doses. Initially the drug was put in the form of a coated pill. The coating on the pill would then break down under either alkaline or acid conditions depending on where the physician wished the drug to be released. With the availability of some of our modern plastics, however, it was possible to encapsulate the drug in small beads where diffusion of the drug through the membrane of the capsule regulated the rate of release. By this means it has been possible with some drugs to achieve the same results with 1/10 the dosage level. Adopting this method for formulation of agricultural chemicals, it was possible to reduce vapor losses, photodegradation, and at the same time increase the safety of those handling the material. Another example of where pesticides have been incorporated into plastic are the plastic strips in which a pesticide is incorporated for sustained release.

Attention is now being given to additives and formulating ingredients to regulate the rate of release and extend the period of control. Other agents are being investigated for reducing vapor losses, prevent wash off, and slowing down biological degradation. It should soon be possible for example, to obtain granular formulations of systemic chemicals that will provide a sustained release that would extend the effective control period by two or three times.

Much remains to be done in formulating chemicals for specific uses and conditions. We now know enough about this problem to undertake such improvement, however. It is especially important to take full advantage of whatever modification of formulations possible to increase human safety, protect the environment, and conserve the limited supply of pesticides. It will be necessary to recognize, however, that pesticides designed for the temperate region are not necessarily the best for the tropics. The formulation must be designed for specific environmental conditions. With what we know today, this is not a formidable undertaking and is one that will yield handsome dividends.

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Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1976

PM/Sr/7
76-10-2

PESTICIDE APPLICATION

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INTRODUCTION

During the past two decades pesticides have emerged as an important tool in both successful agricultural production and public health programs. In the United States over one billion pounds of active pesticides were utilized during 1971. The use of herbicides have increased most rapidly with farmer usage increasing two fold from 1966 to 1971. In 1971 farmers used 228 million pounds of herbicides, 170 million pounds of insecticides, and 41 million pounds of fungicides. This illustrates that chemical pesticides are used extensively for control of our major pests.

Considering the worldwide shortage of both energy and food it is imperative that the efficiency of food production be increased. I believe that the development of sound pest management programs will be a major factor in providing increased food production in the future. As an engineer I would like to point out that pesticide application technology is a key link in efficient utilization of pesticides.

In this paper I would like to discuss some of the principles of pesticide application with the major goal of maximizing effectiveness and minimizing hazards. In general, techniques that may improve deposition of pesticide on the target will also result in reduced hazards.

Worker Safety during Handling and Mixing of Pesticides

1. Pesticide Label - A basic rule for safe handling of pesticides is to know the product. One method of providing essential information to the user is through the label. In the United States all pesticide containers must have a label with certain standard information. To name a few, the label must contain the name of the product, the name and percentage of active ingredients, the directions for use and certain signal words denoting the toxicity. Each product is classified into a given category of toxicity based upon the LD_{50} or LC_{50} of the formulated

product. For instance, the words, "Danger", "Poison" and a Skull and Crossbone symbol must appear on all highly toxic materials; "Warning" on Category "2" materials and "Caution" on Category "3" materials. During the past summer, I had an opportunity to visit and observe some pesticide use problems in a few developing countries. One problem was lack of labels. In many instances the farmer would supply a bottle, oil can or other small container which was filled from a large 55 gal. drum at the pesticide distribution center. No label was generally available for the small container. In this case it would be desirable to have suitable labels or tags that could be wired or attached to the farmer's containers.

B. Mixing and Handling the Concentrate Chemical - One of the most hazardous operations for the pesticide applicator is during the transfer and measurement of the concentrate chemical into the spray tank. If a highly toxic material is handled, it is imperative that the worker utilize waterproof protective equipment such as gloves, boots, apron, respirator and goggles. These items should be routinely checked for leaks or tears and regularly cleaned. Two basic problems have been observed in the field. One, the operator may be unaware of all modes of entry of the pesticide and needs further training. For instance, the applicator may utilize a respirator while measuring concentrate liquid pesticides with bare hands and feet. For many toxic insecticides the material can be readily absorbed through the skin. Secondly, in addition to the training, suitable protective clothing must be available if he handles highly toxic materials.

During 1978, a joint study was conducted by the California Departments of Food and Agriculture and Health to determine the extent of illnesses due to pesticides in each of several occupational categories. Table 1 contains a summary of the results. The two highest categories of reported illnesses were ground applicators accounting for 28% of the illnesses and the mixer-loaders with 11% of the illnesses. This data along with other field observations was considered in developing a new set of pesticide worker safety regulations. The purpose was to provide safe working conditions for pesticide applicators. The regulations cover a wide range of requirements pertaining to minimum age, training, medical supervision, operational procedures, protective equipment, equipment modifications, etc. I will only briefly discuss the requirement for a closed mixing system.

By January, 1977, California regulations will require that a "Closed Mixing System" be utilized for handling Category 1 (and some Category 2) liquid pesticides. This system is defined as a method of removing a pesticide from its original container and transferring it into a closed mixing tank without exposure of any person to the pesticide. Fig. 1 through 4 illustrate some approached to "closed mixing systems". Fig. 1 illustrates a bulk handling system that has been utilized by some aerial applicators. Fig. 2 illustrates a simple system developed by some California mosquito abatement districts. The system consists of a simple closed gravity flow system for transferring the chemical into a translucent vessel. This system could possibly be adapted for dispensing pesticides from large drums into smaller containers appropriate for use by Philippine farmers. Fig. 3 is a portable

system that was developed by a commercial aircraft operator. Fig. 4 illustrates a closed system for handling dry powders that was developed by Dr. G. Carman and R. L. Metcalf at the University of California, Riverside.

Some new packaging techniques are under development that may offer a real improvement for handling and loading toxic pesticides into the small knapsack sprayers. At the present time several companies are working on water soluble packages. For instance the pesticide could be prepackaged into the quantity required for a 3 gallon sprayer. The applicator could then drop the unit into the sprayer and be ready to spray without exposure to the concentrate chemical. Another system that is very attractive is microencapsulated formulations. This system provides a film around each pesticide particle. The wall material controls the release rate and can substantially reduce the hazard or exposure of pesticide to the applicator. Microencapsulated formulations of Methyl parathion are now commercially available.

Although some of the above approaches are in the experimental stages, I thought you would like to be aware of some of the new developments that are on the horizon. I believe some of the improvements in handling techniques will be particularly helpful in the Philippines where it is difficult to wear waterproof clothing during high temperature conditions.

Principles of Ground Sprayer Equipment Selection and Operation

A. Protective Clothing and Equipment - The type of application equipment and toxicity of the chemical largely dictates the type of protective equipment required. In the use of knapsack blower sprayers a very fine drop spectrum is produced and emitted into the air. Thus, if a highly toxic material is applied, the applicator should be fully protected with, waterproof trousers, coat, hat, gloves and respirator. I realize there are some real problems in using this equipment under high temperature conditions. In this case it may be necessary to use a less toxic pesticide or a less toxic formulation such as a microencapsulated formulation mentioned earlier. Another approach is to apply it only in morning or evening conditions when protective clothing can be worn. With compressed air knapsack sprayers the inhalation problem may not be serious and a gauze type mask would probably be sufficient. However, if the operator walks through the sprayed vegetation, the dermal exposure would probably be high and waterproof clothing would be essential. Some ventilation for worker comfort may be obtained by using a split type waterproof apron.

B. Nozzle Selection - The nozzles perform three important functions which are: (1) meters the liquid, (2) atomizes the liquid and (3) distributes the material over a given area. Nozzle selection should be based on all three of the above functions. I am sure most of you are acquainted with the necessity of selecting the proper size nozzle to put on the desired quantity. The other points to consider are the droplet size desired and type, uniformity and width of spray pattern. Some of the different patterns available are hollow cone, solid cone and flat fan patterns. Basically, the degree of atomization is very important in

regards to efficiency and drift hazards. The major factors affecting particle size are nozzle type, size of nozzle and spray pressure. Generally, an increase in fan angle, a decrease in orifice size and an increase in spray pressure results in a decrease in particle size. Gravity flow flooding nozzles can be operated with a head of only two feet or less than one pound per square inch. This produces a very large drop size and a minimum of drift. We have successfully used this type of nozzle for application of 2,4-D for morning glory control in vineyards. The gravity flow system can be used in connection with a knapsack sprayer. In this case the tank can be easily modified to provide a constant head by means of an appropriate air inlet tube extending to the bottom of the tank. The system operates without an air pump as the liquid merely flows by gravity with a constant head maintained between the bottom of the air inlet and the nozzle height.

The pattern or uniformity of distribution is another important aspect in nozzle selection and operation. Generally, flat fan nozzles provide a nearly ideal triangular or trapezoidal pattern that can be readily matched or overlapped to obtain a nearly uniform distribution pattern. The optimum overlap will depend on the type of nozzle and operating pressure. For a given set of conditions there is an optimum nozzle spacing and boom height. One way to determine the optimum height is to put a pair of nozzles on a test stand with a "V" trough table and graduated cylinders to measure the distribution pattern.

One important aspect of application that I cannot over-emphasize is the need to calibrate the system to deliver the desired amount of chemical. Since the calibration may change due to worn nozzles, the calibration should be checked at frequent intervals. I will not list the formulas, but each spray supervisor should know how to check the flow rate, and final application rate per acre for his equipment. Many materials are extremely critical as to tolerance levels. That is the chemical may have a detrimental effect on the desired crop if the application rate is too high and likewise the treatment may be ineffective if the treatment is too low.

Principles of Aircraft Spray Techniques and Factors Related to Drift Hazards

The use of agricultural aircraft has provided a key link in the ability to conduct many pest control programs in agriculture, forestry and public health programs. United States and Russia are by far the largest users of agricultural aircraft. Available statistics show there are 6100 agricultural aircraft in the United States and they treat approximately 42 million hectares per year. Russia utilizes about 7000 aircraft and treats approximately 75 million hectares per year. Statistics collected by the International Agricultural Aviation Center in the Hague, Netherlands indicates that aircraft are used extensively in some 61 countries. Although many benefits have been attributed to the use of aircraft, some problems have arisen. One basic problem is the drift or movement of spray out of the target area. For example, drift of minute quantities of certain pesticides may cause serious injury to nearby people, crops, animals, wildlife or may contaminate the edible food supplies.

In the following discussion, I will summarize some techniques to minimize drift hazards and also maintain efficacy of the treatment.

A. Nozzle Selection and New Developments - Control of particle size is one of the most important factors in controlling pesticide drift. The size and density of particle determines the terminal velocity or settling rate in still air. Table 2 illustrates the terminal velocity and theoretical drift distance for a wide range of particle sizes. The theoretical drift distance was based on a uniform wind velocity of 5 mph, a release height of 15 ft. and zero evaporation. Although assumptions are considerable, the values are intended to emphasize the importance of reducing the number of very fine particles. Unfortunately most conventional nozzles produce some particles less than 100 micrometers in diameter. Drift can be minimized by the proper selection of the nozzle type and orientation with respect to the airstream. A very low drift level can be achieved by using a simple orifice (with no core) and directing it backwards with the airstream. This produces a VMD of approximately 900 micrometers and has been used satisfactorily for 10 gpa applications of translocated compounds such as 2,4-D. Another common nozzle for use with insecticide applications at 10 gpa is the D6-46 hollow cone nozzle directed backwards with the airstream. This nozzle produces a VMD of 450 micrometers. Another common nozzle for low volume applications of insecticides is the D6-45 nozzle directed down. In comparing the drift fallout at 1/2 mile downwind from these aircraft applications, the drift from the D6 orifice was only 1/30 as much as the D6-45 nozzle and the D6-46 was about 1/3 the level of the D6-45.

Next I would like to mention some new atomization concepts and developments that may provide a major breakthrough in controlling spray drift. AmChem has developed a "Microfoil" atomizer that consists of an airfoil shaped manifold with small tubes (0.013 inch I.D.) molded at 0.1 inch spacing along the trailing edge. The system produces a very uniform drop size of about 900 micrometers. The system is probably the best commercial system available for minimizing drift hazards. Unfortunately, the system is only useful on helicopters or vehicles where the airstream doesn't exceed 60 MPH. We are currently conducting research on some experimental units that are designed to produce a nearly uniform particle size of 250 micrometers. This particle size would be suitable for fixed wing aircraft application speeds of 100 to 110 MPH. The device uses a small jet stream principle along with a piezoelectric crystal oscillator.

B. Formulations - A number of spray adjuvants have been introduced as a possible means of altering the atomization process to reduce the number of fine particles. We have measured the drift with both fallout sheets and air samplers for applications with a polyvinyl polymer (Nalco-Trol) and a hyroxyethyl cellulose buffer system (Union Carbide). The air sampler data indicates the great differences in the systems. The Nalco-trol adjuvant produced the lowest amount of material collected by the air samplers located from 330 ft. to 1 mile downwind. The hydroxyethyl cellulose adjuvant also produced a lower amount of deposits on the air samplers as compared to a standard emulsion spray. All above tests were with a simple jet nozzle directed backward for minimum drift. The drift residues on the fallout sheets, however, produced no significant differences over the range from 165 ft. to 1/4 mile downwind.

C. Micro-weather factors - Micro-meteorological parameters are probably one of the most important but least controllable factor affecting drift residues. The aircraft operator should recognize the important influence of two factors: (1) wind direction and (2) atmospheric turbulence. Fortunately, wind direction can be easily measured and it is obvious that drift onto an adjoining field can be avoided if the wind direction is away from the field in question. The second factor of turbulence is difficult to measure and it is likewise difficult to predict the effect of turbulent mixing on the downwind spray drift concentrations.

The smoke plume from an old tire is an excellent visual indicator of wind direction and is useful in estimating turbulence or particulate diffusion. In fact, the use of a smoke column is a standard procedure for aerial applicators applying 2,4-D in certain hazardous areas of California. For example, a smoke plume during normal lapse conditions will rise, mix vertically and diffuse rapidly. During strong temperature inversion the smoke flattens out and may remain intact for several miles, indicating very stable conditions with minimum vertical mixing or dilution. The mixing or dilution of the spray drift "cloud" follows a similar pattern.

However, in an effort to quantify important turbulence parameters, a number of variables were measured during a large number of spray drift tests. It was found that the stability ratio was closely correlated to the drift fallout patterns. The stability ratio can be calculated as follows:

$$\text{Stability ratio} = \text{S.R.} = \frac{T_{32} - T_{8}}{V^2} \quad (27.8)$$

where T is air temperature in degrees F at 8 and 32 ft. elevations and V is the mean wind velocity in miles/hr. at 16 ft. Thus, the temperature gradient and wind velocity can be confined into a single index to predict drift fallout residues. Table below indicates a typical range of stability conditions.

Atmospheric condition	Stability ratio
unstable	-1.7 to - 0.1
neutral	-0.1 to 0.1
stable	0.1 to 1.2
very stable	1.2 to 7.0

The spray tests were made with a very low drift system utilizing D6 jets directed back. The fallout measurements at 660 ft. downwind indicate the residues during very stable conditions, S.R. of 5.8, were 13 times as much during low stability conditions, S.R. of 0.2. The total air burden followed the same trend. At 660 ft. downwind the very stable conditions produced about 4 times as much concentration in the air as during the low stability conditions.

In conclusion, some important considerations to minimize drift from aerial applications are: (1) select nozzles that produce a minimum of fine drops consistent with pest control results. A simple orifice or jet directed back is ideal for minimum drift with chemicals that are translocated or systemic; (2) the use of some types of thickening agents will further reduce the pesticide concentration in the air but may have little effect on fallout levels, and (3) avoid application of toxic materials during very stable conditions associated with strong temperature inversions.

Table 1

REPORTS OF PESTICIDE-RELATED OCCUPATIONAL ILLNESS
IN CALIFORNIA DURING 1973

OCCUPATION	SYSTEMIC	SKIN	EYE/SKIN	EYE	TOTALS
TOTALS	665	452	33	324	1,474
Ground Applicators	187	103	13	121	424
Mixer - Loader	121	19	3	22	165
Field Worker	45	94	0	18	157
Nursery - Greenhouse	18	71	1	22	122
Formulating Plant	41	15	2	5	63
Warehousing - Loading Trucks	33	8	1	9	51
Gardener	14	16	2	34	66
Firefighting	2	0	0	1	42
Fumigation	22	13	1	5	71
Creosote Application	1	24	2	9	36
Drift	10	5	0	11	26
Structural Pest Control	11	5	0	8	24
Flaggers	16	3	0	1	20
Cleaning and Machine Repair	10	6	1	5	22
Aerial Application	10	0	1	3	14
Other	55	70	6	50	181

Table 2

Particle diameter, micrometers	Terminal Velocity (sp. gr.= 1.0) ft/sec.	Horizontal drift dist. ft. (released 15 elevation, 5 MPH wind)	No. of drops based on 10 gal/AC., drops/in^2
10	0.01	11,000.	$1.15\ 10^7$
50	0.25	400.	92,195.
100	0.85	129.	11,524.
500	6.8	16.	92.
1,000	13.20	8.	11.

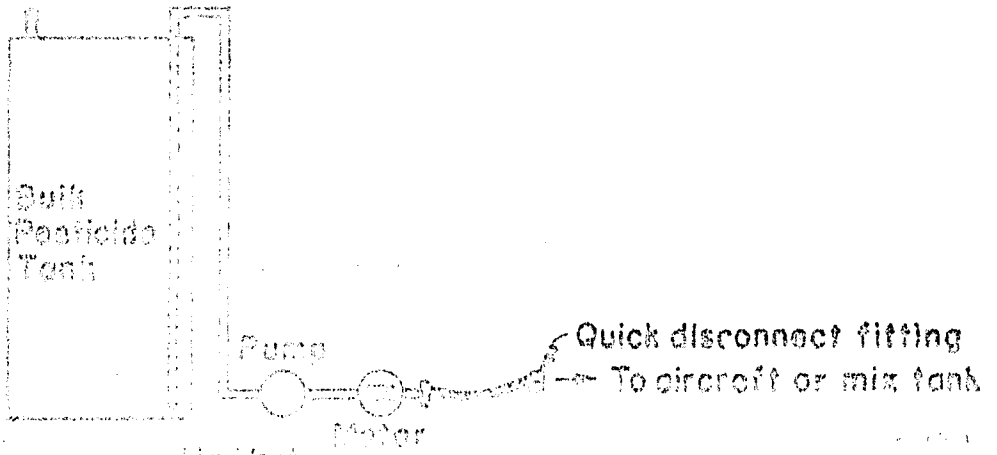

Fig. 1

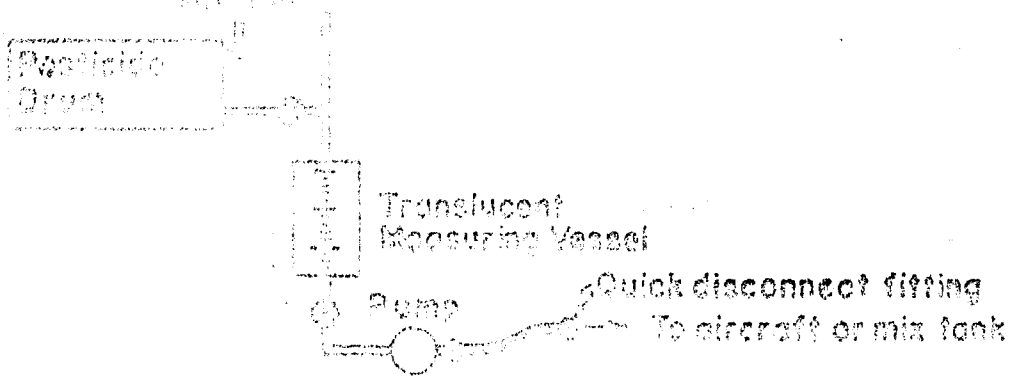

Fig. 2

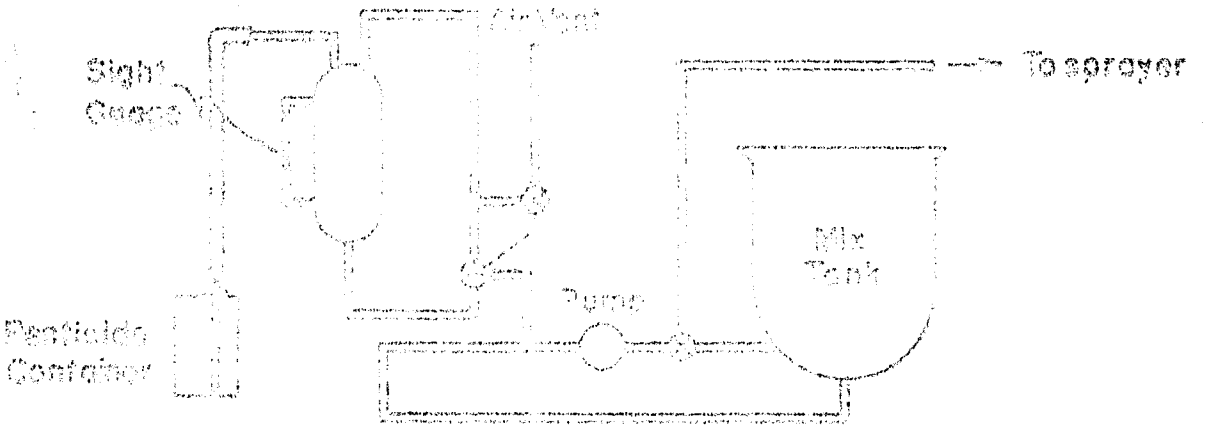

Fig. 3

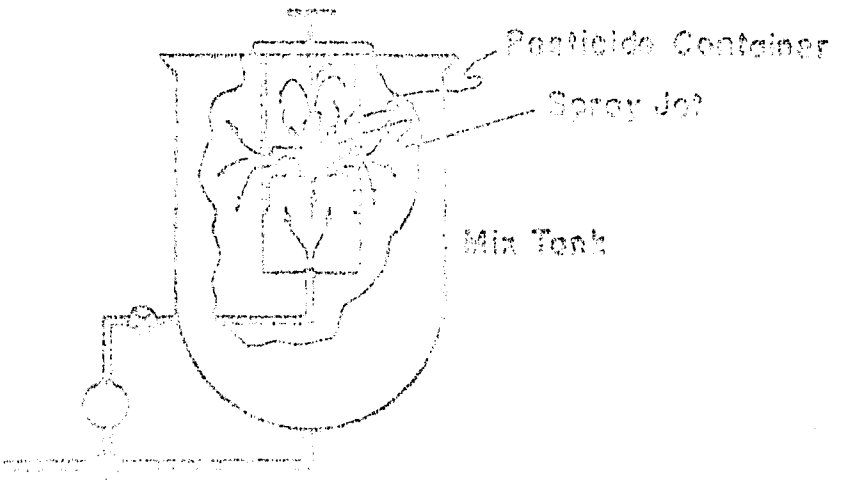

Fig. 4

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/SP/3
75-11-2

ABSTRACT

HAZARDS FROM PESTICIDES

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The effects of pesticides on man are to be considered as part of the cost for the benefits we derive from their use in agriculture, in the home, industry, and in public health. The various types of pesticides include a wide range of chemicals with varying pharmacological action and levels of toxicity. The hazards involved with their manufacture, distribution, and use may affect not only the occupational worker such as the formulators, applicators, operators and agricultural workers, but also the general public. Acute poisoning from the more important pesticides as well as specific and non-specific changes in various physiologic and biochemical parameters observed in man will be presented. Their significance and implication together with corrective or preventive measures to minimize their hazards will be discussed.

Institute Environmental Management in the Tropics
MANILA, PHILIPPINES
19-23 January 1976

PM/SP/9
Th-11-2

HAZARDS FROM PESTICIDES

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INTRODUCTION

Any potent chemical presents hazards to man during its manufacture, distribution, and use. This is very true for pesticides. In the case of pesticides, since these chemicals are directed towards pests other than man, the population at highest risk is ordinarily limited to the occupational workers or handlers, but accidents, ignorance and/or mistakes may expose other individuals or sometimes even larger groups of people, to possible poisoning. In addition to this hazard from possible acute poisoning with pesticides, one must also consider the long-term effects of chronic low-dose level exposure, particularly for those chemicals that persist in the environment and in the tissues of man.

TOXICITY TERMS

Chemicals and drugs in general may be classified as to toxicity on the basis of the acute lethal dose in animals. These data are usually given in terms of the LD_{50} or the dose lethal to 50 per cent of the experimental animal population under the particular conditions of the experiment. On this basis, chemicals and drugs may be assigned to the toxicity levels. The probable lethal dose to man in

1. Acute Toxicity of Chemicals and Drugs

ACUTE ORAL LD_{50} Toxicity (mg/kg)	Toxicity Level	PROBABLE LETHAL DOSE TO MAN
5000 - 15,000	I	up to 1 kilo or liter
500 - 5000	II	up to ½ kilo or liter
50 - 500	III	up to 2 tablespoonful
5 - 50	IV	up to 1 teaspoonful
< 5	V	fraction of a milliliter

2. ACUTE ORAL AND DERMAL LD_{50}-VALUES OF ORGANIC PHOSPHORUS INSECTICIDES FOR MALE AND FEMALE WHITE RATS*

COMPOUND	ORAL LD_{50} (MG./KG.)		DERMAL LD_{50} (MG./KG.)	
	MALES	FEMALES	MALES	FEMALES
Carbophenothion	30	1040	54	27
Chlorthion	880	980	4500	4100
Co-Ral	43	15.5	860	-
DDVP	80	56	107	75
Dolmar	43	25	235	63
Demeton	6.2	2.5	14	8.2
Diazinon	108	76	900	455
Dicapthon	400	330	790	1250
Dimethoate	215	-	400	-
Di-Syston	6.8	2.3	15	6
EPN	36	7.7	230	25
Ethion	65	27	245	62
Fenthion	215	245	330	330
Guthion	15	11	220	220
Malathion	1375	1000	4444	4444
Methyl parathion	14	24	67	67
Methyl Trithion	98	120	215	190
MLD	-	-	2100	1800
Parathion	13	3.6	21	6.8
Phorate	2.3	1.1	6.2	2.5
Phosdrin	6.2	3.7	4.7	4.2
Phosphamidon	23.5	23.5	143	107
Ronnel	1250	2630	-	-
Schradan	9.1	42	15	44
TEPP	1.05	-	2.4	-
Trichlorofon	630	560	2000	2000

* With the exception of the dermal LD_{50} for dimethoate, these values were determined by the Toxicology Section under standardized conditions.

From: Hayes, W.J. 1963.

3. ACUTE ORAL AND DERMAL LD_{50}-VALUES OF CHLORINATED HYDROCARBON INSECTICIDES FOR MALE AND FEMALE WHITE RATS

COMPOUND	ORAL LD_{50} (MG./KG.)		DERMAL LD_{50} (MG./KG.)	
	MALES	FEMALES	MALES	FEMALES
Aldrin	39*	60*	98*	98*
Chlordane	335*	430*	840*	690*
Chlorobenzilate	1040*	1220	-	-
DDA+	740*	600	-	-
DDE+	880*	1240*	-	-
DDT	113*	118*	-	2510*
Dieldrin	46*	46*	90*	60*
Dilan	-	-	6900*	5900*
Endrin	17.8*	7.5*	-	15*
Heptachlor	100	162	195	250
Isodrin	15.5*	7.0*	35*	23*
Kelthane	1100*	1000*	1230*	1000*
Lindane	88	91	1000	900
Methoxychlor	(6000.0)**	-	-	6000*
Perthane	4000*	4000*	-	-
TDE (DDD)	(3400)**	-	-	-
Thiodan	43	18	130	74
Toxaphene	90*	80*	1075	780

*These values were determined by the Toxicology Section under standardized conditions.
**Sex not specified.
+Metabolite of DDT.

From: Hayes, W.J. 1963.

4. ACUTE ORAL LD_{50} OF DITHIOCARBAMATES IN RATS

Compound	LD_{50}-VALUE (mg./kg.)
Ferbam	17,000
Ziram	1,400
Maneb	7,500
Zineb	5,200
Nabam	395

From: Hayes, W.J., 1963.

5. ACUTE ORAL LD_{50} OF CHLOROPHENOXYHERBICIDES IN RATS

Compound		LD_{50}-VALUE (mg./kg.)
2,4-D	- acid	375
	- sodium salt	666 - 805
	- mixed butyl esters	620
	- isopropyl ester	700
2,4,5-T	- acid	500
	- mixed butyl esters	481
	- isopropyl ester	495
MCPA	- acid	700
	- amine salt	1,200

From: Hayes, W.J., 1963.

6. ORAL TOXICITY OF SELECTED SUBSTITUTED DINITROPHENOLS TO THE RAT

Compound (R = 4,6-dinitrophenol)	Tolerated Acute Dosage (mg./kg.)	Acute LD_{50} (mg./kg.)	Tolerated Concentration in Diet (ppm)
2-Methyl-R (DNOC)	10	30	100
2-sec-Butyl-R	5	37	100
2-Cyclohexyl-R	30	80	500

From: Hayes, W.J., 1963.

the various levels are also given in Table 1. Tables 2, 3, 4, 5, and 6 gives the oral LD_{50} in rats for the various classes of pesticides. Dermal toxicity is also given for some of these agents which may have a toxic effect on the skin.

From these data, it can be seen that the chemicals such as fungicides, herbicides, insecticides and rodenticides used to control plants and animal pests belong to diverse chemical classes and spreads out over a wide range of acute toxicity levels. Most of them belong to the middle levels from II to IV. These means that a fairly large dose of the chemicals is required to produce toxic or lethal effects in man. This explains why despite the widespread use of pesticides in agriculture, in the home, in industry and in public health, no really major catastrophe has occured. To be sure, there have been many cases of acute poisoning. With proper use and safety precautions, however, we can continue to reap the benefits from the use of insecticides with a minimum of direct short-term ill-effects to man.

The possible long-term deleterious effects are controversial and will be dealth with later in this paper.

PHARMACOLOGICAL ACTION AND ACUTE POISONING.

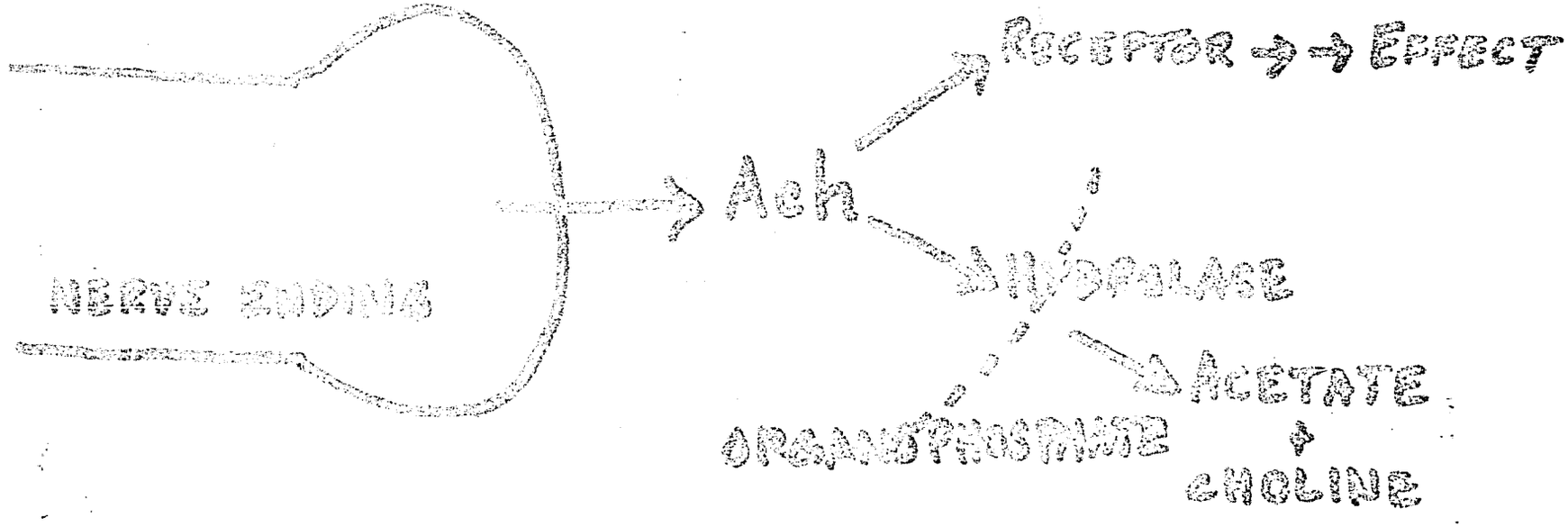
The mechanism of pharmacological action that may lead to the death of pest or man, is as varied as the chemical nature of the agent. To mention but a few:

A. INSECTICIDES

1. Organophosphates

Fig. 1

CHOLINERGIC MECHANISM & THE ACTION OF ORGANOPHOSPHATE PESTICIDES



The organophosphate insecticides act by inhibiting acetylcholinesterase, the enzyme that catalyze the hydrolysis of acetylcholine, the chemical neurotransmitter of the cholinergic system, both in the central and peripheral nervous system Figure 1. The action of acetyl-choline is normally terminated within seconds by this hydrolysis. When organophosphate insecticides and similar drugs are present, the acetyl-choline is not destroyed, thus leading to accumulation, initial stimulation and eventual refractoriness of the postsynaptic membrane to stimulation. This can lead to death due to convulsion and paralysis of respiratory muscles.

Cases of acute poisoning in man result from absorption of the drug through the skin, as well as through the respiratory and gastro-intestinal tract. Many of these cases result from mishandling of the insecticide by occupational workers during its manufacture, distribution, or use. In some cases, the chemicals are ingested with suicidal intent.

The severity of the poisoning depends not only on the degree of depression of acetylcholinesterase activity but also on the rate at which it occurs. A sudden absorption of even a small dose will cause incapacitating acute illness characterized by symptoms of headache, giddiness, nervousness, blurred vision, weakness and nausea. Large doses will cause cramps, diarrhea, chest discomfort, sweating, miosis, tearing, salivation, excessive respiratory tract secretion, vomiting, cyanosis, papilledema, muscle twitching, convulsions, coma, loss of reflexes, and loss of spineter control.

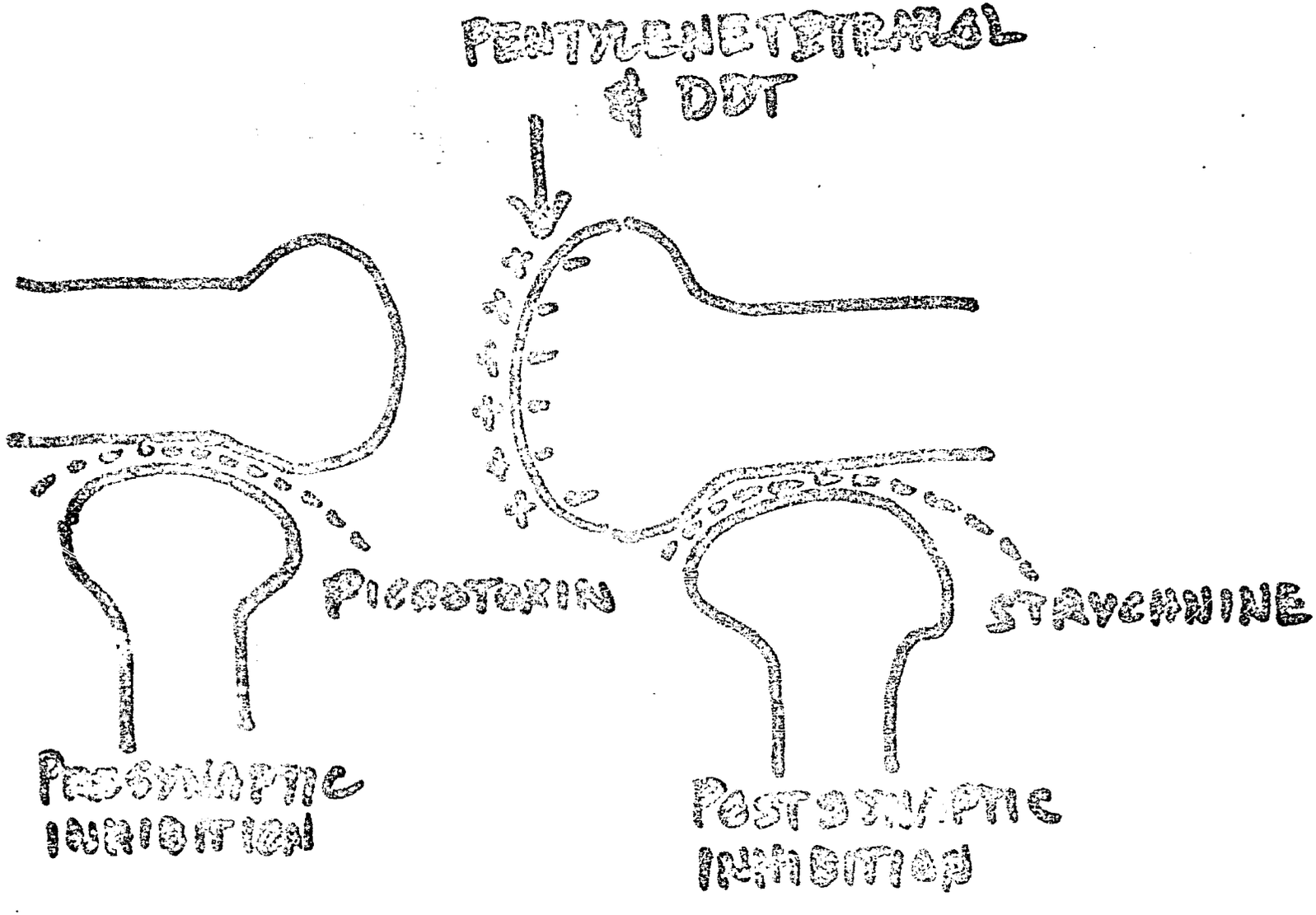
7. CASES OF CHEMICAL POISONING CONFINED AT THE PHILIPPINE GENERAL HOSPITAL IN 1974

CHEMICAL	NO. OF CASES	NO. OF DEAT.
Insecticides		
Organo phosphates	2	2
Carbamate	1	0
Salicylates		
Methylsalicylate	3	0
Miscellaneous		
Phenol	1	0
Mellaril	1	0
Cyanide	1	0
Muriatic acid	1	0
Ammonia	1	0
Kerosene	1	0
Total	12	2

Kintanar, et al 1975 - Unpublished data.

Fig. 2

MECHANISM OF CNS STIMULATION & THE ACTION OF DRUGS



The only deaths from chemical poisoning seen at the Philippine General Hospital (PGH) in 1974 were two deaths resulting from the suicidal drinking of organophosphate insecticides (Table 7). Parenthetically, I would like to note the absence of cases of barbiturate poisoning in 1974 which attest to the effectiveness of the Dangerous Drug Law which by classifying barbiturates among the regulated drugs has made them unavailable for suicidal purposes. In a similar series of poisoning cases in PGH ten years ago, barbiturates was the chemical involved in 25% of the cases (Kintanar, 1970)

2. Chlorinated Hydrocarbon

Chlorinated Hydrocarbons, such as DDT, produce their insecticidal action and its toxic action in mammals, presumably by rendering the postsynaptic neuronal membrane unstable, thus resulting in hyperexcitability and CNS stimulation.

From the elegant studies of the mammalian CNS by Eccles, it was established that stimulation of the CNS can be achieved not only by direct stimulation but also by blockade of inhibitory impulses presynaptically or postsynaptically. Three classical CNS stimulant drugs exemplify each of these mechanisms (figure 2). Pentylenetetrazole acts by direct stimulation, picrotoxin by blocking inhibitory impulses post-synaptically. DDT resembles pentylenetrazol in affecting supraspinal structures more than the spinal centers, and may act on the CNS by a mechanism similar to that of pentylenetetrazole.

Following the ingestion of toxic doses of DDT, signs and symptoms of toxicity begin to appear after a latent period of several hours. Ingestion of 10-20 g of DDT results in severe poisoning. Since this amount of DDT is contained in several hundred milliliters of the commercially available insecticide preparations, the picture of poisoning from commercial preparations of DDT is complicated by the effect of the solvent, many of which, like kerosene, are quite toxic by themselves.

The oral LD_{50} for mammals (and presumably this figure holds true for man, too) has been reported to be from 200-500 mg/Kg. Experimentally, after i.v. injection of a toxic dose, in 5-10 min. the animal begins to show the signs of central nervous excitability typical of DDT intoxication. The LD_{50} for the i.v. route is only 0.50 mg/Kg which approximates the LD_{50} for mosquitoes when calculated on a weight basis. The much shorter onset of action and the smaller LD_{50} for the i.v. route most probably results from the absence of losses due to poor absorption with the i.v. route.

The symptomatology of varying degrees of DDT poisoning in man has emerged from reports of accidental poisoning wherein the amount of DDT ingested could be more or less accurately established.

Smaller doses of 750-1000 mg total accidentally drunk with milk or oil, have resulted after a latent period of several hours first, in sensory disturbances like hyperesthesia or paresthesia. Later, a staggering gait could be observed associated with nausea and cold and clammy skin.

8. EFFECTS OF VARIOUS FORMULATION OF BENZENE HEXACHLORIDE IN MAN

Formulation (Percent Gamma Isomer)	Dosage	Effect
30-50	40 mg./day, 10 days	Diarrhea after 8th day.
60-85	40 mg./day, 14 days	No effect observed.
	110 mg/day, repeated	Diarrhea after 6th day.
100	40 mg./day, 14 days	No effect observed.
	45 mg. t.i.d., 3 days, (20 patients)	No effect observed.
	180 mg/day, repeated	Dizziness and diarrhea after several days.

From: Hayes, W.J., 1963.

A larger dose of 1500 mg total, resulted after 2-½ hours of latency in pricking sensation in the tongue, the upper lips and around the chin, subsequently spreading to adjacent areas; 4-5 hours after ingestion, disturbances of equilibrium such as vertigo were observed together with somnolence, tremors, nausea, headaches, fatigue and moderate clonic movements of the hands. These signs and symptoms subsided within 24 hours except for disturbances in equilibrium which persisted for 48 hours or more (Von Oethingen, 1958).

There is no real antidote to DDT poisoning. Significant protection is afforded by the barbiturates in animals. Favorable effects may also be observed in human cases especially where convulsive movements are a prominent feature of the clinical picture.

The effect of another common chlorinated hydrocarbon Benzene hexachloride (BHC) is shown on table 8. Doses from 40 to 180 mg/day produced from no observable effect to diarrhea and dizziness.

3. Pyrethrum and Allethrin

The effect on the nervous system produced by pyrethrum and allethrin resemble those of the veratrum alkaloids which has been shown to cause reflex stimulation of the CNS through the carotid and other chemoreceptors in the body. The progression starts from excitation, to convulsions to tetanic paralysis, but unlike that of the veratrums pyrethrum also produces muscular fibrillation. Death if it occurs is due to respiratory failure. Being relatively

non-toxic injury to man from pyrethrum has been more of allergic reactions rather than from direct toxicity.

B. RODENTICIDES

1. Phosphorus is formulated as a 2-5% paste for use against rats and roaches. Poisoning results usually from accidental or suicidal ingestion.

Acute phosphorus poisoning presents in two stages. Within a half hour following the ingestion of 15 mg or more, signs and symptoms of severe gastrointestinal irritation occur: The victim may die of cardiovascular collapse during this first stage lasting 24 hours. If the case survives, he may go into a latent phase lasting several hours to a few days which is followed by the second symptomatic stage characterized by abdominal pain, nausea, vomiting, hematemesis, jaundice, hepatomegaly, oliguria, toxic psychosis convulsions, coma, and shock. Death may occur at any time during this second stage from severe tissue damage to the liver, heart, and kidney.

2. Sodium fluoroacetate is a non-specific poison which is used to kill rats, mice, and other animal pests.

It is rapidly absorbed from the gastrointestinal tract. It is believed to cause inhibition of the Krebs tricarboxilic acid cycle by being metabolically converted to fluorocitrate which acts as an anti-metabolite inhibitor of the aconitase enzyme which catalyzes the conversion of citrate to aconitate. As little as 0.50 mg/kg may affect the cardiovascular, nervous and skeletal muscle systems

to a severe degree. Within an hour after ingestion of a toxic dose, the contractile force of the heart declines resulting in a fall in blood pressure. Premature ventricular contractions and other arrhythmias are also seen. In man, the CNS effect manifests as convulsions followed by coma.

3. Warfarin Sodium comes in the form of 0.5% powder in corn starch. When mixed with bread crumbs, meat, etc. as bait, a final concentration of 0.025% is recommended. This is the same drug that is used in medicine as an anticoagulant in such cases as myocardial infarction or cerebral thrombosis. Its principal pharmacological action is to inhibit prothrombin formation by the liver. Prothrombin is the precursor of thrombin which is one of the factors necessary for blood coagulation. When prothrombin becomes deficient, the animal develops bleeding tendency or actual spontaneous bleeding.

A case of the ingestion of 1.7 mg of Warfarin per kilogram per day for 6 consecutive days with suicidal intent has been reported. This dose is equivalent to eating roughly half a kilo of Warfarin Sodium bait (0.025%) daily. The signs and symptoms seen were all referrable to hemorrhage. The case recovered after multiple transfusion and Vitamin K injection, the antidote for Warfarin.

C. FUNGICIDES

1. The Dithiocarbamates act as fungicides for fruit crops, tobacco, vegetables, and ornamentals. As can be predicted from their very high LD_{50} doses, they are relatively non-toxic. The only ill-effects reported among heavily-exposed applicators are mild dermatitis,

pharyngitis, rhinitis, bronchitis and conjunctivitis.

2. Organic Mercury Compounds

The alkyl and aryl mercury compound are used in the form of dust and sprays as fungicides in seed dressings of grains, vegetables, peanuts, soybeans, and ornamentals.

An outbreak of poisoning from alkyl mercury that occured in Ghana in 1967 resulting in twenty deaths was analysed by Derban (1974), to be mainly due to ignorance and gross carelessness. The poisoning resulted from the unauthorized consumption of treated seed grain intended for planting. Mercury after ingestion distribute in lung kidneys and brain producing tissue damages. Unlike the inorganic mercurials which produce acute symptoms referable to the irritation of the gastro-intestinal tract and renal failure, the signs and symptoms from organic mercury compounds are referrable to the nervous system characterized by headaches, paresthesia of the tongue, lips, fingers and toes, fine tremors, loss of side vision, incoordination of movement and speech. Minamata's disease in Japan has been shown to be due to chronir organic mercury poisoning.

3. Pentachlorophenol besides being a fungicide is also used as insecticide, moluscicide, herbicide and bactericide. It is absorbed through the skin, lungs or gastro-intestinal tract. Its metabolic effect results from uncoupling of oxidation from Phosphorylation leading to increase in body temperature, collapse and death in case of severe poisoning. The course tends to be rapid, death occuring from 3 to 30 hours after ingestion of lethal doses. Weakness, dizziness,

nausea, vomiting, sweating, dehydration, dyspnea and high temperature are some of the associated signs and symptoms.

D. HERBICIDES

1. Arsenic in any form is a general protoplasmic poison. Besides being an herbicide various preparations of Arsenic have been used as rodenticide and insecticide. It is absorbed principally from the respiratory and gastro-intestinal tract. In the past, Arsenic has been the most important single cause of accidental deaths associated with pesticides. Abdominal pain and vomiting are prominent symptoms. Cardio-vascular collapse may cause the death simulating cholera. Generally death is delayed 3-14 days after exposure following vomiting and profuse and painful diarrhea.

2. Chlorophenoxy compounds are widely used for selective weed control and in very high dilutions as hormone sprays to prevent the early dropping of fruits as well.

These compounds are relatively non-toxic but in a high dose of 3600 mg i.v. given for possible treatment of disseminated coccidiomycosis, the patient developed coma, fibrillary twitching of muscles, hyporeflexia and urinary incontinence.

3. Dinitrophenols

The dinitrophenols are the classical uncouplers of oxidative phosphorylation. After ingestion or inhalation of toxic doses, signs and symptoms of toxicity include nausea, gastric distress, restlessness, sensation of heat, flushed skin, sweating, tachycardia, fever, cyanosis, collapse and coma. Lethal doses result in a rapid deterioration of the victim with fatal hyperthermia. In smaller doses,

cummulative effect is possible.

CORRECTIVE AND PREVENTIVE MEASURES

Some of the measures that maybe taken to minimize the acute hazards from pesticides are:

1. Legislation

a. strict control of the importation of the extremely toxic pesticides.

b. compulsory registration of all pesticides used in the country.

c. proper labeling which should include the name of the active ingredient and the recommended safe way of using it.

d. Controlling the sale and distribution of the more dangerous pesticides to accredited users who must comply with certain requirements regarding proper equipment, protective clothing and recording of all operations.

2. Education

a. Doctors and other members of the health team should be aware of what pesticides are being used in their area and should be prepared to treat cases of poisoning properly and with dispatch.

b. Education of the end users namely, farmers, cultivators and housewives on the hazards of these potent chemicals and the proper and safe way of using them. Toward this end, demonstration teams may be fielded to show farmers the proper way of preparing and applying the various pesticides. This is perhaps what is needed as part and parcel of the package

deal for farmers in the Masagana 99 rice production program in order to minimize poisoning due to ignorance and gross carelessness.

SPECIFIC AND NON-SPECIFIC CHANGES IN VARIOUS PHYSIOLOGIC AND BIOCHEMICAL PARAMETERS OF DOUBTFUL CONSEQUENCE

The toxic effects following the intake, accidental or otherwise, of excessive doses of the various pesticides often resulting in disability or death already discussed, are obviously unnecessary concomitants of the use of pesticides which should be avoided and minimized. What is more difficult to evaluate are the slight changes in some physiologic and biochemical parameters often seen among the occupational workers in the pesticide manufacturing, distribution and application, and to a lesser extent in the general public as well. Under this heading, I would include the changes in the electromyogram, (EMG) electroencephalogram, (EEG) in blood enzyme levels, in drug metabolism, etc.

It is well established that as a result of widespread use of pesticides particularly those that are resistant to physical and biological degradation, such as the chlorinated hydrocarbons, these chemicals have accumulated in the environment and in the tissues of plants and animals including man. (Table 9). This is true for most countries of the world where pesticides are extensively used in agricultural production and in the eradication or control of endemic insect-borne diseases such as malaria. The concentration of DDT in human body fat was zero in 1942 and climbed up to more than 10 ppm by 1963.

10 COMMUNITY STUDIES ON PESTICIDES

Mean Values for Tests Showing Significant Differences
($P<0.05$) across occupations

Test	Unit	Formulator	Applicators	Pilots	Operators	Agric.	Control
Serum β benzene hexachloride	ppb	1.19	2.39	8.26	2.70	1.41	1.77
Serum dieldrin	ppb	4.18*	20.62	1.61	1.49	0.94	0.98
Serum heptachlor epoxide	ppb	0.59*	1.32*	0.16	0.18	0.15	0.22
Serum p,p' DDT	ppb	11.79*	10.17*	22.47*	11.56*	6.53*	5.90
Serum o, p' DDT	ppb	0.49*	1.29*	0.72*	0.13	0.14	0.11
Serum p,p. DDE	ppb	23.08	34.32	71.39*	42.63*	23.92	24.32
Urine pH	pH	5.73	5.57	5.67	5.39*	5.43*	5.72
Creative phosphokinase	Units/ml	13.22	10.02*	18.12	28.14*	16.75	17.32
Bilirubin	mg/100 ml	0.66	0.75	0.82*	0.74	0.82*	0.67
Blood urea nitrogen	mg/100 ml	15.45	14.82*	16.43	15.72	16.63	16.10
RBC cholinesterase	Umol/min/ml	72.46	11.72*	11.89*	12.28	12.80	12.83
Plasma cholinesterase	Umol/min/ml	4.23	3.44*	3.78	3.90	3.73	4.40
Creatinine	mg/100 ml	1.23	1.26*	1.14	1.08	1.27*	1.15
Total protein	gm/100 ml	7.40*	6.99	7.28	7.17	6.99	7.14
Albumin	gm/100 ml	4.54	4.34	4.66*	4.50	4.14	4.41
L, globulin	gm/100 ml	0.25	0.25	0.21*	0.24	0.25	0.24
alpha globulin	gm/100 ml	0.82*	0.62	0.64	0.63	0.66	0.67
beta globulin	gm/100 ml	0.76	0.81	0.77	0.82	0.88*	0.80
gamma globulin	gm/100 ml	1.23*	1.00	0.99	1.13	1.06	1.06
Hemoglobin	g/100 ml	15.31	15.22	15.91*	15.27	14.81*	15.36
Hematocrit	%	45.40	46.50*	46.20	45.90	45.10	45.70
Band cells	%	0.78	0.94	0.12*	1.33*	0.30*	0.71
Lymphocytes	%	33.19	35.11	35.63	34.32	32.00*	34.85
Eosinophiles	%	3.63*	2.28	2.06	2.22	2.40	2.21
Monocytes	%	4.36*	3.46	3.35	2.76*	3.88	3.53

*Significantly different from control

NOTE: Combined data for 181 white male workers from 14 projects. Jul.-Sept.1969

FROM: Warnick et al, 1972.

What are the implications of such accumulation of pesticides in human tissue. An attempt has been made to see whether this accumulation of pesticides in human tissue has caused some consistent change in some measurable parameters in a series of community studies on pesticides. The data obtained from one such study is reproduced on Table 10. Paraphrasing the authors, the research taken by itself has not indicated differences of consequence between the workers occupationally exposed to pesticides and a comparable non-exposed control group. Although a number of statistically significant differences were seen, it would be improper to conclude that the pesticides are entirely responsible for these differences. Neither were the differences big enough to have significance with regard to health. (Warnick et al 1972)

Other physiologic parameters investigated are electrophysiological. Twenty two percent of workmen continually exposed to chlorinated hydrocarbon insecticides (Mayersdorf, A and R. Israeli, 1974) had abnormal EEG while 40% of agricultural workers using organophosphorus pesticides (Dresth et al, 1972) had abnormal EMG. These changes are within the realm of expectation knowing that the chlorinated hydrocarbons causes hyperexcitation of the CNS, while the organo-phosphorus insecticides inhibits acetylcholinesterase. The abnormality in EEG pattern included bitemporal sharp waves and paroxysmal discharges composed of slow and sharp waves while the abnormality in EMG pattern were similar to those found in myasthenic patients over treated with acetylcholinesterase inhibitors such as neostigmine.

Liver drug-metabolizing enzymes responsible for the hydroxylation of many drugs have been reported to be induced by DDT, (Poland et al 1970) Dudrin (Jager, 1970) and other hydrocarbon insecticides (Kalmodin et al, 1969) resulting in faster metabolism of drugs like phenylbutazone, cortisol and antipyrine. In animal experiments, the metabolism of sex hormones has also been affected with possible important implications in terms of long-term effects on reproduction and fertility (International Workshop, 1972).

As far as the possible carcinogenic effect of pesticides, Terrazini concludes that at the present stage, extrapolation of results from laboratory animals to man on a quantitative basis cannot be attempted perhaps with the exception of data concerning DDT. The fact that storage of total DDT in the fat of mice developing liver tumors is of the same order of magnitude as that occuring in the fat tissue of men occupationally exposed to DDT creates some concern. But species difference will have to be considered.

At the present time, there is not enough data on the possible effects of pesticides on reproduction, teratogenicity and mutagenicity. The same equivocal and incomplete state of knowledge hold true in the case of possible hepatotoxicity or changes in liver function produced by pesticides (Laws et al, 1973).

At this time it is hard to say whether these slight changes in some physiological or biochemical parameters, constitute only an adaptation or compensatory reaction or an early indication of altered function or disease.

11. SUGGESTED GUIDELINES FOR PESTICIDE ABSORPTION AND RESPONSE

Pesticide	Level* 1	Level 2	Level 3
Total DDT	Blood level 0.2 ug/ml	Blood level 0.2-0.5 ug/ml	
Dieldrin	0.1 ug/ml	0.1-0.2 ug/ml	0.2 ug/ml

	Level 2	Level 3
Cholinesterase Inhib.	30% inhibition of pre-exp. acetyl cholinesterol activity level	30% inhib.

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* Level 1 - Values below which no harmful effect should be expected.

2 - Values require action. As regards specific phenomena repeat exam. after appropriate interval, guard against exceeding the upper value of this level, including appraisal of general individual work situation.

As regards non-specific phenomena. Complete exam obtain adequate biochemical profile, repeat after appropriate interval to assess the nature of the disturbance, if any, and attempt to determine its cause.

3 - Values require corrective action including temporary removal from further exposure and appraisal of work situation.

From: International Workshop, 1972

What should we do for these people who are found to have high levels of pesticides in their tissues but who do not demonstrate any symptom or sign of illness? With respect to DDT, Dieldrin and the organo-phosphate insecticide, an International Workshop recommended in 1972 the guidelines presented in Table II. When blood values less than 0.1 ug/ml for DDT and 0.1 ug/ml for Dieldrin, no harmful effects should be expected and therefore nothing needs be done. But when blood values reach 0.3-0.5 ug/ml for DDT and 0.1-0.2 ug/ml for Dieldrin action should be taken to re-appraise the work situation with the view of preventing further undue exposure. In the case of organophosphate insecticide, action should be taken when the level of inhibition reach 30% of the pre-exposure level of cholinesterase activity.

Brown et al in 1973, put it succinctly when they said that "the dilemma of pesticides lies in the fact that while they do such good, they threaten a great deal of harm." While pesticides aid in increasing food and fibre production through protection from insects, rodents and weeds by their poisonous nature they may also endanger human life merely from poisoning or perhaps to an unknown degree over a period of years from subclinical alterations in some physiologic and biochemical mechanisms. Only the future can answer whether these changes have important health consequences in the long run.

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Pesticide Management Seminar - Workshop
MANILA, PHILIPPINES
10--15 February 1975

PM/SP/9
75-11-2

MEDICAL ASPECTS OF PESTICIDES POISONING - DIAGNOSIS AND TREATMENT

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Mr. Chairman, Ladies and Gentlemen:

It gives me very great pleasure to be invited this week to participate with you in this important seminar and workshop in Manila on pesticide management. From our planning endeavors and from the format of the program and the list of attendees, it is obvious that this workshop will introduce a unique presentation of pesticide management because there is such a holistic approach to the problem. There are representatives from 57 agencies attending this seminar and the special skills that they bring to this meeting are reflective of the interests of agriculture, medicine and public health, labor, the pesticide industry and a wide variety of other organizations equally concerned for the protection of man and his environment and on the other hand on the other the important need to increase his food production through the maximum use of modern agricultural genetic and chemical technologies.

The participants from the University of California/USAID Project, also seek to impart this holistic approach to the field of pesticide management, professionally we who have come to this conference from the regions represent the discipline of entomology, chemistry, engineering and medicine. Collectively, we have each come to realize that the goals of integrated pest and vector control which, in our opinion represent man's best solution to the growing problem of hunger and famine can only be resolved by a multi-disciplinary approach to the problem of pesticide management. We believe that the safe and effective use of pesticides and the understanding of pesticide management is an essential component and pre-requisite of the integrated control of the pest and vectors, of diseases in our environment. The Philippines is

one of the important developing agricultural countries in the world. Agriculture is the basis of the Philippine economy and employs approximately 70% of the nation's workers, providing about a third of the national income. You are also one of the leaders of the world in developing integrated pest control approaches and these are some of the many reasons why we are so privileged to be working with you today in this seminar and workshop of pesticide management.

This morning's session is concerned with the bio-chemical physiological effects of this audience. The health and medically interested groups present in today's audience will be the first to recognize the enormous gains in health care delivery that we, as a profession, have seen through the use of modern pesticide chemicals. The management of vector-born disease has made gigantic steps as a result of this technology. Malaria, the greatest scourge of infectious disease has been brought under control in vast areas of the world through the use of DDT. Though not so dramatic as the control of malaria, similar striking achievements in the control of schistosomiasis, trypansosomasis, yellow fever, dengue fever, enchocerciasis and encephalitis have resulted from the use of insecticide chemicals. In addition to the improved control of vector-born diseases, man is better nourished and clothed and his over-crowding has been partly resolved through the ability of these chemicals to open up vast new areas of the world, previously uninhabitable because of pest infestations and now made into salubrious areas where man can live and produce more food. However, it seems to be a rule of life that whenever man manipulates his environment, there are always certain costs as well as benefits and this morning we will try to focus on some of the medical and health costs of pesticide use. In addition we will seek to find measures which can contain or even eliminate these adverse human health effects of this technology.

In my first presentation, I would like to review with you some of the medical aspects of pesticide poisonings including diagnosis and management. In my second presentation, which is after the coffee break, I will attempt to review some of the current medical problems associated with pesticide management. An attempt will be made to identify ways in which we physicians can contribute to the "agro-medical" approach of pesticide management.

Human pesticide poisoning is a growing medical problem in many agricultural areas of the world. As a result of the problems of resistance and environmental effects of the persistent pesticides on fish and wildlife as well as for social and economic reasons, the organo-phosphate pesticides are re-

placing the organo-chlorine pesticides in many areas of the world. This trend, while alleviating the secondary consequences of pesticide contamination has led to the greater use of a group of chemicals which are more acutely toxic and which require greater skills in their application if human poisoning is to be avoided.

Toxicity Vs. Hazards

From the toxicological point of view, pesticide chemicals are classified according to their oral, dermal respiratory and delayed neurotoxicity potentials for poisoning. These various toxicity ratings, which are based upon toxicity tests on laboratory animals, list the amount of materials that is required to kill 50% of the test species (which is usually the rat) when administered by the various routes of application. Tables 1 and 2 list the LD_{50} as they are called, for some of the more commonly used organophosphate and organo chlorine pesticides. The material at the top of the list are the more toxic and the materials at the bottom of the list are the least toxic. For the organo phosphates and parathion and phosdrin are most frequently involved in human illness and endrin and dieldrin are the materials which are most frequently involved in human poisoning by the organo chlorine group of insecticides.

This use of the LD_{50} toxicity of the pesticides is of considerable use to the practicing physician because it provides him with a concept of the relatively toxicity of the different materials; it is important, however, for him to recognize that this is not the only variable that is involved in human poisoning and the concept of the hazard of the material, which is an expression of the potential of the material to produce human poisoning must also be understood. Hazard takes into consideration such factors as the difference in oral and dermo toxicity, it reviews and interprets the consequences of the chemical and physical properties of the materials (vapor pressure, solubility, etc.) and the methods of application and use. These differences between toxicity and hazards can be illustrated by the toxicologic records of parathion and methyl-parathion. The former has an oral LD_{50} of [illegible] mg/kg and the latter 14 mg/kg yet parathion is far more hazardous than methyl-parathion. Part of the explanation for this difference is due to the fact that the Dermal LD_{50} for parathion is 6[illegible] mg/kg whereas the Dermal LD_{50} for methyl parathion is 67 mg/kg and since most cases of poisoning of workers are the results of dermal exposures rather than oral exposures, it is easy to see why parathion causes more problems. This group of pesticides

are broken down to oxones during their metabolism and usually the oxone is many times more toxic than the parent compound. High temperatures favor the conversion to the oxone derivatives and this is one of the reason why many more pesticide poisonings occur during the warmer periods of the year. It is during these times that the rural physician should be alert for the occurrence of organo phosphate poisonings. Since a detailed review of the medical aspect field of all the pesticides in current use is beyond the scope of this presentation, the clinical and therapeutic aspects of only three groups of pesticides will be discussed today. These are:

1. The anti-choline-esterase pesticide (organo-phosphates and carbamates)
2. The organo-chlorine insecticide
3. Bipiridyl intoxicants (paraquat and diquat)

Organophosphate Intoxication - Diagnosis and Treatment

The organophosphates are implicated in more human poisonings than any other class of pesticides.

The clinical picture in acute poisoning can stimulate pulmonary edema, myocardial infraction, diabetic coma or encephalitis. In children, intoxication has been confused with asthma, pneumonia and epilepsy. Often, an obvious pesticide-exposure history is not available. The severity of the illness differs significantly according to the route of exposure. Occupational exposure is largely dermal, producing a relatively milder and less protracted disease than occurs after ingestion. Symptoms of illness devclop within 2 to 4 hours after dermal exposure and within 15 to 60 minutes following oral ingestion.

Recently some new fat soluble organophosphate have been introduced. Dichlofenthion (VC-13) is one member of this subgroup poisoning by this material produced slow evolution of cholinergic signs which progressed to life threatening situation with severe cholinesterase crises in 40 to 48 hours after ingestion. Cholinesterase inhibition and cholinergic signs persisted from 5 to 48 days in 5 cases studied and required maintenance of Atropine theraphy for 4 to 48 days. (Davies et al)

A. Presenting Illness

The initial diagnosis of organophosphate poisoning must be made on clinical grounds alone. Treatment can not be withheld pending laboratory findings. With systemic poisoning,

symptoms and signs are due to cholinesterase (ChE) inhibition and the appearance of muscarinic and nicotinic effects due to acetylcholine accumulation. Muscarinic effects, which usually precede nicotinic effects, include anorexia, nausea, vomiting, abdominal cramps, diarrhea, involuntary defecation and urination, sweating, salivation, lacrimination, pain in the chest with excessive bronchial secretions and blurring of vision due to miosis. Nicotine effects include muscle twitching, fasciculations, weakness and flaccid paralysis. With involvement of the muscles of respiration, further respiratory embarrassment occurs and leads to apnea and death. Death due to respiratory failure also result from bronchial constriction and blockage with secretions and depression of the respiratory center.

Central nervous system signs and symptoms include anxiety, restlessness, giddiness, headache, drowsiness, convulsions and coma.

In the advanced state, the patient is pale, sweating and frothing at the mouth. Most frequently, the pupils are miotic and unresponsive to light, though rarely, dilated pupils will be seen that become miotic with initial treatment. If conscious, the patient usually is dyspnoic, less commonly orthopnoic and rhonchi and coarse rales rather than crepitations are heard. Compared to the degree of respiratory embarrassment, chest x-ray findings are usually minimal. Cardiovascular signs consist of tachycardia and a moderate degree of hypertension; with marked hypoxia, there is no hypertension. ECG abnormalities include S-T depression with flattening or inversion of T waves and a trioventricular block and idioventricular rhythm. Atrial fibrillation has also been reported. Neurologic manifestations often observed are flaccid paralyses, extensor plantar responses and electroencephalographic changes. Hypothalamic spikes were noted by Holmes; which persisted for 3 years after poisoning.

From a metabolic point of view, initial hyperglycemia and glycosuria may be observed, although the level of hyperglycemia is much less than levels associated with diabetic coma, and ketoacidosis is not seen. SGOT and LDH levels may be elevated, and generalized aminoacidemia and aminoaciduria have been reported. Impairment of the tubular re-absorption of phosphorous occurs but returns to normal in convalescence. There is often a moderate degree of fever with a polymorphonuclear leukocytosis. Serum electrolytes are usually normal although hypokalemia may occur rarely and may be accentuated by diuretic therapy.

- S L I D E S -

B. Confirmatory Diagnostic Laboratory Test

The organophosphate and the carbamates insecticides are powerful carboxylic esterase enzymes. The toxicologic effects of this group of insecticides are primarily, if not entirely due to the inhibition of Acetyl Cholinesterases of the nervous system resulting in an accumulation of acetyl choline in the synapses. Acetycholinesterase is the cholinesterase in the red blood cells and in the nervous tissue. Plasma cholinesterase is the cholinesterases in the serum and plasma and in the liver. It is called pseodocholinesterase. A lowered RBC and plasma cholinesterase activity is strongly suggestive of poisoning by this group of insecticides. The measurement of this enzymes is therefore the first confirmatory laboratory test in suspected pesticide poisoning cases. In the field, this can be easily done by various colorimetric tests. These are screening test and the "Acholest" test is one example which can easily be performed if the blood specimen can be centrifugated. This test measure the serum cholinesterase. The "Unipet" field kit is another example of simple field test. It measures both the degree of red cells and plasma cholinesterase inhibition.

A tintometric method is another simple but more costly semi-quantitative method. Confirmatory techniques for quantitative measurements of cholinesterase levels have been reviewed by Witter. The Michel (electrometric) method, the pH-stat method and the gas chromatograph method are the methods most commonly used. The normal range for values by the Michel method for males is 0.39 - 1.02 ΔpH/hr for RBC ChE and 0.44 - 1.63 ΔpH/hr for Pl. ChE; for females, the range is 0.34 - 1.10 and 0.24 - 1.54 ΔpH/hr. For the pH-stat method, the range is 8-17 μ/ml./min. for RBC ChE and 1.2-5.5 μ/ml./min. for Pl. ChE. With the latter method, laboratories should establish their own normal ranges with standard solution. A correction factor for intra-method conversions has been published.

Most organo-phosphate (OP) and carbamates insecticides reduce both the RBC and the Pl. Cholinesterase. There is no absolute levels at which symptoms appear, the rate of cholinesterase decline being an important variable. In a patient who has had no previous exposure cholinergic symptoms usually appear when there is a greater than 50% inhibition of this enzyme but a considerable degree of tolerance maybe observed in the chronic occupationally worker and levels of 60-70% inhibition have been encountered without symptoms. Most of the OP poisoning cases that we have encountered have had an RBC of 0.4 ΔpH/hr or less (Michel) and it has been our practice to remove workers from continued exposure at these levels.

Rapid In Vivo and in Vitro reactivation of ChE levels occurred in carbamate exposures and by the time that these enzymes are measured in the laboratory they may have returned to normal. With the organophosphate Dorsban only plasma cholinesterase is inhibited. For the measurement of these enzymes by the Michel or the pH-stat methods, 6-12 cc of blood should be drawn in a Heparin-lined Vacutainer tube, sent to the laboratory and analyzed within 48 hours. Specimens should be kept cool but not frozen. In organophosphate poisoning the blood should be collected before the administration of oxime antidotes since there is a rapid reactivation of the RBC cholinesterase after the administration of this antidote and interpretation of the findings is complex if the blood is collected post oxime administration.

In addition to pesticide exposures a lowered plasma level of cholinesterase is seen in patients with liver disease, malnutrition, hyperpyrexia and myocardial infarction. 3% of the population have a genetically determined low cholinesterase level and persons with this defect are usually recognized if and when succinyl choline anaesthesia is administered since, with this defect and in the presence of this anaesthetic, post operative respiratory arrest occurs frequently. Additional laboratory studies which can provide diagnostic specificity to the case include the measurement of the ingest pesticide by gas-chromotography studies of the gastric contents and in blood, liver, kidney and brain if there is a fatal outcome. In addition, the identification of the phenolic and dialkyl phosphate urinary metabolites enables specific identification of the pesticides possible in many instances.

In summary, therefore, the diagnosis of organophosphate and carbamate insecticides poisoning must first be made on clinical grounds and be based upon the recognition of cholinergic manifestations. The commencement of antidotal therapy should not await laboratory results for the latter are confirmatory.

C. Clinical Management

Although management will vary according to the severity of the intoxication, the four major essentials of treatment are: (1) restoration of the airway and correction of hypoxia, (2) atropine and oxime therapy, (3) decontamination, and (4) scene investigation and notification.

1. Restoration of the Airway and Correction of Hypoxia.- Respiratory embarrassment due to secretions should be rectified at all levels. The mouth and pharynx should be cleared of secretions with a finger or by suction, if available, and an oro-pharyngeal or naso-pharyngeal airway inserted; if airway obstruction persists, endotracheal intervention should be performed and the cuff inflated before gastric lavage, to avoid aspiration of vomitus. Hypoxia should be corrected either with positive pres-

sure methods or the use of 50% oxygen therapy with a nasal catheter. Serial blood gases should be drawn to monitor respiratory and metabolic dynamics.

2. Therapy.- Atropine should be administered as soon as possible. Most previous reviews have recommended that cyanosis should first be corrected before commencement of atropine therapy. It is important, however, to stress that atropine is lifesaving and should not be withheld if attempts at reversing cyanosis becomes prolonged; in severe poisoning, atropine should be commenced while efforts are made to overcome any respiratory embarrassment. The patient is unusually tolerant to atropine, and large daily doses may be required. Goetsche describes a severe case of parathion poisoning in a man who was unconscious for 14 days and required atropine continuously for 18 days; the greatest daily dose was 445 mg. Therapeutic failures are most often the result of undertreatment. Initially, 2-4 mg. is given I.V. and repeated every 5 to 10 minutes. The goal of treatment is to produce and maintain atropinization, with pupillary dilation and a pulse rate of 140/min. being the most important end points. Proportionately smaller doses are administered to children, but atropinization is the desired state in all cases. Occasionally, cardiac nodal refractorines occurs, leaving the pupillary response as the cardinal sign in atropine therapy. In such circumstances, the availability of simultaneous toxicologic information on urinary PNP levels and blood pesticide levels can greatly assist the physician. Urinary PNP output is a better indicator of continued parathion absorption and provides information for continuance or termination of atropine administration. PNP concentrations in a random sample should be corrected for osmolar differences by standardization to 1,000 mOsm./l since concentration can vary markedly. Therapy should be maintained until the urine PNP levels (corrected for osmolality) fall to 2 ppm. Wyckolf et al. described a severe case of parathion poisoning in a girl who had ingested 450 mg. of parathion. On the second day, the dose of atropine was decreased because of a fever of 106°F. thought to be due to atropine toxicity; signs of poisoning returned, and her condition again became critical. The RBC ChE had risen from 0.1 to 0.6 pH/hr. following atropine and oxime therapy but, on the second day when atropine was reduced, her urine still contained 8 ppm. of PNP, indicating that intoxication was still occurring. Reinstitution of large doses of atropine again controlled the intoxication. In cases of parathion poisoning the urine should be analyzed for PNP every 6 hours and blood concentration of parathion obtained every 12 hours.

The oximes are another group of chemicals that have a specific antidotal action in organophosphate poisonings. The only one available in the United States is N-methyl 2 formyl-pyridinium oxime, used as the chloride. (2-PAM Cl) or Protopam chloride, the bromide (2-PAM Br) and the methane sulfonate (P^2S). Toxogonin is the oxime used in Europe.

The major action of 2-PAM is to disrupt phosphorylated ChE, making available free ChE and promoting a loss of the dealkylated phosphoryl moiety. It relieves the neuromuscular block of muscles particularly the muscles of respiration. Respiratory weakness, generalized muscle weakness and fatigability are markedly improved. 2-PAM should be given as early as possible and always in conjunction with atropine, the two drugs being complimentary in their action. The oximes are not active against all of the organophosphate insecticides and are not recommended for use in cases of carbamate poisonings. Depending upon the particular organophosphate, "aging" of the phosphorylated enzyme occurs, at which time the inhibiting enzyme can no longer be reactivated by 2-PAM. With parathion, aging does not occur for 2 days after exposure, so that 2-PAM may be used up to this time. With malathion, aging is early, and effects of oxime therapy in this intoxication are generally disappointing. The usual adult dose is 1 Gm. I.V., preferably as an infusion in 250 ml. of saline given over 30 minutes. If this is not practicable, a slow I.V. injection of a 5% solution in water can be given over not less than 2 minutes. In severe cases, 2 Gm. can be given initially and a second dose of 1 Gm. can be given in 1 hour. If convulsions are troublesome, trimethadione or thiopental may be used. Since respiratory embarrassment is usually due to excessive bronchial secretions rather than pulmonary edema, opiates, aminophylline, reserpine, phenothiazine tranquilizers, succinylcholine and furosemide are contra-indicated. (SLIDE)

3. Decontamination.- The clothes should be removed and the skin thoroughly washed with soap and water, particular attention being paid to the hair and removal of material under the nails. Because the pesticides are more soluble in alcohol, a second wash with alcohol is advisable. Following oral ingestion, gastric lavage is essential, the first wash being saved for toxicologic studies.

4. Scene Investigation and Medico Legal Consequences.- Not infrequently, additional intoxications can be prevented by a visit to the home of the poisoning. The police, local health department or county agricultural agent should be contacted and an immediate site visit requested. Quite frequently with poisonings involving children, the source of poisoning can be identified in the home; by its removal, the possibility of secondary cases is prevented. Similarly, agricultural agents have facilities to review the work environment that caused the episode and their intervention will help further illness. The local health department should be notified in order to decontaminate homes when necessary. (SLIDE)

The local health department should be notified in order to decontaminate homes when necessary and if there are medical consequences, such as workmen's compensation, which I understand in the Philippines is the one responsibility of the Social Security System, it is essential that the epidemologists obtain the necessary specimens and determine whether an organophosphate exposure caused the illness or death. The chemical analysis of the gastric contents for the intact pesticide by gas chromatography studies, the analysis of blood for cholinesterase determination and the analysis of the urine for the phenoric and dialkyl phosphate urinary metabolites will usually prove with certainty whether the illness was pesticide related or not. If the victim has died, the additional study of the liver, kidney, and brain will provide additional information.

In the Philippines many poisons will occur in remote rural communities and much of the diagnostic and therapeutic aids listed in this report may not be available to the rural physician. What then are the essential diagnostic and therapeutic aids?

First, there should be, in the p hysician a high index of suspicion for organophosphate poisoning, and early diagnosis is essential because treatment must be rapid and vigorous. Cholinergic manifestation can mimic a wide variety of other clinical conditions. Midriasis and fasciculations are the most constant features of organophosphate exposure, and weakness, salivation sweating and respiratory difficulties are the most common symptoms. Atropine refractoriness is a valuable confirmatory clinical observation. Atropine ampoules or multi-vial doses should always be available as well as oxygen and if necessary the ability to insert an endotracheal tube is recommended. An adequate supply of 2 grams ampoules of 2-PAM should also be on hand together ; with the appropriate diluent and, ideally, several bottles of 500 ml. of 5% dextrose and water or saline for intravenous infusion. If I.V. administration of 2-PAM is impossible it can be given intramuscularly but it is less effective via this route.

Organochlorine Intoxication

In contrast to most of the organophosphates, the organochlorine class of pesticides exhibits features both of toxicity and persistence. There is a wide range of toxicity in the various members of this group; most reports of chemical toxicity have followed endrin, dieldrin, lindane and chlordane exposure. Illness is usually the result of accidental or suicidal ingestion of the concentrate although occupational intoxication has also resulted from dieldrin exposure in the field and during manufacture.

Poisoning symptoms are largely due to central nervous system stimulation but include also effects in liver, lung, kidney and blood vessels. Absorption is oral and dermal. Paresthesias, dizziness, ataxia, tremors and convulsions occur. Electroencephalographic changes reflective of brain-stem stimuli are noted and usually precede seizures. These changes involve bilateral synchronous theta waves and occasional bilateral synchronous spike and wave complexes. They return to normal after withdrawal from exposure. Clinically, two patterns of seizures have been described. One is the sudden onset of seizures with no prodrome - these are typical of endrin poisoning. Coble et al. described such a case in a woman who first presented with a hematoma, having no knowledge that she had previously sustained a convulsion which caused it and which was due to endrin poisoning. Muscle twitching, myoclonic jerks and convulsions preceded by headache, drowsiness, nausea and vomiting constitute the other pattern, most commonly seen with aldrin and dieldrin poisonings. In severe cases, death is usually due to respiratory depression but can also be due to asphyxia during convulsions, ventricular fibrillation and renal failure. Chronic exposure can produce peripheral neuritis. Organochlorine studies taken at or shortly after intoxication help confirm the diagnosis. Since in the rat the severity of intoxication was correlated with brain concentrations and since blood is more closely in equilibrium with the brain than adipose tissue, blood levels are more diagnostic of poisoning than fat levels.

In Asia, although information is incomplete, the organochlorine appear to cause more illness than organophosphates. Ceylon, from 1960-63 had 313 organophosphate and 481 organochlorine poisonings. Several epidemics of endrin poisoning have been documented. In Arabia, in 1967, there were 276 poisoning with 26 fatalities. In a survey for the WHO in Indonesia, the author obtained information on 31 organophosphate and 478 organochlorine poisonings. Reports of individual cases and epidemics were encountered. As in Arabia, most were the result of accidental contamination of common foodstuffs such as flour and rice, often through the illicit use of discarded drums or because of leakage of toxic in transit, with seepage into adjoining food. Another hazard recognized was the potential for cross-contamination of food and pesticides in adjoining buildings by flood waters during the monsoon period. Epidemics of poisonings could be seen by reports of clusters of convulsive seizures, with or without preceding gastro-intestinal symptoms; cases were confirmed by retrospective epidemiologic investigations and toxicologic studies.

The clinical management of organochlorine poisonings is symptomatic. Following gastric lavage, CNS sedation should be initiated as rapidly as possible with such drugs as barbiturates and dephenylhydantoin. Morphine and epinephrine are contra-indicated. An intravenous drip of succinylcholine chloride, intubation and respiration with 40% oxygen has proved effective in management of continued seizures.

Bipyridyl Intoxication

Paraquat (1-1 dimethyl 4,4-dipyridylium dimethyl-sulfate) and diquat (1,1'-ethylene-2,2'-bipyridylium) are two bipyridyls that are widely used in agriculture for weed control and defoliation. Paraquat is more toxic than diquat and produces proliferative changes in the lung, cornea, lens, nasal mucosa, skin and fingernails.

Diquat affects the lens and gastrointestinal mucosa and does not produce the lung changes characteristic of paraquat. Except for eye lesions, illness dur to occupational exposure is usually mild and is the result of topical exposure. Epistaxis occurs in workers following droplet inhalation, and conjunctival changes occur with accidental spillage.

Very different is the clinical picture following accidental or suicidal ingestion. Although there are a few reports of recovery following ingestion, most paraquat intoxication are fatal and their management is unsatisfactory and largely symptomatic. Following ingestion of an amount as small as an ounce of paraquat, three clinical stages are recognized. First, there is a gastrointestinal phase with burning in the mouth and throat, nausea, vomiting and abdominal pain with diarrhea. Next, usually several days after exposure, signs of hepatic and renal toxicity appear. These are due to a central zone necrosis in the liver and acute tubular necrosis of the kidneys. Ten to twenty days after ingestion, progressive proliferative changes in the lungs develop. Hyperplastic changes in the terminal bronchioles occur with alveolar fibroblastic proliferation. Loss of lung surfactant has been demonstrated. Within a few days, death from respiratory failure occurs. These severe and relentless pulmonary changes were also noted in a patient who had injected himself with paraquat as a suicidal gesture.

Urine studies in animals and patients indicated that 90% of the ingested paraquat is excreted in the first 24 hours. Delayed pulmonary effects appear to be the result of an irreversible process that develops long after the initial stimulus has gone.

Paraquat is poorly absorbed from the gut. Excretion data suggest that only 1-5% of the ingested material is absorbed in man, but maximal blood concentrations are reached within 4 to 6 hours after ingestion. Treatment in man is directed toward: (1) attempts at limiting the amount of material absorbed, and (2) steps to promote the elimination of paraquat from the body. The absorptive properties of Bentonite, Fuller's earth and other clays on bypyridal absorption have been studied in cats and rats; the first two prevented poisoning in rats and reduced absorption in cats. Fuller's earth (30%) was more effective than bentonite. Early administration of these absorbents is essential and should be combined with gastric lavage. Diuresis should be forced with manitol. Peritoneal dialysis is required for renal failure. Although steroids and antibiotics are given for pulmonary complications, no treatment has been shown to be effective in the management of lt this phase of the intoxication.

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/SP/20
75-11-2

CURRENT MEDICAL PROBLEMS OF PESTICIDE MANAGEMENT

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Presently, the medical problems of Pesticide Management can be categorized according to three categories of Pesticide Exposure representive of Acute, Chronic and Incidental Exposures. These can be figuratively presented by the iceberg shown in Fig. 1.

Acute Exposure

Acute exposures are reflected by incidence data of the number of pesticide poisonings occurring in various parts of the world. Incomplete statistics suggest that this is a serious problem of pesticide management and the WHO estimates that there are approximately 500,000 cases occurring annually with a mortality rate of between 5 to 10% in some countries.

Table 1 and 2 illustrates the incidence of pesticides poisoning in different parts of the world. Poisoning victims can be divided into those who are occupationally exposed and those who are members of the general population. Occupational poisoning, which is usually the result of dermal and respiratory exposure is added than poisoning which is the result of accidental or suicidal ingestion. Poisonings can in turn be sub-divided into applicator poisoning or picker or residue poisoning. In the former, the worker is at some time personally exposed to the pesticide concentrate and is affected both acute through skin contact, during the process of manufacture, formulation, reformulation, loading and application of the material - Parathion, phenolin, endrin, and pentachlorophenol - are most pesticides commonly involved in occupational illnesses. In picker poisoning, the illness results from the contact of the worker with the foliar and soil residues of the pesticides or its more toxic oxon derivative. This phenomenon is not uncommon in the hot and arid areas of the world and is seen most frequently during the picking of citrus and cotton. Here again, parathion has been a major offender and when this type of poisoning occurs, multiple cases rather than single cases are usually reported.

TABLE 1

Pesticide poisoning statistics for Guatemala and Nicaragua. 1968-1971.

Year	Guatemala	Nicaragua
1968	1,374	
1969	736	258
1970	659	221
1971	1,100	356

TABLE 2

Fatal and non-fatal pesticide poisoning cases in El Salvador. 1963-1972.

Year	Fatalities	Non-fatalities
1963	11	1,104
1964	2	965
1965	1	938
1969	7	584
1970	7	474
1971	10	586
1972	5	2,787

The preventive strategies which public health utilizes in these two different situations are (1) worker education and (2) routine cholinesterase testing of certain high exposure groups. Insofar as the prevention of picker poisoning is concerned, in the U.S.A., legislation for the establishment of worker "re-entry times" is under review for specific pesticides. Time intervals after pesticide applications are being developed, during which intervals, it is illegal for the agricultural worker to enter the field for harvesting or thinning of crops.

In contrast to occupational poisonings, accidental poisonings of the general population are the results of a wide variety of factors most of which are indicative of inadequate public education and misunderstanding of the toxicity potential of these chemicals and the dire consequences of misuse. For example, many poisoning have resulted from the ready availability of the more toxic types of pesticides in garden stores and in the "pesticide shops". They are improperly stored in the home, and within reach of the toddler. Even the adult is at risk especially if the chemical is stored in improper bottles. Over-indulgence in alcohol frequently results in accidental pesticide poisoning especially if the pesticide has been transferred to an empty gin or whisky bottle! Accidental spillage has also resulted in many cases of poisoning and food and clothing have been contaminated during the process of transportation of food and clothing together with agricultural chemicals. The illicit use and sale of the more toxic members of this group have also resulted in human fatalities and a strict enforcement of city and provincial pesticide ordinances should be instituted. In those countries who are concerned with this problem, the introduction of appropriate pesticide legislation prohibiting the sale and use of the more toxic materials within the urban environment has greatly reduced the incidence of pesticide poisoning. The accessibility and the utility of unwashed and undestroyed pesticide containers is another example of bad pesticide management and one which can lead to fatalities. The storage of pesticides concentrate in polyethylene bags within the metalic pesticide drum would greatly contribute to the reduction of pesticide accidents and would help prevent many inadvertent contaminations of food supplies. A massive spillage of pesticide concentrate can produce a particularly hazardous situation and several countries are now in the process of introducing emergency telephone numbers which can be contacted in such an eventuality. These centers are manned on a 24 hour basis by persons who are specially skilled in pesticide decontamination. In the U.S.A. several pesticide companies have volunteered to provide the necessary skills and facilities for dealing with a sizeable pesticide spillage of their individual products. Animal and fish kills should also alert the appropriate authorities to the possibility of accidental environmental contamination and reports of these events should always be investigated as quickly as possible. The process of pesticide shipment and storage is another particularly, hazardous phase of the distribution cycle. Careless unloading of the chemical at the dock side can result in leaking containers, and if these are stored in warehouses in close proximity to food, accidental cross contamination may occur. Cross contamination of food may also occur in the event of storms or floods. The general upkeep and waste disposal procedures of the pesticide warehouse is another area which should come under review and is an area which should be inspected regularly. The local pesticide industrial groups can greatly assist the local sanitary authorities in the planning and design of new storehouses.

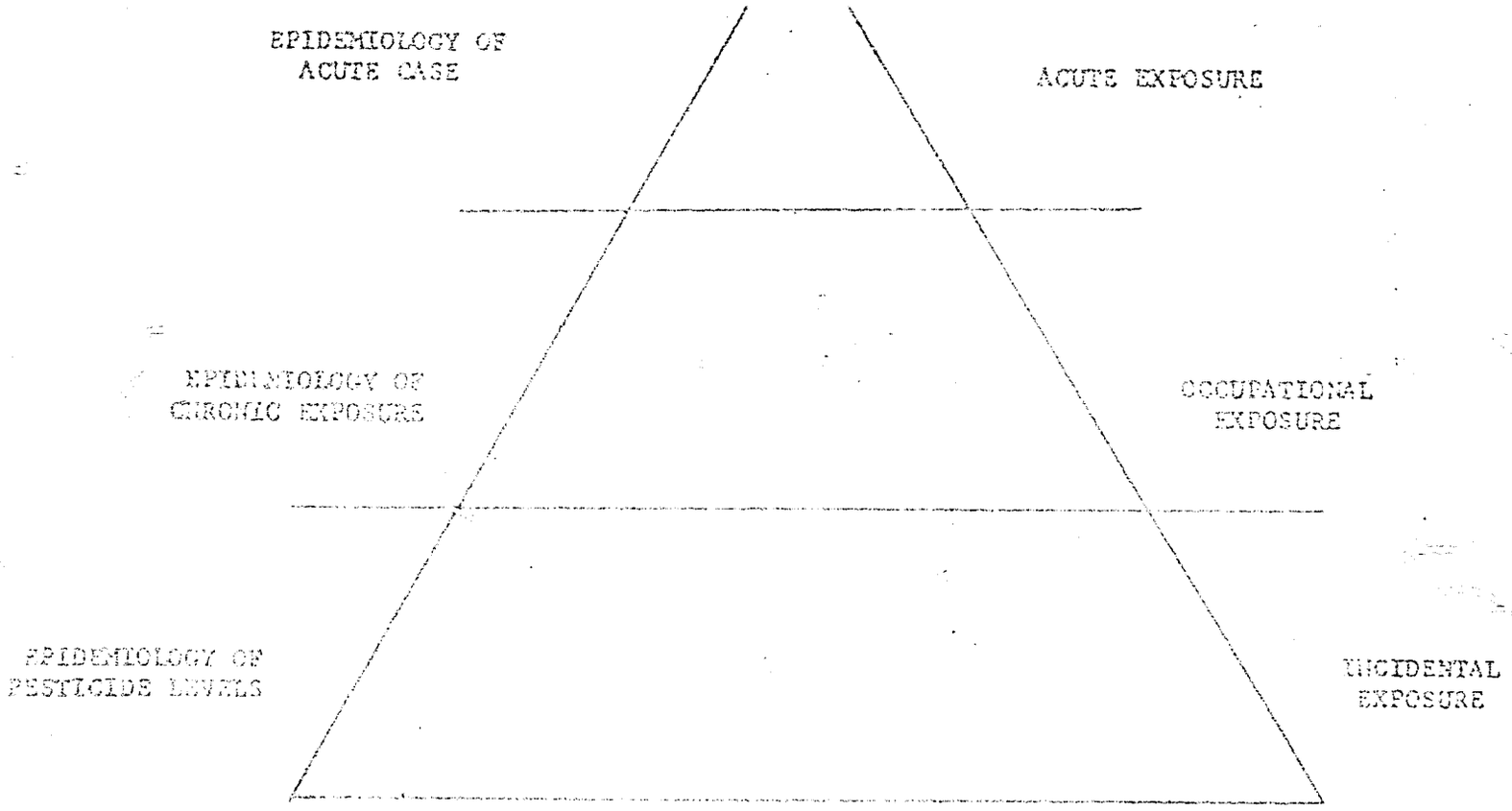
From this short review of some of the environmental and behavioral mechanisms of pesticide poisonings, it will be apparent that this is a problem for several different agencies and institutions. Its resolution will contribute significantly to improved pesticide management, a goal which can only be achieved through effective inter-disciplinary participation.

Occupational Pesticide Exposure

This is the second level of exposure and it is an area of special concern to the physician. Occupational health and safety of the pesticide worker is receiving special attention in the U.S. and the E.P.A., N.I.O.S.H. and the Department of Labor are becoming increasingly involved. Aircraft pilot loaders, pesticide formulators and applicators have been found to be the exposed groups at greatest risk, and routine monthly cholinesterase monitoring of this sub-group is desirable. In many areas of the world, especially during harvest time, there is a tendency to employ temporary unskilled workers for pesticide loading and application. High school students and even children, in some instances, have been recruited. This must be considered to be a highly undesirable state of affairs and a practice to be condemned if there is a genuine concern for the promotion of safe and effective pesticide management. Health and agriculture should move in unison on this issue and both should ensure that the pesticide loader and applicator is properly trained for the job and that the young, the unskilled, and the handicapped should not be entrusted with so responsible a task. This special training should not only cover the essentials for efficient pesticide application but should give equal emphasis to the steps necessary for the protection of the worker and his environment. He should receive special training in container disposal and disposal of pesticide effluent. Here again the ingredients of good pesticide management are education, training and surveillance. These several requirements can only be implemented by the joint efforts of agriculture and health with the pesticide industry also having much to contribute by their experience in these areas. All three of these disciplines have much to gain by improvements in worker's safety. Occupational exposure is an area where there is a great need for collaborative research. For example the use of closed systems for loading aircraft and spray tanks, the potential for new approaches to pesticide formulation and the introduction of innovative techniques in clothing need exploration. Barrier creams and clothing treatments offer considerable promise for increased worker safety.

Incidental Exposure

This is the third and last area of pesticide exposure wherein health is very deeply concerned. This type of exposure is the result of incidental exposure to pesticides through trace amounts of these materials and their metabolites in the air, in the food, in water, on clothing and in household dust.



STRATEGY OF PESTICIDE EPIDEMIOLOGY

Figure 1

Epidemiology of Human Pesticide Residues

This area which represents the pesticide pollution of man is concerned with the distribution of the persistent fat soluble pesticides. Other non-pesticide fat soluble chemicals are also appearing in widely separated communities of the world. The organochlorine pesticides most frequently identified are DDT and its metabolites, dieldrin, heptachlor expoxide and benzene hexachloride. As pesticide use changes and analytical techniques improve, new materials will appear in the human pesticide residue spectrum. Pentachlorophenol is a different type of pesticide which is being found with increasing frequency in the urine of different general population groups. The polychlor biphenyls (PCB's) are examples of non-pesticide chemicals which are detected in recent adipose population surveys. Most of the earlier monitoring studies described the prevalence of DDT and its metabolites. A sizeable body of information on the frequency distribution of this pesticide and dieldrin is on record.

The recognition that the DDT metabolites in fat were significantly correlated with residues in blood permitted the larger and more stratified sampling of communities. It was found that levels of DDT reflected recent exposure to this compound whereas levels of DDE were reflective of chronic life time exposures to DDT. Initially these surveys of the persistent pesticides were used to estimate national prevalences and to make international comparisons of geographical differences and to estimate secular changes of these residues in man. It was first thought that DDT was homogeneously distributed throughout the general population, a distribution which was compatible with the dominant role of food as the major source of this incidental exposure. However, with the introduction of blood instead of fat as the sampling tissue, larger and more stratified sampling became possible. It soon became apparent that DDT was not homogeneously distributed in the population and significant differences in its distribution were identified in relation to the characteristics of person, place and time. Some of these are shown in figures 2, 3, 4, 5, and 6.

In the United States, descriptive personal variables which influence the frequency distribution of total DDT levels include occupation, race, sex, age and social class. Higher levels of total DDT were found in occupationally exposed persons, in males, in people 20 years and over, in blacks when compared to whites and in the poor when compared to the affluent. Place variables show that DDT residues were higher in warmer climates, were greater in urban rather than in rural communities in some areas, and were clustered by families. Each member of a high DDT level home tended to have a higher than average level of DDT. Time variables emphasized a steady increase of DDT levels with age in persons under 20 (Fig. 5) but there was a leveling off of this age effect in the over 20 (Fig. 6).

These frequency distribution characteristics of DDT are not totally compatible with the concept that food is the main source for the human DDT residues and suggest that the home environment, particularly the dust in the home environment, maybe an important variable of this residue in hot climates.

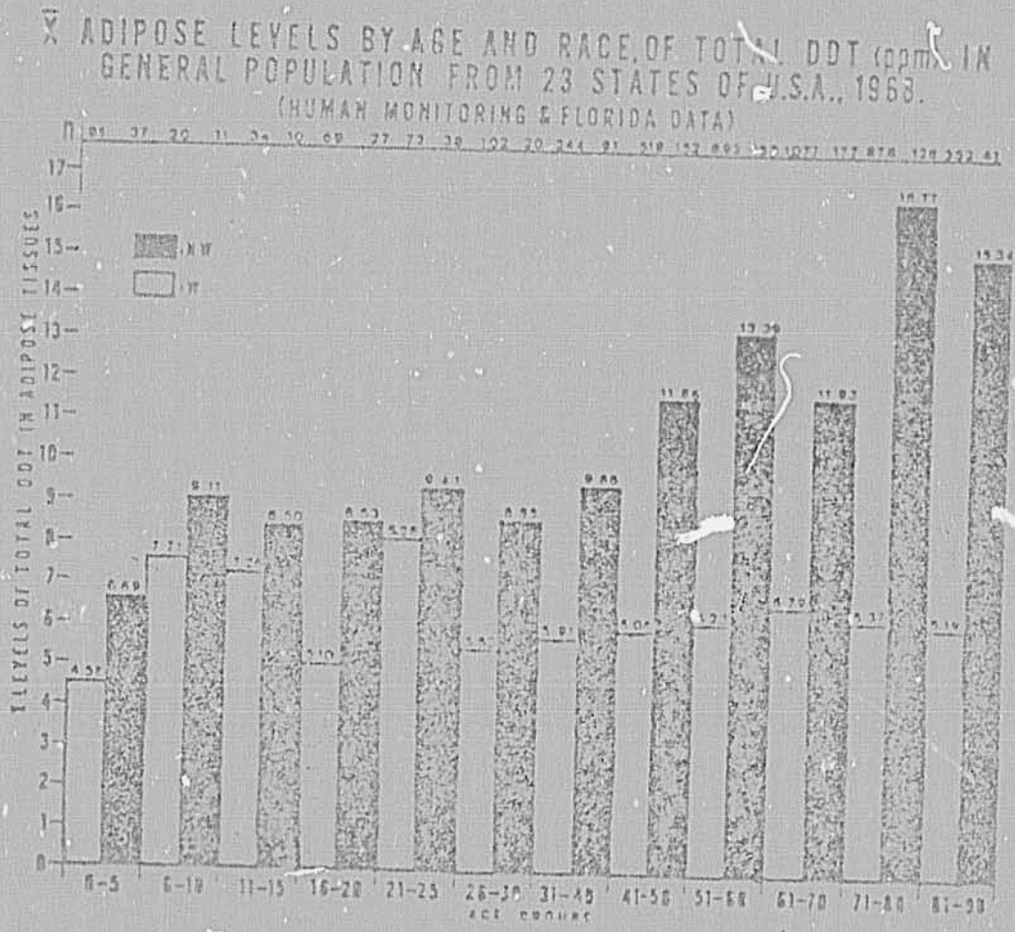
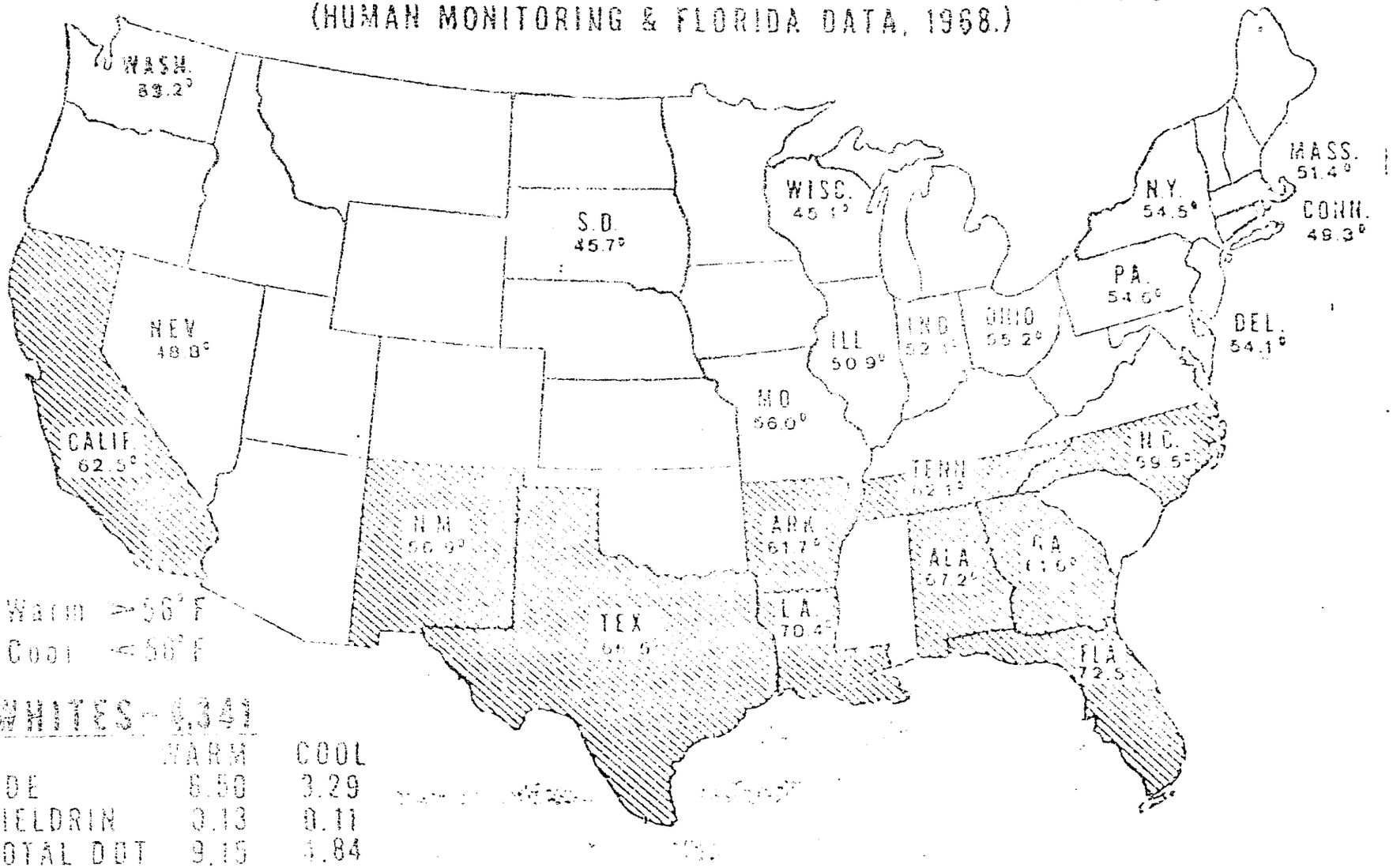

X̄ ADIPOSE LEVELS BY AGE AND RACE, OF TOTAL DDT (ppm) IN GENERAL POPULATION FROM 23 STATES OF U.S.A., 1968.
(HUMAN MONITORING & FLORIDA DATA)
TLEVELS OF TOTAL DDT IN ADIPOSE TISSUES
NW
W
0-5
6-10
11-15
16-20
21-25
26-30
31-40
41-50
51-60
61-70
71-80
81-90
AGE GROUPS

Figure 2

GEOGRAPHICAL COMPARISONS OF HUMAN ADIPOSE PESTICIDE RESIDUES (ppm) IN DIFFERENT MEAN MONTHLY TEMPERATURE ZONES OF THE U.S.A.

(HUMAN MONITORING & FLORIDA DATA, 1968.)



NO. WHITES - 6,341

	WARM	COOL
$\bar{X}$ DDE	6.50	3.29
$\bar{X}$ DIELDRIN	0.13	0.11
$\bar{X}$ TOTAL DDT	9.15	4.84

NO. NEGROES - 893

$\bar{X}$ DDE	9.66	5.26
$\bar{X}$ DIELDRIN	0.13	0.14
$\bar{X}$ TOTAL DDT	[illegible]	[illegible]

Figure 3

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Figure 4 – Concentrations (in ppm) of DDT-type compound and HEOD in adipose tissue in Europe; concentrations of HEOD in italics.

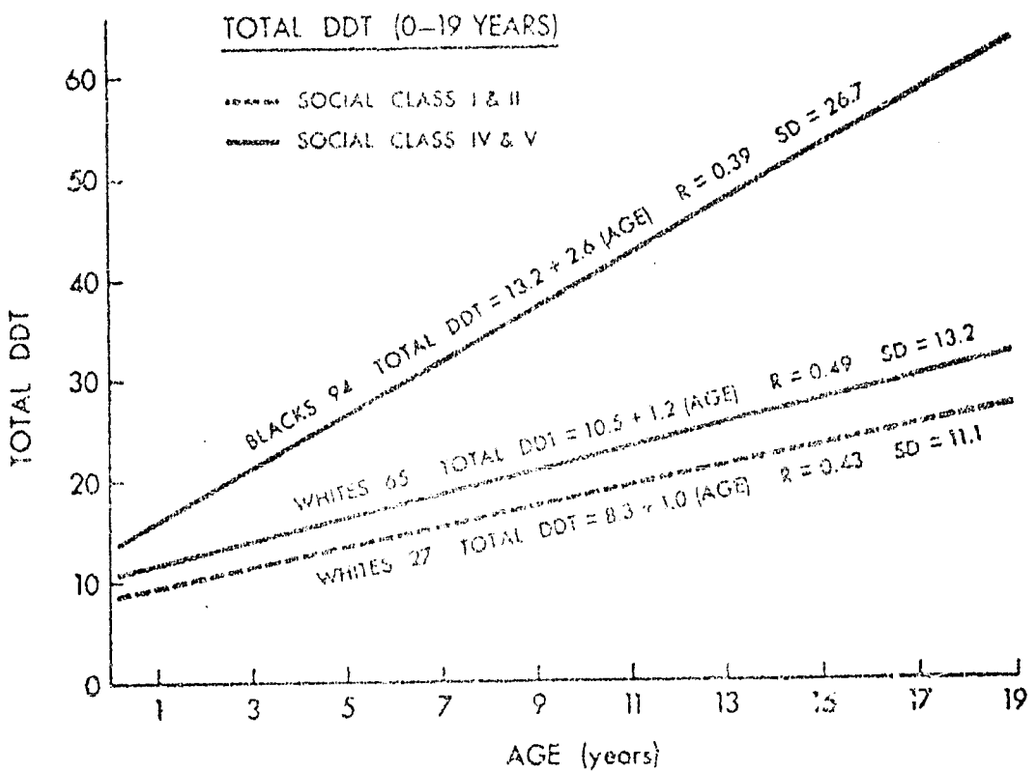

Figure 5 - Correlation of serum Total DDT levels (ppb.) in the general population of Dade County. 1971.

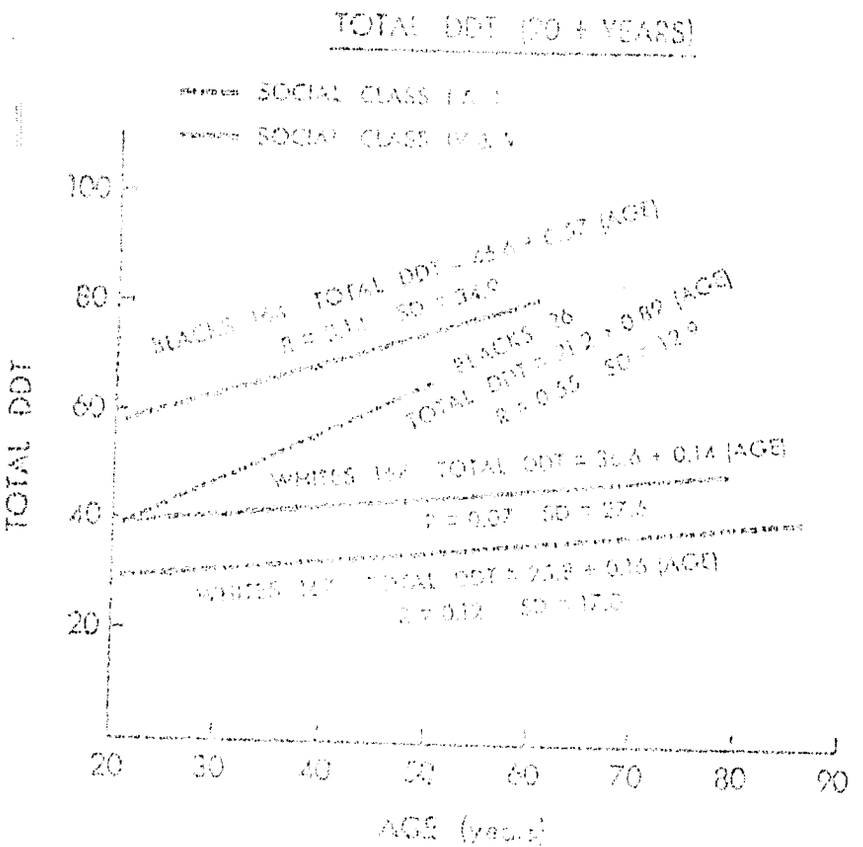

Figure 6 - Correlation of serum Total DDT levels (ppb.) with age (20-80+ years) in the general population of Dade County, 1971.

From a medical point of view, present concern has concentrated in three areas. These are (1) human monitoring programs, (2) microsomal enzyme induction effects, and (3) carcinogenesis, teratogenesis, and mutagenesis.

(a) Human Monitoring Studies - This issue will be discussed more fully in a later session of this symposium. However, as the list of chemicals in the human pesticide residue spectrum grows, it is obvious that medical and public health will become concerned with the need to document these subtle measures of environmental exposure. There is very little information of the yearly changes of these residues taking place in our society. Knowledge of the qualitative and quantitative characteristics of the spectrum may provide clues in the future for the study of human health effects of trace exposures to newer chemicals being introduced into our society. It is not completely satisfactory to rely on epidemiologic studies of the highly exposed worker in order to identify adverse health effects of these new chemicals. Such studies are frequently complicated by the fact that the numbers of individuals receiving high exposures which are the result of their occupation, are often too small in number to judge the health effects of the particular chemical to which they are exposed. Also, frequently many members of this work force change their jobs and are lost to follow-up. Health effects of environmental chemicals can only be identified by occupational studies if the incidence of the disease under study is very high, or if the disease is extremely rare. A good example of the latter was seen recently when angiosarcoma of the liver was recognized in workers exposed to polyvinyl chloride. Liver angiosarcoma is a very rare disease so that when three cases were identified in a PVC Plant in the U.S., it was not surprising that the hazards of this material particularly its carcinogenic potential was quickly recognized. For these reasons public health is particularly interested in the establishment of a sizeable and continuing human monitoring program - a program which should be as thorough as is the food monitoring program.

(b) Liver Microsomal Enzyme Induction - The organochlorine pesticides, in common with many other drugs, alcohol and other foreign substances are capable of inducing the liver microsomal enzymes. These enzymes are mixed function oxidase enzymes which are effective in the detoxication of a wide variety of foreign compounds. They can also alter steroid metabolism, a function which is thought to be, in part, related to the egg shell thinning property of DDT. Aldrin, dieldrin, endrin are all strong inducers and are capable of metabolizing a variety of exogenous materials such as the aromatic hydrocarbon carcinogens. In this respect, Chu has shown that mammary tumor incidence due to dimethylbenzanthracene could be substantially reduced by DDT pretreatment at doses of 10 and 100 PPM. Not only was tumor incidence reduced but the induction time of DMBA tumor induction was extended. The degree of microsomal induction is within certain limits, dose related. Endrin is a strong inducer and Datta, et al, demonstrated significantly lower levels of serum DDE levels in workers occupationally exposed to endrin. Davies, et al, found unusually low and in some cases absent levels of DDT in patients taking diphenyl hydantoin (dilantin). They were able to remove 75-80% of adipose residues of DDT and dieldrin in nine months in volunteers to whom this drug was administered.

Although no clinical indication exists for the artificial reduction of these persistent pesticide residues in man today, this approach has certain potentials for reducing such residues in animals.

Present levels of organochlorine residues in the general population are not considered to be casually related to recognizable enzyme induction although several investigators have demonstrated enzyme induction effects in exposed workers.

(c) Carcinogenesis and Tumorigenesis - In view of the ubiquitous dissemination of pesticide chemicals, it is not surprising that scientific bodies, legislators and other interested groups have been concerned with the risk of cancer from such exposures. At present, the undisputed facts appear to be as follows:

(1) Animal studies have shown that several pesticides are tumorogenic and some marginally carcinogenic.

(2) That an incontrovertible link between pesticide chemicals and cancer in man has yet to be demonstrated.

(3) That specific epidemiologic studies have yet to be implemented which categorically prove or disprove this issue.

(4) That during the occupational exposure to pesticides in the processes of synthesis, formulation and application, workers are exposed to a wide variety of chemicals, some of which are tumorogenic. This work also involves exposures to powders which are used as carriers of pesticides, some of which contain asbestos and other fibrous minerals and, through use of petroleum products, to aromatic polycylic hydrocarbons.

In a review of the occupational cancer risks of pesticide workers, Kingsley Key considers that this group should be considered as a work group which has an occupational risk of cancer.

The last decade has seen the completion of several animal studies designed to evaluate the carcinogenic risks of a variety of pesticides. Time does not permit a review of these studies, but in summary several pesticides were shown to be tumorogenic and marginally carcinogenic in certain test animals. As an outcome of these studies, in certain countries, restrictive legislative action has followed these studies and in the U.S.A. DDT has been banned, its use in agricultural being permitted only for selected pest problems and in limited areas of the country only. Aldrin and dieldrin have suffered a similar fate. By and large these decisions have been made on circumstantial evidence only.

Epidemiologic studies have not provided answers which have totally resolved the issue, although a review of occupationally exposed workers and case control studies of residues in cancer cases and controls have not supported the carcinogenic findings noted in animal studies.

Because the use of DDT is declining in many areas of the world because of legislative action, shortages and the growing problems of resistance, history may well show later that the issue was never totally resolved. Thank you.

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-16 February 1976

PM/SP/11
75-11-2

ENVIRONMENTAL POLLUTION CAUSED BY PESTICIDE

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INTRODUCTION

Until recently, the major sources of environmental pollution in the country are: 1) domestic wastes, from the general public which includes solid waste and domestic sewage; 2) trade wastes coming from industrial processes; and 3) vehicular emissions coming from transportation facilities.

Today, with the intensive food production campaign, agricultural activities has become the greatest contributor of a class of pollutants which now constitute a subject of serious consideration of national scale that has since evoked universal interest and concern.

When man started to till the soil to extract food from the earth, he did not realize the significant change he has introduced nor did he forsee that his intervention of nature's processes would have serious ecological consequences.

PESTICIDE USE

Since then man has started his fight against plant disease, insects, and weeds that compete with crops for nutrient of the soil. Pesticides came to its place in agriculture to destroy tiny competitors of man for agricultural produce. It started with the use of inorganic compounds of lead, arsenic, copper, etc., and other natural products as pyrethrum and rotenone, which were harmful to plants and animals but gives rise to little or no pollution.

DDT came into the picture and changed the whole situation. It demonstrated unparalleled broad spectrum action on insects and its

chemical stability was reg rded as a desirable feature due to its long-lasting action. Because of its remarkable insecticidal properties it gained universal acceptance and was hailed as the farmers weapon against plant pests and an effective tool in wiping out insect-borne disease. Inspite of its proven efficiency and the immense benefit it has given to mankind, in terms not only of food but in health and comfort, time came when insects started to develop resistance and DDT manifested adverse effects. The use of DDT suffered restrictions and new synthetic organo-chlorine compounds which displayed the desirable features of DDT, entered the scene. DDT, nevertheless, remained the pesticides of choice use in public health programs while the organo-chlorine compounds were used extensively in agriculture.

PESTICIDE DISSEMINATION

The global battle wage by agricultural workers against destructive insects and pests and the unrelenting efforts of public workers in their campaign to eradicate malaria has caused the dissemination of the insecticides, fungicides and herbicides continously into the environment. Their presence were recovered in measurable amounts from the air, soil, rivers, coastal waters, seas and oceans and even in underground waters. In no less quantities, have they been found also in the biological world of plants, animals and man.

Pesticides unlike most air and water pollutants, are deliberately introduced into the environment for a beneficial purpose but unfortunately, has also caused unintended and unanticipated harm. Documented ill effects has been produced in the environment specially on fish, shell fish, birds, wildlife and beneficial insects as well. Rachel Carlson's Silent Spring, has raised controversal issues on the use of chemical pesticides because of their acute or chronic toxicity, to man and animals and of greater ecological significance is its adverse effect on the natural environment.

Their toxicity created problems as they accumulate in the environment. It has been shown that when pesticides are sprayed, less than 50 percent reaches the target and the rest are deposited on the soil or elsewhere into the environment. When they accumulate and has concentrated in the biosphere, it gets translocated into plants, animals and birds, etc. And as agricultural wastes are transported to the rivers and the seas, they affect marine life, upsetting the basic elements of the aquatic food web.

POLLUTANT TRANSFER: AIR

Many and varied man made pollutants either gaseous or particulates are distributed to various receptors, by the air as main

transport. Among these are pesticides which have been used throughout the world to increase food production and undoubtedly, its application will continue to increase with modern agricultural techniques.

Blanket aerial application of pesticides is currently used in protecting large areas of banana plantations in Mindanao. This method of treatment accomplishes a wide area coverage and an equally greater area of pesticide dissemination by air to unlimited land surface, rivers, plants, animals and man. Investigation by the Commission revealed the use of a variety of insecticides and herbicides. There were complaints of health effects. Reports of respiratory cases and skin eruption allegedly caused by pesticides have been received by the Department of Health.

Comparatively, speaking the pollution of the air during pesticide treatment in the corn and rice farms by manual spraying may be significantly minimal, except for the unwarranted effects on other biological species it comes in contact with, and possibly the drift towards the applicators.

For the last 25 years DDT has been used and recommended for vector control programs for the eradication of insect-borne diseases. The tremendous impact of the control of malaria on the socio-economic development of the Philippines underscores the continued use of DDT for the successful prosecution of the malaria eradication program, until an effective, non-resistant and less hazardous substitute will be found.

The method employed consists of spraying 2 gm/M^2 area of sprayable surface in the form of wettable powder and emulsion. It is claimed that environmental pollution from spraying indoors with DDT is minimal as the significant amount of DDT sprayed, remains bound up in the walls. Since 1953, the Malaria Eradication Project has no record of cases attributable to DDT resulting directly from spraying operations, either from among the sprayers or the millions of occupants DDT sprayed houses. Unfortunately, the air pollution aspect of this program has not been investigated.

Reviews on the polluting aspect of pesticides in the U.S. and other countries showed that only a few places were found not to yield their residues, but their presence has been detected in the air of unsprayed areas and highlands of some states. The levels found in the ambient atmosphere were below concentrations hazardous to human health and were found highest in agricultural areas and generally lower in urban areas.

The potential importance of the atmosphere as a route of transfer of chlorinated hydrocarbons to oceans are being extensively investigated by the International Decade of Ocean Exploration (IDOE)

Pollutant Transfer Program and have identified the presence of both the gas phase and particulate forms. They have also been found associated with tar droplets which seem to extract the material from the sea water. This finding has caused concern that pollution of the oceans by the atmospheric process may be occurring not only on the regional level but even on global scale.

POLLUTANT TRANSFER: WATER

In our present state of agricultural development, it may be assumed that the major sources of pesticide pollution of our waterways is contributed by agricultural run-offs. The Green Revolution and the "Masagana 99" Program for rice and the "Masagenang Maisan" for corn production have increased considerably not only the area available for intensive farming, improved and increased irrigation system but have correspondingly increased the use of pesticides and fertilizer.

The long list of pesticides for the program and their formulation for use would involve an amount of pesticides that would come up to a staggering figure. A FAO/UNIDO 1973 Survey on insecticides usage and estimated projected requirements gave the figures for the Philippines at a total 942 metric tons of active ingredient of different pesticides for 1972 the year before the Masagana 99 Program was launched and an estimated 24,499 metric tons for the year 1980. Despite proper procedures for treatment, it is likely that more than half of the amount applied will be deposited in the soil, washed by heavy rains or carried by irrigation waters as run-offs to the streams and rivers.

In vector control program, the early method employed was, control of mosquitoes in their aquatic stage (larval control). This is done by applying DDT directly to water bodies. Fortunately, this method of treatment has now been limited thus reducing to a great extent the implications of such application for the pollution of the environment. Nevertheless, due to long half life of DDT, its residues may still be present in the aquatic environment.

An investigation by the Commission on the pesticides pollution of the Davao banana plantations mentioned earlier, revealed that rivers and bays draining these plantations contrain more than the background levels of pesticides as shown in Table I.

The residents claimed that fish population has decreased considerably and that if pollution would continue it is likely to affect a project to develop a fishing industry for the rehabilitation of ex-convicts of the Davao Penal Colony.

Despite the trend of using the less persistent forms of pesticides as the organo-phosphate and carbamate that degrades much more rapidly than DDT and the organo-chlorine compounds, the presence of the latter are still detected in rivers and coastal waters. Limited investigation by the Commission has detected and identified 7 members of the organo-chlorine family. This is shown in Table II and Table III. Lindane was the predominating pesticide in all samples. p,p'DDT was detected in only one sample. One may infer that DDT in the environment may be diminishing as a result of the restricted use.

Wastes disposed by pesticide producers in another major contribution to stream pollution. We have detected presence of high concentrations in the receiving waters from a chemical factory as shown in Table IV. Other studies have shown that waste streams contain 1-5 ppm range of DDE and other related compounds. It had been found in England that the disposal of pesticide wastes into municipal sewers with biological filtration treatment did not significantly reduce the concentration of pesticides

POLLUTANT TRANSFER: SOIL

The current patterns of pesticide application requires repeated treatment which continuously saturate the soil with the deadly and persistent poisons that builds up with time to considerable concentrations. Studies on their persistence showed that they remain in the soil for as long as 14 years or more after treatment. Investigations on this area showed that under normal agricultural conditions chlorinated hydrocarbons persist 3-5 years and the less persistent of 1-3 months or less.

The mobility of pesticides in soils of tight clay materials with high organic content were found to be very slow. Chlorinated hydrocarbons as dieldrin and aldrin migrated only a few feet in natural soil for period of years. Very little horizontal movement were shown by dieldrin, endrin, heptachlor and heptachlor epoxide. It has been shown that organo-phosphates similarly, has slow mobility as it was transported 1 and 1/2 inches through the soil by 6-8 feet of eluted water. In heavy clay soil (37%) only a small percent (5%) of the applied pesticide had move through the soil.

The behavior of pesticides as shown indicate that the possibility of pesticide pollution of ground waters through percolation may not be of much concern, except for the presence of undetected layering, faults and fractures and drainage channels to ground waters which may raise unforseen problems.

POLLUTANT TRANSFER: FOOD CHAIN

The mechanisms of physical dilution, dispersion and absorption have been applied in solving problems of pollution. The pollutant materials are reduced to concentration levels below that, which will be hazardous to man and animals and that will impair the delicate and interdependent web of interrelationship among and between organisms and their physical environment. The physical system permits such mechanism but where biological systems are concerned the situation has been found basically different. The aspects of pollution transfer of persistent toxic chlorinated hydrocarbons by biological means has been on the premise that these substances pass through the food web and is tropically concentrated. The mechanism of concentration is simple. The mass of herbivores can not be as great as the plants on which they feed and with each step higher in the food chain the biomass is reduced.

TABLE I: PESTICIDE RESIDUE IN TUGANAY AND ITS TRIBUTARIES IN DAVAO BANANA PLANTATIONS

SOURCE	CONCENTRATION IN PARTS PER MILLION			
	CHLORDANE	HEPTACHLOR	DDT	LINDANE
SB	0.02	0.04	-	0.09
GF	-	0.03	-	-
TD	0.39	-	-	0.09
M-2	0.11	0.06	0.15	0.11

TABLE II: NUMBER OF PESTICIDES RECOVERED FROM DIFFERENT COASTAL AREA IN MANILA BAY

AREA	NO. OF RIVERS	NO. OF PESTICIDES DETECTED
Cavite	4	6
Parañaque	2	4
Manila	4	4
Malabon	2	2
Bulacan	3	3
Pampanga	3	5
Bataan	6	6

TABLE III: RANGE OF VALUES OF PESTICIDES [illegible] EACH COASTAL AREA OF MANILA BAY IN PARTS PER MILLION

AREA	LINDANE	HEPTACHLOR	ALDRIN	HEPTACHLOR EPOXIDE	DIELDRIN	ENDRIN	p,p'DDT
Cavite	.011-.032	0-.001	0-.003	0-.007	0-.009	0-.032	-
Parañaque	0-.053	0-.002	-	-	.008-.009	-	0-.010
Manila	0-.009	0-.003	-	0-.001	0-.009	-	-
Malabon	0-.013	0-.001	-	-	-	-	-
Bulacan	0-.025	0-.001	0-.003	-	-	-	-
Pampanga	0-.023	0-.003	0-.008	0-.009	-	0-.029	-
Bataan	.016-.022	0-.003	0-.002	0-.002	0-.007	9-.029	-

This follows the second fundamental law of transfer of energy. This is not so with DDT and other chlorinated compounds. The losses of these materials during transfer are small. The concentration builds up or are magnified at each level. The concentrations at the predator and reaches up to ten to many hundreds times as high as they are in the lowest trophic level. In relating this degree of biomagnification to concentration levels in the aquatic medium, the concentration of DDT or any persistent chlorinated hydrocarbons that may be found in the final predator may reach up to million times that are present in water.

Analysis for pesticides in fish has been done by the Commission on small scale for some regions of the Visayas and the levels of different pesticides found can be seen in Table V. With these levels one may infer that the concentration in the aquatic environment is of very low order of magnitude as has been brought out in studies in other countries.

Extensive studies are conducted by IDOE on biological transfer in the marine environment. Evidence has suggested that unicellular algae absorb quantities of pesticides PCBS and DDT in ppt quantities (10-12 gm per gram) by as much as 10,000 fold. In contrast, animals feeding on the algae ingests and accumulate these chemicals only 2-5 fold. This was also demonstrated by fish larvae that feeds on the herbivorous forms.

In an attempt to control the undesirable presence of a gnat, dissastrous effect, resulted in the repeated application of DDD, a less toxic equally persistent kin of DDT on a lake in California DDD disappeared from the water in 2 weeks. Subsequently it was detected in the aquatic biota. Planktons were found to contain 250 x the concentration in the lake water, frogs 2000 x, sunfish 12,000 x grebes as high as 80,000, catfish 10,000 x. This showed the unbelievable concentration powers of the living components of the aquatic ecosystem.

The phenomena of bioconcentration (of the non-metabolized chlorinated and other persistent toxic materials) has been generally accepted. Investigation of IDOE suggests that his concept may be modified to include other factors that influences the concentrations found in marine organisms. These are the lipid content, responsible for increased storage, partition coefficient of individual compounds, which influences the degree of accumulation in the lipid of organisms, the nature and characteristics of cell surface, excretion pathogy and other biological factors.

TABLE V: CONCENTRATION LEVELS OF PESTICIDES RECOVERED FROM FISH SAMPLES FROM SMALL FISHERIES

SAMPLES	PESTICIDES	CONCENTRATION
Bangus Extract	Aldrin	0.0015 ppm
	Endrin	0.045 ppm
Martiniko and Tilapia Extract	Aldrin	0.0008 ppm
	Endrin	0.004 ppm

TABLE IV: PESTICIDES DETECTED AND CONCENTRATIONS FOUND IN PESTICIDE FOOD CONTAMINANTS (ppm)

PESTICIDES	SAMPLE NO. 1	SAMPLE NO. 2
Alpha - BHC	Not Quantified	Not Quantified
Beta - BHC	"	"
Gamma - BHC	1.60	2.50
Heptachlor	0.20	0.45
Aldrin	0.16	0.22
Dieldrin	0.75	0.22

RESIDUES

The use of pesticides at recommended level to effect control of insect pests creates potential hazards for the harvested crops. Toxic residues may remain on or in the plant. Pesticides find their way into the plants by passive diffusion process or by other mechanism accomplishing the transfer. The concentration depends on the property of the chemical, and the extent of danger, a function of amount and degree of toxicity.

Residues remaining on plant surfaces as leaves and fruits have been investigated and shown that easy removal was accomplished from hard, waxy and wet leaves than from hairy surface. The contamination of pesticides on crops may pose a hazard directly to people that eat the crops or may enter the food chain. Problems as contaminated forage when fed to animals may transmit the pesticide to human through the milk.

In an aquatic ecosystem the organisms are exposed to the chemical which undergo a process of biological movement through the food web, and becomes concentrated at the top of the food chain, the fishes.

Recoveries of pesticides at low levels from the aquatic environment should not make people complacement. Because of their tendency to accumulate in the fatty tissues and to be transferred through the food chain, it is expected that many fishes in our streams would contain them.

SUMMARY AND CONCLUSION

Pesticides are useful chemicals but their polluting influences cannot be ignored. Its use has become associated with hazards to health, diminution of biological life and destabilizing ecosystems. Nevertheless, agriculture will continue to use it to increase food production to feed the world's expanding population and health programs to reduce the spread of disease bearing insects. It is hoped that the present concern about the profound undesirable biological effects associated with its use may bring about intelligent use of pesticides to attain effective pest control without the accompanying danger of environmental pollution.

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Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/SP/12
75-11-2

CHEMODYNAMICS

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INTRODUCTION

In the past quarter century man has introduced a variety of chemicals for the protection of his crops and health and to increase the comfort of his environment. These chemicals represent various classes of compounds and are used as pesticides, drugs, surfactants, etc. Recently fears of environmental contamination from certain stable compounds used as pesticides have led to restricting their uses. It is true that pesticide residues have been found widely distributed in crops, soils, water, birds, fish, and air near the places of use. The understanding of how this distribution occurs and the fate of the chemical in relation to exposure of man become of considerable interest.

Studies have provided an understanding of the emerging field of "chemodynamics" which demonstrates the relation of physico-chemical principles to the behavior of chemicals in the environment. While the majority of the examples used deal primarily with herbicides and to a lesser degree with insecticides, the same principles may apply equally to other similar organic compounds. Indeed, one of the benefits accruing from pesticide research is the development of knowledge of "chemodynamics" and toxicology that is applicable to all organic pollutants.

Basic to chemodynamics are the questions: (1) What are the natures and properties of the compounds under consideration? (2) What is the manner in which the properties of the compound and of the environment determine the fate and behavior of the chemical? (3) To what extent does this determine the amount of the chemical to which man and organisms are exposed? These are the main features on which the present account of chemical research will be based.

Chemicals used as pesticides represent a wide variety of compounds. They are grouped according to the purpose for which they are used, e.g., insecticides for insect and mite control, herbicides for weed control, and fungicides for fungus control. One of the main characteristics of the pesticides is that they are generally low molecular weight organic compounds with very low water solubility; however, some inorganic compounds and organometallics also are used as pesticides.

In order to answer the question as to what happens to a chemical when it is introduced into the environment one must have an understanding of the nature of the environment itself. The fundamental phases of the environment are: Land (Lithosphere), water (Hydrosphere), air (Atmosphere), and biota (Biosphere). A rough estimate of the masses of the various phases yields the following: (1) Atmosphere 5.3×10^{18} kg, (2) Soil to six-inch depth 1.1×10^{17} kg, (3) Water 1.3×10^{21} kg, (4) Animals 2.0×10^{13} kg, and (5) Plants 1.1×10^{15} kg. When a chemical is released into the environment it will be distributed (partitioned) between the various phases (Fig. 1) with the concentration in any phase being a function of the properties of both the chemical and the phase. Applying the simple law of Boltzmann distribution to this complex system we have the following equations

$$N_{ij} = N_0 e^{-E_{ij}/kT}$$

If we assume that $N_{ij} = N_{ji}$, $N_{ij} = 0$ when $i = j$ and $N_0 = N_1 + N_2 + N_3 + N_4 + N_5$, where N_0 is the number of molecules of the chemical initially introduced and $N_1 \ldots N_5$ are the number of molecules in respective phases of the environment. In the above equation E_{ij} represents the energy barrier between two phases, k represents the Boltzmann constant, and T represents the absolute temperature. To understand the behavior of a chemical in the above five components one must have a detailed knowledge of the physical and chemical properties of the chemical. In this paper we shall try to discuss the principles governing the behavior of a chemical in atmosphere, water, soil, and biota. The decomposition of chemicals via various mechanisms will also be covered. While some abstract mathematics and chemistry are used in the study of this subject, the findings are of great practical importance as we will try to demonstrate. By application of the principles developed in thermodynamics, we can make more intelligent selections of the pesticide to use, develop applications that save money, and avoid some of the more serious residue problems.

The type of information that is necessary to accomplish these things is basic data on properties of the chemical, such as, what does it dissolve in, how readily does it vaporize, and

how does it react with soil, plant surfaces or an insect. The make-up of the chemical also tells us what type of reactions it is likely to undergo, and hence, to some extent how persistent the chemical may be. The same bits of information about the chemical can guide in proper formulation to achieve the cheapest and most effective results with a particular chemical. We can learn a lot of these things just through experience with a chemical in the field, but this takes a good deal of time and is costly. Fortunately, from some rather simple laboratory studies we are able to obtain a good deal of the information we need on a particular chemical, and use that as guidelines for more effective use.

Basics of Chemodynamics

All of the research to obtain this information, requires a background of chemistry, but it does not take a chemist to understand the basic principles and apply them. The fundamentals are fairly simple and logical. These principles can be summarized very briefly by the following statements:

1. The behavior, biological effects, and persistence of a chemical result from the interaction of that chemical with the biota or some element of the environment.

2. The type and extent of the interaction, depends in part on the measurable properties of the chemical.

3. Most of the nonmetabolic interactions of the chemical are to varying degrees reversible.

4. Knowing something of the nature of the interactions and the properties of the chemicals, one can predict at least in a gross way the behavior and biological effects of a chemical.

To illustrate the application of these principles, let's take a chemical such as parathion used under semitropical conditions. Even without the benefit of field experience with this chemical, from properties that could be determined in the laboratory, we would predict:

1. Its adsorption by and interaction with soil, plant leaves, and animal life with a resulting short lived residue.

2. A rapid breakdown of the chemical by hydrolysis and photochemical means resulting in a short period of control.

3. Rapid vaporization of the chemical with loss of activity.

4. Need for repeated frequent application to maintain insect control.

5. Fairly wide environmental distribution at low levels, but probably sufficient to cause the development of resistance in some nontarget insects.

These predictions are largely negative from the standpoint of economic pest control so that the question arises as to whether or not anything can be done about it. From the base of this information, it is then possible to devise formulations and methods of use to minimize the negative aspects of the behavior of parathion and to promote effective and safer use of it. This we will attempt to demonstrate a bit later on when we talk about formulations.

Importance of Chemical Properties

Let us now turn to a brief examination of some of the factors in the behavior of pesticides as we now use them. We recognize that each chemical is unique in that each has particular chemical and biological properties different from any other chemical. It should be added, however, that these properties tend to follow patterns which makes predictions possible. Now, if one is at all familiar with the subject of chemistry, you know that there are many, many properties or characteristics of chemicals that have been measured. Not all of them are useful to us in the area of Chemodynamics. There are a few of these properties easily measured in the laboratory that are most helpful, however, in assessing the strengths and weaknesses of that chemical as a pesticide. The solubility of a chemical in water and other solvents is particularly important. First of all, knowing the solubility can tell us how the substance should be formulated for application, whether as an emulsifiable concentrate, wettable powder, or in some other manner. The solubility in water, if measured at several temperatures, is very useful in telling us whether the chemical will be strongly adsorbed by soil and other solid material, thus reducing its effectiveness or prolonging its persistence. Similarly, a knowledge of the solubility of a chemical in oil or other solvents can tell us whether or not it is likely to accumulate as a residue in plant and animal.

The tendency of a chemical to volatilize or turn to a vapor is important, particularly where temperatures tend toward the warm side such as in El Salvador. Vaporization means a loss of deposit for control of the particular pests, and also means considerable contamination of the air. This contamination

results in exposure of animals and humans which is undesirable.

Other properties that are of interest and importance in providing guidelines as to how to more effectively use the chemical, include the type of reactions the chemical will undergo, and adsorption by soil or binding by constituents in the plant or animal. We will try to illustrate how knowledge of these properties may have practical application as we talk about adsorption, leaching, vapor behavior and breakdown.

Adsorption

When a pesticide is sprayed on a field, by far the greater proportion of it settles onto the plant leaves and the soil. Experiments have shown that bulk of the chemicals ultimately reaches the soil. Both the plant leaves and the soil present a solid surface to the chemical. Such surfaces are noted for having forces, usually electrostatic in nature that interact with or bind the chemical. The strength of this interaction (Adsorption) depends a great deal on the properties of both the chemical and the surface that it encounters. For examples, in soil we have organic matter, as well as clay, sand, and silt particles. All of these are solid surfaces, but the organic matter of soil is found to adsorb much more chemical per unit weight than does the other constituents of the soil.

The amount of chemical adsorbed or bound by anyone of the different surfaces mentioned, varies depending on the chemical involved. To a first approximation, one may say that the lower the water solubility of the chemical, the larger the amount that will be adsorbed. However, closer examination of the adsorption phenomenon shows it to be more complex than this. A better relationship as to the amount of chemical bound and the strength with which it is adsorbed is to be found in the quantity called "Heat of Solution". This is a quantity readily measured in the laboratory, and once determined permits estimates of the strength of binding and hence the susceptibility of the chemical to leach and its persistence. There are times when advantage can be taken of adsorption to extend the effective life of a pesticide or conversely to reduce the residual toxicity. An example of this later case is where carbon or charcoal is used as an antidote for pesidues or poisoning.

Adsorption is a very important phenomenon in the use of pesticides. As already indicated, much of the pesticide is adsorbed by plant or soil surfaces, and this can modify the activity. Additionally, adsorption regulates the leaching or movement of the compound by water, and its loss from the soil

by vaporization. There is an indication also that adsorption plays a role in the rate at which the chemical breaks down. That is the more strongly adsorbed the material, the slower the initial rate of breakdown.

It is important to understand that the adsorption or binding of a chemical by a solid surface is a process that goes both ways, that is, it is a reversible process. It is because of this reversibility that most chemicals will leach, at least to some extent, as the water moves through the soil profile. If for example, we have a chemical that is very weakly bound to the soil, rainfall may carry it quite deep into the soil. On the other hand, with a chemical that is strongly bound by all of the soil constituents such as DDT, the chemical will be carried into the soil only for a short distance even by large quantities of water.

Leaching

Leaching, of course, is much more of a problem with a pesticide that is applied to the soil, than one applied to a standing crop. Nonetheless, because so much of the chemical does reach the soil, regardless of the purpose of application, the movement through soil must be considered. If the chemical is carried into the soil, it may remain there as a residue that can contaminate a subsequent crop, or if it is a highly mobile chemical it may be leached into the ground water and ultimately reach streams.

In a given soil type, the properties of the chemical are very important in relation to leaching, since these properties determine how tightly the chemical may be adsorbed. For example, the chlorinated hydrocarbon insecticides such as DDT, aldrin, dieldrin, and heptachlor, by virtue of their low solubility in water and strong adsorption, are leached but very little. Some of the organic phosphates such as parathion, are leached somewhat better than the chlorinated hydrocarbons but even they are not highly mobile. On the other hand, there are certain types of pesticides that are only poorly adsorbed by soil and are quite water soluble which move very freely in the soil. This is particularly true of certain of the herbicides.

Volatility

Somewhat earlier we mentioned the matter of vaporization or volatilization of pesticides. This is the tendency of the chemical to change from a solid or a liquid to a gaseous state.

In certain instances, this tendency is advantageous. As for example, in the use of propoxur, for control of mosquitoes in houses, or use of space fumigants. On the other hand, where one may want a residual deposit of a chemical for pest control, vaporization can result in substantial losses, thus reducing the length of the control period and the effectiveness of the treatment. Where vaporization is a problem, as regards to control, modification of formulation or the use of additives can often reduce the rate of loss.

Almost all known substances have a tendency to vaporize. With the organic pesticides one finds a wide variation in the tendency with come compounds having relatively high vapor pressures compared to other. In general, the rate of vaporization increases as the temperature increases, though humidity and other factors, e.g., adsorption, may modify the rate from the theoretical possible.

Breakdown

One of the important considerations of the fate and behavior of a chemical in the environment and its effectiveness as a pesticide is the manner and rate at which it breaks down. All of the organic pesticides breakdown under the influence of the various biological and physical forces in the environment. For some compounds, the degradation by biological means, that is metabolism of plants and microorganisms, is the most important. Other compounds breakdown through normal chemical reactions, examples of which includes the hydrolysis of parathion by the moisture in soil. The rate at which a chemical will break down or be metabolized is dependent in part upon the nature of the chemical, the reactions that it undergoes, the conditions such as temperature and moisture, and, of course, the initial amount or concentration of the chemical. For example, while parathion breaks down very rapidly in soil at normal rates of usage, persistence of the chemical is much prolonged where excessive amounts are placed in the soil.

A mechanism of breakdown of pesticides, the importance of which we are now only beginning to appreciate, is that of photochemical reactions. Probably one of the reasons for the relatively short residual life of parathion, is the fact that it is decomposed by the rays of sunlight. This reaction undoubtedly occurs on the plant leaf as well as after the parathion has vaporized into the atmosphere. Again a practical application of such knowledge is that we can design formulations to reduce photochemical degradation.

Drift of Chemicals

A final consideration in the area of chemodynamics, is the problem of drift of the chemical during its use. During the application of a pesticide whether as spray or dust, the smaller droplets or particles will tend to move out of the area that is being treated. In some instances, particularly under poor application conditions, this can represent a substantial loss of the active ingredient with a concomitant increase in cost. Drift, however, not only increases the economic cost by requiring more material or yielding poor pest control, but also poses a problem of residues on adjacent crops and pastures, in livestock and the unnecessary exposure of human beings to the chemical. There are very effective ways both in formulating a chemical and in its application to reduce the drift problem. Some of these will be discussed under the topic of formulations and application chemistry.

Another important means by which pesticides move from the treated area is by soil erosion. The soil particles contaminated by the pesticide may be washed out of the field or if conditions are dusty, the dust from the field blown by the wind. Water erosion from treated fields affords a particularly important means by which streams may be contaminated with pesticides. Any practices that tend to reduce soil erosion will also tend to reduce environmental contamination by this means.

Summary

In the course of these considerations, we had mentioned a number of factors relating to how chemicals behave in the environment, and noted that it is possible to modify some of this behavior by a proper formulation or application techniques. If we properly utilize the information it can result in more effective pest control at a lower cost, avoid some of the more serious residue problems, and prevent unnecessary human exposure. Much of the data required to do this can be obtained by rather simple and quickly allowed laboratory studies. Though these may not give the final and most precise answer, it can be very important developing guidelines and practices of better pesticide management.

AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523
BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
Batch 97

1. SUBJECT CLASSIFICATION
A. PRIMARY
Food production and nutrition AH00-0000-0000
B. SECONDARY
Plant protection

2. TITLE AND SUBTITLE
Proceedings of Pesticide Management Seminar-Workshop

3. AUTHOR(S)
(101) Pesticide Management Seminar-Workshop,Manila,1975; Calif.Univ./USAID Pest Management and Related Environmental Protection Project

4. DOCUMENT DATE
1975

5. NUMBER OF PAGES
290p.

6. ARC NUMBER
ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Calif.--Berkeley

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)

9. ABSTRACT

10. CONTROL NUMBER
PN-AAG-301

11. PRICE OF DOCUMENT

12. DESCRIPTORS
Meetings
Pesticides
Philippines

13. PROJECT NUMBER
931093000

14. CONTRACT NUMBER
AID/La-C-1195 GTS

15. TYPE OF TRANSLATION

AID 590-1 (10-71)

PESTICIDE MANAGEMENT
SEMINAR-WORKSHOP

Manila, Philippines
10-15 February 1975

Pesticide Management Seminar-Workshop

MANILA, PHILIPPINES
[illegible]

CERTIFICATE

This is to certify that

_____

has participated in the PESTICIDE MANAGEMENT SEMINAR-WORKSHOP organized by the University of California, University of Miami, Oregon State University, United States Agency for International Development and the Government of the Republic of the Philippines.

Given this [illegible] day of February, 1979.

BERNARDO S. CASTILLO
Chairman, Seminar Management Committee
Director, Bureau of Plant Industry

THOMAS NIBLOCK
Director, USAID
Manila

RAY F. SMITH
Project Director
UC/AID Pest Management & Related Environmental Protection Project
University of California

MANAGEMENT COMMITTEE

PESTICIDE MANAGEMENT SEMINAR-WORKSHOP

Manila, Philippines
February 10-15, 1975

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21.	Mr. Hipolito A. Custodio	Exec. Secretary -	BPI
22.	All Chairman of Sub-Committees	Member	

PESTICIDE MANAGEMENT SEMINAR-WORKSHOP

February 10-15, 1975
Ramon Magsaysay Center
Manila, Philippines

A G E N D A

Monday, February 10, 1975

8:00 - 9:00 a.m.	Registration of Participants
9:00 - 10:30 a.m.	Opening Ceremony (see Program A)
10:30 - 10:45 a.m.	Coffee Break

S E M I N A R

Memorial Hall

PESTICIDES AND THEIR USES

10:45 - 11:00 a.m.	Rationale of Pesticide Use	Mr. Simeon A. Fatocapio
11:00 - 11:20 a.m.	World Problems of Pesticides	Dr. Ray F. Smith
11:20 - 11:40 a.m.	Pesticides in Philippine Agriculture	Mr. Renato I. Capinpin
11:40 - 12:00 a.m.	Pesticides in Public Health	Mr. Felipe P. Catangui
12:00 - 12:30 p.m.	Open Forum	
	Moderator:	Dr. Virgil H. Freed
12:30 - 2:00 p.m.	L U N C H	

Monday, February 10, 1975

PESTICIDE CHEMISTRY AND METABOLISM

2:00 - 2:40 p.m.	Chemical Properties and Degradation Patterns of Pesticide Groups	Dr. Edwin Magallona
2:40 - 3:20 p.m.	Formulations of Pesticides	Dr. Virgil H. Freed
3:20 - 3:35 p.m.	Coffee Break	
3:35 - 4:15 p.m.	Pesticide Application	Dr. Wesley E. Yates
4:15 - 5:30 p.m.	Open Forum	
	Moderator:	Dr. Fernando F. Sanchez

Tuesday, February 11, 1975

BIOCHEMICAL AND PHYSIOLOGICAL EFFECTS OF PESTICIDES

9:00 - 9:45 a.m.	Hazards of Pesticides	Dr. Quintin Kintanar, M.D.
9:45 - 10:30 a.m.	Medical Aspects of Pesticide Poisoning	Dr. John E. Davies
10:30 - 10:45 a.m.	Coffee Break	
10:45 - 11:30 a.m.	Diagnosis and Treatment	Dr. John E. Davies
11:30 - 12:30 p.m.	Open Forum	
	Moderator:	Dr. Jacinto J. Dizon
12:30 - 2:00 p.m.	L U N C H	

Tuesday, February 11, 1975

PESTICIDES IN THE ENVIRONMENT

2:00 - 2:40 p.m.	Environmental Pollution caused by Pesticides	Miss Clarita Centeno
2:40 - 3:20 p.m.	Chemodynamics - Chemicals in the Environment: behavior and distribution	Dr. Virgil H. Freed
3:20 - 3:35 p.m.	Coffee Break	
3:35 - 4:30 p.m.	Storage, Handling and Disposal of Pesticides	Dr. Virgil H. Freed and Mr. Renato I. Capinpin
4:30 - 5:30 p.m.	Open Forum	
	Moderator:	Com. Reynaldo Lesaca

Wednesday, February 12, 1975

PESTICIDE MONITORING

9:00 - 9:30 a.m.	Present Status of Pesticide Monitoring in Agriculture	Miss Lydia Crisostomo
9:30 - 10:00 a.m.	Present Status of Pesticide Monitoring in Public Health	Dr. Luzonica Pesigan
10:00 - 10:15 a.m.	Coffee Break	
10:15 - 11:20 a.m.	Pesticide Analysis	Dr. Edwin Magallona
11:20 - 12:00 noon	Open Forum	
	Moderator:	Dr. John E. Davies
12:00 - 2:00 p.m.	L U N C H	

Wednesday, February 12, 1975

ROLE OF PHILIPPINE AGENCIES

2:00 - 2:30 p.m.	Department of Agriculture	Dir. Bernardo S. Castillo
2:30 - 3:00 p.m.	Department of Natural Resources	Dir. Felix Gonzales
3:00 - 3:30 p.m.	Department of Health	Dir. Joaquin Sumpaico
3:30 - 3:45 p.m.	Coffee Break	
3:45 - 4:15 p.m.	Food & Drug Administration	Dr. Luzonica Pesigan
4:15 - 4:45 p.m.	National Water & Air Pollution Control Commission	Com. Reynaldo Lesaca
4:45 - 5:30 p.m.	Open Forum	
	Moderator:	Dr. Ray F. Smith

Thursday, February 13, 1975

PESTICIDE REGULATIONS IN THE PHILIPPINES

9:00 - 10:00 a.m.	Evaluation of Present Status of Pesticide Regulations	Mr. Hipolito A. Custodio
10:00 - 10:15 a.m.	Coffee Break	
10:15 - 11:30 a.m.	Proposals on Pesticide Regulations:	
	Dept. of Agriculture	Mr. Hipolito A. Custodio
	Pest Control Council of the Philippines	Dr. Dante Benigno
11:30 - 12:00 noon	Open Forum	
	Moderator:	Dr. Wesley Yates
12:00 - 2:00 p.m.	L U N C H	

Thursday, February 13, 1975

RECAPITULATION OF SEMINAR PAPERS
AND ORGANIZATION OF WORKSHOP GROUPS

2:00 - 3:30 p.m.	Agromedical Approach to Pesticide Management	Dr. John E. Davies Dr. Ray F. Smith Dr. Virgil H. Freed
3:30 - 3:45 p.m.	Coffee Break	
3:45 - 5:30 p.m.	Introduction to Workshop and Organization of Workshop Groups	Dr. Ray F. Smith
	Group 1. Pesticide Industry	Mr. Renato I. Capingin
	Group 2. Safe Use of Pesticides	Engr. Celestino Asinas
	Group 3. Regulation and Registration of Pesticides	Mr. Hipolito A. Custodio
	Group 4. Education and Research	Dr. Fernando F. Sanchez

Friday, February 14, 1975

W O R K S H O P

9:00 - 12:00 noon M e e t i n g s :

Group 1	Room
Group 2	Room
Group 3	Room
Group 4	Room

(10:00 - 10:15 a.m.) Coffee Break

12:00 - 2:00 p.m. L U N C H

2:00 - 5:00 p.m. Meetings of Groups (cont'd) (Same Rooms)

(3:00 - 3:15 p.m.) Coffee Break

Saturday, February 15, 1975

GENERAL SESSION

9:00 - 10:30 a.m.	Presentation of Recommendations of Workshop Groups 1 and 2	Group Leaders
10:30 - 10:45 a.m.	Coffee Break	
10:45 - 12:00 noon	Presentation of Recommendations of Workshop Groups 3 and 4	Group Leaders
12:00 - 2:00 p.m.	L U N C H	

CLOSING CEREMONIES

3:00 - 5:00 p.m. (Please see Program B)

RESOURCE SPEAKERS

OPENING PROGRAM

Bernardo S. Castillo, BSA, M.S.	Acting Director Bureau of Plant Industry Manila
Clemente C. Gatmaitan, M.D.	Acting Secretary Department of Health M a n i l a
Abelardo Samonte, Ph.D.	Chancellor University of the Philippines at Los Baños
Renato I. Capinpin, BSA	President Agricultural Pesticide Institute of the Philippines Manager, Agriculture Department Shell Chemical (Phils.) Co. Makati, Rizal
Reynaldo Lesaca, M.D.	Commissioner National Water & Air Pollution Control Commission

SEMINAR-WORKSHOP

Ray F. Smith, Ph.D.	Professor, Dept. of Entomological Sciences Director, UC/AID Pest Management & Related Environmental Protection Project University of California, Berkeley, California
Virgil H. Freed, Ph.D.	Professor Director, Environmental Health Sciences Center Head, Department of Agricultural Chemistry Oregon State University Corvallis, Oregon
John Edward Davies, M.D., M.P.H.	Chairman Department of Epidemiology and Public Health School of Medicine, University of Miami, Florida
Wesley E. Yates, M.S.	Professor Agricultural Engineering Department University of California Davis, California

John P. Hummon, Ph.D.	Acting Director USAID Mission, Manila
Reeshon Feuer, Ph.D.	Crop Production Specialist International Rice Research Institute & Cooperative NFAC-IRRI-USAID Rice Program
Norman Olsaker, Ph.D.	Chief, Small Farmer Income Program Agricultural Development, USAID, Manila
Simeon A. Estocapio, B.S.A.	Chief, Crop Protection Division Bureau of Plant Industry
Felipe P. Catangui, B.S.A.	Entomology Adviser Department of Health
Edwin Magallona, Ph.D.	Professor, and Head, Pesticide Residue Laboratory UPLB, Los Baños, Laguna
Fernando F. Sanchez, Ph. D.	Professor, Dept. of Entomology, UPLB Director, Rodent Research Center
Quintin Kintanar, M.D.	Science Research Chief Biological Research Center, NIST
Jacinto J. Dizon, M.D.	Chief, Disease Intelligence Center OIC, Bureau of Disease Control Department of Health
Clarita Centeno	Chief, Research & Development Section National Water & Air Pollution Control Commission Manila
Lydia Crisostomo, M.S. Chem.	Chief, Agric. Chemistry Section Laboratory Services Division Bureau of Plant Industry
Luzonica Pesigan, M.D.	Administrator Food & Drug Administration Department of Health
Felix Gonzales	Director Bureau of Fisheries & Aquatic Resources Manila
Joaquin Sumpaico, M.D.	Director Bureau of Research & Laboratories Manila
Hipolito A. Custodio, BSA, M.S.	Chief, Pest Control Section Crop Protection Division Bureau of Plant Industry

Pedro G. Afable	Vice Chairman & Executive Director National Science Development Board
Dante Benigno, BSA, Ph.D.	Asst. Professor, UPLB President, Pest Control Council of the Philippines
Celestino Asinas	Chief, Sanitary Engineer Malaria Eradication Service Center Department of Health

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/OC/1
75-10-2

OPENING ADDRESS

DIRECTOR BERNARDO S. CASTILLO
Bureau of Plant Industry
M a n i l a

Distinguised guests, friends, ladies and gentlemen:

In behalf of the P.P.I.-USAID and the Management Committee, I wish to extend our warm welcome for your presence this morning.

It gives me extreme pleasure to welcome an elite group such as this body to a historic gathering that has been called to participate and to achieve a noble mission.

This first seminar-workshop on pesticide management in the Philippines is an integrated activity of representatives from public health, agriculture, pesticide industry and educational institutions. This is very timely considering the fact that the Philippines is a fast developing country actively involved in the large-scale use of pesticides in our massive agricultural development programs which has created a problem subsequently on the protection of food and maintaining man's health and well-being.

The benefits mankind has derived from the use of pesticides justify the continuance of their use, especially so because of the worldwide runaway population growth. The use of pesticides in agriculture, forestry and public health in the last three decades has greatly increased the quality and production of crops, protected forests from insect depredations, and saved countless of human lives by controlling insect vectors of human diseases like malaria, yellow fever, plague, etc.

While we all appreciate these benefits, we must be aware that there are serious problems associated with the large-scale use of pesticides, specially with their indiscriminate use, e.g. poisoning in food and of the environment from pesticide residues, destruction

of beneficial insects, and development of resistance by agricultural pests to these pesticides.

This seminar-workshop, with an enlightened group of people in attendance, should be able to evolve concrete measures and policies related to pesticide management, quality control, the determination of pesticide residues, and the investigation of environmental contamination. Our immediate aim then is to protect our sources and supplies of food and our environment - land, sea, and air - for our own sake and that of the coming generations. This seminar I hope, should not only result in improved pest control to increase crop production and human health but also to the conservation of the supply of pesticides that is now facing the threat of shortages.

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/OC/2
75-10-2

INTRODUCTORY REMARKS

Ray F. Smith
Professor of Entomology
Department of Entomological Sciences
University of California, Berkeley
and
Director, UC/AID Pest Management Project

This Seminar/Workshop is the third in a series in which the University of California/USAID Pest Management project has participated. But this one is different, from the very start, it has every indication that it will be one of the most productive and useful of the series. I believe this results from the fact that here in the Philippines, we can start from a much stronger base than in many other countries. The level of training in pesticide management and the awareness of the needs that exists here in the Philippines has provided increased capability and gives strong motivation to get on with the job of improved pesticide management.

We are now in one of the most critical periods of man's existence on earth. What happens during the next few years must and will provide answers to most vital questions for man and his well being. Can we produce an adequate food supply for the worlds population? Can we do this without irreversibly destroying our environment and its future productive capacity? Can we control or eliminate the diseases of man that continue to erode his health and well-being?

A critical element in a satisfactory and complete answer to these three questions is pest and disease control. We cannot produce an adequate supply of food without improved pest control. We cannot maintain the quality of our environment without a better pest control which is ecologically oriented. We cannot control many of the diseases which plague man without good pest control.

It is for these reasons that plant protection and pest control are placed in a new context today as compared to that prevailing as short a time ago as five years. The worlds expanding human population

requires an increasing supply of food and fiber. To obtain this larger supply will require better protection from diseases, insects, and other pests. Unfortunately, the task of achieving this desired goal of improved production through better pest control has now become more difficult. There have been great increases in food production in some regions of the world. These increase have been achieved through use of improved varieties, cultural methods and to some extent pest control. However, the protection of this new food supply rests on very shaky foundations. For example, we have narrowed the genetic base of our agricultural crops and the ability of these crops to resist new pests or old pests in new form. The resistance in certain insect population has greatly reduced the effectiveness of chemical pesticides in a number of important situations.

Nevertheless, despite a variety of very difficult problems associated with our chemical pesticide, e.g. human intoxications, destruction of beneficial insects, development of resistance, these pesticides still ar essential in in the protection of our crops and our health. In fact, the pesticide shortages which have plagued us recently have dramatically demonstrated the essential role of pesticides.

This Seminar/Workshop is to be work session that should result in a functional plan for the improved management of pesticides in the Philippines. We should look forward to improved pest control from the recommendations of this meeting and thus provide increased crop production and improved human health. It also should lead to the conservation of our precious supplies of pesticides.

We, who are representatives of the UC/USAID Pest Management Project, are most pleased to be able to work with you in this Seminar/Workshop. We look forward to an extremely productive session.

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/OC/3
75-10-2

A D D R E S S

Hon. Abelardo Samonte
Chancellor, University of the Philippines
at Los Baños

Secretary Gatmaitan, Director Castillo, Commissioner Lesaca, Dr. Smith, Mr. Capinpin, Distinguished Guests, Participants to the Pesticide Management Seminar-Workshop, Ladies and Gentlemen:

It is my pleasure to extend to our guests and participants of this Seminar-Workshop the greetings and best wishes of the faculties and researchers of the University of the Philippines at Los Baños.

We are fortunate to have with us today foreign specialists and practitioners in pesticide management, who will share with us their knowledge and experience so that we may be able to plan our works and dealings with a view on the worldwide problems on pesticide pollution. We are hopeful that during the course of this week-long activities, the inter-change of ideas and experiences will prove to be mutually beneficial.

The holding of this Pesticide Management Seminar-Workshop is indeed very timely. The accelerated use of pesticide in recent years, specially in our country, has highlighted the use of pesticide in human life and in the environment. It is said by many that the availability of pesticide could lead to a widespread or indiscriminate use.

Pesticide can be very phenomenal in many ways: in agriculture, forestry and public health. In the last 30 years or so, the use of pesticides has greatly contributed to the increased productivity of our farmers. Similarly, Seminars have been held by the millions regarding the control of human diseases like malaria, typhoid, yellow fever and encephalytis.

Pesticides should be required to safeguard agricultural productivity from pest damage. Indeed, crop protection including pesticide management should be given more attention to the development of high-yielding, disease-resistant varieties in worldwide efforts to increase and accelerate food production.

Thus, in the barrios, we are proposing the establishment not only of restricted places for plant breeding but also of regional centers for crop protection. Consequently, pesticide management strategies through sound ecological principles should be developed and applied. This is essential if we are to minimize the hazard commonly associated with pesticide use.

We at the University of the Philippines at Los Baños, August undertook the development of alternative method of pest control to open good possibilities for sound pesticide management program. Development in this area should lead to lesser pesticide use without sacrificing the over-all efficiency of pest control. Nevertheless, we should not also overlook the need to improve our pest control practices. Opportunities for improvement are numerous. For example, mainly due in the disciplinary usage on how to harmonize pesticide use with other methods of control, such as the use of parasites to improve cultural practices, crop varietal resistance to pest and genetic manipulation on pest population.

In the context of recent Philippine events, we have withered out tungro disease, brownhopper and the associated yellow blast disease in rice which are likely in the development of disease resistance. High-yielding rice varieties have been developed in the course of many years of effort and usage. Nonetheless, the educational and training years have found pesticide management neglected. particularly in developing countries.

Technical education and training are needed in any society. It is not only with proper understanding that anyone could really appreciate the positive aspects of pesticide use. The need for effective and economic control of agricultural crop problems in developing countries point to the field of agricultural chemicals. While this maybe so, the need for pesticide research and extension program will insure improvement in kind of pesticides available and the means and manner of using them.

Another avenue that could lead to the improvement of pesticide management is government regulation of pesticide field use. The government should be strict in the sale and use of every toxic pesticide and institute a license program for professional applicator to insure proper usage. Only the relatively safe chemical should be left solely in the hands of farmers and housewives. The dangerous material should be handled only by licensed pesticide specialist who have full appreciation of the need to balance benefit against hazard before using the chemicals.

Pesticide residue should be perennially looked into by the government. The move should be initiated to see to it that foodstuff and animal feed are free from excessive pesticide contamination. Information on food poisoning and levels of human poisoning and contamination should also be helpful in devising appropriate management program.

Coordinated poison control centers should be established in specific areas to help attend to medical emergencies caused by pesticide and to provide the instructions and guidance to occupational workers about proper pesticide management.

We hope that the current interest in pesticide management should lead to the development of a program that will solve or at least minimize the problems associated with the use of pesticide. Government programs and regulations that encourage the development of positive control and strategies through pesticide use along lines of sound ecological principles should lead to the enlightened utilization of pesticide in promoting human welfare through the control of pest.

As head of the University which has long been the center for agriculture, education and research not only in this country but also in Southeast Asia, I wish you all the success in your seminar-workshop. We will do our part in contributing and utilization. Your findings and recommendations will lead to better pesticide management for increased agricultural productivity and for better health and welfare in the rural areas.

Thank you.

A D D R E S S

Dr. John Hummon
Acting Director, USAID, Manila

Mr. Chairman, Director Castillo, Dr. Smith, Director Samonte, Mr. Capinpin, Secretary Estmaiton, Ladies and Gentlemen:

We are delighted to have you here in our opening of this Pesticide Management Seminar-Workshop. We are also delighted to join the Bureau of Plant Industry in this Seminar-Workshop and we hope that the USAID would continuously be involved, even in a small way, in this kind of seminar. I believe this pesticide management is the third seminar of this type, other seminars being held way back in 1973, in Indonesia and also last summer.

We are happy to introduce to you our representative, Dr. Feuer, who is an expert in this field. I understand that there are 267 invited to this seminar.

You are talking about the final analysis and important factors in relationship to people. We are talking about food production. During the past years, we experienced the energy crisis and its consequent impact in terms of feeding the people throughout the world. The population experts predict that by the year 3000, the world population could be doubled, or even tripled. Hence, we should double our food production. This we owe from the farmers of the world.

Regarding the philosophies which are essential in any food production program to find means to feed mankind, we know that most of our critical listeners will delve on the task of pesticide before we go into the environmental concern. But before we get involved in this, we should look at the question of rats, bats and noxious birds.

The consequence of cutting down the USAID money - they cut that for about 25 to 30 percent of some reason - will be reflected in AID projects. Worse, there may come a time when we will have to do something about rats, bats and noxious birds before we could rid ourselves of trouble. Fortunately, the Ambassador expressed positive support

on what the proposed team had discovered.

It is a serious problem in Latin America; it is a serious problem in Africa; it is a serious problem here in the Philippines. It is estimated that rats in the field saturate 20 percent of the crop yearly. There are lots of birds, lots of insects, including the brownhoppers and greenhoppers. It is therefore important to have a sound pesticide management in this country in order to improve production program.

We have reports from rodent centers. There have been discussions on possible regional pesticide centers which will possibly be in close cooperation with the University of the Philippines at Los Baños. We have interest in them. I know our people in Washington have been talking about the people from the University.

In the Philippines, we have program on rural application, rural irrigation, water supplies and what we called the RDA. All of these are designed to help the small farmers improve their income. Of course, pesticide management is an important element in them.

I think the Philippines has made progress during the last two years in its food production programs, specially the Masagana 99 Program, despite floods and typhoons that swept the country. In such programs, the USAID is involved. We are also working with the Lady's Program of feeding school children besides many other different programs where we are involved. Because the level of malnutrition in the Philippines is high, the production of nutritious food is a major task this country faces.

Therefore, I think it is important that the USAID be involved in the Philippines for three reasons. I think we want to see the Philippines developed economically which will lead to the progress of all the people within the country. Consequently, Philippine progress will have an impact on peoples throughout the Pacific area. Indeed, the progress of nations will have an impact with their co-relation with other nations throughout the world.

Secondly, if you go down to Makati, you find a handsome and beautiful area, even surpassing that in the United States, Europe and other developed areas. This shows that the children in this country have tried to fully develop themselves. Moreover, it shows that they have the potential to develop.

Thirdly, we found out that there is a reason of the close relationship between the Philippines and the United States. Filipinos understand us; conversely, Americans like to think that they understand Filipinos, if not understand them.

In closing, I just want to say that we are very glad to be a part of this seminar-workshop. I see that Dr. Feuer is with your

work group and he maybe called to answer every question you have about USAID. In fact, if you would like to see any of our officer anytime for more question, we are happy to accommodate you.

Thank you very much and we wish you all the success.

Pesticide Management Seminar - Workshop
MANILA, PHILIPPINES
10-15 February 1975

FM/CC/4
75-10-2

ADDRESS

R. I. Capinpin
President, Agricultural Pesticide
Institute of the Philippines & Agric. Chemicals Mgr.,
The Shell Chemical Co. (Phil.) Inc.

In behalf of the Agricultural Pesticide Institute of the Philippines, allow me to welcome you to this Pesticide Management Seminar and workshop. This meeting is very timely indeed, and in a way, compliments the current government programmes on food production which recognize the importance of pesticides as an agricultural input. The Bureau of Plant Industry through Director Castillo should be congratulated for organizing this multi-faceted look on the subject of agricultural pesticides.

The urgent need to produce food to meet our growing population brings into increasing public prominence the use of agricultural pesticides as a vital means of boosting crop yields and safeguarding animal health. We, in the field of pesticide, are aware that the products we handle, despite the immense value to the community at large can be the subject of mis-apprehension, prejudice and ignorance. Perhaps this is understandable and even inevitable since the use of agricultural pesticides is a relatively new technology and is expanding rapidly while public awareness is still lagging behind.

Regulatory Policies

A mis-apprehension which I wish to correct is that in the absence of an updated regulatory law on agricultural pesticides, the products are indiscriminately marketed risking the lives of Filipino farmers applying the pesticides as well as the consumers of the farmers produce. This is not so. The country's export-oriented crops such as bananas, pineapple and sugarcane follow strictly the tolerances and other regulations set by the Environmental Protection Agency in the United States as well as the importing countries. On top of these strict standards, the American fruit companies operating in the Philippines follow their own regulatory policies set by their

U.S. offices. At present, almost half of the pesticides imported into the country go to these crop outlets.

For rice and corn, the government supervised credit program set up a technical advisory committee whose responsibility is to screen the different products which can be provided with adequate financing. In the selection, efficacy as well as the hazard posed by each product is considered. On tobacco, the members of APIP, in compliance with the request of the Bureau of Plant Industry, withdrew completely all the DDT formulations from the market and supplied the tobacco growers only with pesticides acceptable to the importing countries. However DDT coming from other sources, not from the trade, continue to find its way to the tobacco plantations. To the European buyers of our leaf tobacco, the local pesticide industry is responsible for the high DDT content of our export tobacco which is enough ground for outright rejection.

I should like to take this opportunity to reaffirm APIP's support to the government's move to regulate the manufacture, distribution and use of agricultural pesticides. We have cooperated with the Bureau of Plant Industry and the defunct Senate in drafting the Philippine Pesticide Bill, which we trust will now be implemented through a Presidential Decree. APIP would also endorse the active involvement of the Philippine government in the Codex Alimentarius Commission of the joint FAO/WHO Food Standard Programme whose main responsibility is to protect the health of consumers and to ensure fair trade practices in food among nations.

Continue Research Programme

Pesticide research and development has been one of the casualties of sustained attack on the environmental aspects of pest control chemicals. As a result, development costs of pesticides have increased considerably. Yet, chemical companies continue their search for newer compounds to meet the need of modern agriculture and to find the answers to the questions raised by environmentalists. It is not generally known for instance that a pesticide may take from 6-10 years to develop, costing $5-10 million with many thousands of new chemicals being tested every year but very few are considered as marketable products.

Pollution

One of the undersirable side effect of the large scale use of pesticide is the possible contamination of the environment with its residue or metabolite. However, before we get alarmed with this particular problem, let us not lose sight of the fact that pollution with pest control chemicals depends largely on level of pesticide usage and weather conditions which are responsible for the chemical or biodegradation of the pesticides. The pesticide usage in the Philippines, particularly among our rice and corn growers is still very low as borne out by a recent survey. The Filipino farmer in general tends to under-dose or use less pesticide than the recommended dosage. On the other hand, our tropical climate, i.e. bright sun, high

temperature and humidity and rains are all conducive to an accelerated breakdown of pesticides and its matabolite. A scientific assessment of the problem is in order to establish once and for all the possible level of pollution so that remedial measures can be instituted.

Today the lessons of the mid 60's have been well learned. We are aware of the problems that surround the use of our products through over-use and mis-use in agriculture and in public health. As a consequence, we are making great efforts to see to it that our products are used correctly thru education of the farmers.

What everybody hopes for and what some people indeed demand is a perfect pesticide, deadly to an insect or lots of insects or weeds, harmless to mammals and easily biodegradable. Over the past decade, the discovery of such pesticide has been jubilantly announced again and again by otherwise reliable publications and authorities. But this ideal pesticide is yet to be found in any economically usable form. The country needs food and pesticides are essential to large scale food production. The different pesticides now available in the market, though not as selective as we may desire, when properly used will not harm men and its environment.

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75-10-2

A D D R E S S

HON. CLEMENTE C. GATMAITAN
Secretary, Department of Health

Thank you very much, Director Castillo, for your very kind introduction. For one who has known me only for several years, particularly during nutrition conferences and relief work after typhoons and floods, I am moved by such a lengthy introduction of my humble self.

Councilor Samonte, Commissioner Lesaca, Dr. Hunnan, Dr. Smith, Dir. Castillo, Mr. Cepingin, Honored and Distinguished Guests, My Friends, Ladies and Gentlemen:

I appreciate very much the opportunity given to me to be with you in this prestigious seminar-workshop on pesticide management, the third of its kind held in three years. According to Dr. Smith, this seminar-workshop is better than the first two past conferences in point of the number of agencies which have participated. For us in the Philippines, there is an added significance in the importance of this seminar, particularly to us in the field of public health.

In our New Society, we are building a train of high-yielding major crops in our development efforts. We aim, among others, to increase agricultural production in order to help ease the th[illegible] of economic crisis.

Because our economy is still predominantly agricultural, one of the main objectives of our government is self-sufficiency in food to support our rapidly growing population. Towards this end, His Excellency, President Ferdinand E. Marcos, has initiated various nationwide food production programs that involve both the government and the private sectors. To attain the objectives of these programs, more land will be made available for cultivation and idle land will be utilized. This will inadvertently entail extensive use

of soil conditioners, fertilizers, and pesticides. Pesticides in various forms are used extensively in agriculture. Indeed, their economic importance to an agricultural boom hardly need to be emphasized.

Apart from their use in agriculture, pesticides are of estimable value to public health. Before inventions can be made to superficially fear my remark by extrinsic features, let me expound further.

Our disease control program would not have progressed in this field, were it not for pesticide. There are main stations in our program to eradicate malaria and to control schistosomiasis, filariasis and hemorragic fever, among others.

Moreover, the Department of Health also uses them in disinfecting and fumigating on board of ship as part of its quarantine services.

Of course, pesticides have become common household items. They are used in business establishments, industry and related fields to a limited extent. But I would like to touch a little more on this point.

I beg your inculgence with regards to our experience in the use of pesticide in our disease control program, because my orientation is basically on public health. Anyway, the illustrations I will cite will also have implications for agriculture and industry.

Our malaria control program in the Department of Health started as a pilot project in 1952. It was expanded to encompass the whole country in 1954. In the middle 40's, the liberation year, malaria took a heavy toll of our people, specially among the rural masses. Our malaria workers at that time estimated that we had some 2 million cases and 10,000 deaths a year.

In 1954, when the malaria eradication program was on the way, the number of registered cases reported to the Department of Health was 71,363 or a case rate of 309.9 per 100,000 population. It ranks second among the leading causes of illness at that time. The number of reported deaths was 5,236 or a mortality rate of 22.7 per 100,000. Death-wise it ranked seventh among the leading causes of death during that year.

After only five years and that was in 1959, the number of cases became 6,763 or only 8.6 per 100,000 and ranked as the tenth leading cause of mortality that year. Between 1954 - 1959, morbidity rate decreased 26% while the mortality was reduced by 62%.

But the things I have cited may be for the barrio statistician alone. What has been the impact of this on the agriculture sector? Consider the following:

The review of the available data of food production program shows no rise in rice cultivation areas from 1920 to 1950. The marked rise from 1950 to 1960 was in the later period that malaria eradication was distributed in the Philippines with widespread experience and which started in 1954.

The period of 1960 to 1970 was characterized not only by further expansion of rice cultivation areas but also by large increase in yield per hectare. The control or elimination of malaria in rice cultivation areas plainly saved too often the development and expansion by maintaining healthy working conditions which are favorable, together with permanent settlement of growers and capital investment, in improving production.

What has been indicated regarding the importance of anti-malaria activities in connection with rice cultivation can also be said, to some extent, for cultivated areas as a whole. The 1966 annual report of the International Rice Research Institute mentioned that the annual total cultivated area in 1963 to 1964 in the Philippines was 10 percent larger than in 1954 and 1956. This increase in cultivation follows the track of anti-malaria campaign into stronger areas of developing land yield, especially the 1960 to 1970 years marked by generally high increases in agricultural production. In formerly malarial areas, such economic advantage may be due to a variety of contributory factors. Nevertheless, the reduction of malaria contributed an important share in helping to make available the necessary human resources.

Even in the logging industry, malaria has curious adverse effect. To cite an example, the Firewood Company in Roxas, Palawan had a costly experience with malaria since it started its operations. On February, 1973 alone, 92 out of 99 employees were infected with malaria. For a 548 man-hours per month law, a production percentage loss of 22.2% of the total labor force is affected. Even mines which are located in certain areas are also susceptible to the impact of malaria.

Another disease, the control of which involves pesticide, is schistosomiasis. The disease is one of our country's important disease problems which relates, in large measure, to agriculture. It has been estimated, on the basis of the studies conducted, that the annual loss resulting from death, disabilities and cost of treatment is 175,000.00.

In the Philippines, the disease is prevalent in agricultural areas, affecting mostly farmers and their families. It is then easy to realize that it is indeed a major deterrent in agricultural activities.

It was reported that in the municipality of Carmen, Davao del Norte, around 3,000 hectares of irrigable rice fields were abandoned by land owners because the people working in the area invariably become infected with the disease. This situation could well be true in other similar areas.

My friends, I have gone to the extent of citing these statistics in order to project the vital role played by pesticides or insecticides in our present way of lives and in our agricultural system.

The amount of pesticides to be used in the Department of Health is considerable. For malaria, we had used about 960.000 kg. DDT, 75% wettable powder per year at present. This calendar year, our spraying operation will cover about 960,000 households with a population of approximately 4-1/2 million people. Today, the malaria eradication service can consume a total of over 1,[illegible].000 kg. of DDT powder and half a million of dieldrin. I refer to the limited use of dieldrin because of its disadvantages over DDT. At that time, however, dieldrin could be abandoned after only two years of use because of its high toxicity to animal. For our schistosomiasis control program, we use an average of 1,400 kg. of molluscides per year to supplement our agro-engineering measure.

With all this amount of pesticide and knowing them to be toxic one way or another, what is the possible impact of pesticide on man and on his environment? Much has been done to develop effective and efficient pesticide for the benefit of the users of the product. Using pesticides may benefit man and his environment. On the other hand, one may expect that the indescriminate use of pesticides may interfer with man's health. Moreover, it may disture the ecology of the region. However, it should be recognized that health may also be affected indirectly by the impairment of well-being.

The evolution of pesticides, for example, may greatly affect health by causing annoyance. Hence, the present growing concern over the evidently increasing introduction of pesticide with toxic and physiological, even carcinogenic effect in man. The concern over this effect in the environment is worldwide and this is eloquently articulated by Rachel Carlson's book entitled The Silent Spring. I am sure many of you here have read that.

In our experiences with the use of pesticides in the public health service, we have not yet come across any report or instant on any serious effect of pesticide in man, even among our handlers.

Our position, therefore, at the present is to continue its use because the advantages far outweight the disadvantages. Even so, we are aware of the hazards and potential ill-effects, particularly chronic or long term one, the widespread use of persistent pesticide may bring. Taking cognizance of the consequences, we have tried to do something about the matter. A few years ago, a committee was formed to undertake a study on the effects of pesticide now in use and to recommend corrective measures. However, we have to admit that not very much have yet been accomplished in that direction. The committee is headed by Director of the Research Laboratory and one of its ranking member is the FDA Administrator, Dra. Luzonica Pesigan. Will you please stand up to be recognized?

Even legislation for regulation and management of pesticide in their use cannot be enacted although it has been proposed many times. It is in this aspect that this seminar-workshop is very much significant and relevant. The expertise, the USAID and the University of California accord our technical men, particularly those in agriculture both in the private and government sectors, will very well give answers to questions we ask and point the way for the rational and expeditious solution of our problems in pesticides. Hopefully, their experience with pesticide, not only in their own countries but also in areas similar to our own could provide us the knowledge that could be obtained only through extensive study and researches. In developing countries like ours, we find such knowledge desirable and very necessary.

In the light of these considerations, we welcome this seminar-workshop and entertain great expectations. We add significance to the mass of knowledge now in application and find the sound basis for future action. This is in consonance with the current emphasis the president with the New Society accords the effort at scientific pursuit. And I quote "In shaping our policies and programs in the field of agriculture, the government is governed by the knowledge and reality, not by superstition and fantasy. We place higher premium in this area on the fruit of research and experiment just as we placed a high value on these things in the management of our financial system in the propagation of arts and development of the critical sciences in our country".

I extend to you all my best wishes for a lively and fruitful discussion.

Thank you and good day.

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Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/SP/1
75-10-2

RATIONALE OF PESTICIDE USE

SIMEON A. ESTOCAPIO
Chief, Crop Protection Division
Bureau of Plant Industry
M a n i l a

Introduction

Nowadays, leaders of the world are tackling the burning problems on how we could produce enough food to avert widespread famine and starvation. And the problems involved are of great magnitude which are further aggravated by the fact that some, like droughts, floods and typhoons are beyond the control of man. These occurrences are not however day to day problems unlike that of the problems generated by agricultural pests and diseases. As such, to some extent, these agricultural pests do more damages than any of the natural causes. This is where, this paper deals with and is taking the cue from Dr. Julian Huxley, the noted English Biologist and author of the "Uniqueness of Man" wherein he aptly Expounded when he said "Man is created the dominant creature on our planet and is placed in his exalted position to have all other animal creations to serve him for his needs and pleasures and with no share in man's salvation or eternal destiny." And further, he said, "man has the capacity for conceptual thought and has given him distinct qualities over other creations which are that of being able to accumulate knowledge or traditions through transmission of organized experience and the ability to use tools with increasing expertness and dexterity. And because of these qualities the capacity of man for rational thinking have in turn enable him to build enduring civilization."

In the light of the famous biologist words, we have in this age and century a civilization that is dominated by unprecedented progress in science and technology which greatly increased our ability to control our physical environment. The science and technology in agriculture is one of these progressive subjects of studies with no less emphasis on the control of plant pests and diseases. This is in-

evitable but understandable bacause man, since the beginning of recorded history, has been pestered by pests of all sorts in his daily activities not only to his direct personal self but to the plants he raised. In fact, as far back as many hundreds of years before Christ, flies and locusts were known as menaces to man and has to continue waging war against them without let-up in order to survive. In this country, which is essentially an agricultural one, has a great number of agricultural pests and diseases and weeds that are harmful to Philippine Agriculture. And to give a clear understanding about these agricultural menaces, a passing review of some of these agricultural pests are to be presented which, by the mere mention of them, would make everyone ponder with sadness and concern.

Extent of Pest and Disease Problems

From the annual reports of the Bureau of Plant Industry, the infested areas in all crops from 1965 to 1970 mainly with insect pests and diseases are presented in Table 1. It is evident that in 1965 and 1966 the total crop area infested was appreciably much higher than the succeeding years. This is true with the rice crop when considered alone. While there has been substantial improvement in crop protection methods and expansion of treated areas, there was likewise a parallel increase in areas put under more intensive cultivation. This may account for the increase of infested crop areas such as in rice. The susceptibility of some new high-yielding rice varieties recommended for the expanded rice production program to pests and diseases should not be overlooked.

Crop Losses

A quantitative assessment of the extent of crop losses caused by several insect pest species on rice has shown that ricefields protected from insect damage yielded an average of 5.4 tons of unhulled rice while untreated control plots yielded 3.1 tons per hectare.

Studies conducted at the International Rice Research Institute have shown that based on 65 replicated trials over 12 crop seasons (from 1964 to 1970), plots treated with the best insecticidal treatments yielded about two and a half tons more rice per hectare than the unprotected plots (Fig. 1).

Field experiments conducted by the IRRI in collaboration with the Agricultural Productivity Commission at 9 different locations in 7 provinces of the Philippines during the period January to June, 1965 showed a 60 per cent increase in yield over the untreated fields (Fig. 2).

Table 1. Summary of Crop Area Infested by Pests and Diseases

Production Period	Infested Areas in Hectares	
	All Crops	Rice
1965 - 1966	334,393	278,303
1966 - 1967	123,540	87,552
1967 - 1968	125,674	94,476
1968 - 1969	145,670	92,318
1969 - 1970	148,411	108,311

(Data taken from Annual Reports of the Pest and Disease Control Division, Bureau of Plant Industry).

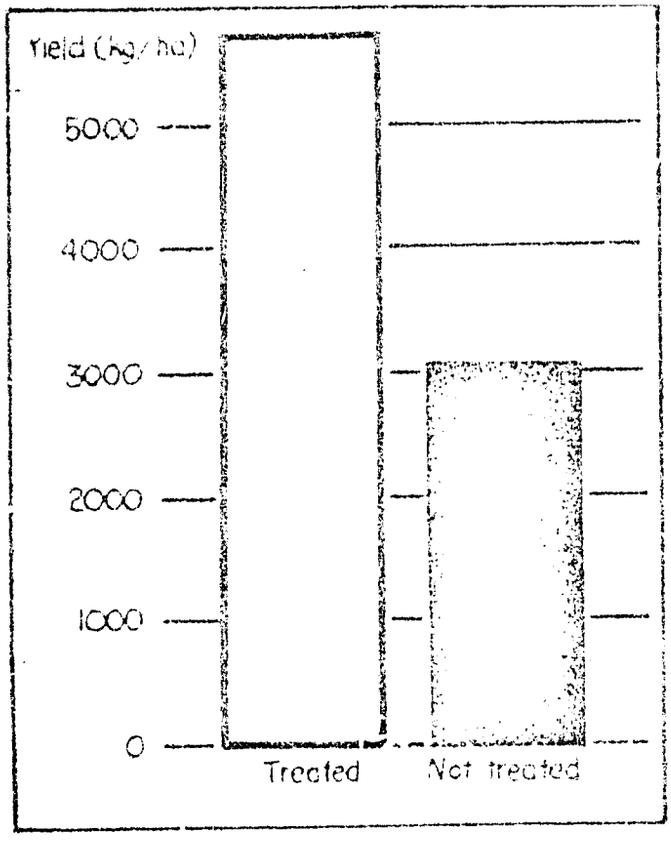
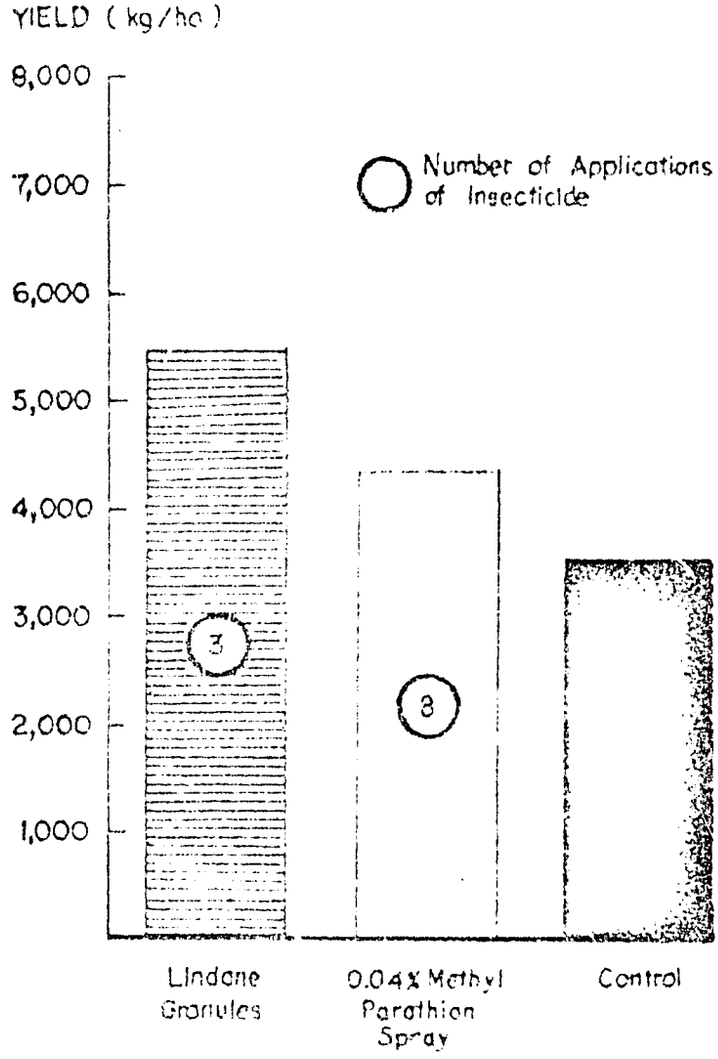


Fig. 1. Effect of insect control on cotton yield. Average of the best insecticidal treatments from each of 65 replicated trials over 13 crop seasons (wet and dry). IPPI, 1964-1970.

Fig. 2. Effect of lindane application to the paddy water at 30-day intervals and 0.04% methyl parathion spray every 14 days on the yields of rice. The bars represent the average of experiments conducted in 4 replications at 9 different locations in 7 provinces of the Philippines. January-June 1965.*



*Experiment conducted by William G. Golden et. al., The International Rice Research Institute, in collaboration with the Agricultural Productivity Commission, The Philip-

Applied research projects conducted jointly by the IRRI and the Bureau of Plant Industry in 15 provinces over five crop seasons (from 1965 to 1967) showed that treated farmers' fields gave an increase of one and a half tons unhulled rice over untreated fields (Table 2).

The damage due to the stem borers in this country may range from 15 to 20 per cent. In ricefields in which no insect control measures are used coupled with the adoption of new rice varieties of moderate susceptibility to the insect, the damage may reach as much as 40 per cent.

Severe infestations with stem borers and planthoppers have caused damage ranging from 50 to 80 per cent.

Rice leaf and midrib maggot may reduce yield up to 25 per cent or more.

Crop losses over a wide area of the Bicol region from rice blast outbreaks in 1962 varied from 50 to 90 per cent, and in Leyte, West Visayas, damage in 1963 ranged from 25 to 60 per cent.

The normal annual loss due to stem rot is 10 per cent, with losses of 25 to 50 per cent in severely affected areas. Damage on the rice crop from sheath blight range from 25 to 50 per cent. Bacterial leaf blight causes a yield reduction of 20 per cent in severely affected fields.

In severe infection with "tungro", one of the most common and destructive virus diseases of rice in the Philippines, yield reductions of 50 to 90 per cent have been registered.

Crop losses from locust infestation range from 50 to 90 per cent, especially when adult locusts settle on rice at their vegetative growth or early heading stage.

The common ricefield rat causes an average annual damage to rice of 100 million pesos. Serious infestations, especially prior to harvest could cause from 50 to 80 per cent crop loss.

Weeds can reduce grain yield in transplanted rice by as much as 50 per cent. Higher yield reductions are registered in directly seeded lowland or upland rice.

Rationale

Considering, the magnitudes of the problems of food production and the attendant pest depredations always associated with them, it is therefore necessary that there is a further need of moulding a national if not global coherent and commodity insect pest control.

Table 2 - Showing the treatments and yields in the different series.

LOCATIONS	A. YIELD DATA						
	SERIES NUMBER	CROP YEAR	SEASON	VARIETY	AVE. PRODUCTION UNTREATED	(Cav./Ha.) TREATED	AVERAGE COST/ BENEFIT RATIO
1. Ilocos Norte							
2. Mt. Province							
3. Pangasinan	I (g-BHC)	1965	Wet	Milfor 6(2)	75.8	92.5	₱ 2.16
4. Tarlac	II (g-BHC)	1966	Dry	Milfor 6(2)	79.9	109.4	3.81
5. Cagayan				Farmer's	76.0	89.0	1.68
6. Isabela	III (g-BHC)	1966	Wet	IR8	103.7	140.8	4.79
7. Bulacan				Farmer's	59.7	83.9	3.13
8. Nueva Ecija	IV (DIAZI-NON)	1967	Dry	IR8	103.1	137.8	4.17
				BPI-76-1	83.7	120.0	4.35
9. Albay	V (DIAZI-NON)	1967	Wet	IR8	92.2	124.8	3.91
10. Camarines Sur							
				BPI-76-1	77.0	100.7	2.84
11. Capiz							
12. Iloilo	VI (DIAZI-NON)	1968	Dry	- DEMONSTRATION/TEACHING PROJECT.			
13. Leyte del Norte							
14. Lanao del Norte							
15. Zamboanga del Norte							
16. Cotabato							

B. BASIS OF COMPUTATION

GAMMA BHC - - - - - - - - - - - - - ₱1.20/kg.

DIAZINON GRANULE - - - - - - - - - 2.50/kg.

P A L A Y - - - - - - - - - 18.00/cav.

Otherwise, their multiplication will tip the balance of survival in their favor and, man, in his present and future state of civilization is existing only on borrowed time. This was aptly stressed by President Marcos when he made his call for a national unity as monitored through the various Media of Communications some few days ago, and exhorted the nations of the world to realize fully the gravity of the global situation to work together in solving the worsening economic crisis which revolves on the shortage of food that is of reality to the extent that some nations have already stopped talking about growth but survival. Hence, it is to this end, that the use of chemical pesticides is a last-ditch a knock-down thrust against the in-roads of destructions by the agricultural pests and diseases that underlines the rationale of pesticides usages although, however, there are some who advocate strongly the use of effective biological control in order to avoid the use of insecticides and fungicides, but to go through with these for the moment and or even for the distant future would be disastrous for the reason that there are still limited materials produced for the purpose. We have to resort to the extensive use of well known commercial agricultural chemicals, therefore.

C o n c l u s i o n

Of all the foregoing, it is evident that the only salvation we have for the present and perhaps for many more years to come, in our effort to raise enough food to control effectively the various pests and diseases that destroy our crops. And the only answer is for us to use judiciously agricultural pesticides. However, it is equally important to keep in mind of the hazards to man's health and to our domesticated animals attendant to their usages; otherwise, our struggle to save the human race would be in vain. Are we to eat and live only on those which are left by the insects or diseases?

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PM/SP/2
75-10-2

WORLD PROBLEMS OF PESTICIDES

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University of California, Berkeley

and

Director, UC/AID Pest Management Project

Introduction

The trends and extent of growth for the production and use of pesticides since World War II are reasonably well documented for the industrial countries of North America, Western Europe and Japan. The overall amount of pesticides sold to the developing countries as a group is also reasonably reliable, but the figures for individual countries and even more the uses made of these imported pesticides are not readily and reliably available.

Nearly all pesticide production is limited at least in large part to the industrialized countries of Europe, North America, and Japan. Although much of the parent pesticidal compounds are formulated in final commercial form in the developing countries, and in less frequent cases some steps in the synthesis of the parent compound may be carried out in the developing country, nevertheless, there is very little production that includes all steps of synthesis and final formulation.

Although the rate of growth in pesticide use in developing countries has tended to be higher in recent years than in the developed countries, the small base from which this growth started still results in the total tonnage of use by all developing countries being small in comparison with the countries with highly developed modern agriculture. In 1970, the United States accounted 45 percent of all pesticide production, Western Europe 29 percent, Eastern Europe 13 percent, Japan 8 percent and the developing countries 7 percent with the remainder in Australia and other developed countries.

The relative growth rate between insecticides and other pesticides has been much less in the developed world compared with the developing

world. In the developed world, insecticides have declined in relative position among pesticides from being the dominant class of pesticide before 1960 to representing only about one-third of total pesticide usage currently. This is in spite of large increases in total tonnage of insecticides used. This is primarily the result of the rapid growth in the use of herbicides which now represent the major portion of pesticides used on global basis and are still increasing in use at a more rapid rate than other classes of pesticides. There is strong indication that this trend may accelerate as farmers are increasingly substituting herbicides for tillage because of higher fuel and equipment costs and equipment shortages. In the developing world, insecticides, remain the dominant class of pesticides used and their use is increasing at a rate that would appear to maintain their dominant position for some time to come.

The use pattern by crops for insecticides is fairly well known for the United States and some of the other developed countries, but it is not well documented for the developing countries. In the United States about half of all insecticide usage in agriculture is in cotton. Maize represents about 10 percent of all use; and of the fruit crops, apples is one of the major consumers. In developing countries, it is hard to evaluate and use of imported pesticides because they are used extensively in public health programs in addition to agricultural uses; reliable figures on relative uses by sector and specific crop are not available. Nevertheless, it is clear that in the past, nearly all agricultural use of pesticide use in developing countries has been on cash crops with cotton representing at least half of all use. Plantation crops such as sugarcane and tree crops have been major consumers of pesticides with vegetables, rice and maize when they are raised as cash crops are of lesser but increasing importance. In some developing countries, use of insecticides to protect stored products is also of importance.

Current International Trends Affecting Agricultural Development.

The disappearance of basic food stock reserves has led to a rapid increase in prices for not only basic food commodities but also for industrial crops such as cotton, rubber, etc. Some of these crops receiving high prices have often been marginal in the pesticides use in the past but now with their increased value there is a favorable cost/benefit ratio. Some of the beverage and plantation crops such as cacao and sugar have also been affected similarly although coffee and bananas have not had any major increase in prices thus far. These more favorable prices for the farmer should stimulate both production and demand for inputs such as fertilizer and pesticides. The impact can already be seen in shortages and rapidly escalating prices for these products. This, in turn, may well lead to greater emphasis by developing countries on increased local manufacture of pesticides at last to the extent possible.

General inflation resulting from the high food prices and shortages based on rapidly increasing demand for many basic raw materials, such as petroleum, metals, paper pulp, etc. has become a world-wide problem. It is seriously affecting the balance of payment position of both industrial countries and those developing countries which are not major exporters of raw materials. The balance of payment problems are expected to increase the desire of agricultural product exporting nations to increase their production as a means of easing payment problems, and for the countries who are not importers of agricultural products to expand local production of agricultural products to reduce import requirements. Since both of these current trends could increase pesticide demand substantially, they could have a major impact on the pesticides industry. This is particularly true because pesticides usually produce a high rate of return on money invested by the farmer. The rate of return can be greatest in developing countries where low labor productivity permits greater cost-benefit potential.

The basic world wide shortage of many raw materials, which generates much of the inflationary pressure, make it difficult to expand production readily to meet the demand for more pesticides. The shortage and resultant rapid price rise in petroleum products has heavily affected the pesticide industry. Most pesticide manufacture involves petrochemical products either as basic building blocks in manufacture or as solvents or emulsifiers in formulation. In addition, the shortages of plastics, metals, and paper products used in packaging are also affecting pesticide production adversely. In some cases, shortages of transport for either raw materials or finished products have slowed production. All of these factors are depressing supplies of both pesticides and fertilizers which would result in further depression of the growth of agricultural production.

Phenols are also major pesticide intermediates and supplies have been drastically reduced because of the destruction at several major phenol producing factories by explosion and fire.

As a result of all of the various factors listed above, the general trend has been about a 25 percent world wide increase in orders for pesticides during the past season but probably a slightly decreased level of production. Under normal conditions, the pesticide industry keeps current production reserve for field use in the following crop season. This year the increased demand has largely been met by the current production which normally would have been used to build the 1974/75 inventory stocks. This suggests that the short fall in the 1974/75 season will be at least in the order of 25-30 percent. This situation has been aggravated by speculative and panic purchases. Any global shortage could be most severe for the developing countries as they consume less than 10 percent of the world pesticide production, but many now wish to increase their consumption rapidly. As the basic manufacturing of pesticides is conducted outside the developing countries, the prospect for this increased use is not bright.

Another development in the past six months which has eased the supply problem somewhat is the deteriorating price for cotton. Many farmers have greatly reduced or will greatly reduce their planted acreage in the coming growing season. In the United States there may be a 3 million acre reduction in cotton. The shift in other part of the world will come more slowly. These shift will have their greatest influence on the 1976 supply situation. As cotton is the largest consumer of agricultural pesticides this will ease to an extent the anticipated shortages in the coming season. Nevertheless a number of pesticides will remain in short supply.

Current trends in pest control and pesticide usage and their implications.

The growing concern for greater protection of the environment especially in developed countries has had major impact on pest control programs. This is most strongly manifested in the efforts that have been made to restrict or eliminate the use of pesticides that persist in the environment over long periods. This is having a major impact on the use of chlorinated hydrocarbons with the greatest influence on the use and availability of DDT.

Although the effort to restrict DDT and other chlorinated hydrocarbons originated in the United States, it has been taken up rapidly by other industrial countries, furthermore the current trend is that most developing countries follow the pattern set in the industrial world and establish increasingly rigid use restrictions soon after these have been adopted in the United States or Europe. This has had a major impact on both the availability and type of compounds used. This effects the cost of plant protection and other pest control because most of the potential alternatives prove to be much more costly.

Some of the adverse consequences of wide scale use of pesticides have caused some to advocate the elimination of most or even all pesticides. This is foolish because knowledgeable plant protection experts have been unanimous in recognizing that pesticides are essential for agricultural and public health for the present and the future. Nevertheless certain adverse consequences of pesticides, e. g. development of resistance to pesticides, persistence of residues in food, destruction of beneficial organisms, and human intoxication has led to restudy of pesticide use patterns. This trend has produced interest in expanding the integrated control approach to crop protection. In this approach primary reliance in placed on naturally occurring mortality with supplemental manipulation of parasites, predators and pathogens, on resistant varieties, on pesticides, and on cultural practices to keep pests below the levels that cause economic damage. Pesticides are used in compatible ways and are kept to the needed minimum to supplement the other controls.

The expanded interest in integrated pest control has also created the demand for more narrowly specific pesticides which have greatest possible impact on the target pest problems while at the same time causing minimum effect on other species in the environment. This has led not only to greater interest in developing highly specific pesticides but also in including natural compounds which can be used to manipulate pest populations. This includes such chemicals as hormones or hormone mimics that can disturb the normal development pattern and pheromones that can be used to attract or repel pests or can confuse normal behavior. This same trend has caused increased interest in artificial rearing of parasites, predators and pathogens and in the genetic manipulation of pest populations.

Although these new trends will result in the development of new compounds, but the continued use of older pesticide compounds will be necessary. Furthermore, these trends are fraught with many problems when it comes to maintaining adequate pest control capability for economical crop protection and production in the future.

<u>Problems in the Development of New Pesticides, particularly specialty compounds and novel chemicals useful in pest control.</u>

One of the biggest factor which creates difficulty in the development of any new pesticides is the rapidly increasing research and development cost required to bring a new product to the market stage. This cost has reached the level of more than ten million dollars to get a new product on the market and requires an average of ten years to fulfill all the regulatory requirements. Much of this large cost results from the greatly increased regulatory requirements that have generated from a height of a decade ago concerned with the environment. These requirements are often only for the specialized requirements needed to insure an adequate agricultural market at reasonably assured levels of safety.

It is clear that we will be faced with pesticide shortages of the next few years. What can we do? We must conserve of our supply of pesticide like a man in the middle of a desert conserves his one canteen of water. <u>Pesticides must not be wasted</u>. The insurance treatment applied because pests <u>might be present</u> or might do damage is wasted pesticide. To conserve pesticides, they must be applied at the correct dosage in the most effective manner possible and only when necessary. Where possible the integrated control approach should be utilized because it makes maximum use of the naturally occurring mortality, and thus extends the effectiveness of the available pesticides.

Pesticide Management Seminar - Workshop
MANILA, PHILIPPINES
10-13 February 1975

PM/SP/2
75-10-7

PESTICIDES IN PHILIPPINE AGRICULTURE

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Background

The use of pest control chemicals in Philippine agriculture is not new but general acceptance of this technology, particularly on rice and corn, is still lagging behind.

The era of pesticide usage can be traced to:

	Chemicals used/crops
Pre-Pacific War	Kerosene - soap solution for coconut leafminer control Arsenicals - insect infestation and tobacco Nicotine - dust/liquid - vegetables Pyrethrum - general pest control
War time	Pyrethrum dust/emulsion and soap solution for cotton pest control
Post-Pacific War	Beginning of DDT crops for tobacco, mango, rice and other crops. THIP for rice leaf, Malathion for citrus, 2,4-D for rice and sugarcane

There are now 22 chemical companies engaged in the manufacture and/or distribution of agricultural pesticides, which have organized themselves into a trade association now referred to as the Agricultural Pesticide Institute of the Philippines. These agricultural chemical

companies are mostly affiliates of chemical companies in U.S.A. and Europe or distributor of Japanese manufacturers. Because of this set up, our farmers benefit from the results of very expensive research programme being undertaken by each company.

Some of these companies and their respective strength by way of products originally developed, or currently manufactured.

Fungicides	Du Pont Rohm & Haas	
Herbicides	Monsanto Du Pont Elanco Agchem	Dow Warner Barnes (ICI) Ciba Geigy
Insecticides	Bayer Shell Chemicals Hoechst Planters Products Trans World American Cyanamid	Union Carbide Ciba Geigy Pharma Velsicol BASF Interchem

Characteristics of the Philippine Market

1. Small farmers market - small packs

With an average land holding of about 2½ Ha. agricultural pesticides are marketed in pack sizes that farmers can afford to pay and not necessarily what they require. We deal with thousands of farmers to achieve a volume.

2. Education - although the potential user may be aware that he has a pest or disease problem, he is often ignorant of its nature and the measures necessary to control it. As a consequence, we have to undertake education of the farmers and a well informed technical sales backing is therefore essential.

3. Toxicity problems - pesticides are biologically active substances and which can be highly toxic; their use involves the risks of intoxicating the user and the consumer of treated crops. In this connection, government regulatory measures are indeed very useful to the industry.

4. Controversial - in some countries, the "interference with nature" which is caused by new agricultural technique is a controversial subject and "nature lovers" frequently criticize the use of pesticides.

5. Unpredictable business - as a result, substantial amounts of working capital must be invested in stocks.

6. Credit- financing of sales to distributors to ensure availability of stocks when the farmers ask for the product. This again increases amount of working capital.

7. High cost of sales - the cost of selling pesticides is high due to the seasonality of the business and to the widespread scatter of the farmers.

Crop Outlook, Pesticide Consumption, Extent of Use

Commercial Crops	No.	Area being treated	Pesticide Use
1. Pineapple	27,000	25%	Insecticides Nematocides Herbicides
2. Bananas	250,000	10%	Fungicide Herbicide Insecticide
3. Sugarcane	450,000	50%	Herbicide Insecticide Fungicide
4. Tobacco	84,000	20%	Insecticides
5. Mangoes	1.5 million bearing trees	10%	Insecticide

Food Crops

1. Rice	3.1 million	15%	Granular Insecticide
		25%	Liquid Insecticide
	less than	15%	Granular Herbicide
		25%	Liquid Herbicide
Vegetables (Beans, Cabbage, potatoes)	50,000	10%	Insecticides Fungicides

Prospect of the Agricultural Pesticide Industry

With the government insistence on food production and the recognition of pest control chemicals as [illegible] in production from food, it is almost certain that the agricultural Pesticide Industry is here to stay with sufficient room for expansion. Our export crops such as sugarcane, bananas, pineapple, and very soon mangoes, will continue to expand in acreage to meet growing world demand. The growth of the pesticide market, however, will depend on the following:

1. Supply Position - worldwide situation has not firmed up and majority of the pesticides now available in our market are in very short supply resulting from shortages of raw materials and

and also increasing demand. Almost all countries including the more developed ones who have depleted their food reserves have now given emphasis on food production and developing countries like ourselves, compete with them for the necessary supplies.

2. Increase in cost - because of product shortages and increase in demand, fertilizer prices have always been on the rise, a situation which is aggravated by inflation which is affecting almost all nations of the world. To make pesticides available to the Filipino farmer, the chemical companies have to meet on-going world prices and terms.

Some of our crops may not be able to absorb these cost increases because of pricing policies. A good example is in the case of chemical herbicide for rice 2,4-D. The gap between the cost of chemical herbicide and manual labour using rotary weeder has narrowed down to a point that more farmers including those provided with financing are now resorting to rotary hand weeder. The use of a rotary hand weeder is further encourage with the new system of planting rice in straight rows.

3. Resistant varieties - the full impact of rice varieties resistant to almost all insect pests may be realized in 2-3 years time thereby affecting also the insecticide market. The rice insecticide market can be expected to taper off during the period but no doubt new usages on other crops such as corn, sorghum and soybeans will be developed and new crops such as cotton will be grown in a wider scale.

4. Infrastructure programs - the construction of more irrigation system and improvement of existing ones and also feeder roads in the rural areas will promote more intensive farming and thereby create the market for agricultural chemicals.

5. General Order No. 47 - this order which will require big corporations to produce rice for their employees will serve as the source of the necessary farm technology and supervision of farmers who do not participate in Masagana 99 rice programme.

Agricultural Pesticides in Masagana 99

Masagana 99 rice production programme is a package consisting of three important components, namely:-

Financing from rural banks and PNB branches to provide necessary funds for inputs such as fertilizer, pesticides and seeds of high yielding rice varieties

Technology - the application of a pattern of cultural practices including the use of pesticides, and

Supervision - government extension agents or production technicians to assist the farmer obtain his financing and guide him in the 16 steps of Masagana 99.

Pre-Masagana 99

Let us look back when the above scenario on Masagana 99 did not exist, particularly on the utilization of pest control chemicals. The promotion of pesticides mainly through the education of farmer, was the responsibility of chemical companies. The government through the Bureau of Plant Industry and the Bureau of Agricultural Extension assists through their extension men while in the case of the Bureau of Plant Industry undertake some actual pest control on pests affecting the whole community such as rats and locusts.

The chemical companies promote their products

a) by use of mass media
b) convincing the farmer by field demonstration
c) organizing farmers meeting
d) sales promotion techniques such as contests and raffles, and
e) employing agricultural graduates who can discuss with the farmer on his problem, particularly on pest control.

To support the sales organization, each company has its own technical department which initiates field trials to confirm dosage rates on particular pest of specific crops and also to serve as a bridge between research and sales. In brief, all efforts by each company are directed towards the farmer who will decide for himself if he is satisfied with a particular product. Although competition was fierce between companies, some brands prevailed in the market over others such as Folidol, as a general purpose spray, Phosdrin for vegetables, Sevin for mangoes. The acceptability of these products or brands was mainly dependent on the farmers demand. Of course, upon the influence of the chemical company. In some instances it was difficult for companies to introduce new product because of the insistence of farmers in using a particular brand. This was a slow process of getting to the farmers but we believe that they were happy with the situation when they can exercise their own judgment in the selection of a particular pesticide.

The Filipino farmer is not as ignorant about pesticides as we may presume. He will ask and use a product which is effective based on his experience and others and also subject to price consideration. He will even mix his own cocktail of insecticides to make his spray more effective and perhaps cheaper. He is easily impressed with instant kill rather than slow acting safe chemicals and last but not least he always remembers his experience in one particular insecticide, particularly if he needs replenishment.

Masagana 99

The first phase of Masagana 99 in 1973 has resulted to a significant increase in pesticide usage on rice. However, the marketing of all agrochemicals needs a different approach. Chemical companies have to provide their products to production technicians who then [illegible] pesticides through financing from the bank. The production technician becomes a very important link in promoting a brand of product to the farmer, to the extent that whatever the farmer has learned prior to Masagana 99, is completely ignored.

On the basis of areas actually planted, Masagana 99 Phase I should have provided a market potential of about 1,000 metric tons active ingredient of insecticides valued at about P65 million and 500 metric tons a.i. of herbicide worth P21 million, or a total market of [illegible] million. During the same period total pesticide market, including sales to commercial crops, i.e. bananas, pineapple, etc. which constitute about 50% of total it only about P100 million. This is an indication that the full potential of the programs [illegible] is not being realized.

Problems of Masagana 99 vis-a-vis chemical pest control

A massive program such as Masagana 99 involving thousands of people in a wide location, [illegible] is likely to have problems during the implementation. AFI as an input supplier sits as a member of the management committee which oversees the implementation of the programs. The [illegible] problems regarding pesticides availability, pricing, etc. are referred to us for action. It is also AFI's responsibility to maintain inventory of the necessary pesticides to support the programme and to locate these stocks in the different places where they are needed, following the programs of planting. I would like to mention some of these problems, particularly which have direct bearing to chemical pest control. We trust that when a similar programme is re-designed, these problems and possible solutions are included.

As earlier stated, the production technician is the focal point of all activities with regards to pesticide usage. Naturally we are not familiar with their activities and related problems. To name a few:

1. Inadequate supervision - the technicians on which depend the success of the programs are assigned more farmers than what they can actually handle thus their role as a teacher or as an adviser is not fully complied with. As a consequence the implementation of cultural practices covered by the 16 steps of Masagana 99 is not well supervised.

News stories about complaints of farmer having been asked to buy more pesticides than what they need, is to our observation the result of lack of proper advice on its usage. Furthermore most of the farmers who availed of loan from the bank to buy his pesticide had no choice but to accept a product since a firm plan and budget was prepared for him by the technician. The farmer had no say on what to use.

Another direct result of inadequate supervision is the common practice among the farmers to apply less pesticide than the recommended dosages resulting to poor control of the pests. Our recommendation here is to limit the programme areas, to a size which can be adequately supervised by the existing number of technicians.

2. Farmers adviser need more training on pesticides.

3. System of supervising the farmers - the production technicians tell the farmers what to buy without giving the farmers an opportunity to decide for himself on what particular pesticide to buy. I believe that after three phases of Masagana 99, the farmer has already learned something about pesticide and has the experience to guide him in his choice.

4. Interference on the recommending process - the technicians are often under pressure from interested groups to recommend only products which are available from them but not necessarily the most effective.

5. Production technicians - potential for abuse. Because of the new importance of their role in the financing programme, the production technicians can abuse their role in the following manner:

a) to go into alliance with dealers to push a particular brand for a fee, and
b) to go into business themselves

Pesticide Management Seminar-Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/SP/4
75-10-2

PESTICIDES IN PUBLIC HEALTH

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Introduction

After the Second World War, the general trend on Public Health campaign in the Philippines was to encourage and develop programs for the control of vector-borne diseases and the gastro intestinal infections. Both groups of diseases are intimately related to the local environment. However, attempts to control these diseases through significant or rapid improvement of the environment was costly and beyond the financial reach of our country. The only immediate financially feasible alternative for control and good sanitation was the application of pesticide.

Pesticide in public health is mainly used to control insects, snails and rodents which transmit or serve as carriers of human diseases: like malaria, dengue hemorrhagic fever, Filaria, cholera, el tor, schistosomiasis, plague, etc. The continued use of these chemicals depend on the present rapidly changing situation in the field of vector control. This change is brought about by the ever-increasing occurrence of resistance to insecticides on the one hand and on the other, development of numerous new methods, materials and concepts to meet this problem.

I. MALARIA: DDT in the Philippine Malaria Programs

From 1946 to 1960, the Department of Health through the Division of Malaria was undertaking a malaria control program. The control measures being followed were mechanical and naturalistic methods directed against Anopheles flavirostris the principal malaria vector

which breeds on clear, slow flowing and partly shaded streams. These measures were automatic siphon, sub-soil drainage, clearing of streams and larval control with Paris green.

Malaria in the Philippines is a rural disease and it is found in almost every province at that time. But the campaign was so limited in its scope due to financial reason. Because of this shortcomings, the Department of Health and the World Health Organization (WHO) with the assistance of the United States Mutual Security Agency (MSA) now Agency for International Development (AID) agreed on February 15, 1952 to establish Malaria Pilot Project to find out whether DDT residual spraying of houses could be an effective and economical method of controlling malaria in the Philippines. After one year of study the results showed the effectiveness of DDT in controlling the disease. Now, based this on the basis, the Philippine Government started its nation wide malaria control programs using DDT as the main weapon.

The recommended dose of DDT twice a year by the (WHO) which was tried at the Bindon Pilot Project was adopted as the standard dosage for the whole country. All malarious areas of the country were receiving total coverage at least a year at an interval of six months. The sprayed were bamboo houses, dwellings and their sheds, temporary shelters and tents, and any structure where people may sleep, consider as spend some hours at the night.

Safety measures are followed in the handling, preparation of the suspension and spraying are as follows:

1. DDT powder enough for one load of a spray can are weighted at the Unit headquarters and placed in plastic bags for use in the field.

2. Before spraying a house, all materials including drinking water, cooking and drinking utensils and food are placed in the center of the room and covered with mat and plastic sheets.

3. Domestic animals and chickens are placed in a cage outside the house.

4. During the actual spraying of the house, only the spryman is allowed to stay inside the house.

5. Houbs with a newly born child or sick person is not sprayed until after sometime. Since 1953, there is no record of illness - attributable to DDT resulting directly from the normal spraying operations among either the many thousands of spraymen or the millions of occupants of DDT treated houses.

From 1952 to 1974, the Malaria program consumed 26,480,653 lbs. of DDT and these were sprayed to 19,895,498 total number of houses (Table 1). This anti-malaria efforts have brought about a reduction of malaria from an estimated 2,000,000 cases and 10,000 deaths each year in the 1940's to 40,000 cases and less than 1,000 deaths in 1972. In the same period, malaria used to be the number two disease killer of the country and now reduced to number 14 in the list.

Other Insecticides Used in the Malaria Program

(a) DIELDRIN - In 1956, a pilot project on the possible uses of dieldrin for intradomiciliary spraying against malaria vector species was established in Cagayan Valley. This studies proved to be effective in interrupting malaria transmission. In (1956 - 1959) the program used a total of 1,190,601 lbs. of this insecticide on a nationwide basis. Within a short span of two years, the principal malaria vector of the country (the Anopheles flavirostris) developed resistance to this particular insecticide (Table II). Also, Dieldrin was relatively more toxic than DDT and the people complained of affecting their domesticated animals. As a result, the program reverted back to the use of DDT.

(b) BAYGON - (Propoxur a carbamate insecticide) - The potentialities of this insecticide as a possible substitute for DDT in fighting malaria in this country was tried in several highly endemic localities in Palawan last 1974. Baygon was formulated to 5% suspension with water and sprayed at 2gm/m^2. Although, this insecticide has a long residual effects against the vector species yet it has the same objection from the people as DDT in making the walls of houses untidy. Also, during the actual spraying, spraymen complained some discomfort like headache, nausea, etc. Because of these disadvantages, the field trial was discontinued even before a sufficient epidemiological data could be gathered.

(c) ABATE - An Organo-phosphorus insecticide was used in the Philippine Malaria Program as a larvicide against (Anopheles flavirostris) the principal vector which breeds on the foot hill streams. Also, this was used against An. sinensis and An. litoralis both secondary malaria vectors of this country.

Abate (500%) a 44% of pure liquid material, was formulated at one cc. to one liter of water (0.05% pm). The interval of application was on a weekly basis with the aid of a spray can. In our larviciding program, we noted the excellent effects of Abate against the larval stages of both Anopheline and culicine groups of mosquitoes. Our consumption of Abate amounted to 312 gallons. The epidemiological assessment of the area under larviciding showed that malaria transmission could be interrupted successfully. However, the operation was several times more

expensive than the ordinary indoor spraying of houses. To compensate the high cost of the operation it is advisable to undertake larviciding in places where population is dense. This larvicide was found to be safe and we never had any complaint from people using the streams for domestic uses.

II. FILARIA

Filaria is one of the major insect borne diseases next to malaria in this country. Although, not a deadly disease it causes monstrous deformities thus rendering the individual a social outcast.

Of the 66 provinces in the Philippines, 48 have been surveyed for filaria. The disease was found endemic in 29 provinces. A total of 282,712 persons coming from 48 provinces have been examined with an overall micro-filaria rate of 3.7%. Filariasis in the Philippines is caused mainly by Wuchereria bancrofti. This is transmitted by Culex pipiens fatigans in big municipalities or in semi-urban areas. The mosquitoes breeds on stagnant water and artificial containers. Whereas, in provinces where abaca (Musa textiles), banana "Saba" (M. sapientum compressa), "Pandan" (Pandanus Sp.) plants are common the vector is Aedes (Finlaya) poicillius. This mosquito breeds on axils of abaca, banana and pandan plants. In the absence of these two vectors, in some places the Anopheles flavirostris the principal malaria vector was found to transmit the bancroftian type of filariasis. Another filaria parasite that is found in the country is the Brugia malayi. It is found in the Southern part of Palawan. The mosquito vector is Mansonia bonneae. It breeds on bodies of fresh water with acquatic plants like Pistia stratiotes and Eichornia crasipes. The larvae of this species attach itself to the roots of these plants under water thus it is difficult to control with larvicide.

Filariasis being a mosquito-borne disease, studies on its transmission, epidemiology, treatment and control follow certain patterns similar to malaria. The method of control using DDT at 2gm/m² at six months interval was found to be effective and showed reduction in adult mosquito density and the vector infection rates.

However, if a country wide control for filariasis is contemplated it is more difficult because Wuchereria and Brugia have a multiplicity of mosquito vectors representing a wide variety of ecological conditions.

III. DENGUE/HAEMORRHAGIC FEVER

This disease is an arthropod borne virus that is transmitted by *Aedes aegypti*. At present, H-fever is being considered as one of the major public health problem of this country. Usually, this disease occurs in epidemic proportion during rainy months, (July-September) and always associated with the fluctuating densities of *Ae. aegypti*.

Last 1966, the Greater Manila area had its worst H-fever epidemic, wherein the total cases amounted to 9,364 with 250 deaths. The hardest to be hit were the poorer sectors of the urban area where housing condition appears congested.

Chemical control, in the form of fogging, residual spraying and larvicidings is the only immediate recourse to relieve the population during epidemic. However, control of the vector *Ae. aegypti* is hampered by its development of resistance to DDT in this country. Because of this prevailing problem, the different cities and municipalities within the Greater Manila area used Mistox-C and Malathion for fogging and spraying. These two insecticides both contain DDVP (0,0-dimethyl 2,2-dichlorovinyl phosphate) of different concentration as the active ingredient. The final concentration of the emulsion was 0.5% and observed to be effective against *Ae. aegypti* and other mosquitoes. Consumption of these two chemicals were minimal in quantity due to lack of funds among the different city and municipal health departments.

Abate - As a larvicide was found to have excellent effect on the larval stage of *Ae. aegypti*. The most convenient formulation for *aegypti* control was the 1% sand granules.

IV. SCHISTOSOMIASIS

Schistosomiasis in the Philippines is caused by *Schistosoma japonicum*. It is transmitted by a snail intermediate host called *Oncomelania quadrasi*. The disease is maintained or may be contracted when an infected person or animal deposits his stools with ova in it on the water. While on the water, the ova will hatch into miracidia. The miracidia will parasitize the *O. quadrasi* and when inside the snail, an enormous multiplication occurs in this intermediate host. After reaching a certain stage of development, the parasites leave the snail as fork-tailed cercariae and live in the aquatic environment. The cercariae can penetrate the intact skin of man and do so when exposure takes place in water containing them.

In the Philippines, there are 23 provinces found to be infected with this disease. The estimated population at risk was 3,374,951 persons with an estimated total cases of 529,070. This disease mainly affect agricultural workers and their families.

Control of snails by means of agro-engineering methods appears to be the most practical way of minimizing the disease. The use of molluscocides is only resorted to as a terminal measure when the distribution of snails still exist in small pockets. The molluscocides commonly used for this purpose are NaPCP (Sodium Pentachlorophenate) and Bayer 73 (Niclosomide). These are formulated at the rate of 5gm/sqm and 0.5gm/sqm, respectively. The application was at monthly interval and found to be effective against guadrasi snails.

V. PREVENTION OF PLAGUE

Plague is a highly infectious disease and has a high mortality rate to human. The causative organism is Pasteurella pestis. It is essentially a disease of rodents usually transmitted by rodents fleas, Xenopsyela cheopis as the intermediate host.

The Bureau of Quarantine is continously guarding our shores from the possible importation of this dangerous disease. All "Open Ports" of our country are being watched as the possible entrance through commercial ships coming from infected countries like India and Vietnam. Quarantine personnel are impowered to fumigate any ship found with high density of fleas on board. For fumigation, the Bureau of Quarantine has been using cyanogas and sulphur (Table III).

For rat control in the Pier area, they used these rodenticides; Sodium flauroacetate "1080" and lipnadione - consumption of these chemicals were minimal due to their high toxicity. The Bureau of Quarantine has to be highly commended in their efforts in preventing the occurrence of such a disease in this country.

VI. HOUSEHOLD PEST

1. Common Houseflies:

(a) Musca domestica
(b) Musca sorbens

2. Cockroaches:

(a) Blatta orientalis
(b) Blatella germanica
(c) Periplaneta americana
(d) Periplaneta australasiae

3. Culicine Mosquitoes:

(a) Culex pipens fatigans
(b) Aedes albopictus
(c) Aedes aegypti

4. F l e a s :

(a) Ctenocephalides canis
(b) Ctenocephalides felis-felis
(c) Ctenocephalides felis-orientis

5. Bedbugs :

(a) Cimex lectularis
(b) Cimex hemipterus

6. A n t s : Most household ants belongs to the family Formicidae.

The control of these insects listed above has long been recognized as vital to the community. Both from the standpoint of being a potential disease carriers and its capacity to annoy. These groups of insects are the most highly exposed to the different preparation of insecticides intended for household consumption. Last year alone the estimated quantity sold throughout the country by the different enlisted companies amounted to several million liters not considering the powder forms. Actually, this is an indication that there is a big demand in the market for such products. Because of this, public interest should be guarded from over exposure. The government should establish a research laboratory that will ascertain the toxicity of every preparation being sold to the public. Together with this, Health Education in the proper usage of these chemicals should be carried out.

Pesticides are indispensable in the maintenance of Health and comfort at this modern age. However, the use of these chemicals seems short lived because these household pests developed resistance to a wide variety of insecticides used against them in less than two decades.

###

Summary

1. Pesticide in public health is mainly used to control insects, snails and rodents which transmits or serve as carriers of human diseases; like malaria, dengue/haemorrhagic fever, Filaria, cholera, el tor, schistosomiasis, plague, etc.

2. Last February 15, 1952, the Philippine Government, the World Health Organization (WHO) and the United States Mutual Security Agency (MSA) now Agency for International Development (AID) agreed to establish the Malaria Pilot Project to find out whether DDT residual spraying of houses could be effective and economical method of controlling malaria.

3. The recommended dose of 2gm/m twice a year was adapted as the standard dosage for the whole country. The spraying were done inside houses, dwelling and their sheds, temporary shelters and tents, and any structure where people may sleep, assemble or spend some hours of the night.

4. From 1952 to 1974, the malaria program consumed 26,480,653 lbs. of DDT and these were sprayed to 19,895,498 total number of houses. This anti-malaria efforts have brought about a reduction of malaria from an estimated 2,000,000 cases and 10,000 deaths each year in the 1940's to 40,000 cases and less than 1,000 deaths in 1972. In the same period, malaria used to be the number two disease killer of the country and now reduced to number 14 in the list.

5. Dieldrin, although effective in interrupting malaria transmission, however, we stopped using it because the principal vector, Anopheles flavirostris developed resistance to this insecticide.

6. Baygon or Propoxur has long residual effects against the vector, but people objected to its use because it makes the walls of houses untidy. Also, during the actual spraying it has some side effects to the spraymen.

7. Abate when used as a larvicide against the aquatic stages of An. flavirostris, An. mangyanus and An. litoralis showed that malaria transmission could be interrupted successfully. However, the cost of operation was something prohibitive.

8. Filariasis being a mosquito-borne disease the method of control using DDT at 2gm/m at six months interval was found to be effective in reducing the adult mosquito density and the vector infection rates.

9. During M-fever epidemic chemical control, in the form of fogging, residual spraying and larvicidding is the only immediate measure to relieve the population. However, Ae. aegypti has developed resistance to DDT in this country.

10. Abate proved to be an excellent larvicide against the aquatic stage of Ae. aegypti.

11. Schistosomiasis in the Philippines is transmitted by a snail intermediate host (Oncomelania quadrasi) and it is traditionally controlled by means of anti-schistosomiasis measures. The use of molluscicides is only reported to be a minimal measure when distribution of snails still exist in small pockets.

12. To prevent the possible importation of even a single case of plague in our country, the Bureau of Quarantine has been using cyanogas and sulphur to fumigate ships coming from infected areas. For rat control within the city proper they use Sodium fluoroacetate "1080" and lipnadione.

13. Household pests are the most highly exposed group of insects to the different preparations of insecticides intended for domestic uses. Because of this, the government should protect the public from over exposure by establishing a research laboratory and through Health Education campaign.

14. Pesticide is indispensable in the maintenance of health and comfort at this modern age.

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1. ESTRADA, J.P. and D.G. BASIO: Filariasis in the Philippines, Jour. Phil. Med. Association, 41:100, (1965).

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TABLE I

DDT USED, HOUSES SPRAYED & NO. OF PERSONNEL EMPLOYED BY THE MALARIA ERADICATION SERVICE
(Fiscal Year 1953-1974)

Fiscal Year	Houses Sprayed	Insecticide Used			Personnel Employed
		DDT 75% Powder in lbs.	Dieldrin in lbs.	25% Emulsion Concentrate (gal)	
1952 - 1953	149,879	329,734			
1953 - 1954	1,260,694	2,773,527			
1954 - 1955	1,260,478	2,749,142	10,868		
1955 - 1956	1,429,314	2,372,227	351,029		
1956 - 1957	1,520,489	77,393	505,140		5,142
1957 - 1958	426,783	51,953	149,160		3,280
1958 - 1959	486,350	65,872	179,404		11,873
1959 - 1960	687,915 #	836,463			2,124
1960 - 1961	535,162 #	644,991			1,782
1961 - 1962	648,509 #	991,315			1,503
1962 - 1963	574,487 #	1,038,279			2,450
1963 - 1964	978,111 #	1,396,383			3,848
1964 - 1965	1,235,031 #	1,[illegible]2,518			1,669
1965 - 1966	676,215	896,730			3,916
1966 - 1967	1,048,379 #	1,296,925			3,825
1967 - 1968	923,819 #	1,378,259			3,502
1968 - 1969	1,737,224 #	2,417,300			5,046
1969 - 1970	1,273,412 #	1,591,473		19,925	3,899
1970 - 1971	468,628 #	424,125		136,578	2,883
1971 - 1972	537,627 #	831,150		54,203	2,342
1972 - 1973	543,401 #	721,919		42,171	2,791
1973 - 1974	832,644	1,004,606			1,168
1974 - 1975($\frac{1}{2}$)	537,370	718,472			1,891
TOTAL	19,895,498	26,480,653	1,195,901	252,880	65,534

NOTE: # - Two cycle/year spraying
@ - Total personnel employed exposed or handling insecticide

/ngs

TABLE II - SUSCEPTIBILITY STATUS OF *A. minimus flavirostris* to DDT and DIELDRIN

Date of Test	LOCALITY	DDT		% Mortality to 4% DDT for 1 hour	Susceptibility Status*	DIELDRIN		% Mortality to 1.6% DN for 1 hour	Susceptibility Status*	REMARKS
		LC-50	LC-100			LC-50	LC-100			
June 1959	Malasila, Midapawan, Cot.	0.5	2.0	-	S	-	-	44.0	R	-
July 1959	Malasila, Midapawan, Cot.	-	-	-	-	-	-	33.0	R	-
July 1959	Midapawan, Cot.	0.5	1.0	-	S	1.27	-	37.0	R	-
Sept. 1961	" "	-	2.0	-	S	-	-	55.5	R	-
June 1967	" "	0.44	2.0	100.0	S	-	-	-	-	No test made w/DN
July-Aug. 1968	" "	0.5	1.0	100.0	S	-	-	46.5	R	-
July 1969	" "	0.5	4.0	99.0	S	1.6	-	49.5	R	-
Oct. 1961	Maguindo, Butuan City	-	2.0	-	S	-	-	65.2	I	-
July 1969	Cadunan, Sabini Davao del Norte	-	4.0	99.0	S	-	-	-	-	
Mar. 1961	Tawi-Tawi, Sulu	0.5	-	-	S	-	-	-	-	74% Mortality to 1% DDT; no test w/DN
Nov. Dec. '59	P. Princesa Palawan	0.42	4.0	100.0	S	0.04	0.2	-	S	-
Aug. 1960	" "	-	4.0	100.0	S	-	-	-	-	-
Apr. 1964	" "	0.9	4.0	100.0	S	0.05	0.2	-	S	-
Oct. 1968	" "	1.0	4.0	100.0	S	-	-	-	S	97% R to 0.4% DN
June 1969	" "	-	4.0	100.0	S	-	-	-	-	No test w/ DN
Aug. 1969	Baba, Candoni, Negros Occ.	0.5	2.0	100.0	S	-	-	-	-	" " "

* - R - Resistance; I - Intermediate; S - Susceptible; Classification in accordance with categories as defined in WHO/Malaria/446, WHO/VBC/04 30.Mal/71 dated May 12, 1964.

TABLE III - CONSUMPTION OF CIANOGAS AND SULPHUR AS FUMIGANTS BY THE BUREAU OF QUARANTINE (1969-1973)*

YEAR	NUMBER OF VESSELS FUMIGATED	CUBIC FEET FUMIGATED	QUANTITY USED OUNCES CYANIDE GAS	RATS RECOVERED	CUBIC FEET FUMIGATED	QUANTITY USED OUNCES SULPHUR	RATS RECOVERED	TONNAGE OF CARGO FUMIGATED
1969	161	7,719,152	2,404	41	2,812,183	8,451	225	24,297
1970	160	6,616,904	19,338	59	1,45[illegible],135	4,319	233	7,489
1971	291	30,896,950	111,203	75	2,103,234	6,426	358	314,067
1972	282	31,928,093	124,859	57	2,326,789	6,788	301	401,385
1973	139	28,273,444	98,565	58	965,083	2,890	236	246,377
TOTAL	1,043	105,524,543	355,429	290	9,665,424	28,874	1,353	993,615

*Only for the Port of Manila as compiled by the Bureau of Quarantine.

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Pesticide Management Seminar - Workshop
MANILA, PHILIPPINES
10-15 February 1975

PM/WP/5
75-10-2

CHEMICAL PROPERTIES AND DEGRADATION PATTERNS OF PESTICIDE GROUPS

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INTRODUCTION

There are now about 900 pesticides in 45,000 distinct formulations and the detailed chemistry of these compounds will constitute a massive book in itself. Although it is some consolation that pesticides may be conveniently arranged into groups, it is by no means simple to present the chemistry of each group. This is because, and this point is always worth remembering, the chemistry of a particular compound is distinctly its own. Thus, any grouping of pesticides is intended to serve only as guides to understanding them and allows generalized ideas of the chemistry of the compounds within the group but should not be looked at as rigid compartmentalization of these compounds.

Table 1

Model Compounds for Pesticide Groups

I. Fungicides

a. Dithiocarbamates -- Nabam

b. Captan and analogs -- Captan

II. Herbicides

a. Phenoxy acids -- 2, 4-D

b. s-Triazines -- Simazine

III. Insecticides

a. Organochlorines -- DDT / Dieldrin

b. Organophosphates -- Parathion / Malathion

c. Carbamates -- Carbaryl / Aldicarb

In view of the limitations of this paper and in an attempt to be relevant to the Philippine setting, it seems most appropriate to discuss pesticide groups using a few model compounds and also discuss only the organic pesticides. It is hoped that through the use of model compounds, group characteristics and dissimilarities may be more clearly illustrated. Since organic compounds constitute the large bulk of the pesticides in the country, a discussion of inorganic compounds would be nothing more than an academic exercise.

A further consideration in this discussion would be the rationale behind the seminar-workshop. Definitely, when talking about pesticide management, the concern is with the why, what, where, and how of pesticide use. Our concern, although primarily man, also extends to the environment and the ecosystem, thus our concern for pesticide degradation. This discussion will therefore focus on two aspects of pesticide use, residues in food and feed which concerns man directly, and those in substrates which affects man indirectly through environmental contamination and ecosystem imbalance.

Table 2

Toxicity Data for Some Organic Pesticides

Pesticides	Rat Acute LD_{50} (mg/kg) Oral	Dermal
A. FUNGICIDES		
Binapacryl	150-350	1,350 (Rb)
Nabam	395	800 (Rb)
Thiram	780	>2,000
Vapam	820	
Dinocap (Karathane)	980	>9,400 (Rb)
(Morestan)	>2,000	>2,000
Zineb	>5,200	>1,000
Captafol (Difolatan	6,200	15,400 (Rb)
Maneb	6,750	>1,000
Captan	9,000	
Benomyl (Benlate)	>10,000	>1,000
Daconyl	>10,000	>10,000
Thiophanate	>15,000	>15,000
B. HERBICIDES		
Paraquat (Gramaxone)	150	80- 480
Diquat	400-440	>500 (Rb)
2,4-D amine	300-1,200	1,500
2,4-D ester	500-1,200	
Diphenamid	1,000	6,320
Atrazine (Gesaprim)	3,080	
Diuron (Karmex)	3,400	
Asulam (Asulox)	>5,000	
Terbacil (Sinbar)	>5,000	
Picloram (Tordon)	8,200	>4,200 (Rb)
C. INSECTICIDES		
1. Organochlorines		
Endrin	5	60
Endosulfan (Thiodan)	30	359
Aldrin	55	>200

Table 2 ..... con't.

Dieldrin	60	>100
DDT	113	2,500
Methoxychlor	6,000	>6,000
Perthane	8,170	-

2. Organophosphates

Parathion	3.6	6.8
Mevinphos (Phosdrin)	6-7	34 (Rb)
Mephosfolan (Cytrolane)	8.9	9.7
Methylparathion	9-25	300-400 (Rb)
Leptophos (Phosvel)	52.8	>10,000
Triazophos (Hostathion)	82	1,100
Chlorpyrifos (Dursban)	163	202
Diazinon	300-400	455
Fenitrothion (Sumithion)	500	1,300
Acephate (Orthene)	866	
Malathion	1,375	4,100 (Rb)

3. Carbamates

Aldicarb (Temik)	0.93	5.0 (Rb)
Carbofuran (Furadan)	11	10,500 (Rb)
Methomyl (Lannate)	17	>5,000 (Rb)
Propuxur (Baygon)	95-104	1,000
MTMC (Tsumacide)	286 (m)	6,000 (m)
BPMC (Bassa)	410	
MIPC (Etrofolan, Mipcin)	485	>500
Carbaryl (Sevin)	500	>500

D. RODENTICIDES

Sodium Fluoroacetate (1080)	0.22
(Gophacide)	3.7-7.5
Fluoroacetamide (1081)	15
Conmafuryl (Fumarin)	25

1/ The data should be regarded only as useful approximate indices rather than as exact data. Where possible, data were taken from "FARM CHEMICALS HANDBOOK", Meister Publishing Co., Ohio (1974). Data not found in this handbook are supplemented from the following:

1. von Rumker, R., and Kerney: Pesticide Manual, Univ. of California-U.S.A.I.D. (1970).

2. Ben-Dyke, R., D. V. Sanderson, and D. N. Noakes: Acute toxicity data for pesticides (1970).

3. Manufacturers' technical data.

2/ Names in parentheses are the most commonly used trade names.

3/ LD_{50} is defined as the dose that kills 50% of a test population. Where there is a choice, data are taken for pure compounds and with female rats. No rabbit is used as the experimental animal while no mouse is an experimental animal.

II. PESTICIDE CLASSIFICATION AND TOXICOLOGY

A conventional classification scheme for pesticides would be according to the living system that it controls. If the definition of a pesticide in the U.S. Federal Insecticide, Fungicide, and Rodenticide Act is adopted, that is, that a pesticide is ".... any substance or mixture intended for preventing, destroying, repelling, or mitigating any insect, rodent, nematode, fungus or weed .....", then the major pesticide groupings will be 1) insecticides, 2) rodenticides, 3) nematocides, 4) fungicides, and 5) herbicides, respectively.

In order to evaluate the hazards in pesticide use to man and other mammals, Table 2 would be important. Toxicity is expressed in terms of LD_{50} values or the dose, in mg/kg body weight, that kills 50 percent of a test population. On the basis of rat acute oral LD_{50} values, pesticides may be classified as highly toxic (LD_{50} = <50), moderately toxic (LD_{50} = 50-500), and safe (LD_{50} = >500). Therefore, the lower the LD_{50} value, the more toxic is the compound.

Acute oral toxicity values are important for pesticides that may be present in food or feed whereas acute dermal toxicity gives an indication of the hazards due to accidental spillage or contact. Chronic toxicity would be more insidious and important but because

of the paucity of data and complexity of the tests, they are not included in the tabulation. Persistence would be another helpful data but its measurement is subject to so much variability that unless work is done on near-identical conditions, the data will only serve to confuse. Besides, even the so-called non-persistent insecticides have been shown to persist in the soil for a long time at low levels.

Considering the rationale for their use and toxicity to warm-blooded animals, there seems to be little cause for worry with herbicides in food and feed. The most likely problems in their use would be related to environmental contamination and disturbance of the microbial fauna in the soil. Fungicides, although generally of lower toxicity, are sometimes applied directly in fruits, vegetables, or may be applied unintentionally so that the more persistent or those able to penetrate the surface may be residue hazards. Since rodenticides are usually kept separate from crops in the field or in the household with baits, they do not pose a direct hazard to the health of humans except through accidental ingestion.

On the whole, insecticides are the compounds of particular concern. The problem comes about because the target is another animal which competes with man for the crops grown or are present

in domesticated animals. It is seen in Table 2 that among the comparatively safer insecticides are acephate, carbaryl, malathion, methoxychlor, and perthane. The fact that there is a wide divergence between oral, and dermal toxicity for several compounds serves to reaffirm the original point that the chemistry and toxicology of these compounds are distinctly their own and generalizations are full of exceptions.

In view of their potential hazards to health, a brief discussion of insecticide toxicology maybe in order so that these compounds may be placed in the proper perspective in subsequent discussions.

Basic to the understanding of insecticide toxicology is the concept of site of action. This concept presupposes the existence of a site in the animal system wherein the insecticide exerts its action and is responsible for death. As can be seen in Figure 1, there are several barriers which a toxic compound must pass through before it reaches the site of action. Only a small fraction of the initially applied dose will, or need to, reach the site of action. Within the insect system therefore, there is a competition between penetration, intoxication, detoxication, inert storage, and excretion. Predominance of intoxication mechanisms may result in insect death while the reverse situation makes a compound harmless.

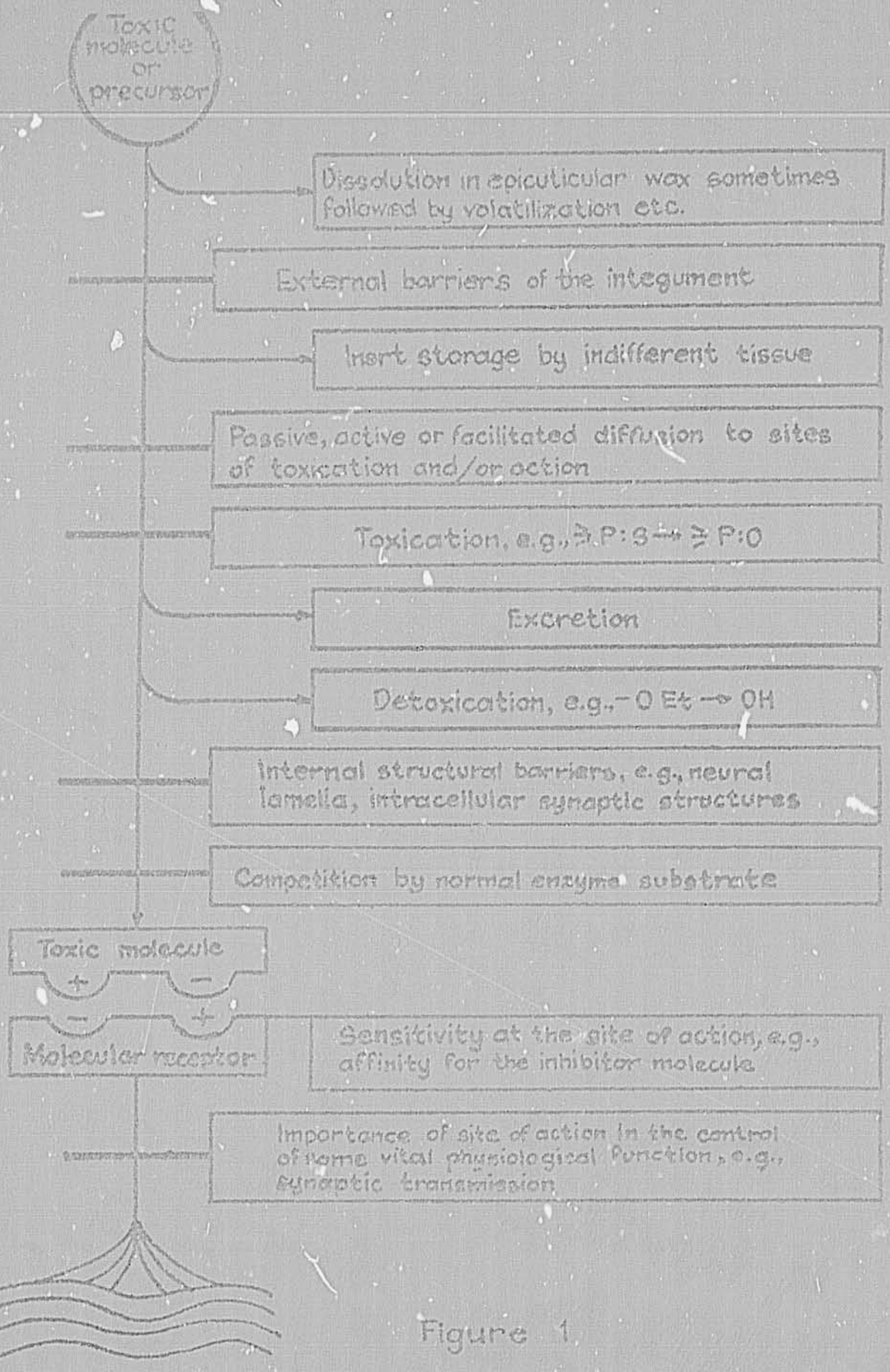


Figure 1

Diagrammatic representation of biochemical and physiological ratelimiting steps and effective barriers in the toxicity of an externally applied insecticide. The vertical arrow represents the successful formation and survival of toxic molecules as far as the molecular receptors of the "site of action." Horizontal arrows represent competing processes of inert storage, detoxication, excretion etc. Horizontal bars represent rate-limiting steps or barriers in the overall process of intoxication. (Winteringham 1969).

Insecticides generally exert their toxic action through their effects on the nervous system. The organochlorines belonging to the DDT and lindane groups are believed to act on the peripheral nervous system while the cyclodienes like aldrin, dieldrin, and endrin may act on the ganglia of the central nervous system. In both cases, the precise biochemical lesion responsible for death is unknown. On the other hand, organophosphate and carbamate toxicity is known to result from the inactivation of the enzyme acetylcholinesterase (AChE). This enzyme is responsible for the hydrolysis of acetylcholine, the nerve impulse transmitter which is present in the nerve endings. The difference between the mode of action of the organophosphates and the carbamates is that while the former is an irreversible inhibitor of AChE, the latter is a reversible inhibitor.

Since the system acted upon by insecticides are present in insects as well as in mammals, it is obvious that care must be taken in their use. There are also differences in the physiological processes between insects and mammals leading to differences in insecticide metabolism, e.g., the presence of carboxyesterase in and its absence in insects. These differences have been taken advantage of in designing compounds with selective toxicity. Spe-

cificity for pest species to the exclusion of beneficial insects are more difficult to take advantage of because of species overlaps.

III. COMPARATIVE DEGRADATION CHEMISTRY

The relationship between toxicology and degradation rates may be seen in Figure 2. Point 1 may be taken as the concentration of the initial deposit whose degradation shows a layering effect, that is, the upper layer of molecules will be decomposed ahead of those found in the lower layer. Point 2 may be taken as the minimum level effective for pest control so that region A represents the concentration effective for the pest. Region B is the degradation curve where penetration and reissue takes place while region C is the persistence curve; the distinction between regions B and C is only of academic interest.

A. Substrates of Importance and Factors Responsible For Degradation

The actual shape of the residue curve is influenced by biotic and abiotic factors present or acting on the substrate. Pesticides may undergo substrate transfers in accordance with their chemical and physical characteristics.

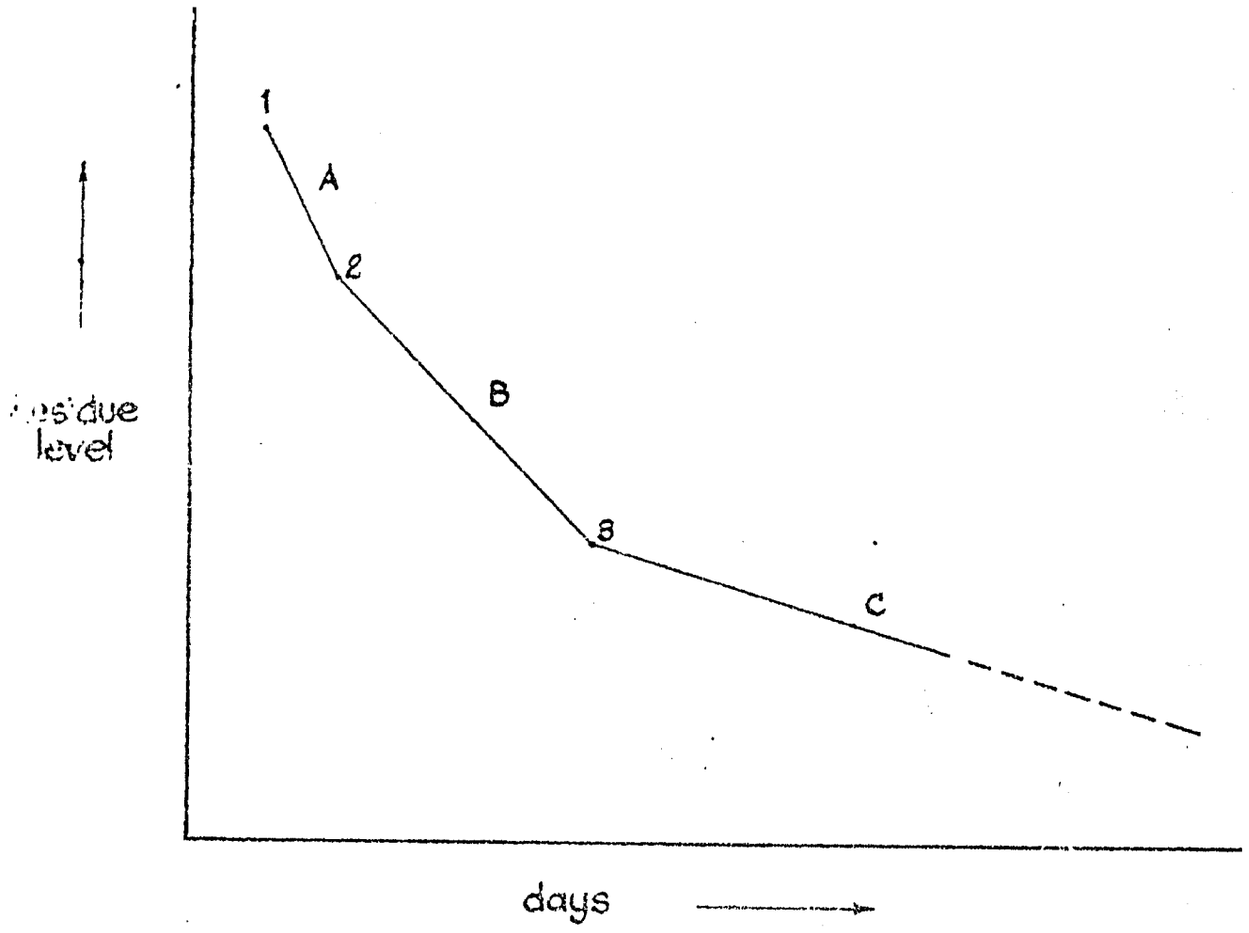


Figure 2

A typical residue curve in plant substrates

It can be seen from Figure 3 that in addition to the plant system the substrates that are important in pesticide decomposition are air, soil, and water. In the plant system, degradation occurs either through the forces acting on the surface or subsurface deposits. Light, heating effect of solar radiation, and hydrolysis due to moisture are the major factors causing degradation. Enzymatic and chemical mechanisms are responsible for the breakdown of subsurface deposits usually into polar molecules which may then react with other indigenous molecules to form conjugates.

The soil is the main matrix of pesticide deposition as a result of direct application, run-off from treated surfaces, drift, sloughing off through moisture or rain action, rainfall to bring down the pesticides which may have sublimated with water, as well as the normal proportion which falls to hit the target plant surface. Microbial degradation is the main pathway of decomposition with chemical and physical reactions also playing a small part.

Pesticides may be present in the water due to soil erosion, direct application, rainfall, and the limited solubility of compounds in this medium. In the water itself, degradation may occur through hydrolytic and photolytic mechanisms. Aquatic organisms and animals feeding on them could concentrate the pesticides and cause

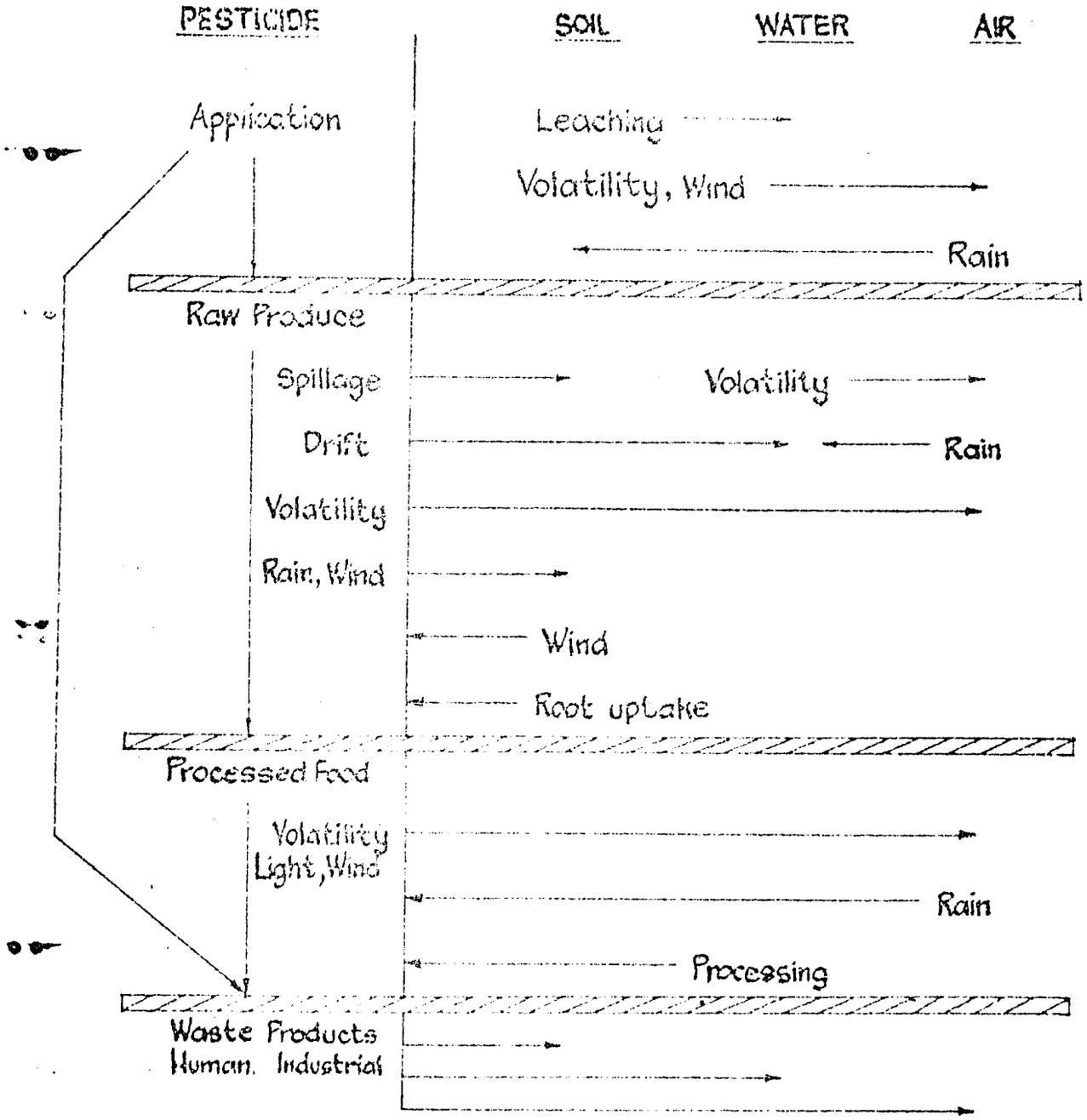


Figure 3

DISTRIBUTION OF PESTICIDES

their decomposition. The settling muds will also reduce pesticide levels in water.

In air, photodecomposition is expected to be the major degradation mechanism with some limited hydrolysis also occuring. The presence of pesticides could be due to volatilization, drift during spraying operations, and the continued suspension of very fine deposits in air.

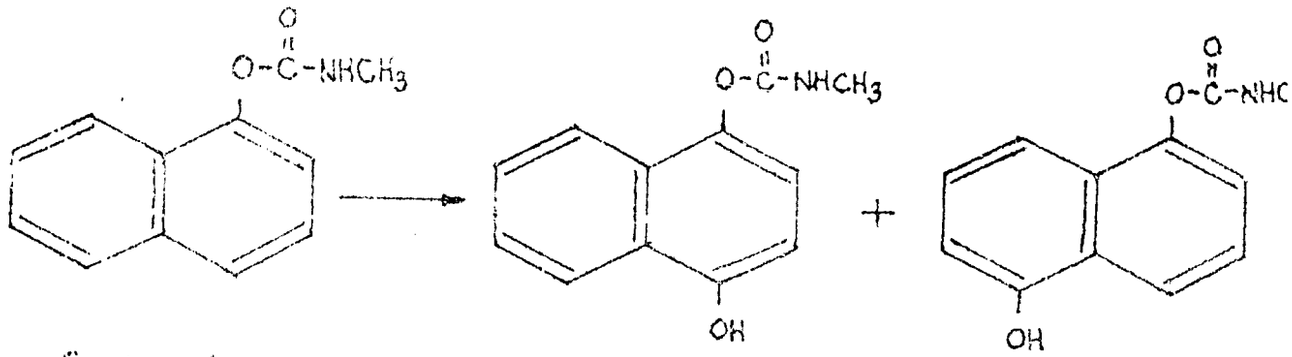
B. Generalized Reaction Mechanisms

Two major types of degradative reactions can be recognized, namely, 1) The biochemical reactions which occur in the presence of an organism or its component, and 2) non-biochemical reactions which takes place in the absence of any effect from living systems. A reaction may however be both biochemical or non-biochemical and the distinction between the two mechanism in a complex matrix like the soil or plant is quite difficult. In Table 3 are given some of the representative reactions of pesticides. Two or more of these reactions are responsible for the total degradation of pesticides in the environment. Some of the reactions may also be activation rather than inactivation reactions. Activation reactions make the

Table 3

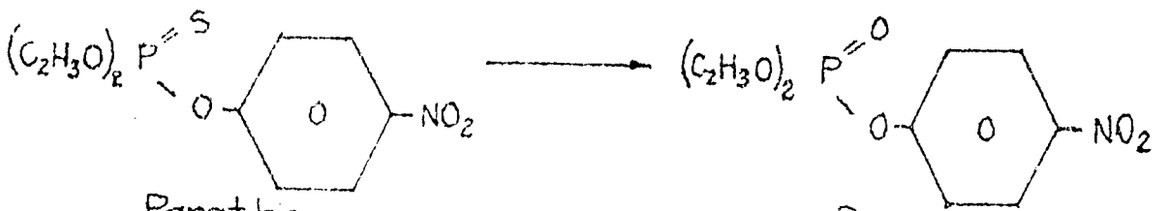
Some Reactions of Pesticides

1. Ring Hydroxylation



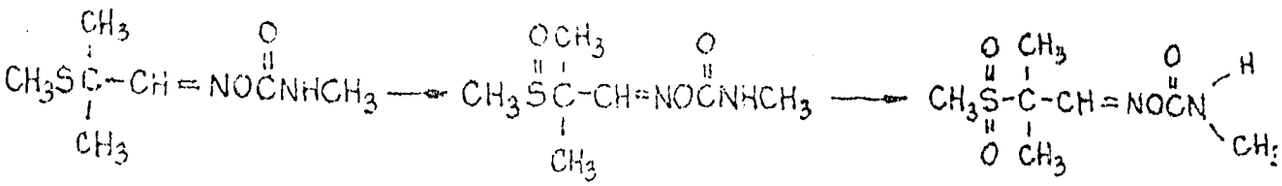
Carbaryl 4-OH Carbaryl 5-OH Carbaryl

2. Desulfuration



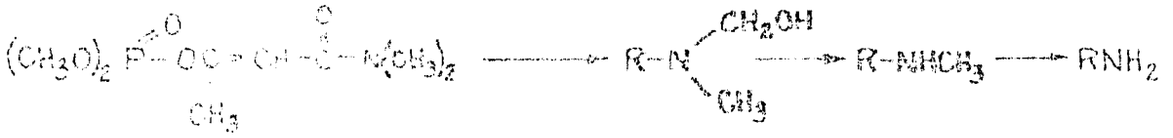
Parathion Paraoxon

3. Thioether Oxidation



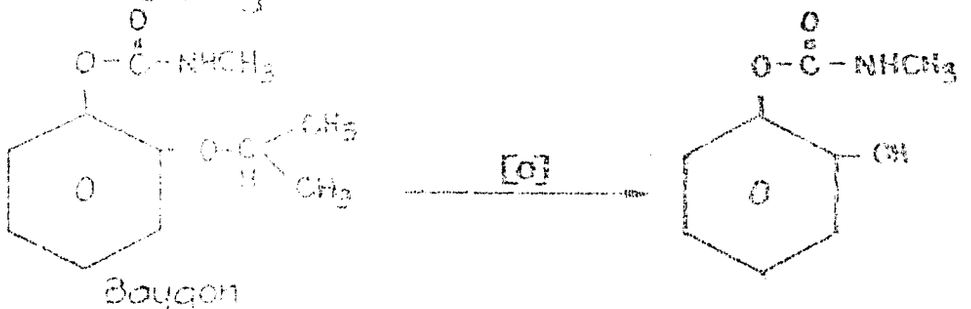
Aldicarb Aldicarb sulfoxide Aldicarb sulfone

4 N – Dealkylation



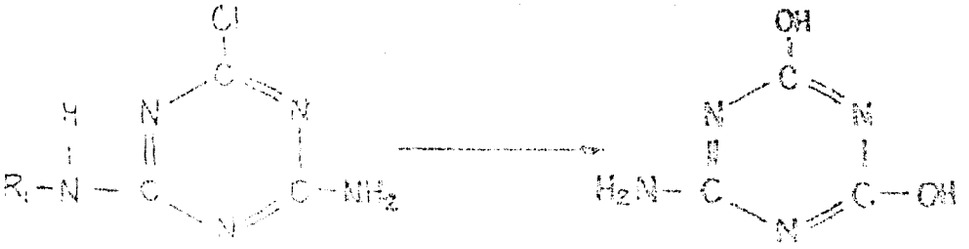
Bidrin

5. O – Dealkylation



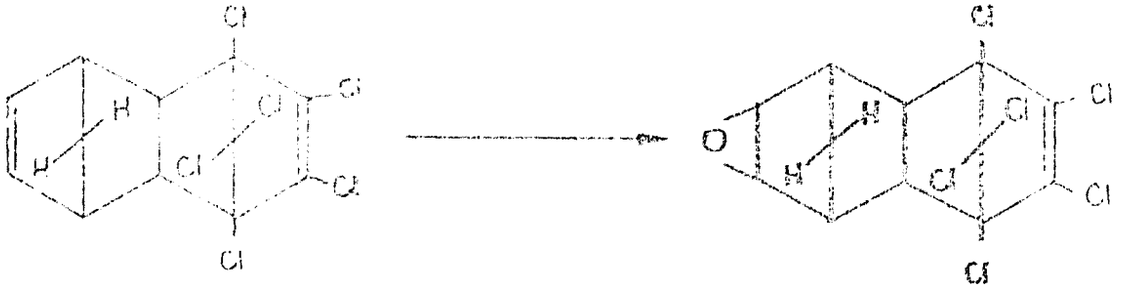
Baygon

6 Deamination



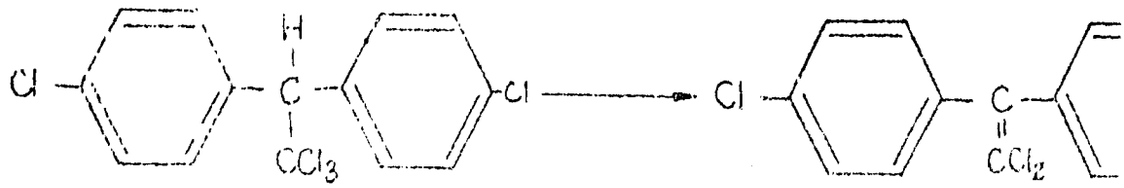
Chloro – s – triazine

7. Epoxidation



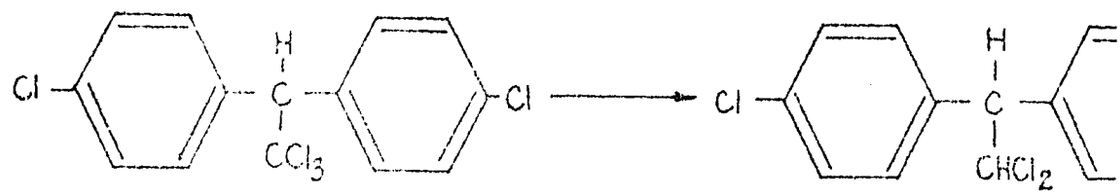
Aldrin Dieldrin

8. Dehydrohalogenation



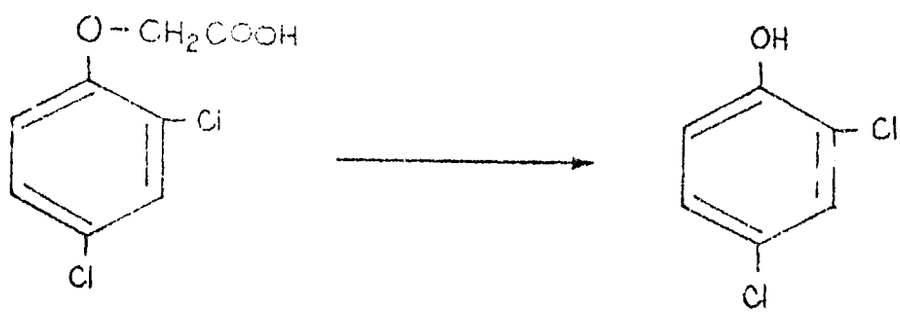
DDT DDE

9. Dehalogenation



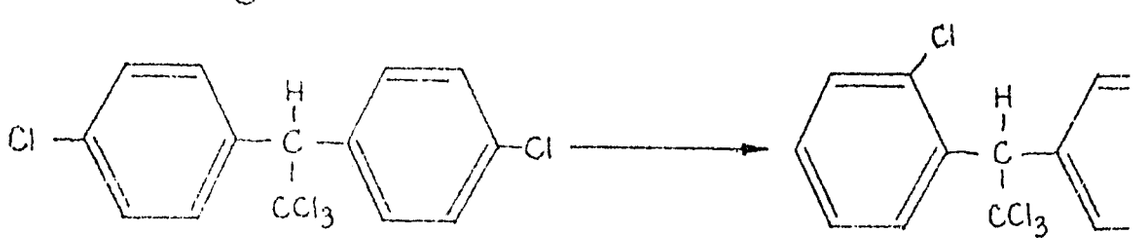
DDT TDE

10. Decarboxylation



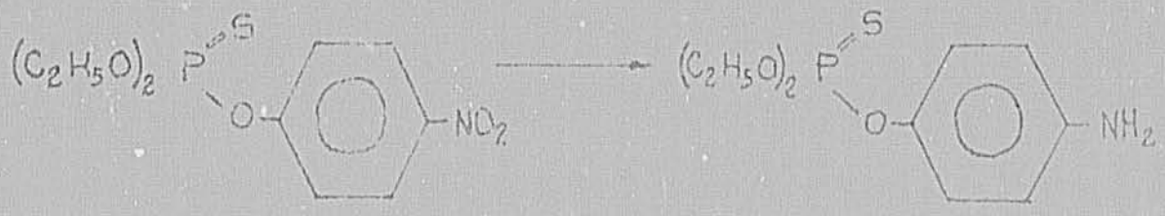
2,4-D 2,4-Dichlorophenol

11. Rearrangement



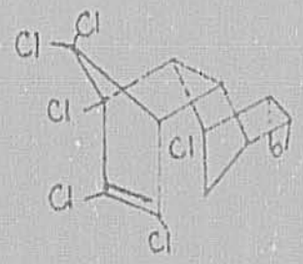
p,p'-DDT o,p'-DDT

12. Reduction

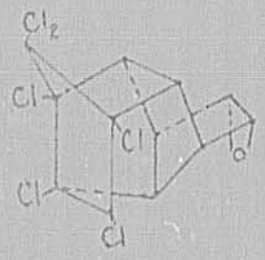


Parathion Amino parathion

13. Photolysis

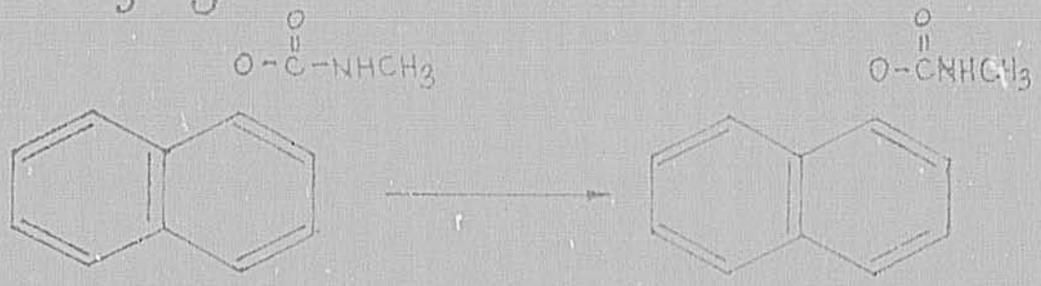


Dieldrin



Photodieldrin

14. Conjugation



4-OH- Carbaryl O-glucoronide

compounds more toxic. Examples of these reactions are thioether oxidation, sulfur oxidation, N-dealkylation, and some photochemical reactions. The other reactions are generally detoxication reactions.

C. Transformation of Model Compounds

Combinations of reaction in several substrates of model compounds are shown in Figures 4-13.

1. Fungicides

a. Model Group No. 1: Dithiocarbamates

Model compound: Nabam

Related compounds: Maneb, zineb, metham, ziram

Comments on group: These compounds are the most widely used and most versatile of the organic fungicides. The watersoluble analogs, zineb and maneb, have very wide spectra of activity as foliar sprays for fruits, vegetables, and ornamentals for the control of blights, leafspots, blotches, and mildews. The dithiocarbamates are generally of low mammalian toxicity and are unstable in soil.

Nabam Transformation (Figure 4):

Direct microbial degradation and conjugate formation has not been demonstrated unequivocably. However, nabam is quite unstable in agneous solutions. Under slightly acid conditions it is split into ethylenediamine and carbon disulfide with the former possibly being

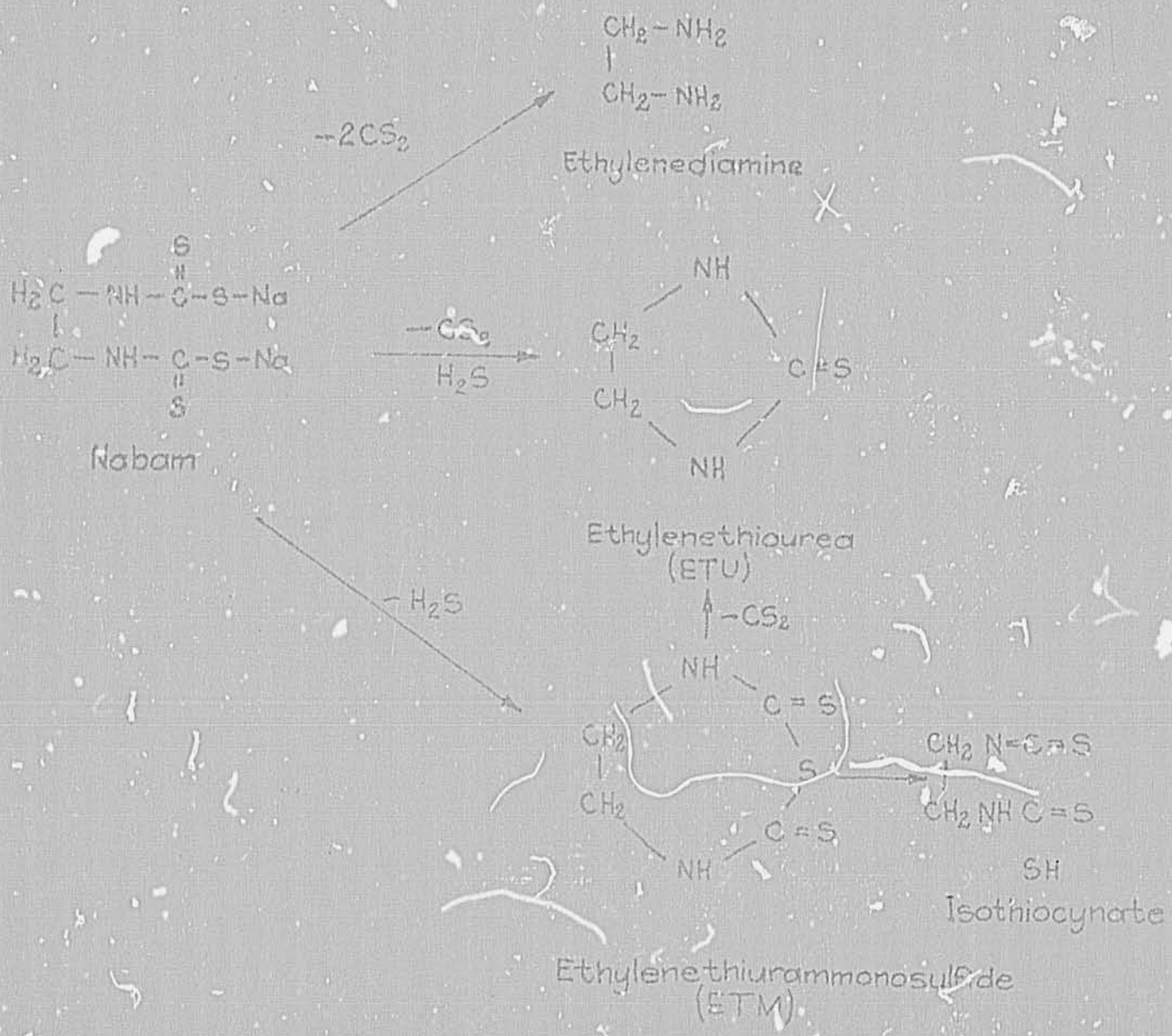


Figure 4

Some Conversions of Nabam

used by a variety of bacteria as a source of nitrogen. Ethylenethiourea (ETU) and ethylenethiuramonosulfide (ETM) appears to be the major products in soil. ETU is a stable compound. Polymerization and reaction with heavy metals are also known to occur.

b. Model Group No. 2: Captan and analogs

Model compound: Captan

Related compounds: folpet, difolatan

Comments on Captan: Captan is one of the safest fungicides to plants and mammals. It is widely used for the control of plant diseases such as scab, rots, leafspot, blotch, mildew, blights, and damping off. The biochemical lesion may be due to its reaction with -SH groups within the fungus cells to produce thiophosgene which in turn react with free sulfhydryl, amine, and hydroxyl groups of enzymes.

2. Herbicides

a. Model Group No. 1: Chlorophenoxy acids

Model compound: 2, 4-D

Related compounds: 2, 4, 5-T, MCPA, silvex

Comments on group: Forerunners of modern herbicides, these compounds are cheap and can be translocated in plants. They are selective for broad-leaved weeds in cereals and could be absorbed from soil as pre-emergent herbicides.

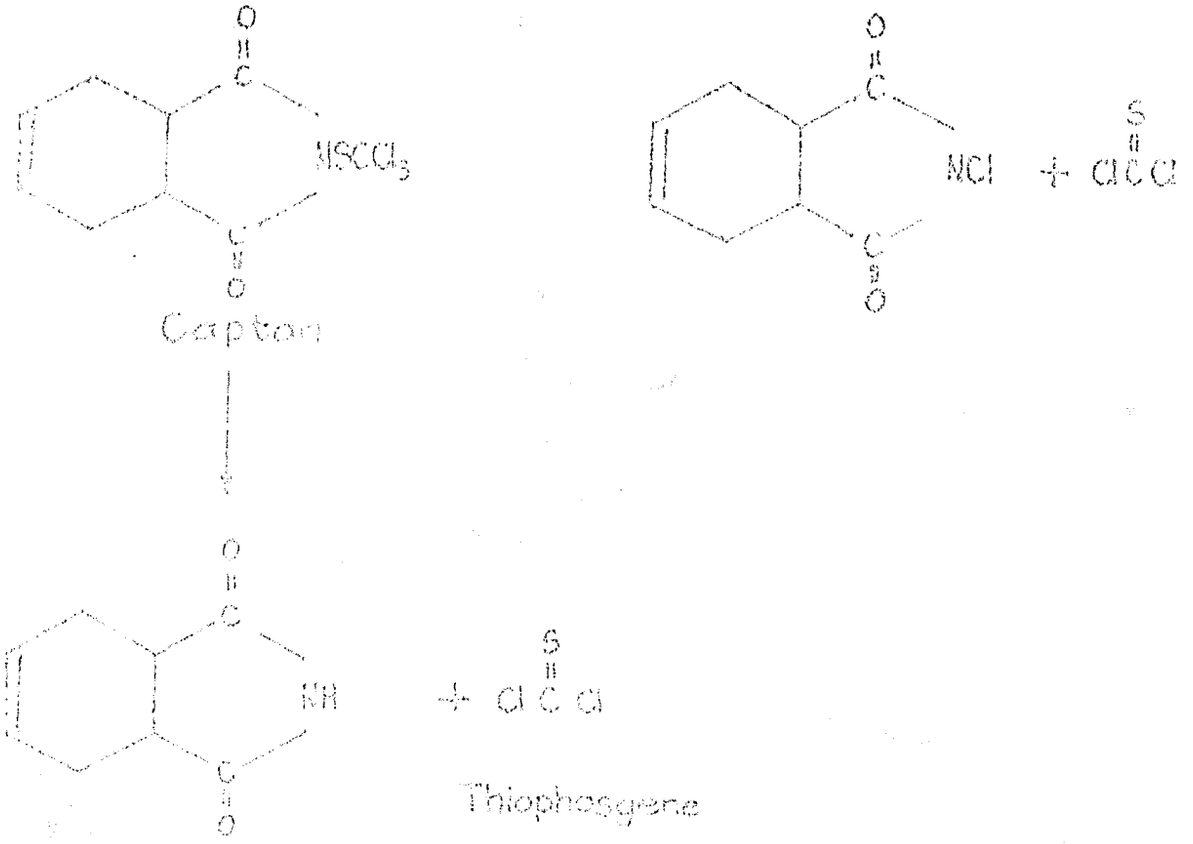


Figure 8

Transformations of Captan in Fungal Cells

a. 2, 4-D transformations (Figure 6):

Degradation is mainly through ring hydroxylation and decarboxylation with the resultant hydroxylated products being available for conjugation. Alternatively, the aromatic ring may be cleaved to give chloromuconic acid. There is very little metabolism of 2, 4-D in mammals and unaltered herbicides are excreted in the urine and feces.

b. Model Group No. 2: s-Triazines

Model compound: Simazine

Related compounds: Atrazine, ametryne, prometryne.

Comments on group: The triazines have a wide variety of herbicidal action and are valuable as post- and pre-emergent compounds. At low dosages, they kill broad leaved weeds and are soil sterilants at high dosages. They act by inhibiting photosynthesis.

Simazine transformations (Figure 7):

Simazine is the most versatile of the triazine herbicides because of its very low water solubility and high binding energy to colloidal soil particles. In plants and soils, the major route of decomposition is through the substitution of the chlorine at the 2-position with the hydroxyl group; this is true with all 2-chloro-s-triazines. Dealkylation is a minor reaction catalized by several soil microorganisms.

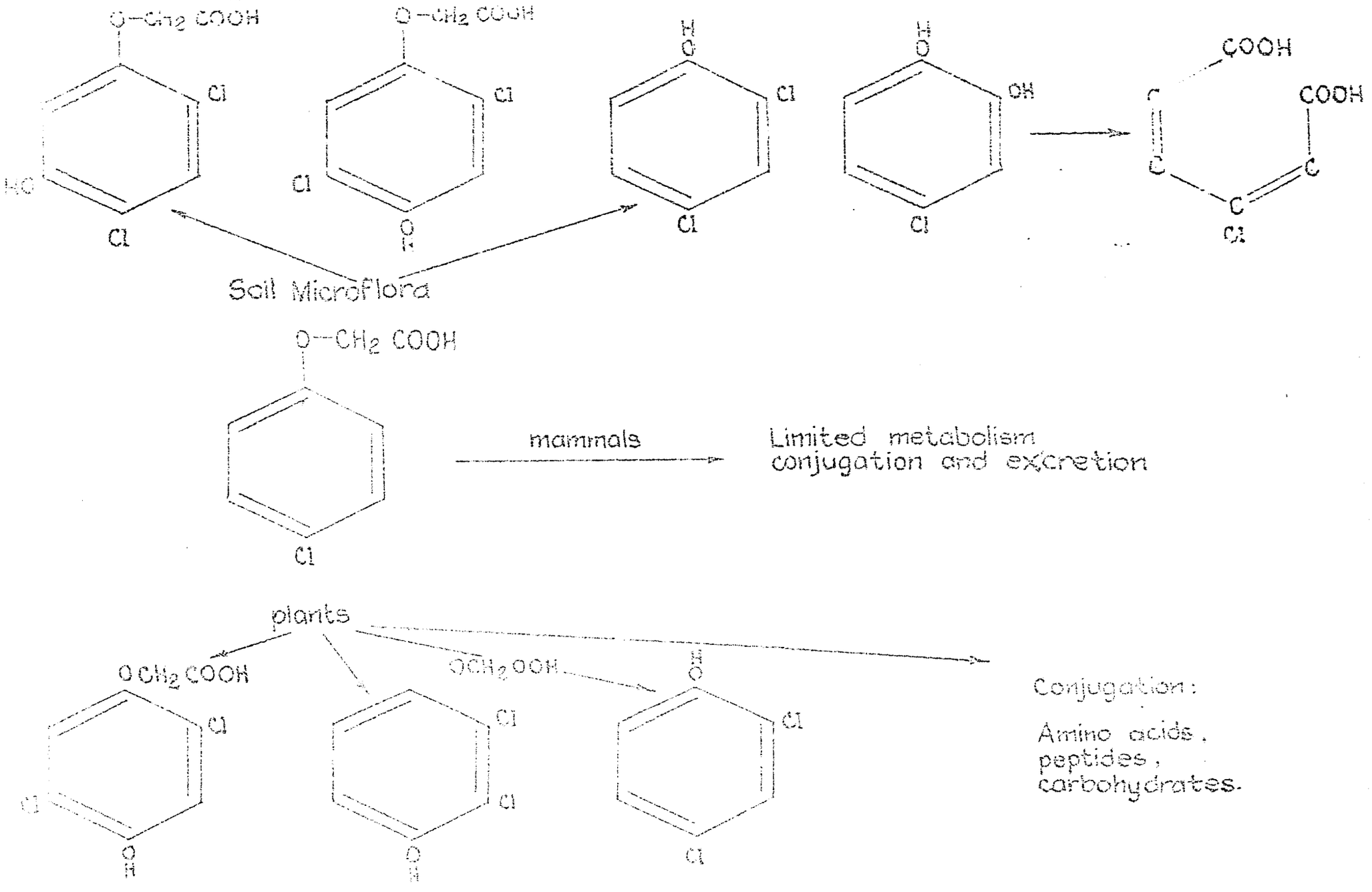


Fig. 5. Metabolism of 2,4-D in plants, mammals and soil microflora.

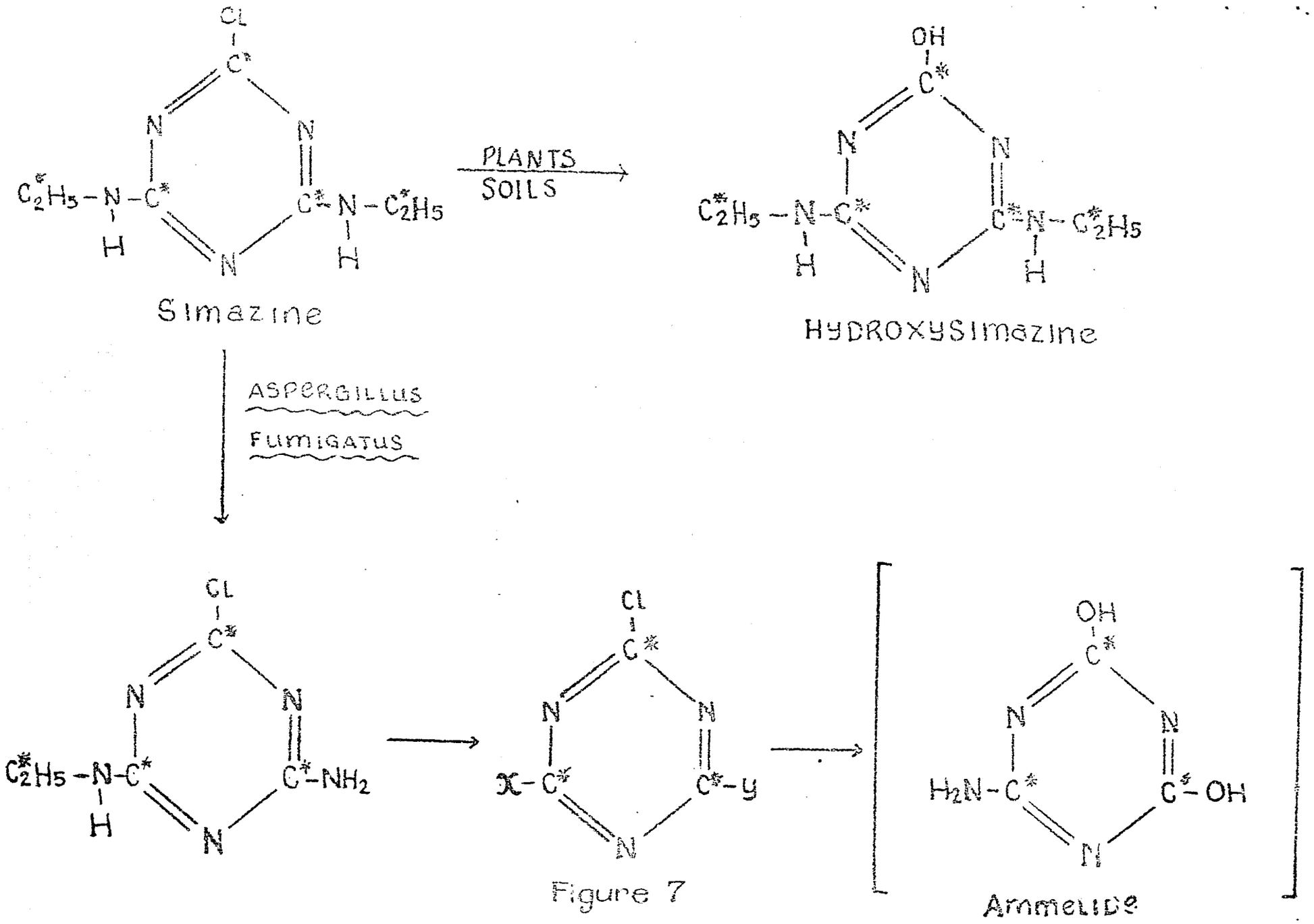


Figure 7

Proposed pathways of simazine decomposition in soils (from KEARNEY *et al.* 1965 b)

3. Insecticides

a. Model Group 1: DDT-type compounds

Model compound: p, p'-DDT

Related compounds: TDE, Perthane, Methoxychlor, Kelthane

DDT transformations (Figure 8):

The main metabolic and environmental transformation product of DDT is DDE. For mammals and some soil microorganism TDE is the major transformation product. Kelthane is one of the products in insects. DDT persistence in the environment and some of its adverse effects have been attributed to DDE.

b. Model Group 2: Cyclodienes

Model compound: Dieldrin

Related compounds: Aldrin, endrin, telodrin, heptachlor.

Dieldrin transformations (Figure 9):

Dieldrin may be formed through the epoxidation of aldrin in plants, animals, insects enzyme systems, and microorganisms. Further metabolism gives rise to a several products, the major metabolites being 4a-hydroxydieldrin and water-soluble glucoronides of the hydroxylated cage structures. Of particular interest is photodieldrin formed when dieldrin is irradiated with sunlight resulting in the methylene bridge being bonded to an adjacent carbon atom.

Photodieldrin is twice as toxic as dieldrin to houseflies and mosquitoes and about 2-4 times more toxic to mice (LD_{50} = 5 mg/kg).

c. Model Group 3: Parathion group

Model compound: Parathion

Related compounds: Fenitrothion, Chlorthion

Parathion transformations (Figure 10):

Parathion is susceptible to microbial degradation. Under aerobic conditions, the major metabolite is aminoparathion which is further degraded to other compounds. None of this transformation occurs under anaerobic conditions and aminoparathion is the end product. Breakage of the P-O bond to give the nitrophenol occurs quite rapidly.

d. Model Group No. 4: Malathion group

Model compound: Malathion

Related compound: Mevinphos

Malathion transformations (Figure 11):

Malathion is readily degraded by hydrolysis of the P-S or of the carboxyester bonds. In soils this gives rise to the monoacid or to the dimethyl thiophosphoric acid. The primary route of detoxication in mammals is carboxyesterase cleavage of the ester bond whereas in insects, metabolism is to the toxic malaoxon.

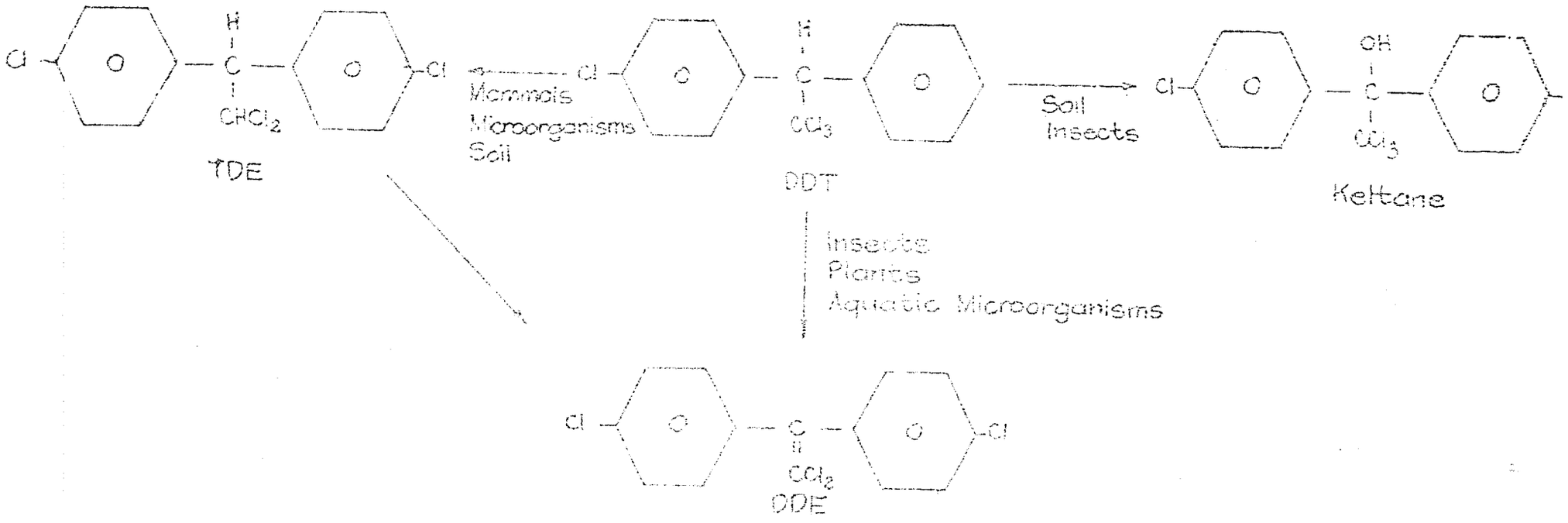


Figure 8

Major Transformation Products of DDT

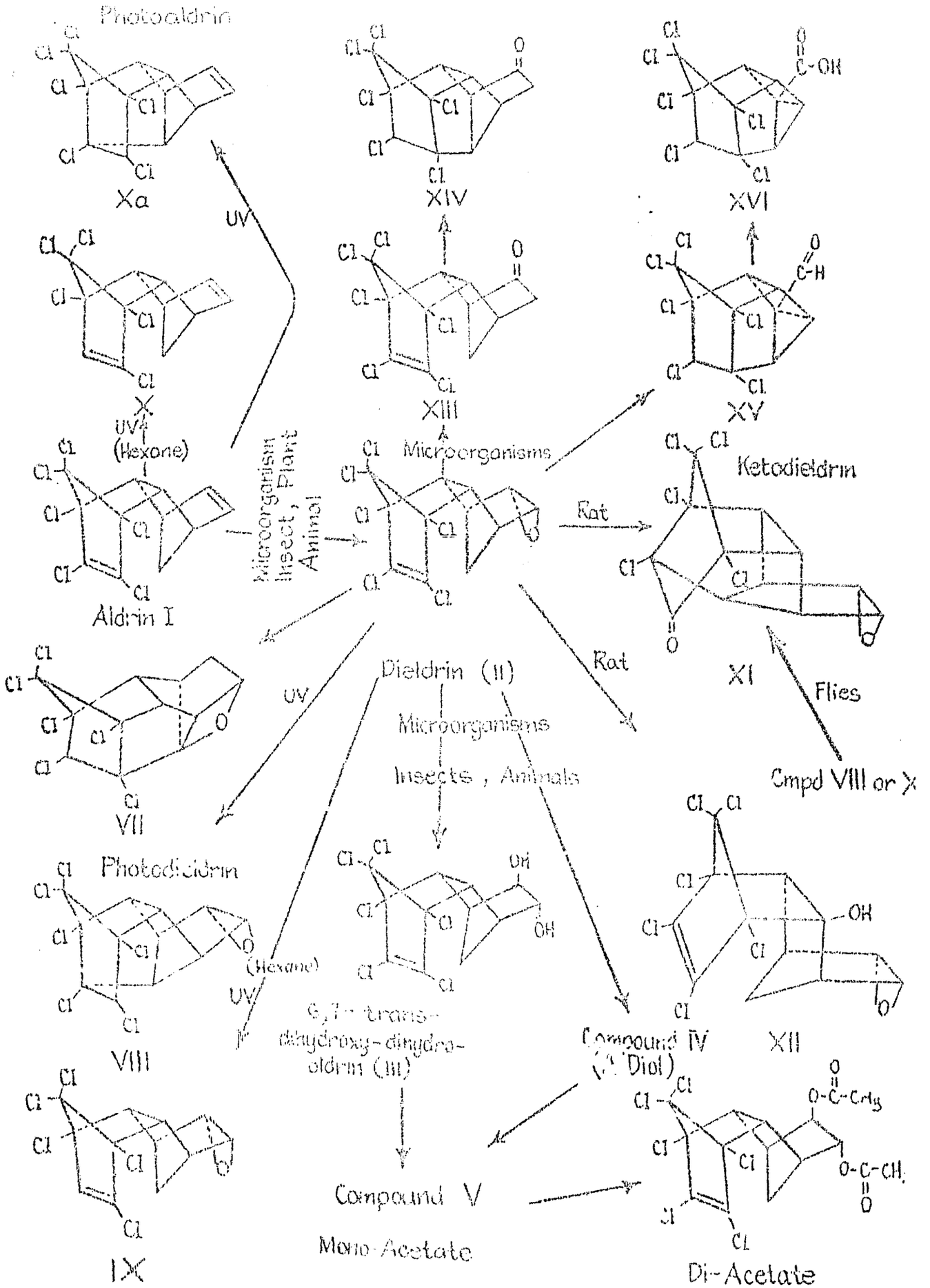
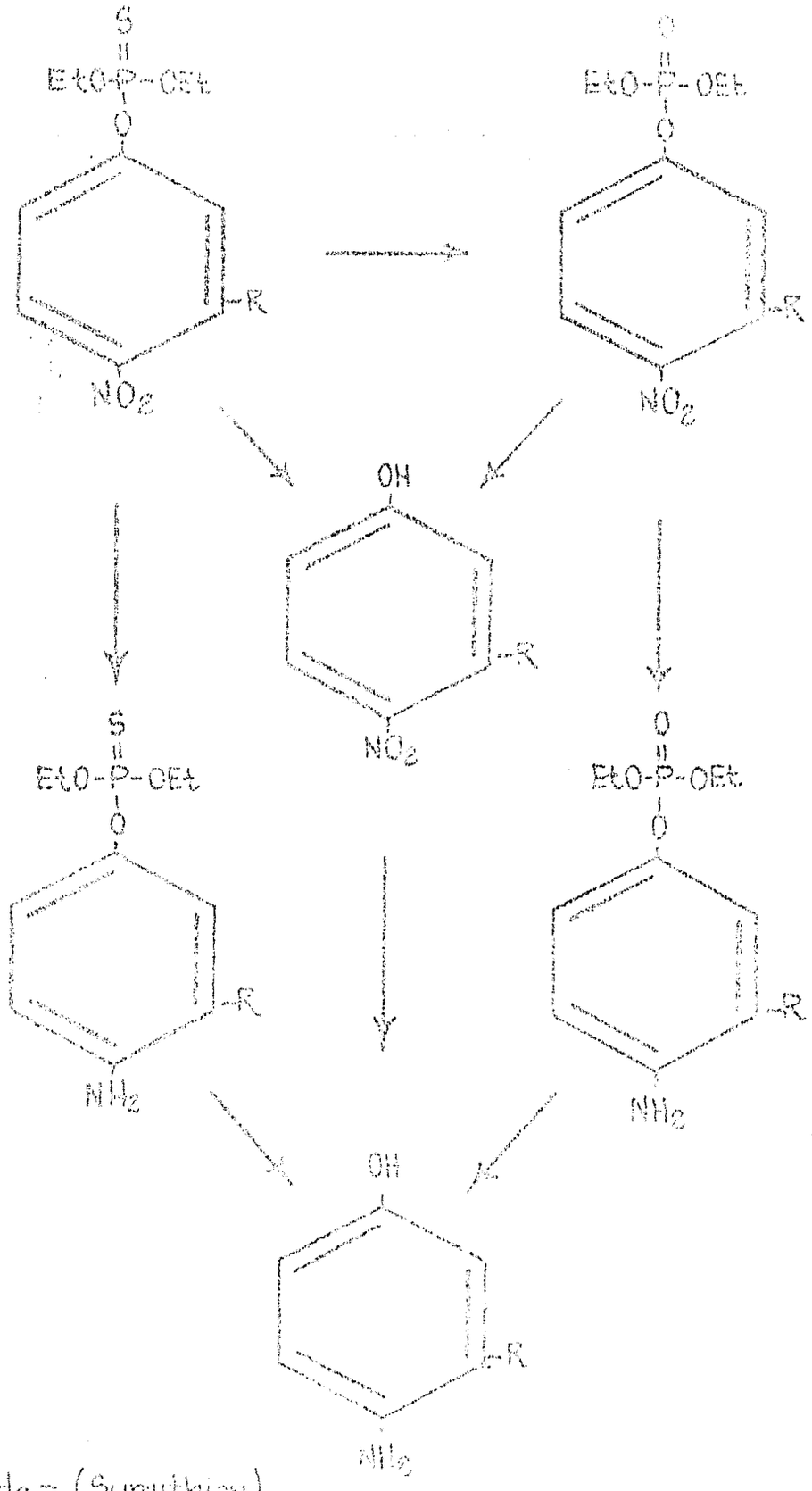


Figure 9

Transformation of Dieldrin



R = CH_3 – (Sumithion)

= Cl (Chlorthion)

= H (Parathion)

Figure 10

Transformations of Parathion – type Insecticides

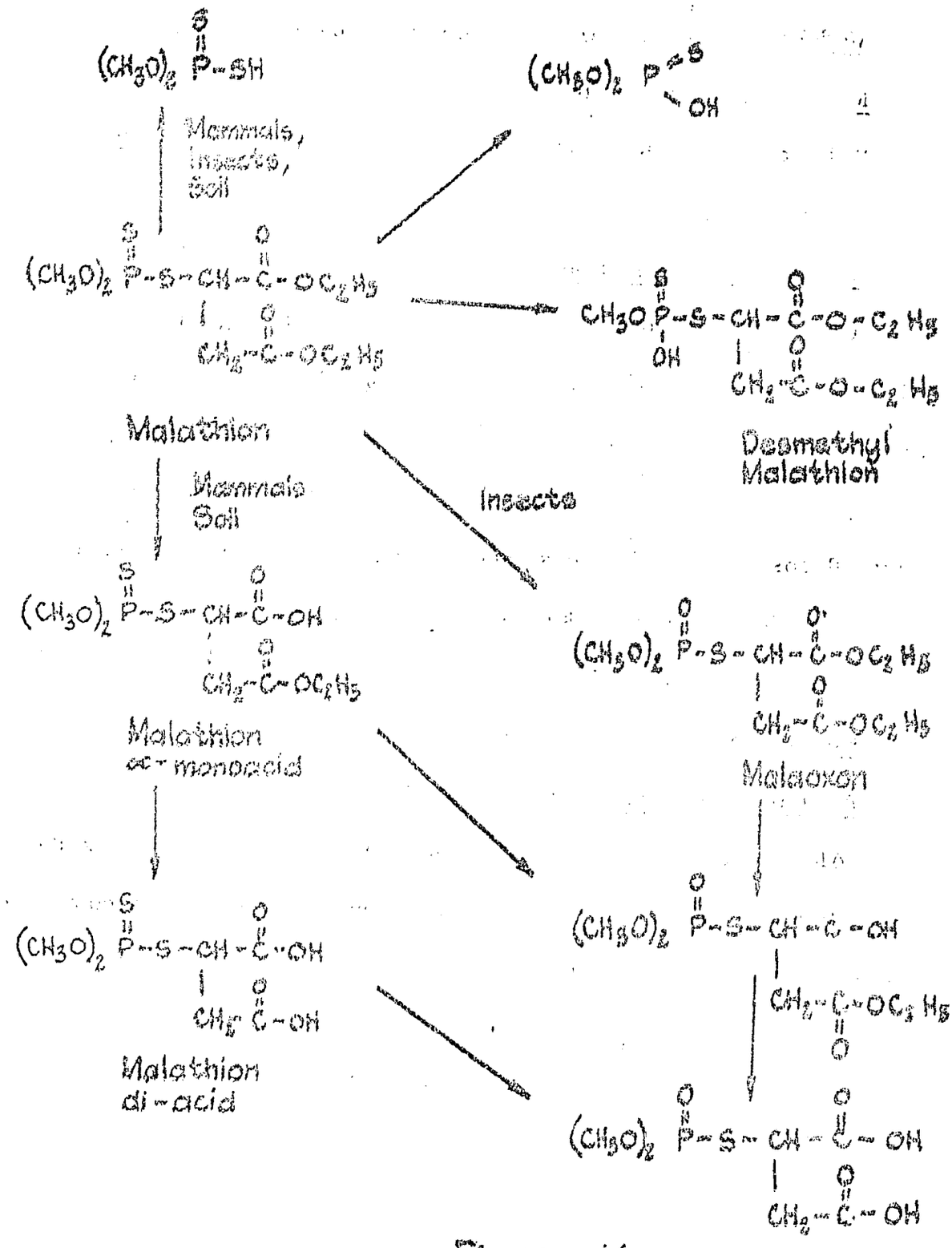


Figure 11

Major Transformations of Malathion

e. Model Group No. 5: Aryl N-methylcarbamates

Model compound: Carbaryl

Related compounds: carbofuran, propoxur, mesurol, MIPC, BPMC, MTMC.

Carbaryl transformations (Figure 12):

Carbaryl is readily 1) hydroxylated at the 4 and 5 positions 2) cleaved at the amide link to give CH_3NH_2, 3) oxidized at the N-methyl group, and 4) hydrolyzed at the carbamate ester link to give 1-naphthol. The resultant hydroxylated materials are then conjugated with glycosides, glucoronides, and sulfates to harmless compounds.

f. Model Group No. 6: Alkyl N-methylcarbamates

Model compound: aldicarb

Related compound: methomyl

Aldicarb transformations (Figure 13):

Aldicarb is sequentially converted to the sulfoxide and then to the sulfone with increased toxicity. These compounds are in turn converted to the oximes and other innocuous polar metabolites.

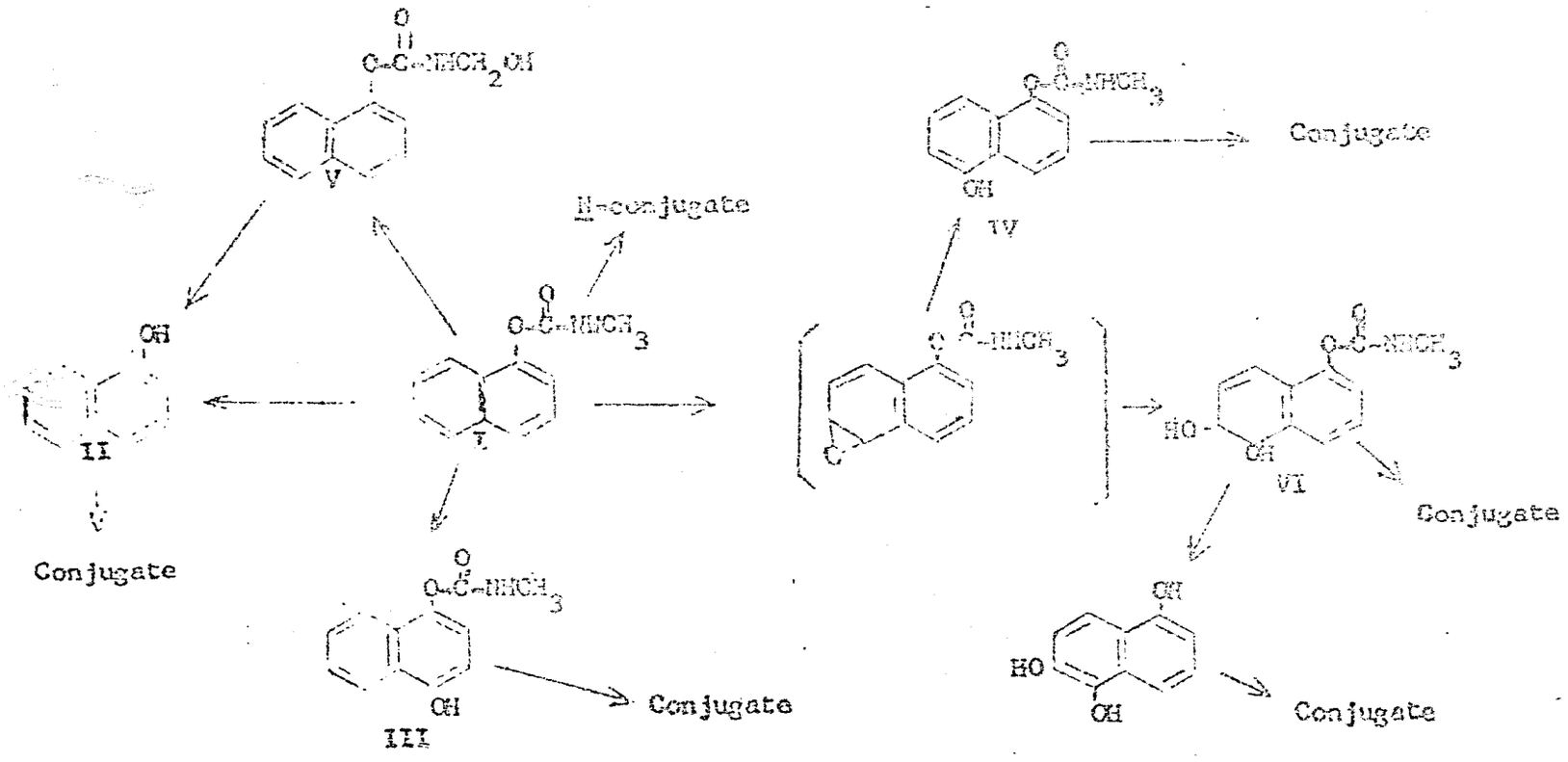


Figure 12

Proposed metabolic pathway for carbaryl in living systems (After Dorough 1970).