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MALARIA CONTROL II PROJECT, NO.391-0472

EXTERNAL EVALUATION PART II : ENTOMOLOGICAL ASPECTS

REPORT OF THE
EXTERNAL EVALUATION TEAM
September 12-30, 1983
ISLAMABAD, PAKISTAN

FACE SHEET EXTERNAL EVALUATION REPORT : (PART II)
September 12 - 30, 1983

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		136,500	7,000

REPORT OF MALARIA EXTERNAL REVIEW TEAM

PART II : ENTOMOLOGIC ASPECTS

September 12 - 30, 1983

ISLAMABAD, PAKISTAN

Dr. George P. Georghiou

Dr. Jesse H. Hobbs

Dr. L. Boschi

Dr. William Chin

Dr. Imtiaz Hussain Shah

THE EXTERNAL REVIEW OF THE PAKISTAN MALARIA CONTROL PROGRAM:

PART II - ENTOMOLOGIC ASPECTS

(September 12-30, 1983)

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THE EXTERNAL REVIEW OF THE PAKISTAN MALARIA CONTROL PROGRAM:

PART II - ENTOMOLOGIC ASPECTS

(September 12-30, 1983)

I. SUMMARY:

The external review of the Malaria Control Program (MCP) in Pakistan, Part II, took place from September 12-30, 1983. This assessment focused on issues related to the control of the vector, particularly the use of residual insecticides. Due to the EID holidays and the time constraint, field visits were limited to Sheikhupura and Sialkot districts of the Punjab and the Mardan and Peshawar zones in the NWFP. During the EID holidays, team members discussed extensively the various issues among themselves and with personnel of the ICMRT, Lahore. The team concluded that the spray operations for 1983 were conducted with a low degree of efficiency; that entomologic data were generally not used to guide program operations; that evidence is emerging to show incipient resistance to organophosphate insecticides by the 2 major vectors and that there has been a significant relaxation of the safety measures developed to protect the spraymen from insecticide intoxication. At the conclusion of the evaluation, one of the consultants, Dr. Georghiou, presented a seminar on the resistance of vectors to insecticides to the senior staff members of the Directorate of Malaria Control and Provincial MCP. The major recommendations of this review include: that the insecticide procurement for 1985 be contingent on a significant improvement in spray operations as determined by in-depth evaluations by "surprise" field visits during the 1984 spray operations; operational research be conducted to guide the efficient use of insecticides to localities with proven malaria transmission and to structures where the majority of the vectors rest; to use malathion as the insecticide of choice until there are entomologic and parasitologic evidence to indicate a need to change; to carry out insecticide resistance monitoring on a more systematic basis emphasizing the insecticides in current use; to upgrade and enforce the procedures for safe handling of insecticides and to re-evaluate the policy of mosquito control support to municipalities taking into added consideration the potential threat of viral disease transmission by "pest" mosquitoes.

II. INTRODUCTION:

The objective of a Malaria Control Program (MCP) is to achieve a reduction of malaria transmission to a level where the disease incidence is no longer of public health importance. Operationally, the control methods to be used are dependent on the local epidemiologic conditions and on available local resources. More important is the requirement that these control measures be applied as needed for an indefinite period of time. Taking this long range view, there is an urgent need for the MCP of Pakistan to be self reliant and to use the scarce national resources most efficiently.

In any control program, anti-vector measures, particularly the use of house spraying with a residual insecticide remain a most important if not the principal control method. The available insecticides which have replaced DDT not only have higher cost but are generally more toxic to man as well. Thus, insecticides, whether as larvicides or adultacides must be used judiciously and safely. Their use must also be guided by reliable and the most current information on the response of the target vectors to the insecticides. Practically speaking, the judicious use of insecticides may be viewed from at least 2 perspectives: Operationally, whether spray programs are conducted with efficiency and safety and technically, whether the appropriate compounds are being used and whether they are applied on a timely basis. These are the basic issues which determine the most economic use of insecticides to yield optimal results. The purpose of the external review II is to evaluate these issues and based on the findings, to formulate a long term strategy to define the role of anti-vector measures, particularly the use of insecticides, in the MCP of Pakistan.

III. EXTERNAL REVIEW, PART II, 1983:

A. External Review Team

1. Dr. George P. Georghiou : Professor and Chairman, Department of Entomology, and Head, Division of Toxicology and Physiology, University of California, Riverside, Ca.92521.

2. Dr. Jesse H. Hobbs : Entomologist, Malaria Branch, Division of Parasitic Disease, CDC, Atlanta, Ga.30333.

3. Dr. Imtiaz H. Shah : Director, NMTC, Lahore.

4. Dr. L. Boschi : Malaria Advisor, WHO, Islamabad.

5. Dr. William Chin : Malaria Advisor, USAID, Islamabad

B. Terms of Reference

To assess the antivector methods in current use by the MCP and the potential usefulness of alternative methods by the evaluation of:

1. Spray operations in 1983.
2. Insecticide resistance testing.
3. Adequacy and reliability of vector surveillance studies.
4. Adequacy of training, monitoring and use of safety precautions in the handling of insecticides.
5. The potential usefulness of alternative methods of vector control, and to recommend:

6. Priority operational research needed to fill the many voids existent in the current knowledge of vector ecology and habits.
7. To conduct a seminar on the resistance phenomenon of anopheline mosquitoes to insecticide with emphasis on the use of organophosphates insecticides against local vectors.

IV. HISTORY OF INSECTICIDE USE BY THE MALARIA PROGRAM, PAKISTAN:

Before Independence, malaria control activities in Pakistan consisted chiefly of larviciding with motor oil and Paris green and were limited to the military cantonments and economically important towns. After Independence, when DDT became available in 1951, control activities were extended to some rural areas. Irregular use of DDT in areas of high malaria prevalence and immediately after floods, continued until 1960 when the 14-year Plan of malaria eradication was launched. During the eradication era, intradomiciliary spraying with 2 rounds of DDT at a dose of 1 gm/m² was carried out. The eradication effort first began in the Northeast districts in 1960 and gradually extended to the Southwest till the entire country was covered by 1968. Beginning in the late 1960s, due in large measure to DDT resistance by the major vectors, a resurgence of malaria transmission occurred, reaching epidemic proportions by the early 1970s.

Limited use of BHC was made during 1970-74 in an effort to control the epidemics. In 1975, the first 5-year extension plan for malaria control was launched and malathion was used for the first time. During the first four years of this extension plan, 2 rounds of malathion were applied and more than 50% of the houses in the country were sprayed by at least one of the 2 rounds.

The type and amount of insecticide used in the MCP, Pakistan from 1976 to 1982 is summarized in Table I.

Figure 3.8 in the annex, taken from a WHO assignment report by one of us (LB), depicts graphically the areas within the country covered by house spraying with an insecticide from 1961-81.

The reported proportion of total population protected and the % of houses sprayed by the MCP from 1976-82 are presented respectively in Figures I and II.

V. FINDINGS:

A. Spray Operations, 1983

The evaluation of spray operations as reported by most of the previous external assessment teams, is based on annual reports from the provincial MCPs or the percentage of the spray coverage (No. houses

TABLE - I

INSECTICIDES UTILIZED IN PAKISTAN FROM 1976 to 1982
FOR MALARIA CONTROL (Intradomiciliary Spraying)

		Amounts, in metric tons, of W.D.P. Formulations			
		75% a.i. D.D.T.	(*)12.5% a.i. (**)26 % a.i. B.H.C.	50% a.i. MAL.	40% a.i. FEN.
PUNJAB	1976	530	1,570 (*)	3,349	27
	1977	50	609 (*)	3,986	91
	1978	44	385 (*)	4,763	61
	1979	-	(*) 109 (**)	1,870	3
	1980	49	19 (*)	1,164	391
	1981	4	-	110	345
	1982	8	-	98	417
SIND	1976	422	240 (*)	228	-
	1977	11	477 (**) 1,163 (*)	-	-
	1978	-	143 (*)	640	-
	1979	-	86 (*)	1,871	-
	1980	-	-	456	-
	1981	-	-	-	125
	1982	-	-	12	235
N.W.F.P.	1976	148	-	1,256	-
	1977	182	-	1,019	-
	1978	64	-	506	-
	1979	120	-	291	-
	1980	-	-	316	-
	1981	-	-	-	125
	1982	-	-	-	28
BALUCH.	1976	-	18 (*)	17	-
	1977	-	68 "	50	-
	1978	-	21 "	28	-
	1979	-	42 "	49	-
	1980	-	11 "	27	-
	1981	-	12 "	-	8
	1982	-	-	18	3

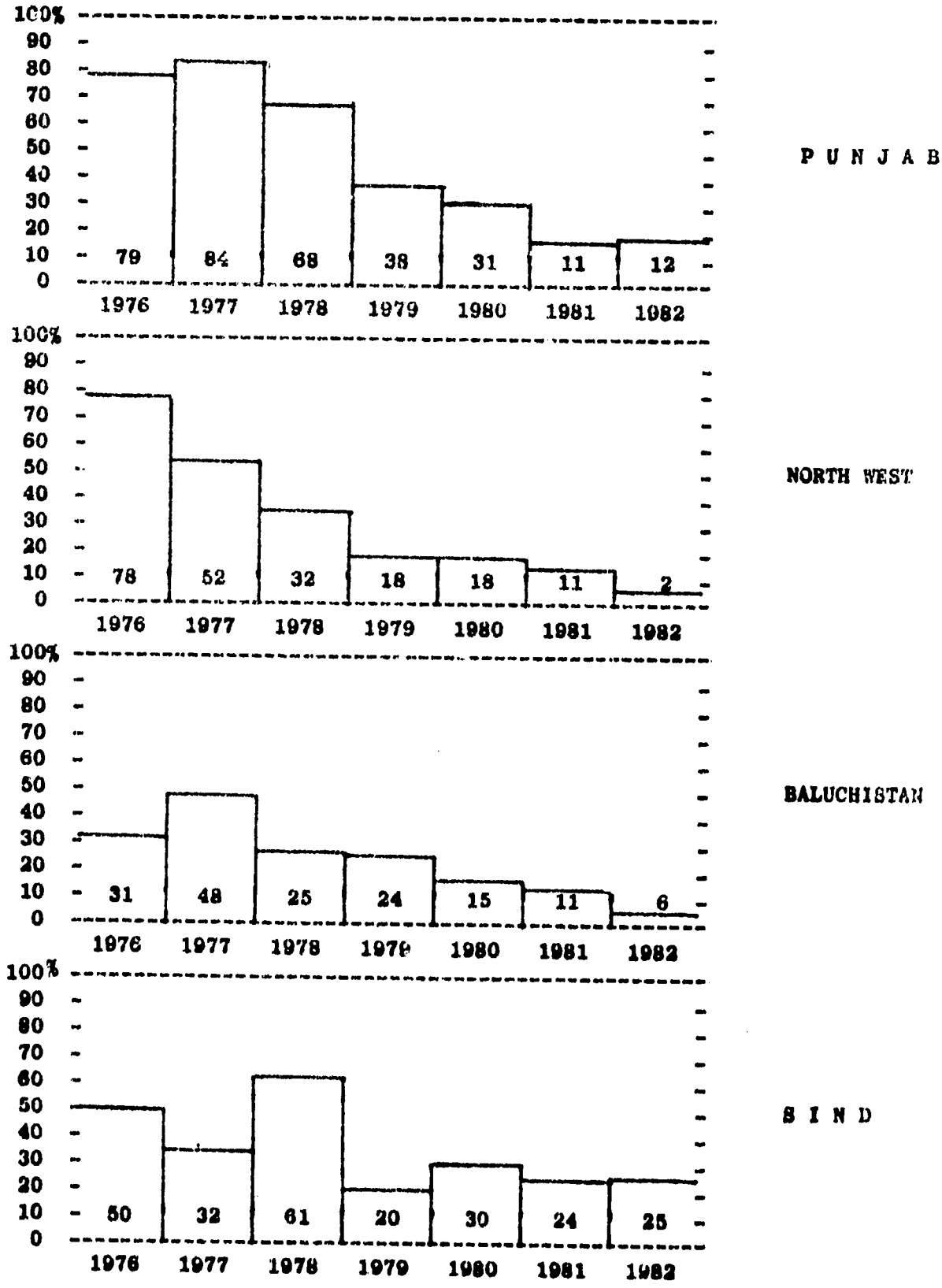
(Data ex D.O.M.C.)

a.i. = active ingredient
W.D.P. = Wettable Powder

FIG. - I

PERCENTAGE OF TOTAL POPULATION , IN THE FOUR PROVINCES OF PAKISTAN , DIRECTLY PROTECTED AGAINST MALARIA BY INTRADOMICILIARY SPRAYING

(BETWEEN 1976 and 1982)

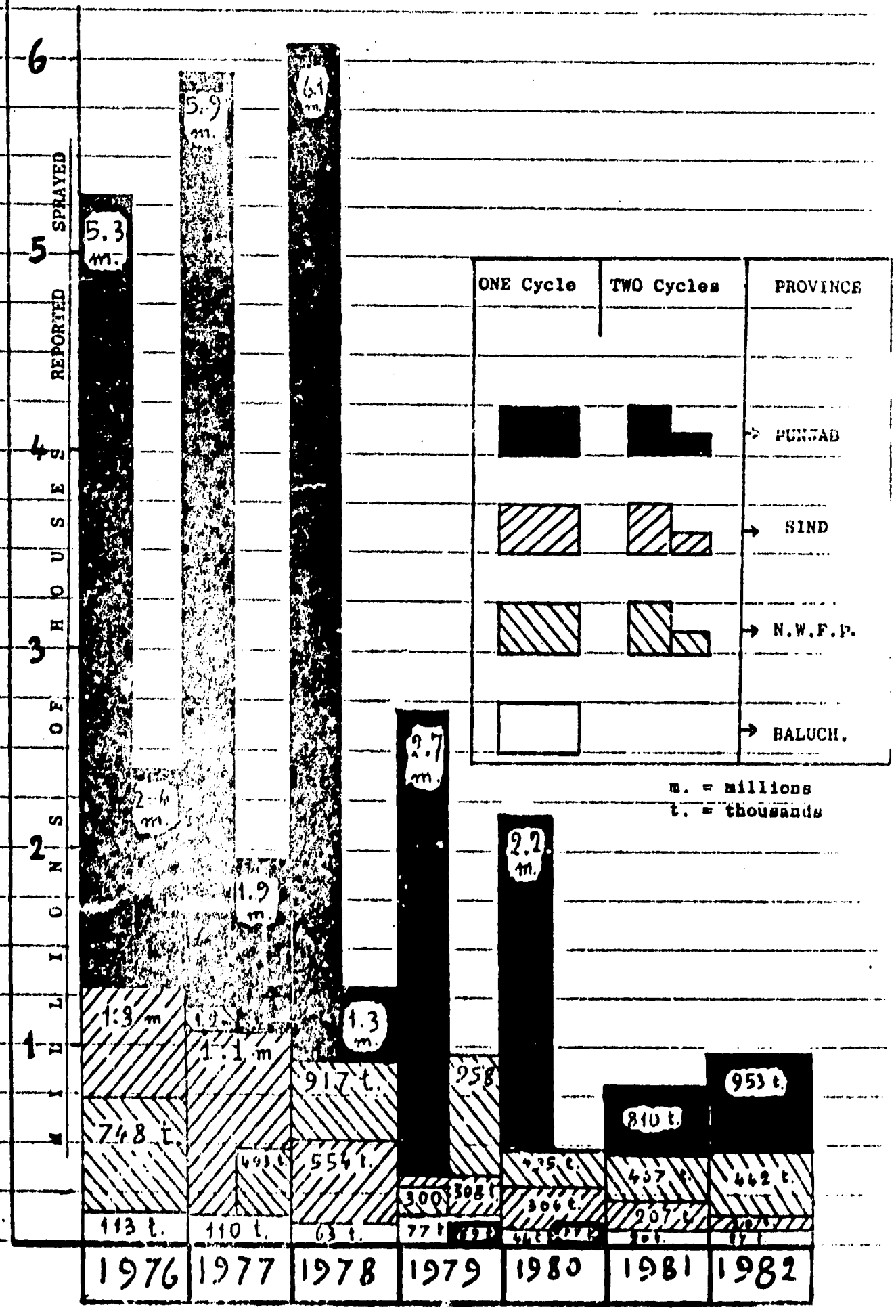


Boschi-W.H.O-MPD-001-PAK. -- (Data ex DOMC)

FIG. - II

INTRADOMICILIARY SPRAYING FOR MALARIA CONTROL IN PAKISTAN

(Number of HOUSES reported sprayed between 1976 and 1982)



Bqschi-W.H.O.-MPD-ODI-PAK. -- (Data ex DOMC)

sprayed compared to No. projected for spraying) or simply the percentage of existing houses covered. The results provided by the MCP, Punjab from 1976-1980 on the spray coverage with malathion showing that as high as 96% of the projected quota of houses were sprayed, appear highly satisfactory. Unfortunately, such statistics not only do not tell the full story but because of the tendency for inaccurate reporting from the lower operational levels, may even be grossly misleading. Such data are only meaningful if the degree of efficiency of spray operations is also known. Field evaluations to assess efficiency takes considerable amount of time usually not available to an external review team. This year, the spray operations in the Punjab and NWFP were evaluated by members of the Directorate of Malaria Control (DOMC) and the respective malaria advisors for the WHO and USAID. The collective observations of these field evaluations are summarized:

Program Planning:

Meetings were held during March-April, 1983, between the Provincial MCP staff and the District Health Officers (DHOs)/ Zone Chiefs and their staff to plan the year's spray operations. At these meetings, malaria surveillance data from 1982 for each District/Zone down to locality level were reviewed and decisions made as to the subsectors to be sprayed. Because of the acknowledged unreliability of the surveillance data (refer to 1983 external review report Part I), areas to be sprayed were determined more by the anticipated availability of insecticide than by precise data pinpointing areas of need. Occasionally, areas for spraying were selected based on non-technical considerations. For 1983, DOMC made the following allocation of insecticide procured by the USAID:

	(Metric Tons - equivalent to 2200 lbs)	
Province	Malathion	Fenitrothion
Punjab	1200	50 (for research use)
Sind	870	-
NWFP	308	-
Baluchistan	20	-
Total:	2398	

Based on the decisions reached plus knowledge of how much would be allotted to the province, insecticide was allocated to each District/ Zone. In the Punjab, the amount of insecticide agreed upon for each district was reduced by 10%, an arbitrary decision of the Provincial Chief taking into account the known past inefficient use of insecticides. Instructions were then issued for each District/Zone, to check all equipment to ensure adequacy of numbers and to procure spare parts as required. At the Federal level, the DOMC was

responsible for the procurement and distribution of the insecticides and 2 sets of uniforms for each sprayman.

Spray Operations:

Spraymen are hired from the locality where spraying is to occur. Their daily wage is fixed at Divisional level and ranged from Rs.16-25. Prior to spraying, spraymen are given 1-2 days of training on safety precautions and on proper spraying techniques; uniforms are issued and pre-spray tintometric test performed on some to determine baseline levels of cholinesterase.

Spraying operation begins with the malaria supervisor visiting a house, explaining the procedure and with consent, removes cooking and eating utensils to outside the house while covering the heavier items as furniture. The mixer then fills the pumps by mixing the required amount of formulation in a bucket with 4 liter of water and pours the suspension through a funnel containing a sieve to strain out the coarser particles to minimize clogging of the nozzel tip. More water is then added to bring the volume to 10 liters. According to instructions from provincial MCP, each mixer was to be supplied with 3 buckets and for the mixing to take place away from the water source.

Each room of the house, including the ceiling, is sprayed and the supervisor records the coverage achieved (number of rooms sprayed). This information is also written on the front door by white chalk. To monitor the amount of insecticide used, record is kept of how many times the spray pump is filled per sprayman, assuming an average coverage of 3 rooms per each full pump. Each sprayman is expected to spray between 30-40 rooms/day depending on the locality to be sprayed. The team was told that in some localities in NWFP, the daily quota for each sprayman was set at 200 rooms/day.

Observations:

Uniforms - Only one set of uniform was procured for each sprayman this year and due to late arrival, was not distributed until 2-3 weeks after spraying began. The quality of the uniforms was poor; the weave appeard too loose to withstand the daily washes required for 2 months.

Equipment - Spray squads having 3 buckets as required were rarely seen. Most had only one until the provincial authorities were notified at whichtime an attempt was made to provide additional buckets. There was no standard container to measure the amount of insecticide. One kg amounts were approximated by various devices ranging from pieces of

bricks and stones on a hand-held balance scale to different size containers. While funnels were available, less than half were equipped with a sieve; some of the mixers used a cloth to strain the suspended insecticide. All the pumps inspected were old, some dating back 23 years when they were first procured for the eradication program. The availability of spare parts for the pumps varied according to districts. None were available in some of the districts visited. The use of defective or worn nozzel tips which produce a characteristic streaky pattern was not infrequently encountered and accounted for up to 50% of the tips examined in some localities.

Safety Measures - The vast majority of the mixers observed were mixing the insecticide and pouring the suspension into spray pumps at the water pump. Cartons of insecticide were never more than 2-3 meters from the water source. Rinsing of contaminated gloves and equipment was done at the water pump. Occasionally, significant amount of unsuspended insecticide was rinsed and poured onto the pump area.

Most of the supervisors visited carried atropine for use to counter the effects of insecticide poisoning but not all had syringes to deliver the medication. We were told that not all supervisors know how to inject the drug.

With the exception of Gujranwala, the other districts/zones produced records of cholinesterase level monitoring on the spraymen. In Gujranwala, tintometric tests were not done because the entomologist who performs the tests, had been on indefinite leave of absence. In Peshawar zone, results of tintometric tests on spraymen applying fenitrothion showed that 23/46 tested had cholinesterase levels of 50% or less and 10 of these had 0% level. Of the 12 spraymen in the 25% range or less, all were symptomatic. We were further told that attempts had not been made to following the 12 spraymen sent home because of symptoms due to intoxication. Samples of the remaining fenitrothion were taken by team members for analysis to determine toxicity to animals as well as to vectors.

Spray Performance -

1. The use of worn or defective nozzel tips was not a rare occurrence. Such nozzel tips produce characteristic uneven streaky effects resembling in some cases typical Picasso murals.

2. Malathion deposits on sprayed surfaces were generally light. At a dose of 2 gm/m^2, there should have been a white wash effect. Also absent in most of the rooms which had been freshly sprayed was the strong odor characteristic of the proper dosing with malathion.

3. House coverage recorded on the doors rarely corresponded to the work performed. Frequently, less than half the rooms were sprayed in houses labelled with a "T" (totally sprayed).

4. Empty store rooms with the door usually closed were the most frequently sprayed rooms. In fact, the spraymen were usually encouraged by the householders to "overdose" the store rooms to sometimes include the floor.

5. Householders complained that eating utensils and family treasures displayed on shelves were not removed prior to spraying. Such complaints were not common however.

6. In approximately half of the living quarters visited which had been sprayed, the insecticide was removed after drying by washing or wiping. This practice was more prevalent in the better homes. Various reasons were offered, from bad odor to messy appearance of a white splotchy effect against a blue or green wall.

Taking into account the observations on the quality of spray, the wipe offs and the tendency to over report coverage, the amount of insecticide which remained on the walls one week after the spray is estimated to be more than 30-35% of the amount allotted.

Reasons for the poor performance

1. By far the most important reason is inadequate supervision. In the Punjab, the spray season came at a time when the activities for the expanded program on immunizations (EPI) were also being intensified. In Gujranwala, inspite of directives issued by the Director of Health Services, Punjab, that the CDC officer should devote his full time to spray operations during the spray season, the officer was spending his full time instead on EPI activities during the first part of the spray cycle. Other problems which discouraged field supervision include the unresolved issue of not providing open travels allowance (TA) to supervising staff in the Punjab. The CDC officer is still on a fixed TA of Rs. 100/month. The CDC inspector, even though provided with a motor bike, collects a fixed TA of Rs.35/month without extra allowances for petro or per diem. The problem in the NWFP was somewhat different and involves the limited petro allowance authorized. The average petro fund available to each vehicle approximates only Rs.500/month. With inadequate field supervision, the spraymen perform their chores in a perfunctory way, interested primarily in finishing their allotted rooms as quickly as possible. The supervisor, to make his reports more acceptable, indulges in over reporting.

2. Resistance by the population to house spraying. The rate of resistance was highest in more prosperous communities. It is not coincidental that such localities often contain a health post where malaria cases are detected giving rise to a falsely high incidence of malaria attributed to the

locality with the health post and not the homes of the patients. Interviews with householders in such areas often failed to substantiate the occurrence of malaria in the community.

3. Shortages of spare parts particularly nozzel tips. There is no excuse for not having sufficient spare parts. Each district visited indicated that funds were adequate and that many of the parts such as rubber rings were available on the local market.

Conclusion

There is little doubt that the 1983 spray operations were performed with a low degree of efficiency. Not as clear is the issue of how much longer can the continued squandering of such scarce resources be allowed. Fortunately for Pakistan, the malariogenic potential, even in problem areas, is not that high. Past epidemics, while devastating, were due to the unchecked and overwhelming production of the malaria mosquito. Thus, given the poor vectorability of the local vector, anti-mosquito measures, even when inefficiently applied, if they result in some reduction of vector density, is bound to impact malaria transmission. For this reason, even a 30-35% spray efficiency may result in some control of malaria, provided the insecticides are applied in areas with malaria. Unfortunately, given the imprecise nature of the surveillance data, even the targeting of spray operations to malarious areas cannot be assured consistently.

It has been proposed by some provincial personnel that a major reason for the poor performance observed may have been that the field evaluations were carried out, for the most part, during the early part of the spray cycle. While there may be some merit to this reasoning, it should also be noted that spray operations are not new to the MCP staff; and have been carried out with one or two cycles annually since 1960! Of interest to the team is the similarity in the observations reported by a USAID consultant, Mr. John Stivers, in 1978. Summarized below are his major observations:

> "Certain deficiencies were observed in the measuring of sprayer charges of insecticide and in spray application technique resulting in uneconomical over-dosing or under-dosing. In a few squads where the insecticide was being weighed, the counterweights used with the balance were unmarked stones or broken pieces of brick. The use of clogged or damaged nozzels was noted frequently. Also noted was a tendency to spray some rooms of a house and leave others untouched or to spray some walls of a room without treating others. In one particularly flagrant case, the outside front of the houses of almost an entire village were the only areas sprayed, while the houses were marked and recorded on the squad leader's work sheet as completely sprayed".

Inefficient spray operations can not be allowed to continue. Ways to improve spray operations are well known to the MCP. To implement such methods requires the unflinching determination at the highest authorities of health planners at both the federal and provincial levels to improve spray operations. The methods are simple: Improve supervision to include provisions for accountability; upgrade training at all operational levels and most of all, be prepared to accept the likelihood that donor agencies can not always remain complacent when assistance funds, which are so scarce, are being wasted. Also needed to improve efficient use of insecticides is access to more accurate epidemiologic data to guide the selection of areas for spraying. Weaknesses in the surveillance system, highlighted by the external review, Part I, are being addressed and hopefully, improved surveillance data will be available for use in planning the next spraying cycle. Lastly, information is needed to target the selective use of insecticides to specific areas within the house and within the locality where the majority of the vectors rest. Such data can only come from well conducted operational research.

Recommendations

The team wishes to express our deep concern to the highest possible authorities in the Government of Pakistan (GOP) on the consequences to the malaria control effort should the inefficient spray operations, as observed in 1983, be allowed to continue. At the same time, we are sympathetic to the requirement that time is needed to upgrade various technical aspects of the program such as improvements in surveillance operations. Taking these views into consideration, the team recommends that: the Malaria Control Project II agreement be amended or re-emphasized, as required, to provide specific conditions to be met prior to the procurement of insecticide for 1985. These would include:

Absolute requirements

1. That the criteria for the selection of areas to be sprayed have been based solely on epidemiologic grounds.

2. That the overall spray operations for 1984 have been carried out with significant improvement in efficiency as determined by in-depth field evaluations conducted by representatives of the DOMC, WHO and USAID, on the basis of "surprise" field visits.

3. That all the recommended safety measures have been implemented during the 1984 spray season.

4. That within 1 month following the completion of the 1984 spray operations, all remaining insecticide have been collected from the field, delivered to central sites, inventoried and a final report submitted to DOMC.

Relative requirements

1. Improvements in the surveillance system to provide more reliable epidemiologic data to plan the spray operations for 1984.

2. The DOMC, through the operational research unit, assign the highest priority to the study of the resting habits of vector species in areas with different geographic and ecologic features.

B - ANTI-VECTOR METHODOLOGIES

1. Entomologic Data, Adequacy and Reliability

Routine entomologic observations (other than insecticide susceptibility testing) have been periodic measurements of vector densities in fixed indicator villages, occasionally supplemented by captures in randomly chosen villages. These captures are done by the Zonal/District Assistant Entomologists assisted by a team of mosquito catchers. Techniques used are pyrethrum spray catches of mosquitoes in living rooms, as well as hand catch of resting mosquitoes, in rooms and animal shelters.

The district/zonal entomology teams seem to be well trained in the techniques of mosquito capture, and most of them have years of experience in this type of work. We believe that their reports are reliable.

An enormous amount of information has been collected as a result of these routine observations, but relatively little effort has been put into the organization and interpretation of the data. The original purpose for the collection of these mosquito density figures was to provide information for the correct timing of spraying cycles, and also to provide a picture of the insecticidal impact on vector populations. Neither purpose is well served by the data as it now stands. The great mass of information collected needs to be summarized and organized graphically in such a way that it is useful to the planners. District/Zonal wide total density indices, as now reported, are not very informative. Since localities are not sprayed at the same time, and may vary in degree of coverage, such total indices will not lead to a reliable assessment of the spraying effectiveness.

It is recommended that routine entomologic density sampling in each province be limited to a few indicator localities with high vector density, representing areas with high malaria endemicity. It may not be necessary to cover every zone or district with entomologic sampling. It is also recommended that additional information be collected as to the daytime resting preferences of females of the vector species. Although some information has been collected on resting mosquitoes in animal shelters, living rooms and storage rooms, more complete and detailed observations are needed on daytime resting sites. Future strategy for the use of insecticides in the MCP Pakistan may involve the selective approach to coverage and spraying in malarious localities. More information is urgently needed on vector preferred resting places in order to make informed decisions on priority surfaces to be sprayed.

Also needed is additional information on vector resting habits in structures on the periphery of villages in comparison with resting in houses and other structures in the center or interior of the villages. This kind of data is needed, since in certain types of localities, barrier or peripheral spraying may be a justifiable alternative to complete coverage of all the houses of the locality.

2. Use of Safety Measures

Following the unfortunate insecticide intoxication outbreak among spraymen in 1976, a great deal of effort by DOMC, USAID and WHO was devoted to training of program personnel in safe insecticide use practices, and to the actual enforcement of safety precautions during spraying operations. Training courses were organized in each Province of the country, utilizing the participation of visiting toxicologists and operational specialists as well as national specialists in these fields. Spraying supervisors were trained who in turn trained spraymen who were employed for the next spray cycle. Great emphasis was given to supervision of insecticide application, with safety officers designated in each Province. In addition a local USAID employee was detailed for safety precaution monitoring, as well as three locally employed WHO technical officers. Spraymen were provided with two sets of uniforms to ensure use of clean clothing. A system of cholinesterase testing was established for spraymen and mixers in each Province and firm guidelines set for removal of spraymen from service if their cholinesterase level was depressed.

The result of all this effort was that the spraymen and their supervisors were instilled with a healthy respect for the possible hazards of insecticides, and the need to protect themselves from these hazards. No serious cases of insecticide intoxication have been reported among spraymen since these safe use practices were adopted and enforced.

This External Review Team has noticed a certain relaxation in the enforcement of the recommended safety precautions during the spraying season of 1983. The following shortcomings were observed and need to be reiterated:

(a) The team members saw cases of faulty and leaking sprayers being used by spraymen. The use of leaking sprayers can lead to extensive skin contamination and should be absolutely prohibited.

(b) The spraymen were issued only one uniform for the 1983 spray season instead of the recommended two. This, we understand, was done for economy reasons, but we would like to recommend that if economies are necessary, that they be made at the expense of other items, and not in the purchase of protective clothing.

(c) Spray squad mixers were found in the majority of instances to be mixing the insecticide immediately adjacent to the village well or pump. This is completely wrong, since it could possibly lead to the contamination of the village water supply. Better supervision on the part of the spray squad leader is needed to correct this type of fault.

(d) In a few cases observed, cooking utensils and foodstuffs had not been removed from houses before spraying. Preparation of the house is the responsibility of the householder, but the house should be carefully checked by spray squad leaders before spraying, to assure that kitchen utensils and food are removed from the house.

The team recommends the following series of actions which would help to bring the application of safety measures back to acceptable levels:

1. Of prime importance is the retraining of spraymen and their supervisors in scheduled, structured training sessions. Emphasis should be given during the training to the early recognition of the clinical signs of organophosphate insecticide intoxication, as well as personal protection requirements.

2. Through advance planning, to ensure that prior to the spray operations, that each spray squad is provided with all the recommended safety gear including 2 sets of uniforms per spray-man* and that all the spray pumps have been inspected to ensure proper functioning.

3. Should evidence of intoxication appear, the supervisor be required to not only administer the treatment promptly but that his superior be notified and that the patient be followed until he recovers.

4. Coordinate through the WHO/USAID, the testing of insecticides which have been in storage for more than 1 year, prior to its use, to detect toxic components which may have formed.

5. For USAID to re-evaluate the need to refill a previously existent position by the hiring of a national whose primary responsibility would be the monitoring of field activities, particularly, insecticide use and storage.

3. Insecticide Resistance Testing and Results

a. Introduction

The phenomenon of resistance to insecticide has been of concern in malaria programs for over 30 years. The problem has been more acute since the appearance of "multiple" resistance involving organophosphates (OP), and in certain cases carbamate insecticides, in addition to DDT and dieldrin/BHC resistance. In certain cases, as in Anopheles albimanus in Central America, the type of OP and carbamate resistance that has developed is so non-specific as to involve nearly all members of these two classes of chemicals (Georghiou et al 1974). Furthermore, these resistant populations are cross-resistant at various degrees towards the relatively new class of synthetic pyrethroid insecticides, largely as a result of the existing DDT resistance. It is now generally recognized that any concerted effort of a mosquito control program, whether short-term or long-term, must include a consideration of resistance with a view toward delaying or avoiding its evolution and consequences. In Pakistan, the accumulating evidence of emerging resistance toward malathion in the principal malaria vectors An. culicifacies and An. stephensi places the long term objective of the control program in jeopardy and dictates the need for frequent review of operational strategies. Although in this

*Temporary spraymen working for less than 2 weeks should be issued one set of uniform.

section, we are concentrating on the current procedures for surveying for resistance and on the results obtained, we have also discussed briefly aspects of the history and dynamics of resistance in these vectors in order to provide the basis for our recommendations.

The MCP of Pakistan, through its provincial entomologists and other staff has been conducting for many years, extensive tests for the detection of resistance in An. culicifacies and An. stephensi. These tests have been based on the standard WHO method, including the recent revision (VBC) that utilizes discriminating doses of the principal insecticides, namely DDT 4% (1 hr exposure), dieldrin 0.4% (1 hr) malathion 5% (1 hr) fenitrothion 1% (2 hr) and propoxur 0.1% (1 hr) (WHO 1980). These doses are lethal to "susceptible" mosquitoes but not to those that are resistant (heterozygous or homozygous resistant). Thus the percentage of mortality achieved in these tests serves as an indicator of the frequency of susceptible individuals in the test population. We have been given full access to the results obtained in the Punjab and the NWFP provinces. Additionally, we have contacted Dr. H. Rathor of the ICMRT at Lahore who kindly provided us with results of resistance tests and of other relevant studies conducted by him and his associates. These results, and a number of published papers (Rathor and Toqir 1980 a, b, 1981, Rathor et al 1980, 1983, Omer et al 1980) constitute our sources of information on the Pakistan situation.

b. Status of Resistance - DDT and Dieldrin

Both An. culicifacies and An. stephensi are widely resistant to DDT and dieldrin. Anopheles stephensi is reported to be resistant to DDT in nearly the entire range of its distribution including Afghanistan, Saudi Arabia, India, Iran, Iraq, Oman, Pakistan and the Sudan; and to dieldrin in Afghanistan, India, Iran, Iraq, Oman, Pakistan and Saudi Arabia (WHO 1980). Likewise, An. culicifacies is reported to be resistant to DDT in Afghanistan, Burma, India, Iran, Nepal, Pakistan and Sri Lanka, and to dieldrin in Afghanistan, India, Nepal, Oman and Pakistan.

Data from Pakistan indicate that the frequency of DDT and dieldrin-resistant individuals of both species is very high in most areas of the country.

In the Punjab province, all 50 tests conducted with DDT in 1983 on An. culicifacies from 10 districts resulted in classification of the sampled populations as "resistant" (i.e. mortality less than 80%); also, of 43 tests conducted with dieldrin, 37 tests qualified the populations as resistant, 6 tests as "intermediate" (i.e. mortality of 81-98%) in 7 districts and none as "susceptable".

With An. Stephensi in the Punjab, 15 of 18 tests in 7 districts showed the population to be resistant to DDT and 6 of 12 tests in 5 districts to be resistant to dieldrin.

When the actual percentages of mortality obtained are considered, the frequency of resistant individuals is evidently high, often exceeding 50%. Thus, 1983 tests (May - September) from 6 localities of Sheikhupura District yielded the following results:

An. culicifacies	% Mortality 4% DDT	4% Dieldrin
	65.3	66.3
	58.8	68.0
	56.0	70.8
	65.0	72.0
	52.0	
	61.5	
	62.5	
Avg.	60.2%	67.4%
Number tested	(258)	(98)

Similarly, 1983 results from the NWFP showed the following results:

	% Mortality 4% DDT	4% Dieldrin
An. culicifacies	44.4%	-
Number tested	(36)	
An. stephensi	41.6-76%	42.5-55%
Avg.	55.7%	48%
Number tested	(567)	(205)

Resistance determinations by Rathor et al (1980, 1983) have confirmed, by laboratory tests, the high frequency of DDT and dieldrin resistance revealed by the field data from the provinces. These authors have also found that high frequencies of resistance are also present in population of other Anopheline species, i.e. An. annularis (DDT, dieldrin), An. subpictus (DDT, dieldrin), An. fluviatilis (DDT, dieldrin), An. maculatus (DDT, dieldrin) and An. pulcherrimus (dieldrin).

It is apparent from the foregoing that the frequency of DDT and dieldrin individuals, especially in An. culicifacies and

An. stephensi is so high as to make it highly unlikely that these chemicals could produce any cost-effective benefit in malaria control. It is also highly unlikely that there will be any significant reversion of these types of resistance in the foreseeable future as long as the mosquito population continues to be selected directly or indirectly by the large variety of chemicals that are employed in agriculture. Evidence for the stability of resistance to DDT and dieldrin in the natural populations is provided by data from Punjab from 1975 to 1983. The percentage of tests conducted in the Punjab province resulting in the test population being qualified as "resistant" are shown in the following table:

MALARIA VECTORS IN THE PUNJAB

% of "resistant" tests

Year	DDT Tests		Dieldrin Tests	
	An. culicifacies	An. stephensi	An. culicifacies	An. stephensi
1975	82 (225)	82 (71)	57 (318)	48 (80)
76	80 (107)	67 (61)	76 (143)	85 (98)
77	69 (71)	74 (43)	64 (106)	57 (74)
78	58 (59)	77 (60)	49 (67)	77 (75)
79	87 (127)	92 (96)	57 (109)	71 (98)
80	99 (111)	100 (64)	99 (78)	100 (59)
81	99 (85)	100 (33)	90 (72)	98 (44)
82	92 (204)	85 (24)	86 (180)	86 (86)
83	100 (50)	83 (18)	86 (43)	50 (12)

(In parentheses, number of tests).

The existence of DDT and dieldrin resistance at such high level, especially in the Punjab, and NWFP, makes it inadvisable to continue conducting resistance tests with these insecticides, except at widely spaced intervals, and when an excess of test mosquitoes are available. The available resources should be devoted to careful surveillance of malathion and fenitrothion resistance, and to a lesser extent on carbamate and pyrethroid resistance.

c. Organophosphates

Unlike the situation with DDT and dieldrin, resistance to organophosphates in An. culicifacies and An. stephensi is of more recent origin, and considerably more restricted geographically.

Evidence of incipient resistance to malathion in An. stephensi was first noted in Iraq in 1973 (Table II) and definitive resistance developed by 1975 in Bandar Abbas, Iran (Manouchehri et al 1976) (Table III). Subsequently resistance was found in the area of Lahore in 1979 (Rathor and Toqir 1980) and in India (WHO 1982).

In An. culicifacies, malathion resistance has been reported from India (Gujrat, Sambalpur Andhra Pradesh and Maharashtra), Sri Lanka (Hingrakgoda) (Table II) and according to resistance surveillance data, it is also found to a limited extent in Pakistan. Of considerable significance is the extension of malathion resistance in An. culicifacies at Gujrat, India to fenitrothion (Herath et al 1980) and the discovery of a population of this species in Maharashtra State, India, that displays a wide spectrum of OP multi-resistance which, in addition to malathion and fenitrothion, extends also to chlorthion, chlorphoxim, iodophenphos and pirimiphos-methyl (Herath and Davidson 1981). This development raises ominous implications that are reminiscent of the situation with An. albimanus in Central America.

We have studied in detail the data of susceptability tests involving malathion and fenitrothion provided to us by the provincial officers of Punjab and NWFP.

The published cases of OP resistance in An. culicifacies and An. stephensi in Pakistan are listed in Table IV. They involve the initial cases of malathion resistance which were observed in the area of Lahore in 1979 (Rathor and Toqir 1980, Rathor et al 1980) and further evidence of the presence of resistance in various localities of the Punjab province obtained in 1980 from District offices, and in certain cases from laboratory tests at ICMRT (Rathor et al, in press).

4. Methods to Reduce Reliance on Insecticide Use

Although selective intradomicilliary spraying with residual insecticides seems at present to be the most cost-effective method of malaria control for Pakistan, we must look to the future when insecticides may be too costly to use on a large scale, or ineffective due to the development of vector resistance to the available insecticides. If and when it becomes necessary to use non-insecticidal malaria control measures, such as biological control and environmental modification, program planners will need information on the efficiency and applicability of these alternative methods to local conditions. Very little of this type of information is available now, since these alternative control methods have not been used or tested in this country.

TABLE - II

Reports of cases of resistance to organosphosphate insecticides available in the WHO Computer bank[1/]

Test date (mo/yr)	Anopheles species	Country	Area & Locality	Insecticide	% Mortality	Resistance status 2/	Investigator
10/79	stephensi	Iraq	Basrah, Abu Hilwa	Malathion 5% 1 hr	96		Malik
11/79	"	"	" "	" "	82		"
"	"	"	" "	" "	97		"
07/80	"	"	" Al Khas	" "	90		"
11/79	"	"	" Garmat Ali	" "	82		"
"	"	"	" Gindalan	" "	89		"
12/80	"	"	" Jagerah Owla	" "	92		I. Malek
11/79	"	"	" Kebasikepear	" "	98		Malik
05/81	"	"	" Mouariya	" "	96		Amir & Alokaili
09/73	"	"	Nassiriya, Alsalba	" 3.2% 1 hr	93		Malik
12/74	culicifacies	India	Gujarat, Amreli	" 5% 1 hr	?		Ent. Team
04/74	"	"	" Bulsar	" "	?		"
03/75	"	"	" "	" "	79	R	Vaishnar
04/75	"	"	" "	" "	93		"
12/74	"	"	" Junagar	" 3.2% 1 hr	88		Ent. Team
02/74	"	"	" Surat	" "	74		"
03/75	"	"	" "	" 5% 1 hr	91		
08/74	"	"	Karnataka, Gulbarga	" 3.2% 1 hr	88		Sitaraman
03/74	"	"	Maharashtra, Jalgaon	" "	90		Mustafa
10/75	"	"	" Sangli	" 5% 1 hr	88		Deshpande
12/81	"	"	Sambalpur, Holdapoli	" "	76	R	Collins & Dhal
"	"	"	" "	" "	72	R	"
"	"	"	" "	" "	94	?	"
08/79	"	Sri Lanka	Amparai, Mangla Oya	" "	81		Shanmugarajan
09/79	"	"	Hingrakgoda, Kithuluthuwa	" "	68	R	Weerasinghe

1/ Kindly provided by WHO/VBC, Geneva.

2/ Mortality 80-98% = V (verification required). Mortality 80% = R (resistant).

TABLE - III

Published cases of resistance to organophosphates in *Anopheles stephensi* and *An. culicifacies* in various countries

Species	Insecticide	Country/Area	Year	Reference	
An. culicifacies	malathion	India/Gujarat	1973	Rajagopal	1977
"	"	" /Andhra Pradesh	1979	Rao	1979
"	"1/	" /Maharashtra	1976	Herath & Davidson	1981
An. culicifacies	fenitrothion1/	India/Maharashtra	1976	Herath & Davidson	1981
"	"	" /Gujarat	1980	Herath et al	1981
An. stephensi	malathion	Iran/Bandar Abbas	1975	Manouchelri et al	1976

1/ Wide-spectrum of OP resistance involving chlorthion, chlorphoxim, iodophenphos, and pirimiphos-methyl, in addition to malathion and fenitrothion.

TABLE - IV

Published cases of resistance to organophosphate and carbamate insecticides in Anopheline mosquitoes in Pakistan[1/]

Year of Test	Anophele species	Area and locality	Insecticide	Number tested	% mortality	Investigator
1979	An. stephensi	Lahore, Khano-Harni	Malathion 5%	846	37.8	Rathor & Toqir (1980)
"	"	" Kehna, Purana	"	301	27.9	"
"	"	" Khano-Harni	"	328	66.8	Rathor etal (1980)
"	"	" Kot Baghicha	"	51	60.8	"
"	"	" Sattoki	"	136	10.3	"
1980	"	D.G. Khan	"		18-100	Rathor etal (1983)
"	"	Faisalabad	"		30-46	
"	"	Gujrat	"		0-100	"
"	"	Jhang	"		8-15	"
"	"	Muzaffargarh	"		37-95	"
"	"	Rawalpindi	"		58	"
"	"	Sargodha	"		36-85	"
"	"	Faisalabad	Propoxur 0.1%		60-88	"
"	"	Gujrat	"		3-100	"
"	"	Muzaffargarh	Fenitrothion 1%		65-100	"
"	An. culicifacies	Sialkot, Antowali	Fenitrothion 1%		80%	"
1980	An. subpictus	Bahawalpur	Malathion 5%		4-74	"
	"	D.G. Khan	"		0-58	"
	"	Faisalabad	"		0-100	"
	"	Jhang	"		2-50	"
	"	Muzaffargarh	"		15-61	"
	"	R.Y. Khan	"		9-100	"
	An. subpictus	Bahawalpur	Propoxur 0.1%		67-100	"
	"	D.G. Khan	"		50-96	"
	"	Jhang	"		42-100	"
	"	Muzaffargarh	"		47-100	"
	"	R.Y. Khan	"		5-100	"

1/ Determination by the WHO standard test.

With the establishment of an operational research unit (ORU) within the DOMC, an organization will exist which can carry out the required investigations. Some important topics for operational research are discussed below:

a. Biological control: Biological control by the use of larvivorous fish has proved to be a useful supplementary method of malaria control. The use of local fish species as predators of mosquito larvae needs to be investigated, as well as the best ways to culture, distribute and maintain these fish under the prevailing local conditions. The possibilities of collaborative research with the Department of Fisheries and with fisheries experts at national universities should be explored.

b. Source reduction: Although the possibilities of malaria control through water management in the irrigated areas of Pakistan at present seem quite remote, certain types of man made breeding places in proximity to villages, such as borrow pits, might be eliminated by drainage or filling. There is increasing interest in many countries in community participation in malaria control. We have little information or experience concerning the best ways to motivate villagers to participate in the solution of their own malaria problems by eliminating vector breeding places near their own villages. This is an area for operational research, with the participation of health educators and village leaders.

5. Malaria and Mosquito Control in Urban Areas

Karachi experienced a devastating malaria epidemic in 1968. In its aftermath, recommendations were made by numerous consultants on the need to activate a surveillance system for both the parasite and the vector in urban areas so that the transmission of malaria may be monitored. In general, most of the recommendations remain unheeded. As a result, the current extent of malaria transmission, if any, in urban centers is unknown.

There is little doubt that malaria is a rural disease. Studies of urban malaria in other countries indicate that malaria transmission in urban areas occurs as a result of spillover from increased transmission in rural areas; the vaguely defined fringe separating urban from rural environments, particularly in rapidly expanding urban populations, being the usual locality affected. It is also likely that the malariogenic potential of established urban centers in Pakistan is low. The presumed but unproven epidemologic factors which give rise to urban malaria in Pakistan would indicate that the key to its control lies in the effective control in rural areas together with measures to prevent potential vectors from reaching excessively high densities.

Another and perhaps a greater justification for instituting mosquito control activities in towns is the potential threat of other vector-borne diseases transmitted by "pest" mosquitoes which may pose a far greater public health problem than malaria. Specifically, the continued spread westward of dengue hemorrhagic fever and Japanese B encephalitis from India needs to be taken seriously in the development of overall policies regarding mosquito control in urban centers.

If the condition precedent (CP) for defining urban malaria as a problem, a demonstrated annual parasite incidence of 0.5 case /1,000 pop. or higher remains unchanged, no urban center in Pakistan will qualify for assistance for mosquito control in the form of equipment and supplies. Equally clear is the need to continue efforts to encourage municipalities to establish malaria surveillance systems. It might be possible to accommodate the 2 needs with the following trade-off: Amend the CP from a rigid requirement of a specific level of malaria incidence to a demonstration of a functioning malaria surveillance system irrespective of incidence.

With regard to the type of assistance to be provided, the team is in agreement with the recommendations of previous consultants including those of John Stivers (1978). These recommendations focused on the need to employ labor intensive methods such as source reduction and limiting the use of expensive, difficult to operate and maintain equipments such as the truck mounted space-spraying machines. For a detail review of the technical considerations of urban malaria/mosquito control methodologies, reference is suggested to the comprehensive report by one of us (LB) on "Guidelines for Planning Malaria/Mosquito control in urban environments (Pakistan), 1983."

VI. CONCLUSIONS:

1. Spray operations in 1983 were carried out poorly at an efficiency rating estimated at no higher than 30-35% based on the evaluation of the house spraying operations in the Punjab and NWFP. Field supervision was inadequate resulting in errors in spraying technique, in the inaccurate recording of coverage achieved and in the scarcity to non-availability of spare parts for the pumps. Resistance by the community was also encountered manifested by the wiping of insecticide from the walls or in token spraying, usually just the storage room, to appease the householders and to justify the coverage as partially sprayed. Such substandard performance, resulting in considerable waste of insecticide, should not be tolerated by the GOP nor the donor agencies.

2. Project performance could be improved in terms of selective spray coverage and targeting of spraying to priority localities. This type of approach will only be possible if malaria case surveillance is improved to the point where priority localities can be identified.

3. Project performance in regards to strict adherence to recommended safety precautions for workers exposed to insecticide definitely need upgrading. Previous high standards of safe use practices have apparently been relaxed.

4. Tests for detection of vector resistance to insecticides have been conducted at random with disproportionately small emphasis being placed on the presently used insecticides. There has been inadequate follow-up of cases of suspected resistance with confirmatory tests as specified in WHO protocols.

VII. RECOMMENDATIONS:

1. Of prime importance at this point to the malaria control program is the development of a selective approach to coverage and spraying of insecticides which would reduce the amount used. We believe that such a selective approach would still bring about effective malaria control. By selective coverage, we mean the restriction of spraying to active malaria foci and selective spraying to those epidemiologically important structures within localities or villages. Such an approach is also expected to retard the development of resistance to insecticides. Operational research is needed to define more precisely the targeting of spraying operations when the selective approach is used.

2. The procurement of insecticide for 1985 be contingent on the results of an in-depth evaluation of spray operations in 1984 by teams representing the DOMC, WHO and USAID based on comprehensive "surprise" field visits. The following parameters are to be assessed: efficiency of operations, use of safety precautions, and the timely retrival of left over insecticide from the field after the completion of spray operations.

3. More systematic surveillance of resistance to insecticides is needed, consisting of scouting activities aimed at detecting emerging cases, and of regular tests (twice per year) in problem areas to provide necessary data to guide control operations.

4. The use of organo-phosphorous (O-P) compounds should be maintained as long as possible. We recommend that malathion be the only insecticide for use in spray operations until such time as when there is epidemiologic evidence of the ineffectiveness of this compound. A change to another O-P compound, e.g., fenitrothion, when indicated by a combination of resistance and epidemiologic data, should be on a sector wide rather than larger scale.

5. An upgrading of insecticide handling practices is needed. Improvement in compliance with safety precautions can be achieved through retraining, issuance of proper protective clothing, and strict field supervision of spraying operations. Since cholinesterase level monitoring can only be used to sample a minor proportion of the spraymen, that a major reliance be

placed on the early recognition of clinical manifestations of intoxication as a means of preventing a tragic occurrence, similar to the 1976 episode, from taking place.

6. There is a need for operational research in order to identify non-insecticidal control methods which are applicable to the malarious areas of Pakistan.

7. The requirement for a demonstrated incidence of 0.5 malaria case/ 1,000 pop. or higher in urban centers before equipments and supplies are to be provided to municipal bodies for malaria/mosquito control appears too rigid and needs to be amended to a demonstration of a functional malaria surveillance system.

VIII. PLACES VISITED AND PERSONS MET BY THE EXTERNAL REVIEW TEAM

DOMC

Dr. S. M. Mujtaba	-	Director, Directorate of Malaria Control
Dr. G. Hashim	-	Epidemiologist, DOMC

USAID

Mr. Jimmie Stone	-	Acting Director
Dr. Cornelia E. Davis	-	Chief, Office of Health, Population and Nutrition
Dr. Rifaq A. Ismail	-	Public Health Physician

PUNJAB

Office of the Provincial Chief

Dr. S. M. Nasir	-	Assistant Director, CDC (Malaria)
Mr. Makhtar Ahmad Shah	-	Parasitologist
Mr. Javed Iqbal Malik	-	Assistant Entomologist
Mr. Sana A. K. Mahmood	-	CDC Officer

District Health Office, Sheikhupura

Dr. Aftab Ahmad Chaudhry	-	District Health Officer
Mr. Naseer Ahmed Sheikh	-	Assistant Entomologist
Mr. Mohammad Azam	-	CDC Officer

Locality visited

Bhallar (C-1)	-	Mr. Mohammad Hussain, CDC Supervisor
Chak No.22 (b-4)	-	Landrin trial area
Kot Hayat (b-7)	-	Mr. Tayyab, CDC Supervisor

District Health Office, Sialkot

Dr. Wasim	-	District Health Officer
Mr. Mohammad Aslam Rana	-	Assistant Entomologist

Locality visited

Wadala Sandwan (d)	-	Mr. Mohammad Sharif, CDC Supervisor

ICMRT, Lahore

Dr. Richard Sakai	-	Acting Director
Dr. H. Rathor	-	Entomologist

NWFP

Office of the Provincial Chief

Mr. Mohammad Iqbal Khan	-	Acting Provincial Chief
Mr. Fazale Raziq	-	Entomologist
Mr. A. Aziz Khan	-	Senior Malaria Superintendent

Mardan Zone Office

Dr. Said Qureshi	-	Zone Chief
Mr. Ajmal Khan	-	Administrative Officer
Mr. Mohammad Jamil	-	Malaria Superintendent

Peshawar Zone Office

Mr. Murtaza Khan	-	Zone Chief
Mr. Abdul Raheem	-	Assistant Entomologist
Mr. Kebad	-	Malaria Superintendent

IX. ACKNOWLEDGEMENTS:

We hope that next year, more time will be allotted for the evaluation so that the Sind and Baluchistan provinces will also be included and at that time the team can express our sincere regrets for the inability to visit them this year. To the Provincial and District/Zonal personnel visited, we express our thanks for their generous cooperation and cordial hospitality. To the DOMC, WHO and USAID, we are grateful for making possible this assessment by providing the necessary administrative and logistical support. Finally to Dr. Richard Sakai, of the ICMRT, Lahore, we are especially appreciative of his generosity in spending a great deal of his valuable time to share with us his views on the entomologic aspects of operational research and in providing to one of us (G.P.G.), eggs from a number of vector isolates from his insectary. These vector strains, once established in the U.S. will be available to other American scientists to extend the studies not only on

susceptibility of the strains to insecticides but also to infection with malaria as well.

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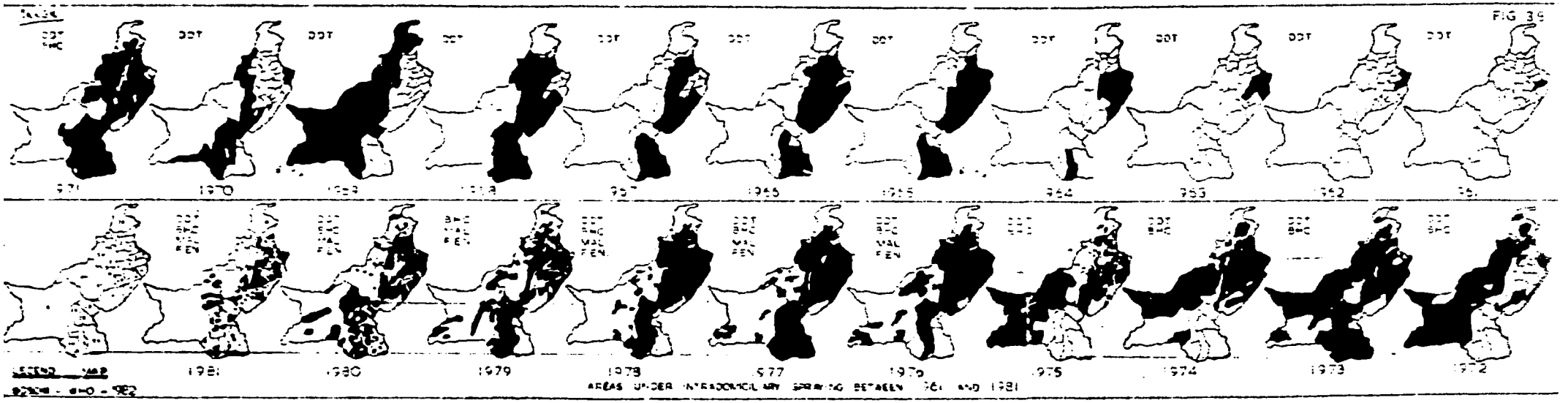
FIG 3.5
DDT
1970
1981
1980
1979
1978
1977
1976
1975
1974
1973
1972
AREAS UNDER INTENSIVE MONITORING BETWEEN 1961 AND 1981