

PEST MANAGEMENT AND THE EFFECTIVE USE
AND SAFE HANDLING OF PESTICIDES
FOR SOUTH VIETNAM

by

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Pest Management and the Efficient Use and Safe Handling
of Pesticides in South Vietnam

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INTRODUCTION

I visited South Vietnam from February 13 to March 2, 1974 under the sponsorship of the USAID-University of California contract on pest management. USAID officials provided transportation, accommodations and secretarial and technical assistance. I am grateful to Mr. Wilmot L. Averill, Associate Director for Food and Agriculture of USAID, Saigon, and to Mr. Emory M. Howard and to their staffs in Saigon and at field locations for assistance and guidance.

The purpose of the visit was to consult on problems relating to pest management policies and procedures with particular regard to the safe and efficient employment of pesticides in plant protection. Agricultural areas were visited in the vicinity of Tuy Hoa and Nha Trang in the central coastal area and near Can Tho in the Mekong Delta. Conferences were held with industry, university and governmental personnel in the field and at Saigon.

Information and opinions were gained from field observation and direct contact with personnel in both public and private agencies.

Sources included:

Official documents and reports

^{1/} Professor of Plant Physiology, Department of Plant Pathology, University of California, Berkeley.

Agricultural officials and cadre at field locations

University of Saigon, Professor Pham Hoang Ho and associates

Pasteur Institute, Director Nguyen Van Ai and key personnel

Ministry of Agriculture, Director General Doan Minh Quan and staff

Agricultural Research Institute, Associate Director Hieu and Dr. Vo Dinh Long, Chief of Field Crops Service and associates

Vector Control Agency, Ministry of Health

Shell Company Formulation Plant, Messrs. Nguyen Cong Danh and Mai Thanh-hieu

Thanh Son Co., Madame Le-Nhat-Hein, Director General and staff

Plant Protection Service (Ministry of Agriculture)
Nguyen L. Duyen, Director and staff

Conferences with Mr. Duyen and his staff were thorough and exhaustive, including observation of field programs, visits to public and private facilities, and discussions of subject matter in depth. Consultation was frank, constructive and cordial.

GENERAL INFORMATION

Protection of crops from pests and diseases has high national priority in Vietnam. Traditionally South Vietnam has produced food in excess of its own requirements and has exported the surplus, particularly rice. Due to the war and related civil dislocations agriculture has declined in recent years and the country has had to import rice and other commodities to supply the food deficit. Current economic conditions are such as to make it critical that the country again become

self-sufficient in food production and resume and expand its role as an exporter. The expansion of rice production in particular has become a matter of the highest national priority.

The technological means to increase rice production are currently under intensive development internationally and the new technology is at least partially adaptable to conditions in South Vietnam. These methods are based largely on the culture of improved varieties, expanded use of fertilizer and better crop protection. Crop protection is particularly important in Southeast Asia where it has been usual for about half of the potential production of rice to be lost to insect pests, plant diseases, weeds, nematodes and rodents.^{2/} Routine protective measures are observed to increase yields 20 to 30 percent.^{3/} Frequent failure or inability to apply appropriate crop protection procedures is a prime factor limiting the yield of rice and other crops in Vietnam.

Important pests and diseases of rice include plant hoppers, leaf hoppers, leaf rollers, black bugs, stem borers, gall midges, nematodes, rice blast, bacterial leaf blight, field rats and an assortment of aggressive annual and perennial weeds.

A large number of pests also attack upland agronomic and vegetable crops. The population of the country is largely rural and most of the people maintain dooryard subsistence gardens. Collectively

^{2/} Cramer, H. H. Plant Protection and World Crop Production, Bayer, Severbusen, 1967.

^{3/} Anonymous. Rice Diseases and Pests of Thailand. FAO and Government of Thailand, 1971.

these constitute a major national resource. These gardens are severely attacked by a wide variety of pests and their productivity is greatly reduced by lack of effective protective measures.

In Vietnam the main thrust of pest control measures for arthropods is based on the application of pesticides. The emphasis for disease control, to the extent that there is a conscious effort, is on resistant varieties and preventive or corrective agronomic procedures. Weed control is mainly by hand methods. These interests are reflected in the numbers and kinds of pesticides used in Vietnam as appearing in the "positive list" of pesticides authorized for import into the country. This list includes 21 insecticides, 7 herbicides, 5 fungicides, 2 rodenticides and 1 fumigant.^{4/} Insecticides constituted about seven-eighths of the dollar value of total imports of agricultural pesticides in calendar year 1973. This is about 15 times greater than expenditures on herbicides or fungicides.^{5/} The total value of pesticide imports in calendar 1973, including inert ingredients for formulation was in excess of \$4 million. This represents about two thousand metric tons of active ingredients. This is equivalent, with allowance for urban and public health uses, to perhaps 1/2 Kg per hectare per year on agricultural land.

^{4/} Chemical Market Survey, USAID, 1973.

^{5/} Vietnam, 1973, Agricultural Pesticide Imports, Annual Report. January, 1974.

Stock levels and use of pesticides are given in Table 1 for fiscal years 1972 and 1973. The data show major variations in relative use of pesticides probably less due to variations in market demand and pest control needs than to altered government policies. In both years insecticides constituted about 80 percent of pesticide use. In FY '72 fungicides and herbicides constituted respectively 5 percent and 15 percent of the total, while the following year use of the two classes of pesticides was about equal. The current expanded use of diazinon is reflected in a four-fold increase in FY '73 while use of azodrin increased six-fold and dalapon decreased by 90 percent.

IMPORTATION AND FORMULATION OF PESTICIDES

The ingredients of pesticides are imported into Vietnam as technical grade chemicals. Commercial products are formulated locally from imported active ingredients and suitable adjuvants, carriers and diluents, some of which are produced domestically. Importation of formulated products is prohibited except under unusual circumstances. The government's policy is that no pesticide may be imported that can be formulated and packaged by the domestic industry. Only those commodities and ingredients that cannot be made in Vietnam and for which there is no local substitute are allowed to be imported. Importation of certain highly toxic, persistent or environmentally injurious pesticides has recently been prohibited except for emergencies under special permit. These include DDT, Aldrin, Dieldrin, Endrin, and BHC. Present stocks of these materials will be used up but not replaced.

PESTICIDES USED AND ON HAND
DURING FISCAL YEARS 1972 AND 1973 (Metric Tons)^{1/}

<u>Pesticide</u>	<u>FY 1972</u>		<u>FY 1973</u>	
	<u>M/T</u> <u>USED</u>	<u>MT ON HAND</u> <u>6/30/72</u>	<u>M/T</u> <u>USED</u>	<u>MT ON HAND</u> <u>6/30/73</u>
Maneb	25	13	131	51
Zineb	41	3	50	23
2,4-D Acid	95	85	152	38
2,4-D Ester	50	6	46	0
Dalapon-Na	45	6	4	0
DDT, tech.	31	4	23	26
DDT, 75% WP	265	53	514	106
Aldrin	1	3	1	2
Dieldrin	3	1	0	1
Endrin	72	44	86	3
BHC	3	21	64	37
Lindane, tech.	5	6	10	0
Methyl Parathion	69	30	43	14
Diazinon, tech.	56	97	235	73
DDVP	137	48	98	22
Bidrin	13	12	18	0
EPN	3	5	4	0
Gardona	2	4	1	5
Malathion	213	116	227	70
Azodrin-5	10	0	63	24
Dibrom	92	52	57	35
Phosvel	2	14	3	0
Phosphamidon	3	7	6	3
Carbaryl (Sevin)	4	6	18	5
Zinc Phosphide	9	17	19	0
Furadan	--	--	22	25
	<u>-----</u>	<u>-----</u>	<u>-----</u>	<u>-----</u>
TOTALS:	1,249	653	1,896	533

^{1/} Adapted from: Agency for International Development, USAID/VIETNAM, Commercial Import Program, "Chemical Market Survey FY'73," Michael McAllister, Commodity Analyst-Chemicals, Consultants.

Regulation of the importation, formulation, distribution, and use of pesticides in South Vietnam is largely vested in the Plant Protection Service (PPS). This agency also has such other functions as pest and disease detection, survey, and assessment of losses, plant quarantine, experimental work on pest control technology and the mounting of governmental pest abatement campaigns when appropriate. The responsibilities of PPS are numerous, ranging from the direct delivery of pest management services to the exercise of governmental police powers in matters relating to pesticides and plant protection. In the latter capacity PPS is the principal agency involved in the administration of the decree of May 9, 1966, "Determining the Regulations for Exercising the Professions of Manufacturing, Trading, Storing and Circulating Plant Protection Chemicals."^{6/}

LAW AND REGULATIONS

The 1966 decree defines insecticides, rodenticides, herbicides, molluscicides, fungicides, nematocides and weedicides as plant protection chemicals subject to regulation. It is specified that only designated persons may manufacture or formulate these materials and import the necessary technical grade materials to do so. Formulated pesticides may not be imported for resale but may be brought into the country on an emergency basis by end users such as rubber planters.

^{6/} Decree No. 30/SL/CN Central Executive Committee, Saigon. May 9, 1966.

Such importation must be approved by the Minister of Agriculture (PPS) in each instance.

It is provided that a license to manufacture pesticides may be granted to firms by the Commissioner of the Economy upon certification by the Ministry of Agriculture that the applicant is properly qualified and that there is a need for the product. The products to be manufactured must be registered with PPS which issues a "certificate of verification" authorizing manufacture and sale. Petitioners for such permits must disclose the nature of the product, its content of active ingredients, directions for use, information on toxicology and antidotes, data to support claims of effectiveness, and supply samples of the product and a certificate of analysis. Details for registration, extension of registration and possible cancellation of registration are given in the law.

Official requirements for labelling are specified. The label must state the nature and content of active ingredients and explain how to use the material. Conditions requiring display of the skull and crossbones are prescribed and a system of colored bands is specified to appear on labels. The most toxic materials are indicated by orange color, while bands of yellow and green indicate successively lower mammalian toxicity.

The law requires that pesticide dealers be licensed and that commercial channels for storage and sale of pesticides be absolutely separate from the handling and sale of food and drink. Shops licensed to display and sell pesticides must periodically report to PPS the

chemicals offered for sale. It is illegal for dealers to stock and sell unregistered or improperly labeled pesticides or ones labeled for experimental use only. It is forbidden to tamper with pesticide packages or labels or to adulterate, repackage, modify or mix pesticide formulations in market channels.

The law grants to properly appointed authorities in the Ministry of Agriculture (PPS) authority for surveillance, investigation, search, and prosecution as necessary to enforce pesticide regulations. The Ministries of the Economy, Finance, Interior and Health have administrative responsibilities for pesticides appropriate to their governmental functions. The Ministries of Agriculture and Health, for example, are given joint responsibility for setting and enforcing tolerances for permissible levels of pesticides in food and feed.

Adequacy of the Law

The law is simple and yet, appears to contain the essential elements needed to regulate the manufacture and distribution of pesticides in South Vietnam. Necessary authority, where not specifically granted, with some exceptions, may reasonably be inferred. A notable omission is that procedures for the licensing and supervision of commercial applicators other than "fumigators" involved in industrial and urban pest control are not given. The infant application industry is not yet a major factor in agricultural pest control but likely will eventually become so. Perhaps the provision for licensing of "fumigators" may be interpreted to include all custom applicators.

An unusual requirement of the law is the protectionist provision that excludes the importation of formulated pesticides. The purpose of this provision does not appear to be safety but presumably is to conserve critical foreign exchange and encourage local industry. It should be recognized that these advantages are gained at the expense of greater technological isolation from the research services normally available through the international field staffs of the major chemical manufacturers. In fact, local field research and development is not a strong point of the domestic pesticide industry. Local industry is not well-staffed, equipped and funded for field studies on how to use its products and on the fate of these materials in food and feed and in the environment generally. These firms are also notably deficient in the conduct of public education programs on the safe and effective use of their products and the integration of pest control procedures into agronomic systems.

Administration of Pesticide Law

Although a statute may provide an adequate basis for regulations governing safe and effective use of pesticides, administration and enforcement of the law determine the outcome. The laws and the regulations derived from them accomplish their purpose only after they are widely understood and become reflected in practice. Requirements placed on manufacturers, shippers, marketers, users and consumers should be realistic, widely understood and thoroughly and fairly enforced. The degree of compliance can be increased and the need for punitive enforcement can be diminished by education programs that

explain the need for proper practice and point out the hazards resulting from careless or negligent actions. Officials charged with administering the law should be knowledgeable and dedicated. Administrators at all levels should have no business connections or conflicting financial or personal interests in pest control firms nor should governmental agencies be assigned mutually conflicting or incompatible functions. The aim of good regulations is the achievement of good practice. This aim is shared among educational agencies, commercial concerns, government, and the public. The safe and effective use of pesticides is of concern to everyone. All citizens stand to benefit or lose, but not to the same extent. The livelihood or, indeed, the lives of some hinge upon pest control practices. To others the reward or loss may be cheaper or more expensive food or greater or lesser convenience and comfort.

The immediate hazard and burden for good practice in the use of pesticides falls on the manufacturers, handlers and users. As a rule, persons with occupational exposure who are in frequent contact with pesticides are in greater danger of injury than the general public. This is particularly true in Vietnam where most of the population is rural and is directly concerned in the purchase and application of pesticides and with the storing and handling of these materials in and around the household. The implementation of the law in terms of effective and safe practices in South Vietnam is best seen by examining current practices through importation, manufacturing, marketing and user channels.

PRACTICES IN THE HANDLING AND USE OF PESTICIDES

Manufacturing and Distribution

The chain of pesticide handling and resultant exposure of personnel begins in Vietnam as technical grade pesticides enter the country through shipping channels. Shipping drums are subject to damage or leakage with the possibility of occasionally exposing stevedores and warehouse personnel to unformulated pesticides in highly concentrated form. There is no evidence that this has been a significant or recurrent problem. However, should a major spillage occur, it does not appear that the means to cope with it are presently available. The capability to deal with major spillage should be developed in South Vietnam specifically for each hazardous pesticide imported, warehoused or shipped in the country. This capability could be developed in a governmental agency or commercial establishment or perhaps become a requirement of manufacturers authorized to import and formulate each chemical. In the latter case licensed formulators might be required to supply a workable "disaster plan" as part of the licensing or registration requirement. In this case, the plan would establish trained decontamination teams equipped with protective clothing, decontamination materials and disposal equipment subject to call in the event of need. The competence and state of readiness of the teams would be subject to governmental inspection and corrective action in the event of deficiencies. Teams could be composed of regular personnel in the formulator's plant or arranged by contract with firms specializing in disposal of hazardous materials.

Such emergencies could be met as an additional function of firms or a governmental agency specializing in disposal of "empty" pesticide containers and the disposal of outdated or obsolete pesticides. There is clearly the need for suitable means of disposal of pesticide shipping containers in South Vietnam. One manufacturer punctures steel drums in which technical grade pesticides are received and disposes of the scrap through ordinary salvage channels. Others were observed to reuse the containers for various purposes including in one observed instance bulk packaging of formulated pesticides for retail channels. There was, however, no indication that bulk pesticide containers were reused as food, feed or seed containers. Special disposal facilities and agencies should be developed to decontaminate or safely destroy bulk pesticide containers. Whenever possible, containers should be returned to the original supplier of the chemical for reconditioning and reuse. It should be recognized that disposal of containers is an integral part of the formulation process and a necessary part of the competence of a licensed formulator. This responsibility should be recognized as being subject to regulatory inspection and enforcement.

The routine handling of pesticides in formulation plants in South Vietnam indicates that manufacturers are sensitive to the hazards inherent in such operations. For example, it was observed that materials were transferred from shipping containers to mixing vats by pumping or other methods that reduce the exposure of personnel. Sanitation procedures in formulation plants range from fair to excellent

for routine mixing and packaging. Provisions for coping with accidental spills are not always satisfactory, particularly on packing lines. Rough or porous floors not subject to easy cleaning of spilled materials were observed. The need to mount bottling machinery over waste recovery sinks is not recognized and packing line machinery is not designed or arranged for easy decontamination. Packing line workers are required to wear rubber gloves, protective clothing and respirators in situations of high exposure; however, in common with human nature everywhere, workers discard these devices at the slightest lapse of supervision. In one factory, persons exposed to an organophosphate pesticide on the packaging line are rotated periodically to other kinds of work. Choline esterase levels are routinely monitored in these workers through an arrangement with the Pasteur Institute in Saigon. It is important that this agency is equipped and staffed to perform this important test, however, it was not determined to what extent and under what arrangements this diagnostic capability is utilized.

A notable deficiency among formulators is inadequate quality control. Formulation plants are not commonly equipped and staffed to perform precise analyses of the technical grade pesticides received from manufacturers, and of the various diluents, carriers, surfactants, adjuvants and contaminants that appear in the commercial products. Typical quality control analyses may consist of total phosphate determinations on organophosphate insecticides, titration of an acid or base if the product is so constituted, or perhaps determination of

the specific gravity of the formulation with a hydrometer. Quality control samples of production batches are kept for future reference in some instances and not in others. Discussion with managers in formulation plants reflects a genuine lack of appreciation of the need for such controls and a naive confidence in the reliability of the manufacturing chemists who supply basic materials and an equal trust in the infallibility of their own measuring and mixing procedures.

Uncertain quality control by formulators is matched by an uncertain surveillance of product quality by PPS. That agency does not have modern laboratory facilities for pesticide quality surveillance and the detection of error and fraud. Limited facilities for formulation analysis are available at the Pasteur Institute and that agency has official responsibility for providing analytical services to, among others, the courts in cases of prosecution and litigation. This service falls far short of fulfilling the general requirements for quality assurance.

As a result of ineffective quality control and supervision there is widespread suspicion that pesticides in South Vietnam are often fraudulently or erroneously labeled and do not contain the full amount of ingredients claimed. Suspicion falls upon basic formulators and all others in the supply chain but particularly upon retailers who repackage pesticides for small lot sale. Determination of the truth of these suspicions requires facilities for analytical monitoring beyond present capacity in the country.

A serious deficiency in the formulation of pesticides in

South Vietnam is faulty packaging. The container is an important part of a pesticide and should be as carefully designed and adapted to the particular task as the very ingredients of the product. Containers should be sufficiently sturdy to withstand the most rigorous hazards of handling likely to be encountered in filling, shipping, stacking, warehousing and end use. Closures should be extremely secure against tempering and as near leak proof as reasonably possible. The label should be either printed on the container or fixed to it so to remain attached through wetting, drying, and other environmental extremes. In Vietnam liquid formulations are commonly packaged in glass bottles with labels attached with rice paste. Under the prevailing high humidity, labels frequently become detached from bottles and the identity of the contents becomes uncertain. This is so commonplace in retail outlets that perhaps one bottle in ten or twenty may have a loose or misplaced label.

Effective closure of glass containers is equally a problem. Inspection of a retail store usually discovers leaky bottle caps or signs of recent leakage on counter tops or storage racks. Cartons of bottles were observed to be leaking on arrival at retail stores. Packaging, however, is not uniformly substandard. Excellent polyethylene bottles with imprinted labels and temper-proof caps were observed. Certain granular materials are packaged in high quality multiwall bags having effective vapor barriers. Nevertheless, there is need for a general improvement in the quality of packaging of pesticides in South Vietnam.

Retail Handling

Retail outlets are well distributed in villages throughout the countryside. The stores are typically small, open fronted shops, usually displaying from a few packages to a half-ton or so of pesticides. Compressed-air sprayers and "flit" guns are usually on display as well as an inventory of agricultural implements, hardware and fertilizer. Shelving is typically arranged from floor level to head-high and is ordinarily not protected by doors. Shelving is not infrequently improvised from miscellaneous crating materials and pesticides are sometimes seen to be warehoused in the retail outlet by stacking containers in their original shipping containers.

Storekeepers appear to be knowledgeable about their products, often having uninhibited opinions differing from the labels about rates of application, volume of diluent and specific pest response. Evidently the dealer serves to a degree as an informal pest control advisor and apothecary in the dispensing of pesticides. Open bottles and bags are generally present in stores both by accident and by design. Packages often contain larger amounts than the customer is interested in buying, and the storekeeper solves this problem by opening containers and dispensing the contents in amounts appropriate to the need. This is particularly true of granular materials such as Basudin, a 10% diazinon mixture formulated on sand. This insecticide is often weighed into polyethylene bags and marketed without labels. Fortunately, the material has a distinctive appearance and appears to be readily identified in agricultural channels.

The odd-lot distribution of pesticides in miscellaneous containers must surely be regarded as some ultimate malpractice in the marketing of these chemicals. The regulatory safeguards provided by label instructions on proper use, warnings against misuse and health hazards are lost. The very identity of a material as a pesticide and toxicant becomes a matter of uncertain memory and hearsay. There is unrestricted opportunity for adulteration and fraud, and whether or not dishonest practices become widespread, a general breakdown of confidence in the identity and usefulness of pesticides is inevitable.

Repackaging leads to spilling as is visibly evident on the floors and counter tops in retail outlets. The label admonition to "Keep out of Reach of Children" is universally ignored and barefoot children are seen to track through pesticide spills and to play precariously near low boxes and shelves stocked with pesticides. The exposure level of storekeepers and their families and customers must surely be high. Fortunately, the pesticides commonly available are usually not highly toxic. Merchants are well aware of this and are also aware that certain materials require special handling precautions. Nevertheless, the hazard of fires, major spills and other accidents and of chronic exposure to pesticides is unquestionably great and individual incidents of poisoning frequently come to the attention of agricultural and health authorities. Unfortunately public health records are not such as to determine the number of cases of morbidity and mortality from such accidents.

The correction of the deficiencies in the retail distribution

system requires no new technology, no new laws, and no special equipment or detection facilities. The first need is for education to instruct storekeepers on what constitutes good practice and to instruct them on the laws and regulations governing retail trade in pesticides. The second need is for inspection, detection and enforcement by regulatory officials. There will be further reference to these requirements in later sections of this report.

Application of Pesticides

Agricultural pesticides are usually applied by the farmer himself or by a member of his family. Applications of liquid pesticides to rice and row crops are essentially universally by hand-carried or back-pack sprayers, and granular materials are thrown by hand. The rice grower dips his water from a canal or stream, prepares the spray mixture at the application site, washes his sprayer in the same stream, and salvages or disposes of the empty container as suits his need or convenience. The sprayers are equipped with adjustable cone nozzles and the operator sets these to spray a pattern judged by the operator to be most effective. He slowly wades through the crop swinging the spray nozzle in an arc ahead of himself. Respirators are not regularly worn but the operator may tie a cloth over his nose and mouth. He ordinarily wears shorts and in wading through the freshly sprayed crop is always more or less wet by the spray mixture. Spray operators were seen to spray in both directions relative to the wind and rarely take the trouble to walk to the windward side of the field to work down wind and avoid spray drift to themselves. They are known to mix

different kinds of pesticides or mix them with fertilizer without recognizing that chemical reaction or alteration of physical properties could result.

Persons engaged in applying pesticides in Vietnam appear to have the greatest exposure to these materials of any occupational group. The applicators appearing to have the greatest exposure are public health employees in vector abatement programs who spray every working day. Farmers may spray several times per crop cycle, but intensive vegetable growers may have exposure approaching that of public health workers. There are no accurate or even approximate statistics on poisonings of spray applicators. It is widely believed that poisonings of farmers is fairly common and indeed it would be surprising if this were not the case. On the other hand, work records of public health applicators with seemingly greater exposure show that these employees are rarely injured by chemicals. The parallel is, however, probably more apparent than real. Public health workers are trained employees working under supervision in the company with other experienced workers applying chemicals which are often less hazardous than materials applied by farmers. In any event, the hazard to the farmer and members of his family who must undergo frequent wetting by pesticides cannot be otherwise than high. There is a great need for a better way to do this.

Environmental and Consumer Hazards

There is no systematic way of disposing of used pesticide containers by farmers. One sees the empty bags in which granular pesticides were shipped lying around on ditch banks and near farmers'

dwellings. Bottles are washed and reused as farm and household containers for various purposes or find their way into salvage channels.

Another potential source of exposure to pesticides is residues in food. The provision in the decree of 1966 for the establishment of residue tolerances for pesticides in food has not been implemented. There is no effective imposition of limits on the occurrence of pesticides in food and feed and no general monitoring of food supplies for pesticides. There are rumors about probable excessive residues in foods, particularly fruits and vegetables, and reports of the occurrence of toxic residues in domestic water supplies. There are seemingly credible reports of fish kills in streams, lakes and canals and of persons poisoned by the handling and consumption of food contaminated by pesticides. The frequency of such occurrences and the actual cause of injury in individual cases are difficult to evaluate. The available resources for analysis and diagnosis of suspected cases are rarely sufficient to reach reliable conclusions.

Despite opinions and convictions one way or another about hazards to life and property from the use of pesticides in South Vietnam it can be said in summary that the actual situation is obscure. The number of persons poisoned is not known but occasional authentic reports plus a wealth of circumstantial evidence indicate that the number is not inconsequential. The levels of exposure of persons to pesticides are greatest in and around pesticide shops, in farmers' fields and gardens. Such exposure can be greatly reduced by proper education and routine inspection and enforcement procedures.

DISCUSSION

There is a great need for improved and enlightened pest management in South Vietnam. The need can be met by measures directed toward a better information and educational base and a stronger technological and managerial basis for pest abatement activities in both the private and governmental sectors. South Vietnam is not exceptional among nations in this need nor is the need necessarily first among the many unfilled demands upon the resources of this nation, beset as it is by so many problems. Nevertheless, any rational analysis of the Vietnamese economy must recognize food as a factor of the first magnitude, and consequently identify protection of crops, livestock and stored commodities from pests and diseases as a key factor in food production and utilization.

Consideration must go beyond the recognition of the need for better pest management, and face the matter of identifying and evaluating specific problems and assigning resources for their solution.

There are inherent conflicts that complicate the making of decisions on actions to be taken in pest management systems. Determination of the nature of policies and programs requires reliable assessment of the probable consequences, both beneficial and detrimental, of the measures employed. Systems should focus on root causes and significant problems rather than the superficial treatment of symptoms. Policies should be such that resources, both private and governmental, are effectively applied in accordance with carefully evaluated priorities. In South Vietnam with its many needs and limited

resources it is particularly critical that priorities be carefully assessed and resources applied to the solution of the most serious problems. The following suggestions for improvement in pest management in South Vietnam are made with these considerations in mind. They are presented and evaluated in terms of upgrading personnel, improvement in materials and methods, acquisition of information, occupational and public health, environmental protection, regulatory activities, and improved communications.

Personnel

First priority for improvement of plant protection is general upgrading of the technical competence of pest management personnel in South Vietnam at all levels from the farmer and field worker to the administrator and industrialist. The need in pest management throughout the country in both industry and government is rarely for additional personnel but is for persons better trained to do their jobs.

Objective No. 1: To develop a select corps of highly trained professional workers in the pest management technologies.

These persons should receive graduate level training in entomology, plant pathology, weed science, nematology, chemistry, engineering, toxicology, and other disciplines relating to pest management. In addition to specialized training, education should include an interdisciplinary overview of pest management philosophy and policy. The advanced phases of training should be pursued abroad in internationally recognized centers of education and research. The intention is that these highly trained people should ultimately fill key positions in

research, development, education and administration in industry, government and in colleges and universities. These professionals will in turn expand the domestic capability for advanced training.

Objective No. 2: To upgrade the technical competence of intermediate level governmental and industrial workers in pest management technologies.

Short course and on the job training programs should be expanded and intensified with the aim of increasing the competence of technical personnel at all levels to identify, analyze, evaluate and solve problems based on application of principles and to exercise responsibility and initiative in pest management affairs. Suitable training manuals, workbooks, and pamphlets relating to problems important in Vietnam should be prepared and become the basis for present and future training programs.

The need for this educational effort is too urgent to await the development of the full domestic training capabilities contemplated under Objective 1. Training should be undertaken at once relying on such highly qualified teachers as are presently available in the country, and as much as possible, drawing heavily on the training resources already available from American universities through USAID. Under suitable arrangements, teams of qualified instructors could travel to South Vietnam and conduct intensive schools on all aspects of pest management.

Objective No. 3: To upgrade the technical competence, enhance the sense of public responsibility, and improve the stature and status of pesticide dealers.

The pesticide storekeeper is the contact man between the pesticide industry and the pesticide user. Regardless of his level of com-

petence and despite possible disclaimers of past experience or specialized knowledge, his opinions at the time of actual sale of the pesticide, either expressed or implied, probably have greater influence in pest control decisions than any other source of information. It is a matter of greatest urgency that short courses or other appropriate training specifically aimed at teaching the duties and responsibilities of dealers be given to all pesticide storekeepers and their key employees. One or more national "Flying squads" of instructors might conduct these courses by traveling from district to district. After the initial course dealers should be given periodic review courses. Manufacturers should be encouraged or perhaps required to supply dealers with suitable training pamphlets covering all aspects of the effective and safe handling of their products.

Objective No. 4: To upgrade the technical competence of farmers, market gardeners, landholders and householders in the identification of pests, the assessment of pest problems and the choice of methods of reducing losses caused by pests.

The aim is to place the grower in a better position to make discriminating choices in pest management, rather than to treat pests by schedule whether needed or not. Teaching should recognize and appropriately emphasize the roles of sanitation, source reduction, choice of resistant and disease-free plant materials, clean seed, the importance of sound agronomic practices and the significance of natural enemies and other managerial and naturalistic factors in plant protection. He should be taught procedures for the selection and safe application of pesticides, including the hazards of storing toxic materials in and around the household, means of avoiding excessive exposure of persons

applying pesticides and procedures for disposal of containers. Teaching should be by the recognized extension methods of personal contact, demonstration plots, field days, circulars and pamphlets. Posters and signboards should be employed and radio and other public media should be used to inform farmers of present or evident pest outbreaks and the options available for protective action and the basis for making a choice between them.

Information

The second most pressing need is for an expanded base of information on pests and pest management.

Objective No. 5: To establish an information center to collect, catalog and monitor significant world plant protection literature in relation to policies and practices in South Vietnam and make the information available in suitable form to active research and development programs, extension personnel and technical workers in all programs conducted by government and industry.

This national plant protection information center should have the sole function of keeping abreast of the advancing body of evidence forming the scientific basis of pest management and providing information and consultation on these matters. This activity might best function in relation to a university where the linguistic bibliographic and scholarly resources and attitudes necessary for such an enterprise are more likely to flourish.

Objective No. 6: To perform adaptive research and development on pest management methods and systems.

Since information derived from basic sources and other regions is rarely directly applicable to local problems, adaptive research and

development on plant protection must be carried out under the conditions of intended use. Testing of non-chemical agronomic, biological, and managerial methods should go hand in hand with experiments on chemical procedures. Research should include surveys of losses caused by pests, economic analyses and reviews and continuous reassessments of the effectiveness of current practices. Each manufacturer of pesticide formulation in South Vietnam should conduct scientific research to improve its products and define precise conditions for their use. This should be recognized as part of the performance basis of pesticide manufacturing licensees.

Materials and Methods

Pest control in South Vietnam is currently excessively dependent on a relatively few insecticides and even fewer fungicides and herbicides. In addition to the use of pesticides, there are encouraging developments toward the widespread use of resistant varieties, but otherwise pest control methods are largely the traditional ones that have remained essentially unchanged through the centuries.

Objective No. 7: To increase the variety and diversity of materials, equipment, and procedures available for pest management in South Vietnam.

The essence of efficient pest management is the efficient fitting together of mutually supporting methods into systems adjusted to individual cases. The few choices of insecticides and even fewer of other pesticides reduces the options for tailoring pest management systems to specific situations. There is a need for a broader spectrum of pesticides and a parallel need for a broader choice of non-chemical

methods. Closer attention should be given to resistant varieties suited to local conditions and to biological, cultural and managerial methods to be used alone or in conjunction with pesticides. The greatest lack is noted for herbicides which, in terms of the diverse kinds and widespread use elsewhere, are relatively unknown or unrecognized in South Vietnam. This neglect is perhaps less serious for herbicides than it would be for other pesticides, since in a country critically short of foreign exchange, labor can be essentially fully substituted for herbicides while this option is less available in the control of insects and plant diseases. Nevertheless, losses caused by weeds are undoubtedly very great and will become greater with the trend toward culture of rice by direct seeding rather than transplanting. The success of direct seeded rice is fundamentally dependent upon weed control with herbicides.

Health

The benefits and hazards to health from the use or non-use of pesticides pose particularly difficult problems in assessing which materials and practices should be permitted and which should not. Pesticides are used in public health vector abatement programs presumably with net health benefits. On the other hand, agricultural uses realize economic benefits at the risk of health and life. Neither benefits nor hazards can be accurately evaluated in South Vietnam but the comparative danger from different operations in the manufacture, distribution and use of pesticides can be estimated on the basis of likely exposure to pesticides and their residues. Corrective measures should

be directed to points of greatest hazard as expressed in the following objectives presented in descending order of priority.

Objective No. 8: To reduce the hazard to persons applying pesticides with compressed-air canister sprayers.

A two-pronged approach should be mounted toward reduction of exposure in spraying. First, an educational campaign should be conducted to teach people to protect themselves at least partially from spray materials. Applicators should be taught to keep spray pressures low, avoid or reduce body contact with crop foliage wet by the spray, avoid spraying into the wind or working in the wind drift pattern and to wear a filter paper or gauze mask to reduce spray inhalation. Careful attention to these precautions can greatly reduce exposure to pesticides. It should be recognized that full protective clothing is impractical under tropical conditions.

The second approach is to conduct experiments on possible improved methods of application. Even marginal improvements such as switching to commercially available low drift nozzles or perhaps the use of plastic aprons may provide a useful degree of protection to applicators. Research and extension workers can employ non-toxic food dyes to test spray patterns and devise and demonstrate means to reduce personnel exposure.

Objective No. 9: To reduce exposure to pesticides in and around retail stores and in household storage.

This is a complex of many problems soluble by attention to detail in storage and handling. An intensive educational and enforcement effort can largely eliminate human exposure incidental to repackaging

into miscellaneous unlabeled containers, shelf storage within reach of children, failure to take prompt action in spills and leaks and similar neglectful practices.

Objective No. 10: To reduce human health hazards from occupational exposure in manufacturing and shipping channels.

The hazard is greatest from accidents such as broken or leaky containers, particularly of technical concentrates. Such exposure is largely preventable by intensive worker training and proper design of industrial plants and handling equipment. Existing lapses from good practice do not appear to be serious, but should be identified by regulatory inspections and brought to the attention of manufacturers and shippers for corrective action.

Of potentially greater concern is the possibility of major accidents such as fires and explosions or catastrophic shipping accidents that could release massive amounts of toxicant into populated areas or waterways. Manufacturers and public agencies should recognize the remote but nevertheless real danger of such happenings, and in addition to taking all reasonable precautions against them, set up plans and allocate resources to provide equipment and trained personnel, perhaps in fire departments or civil defense agencies to perform clean-ups and limit property losses and human injury.

Objective No. 11: To protect the public from ill effects caused by harmful residues of pesticides in food.

Very little is known about residue levels in food in South Vietnam. Commodities are not monitored for content of pesticides and a laboratory suitably equipped and staffed to carry out the necessary

analyses does not exist in the country. Thus in the absence of both medical and analytical evidence there is no reason to believe that residues constitute a health problem or that they do not. There is interest among regulatory and health officials in establishing a residue laboratory to monitor pesticide levels in food, feed and water supplies. This would provide the mechanism to establish and enforce residue tolerances in commodities as provided by law. Such a decision is complicated by the high cost of outfitting and operating a modern laboratory and the fact that it is uncertain that a real problem exists. The seriousness of these drawbacks indicates that perhaps further information should be gathered and alternate solutions examined before undertaking so expensive a commitment.

The first need is a survey of current pesticide levels in food, feed and water supplies. A few hundred market basket samples of commodities could be collected over a year's time and custom analyzed on contract by a commercial laboratory in the United States or elsewhere. This would provide a factual basis for decision rather than proceeding on speculation as must be the case at present. Meanwhile authorities should begin to examine the full range of alternatives for the establishment of an analytical capability either within the country, or on a contractual basis with an external agency, or jointly with other Southeast Asian nations. The latter alternative has many attractions. In this event, residue tolerances could be established by a joint commission of the cooperating governments based on evidence compiled for the region and from the experience of other nations and the

recommended standards of the World Health Organization. A jointly supported laboratory could monitor residue levels and supply information to participating nations for individual enforcement actions as appropriate.

In any event, unlike the obvious health hazards from the distribution and application of pesticides which require immediate action, there appears to be time to proceed more deliberately toward the regulation and monitoring of pesticide residues, preferably on a cooperative basis in the Southeast Asian market area.

Pesticide manufacturers also must come to recognize that their responsibilities extend beyond the manufacture and delivery of formulated materials into market channels. Each manufacturer should have, either in-house or by contract, an analytical capability for his products in manufacturing and market channels as well as for residues in commodities and the environment. It is his responsibility to supply experimental evidence sufficient to assure regulatory officials that when applied as recommended his product will not endanger the public health. Safety then becomes a matter of preventing misuse, that is, treatments or handling contrary to approved practices.

Environment

Much of what has been said about pesticides and public health is applicable to the effects of pesticides on the general environment. Adverse effects of pesticides on health derive from inadvertent or unavoidable exposure of the human organism while so-called environmental effects are concerned with hazard to non-target organisms.

Objective No. 12: To protect livestock, wildlife, and other beneficial or innocuous organisms from needless injury by pesticides.

Information on injury to non-target organisms resulting from spray drift and the contamination of air, water, soil and food chains in South Vietnam is scant. There are observed cases of local kills of aquatic organisms in ditches, streams and other bodies of water. There are persistent reports of toxic residues of insecticides in surface waters in the vicinity of Dalat. Similarly suspect are places where there is intensive use of pesticides in market gardening in restricted areas. However, there is no evidence that these occurrences are frequent or extensive.

In seeking relief from environmental hazards as in the case of the suspected occurrence of harmful residues in food, knowledge should come before action. Perhaps in conjunction with a one-time survey of residues in food and feed, a study of the occurrence of residues in water, soil, wildlife, vegetation, and natural food chains could be conducted on a contract basis by a qualified laboratory. Appropriate corrective action and the nature and extent of needed future residue monitoring programs could thus have a factual rather than a speculative basis, thus possibly avoiding an expensive "solution of a non-problem."

Regulation

The regulatory function as applied to pest control is concerned with exercising in the public interest the police powers of the state to govern actions taken against pests. These actions may include:

the setting and enforcement of standards and requirements for persons and firms to engage in pest control operations or to manufacture, distribute, use or advise on the use of pest abatement materials and devices; the authorization through license of the manufacture, sale, and conditions of use of pest abatement materials and devices; and the detection, investigation and exaction of legal remedy in cases of malpractice, negligence and fraud in matters relating to pest control activities.

Agencies exercising regulatory power stand in a largely adversary relationship with the persons and firms being regulated, although this need not, and should not, become an antagonistic or hostile relationship. The best relationship is obtained when the organization and administration of regulatory programs is entirely separate from research, education, and action programs. Such programs may have the same general objective, and require coordination at some superior level of administration, yet the cordial and informal relations with the public necessary in field research and extension is difficult to achieve if the teacher is simultaneously a policeman. Needless to say, proper exercise of the regulatory function places severe demands upon the technical competence, devotion to duty, discipline and incorruptibility of administrators and agents of the regulatory service.

Regulation of pesticides focuses primarily on the manufacturer, distributor and retailer. The problems of individual farmers and householders, although collectively important, are dispersed beyond practical correction by inspection and supervision as the primary method. Pro-

gress toward the correction of abuses involving millions of people is largely a matter dependent upon education. The regulatory agency can best concentrate its resources on high priority problems in pesticide manufacture and trade. In this regard, it is manifestly evident that the most critical problem is the retail store. Every aspect of the storage, display and handling of pesticides in retail shops falls short of rudimentary standards of good practice. First priority should be given to improving retail operations.

Objective No. 13: To improve the quality and security of pesticide packaging, eliminate tampering with insecticide packages in commercial channels and prevent opening of containers for odd-lot sale.

The aim of this objective is no less than maintaining the absolute integrity of pesticide packages through all commercial channels from the manufacturer to the user. Regulatory action should clearly place upon the manufacturer the responsibility of making his material available in the proper sized packages. He should be required to supply regulatory officials with market studies and other appropriate data supporting his choice of package sizes and giving assurance that these sizes are such as to largely supply the buyer's wants without the need for odd-lot sales. The quality of packages should be given close regulatory scrutiny in terms of security of labels, freedom from leakage and resistance to handling abuses. All containers should have tamper-proof closures.

There should be vigorous inspection and enforcement of packaging and package security procedures in all trade channels. Leaky containers, ones without labels or with loose labels, and containers

that have been opened or tampered with should be summarily confiscated and appropriate sanctions applied.

Objective No. 14: To protect shopkeepers, shoppers and the public from the unsanitary and hazardous stocking and display of pesticides in retail stores.

This objective covers a multitude of often petty abuses in the retail handling of pesticides. Enforcement should concentrate on achieving clean, orderly, and efficient shelf storage and display, easy to clean premises, and an improved level of general sanitation. Stores should be inspected to see that pesticides are kept out of the reach of children and that children and others are not allowed to play, or loiter, or consume food or drink in pesticide stores. There should be prompt cleanup of spills and safe disposal of spilled pesticides and cleaning materials. Inspection and enforcement should aim at the reduction of odors and maintenance of generally pleasant and wholesome conditions in these establishments. Approved safety posters should be on display and the operators license and record of inspections should be posted for public view. Regulatory action should be based on the frequent and thorough inspection of premises making clear what is required, allowing time for compliance when necessary and in due course issuing citations, suspending licenses and closing shops where these drastic actions become necessary in last resort. It should be recalled that these actions are in addition to the intensified education previously recommended.

Communications

The entire plant protection apparatus, both private industry

and governmental agencies, is deficient in mutual interchange of information on technology and programs. There is need for a professional society on plant protection with broad membership by persons engaged in industry and governmental research, education and action programs. There should be periodic meetings at which papers are presented and information exchanged.

Qualified persons should become members of international professional societies and attend meetings and interchange ideas with scientists, administrators and educators in other nations. Particular attention should be given to interchanges with other Southeast Asian nations and countries in other parts of the world having similar conditions and problems.

The government and industry should consider sponsoring technical meetings and workshops drawing on the services of USAID instructional teams available through university contracts such as the one arranging the services of the present consultant. Such meetings could, in addition, draw on the worldwide experience of chemical industry scientists, research workers from international research institutes and the experience of other tropical nations.

SUMMARY

Expansion of agricultural output is a major goal of South Vietnam. Protection of crops and commodities from excessive losses caused by insects, plant diseases, weeds and other pests is essential to the achievement of that goal. Protection from insect pests is

largely by insecticides while protection from plant diseases, nematodes, weeds and other pests is by traditional cultural and manual methods supplemented by limited employment of pesticides.

Pesticides are formulated by domestic firms and packaged and distributed through small retail stores. The importation, formulation, labeling, sale, and use of pesticides are subject to regulatory control primarily by the Plant Protection Service. There is need for improved packaging and better quality control at the manufacturing level and improved handling and merchandising at the retail level. Personnel in and around retail stores and farmers and their families are subject to excessive and unnecessary exposure to pesticides. The practice in retail shops of opening factory containers and selling odd-lots of pesticides in miscellaneous containers is a serious source of error, deception and danger in the marketing of pesticides. There is excessive exposure of persons to pesticides in its handling and particularly its application by farmers and gardeners. Education can reduce these hazards but the best available technology offers only an imperfect solution. This problem needs special research attention.

Better and safer pest management in South Vietnam can be achieved by having better trained people at all levels of operations, by strengthening and diversifying available methods and materials, and by the realistic, conscientious and humane administration of suitable laws and regulations.

Education is clearly the first priority in any effort under-

taken to improve pest management in South Vietnam. Its objective is to provide the intellectual, scientific, technological, manipulative and motivational basis for all pest management activities. The development of a wide array of methods for integrated pest management through research and field testing by industry and government should be given high priority. Regulatory agencies should give first priority to eliminating negligent and fraudulent practices in the retail handling of pesticides. Authorities should undertake preliminary steps toward the establishment and enforcement of tolerance levels for pesticide residues in commodities and the general environment preferably in cooperation with other Southeast Asian nations.

A professional society and a program of conferences, seminars, and workshops aimed at diffusing knowledge and increasing intercommunications should be initiated. These meetings should draw heavily on regional and international talent including American university resources available through USAID.