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Appendix 1

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Project Appraisal

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

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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.