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CLASSIFICATION

PROJECT EVALUATION SUMMARY (PES) — PART I

Report Control Symbol U-447

1. PROJECT TITLE	2. PROJECT NUMBER	3. MISSION/AID/W OFFICE
Development of an Environmentally Acceptable Replacement for DDT. (WHO/Indonesia Grant)	931-0068	S&T/HEA

4. EVALUATION NUMBER (Enter the number maintained by the reporting unit e.g., Country or AID/W Administrative Code, Fiscal Year, Serial No. beginning with No. 1 each FY) 81-41 8/20/81

☐ REGULAR EVALUATION ☐ SPECIAL EVALUATION

5. KEY PROJECT IMPLEMENTATION DATES

A. First PRO-AG or Equivalent FY 76

B. Final Obligation Expected FY 81

C. Final Input Delivery FY 82

6. ESTIMATED PROJECT FUNDING

A. Total $ 1,298

B. U.S. $ 1,298

7. PERIOD COVERED BY EVALUATION

From (month/yr.) 6/78

To (month/yr.) 4/81

Date of Evaluation Review 4/16/81

8. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

A. List decisions and/or unresolved issues; cite those items needing further study. (NOTE: Mission decisions which anticipate AID/W or regional office action should specify type of document, e.g., airgram, SPAR, PIO, which will present detailed request.)	B. NAME OF OFFICER RESPONSIBLE FOR ACTION	C. DATE ACTION TO BE COMPLETED
The Health Technical Committee reviewed the Evaluation Team Report along with several options for the future of the project which were formulated by the then-DS Bureau. The decision was made to fund the project for one additional year when it would then terminate in Sept. 1982. Actions to be completed are:		
1. Prepare PAF amendment and funded PIO/T for one year extension of project.	J. Erickson, S&T/HEA	Completed 6/19/81
2. Prepare terminal evaluation report or project completion report.	S&T/HEA	10/82

9. INVENTORY OF DOCUMENTS TO BE REVISED PER ABOVE DECISIONS

☐ Project Paper ☐ Implementation Plan e.g., CPI Network ☐ Other (Specify)

☐ Financial Plan ☐ PIO/T

☐ Logical Framework ☐ PIO/C ☐ Other (Specify)

☐ Project Agreement ☐ PIO/P

10. ALTERNATIVE DECISIONS ON FUTURE OF PROJECT

A. ☐ Continue Project Without Change

B. ☐ Change Project Design and/or ☐ Change Implementation Plan

C. [XX] Discontinue Project

11. PROJECT OFFICER AND HOST COUNTRY OR OTHER RANKING PARTICIPANTS AS APPROPRIATE (Names and Titles)

J. Erickson, S&T/HEA

12. Mission/AID/W Office Director Approval

Signature

Typed Name Jack Royer, Director (Acting) S&T/HEA

Date 8/20/81

AID 1330-15 (3-78)

SUMMARY: With concern about the residual effect of DDT on the environment and the appearance of DDT resistance in many of the malaria-bearing mosquito species, the need for an environmentally acceptable alternative to DDT became a priority. By the early 1970s there were several newly developed, acceptable insecticides available, but their effectiveness under LDC conditions was not known. This project was then developed with WHO and its Vector and Rodent Control Unit in Indonesia in order to develop and test alternative residual insecticides. (At an early stage of the project the University of Illinois was involved in preliminary testing of compounds for insecticidal effect and biodegradability; this activity was phased out in 1978.) The transfer of technology to other countries in the region was also an objective of the project.

The evaluation was carried out in February 1980. The team report, which is attached, found that the project has taken advantage of the large body of research and development information on insecticides from laboratories in different parts of the world - an effort coordinated by WHO. Promising compounds tested included all major types of insecticides, i.e., chlorinated hydrocarbons, organophosphorous compounds, carbamates and synthetic pyrethroids. The testing approach was well designed and used Stage IV and Stage V type trials; in fact, at the present time this facility is the only one in the world with the necessary expertise and experience for the conduct of Stage IV and Stage V field trials of alternative insecticides.

Results obtained have been highly significant. The demonstration of the ineffectiveness of malathion at dosages and with formulations normally considered highly effective in other parts of the world where malathion is the insecticide of choice as a substitute against DDT-resistant anopheline mosquitos prevented expenditure of millions of dollars for a treatment that would not be satisfactory. Fenitrothion was developed as a viable substitute for DDT with costs of application to be reduced by selective spraying or reduced dosage. Ultra Low Volume (ULV) applications of fenitrothion were shown effective, but expensive because of the requirement of weekly applications

The team concluded that the priority for developing alternative insecticides remains high both regionally and world-wide, and recommended that the project be continued for a three-year period. Residual spraying is presently still the most cost effective method of malaria control as long as the mosquito is susceptible to the insecticide used. The team also noted, however, that the rising cost of insecticides made it imperative to reduce the quantities being used and suggested the need to investigate other methods of control, e.g., attacking larval habitats, changing irrigation practices, testing biological control agents etc., for possible integration into a comprehensive malaria vector control program. AID agreed with the need for a comprehensive vector control program and is in

the process of designing one with start-up funding to begin in FY 1982. Concurrently it was decided that, although the WHO/Indonesia activities should be continued, enough progress had been made and interest stimulated that other donors could be found to substitute for the AID contribution to the project. Therefore, WHO was informed that instead of a three-year renewal of project funding, AID would fund one additional year (through September 1982). It is also possible that some of the WHO/Indonesia activities may be included in the new project.

EVALUATION METHODOLOGY: The initial evaluation study took place in February 1980 and was carried out by a team of three consisting of a consultant from USDA's Laboratory for Insects Affecting Man and Animals, the World Health Organization's project coordinator from WHO's Division of Vector Biology and Control, and the AID project manager from the Office of Health. The team conferred with Government of Indonesia officials in Jakarta, Bogor, Semarang and Den Pasar; visited the project laboratory and field stations at Semarang; and inspected a potential field station site for malaria vector control research on the north coast of Bali. The team report is attached.

With the team report in hand, a second stage of the evaluation took place in AID/W and involved top officials of the then Development Support Bureau, the DSB Office of Health and health technicians from other bureaus, principally Asia. At the heart of this stage of the evaluation were programming issues which arose from recommendations contained in the team report; for although the team found project progress satisfactory and recommended continued funding, they also noted that a vector control approach would be needed to make significant inroads to the malaria problem even if highly effective alternatives to DDT were found. These issues were resolved in April 1981.

PURPOSE: "To test the effectiveness and safety of various environmentally acceptable alternatives for DDT for use as residual insecticide sprays in field operational anti-malaria programs."

Residual insecticides tested were those normally available commercially and which showed promise through the WHO insecticide evaluation scheme conducted collaboratively with several laboratories in different parts of the world. Those selected were biodegradable DDT, fenitrothion, malathion, chlorphoxim, pirimphos-methyl, carbaryl and Decamethrin. Fenitrothion and pirimphos-methyl were the only two compounds which showed sufficient biological activity - residual persistance and air-borne toxicity - throughout the tests at Stages IV and V. Fenitrothion was shown to be effective at both a high and low dosage although the low dosage required more frequent respraying. A "selective spray" method was also developed for fenitrothion which may become highly significant since this compound is

much more expensive than DDT. Pirimiphos-methyl was also effective at high and low dosages but the higher dosage caused surface spotting and erosion of the spray nozzles.

The assessment that Decamethrin was not proving effective was based on incomplete trials at the time of the team visit; final conclusions should await completion of the trials.

The conclusion that malathion was not satisfactory is significant. It has been the standard choice for replacing DDT in other parts of the world. This research effort demonstrated that it is not always possible to predict results in local situations with materials shown effective in other areas, even when the material is considered as a "broad spectrum" insecticide. The testing saved the expenditure of large sums of money for a DDT substitute which would not have been effective and pointed out the need to test any new insecticide against specific vectors under local conditions.

ATTACHMENT:
Team Report

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Site Visit Review

Development of Environmentally Acceptable Replacement

for DDT (WHO - Indonesia

Grant No. AID/ta-g-1210 and Grant No. AID/DSPE-IGC-0017

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The team conferred with Government of Indonesia officials in Jakarta, Bogor, Semarang, and Den Pasar; visited the project laboratory and field stations at Semarang; and inspected a potential field station site for malaria vector control research on the north coast of Bali near Singaradja.

In addition to the Team Report the following are attached:

1. Project Appraisal by external consultant
2. Overview of Research Activities of the Semarang Sub-unit
3. ~~Itinerary~~
4. ~~List of persons contacted by the team.~~

NOT ATTACHED

TEAM REPORT

Background

The Vector and Rodent Control Research Unit (VRCRU) was established in Jakarta in 1972 to conduct research on all aspects of the ecology and control of important insect vectors of disease and of urban and peri-urban rodent populations with special emphasis on dengue haemorrhagic fever, filariasis, malaria, rodents and their ectoparasites. During the first two years, research was started in all of these fields except malaria.

In 1974, VBC of WHO/Geneva sent a consultant to Indonesia to review the research program and make recommendations as to the nature of malaria research appropriate for the Unit to carry out. At the same time, AID/Washington sent two specialists on malaria research and training to Indonesia to consult with the Government of Indonesia malaria officials on the training and research needs of the malaria control program in connection with the proposed USAID loan for support of the Indonesian malaria control effort. The reports of both WHO and AID consultants indicated that in light of the wide spread development of DDT resistance in Anopheles aconitus the highest research priority of the Indonesia malaria control program was for the development and testing of alternative residual insecticides to be used in place of DDT.

In late 1975, a sub-unit was established in Semarang, Central Java, supported primarily by a two-year grant from the US Agency for International Development, and was later extended for a further three years until September 29, 1980.

Significant inputs have also been made by the WHO which supports one staff member of the three professional staff at the Unit and the Government of Indonesia which provides counterpart professional staff, spraymen, laboratory facilities, store houses, etc. The primary objective of the grant was to search for an environmentally acceptable insecticide for the control of DDT-resistant An. aconitus, the main vector of malaria in most of the islands of Java and Bali. This was done by carrying out field trials on insecticides emanating from the WHO scheme for the screening and testing of new insecticides. This program has a high priority for the Government of Indonesia as malaria represents the No. 1 problem among the communicable diseases listed in the Indonesia Country Health Program.

The priority for developing alternative insecticides remains high regionally and world-wide. Residual spraying is still the most cost effective method of malaria control as long as the mosquito vector is susceptible to the insecticide used even with the most expensive alternative insecticides available.

At the present time this project is the only one in the world with the necessary expertise and experience required for conduct of Stage IV and Stage V field trials of alternative insecticides.

An indication of the need to maintain this expertise is to be found in recent WHO reports on vector resistance. A tabulation of these reports shows that so far, 24 species of Anopheline mosquitos in 48 countries have been confirmed as being resistant to DDT, 43 species in 72 countries are resistant to dieldrin HCH, 6 species in 10 countries to organophosphate insecticides and 2 species in 5 countries to carbamates. Vector resistance to insecticides has been reported in 12 of the Asian countries in 16 vector species.

Recommendations:

1) Village scaletrials of new insecticides, insecticide formulation and applicant equipment should be continued.

These trials should be carried out in areas where the Anopheles vectors of malaria are already resistant to DDT and other chlorinated hydrocarbons. Though earlier work of the sub-unit has already demonstrated the efficacy of fenitrothion against An. aconitus the possible development of resistance to this compound cannot be excluded as organophosphate insecticide resistance has already developed in other malaria vectors. Though the number of new compounds becoming available is much reduced, it is important to retain the capacity for testing these under field conditions. The results of these trials will be of importance not only to the Government of Indonesia but to many other countries in the South-East Asia and Western Pacific Region, where vector resistance is also a problem.

Studies should be carried out both on newer compounds and those which have already successfully undergone field trials to determine how they might be applied more selectively, effectively and, consequently, more economically.

Experience at the sub-unit has already shown that at minimal cost the villagers can be readily trained to apply and even participate in the evaluation of residual insecticides under appropriate supervision. Extending this concept to larger areas could result in major savings in labor costs.

2) Additional research should be devoted to the evalution and development of the ultralow volume concept of adult anopheline control and should include:

a. A determination of any residual effects following application
b. Evaluation of vehicle mounted ULV equipment

3) Research should be conducted on the development of comprehensive and integrated methods of malaria vector control.

Even in those geographical areas in which insecticides resistance has developed in malaria vector populations, the rising cost of insecticides has made it imperative to reduce, as much as possible, the quantities being used. This might be done by their more selective use. Another approach, however, is to integrate into vector control programs other feasible methods of control which would reduce the amount of residual spray required. Studies should be carried out to determine the

possible application of environmental management and, particularly, source reduction methods which could be applied by the communities themselves. These might involve either changes of irrigation practices or, where feasible, permanent elimination of breeding sites in the vicinity of villages. Charges in salinity might control mosquito breeding in coastal lagoons.

When available, biological control agents should also be tested to determine their possible place in an integrated malaria vector control program.

In some larval habitats such as that of lagoons, the use of larvicides might prove more economical than that of adulticides and this should be examined.

4) The sub-unit should expand their studies on the ecology of malaria vectors on Java and Bali, particularly those breeding in irrigation water and brackish water e.g. rice fields and lagoons.

Fundamental to the development of more selective control methods whether by insecticides or alternative approaches is the need for a better understanding of the ecology of the vector species both of the aquatic and adult stages. Such studies should focus on species breeding in irrigation water, particularly in rice fields and those breeding in brackish water, especially coastal lagoons and fish ponds. Both of these types of habitats while common in Indonesia are also of great regional importance throughout Southeast Asia. Studies should include location of larval populations and variations in their seasonal densities, adult movement and resting habits both indoors and out, both in houses and in animal shelters as well as natural resting places.

5) As a basis for development of Comprehensive Vectrol Control studies should be conducted on the vectorial capacity of Anopheline species on the outer islands.

In many areas of the vast outer islands of Indonesia the relative importance of the various potential vectors of malaria is uncertain. Since such information is basic to any future control programs, studies should be organized and carried out in collaboration with both research and control groups of the Indonesian Government to determine the species of Anopheles responsible for malaria transmission on the outer islands. Such studies should include checking sporozoite rates and blood meal feeding preferences.

6) Also as a basis for development of comprehensive vector control, studies should be conducted on the ecology of Anopheles vectors of the outer islands.

Once the identity of the Anopheles species responsible for malaria transmission has been determined, studies on their ecology should be started to obtain information on their larval habitats, their characteristics, adult movement, host preference, favored resting place, and biting habits. This information is needed in order to plan selective and economic programmes for the control of these vector species.

7) Transfer of Technology

A special effort should be made to involve Indonesian staff at all levels, both scientists and technicians. The transfer of the technology involved in the implementation and assisting of the Government of Indonesia, and other Governments of the Region to develop scientific manpower to pursue the research independently, must be regarded as one of the most important objectives in the future conduct of this research project.

8) The recommended activities should be carefully coordinated with other ongoing or planned research and the the operational needs of the GOI-CDC, particularly the malaria control program. Therefore, it is recommended that a special coordinating committee be established to review and approve the various elements of research proposed in the planned expansion of the insecticide testing sub-unit at Semarang. The members of such a committee should include representatives of all organizations or agencies concerned with or conducting malaria research in Indonesia such as CDC, Litbang Kes, the WHO Malaria Advisory Team, the WHO VBCRU, the USAID Mission's office of health, NAMRU and the Universities.

It is suggested that fuctions of the coordinating committee may include:

1. Ensuring that planning of malaria research is done with full knowledge of all pertinent information available within the country.
2. Ensuring that malaria research planned is designed to solve the priority operational problems of the National Malaria Control Program.
3. Planning of research to avoid unnecessary duplication of effort.
4. Planning for the development of systematic coordination, cooperation and collaboration as appropriate among the various entities concerned with malaria research.
5. Arranging for routine exchange of reports and other pertinent information among all committee members.

It is further suggested that regular, perhaps quarterly meetings would be desirable for planning, for revieweing of progress and research results and to expedite prompt utilization of research results for actual field application.

This recommendation is consistent with the conclusions reached at the WHO Workshop on South-East Asia Regional Programme for Applied Research in Malaria Control which stated, "Co-ordination of research activities is essential at the Regional and National levels. In this regard at national level the existing mechanism should be utilized if adequate. Where necessary, the establishment of a co-ordinating body/council shoud be considered."

9) It is recommended that the project should be continued for a three year period with a gradual expansion, and re-structuring to enable the project to continue the insecticide studies as well as phase into the additional studies recommended above on a priority basis as determined by the Government of Indonesia.

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Appendix 1

Project Appraisal

Development of Alternative Insecticides for Anopheline and Malaria Control, Principally Semerang Subunit of World Health Organization

D. E. Weidhaas

At the time of this site visit (February 11-22, 1980), 4½ years of the 5 year project had been completed. The primary objective of the project was the development of alternative insecticides to be used as residuals to replace the use of DDT. Since the insecticide resistance problem is world-wide, the project has significance to many areas of the world. It is an excellent location for the project because of the problem of DDT resistance in *Anopheles aconitus* in Central Java. The project has made excellent progress in its primary objective and has, through innovative research on methods of application and ecology, reduced the costs of application of an alternative residual insecticide. Since alternative insecticides are much more costly than DDT this research development is highly significant. In general, the results of the project are significant both to problems in other malarious areas in other parts of the world as well as the specific problems in Indonesia. The Vector Biology and Control Research Unit in Jakarta has maintained an awareness of other problems in malaria control, e.g. malaria transmission on Bali by lagoon-breeding *An. sundiacus* and malaria transmission on outer islands associated with transmigration programs. It is significant that they have started survey and ecological studies of these problems.

In summary form, specifics of the USAID - supported project on the development of alternate residual insecticides is as follows: it is important to note that the insecticides chosen for evaluation were those which would be available commercially and showed promise through the WHO insecticide evaluation scheme conducted collaboratively with several laboratories in different parts of the world.

Candidate residual insecticides were tested in stage IV (evaluation in houses for residual and air-borne toxicity) trials. Summary reports indicate 5 insecticides were tested, but only 4 - fenitrothion, biodegradable DDT, carbaryl and pirimiphos-methyl - were summarized. Only 2 of these compounds showed sufficient biological activity - residual persistance and air-borne toxicity - to evaluate in stage V trials (village scale).

These two materials - fenitrothion and pirimiphos-methyl - were tested at 2 dosages - 1 and 2 g/m^2 in village trials. Two other materials - malathion and chlorphoxim - were tested at 2 g/m^2. Malathion was the standard material of choice as a replacement for DDT in other parts of the world. Chlorphoxim was a very promising material from the WHO insecticide scheme. Decamethrin®,

a promising pyrethroid insecticide, was also added to village scale trials. Several significant findings resulted and led to improved application methods.

Fenitrothion was shown to be an effective residual for 3 months at 2 g/m^2 and 2 months at 1 g/m^2. Pirimiphos-methyl was shown to be effective for 2 months at 1 g/m^2 and 3 months at 2 g/m^2. The formulation of pirimiphos-methyl is as satisfactory at 1 g/m^2, but the 2 g/m^2 left unsightly brown deposits on surfaces and caused excessive erosion of nozzle tips of sprayers. Fenitrothion formulation was satisfactory at both dosages. Thus, 2 potential replacements for DDT were identified with fenitrothion the alternative of choice because of better biological activity.

Further research on the behavior and ecology of *An. aconitus* quantitated a much earlier observation made on *An sundiacus* that *An. aconitus* tends to rest on the lower surfaces in houses. On the basis of this observation, a method of "selective spraying", i.e. treating a swath from 10 cm to 85 cm above the floor, was developed and shown to be effective when fenitrothion was the insecticide used for residual treatment. In general, the effectiveness of fenitrothion can be rated as follows from testing in this project: (1) total coverage at 2 g/m^2; (2) total coverage at 1 g/m^2 and "selective spraying" at 2 g/m^2.

Since fenitrothion is much more expensive than DDT the development of the "selective spray method" is highly significant and makes possible the use of this alternative or substitute residual insecticide. Pirimiphos-methyl is a potential back-up insecticide.

Two points are of interest in the lack of satisfactory results in village scale trials with malathion and Decamethrin. (Note that the Decamethrin trials have not been completed. A preliminary assumption that Decamethrin is not satisfactory may be premature and final conclusions should await completion of the trials). It is significant that density evaluations, bioassays, and parous rates showed that malathion formulations tested to date are not sufficiently effective. Results were similar in 3 replications. This research effort demonstrated that it is not always possible to predict results in local situations with materials shown effective in other areas even when the material is considered as a "broad-spectrum" insecticide. It saved the expenditure of large sums of money for a substitute for DDT which had not yet been tested for the local problem. The other significant point is that bioassay data obtained in stage IV and stage V trials indicate selections of candidate residual insecticides can be made on the basis of stage IV trials with a good degree of confidence. In light of the fact the malathion and Decamethrin were first tested at the stage V level it seems significant to suggest that further trials of these and new candidate residual insecticides be evaluated at more than one dosage for effectiveness in stage IV trials before conducting stage V trials.

In addition to the primary objective of developing substitute residual insecticides for DDT, the project has begun to evaluate ULV (ultralow volume) applications of fenitrothion against adults. Such trials are

preliminary at this stage. However, they have demonstrated that ULV treatments can be effective but are expensive because of a short cycle between retreatments. Further studies are needed on the use of the ULV technique.

In general review of this project, it should be viewed in the following categories: (1) use of existing data and information developed locally and in other parts of the world; (2) approach to primary problem; (3) methodology; (4) results; and (5) recognition of future problems and needs.

The project has taken advantage of the large body of research and development information on insecticides from laboratories in different parts of the world which was coordinated by the WHO insecticide scheme. They have tested promising compounds including all major types of insecticides: (1) chlorinated hydrocarbons, i.e. biodegradable DDT; (2) organophosphorous compounds, i.e. fenitrothion, malathion, chlorphoxim and pirimiphos-methyl; (3) carbamates, i.e. carbaryl; and (4) synthetic pyrethroids, i.e.Decamethrin.

The approach was well designed by using stage IV and stage V type trials. The methodology for evaluations included bioassays of residual and "air-borne" toxicity as well as indicators of density trends and survival of adult females. Since mosquito density and survival are the 2 most important vector parameters in malaria transmission the methodology was sound.

Results obtained were highly significant. The demonstration of the ineffectiveness of malathion at dosages and with formulations normally considered highly effective in other parts of the world where malathion is the insecticide of choice as a substitute against DDT - resistant anophelines prevented expenditure of millions of dollars for a treatment that would not be satisfactory. Fenitrothion was developed as a viable substitute for DDT with costs of application to be reduced by selective spraying or reduced dosage. ULV applications of fenitrothion were shown effective, but expensive because of the requirement of weekly applications.

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OVERVIEW OF RESEARCH ACTIVITIES OF THE SEMARANG SUBUNIT OF THE VECTOR BIOLOGY AND CONTROL RESEARCH UNIT-II.

INTRODUCTION

In view of increased resistance of many malaria vectors to DDT in many parts of Southeast Asia, including Indonesia, the World Health Organization (WHO), in collaboration with the Ministry of Health (MOH) of Indonesia and with financial support from USAID, established a sub-unit of the Vector Biology and Control Research Unit (VBCRU-II) in Semarang, Central Java, in June 1975. The principle objective of this Sub-unit was to search for an environmentally acceptable alternative for DDT for the control of DDT-resistant Anopheles aconitus, and possibly other DDT-resistant vectors in other countries of the region as well. Other objectives were to test any new application methods with new formulations and practices, as may appear practical.

The MOH provided the laboratory facilities and placed at the disposed of the Sub-unit 28 of junior and senior staff. With the financial support of USAID, one entomologist and one sanitarian were assigned while WHO appointed one entomologist in Semarang, in addition to technical supervision provided by periodic visits and field participation by other WHO staff from the Jakarta based VBCRU-II. In addition to the main laboratories in Semarang, the Sub-unit established, in collaboration with the provincial Health Authorities of Central Java, a field station at Tambangan near the areas where the field trials have been carried out since 1976 (Fig. 1).

RESEARCH ACTIVITIES

During the past four years (1976-79) four OP compounds in different formulations and dosages were tested to determine their residual effectiveness in groups of villages (Stage V trials) and five residual insecticides were tested in house-scale trials (Stage IV). In addition, two village-scale trials were conducted to develop new application methods applicable to local conditions of intensive rice growing areas of Central Java, i.e. outdoor ULV application of fenitrothion technical grade by knapsack machines and partial indoor treatment of fenitrothion on only lower part of walls. None of the compounds had been tested before in this area for the control of DDT-resistant An.aconitus.

A list of the Stage IV trials is shown in Table 1. Fenitrothion 40% wdp at 1 and 2 gr/m^2, and pirimiphos-methyl 50% EC at 2 gr/m^2 showed sufficient promise to be further evaluated in Stage V trials, i.e. having bioassay mortalities on sprayed surfaces above 50% for about 8 weeks or longer, and/or evidence of an airborne effect. A summary of these stage V trials are shown in Table 2 and comparative results in Table 3. Other research activities have been studied on the ecology and behaviour of An.aconitus in Central Java (Table 4).

Fenitrothion: This compound has been the most effective all of those tested. However, high cost has prevented large scale operational use of this insecticide at the standard dosage of 2 gr/m^2 by the MOH. Because of cost, as well as mammalian toxicity and possible resistance considerations, two stage V trials have been carried out using reduced amounts. In the first trial, with normal total coverage at 1 gr/m^2 manpower requirements were the same as at 2 gr/m^2, but insecticide usage was reduced by one-half and the residual effectiveness only by about 1/3, i.e. to 2 months from 3 months at 2 gr/m^2. The second trial to reduce amounts of insecticide was by spraying at 2 gr/m^2 only one horizontal swath between 10 and 85 cm from the ground. This reduced insecticide use by about two-third and manpower by over one-half. Preliminary analyses of results indicate that vector populations were effectively suppressed for over 2 months, slightly less than that of total coverage at 2 gr/m^2, but more effective than at 1 gr/m^2 total coverage.

The rationale of this one swath "selective" spraying was based on observations on othe resting behaviour of An.aconitus, which showed that about 78% rest below 85 cm from the ground.

Malathion: This OP compound has been the most common replacement for DDT since the early 1960's, because of its safety, relatively low scost and effectiveness. As the DDT-resistant population of An.aconitus prevailed in Java, the MOH became extremely interested in replacement of DDT with malathion. Accordingly, the Sub-unit tested this insecticide in 3 trials in 1976 and 1977 against DDT-resistant An.aconitus and found to be ineffective each time. Man-vector contact indices (indoor and outdoor landing rates) and associated parous rates were not reduced, and other population density indices and parous rates were only reduced for short periods, generally less than 4-6 weeks. The reasons for this is yet to be established.

Pirimiphos-methyl: Two trials of this compound were carried out, one with a 25% wdp formulation at 2 gr/m^2 and the other with 50% EC at 1 gr/m^2. The 2 gr/m^2 wdp treatment was effective for about 3 months, but the formulation was shown to be unsuitable because of heavy, unsightly brown deposits left on surfaces and high erosion of nozzle tips. The 1 gr/m^2 EC treatment was effective for about 2 months and the formulation very suitable.

Chlorphoxim: This compound was applied as a 50% wdp at 2 gr/m^2 and was found to be only marginally effective, the most important deficency being failure to reduce indoor and outdoor man-vector contact.

Fenitrothion ULV: A stage V trial of ground ULV treatments was carried out using back-pack machines and 95% fenitrothion to apply 5 weekly cycles of about 40 ml per house per cycle. Vector populations were effectively suppressed during the treatment and for about 2 weeks after the last cycle. However, considering the amount insecticide used (about the same as selective spraying), short residual effects, equipment costs and intensive supervision required, it was concluded this type of ULV application would only be useful for epidemic situations of limited area.

RELEVANCE TO APPLICATION

The implications of these results for the Government of Indonesia (GOI) are the following:

a). The three village trials with malathion enabled the MOH to avoid planned large expenditures for this compound to replace DDT.

b). The MOH will spray 200 tons of 40% fenitrothion wdp in 1980/81 as a pilot operation, and have proposed an operational trial of "selective" spraying in two high malarious districts in Central Java.

c). Also, the MOH is planning to carry out a large scale operational trial covering a population of over 75,000, with pirimiphos-methyl in Central Java with financial support from the chemical company and technical assistance of the VBCRU-2.

d). Based on the field studies on the ecology and the behaviour of An. aconitus, advanced selective spray trials can be organized to reduce further insecticide use in the near future by the team in collaboration with local Government.

e). In addition, the GOI and MOH have been enjoying in the in-service training opportunities for htheir personnel assigned to the Sub-unit, both in entomology and spraying operations. Also, 10 WHO fellows from WHO member states in the Southeast Asia and Western Pacific Regions have visited annually and been trained at the Sub-unit.

Table 1. Summary of Stage IV trials.

Trial No.	Year	Insecticide and formulation	Target dosage
1.	1976	fenitrothion (OMS-43), 40% wdp	2 gr/m^2
2	1976	fenitrothion (OMS-43), 23.9% encapsulated EC	2 gr/m^2
3	1977	biodegradable DDT (OMS-1856), 75% wdp (in a DDT resistant area)	2 gr/m^2
4	1977	As above, in a DDT susceptible area	2 gr/m^2
5	1978	pirimiphos-methyl (OMS-1424), 50% EC	2 gr/m^2
6	1978	carbaryl (OMS-29), 75% wdp	2 gr/m^2
7	1978	fenitrothion (OMS-43), 40% wdp	1 gr/m^2

Table 2.

Summary of Stage V trials: Number of houses treated, amount of, insecticides used and spraymen employed.

Trial No.	Year (No.hamlet)	Insecticides and formulation	Target dosage (gr/m2)	No. houses (pop.)	Amount insecticides per house (kg)	1/	Sprayman Total (man day)	No.house/ man day
1	1976 (16)	fenitrothion 40% wdp	2	978 (4469)	1.53	613	200	4.9
2	1976 (8)	malathion 50% wdp	2	819 (3823)	1.22	612	190	4.3
3	1977 (16)	malathion 50% wdp	2	836 (4064)	1.35	675	252	3.3
4	1977 (16)	malathion 2/ 50% wdp	2	1078 (5382)	1.20	599	300	3.6
5	1978 (14)	Pirimiphos methyl 25% wdp	2	1122 (5088)	2.03	509	264	4.3
6	1978 (10)	Chlorphoxim 50% wdp	2	829 (3814)	1.14	572	180	4.6
7	1979 (15)	Pirimiphos methyl 50% EC	1	874 (4152)	0.54	271	210	4.2
8	1979 (18)	fenitrothion 40% wdp	1	1053 (4554)	0.75	298	240	4.4
9	1979 (10)	fenitrothion 3/ 40% wdp	2	1062 (5005)	0.55	221	118	9.0

1/ Active ingredient in grams used per house
2/ The 2nd round in June-July
3/ One horizontal swath between 10 and 85 m above the ground and applies against the 2nd peak.

Table 3.

Number of weeks showing effective control of *Anopheles aconitus* by various residual sprayings as determined with female densities (d) and parity (p).

Trial No.	Insecticide and dosage	1/	Night landing catches		Resting catches			
			Indoor	Outdoor	houses morning	cattle-shelter night	cattle-shelter morning	natural-site morning
1	OMS-43 wdp	d	12	12	> 30	7	12	< 12
	2 g/m^2,1976	p	12	13	NA	17	12	20
2	OMS-1 wdp	d	< 2	NS	> 25	< 2	2	< 2
	2 g/m^2,1976	p	NA	3	NA	7	NA	NA
3	OMS-1 wdp	d	1	NS	7	NS	4	4
	2 g/m^2,1977	p	7	7	6	7	6	8
4	OMS-1 wdp	d	NS	2	NS	5	1	NS
	2 g/m^2,1977	p	2	NS	NA	7	1	2
5	OMS-1424 wdp	d	9	9	14	7	> 10	7
	2 g/m^2,1978	p	9	8	> 10	11	10	12
6	OMS-1197 wdp	d	5	4	> 10	4	> 10	10
	2 g/m^2,1978	p	7	7	14	5	14	> 14
7	OMS-1424 EC	d	6	5	> 10	7	4	> 10
	1 g/m^2,1979	p	6	7	NA	6	7	6
8	OMS-43 wdp	d	> 10	10	14	3	17	17
	1 g/m^2,1979	p	11	11	13	8	9	9
9	OMS-43 wdp	d	11	> 11	> 12	9	> 12	> 12
	2 g/m^2,1979	p	11	11	NA	6	> 12	8

1/ "d" refers to natural densities while "p" represents parous rate.

NA = not applicable

NS = no significant

Table 4. List of Publications of VBCRU-II Sub-unit, Semarang.

Trials made in	Authors	Insecticides/or subject	Trial	WHO/VBC document
1976	Joshi et al	Fenitrothion wdp 2 g/m^2	Stage V	77.675
1976	Joshi et al	Ecoloy/ An.aconitus	Field	77.677
1977	Pradhan et al	Fenitrothion 95% ULV	Stage V	79.729
1978	Shaw et al	Pirimiphos methyl wdp, 2 g/m^2	Stage V	79.722
1978	Fanara et al	Chlorphoxim wdp, 2 g/m^2	Stage V	79.724
1978	Pradhan et al	OMS-43, OMS-1424 OMS-29, 2 g/m^2	Stage IV	79.739
1979	Supratman et al	Fenitrothion wdp, 1 g/m^2	Stage V	79.738
1979	Supalin et al	Pirimiphos methyl EC, 1 g/m^2	Stage V	79.752
1979	Damar et al	Behaviour/ An.aconitus	Field	manuscript in preparation
1979	Bang et al	Seasonal abundance/ An.aconitus	Field	manuscript in preparation.