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Vector Biology
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Report of an External Review

of the Pakistan Malaria Control Program

Islamabad, March 4-26, 1990

by

R. Scholtens (VBC)
L. Cowper (VBC)
N.G. Gratz (VBC)
G. Hashim (Pakistan Malaria Control Program)
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VBC Report No. 81126

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Acronyms and Abbreviations

ACD	Active Case Detection
A.I.D.	Agency for International Development
API	Annual Parasite Incidence
ARD	Agricultural and Rural Development (Division, USAID/Islamabad)
BHU	Basic Health Unit
CD	Communicable Disease
CICP	Consortium for International Crop Protection
DOMC	Directorate of Malaria Control
EA	Environmental Assessment
EC	Emulsifiable Concentrate
EE	Energy and Environmental (Division, USAID/Islamabad)
EPA	Environmental Protection Agency
GHS	General Health Services
GOP	Government of Pakistan
HCH	Hexachlorocyclohexane (=BHC)
HPN	Health, Population and Nutrition (Division, USAID/Islamabad)
IEE	Initial Environmental Examination
MCP	Malaria Control Program
MT	Metric Ton
NIMRT	National Institute of Malaria Research and Training
NMCP	National Malaria Control Program
OP	Organophosphate
PACD	Project Assistance Completion Date
PCD	Passive Case Detection
PID	Project Identification Document
PP	Project Paper
PUO	Pyrexia (fever) of unknown origin
RHC	Rural Health Center
ULV	Ultra Low Volume
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VBC	Vector Biology and Control Project
WHO	World Health Organization
WDP	Water Dispersible Powder
WP	Wettable Powder

Basic Project Identification Data
(Outline)

1. Country		Pakistan	
2. Project Title		Malaria Control Project	
3. Project Number		391-0472	
4. Project Dates:			
a. First Project Agreement		May 19, 1982	
b. Final Obligation (Actual)		.....	
c. Project Assistance Completion Date (PACD)		September 30, 1992	
5. Project Funding:			
a. A.I.D.: Bilateral funding (grant)		ESF Grant $66,000,000 Mondale Rs.21,000,000	
b. Other Major Donors		World Health Organization	
c. Host Country Counterpart Funds		Rs. 1,056,476,000	
Total		$116,368,037.00	
6. Mode of Implementation		Contract with VBC, No. DPE-5948-0-00-9031-00	
7. Project Design		Government of Pakistan USAID/Pakistan A.I.D./Washington IOC Consultants	
8. Responsible Mission officials		Mr. James Norris, Mission Director Dr. Rifaq Ismail, Project Officer	
9. Previous Evaluation		External Evaluation, 1987	
10. Cost of this Evaluation	Person Days	Dollar Costs	Rs.
a. Direct hire:			
A.I.D./W TDY USAID Staff	12		
b. Contract:	42 person days	$45,152	--
c. Other: WHO	21 person days	N/A	--

-1-

1. Executive Summary

USAID/Islamabad, the Government of Pakistan (GOP) and the World Health Organization (WHO) requested an external review of the Pakistan Malaria Control Program (MCP). This program is assisted by A.I.D. Malaria Control Project II Extension (391-0472). The principal goals of the review were to assess the impact of the MCP, including the effect of current insecticide spraying on the annual parasite incidence (API), the completeness of malaria surveillance, progress toward reducing reliance on insecticides and developing operational research capabilities, the importance of insecticide and drug resistance, and sustainability of the program without donor assistance.

The review was conducted in two stages. An insecticide resistance expert visited Pakistan from January 14-19, 1990. During the second phase, a team of malaria specialists from the Vector Biology and Control Project, the World Health Organization and the GOP worked with officials and staff at facilities of the MCP and General Health Services (GHS) March 4-26, 1990.

The team found four very different provincial programs, with adequate coordination and training support but less than adequate operational research capabilities. Integration of malaria control into the GHS, so far as it has gone, has strengthened the MCP by granting it a degree of stability and permanence, but has weakened its once formidable discipline, direction and operational resources. MCP activities in Punjab are relatively strong and successful, but technical, administrative and security problems impair performance to a greater degree in NWFP, Sindh and Baluchistan.

The malaria surveillance effort remains substantial. Annual reported cases increased from 59,386 in 1988 to 104,447 in 1989, due partly to a continuing shift from active case detection (ACD) to passive case detection (PCD), which produces fewer blood slides from those who have had a recent fever and more from those with a current fever. In 1989, 22.3 percent of all slides came from PCD, an increase of five percent since 1988. But the rising number of malaria cases is also due to increased incidence because 9.03 percent of all 1989 PCD slides were positive, compared to 5.76 percent in 1988. This is troubling, particularly because falciparum malaria increased from 37 to 53 percent of all cases. The total number of malaria cases and number of falciparum cases increased dramatically in Sindh, markedly in Punjaband NWFP, and decreased slightly in Baluchistan.

Falciparum malaria cases occurred mostly in the Sindh and adjacent areas in Punjab and Baluchistan. Because there is increasing evidence of chloroquine-resistant falciparum malaria at the regional

and national levels, and because chloroquine is given to each suspected case of malaria in the country, drug resistance should be considered a possible cause of this dramatic rise in falciparum malaria.

The other resistance problem is the potential impact of the widespread resistance of *Anopheles stephensi* to malathion, which was documented by Dr. Georghiou in January. The important field research necessary to determine the role of this species in malaria transmission in Pakistan remains incomplete. This evaluation team's considerable effort to relate disease surveillance findings to sites with known *A. stephensi* resistance produced no epidemiologic justification for any substantial replacement of malathion with fenitrothion.

In 1989, just one house in 10 was sprayed with malathion to control malaria. Only houses in localities where malaria cases were most abundant were sprayed. They only received one application of malathion, whose residual effect may not exceed 30 days. This rather marginal control measure may have limited impact on disease transmission. The MCP strategy is to reduce dependence on insecticides while implementing alternative control measures. The reduction has occurred, but the alternative measures, which were to be identified through an active operational research program, have not been defined. We found the malaria control operational research capacity very limited and without much promise. For now, spraying residual insecticides remains the most cost-effective means of malaria control in Pakistan.

Microscopy services have remained strong during this time of integration and decentralization. However, the planned tenfold expansion of microscopy services to provide services in each Basic Health Unit (BHU) seems excessive.

The team's major recommendations are:

1. Because of increased malaria incidence, spraying criteria should revert to those used in 1988.

2. Epidemiologic evidence does not justify the immediate use of fenitrothion in the Punjab, but supports its careful introduction in NWFP.

3. Research into critical operational issues, such as the vectorial capacity of *A. stephensi*, the extent and importance of vector resistance to malathion and of chloroquine- resistant falciparum malaria, and the usefulness of alternative control measures, must be conducted on a large scale if the MCP is ever to become sustainable without donor assistance.

2. Introduction

a. History of the program

USAID malaria assistance to the Government of Pakistan (GOP) began in 1961 as part of the global malaria eradication program. This support was terminated in 1970 when it was thought that the Pakistan program was close to success. Unfortunately, a resurgence of malaria had already begun and by 1972, an epidemic was underway. It reached a peak of perhaps 10 million cases in 1974. USAID assistance to the Pakistan Malaria Control Program (MCP) was renewed in 1975. Because vector resistance to DDT and HCH had become widespread, malathion was introduced and a 99 percent reduction in malaria cases was achieved. By 1981, however, the incidence of malaria began to increase again, possibly exacerbated by the influx of several million refugees from Afghanistan.

In May 1982, the Malaria Control Project II was signed to assist the GOP in maintaining the malaria Annual Parasite Incidence (API) at or below 0.5, or 0.5 cases per 1,000 population. In addition to USAID/Islamabad, the World Health Organization (WHO), the United Nations Children's Fund (UNICEF) and the Government of Japan also provided assistance. Emphasis was placed on integrating the MCP into general health services, passive case detection (PCD), treatment methods and a more judicious use of insecticide house spraying.

A good measure of success has been achieved, but there have been recent increases in malaria incidence for a variety of reasons. Nevertheless, substantial, positive changes are underway in the MCP, with a strengthening of PCD and an accelerating decentralization of malaria microscopy services.

b. Purpose of the USAID project

The MCP II (371-0472) was designed to help the GOP achieve self-reliance in malaria control operations. Its objectives are functional integration of malaria control with general health services, development of an operational research capacity, and implementation of cost-effective vector control measures. These objectives are to be achieved by reducing the use of imported insecticides and increasing reliance on alternative means of control. An active, productive operational research program and efficient management of malaria

control operations are critical to achieving these objectives. MCP II efforts began in 1982 and are scheduled to end in 1992.

c. Evaluation dates and methods

The external review team started its tasks with briefings at the USAID/Islamabad offices on March 4 and at the Pakistan Directorate of Malaria Control (DOMC) the next day. After meeting with senior GOP officials and completing travel arrangements, team members flew to Lahore on March 7. They met with Punjab MCP officials, visited the National Institute of Malaria Research and Training (NIMRT), then split into two teams for travel to the field and the other provincial malaria control programs.

Team A (Cowper, Hashim and Van Dijk) evaluated the pilot program of voluntary collaborators in the Punjab and the MCP in Baluchistan and in Sindh, returning to Islamabad on March 17. Team B (Gratz and Scholtens) flew to Multan and toured districts in the southern Punjab with Mr. Mohammad Azam of the Punjab MCP before flying to Peshawar to review the NWFP malaria program. Dr. Gratz left for Karachi on March 15, where he met with Team A before departing Pakistan on March 17. The remaining four team members then drafted the report for presentations to USAID/ Islamabad (March 22) and the GOP (March 26).

Before separating into sub-teams, team members identified issues of particular importance. They agreed to focus their attention on the state of operational research and the NIMRT, surveillance data related to the increasing threat of malaria outbreaks, the apparent deficit of methods and resources available to contain malaria, and evidence of the real need for alternative insecticides. They also agreed on an outline of the final report and principle responsibilities for writing various sections.

d. Scope of work

The review team was instructed to:

" 1. Assess the overall impact of the program and its various components;

2. Review and evaluate current operational strategies of the program and advise on supportive and/or corrective measures to facilitate meeting of project objectives;

3. Identify areas of the program where USAID assistance could play a more effective role;

4. Assess the adequacy of both USAID and GOP inputs into the program, identify problems encountered in their availability in regard to timeliness, quantity, and quality, etc. and advise on related implications observed;

5. Review available information about the quantities of insecticides utilized for vector control/spray operations under the project in the past five years and concurrent annual parasite incidence. Comment on GOP's progress toward achievement of reduced reliance on insecticide for malaria control and prospects for sustainability of the program with the phasing out of donor assistance in the future. Recommend further actions to support the emphasis on long-term sustainability of the program through lowering use of insecticide by recommending alternate options;

6. Review action taken to establish malaria case detection capabilities in the general health and integrated services, assess the status of malaria parasite control through PCD to reduce the malaria transmission potential and recommend measures to expedite establishment of passive case detection (PCD) and treatment services at the health facilities;

7. Review the overall malaria surveillance operations and the status of computerization of surveillance data. Recommend methods for improvement of surveillance and effective utilization of data for the better management of the program;

8. Review the status of the operational research program of the NIMRT, assess actions taken to improve research staff and skills through the October 1989 Training Workshop on "Techniques of Development of Operations Research Protocols" and recommend actions to expedite establishment of functioning operational research activities at the NIMRT and in the provinces;

9. Review available information on the sensitivity of *Plasmodium falciparum* to antimalarial drugs, assess the extent of the problem of chloroquine-resistant *P. falciparum* and recommend measures to address it in the program;

10. Review the status of Participant and Incountry Training including the long and short term training supported by the project to develop national expertise in malaria control. Recommend any modification needed in the current program."

3. Malaria Surveillance

a. Prevalence of malaria

The purpose of disease surveillance is to obtain periodic collections of comparable data that make it possible to detect changes in disease occurrence. The important changes are temporal (in frequency) and spatial (the distribution of cases). Sophisticated methods are not as important as consistent effort. In the Pakistan MCP, there has been a consistent surveillance effort. Five to seven percent of the populace has been tested for malaria annually. The results (Table 1, Annex 3) show that the disease was well controlled after 1976, but now cases are increasing. The cases are not uniformly distributed, as shown by the Annual Parasite Incidence (API), or number of cases per thousand people (Table 2, Annex 3). There is now more malaria in Sindh and NWFP than in Punjab or Baluchistan. These data and all others in Annex 3 do not include malaria cases among Afghan refugees in Pakistan.

Until recently, Pakistan has relied heavily on active case detection (ACD). In ACD, malaria workers visit houses monthly to locate those who have had a fever and take a blood slide to determine whether the fever was caused by malaria parasites. A tool of malaria eradication, ACD is labor-intensive and is designed to be used in areas where the incidence of malaria has declined to extremely low levels. ACD was used as an offensive weapon in eradication programs to find and eliminate the last cases of malaria infection through treatment. It was intended for areas where no other means of case detection or malaria control were in use.

In recent years, with the integration of malaria control and the general health services, passive case detection (PCD) is replacing ACD in Pakistan. The slowness of that shift is apparent from the data in Table 3, Annex 3. During the past five years, the proportion of PCD slides has risen from 13 to 22 percent.

b. Status of malaria in Pakistan

The method of case detection influences the frequency of positive findings. Since PCD slides are taken from people who are ill, they are positive more often than ACD slides. With increasing PCD, the number of cases detected can increase while the overall incidence of disease remains unchanged. The number of cases detected in Pakis-

tan has risen (Table 4, Annex 3), but this increase cannot be attributed solely to the shift toward PCD. The percentage of positive PCD slides also has increased, from 5.76 in 1988 to 9.03 in 1989, indicating that malaria incidence is rising. The level of malaria is now about what it was in 1986.

There has been an alarming increase in the proportion and absolute number of falciparum malaria cases in Pakistan (Table 5, Annex 3). One of the targets of the MCP was to lower the incidence of this more serious form of the disease to less than 20 percent of total cases. It now exceeds 50 percent.

The extent of the effort to collect PCD slides in the provincial programs is uneven (Table 6, Annex 3). According to the data reviewed, the program in the Sindh has been most successful, with much of that progress occurring in 1989. There is steady progress toward collecting more PCD slides in both NWFP and Punjab, but the very large number of ACD slides that continue to be obtained in the Punjab tends to obscure the improvements there. One reason ACD continues to be emphasized in the Punjab is that it is a means of extending surveillance coverage to otherwise neglected areas.

The relative success of the Punjab MCP in controlling malaria is evident in its low Slide Positivity Rate (SPR) and relatively low proportion of falciparum cases (Table 7, Annex 3). Provincial trends, the number of cases detected, the percent of positive PCD slides (an indicator of how ill the populace is with malaria), and the percent of falciparum cases for the years from 1985-1989 are detailed in Annex 3, Tables 9-12. The principal conclusions that can be drawn are that the most, and most serious, malaria is in the Sindh and is of recent origin, the situation in NWFP is steadily deteriorating, the Punjab is holding steady, and malaria has increased but is still a minor health problem in Baluchistan.

In summary, malaria surveillance efforts in Pakistan have remained rather constant with the results influenced somewhat by the slow shift from ACD to PCD. The number of cases remained relatively low during 1987-1988, undoubtedly partly due to exceptionally dry weather, particularly in areas of the Punjab during 1988. This favorable trend was reversed in 1989, when the number of recorded cases exceeded the 100,000 mark again, and, more alarming, the number of falciparum malaria cases surpassed those of vivax. The predominance of falciparum malaria appears to have been a constant feature in Sindh during the past five years, reaching a very high level in 1989 (Table 20, Annex 3).

c. Use of insecticide versus frequency of malaria

The operational strategy of the MCP is to reduce reliance on insecticidal spraying and replace that dependency with expanded disease surveillance through PCD and other control measures developed by a lively operational research program. The usefulness of insecticide spraying is therefore of considerable interest. The Project Paper (p. 55) requires that cases be recorded as occurring in sprayed or unsprayed localities. Such records and awareness of the effects of spraying in the more than 43,000 localities (villages) in Pakistan reside only at the lower levels of the MCP with malaria supervisors (called CDC supervisors in the Punjab) and, to a lesser extent, with their supervisors, the malaria or CDC officers at the district level.

The team was asked to review available information about the quantities of insecticide used and concurrent malaria, and to review the changing case detection capabilities at local levels. Because it was impossible to obtain or compile such data during a brief multipurpose review, we attempted instead to collect 1989 surveillance and spray data from all 81 districts in the four major provinces. Surveillance data were lacking in a few districts and spray coverage data from quite a few, but more insight was gained into the state of affairs at the mid-level of MCP operations than had been available previously. In Annex 3, Table 8, 78 districts are listed in order of decreasing API.

Since houses throughout the country are sprayed in July or August at the beginning of the malaria transmission season, the effect of insecticide use should be detectable in the malaria cases recorded in that same calendar year. The listed districts should therefore provide some degree of inverse correlation between the incidence of malaria and level of spraying. No such correlation between these district data is apparent -- perhaps because case data and spray data are from different localities or because the quality of spray operations was deficient.

Several things are evident. The number of blood slides examined among the total population (Annual Blood Examination Rate, or ABER) is quite satisfactory in most districts except some in Baluchistan. Most of the 24 districts with an API exceeding 2.0 are in NWFP (11) and Sindh (7), but there are four from Baluchistan, which has the least developed MCP. The two Punjab districts with the highest APIs are close to the Baluchistan and Sindh areas of high incidence. A population exceeding 6 million lives in problem districts in Sindh, several million more than in threatened areas of NWFP. The bulk of the apparently protected populace lives in the Punjab. In Baluchistan,

quite a few districts with low API have a low ABER and a relatively high slide positivity rate (SPR), indicating that considerable undetected malaria is likely. Of these 78 districts, 21 have an API that meets the national target of less than 0.5. A map showing the location of districts with APIs exceeding 2.0 is included in Annex 6.

Quarterly surveillance data from the 19 NWFP districts and tribal areas provides some insight into the diminished effect of insecticide spraying on malaria incidence, at least at the low application levels now employed. Annex 5 includes two bar graphs showing the quarterly number of vivax and falciparum cases and the number of houses sprayed. In 1986 and 1987, the number of vivax cases declined from the third to the fourth quarter after spraying, but in 1988 and 1989, it remained essentially the same or increased slightly. The number of falciparum cases rose during the quarters after spraying in all four years, particularly in 1988 and 1989. Provided the insecticide was applied correctly, such data suggest that the current spray program with malathion, certainly at the levels now in use, is not achieving the desired effect. However, it is also possible that the majority of cases occurred in unsprayed areas. That locality-level information was not available. It should be obtained and analyzed.

d. Surveillance methods

Errors and inaccuracies were found in surveillance data from all levels of the program. This can be expected when large programs are required to monitor numerous parameters at multiple operating levels with only paper, pen and calculator. Since malaria control operations and the criteria to be monitored are well-established, an automated data processing and analysis system could be developed quite readily. Suitable mechanisms for obtaining and processing data from integrated operations, such as information about fever or "pyrexia of unknown origin" (PUO) cases and the number of slides taken from these cases for malaria examination, must be developed. It will only be possible to monitor and comprehend cause and effect of such large amounts of data at the necessary levels with a microcomputer-based data management system. The confusion surrounding the effect of malaria control measures stems from the current marginal ability to compile and comprehend the data available to explain what is happening and why.

Since malaria surveillance is based on cases confirmed by microscopic slide examination, the quality of the data is affected by the performance of the microscopists. Prior to integration, all slides were taken to district-level central laboratories. Since integration, many of

the microscopists from the district labs have been moved to Rural Health Center (RHC) laboratories, which now serve as regional centers for microscopic slide reading. We frequently found that the former malaria microscopists had trained the laboratory assistants who work in these laboratories to read malaria blood smears and assist in malaria microscopy.

This integrated system appears to be working well, without any loss in the quality of blood slide interpretation. But using a microscope to examine blood smears for malaria parasites is a difficult, rather subjective skill that is greatly improved through experience. That is why we are troubled by the plan to train large numbers of newly recruited staff as microscopists for each Basic Health Unit (BHU). In Punjab, for example, the planned expansion would increase the number of microscopists from the 290 prior to integration to about 2,374 -- one for each BHU at the Union Council level. Aside from the extreme difficulty of training such a large number of skilled technicians, we doubt that they could maintain their skills examining the low number of slides they might be expected to encounter. In 1989, there were 104,447 positive malaria blood smears from 3,098,759 slides. If, for example, these were evenly distributed among 3,832 microscopists (one per BHU, one BHU per Union Council), each microscopist would read about three slides a day and see a positive slide every other week.

There is a second planning issue. We interviewed RHC and BHU staff about outpatient loads, the number with PUO, and the number of blood slides taken. The number of patients who actually present themselves and need to have a blood smear taken probably does not routinely exceed 40 to 50 percent.

For example, there was an outbreak of malaria in Sinawan, Muzaffargarh district, Punjab, during 1989 that resulted in more cases in that Union Council area than in 28 of the 29 districts of that province. We talked to the medical officer at the RHC about the malaria and his PUO cases. During 1989, the RHC recorded 7,049 PUO cases, took blood smears from 5,928 and found 1,680 slides positive. Under conditions that promoted seeing PUO patients and taking blood smears, 84 percent blood slides were taken. Except for the unusual circumstances, the number of blood smears would justifiably have been much lower. Therefore, we think the targeted proportion of PUO patients from which blood slides will eventually obtained (85 percent) is excessive and not attainable by 1992. A 1992 target of 40 percent would be more realistic.

e. Voluntary collaborators

To further improve malaria case detection coverage, voluntary collaborators (VC) have been selected on a trial basis in the Kasur and Sheikhupura districts of Punjab province. In each of these districts, five Union Councils (subsectors) have been chosen and in each Union Council, five VCs have been selected in five villages, for a total of total of 50 VCs. The selection was primarily based on the candidate's willingness to act as VC and his prestige and acceptability in the village. The VCs include a retired schoolteacher, a shopkeeper and a former CDC supervisor. The project was launched in November 1989 and is being run on a completely voluntary basis. A token incentive for excellent services is under consideration.

So far the trial has been exceptionally successful, turnover of VCs minimal and production of blood slides beyond expectations. It is too early to make definite conclusions yet. Training and selection of VCs has been the responsibility of the CDC supervisor of each Union Council, supported by higher echelons as required. The functions of the VC are restricted to collecting blood slides from fever cases and suspected malaria cases and administering presumptive treatment with chloroquine. It is also planned that they will provide treatment for common minor ailments, but the MCP would be advised to phase in this addition slowly.

The team believes that each VC should have a sign on his house to identify the VC post. In line with selection criteria, all VCs are male and literate. Each is supported by an assistant, often a close relative, who will take over his function during the VC's absence. Once the project has been running successfully for six months, it is envisaged that it will be expanded to other districts. VCs are routinely visited three times per week by the CDC supervisor for encouragement, collection of blood slides and replenishment of supplies. So far, the only problem has been that USAID/Islamabad has had some difficulty replenishing VC supplies.

The impressive results obtained during the first three months of the project are summarized below. Both sexes and all age groups, particularly children, are well-represented among those from whom a blood slide was taken. The VC in Maluki (Kasur), with a population of 2,300, collected 50 slides during the first month of operation and 30 slides during the second.

Slides Collected by Voluntary Collaborators in Punjab November 1989–January 1990

District	Month	Slides Collected	Slides Positive	falciparum	vivax
Kasur	Nov. '89	478	0	-	-
	Dec. '89	972	0	-	-
	Jan. '90	736	1	-	1
	TOTAL	**2186**	**1**	**-**	**1**
Sheikhupura	Nov. '89	204	35	29	6
	Dec. '89	240	21	20	1
	Jan. '90	171	4	2	2
	TOTAL	**615**	**60**	**51**	**9**

14. Malaria Treatment and Drug Resistance

a. Malaria treatment

A malaria/CDC supervisors' manual and the plastic laminated treatment cards that were prepared several years ago have been widely distributed. They have helped standardize chemotherapy of uncomplicated malaria in the MCP to regimens recommended by the DOMC. The regimens and dosages of chloroquine and primaquine given for the treatment of falciparum and vivax malaria cases, respectively, are still valid and do not require amendment.

As suggested by the terminal evaluation team in 1987, the addition of a single dose of primaquine to the presumptive treatment is recommended wherever *P. falciparum* is predominant and possibly chloroquine-resistant. The appropriate single dose for adults is 30 mg primaquine, i.e. 4 tablets of 7.5 mg base. Based on the information at hand, there is no justification for replacing chloroquine with amodiaquine in Pakistan. A shortage of chloroquine was noted in Baluchistan and Sindh.

In the wake of chloroquine resistance, it has been recommended that a follow-up slide be collected one month after radical treatment is administered for falciparum malaria. If the follow-up slide is positive, an alternative treatment should be administered. Collecting follow-up slides after one month remains the exception rather than the rule in Pakistan. However, in light of the increasing number of falciparum cases showing R-II level of resistance to chloroquine, the following regimen of follow-up slide collection is now being recommended:

> A first follow-up slide should be collected five to seven days after the beginning of the radical treatment. If it is positive for asexual parasites, the chloroquine-primaquine treatment should be repeated, but under the fullest supervision possible. If a blood slide taken five to seven days after the beginning of the second radical treatment course is found positive for asexual parasites, an alternative drug should be used. (See below under Drug resistance.)
>
> If the first follow-up slide collected five to seven days after the beginning of radical treatment is negative, a second follow-up slide should be collected four weeks after the beginning of radical treatment. If this second slide is positive for any

falciparum parasites, the radical treatment with chloroquine and primaquine should be repeated, but under the fullest supervision possible. If a blood slide taken after another four weeks is again positive for falciparum parasites, an alternative drug should be used (see below under Drug resistance).

Whenever feasible, the radical treatment of falciparum cases should be properly supervised. This would eliminate the need for repeated chloroquine-primaquine treatment and allow apparently chloroquine-resistant cases to be treated with an alternative drug. It is suggested the person in charge of initiating the radical treatment be made responsible for collecting follow-up slides. In several instances, this would be the malaria (CDC) supervisor.

b. Drug resistance

Testing for chloroquine-resistant falciparum malaria was initiated in early 1976 in some districts of Punjab. The first resistant parasites were found in late 1981 in the Sheikhupura district, where two out of 60 cases of *P. falciparum* tested proved to be resistant at RI level. The first RII level resistant case was detected in a survey conducted in December 1983-January 1984 in the Bahawalnagar district of Punjab. Only 17 of the 33 cases tested were found to be sensitive to chloroquine. Up to December 1984, a total of 476 cases had been tested. The majority of cases were tested *in vivo*. Most were in Punjab and some in Sindh. Of these, 417 were still sensitive to chloroquine, 55 were resistant at RI and three were resistant at RII level.

Subsequently, sensitivity to the alternative drugs amodiaquine and Fansidar also was tested. Results of tests conducted by the NMTC/NIMRT in Lahore and by the MCP (CDC) personnel in Punjab and NWFP are provided in Tables 1 and 2, Annex 4. From these results, it appears that:

a. resistance to chloroquine at RI level has become very common in Punjab and cases showing resistance at RII level are increasing gradually;

b. resistance to amodiaquine is by and large as common as, and of a similar magnitude to, resistance to chloroquine;

c. so far, few cases have been found to be resistant to Fansidar, but the number of tests carried out with this drug is also small. The outcome of the tests conducted in 1985-86

in Sialkot, where about half the cases proved to be resistant to Fansidar, is of particular concern.

There is nothing to be gained by replacing chloroquine with amodiaquine to treat chloroquine-resistant falciparum malaria. In view of occurrence of Fansidar-resistant infections in Punjab and the serious side-effects experienced with the use of this drug elsewhere, mefloquine must be considered the best alternative for treating chloroquine-resistant falciparum malaria at this time.

c. Treatment of chloroquine-resistant falciparum malaria

By the end of 1989, the World Health Organization's Malaria Action Program had formulated the following recommendation for treating chloroquine-resistant falciparum malaria:

Lariam tablets containing 250 mg mefloquine-base.

For adults: 15 mg per Kg body weight taken in two doses, not in an empty stomach, maximal dose 1,000 mg (four tablets), e.g. 60 Kg and above: 4 tablets of 250 mg, 2 tablets immediately and 2 tablets eight hours after the first dose.

For children: 15 mg per Kg body weight, not in an empty stomach, e.g. about one tablet for 15 Kg to be taken in two doses = first dose 1/2 tablet, second dose 1/2 tablet eight hours later.

This treatment should be complemented with the usual dose(s) of primaquine against falciparum gametocytes.

If mefloquine is not available, Fansidar may be used.

For adults:	three tablets	
For children of	1-3 years:	1/2 tablet
	4-11 years:	one tablet
	12-15 years:	two tablets

One should avoid a second dose later, because of problems of sensitization, which can be dangerous. This treatment should be completed with the usual dose(s) of primaquine against falciparum gametocytes.

Intravenous quinine remains the drug of choice for treatment of severe cases of malaria.

Pertinent information about the geographical distribution of drug resistance in Pakistan appears to be limited to localities where surveys have been conducted by either the NMTC/NIMRT or malaria (CDC) staff in NWFP and Punjab. On the basis of clinical evidence and unconfirmed reports, however, it must be assumed that chloroquine resistance is quite widespread throughout the four provinces, constituting a serious technical problem for the malaria control program.

5. Vector control, Insecticide Use and Resistance

a. Spray operations

The national malaria control program is based principally on two activities: 1) surveillance and treatment, and 2) residual spray operations. In an effort to reduce the amount of insecticide used in the program, the MCP is paying increased attention to detection and treatment of positive cases. However, it is apparent that residual spray operations will remain a major activity of this program over the life of the current A.I.D. project because spraying is a cost-effective, efficient and practical control measure against malaria.

The current strategy is based on an epidemiological approach to spraying rather than total coverage, as was practiced in the past. This approach requires thorough knowledge of malaria endemicity, climatic conditions, past malaria experience, population movements, waterlogged conditions and numbers of laborers in the areas being reviewed for spraying. Using national standards, the MCP works with provincial authorities to select the areas to be sprayed. The major malaria criterion for selecting localities for spray application (see Annex 7) is that during the previous 12 months:

1. there were two or more indigenous *P. falciparum* cases; or

2. there were six or more *P. vivax* cases.

It should be noted that complete insecticide coverage will be provided for selected localities with populations of less than 2,000. Only peripheral spraying will be carried out in larger localities.

From 1985 to 1989, MCP residual spray operations consisted of one application of malathion 50% WDP during the mid-July to September period with limited additional focal spraying. Hudson hand compression pumps were used to apply the insecticide on the inside of houses, roof eaves, and cattle sheds and other outlying structures. Spray squads of four to five men led by a supervisor carry out the effort. Spraymen generally are recruited locally as temporary workers, provided three to five days of training on the techniques of spraying and health and safety measures, and issued protective clothing. The spray program is scheduled by locality and day for the teams. Supervision by senior staff is critical to ensure that the insecticide is applied properly and all environmental and safety concerns are met.

Every year a geographic reconnaissance is conducted from January to March to update the census data. This provides information about manpower, insecticides, transport, training and funding that can be used to plan spray operations.

The team reviewed the residual spray programs at the national, provincial and, when possible, district levels. Spray operation procedures were uniformly understood. This method of control has been conducted successfully for many years. The provinces reported the following spray coverage of the target areas for the 1985-1989 period.

Percent of Target Areas Sprayed, 1985–1989

Province	1985	1986	1987	1988	1989
Punjab	94	92	91	93	93
Sindh	87	77	82	91	98
NWFP	89	85	89	72	71
Baluchistan	88	63	56	65	59

The spray coverage was, in general, very satisfactory for two of the provinces, but fell short of the planned objectives in the two others. Azad Jamu Kashmir is not included in these tables. The team visited a number of areas and found evidence of spraying, but it was not possible to determine quality of the spraying effort because spray operations were not in progress.

Details of the 1989 spraying are summarized on the next page.

Spray Report for the Year 1989
Malaria Control Program

	Punjab	Sindh	NWFP	Baluch-istan	Azad Kashmir	TOTAL
Population Protected:	2,800,682	1,976,409	1,566,810	361,170	250,762	6,955,833
Houses Sprayed:	520,411	337,426	289,948	57,020	38,423	1,243,228
Insecticides Used (m.T):	447.195	334.610	307.044	70.195	35.136	1,194.18
Percent Population Covered:						
i. Existing	7.00	19.00	10.31	10.31	10.00	10.45
ii. Planned	94.90	91.21	72.40	49.46	87.00	84.85

It appeared to the team that the population protected was too low considering the present state of surveillance. The team also believes that it is important to have a 20 percent reserve of insecticide to address any major outbreaks and to carry out focal spraying.

The training of spray personnel in the handling, application and storage of the insecticide was reviewed in-depth by the team. In brief, we found evidence of cholinesterase testing, use of protective clothing and schedules for training in health and safety. No malathion intoxication incidents were reported among spray personnel or village residents in 1988 and 1989.

b. Urban malaria control

Over the years, the MCP has encouraged urban malaria control in the major municipalities of Pakistan, such as Karachi, Lahore, Peshawar, Multan and a number of other cities. The DOMC provides technical assistance, training, some evaluation and supplies to three urban programs. In addition, the DOMC also has helped these programs develop PCD posts and laboratories.

The major equipment supplied to the urban malaria programs during the past year is listed below. The DOMC provides protective clothing and larvicides such as fenthion, Actellic and Abate.

Major Equipment Supplied to Urban Malaria Programs, 1989

	Karachi	Lahore	Hyderabad	Peshawar	Mardan
ULV Fogging machines	3	2	1	1	1
Suzuki PU trucks	3	2	1	1	1
Hudson sprayers	200	200	100	100	100
Microscopes	8	5	3	3	2
Gloves (pairs)	500				

The team was able to visit the urban malaria programs in Lahore and Karachi. It was evident that the majority of their activities were more useful for controlling pest mosquitoes than for malaria control. Team members visited PCD posts in both cities and observed field operations. We were impressed by the magnitude of the mosquito problem and the devotion to duty displayed by the assigned personnel, who operate under severe financial and equipment restraints. The program in Karachi under the Karachi Municipal Corporation (KMC) has recently received three TIFA machines mounted on Suzuki pick-up trucks. The usefulness of this equipment can best be evaluated through entomological surveys. The team encouraged KMC officers to continue efforts to evaluate mosquito control methodology.

One of the major problems in the Karachi and Lahore areas is that related areas such as Cantonment, KDA, Civil Aviation, Railways and Housing authorities do not coordinate their efforts, if any, with the ongoing programs of the KMC and the Lahore Municipal Corporation. It appeared to the team that a coordination board could be established with these various entities to improve the effectiveness of the effort. Such a coordination committee did exist in Karachi some years back under a trained scientist and it seems to have worked satisfactorily.

Team members emphasized the increased use of environmental management methodology to correct mosquito breeding problems rather than the use of chemicals, which are short-lived and cannot permanently solve the urban malaria problem. In Karachi, 400 million gallons of water are supplied to the city area every day, but only 40 million gallons per day are disposed of properly. This leaves 360 million gallons to flow into river beds, canals and depressions where mosquito breeding can occur. Establishment and maintenance of proper wastewater drainage is essential if the mosquito problem is to be overcome.

c. Larviciding

Outside of urban areas, MCP activities do not include larviciding. The major malaria vectors of Pakistan breed on a wide variety of water collections such as rice fields, canal seepages or pools, and river beds. Such widespread breeding sites cannot be treated effectively with larvicides in rural areas. However, the team believes that for a few weeks during the dry season, there might be opportunities for applying larvicides in some areas of the country, such as in Baluchistan, where water sources are scarce. Larviciding these sources would slow the growth of the vector population and help reduce

malaria transmission rates. Only a few of the most effective larvicides should be used.

In all cases, larvicides should be applied in conjunction with entomological evaluation to determine the effectiveness of the activity. In the larviciding applications observed by the team in Lahore, MCP workers did not appear to be following proper entomological procedures or applying the larvicide formulation correctly. It appeared to the team that use of larvivorous fish to control mosquitoes would be effective in some situations within the urban areas.

d. Insecticide use and resistance

The team was asked to "review available information about the quantities of insecticides utilized for vector control/spray operations under the project in the past five years and concurrent annual parasite incidence. Comment on GOP's progress toward achievement of reduced reliance on insecticide for malaria control and the prospects for sustainability of the program with the phasing out of donor assistance in the future. Recommend further actions to support the emphasis on long term sustainability of the program through lowering use of insecticides by recommending alternate control methodology/ options."

Since 1984, the following quantities of malathion 50% WDP. have been procured and used in the malaria control program:

Malathion Used In the MCP, 1984–1989

Year	Quantity
1984	1,650 metric tons
1985	3,700 metric tons
1986	3,000 metric tons
1987	2,400 metric tons
1988	1,200 metric tons
1989	1,234 metric tons

It is apparent that there has been a sizeable reduction in the quantity of insecticides ordered and applied. The reasons are:

1. The application of stricter criteria for the spraying of localities. (Until 1989, localities were sprayed if a single case of *P. falciparum* or three cases of *P. vivax* were detected prior to the spray season. In 1989, only localities showing two or more falciparum cases and six or more vivax cases were sprayed. Complete insecticidal coverage was provided only to localities with a population of less than 2,000. Only a peripheral spray was applied in larger localities.)

2. Increased reliance on PCD and treatment as a method of reducing transmission.

3. Increased emphasis by A.I.D. on reducing the use of residual insecticides in the program.

Visits to the provinces revealed that spraying policies are not followed consistently from one district to another. Because of the reduced availability of malathion WDP, some localities or villages that fit the criteria outlined above are not sprayed. In many other localities, only certain houses in the village are sprayed (usually those on the periphery). Increased reliance is now placed on "focal spraying," which is the late application of insecticide to localities found to have malaria cases after the normal residual spray operations are completed. In Pakistan, villages receive focal treatment if a number of cases of *P. falciparum* appear. This is a risky practice, dependent on a high degree of reliability of either PCD or the residual ACD in detecting foci of transmission. It is doubtful that the present surveillance system is sufficiently sensitive to promptly detect all active foci of malaria transmission. Indeed, there are reasons to believe that the quantity of insecticides allotted for the 1990 spray program may be too small in light of the definite increase in malaria transmission during 1989.

The MCP has requested the purchase of 250 tons of fenitrothion for application in the Punjab in 1990. This request was prompted by increasing evidence of *A. stephensi* resistance to malathion. The assessment team was specifically requested to advise the Mission and the DOMC on the need for fenitrothion. There is no question about the widespread resistance to malathion in *A. stephensi* populations. This has been documented in two separate reports by Georghiou, the most recent in January, 1990. He recommended selective employment of fenitrothion by the MCP in 1990, but cautioned that because of

the higher mammalian toxicity of fenitrothion and the continuing susceptibility of *A. culicifacies* to malathion, such a change should be made only where certain criteria were met. Those criteria are that:

" a. resistance to malathion as measured by survival of *A. stephensi* in the WHO diagnostic test has exceeded 50 percent on average during the last two years;

b. there is clear evidence that the incidence of malaria transmission significantly exceeds the norm for the district."

It does not appear that the second of these criteria is met in Punjab. Georghiou reports on the level of resistance in *A. stephensi* populations in seven of 14 districts of the Punjab in 1989 (page 33, table 14). He ranks 14 high-resistance districts of the Punjab in decreasing order of resistance to malathion observed in *A. stephensi* during the last two years (page 29, table 12). These districts are listed below with data the team obtained on the API and percent of *P. falciparum* cases. There appears to be no substantial degree of correlation between the ranking of resistance to malathion and the API or percentage of *P. falciparum* in the various districts.

Districts in the Punjab with High Mosquito Resistance to Malathion, 1989

District	Average mortality (%) W.H.O. Test	API	% of P.f.
D.G. Khan	18.7	2.07	67.2
Rajanpur	28.6	1.01	71.4
Bahawalpur	29.0	1.10	28.5
Bahawalnagar	35.5	0.30	9.0
Rawalpindi	41.6	0.71	2.6
Okara	42.5	0.71	35.3
Khushab	43.6	1.12	59.7
Lahore	44.4	0.24	29.6
Jhang	45.7	1.04	46.1
Kasur	46.6	0.21	16.8
Sheikhupura	52.9	1.84	46.7
Sahiwal	53.6	0.70	3.5
Faisalabad	53.9	0.37	37.2
Sarghoda	53.9	1.77	47.9

The team also reviewed entomological and epidemiological data provided by the Punjab Provincial MCP to ascertain what insights these data could provide about the vectorial role of *A. stephensi* and the effect of malathion spray applications on malaria transmission. The data were reviewed with MCP personnel who had carried out surveys in 10 localities with populations of both *A. culicifacies* and *A. stephensi*. They provided data for the following villages or localities: Muzzaffargarh, Vehari and Sarwel. The data from all three districts were similar. In Muzzaffargarh district, three localities -- Mehrpur, Basti Arbi and Charbarpur -- were followed during 1988 and 1989. The unsprayed locality of Mehrpur presented six cases of *P. vivax* (*P.v.*) and three of *P. falciparum (P.f.)* in August 1988 and seven *P.v.* and five *p.f.* in November. An entomological survey made in this locality November 20 showed an average of 5.3 *A. culicifacies* and 15.1 *A. stephensi* per room.

In the locality of Charbarpur, an outbreak of 61 *P.v.* and 25 *P.f.* cases was detected in August. As a result, the locality was sprayed with malathion on August 30. On November 20, 82 days after the spraying, another survey found an average of 1.5 *A. culicifacies* and 25.5 *A. stephensi* per room. At the same time, only one *P.v.* and one *P.f.* case were detected in this locality. It would thus appear, accepting the figures given, that spraying had little effect on *A. stephensi* densities, but it did coincide with a reduction of malaria transmission in the locality. Similar observations have been reported from other localities in the Punjab.

In NWFP, *A. stephensi* also has developed resistance to malathion, with average mortalities ranging from a low of 51.95 in a test in the D.I. Khan district to 100 percent mortality after exposure to five percent malathion papers elsewhere. Less resistance to malathion was found in NWFP in tests in Punjab, (Georghiou, 1990, table 8). However, more recent test results provided by the NWFP district Health Office entomologist show still lower mortalities than those reported by Georghiou. The team was told that there had been some question about the accuracy of susceptibility test reporting in the province.

As in the Punjab, very adequate control of *A. culicifacies* populations is obtained after malathion applications in the NWFP, but this does not seems to be the case with *A. stephensi*. Unfortunately, the entomological evaluation data provided from NWFP do not include mosquito densities in sprayed areas before and after application of the residual insecticide or a comparison of densities in sprayed and adjacent unsprayed areas. We were told by UNHCR staff that *A. stephensi* densities appeared to be very high in sprayed huts immediately after spraying, but no data were provided. On the other hand, unlike the situation in the Punjab, malathion applications appear to

have had little effect on malaria transmission, as was described graphically in de Zulueta's report to the UNHCR. Data presented by Zulueta and those provided to us by the district office show a moderate rise in *P. vivax* but a continuing increase in the number and proportion of *P. falciparum* cases (see Chapter 3 of this report).

In light of the very considerable amount of epidemiological evidence, (but again, with very little entomological evidence other than susceptibility tests!), it would seem that *A. stephensi* is sustaining the transmission of malaria in the NWFP in the apparent absence of *A. culicifacies* after malathion applications. Therefore, we support Dr. Zulueta's contention that at least in those areas of the NWFP where transmission of *P. falciparum* continues to increase, another organophosphate insecticide should be used. There is a high level of susceptibility to the fenitrothion in the NWFP and the MCP has experience in its application (Georghiou, 1990). It is suggested that malathion be replaced with fenitrothion in the areas of the NWFP and the Afghan refugee camps where it is apparent that malathion is no longer effective in controlling the disease.

It is most regrettable that adequate entomological data are not available to explain what has occurred, but the application of fenitrothion in the most seriously afflicted localities should soon demonstrate whether or not *A. stephensi* is responsible for the increased transmission. It is absolutely essential that detailed entomologic and epidemiologic follow-up be made of the fenitrothion applications. In general, there is a need for operational research to test the efficacy of alternate insecticide compounds and formulations in the different provinces and to obtain objectively valid national data should resistance preclude further spraying with compounds currently in use.

We understand that the UNHCR has already ordered a quantity of fenitrothion for application in 1990 in certain localities for which it is responsible. The DOMC should take advantage of the opportunity to evaluate the results of these applications both epidemiologically and entomologically in greater detail than in the past.

e. Environmental Issues of the Project

Under the Malaria Control II Project, USAID assistance includes funding for insecticides, spray equipment and items for protecting spray personnel. An Environmental Assessment (EA) providing a detailed review of the environmental implications of the project was prepared in August 1988. The A.I.D. Malaria Control Project Paper prepared in 1982 included an Initial Environmental Examination

(IEE), which concluded that the project would have no adverse effects on the environment. This project extension conducts program activities similar to those of the 1982-86 period, but emphasizes the reduced use of insecticides and encourages increased reliance on surveillance and epidemiological evaluation to guide a limited spray operation. The 1988 EA concluded that, given currently available options, the use of residual house spray insecticides in combination with chemotherapy was the most balanced approach to environmentally acceptable, economical and effective malaria control.

Both project papers were concerned about environmental protection and worker health and safety associated with the current use of residual insecticides, such as malathion, and future use of fenitrothion, Baygon, bendiocarb (Ficam), Actellic and other compounds. Both the IEE and EA concluded that the presumed environmental impact of such alternative insecticides would be no greater than that of the currently used intradomiciliary insecticide because they would be applied at low dosages to inside wall surfaces in a manner consistent with long-term practice and experience in Pakistan.

At each level of the program from federal to village, the team reviewed the standard procedures used for applying larvicides and residual insecticides. Training of spray personnel has been planned and carried out for each spray cycle. Emphasis is given to proper insecticide application and environmental protection, particularly in the washing of the spray pumps at the end of the day and safe, secure storage of the insecticide at the central and peripheral levels. As part of a continuing effort to evaluate the safe use of malathion in the MCP, a VBC consultant was assigned to review procedures from August 13 - September 5, 1989. The report (AR-119) concludes that "the overall effort to provide safe, effective coverage using malathion was quite commendable."

Team members reviewed data from cholinesterase testing performed on MCP spray personnel in each province during 1989. The data showed that there were no serious organophosphate intoxications among the hundreds of spray personnel involved. There were cases of mild cholinesterase depression (87.5 to 75) in some individuals. These individuals were carefully monitored by the supervisors to ensure that they were using proper procedures when handling insecticides.

Storage facilities for malathion were observed in Baluchistan, Punjab and NWFP. In all cases, the A.I.D.-provided malathion was kept in locked, well-built storage areas and, where necessary, under guard. The storage areas were clean and boxes properly stacked. The team noticed that the Marman-supplied malathion produced in April

1989 did not have a safety warning printed in Urdu. There was a safety warning printed on the boxes in English. The contract for future procurement of malathion should include a specification that the warning also be printed clearly in the national language.

Protective clothing is to be provided to each sprayman. It is not known whether each sprayman was, in fact, provided this protective clothing because the evaluation was held during a non-spraying period. However, the results of the cholinesterase tests indicate compliance with insecticide safety standards. There were no reports of malathion intoxication in any village resident or adverse effects on domestic livestock or wildlife. This finding is in accord with past experience in Pakistan and in other parts of Asia where malathion has been used for malaria control. Proper indoor residual spraying as carried out in malaria control efforts has been shown by a number of studies to be environmentally acceptable.

Pakistan has a history of safe application of insecticides during this project and the team believes the GOP/DOMC/MCP is more than meeting its environmental responsibilities as prescribed in the project paper. However, the team emphasizes that continual monitoring of safety measures is essential during each operational period to ensure that all approved procedures are strictly followed and that spray operations are supervised by well-trained personnel. It is suggested that a full-time environmental monitor be employed to continually evaluate the 1990 spray operation for compliance with safety and health standards for insecticide application.

Interaction between the A.I.D. Malaria Control Project and other A.I.D.-assisted projects, especially in irrigation and water development, is essential. The Mission should demonstrate its commitment to interdisciplinary review of A.I.D projects to ensure that assisted projects do not cause health problems and increased malaria. Such internal activities would provide a working example to the various GOP agencies that environmental considerations are important aspects of project planning and development.

6. Operational Research

The team was asked to: "review the status of the operational research program of the National Institute of Malaria Research and Training (NIMRT), assess actions taken to improve research staff and skills through the October 1989 Training Workshop on 'Techniques of Development of Operations Research Protocols' and recommend actions to expedite establishment of functioning operational research activities at the NIMRT and in the provinces."

The team visited the NIMRT, Lahore, on March 7, 1990 and met with the director of the Institute, Dr. I. H. Shah, Mr. S.D. Parvez, scientific officer, Mrs. Ghazala Nadeem, scientific research officer (entomology), and technical officers.

The director reviewed the history of the Institute, emphasizing that it had been meeting the training needs of national malaria activities since 1961 as the Pakistan Medical Research Centre. He said that since the integration of the MCP with general health services, this training responsibility had increased considerably, particularly in the training of microscopists. For some years, the Centre was the site of the Institute of International Medicine of the University of Maryland School of Medicine, whose program primarily focused on mosquito genetics. With the departure of that team, the Institute was reconstituted in its present form in 1985. A list of recent, current and planned research projects was presented. These include the following studies:

1. The determination of effective and economical insecticide spraying regimens in the field. (Mrs. Nadeem)

   Three of four villages in the Punjab were given different types of spray coverage with malathion while the fourth served as a control. In one village, only cattle sheds and store sheds were sprayed. In the second, only living rooms were sprayed, and in the third, both animal sheds and living quarters. The densities of *Anopheles culicifacies* and *A. stephensi* were assessed before and after the spraying. There was some degree of variation during the first and second weeks after the applications, but treatment of animal shelters and total coverage gave the best control against *A. stephensi*, despite the probable resistance of the latter to malathion. By week six, when observations stopped, all treatments were providing between 89.1 percent and 100 percent control of both species. No study was made of the impact on malaria transmission.

2. Report on the two-year, large-scale field test to compare Reldan and malathion. (Parvez, Rai and Abdul-Aziz of N-IMRT, Ahmed and Shah, MCP)

In 1989, a field assessment of two organophosphate insecticides, Reldan (Dow Chemicals, USA) at 1gm/m2 and malathion at 2gm/m2, was conducted in 24 localities of a highly malarious area of the Punjab. (Smaller-scale trials in 1988 also included an ICI pyrethroid, ICON or lambda cyhalothrin, but no data are presented in the report on the results of the 1988 trials and this compound was not tested in 1989). In the Reldan-sprayed, villages neither *A. culicifacies* nor *A. stephensi* were found for at least 80 days after spraying. In the malathion-treated villages, small numbers of *A. stephensi* continued to be found from 12 days after the treatments and *A. culicifacies* were first found 55 days after. Small numbers of both species were found in window traps and biting animals from within 12 days after the spraying in the malathion-treated villages, compared to virtually none in the Reldan-treated villages. The authors found that a low level of malaria transmission persisted in the malathion-treated villages while no indigenous cases were detected in the Reldan village during the four-month post-spray evaluation.

3. Role of *Anopheles stephensi* as malaria vector in a rural area of Pakistan. (Pervez and Shah, Pak. J. Hlth 26(1/2):73-84, 1989)

Pervez and Shah reviewed previous literature about the role of *A. stephensi* as a malaria vector in India and Pakistan and described a study they had conducted in three villages of Lahore district and two in Kasur district in 1987 and 1988 to determine the role of the *A. stephensi* as a vector. In 1987, 19 villages in Lahore district and 12 villages in Kasur were visited a total of 50 times. Parasitological surveys of fever cases and gland dissections of 2,473 *A. culicifacies* and *A. stephensi* were carried out in these areas where MCP reported little or no transmission. No sporozoites were found.

In 1988, surveys were conducted in the Sheikhupura district and both *P. falciparum* and *P. vivax* were noted. Dissections of the two species in the field and of specimens collected in the field and held for two to seven days in the laboratory showed 0.94 to 2.1 percent gland positives for *A. stephensi* and 1.3 to 2.24 percent gland positives for *A. culicifacies*. Based on these findings and on experimental studies, the authors concluded that *A. stephensi* played an important role in the transmission of *P. falciparum*.

4. Larvicidal effect of Neem tree, *Melia azadirachta* L. against *Anopheles culicifacies* and *Anopheles stephensi*. (Abdul Aziz)

A study comparing methods of extracting a larvicidal terpenoid from leaves and fruit of the Neem tree and proposing its use as a larvicide against anopheline mosquitoes.

5. Larvicidal effect of *Melia azerdarach* against *Anopheles culicifacies* and *Anopheles stephensi*. (Abdul Aziz)

Laboratory study similar to preceding paper.

6. Rapid staining for early diagnosis of malaria parasites. (Abdul Aziz, M. Tavvab, M. Khalid).

A study proposing a somewhat more rapid technique than the conventional one for staining blood smears taken to diagnose malaria.

7. *Punctius ticto*, Chidu fish for mosquito control. (Abdul-Aziz)

A laboratory and small field study of a local fish as a possible larvivorous fish for anopheline larval control.

8. Evaluation of mosquito repellent bar in the laboratory and field.

A trial of a permethrin-impregnated "soap" bar was conducted to ascertain its possible use as a repellent in preventing mosquito bites in Pakistan. Author concludes that while it does indeed repel, its effect is not long lasting.

Some of the more recent studies presented above and those said to be planned are the result of proposals developed with the assistance of Dr. W. K. Reisen at the USAID-sponsored project, Applied Field Research in Pakistan: "Workshop on Proposal and Protocol Preparation" (VBC Project report, AR-118-4, 1989) held at the NIMRT Lahore, October 21 to October 31, 1989.

Several of the studies listed above, particularly numbers 1 to 3, are of direct relevance to the Malaria Control Program of Pakistan, as were studies that the NIMRT had apparently carried out on some aspects of malaria epidemiology in the NWFP. Other studies or research at the Institute are of minor importance to the MCP and another on cockroaches, which is not listed, is of no relevance at all to malaria control. It was disappointing to find that there was only limited formal coordination between the MCP and the NIMRT in planning training courses and parasite susceptibility tests.

The Institute is clearly understaffed and many of the existing facilities and laboratory rooms are not in use. Dr. Shah stated that it was his intention to recruit further staff only after the Institute had moved into a new building. However, we understand that the negotiations for the purchase of land and construction of a new building have been of an unusually protracted nature, and it is unlikely that the Institute can move to new premises before December, 1992. In view of the heavy training schedule of the Institute and the urgent operational problems of the MCP that require investigation, it would be most unfortunate if additional professional staff were not hired and trained by the NIMRT in as expeditious a manner as possible.

7. Present and future training

The National Malaria Eradication Training Center (NMETC) was established in 1961 as a part of the countrywide Malaria Eradication Organization (MEO). Since then the training requirements of the project within the country have been fulfilled at this center. With the change from malaria eradication to malaria control methodology and the gradual administrative as well as functional integration of the Malaria Control Program (MCP) with the General Health Services (GHS) in the mid-seventies, the demand for training significantly increased. The MCP staff was required to be trained in other preventive techniques before completion of functional integration and the employees of GHS and other vertical programs were required to be trained in malaria control. Training of local staff in urban malaria was an additional responsibility.

Malaria control laboratories formerly functioning at the district level were decentralized and microscopists were posted at Rural Health Centers (RHCs). This step was taken to reduce the time lag between the collection of blood slides and the initiation of radical treatment of malaria cases and to increase the role of PCD, which had not contributed its expected share to surveillance operations. To attain the objectives of decentralization, all the laboratory technicians working at RHCs and other curative health institutions and the medical officers are required to receive training in malaria microscopy and malariology through condensed refresher courses.

As a first step, all the laboratory technicians working at RHCs in the Punjab were trained in malaria microscopy. The training was later extended to other provinces. For the training of GHS staff (laboratory technicians, medical officers), it was decided to train a team of trainers for each province. Second-level training has been arranged at the provincial and district level in accordance with the training needs of each category of workers.

Decentralized laboratories, PCD activities, voluntary collaborators, medical officers of BHUs/RHCs, monitoring of parasite and vector resistance to drugs and insecticides, control of urban malaria, safe use of insecticides and full functional integration can be successful only if all staff members involved in these activities are properly trained.

Adequate training of all staff is not feasible at the training center. There is an urgent need to reorganize the newly established NIMRT into professional categories by specialized subjects, which in turn

would be divided into branches according to function. Properly planned, pretested and accordingly revised curricula and other training materials need to be prepared in consultation with national and international experts and agencies. A few advanced, specialized courses in malariology, epidemiology, entomology, various operational methodologies, health education, drug sensitivity, statistical data analysis, computer applications and research methodology should be provided at the NIMRT. The other more routine courses for the staff and refresher courses can be managed at the respective provincial, divisional and district levels.

In addition to in-country training of various tiers of malaria control personnel, project training abroad in the fields of epidemiology, entomology, health education and training, and research is recommended.

a. Training abroad

The critical technical manpower shortage at the higher levels of the MCP and the urgent need for recruitment, training and retraining of key staff and personnel in the program's major disciplines appears to have resulted in inclusion of specific targets in the Project Paper, Amendment 2, for long- and short-term training abroad during the years 1987-88 to 1991-92.

Progress has been made in nominating and selecting candidates for training. Ten medical officers/scientists have recently been or soon will be receiving training abroad under this project. However, it is disappointing to note that the great majority of these scholarships have gone or may go to officers who will contribute very little to strengthening the technical capabilities of the MCP after completion of their studies abroad.

b. Training at the NIMRT in Lahore

After merging with the NIMRT, the National Malaria Training Center (NMTC) in Lahore continued its important task of providing basic and in-service training in malariology to MCP personnel and selected officers of the General Health Services. The courses conducted have continuously been adjusted to meet the changing needs of the program and incorporate technical developments and innovations. As a result, certain courses gradually disappear from the training curricula and new types of courses are introduced.

Courses Given at the National Malaria Training Center, 1985–1989

Year	Number of courses conducted	Number of successful participants
1985	11	256
1986	16	382
1987	15	331
1988	10	260
1989	9	194

In 1986, the NMTC hosted a WHO Regional Workshop for monitoring the *P. falciparum* response to antimalarial drugs, which was attended by 14 foreign participants. In 1989, the NIMRT organized a WHO Workshop on Environmental Management for Disease Vector Control in which 15 foreign and five national scientists participated.

c. Training at the provincial level

One of the courses concluded at the NIMRT in 1989 was the Master Trainers Course. Twenty officers/senior microscopists from all the provinces including Azad Kashmir participated to learn how to provide refresher training in malaria microscopy at the provincial level, mostly for general laboratory technicians. Five courses with 20 participants each are being planned annually. The first course is underway in NWFP with 17 students. The second course is being conducted in Punjab, where it is estimated that they could train 200 technicians a year. One course was conducted in the Sindh and Baluchistan, but these courses had very few participants.

8. Sustainability of the Malaria Control Program

a. GOP Involvement

For the fiscal years 1986-1989, the GOP provided approximately 33 million rupees to support the MCP's local costs. This represents an important financial commitment for the government. Foreign exchange funding, almost entirely from USAID, covered the costs of insecticides, vehicles, training, research support and technical consultants to the program. The financial inputs by the GOP and USAID and the manner in which they have been allocated were extensively analyzed in the Project Paper, Amendment 2, and need not be repeated here. Suffice it to say that it is the team's viewpoint that if the USAID foreign currency contribution were to cease in 1992, the MCP in its present form could not be sustained.

Without USAID support, the malaria control program almost certainly would continue in some form because the government clearly has a strong commitment to malaria control. If no other donor contributions were forthcoming, the efficiency of the program would, without question, be seriously compromised and the degree of control now being obtained would probably fall rapidly. The reservoir of malaria in the country and its malariogenic potential has not, as yet, been fundamentally altered, particularly with the disruptions brought about by the influx of Afghan refugees and disturbance in other countries. The country would either have to seek other donor support immediately or accept the loss of all the gains accomplished against malaria since the major outbreaks of the early and mid-1970s.

It is questionable whether such a passive course would be politically acceptable. The team is not in a position to predict to what extent the GOP would use its own foreign currency resources to purchase insecticides, application equipment and other supplies in order to sustain the program. The GOP would, no doubt, turn to other donors for support of at least some major portion of the costs of insecticides. Whether or not those insecticides were appropriate to the needs of the MCP would probably depend on which donor provided them.

b. Strategic Issues

It is the team's considered opinion that the extent to which the MCP has reduced its dependence on insecticides has probably reached its practical limit (if not fallen below it) at this time. As the passive case detection system becomes more efficient in detecting

significant transmission, further reductions in insecticide use will, no doubt, be possible. The team has been impressed that the GOP is expending a considerable effort to improve PCD. The benefits of this effort will increase as the efficiency of PCD increases. But however well-developed, PCD is not in itself an effective control measure and cannot replace the necessity for insecticidal, biological or other forms of vector control, especially in rice-growing areas and other geographical and ecological areas of the country where the malariogenic potentials remains high.

There are also technical limits to the extent that alternative methods can replace residual application of insecticides. Most of the larval habitats of the malaria vectors in rural Pakistan are simply not subject to environmental control, though there are notable exceptions. For example, there is the possibility of periodic drying of rice fields for one day a week, which may also have a beneficial effect on rice production. Rice fields, however, are not the only or even most important source of anopheline vector breeding. Other habitats, such as seepages from irrigation systems, pools that form in riverbeds after it rains and water collections in frequently water-logged areas, are far too numerous to be eliminated by man.

Biological control agents, whether fish or the recently developed bacterial toxins, can certainly contribute to the reduction of vector densities. Fish, however, would have to be constantly replenished and the bacterial toxins, however efficient they are as mosquito larvicides, have the same inherent limitation of all larvicides against species breeding in a large variety of natural habitats. Little impact on the adult mosquito vector population can be expected without expenditures in larvicides and manpower that would be uneconomical and certainly not feasible in many rural areas.

Other methods could contribute to the reduction of the parasite reservoir pool including, principally, more efficient, widespread distribution of chemotherapeutic agents. The ability to obtain and sustain such a level of distribution will depend on the level of development of the PCD system and the general health services into which the malaria program has been integrated. However, the continuing increase in parasite resistance to antimalarial agents may make over-dependence on this approach counterproductive by increasing the level of selection for such resistance.

The use of insecticide-impregnated curtains over doors and windows has also been proposed. If field trials show that these measures reduce biting rates in protected houses, they will at least help reduce the number of malaria attacks. Unfortunately, a good proportion of the population sleeps outdoors during much of the year. Because the

vectors readily feed outdoors as well as indoors, impregnated curtains might have little effect on transmission.

The long-term solution to malaria transmission in Pakistan rests, as it has in other countries, in the overall socio-economic development of the country and improvement of its health services. Pakistan has certainly made progress on both fronts, but it cannot be anticipated that adequate progress will be achieved by 1992. Cessation of insecticide applications or donor support for them at that time would carry a risk of grave epidemiological consequences.

If the USAID wishes to reduce or cease its support for the MCP by 1992, it would seem that, in fairness, A.I.D. should encourage GOP consultations with other donors at the earliest opportunity. This would facilitate a rationale transfer of support and provide time for the GOP to gradually increase the degree of its own contribution, particularly of foreign currency allocations for the purchase of commodities abroad. At the same time, it can be reasonably expected that continued improvement of the health services, particularly those associated with vector-borne disease control, will enable these services to increasingly reduce reliance on insecticidal control without the danger inherent in a sudden cessation of this type of control.

c. *Anopheles stephensi* as a malaria vector in Pakistan

Everywhere the team visited, the question of *Anopheles stephensi*'s role as a vector of malaria was raised. A review of the literature shows that this question has already been the subject of several investigations or literature reviews in Pakistan, India and elsewhere. However, the reports are often contradictory, and *An. stephensi*'s vectorial status in all provinces of Pakistan is still uncertain.

It must be emphasized that this question is not an academic one. It has major implications for vector control policies and the selection of insecticides. *A. stephensi* populations have developed a high degree of resistance to chlorinated hydrocarbons and, more recently, to malathion. The resistance status of this species has been covered in reports by Georghiou to USAID in 1986 and 1990. Broadly speaking, a high frequency of malathion-resistant *A. stephensi* has been found in several districts of Punjab province, as well as lower frequencies in the Sindh and NWFP.

At the same time, *A. culicifacies* continues to be susceptible to malathion. It has been concluded in a number of districts that since *A. culicifacies* is controlled by malathion applications, *A. stephensi*

must be responsible for continuing transmission of malaria. However, partial spraying of malathion in many localities and the continuing presence of exophilic, exophagic and partially zoophilic populations of both species throughout the country may account for continuing transmission. Therefore, it cannot yet be said that the precise role of *A. stephensi* as a vector has been determined.

In his second report (1990), Georghiou raises the question of whether the increased malaria incidence in 1989 in some localities can be associated with increases in vector populations (and, by implication, *A. stephensi* populations). He points out that this question can be answered only by obtaining good epidemiological and entomological data from sprayed and unsprayed areas. He also believes that though the vectorial capacity of *A. stephensi* may be low, localized high population densities may enhance its ability to transmit malaria. This possibility seems more likely in the NWFP than in the Punjab. It is our belief that the epidemiological and entomological data required to investigate these hypotheses have not as yet been assembled for most of the areas involved.

It has been reported that there are probably two forms, subspecies or races of this species, *A. stephensi* and *A. stephensi mysorenis*. The former is said to be the more efficient vector in many areas. It is surprising that an issue of such importance to the control of malaria transmission in Pakistan has not been addressed in greater depth. The only recent study on this question in Pakistan was conducted by Pervez and Shah, 1989. However, this study needs to be repeated in other areas and backed up by genetic studies.

9. Management and Finance

a. The Directorate of Malaria Control

The DMOC is a division within the federal Ministry of Health, Special Education and Social Welfare. The Director of the DMOC is responsible for program policy, supervision, supplies, evaluation, donor coordination and program planning. The DOMC prepares long-range plans, including the PC-1 (Plan of Operations), which is the GOP document required to fund and implement the activities of the program. The DOMC also reviews the provinces' annual plans for program activities. The National Institute of Malaria Research and Training (NIMRT) is within this Ministry but is not part of the DMOC organization.

To ensure policy and operational coordination between the federal level DOMC and the provincial malaria/CDC control programs, the Federal Secretary of Health established a Malaria Control Coordination Committee in January 1988 under the chairmanship of the Director General of Health. This Coordination Committee is scheduled to meet twice a year, but only met once in 1989 (in December) and once in 1988. In addition, interprovincial coordination meetings are held regularly to review and plan overall malaria control strategy and operations.

On January 31, 1990, the Regional Inspector General for A.I.D finalized a report of an audit made on the Malaria Control II Project in Pakistan (Audit report #5-391-90-05). The report recommended "that (1) USAID/Pakistan should develop better quantifiable indicators and reporting systems to measure project papers; and (2) A.I.D. funds may be more effectively spent on insecticides if needed research and monitoring determine that mosquitos that spread malaria have developed a resistance to the insecticides used." The team interprets this to mean that A.I.D. funds are being used to purchase an insecticide -- malathion -- whose effectiveness in Pakistan is unproven. We support these audit recommendations for important program management improvements. We have addressed these issues in more detail in this report.

b. Personnel

The staff lists at federal and provincial levels indicate that there are few vacancies in authorized staff positions, but there are important senior level positions not filled by permanent appointments. The

most important of these is the position of the Director of the DMOC. The Acting Director has served for several years and has double duties: those of the Directorate and those of senior program entomologist. This should be corrected because the present workload is too great for one individual. There is also a vacancy for a medical officer at the DMOC, which should be filled in order to expedite programs in PCD and epidemiology.

The staffing in the provinces and districts is mostly up to authorized strength and the vacancy rates are well below five percent. As expected, the majority of the vacancies are at the malaria/CDC supervisory levels. For example, the Punjab has 10 vacancies for CDC officers and five for entomologists at the district level.

c. Transport

The team studied the transport situation in the provinces and determined that there were a large number of vehicles in need of repair. For example, in NWFP there are a total of 58 vehicles, of which 38 are out of service. Although most of these vehicles could be repaired, many are old and get poor mileage, which makes them very expensive to operate. There are a number of vehicles that need to be retired and removed from the inventory. Details are provided in the benchmark section. A.I.D. recently supplied a number of vehicles, including 62 Suzuki PUs, 29 Suzuki Jeeps and one Land Cruiser to the DOMC, as well as vehicles for the corporations (9) and the NIMRT (1).

d. Finance

The GOP is putting considerable resources into the MCP. The Director of Malaria Control reported that the development budget for the 1987-88 to 1992-93 period was authorized at an estimated 923 million rupees, of which 787 million are estimated for foreign exchange and 136 million rupees are for local cost, as approved in the PC-1. The national non-development DOMC budget is approximately 1 million Rs. per year. The provincial funding of the MCP shows an increase in budget support.

National DOMC Expenditures, FY 85–FY89*

Expenditures: (Allocations)	FY 85/86	FY 86/87	FY 87/88	FY 88/89	FY 89/90
1. National Directorate of Malaria Control (DMOC) Development Budget for Local Expenditures (million Rs.)	9.766	7.76	4.96	10.586	13.00
2. Non-Development	761,823	1,032,000	1,087,000	1,241,000	
3. NIMRT Allocations	866,000	2,483,000	2,855,000	2,116,000	

*Data from DOMC

Table 18
Provincial Funding of the MCP, F 86–FY89

Province	1986/87	1987/88	1988/89
Baluchistan	7,140,645	7,526,405	8,379,490
Sindh	17,492,910	21,491,890	22,517,160
Punjab	45,780,000	48,060,000	50,460,000
	(These budgets are mixed with the GHS budgets and are not available specifically for malaria)		
NWFP	NA	19,323,460	22,000,320

1. Foreign exchange

The non-development and development budgets at the federal and province levels show a general rise in expenditures, but these funds do not cover foreign exchange costs. The team believes that foreign exchange costs should be phased into the GOP budget support mechanism and the GOP should not rely entirely on foreign donors to meet these costs.

e. Reporting

The federal and provincial levels provide an annual report each year. The data presented in these reports cover operations, management and epidemiological surveillance. They represent important benchmarks in the program. The detailed data for localities usually can be found only at district level, which makes review of target spray areas difficult at higher levels, where operational decisions are made. Improved reporting and epidemiological review could be obtained by adding computers at the district level.

The team found a number of errors in the reports, which resulted in a variance of statistical presentations. There should be more scrutiny of reports before they are submitted to the next level of authority. The addition of inexpensive, hand-held, solar-powered calculators for support staff has been of great assistance in improving the quality of the data in other areas of the world.

In November-December 1989, a consultant group reviewed the reporting mechanisms between USAID/Islamabad and the GOP for monitoring the malaria control project's progress. The team recommended improved project indicators that will be incorporated into the Mission's management information system (MIS) in FY 1990.

10. Status of Project Implementation

The overall goal of the project is to reduce morbidity and mortality from endemic diseases, especially malaria, through establishment of a responsive, efficient and effective nationwide health delivery system.

The more specific purposes of the project are to help the Government of Pakistan contain and further reduce the incidence of malaria in the country, maintaining malaria incidence at a level that does not constitute a major public health problem. The project extension is designed to assist the GOP in developing self-reliance in malaria control through 1) strengthening the general health services and treatment of cases; 2) various measures to reduce reliance on expensive insecticides; 3) strengthening the capacity for operational research; and (4) training a cadre of technical personnel to sustain the control program.

a. Specific objectives

The specific objectives of the project and the summary finding of the External Review Team are as follows:

a. Maintain an Annual Parasite Incidence (API) at or below 0.5 cases per 1000 population.

a(1).The countrywide API for the period 1985-1989:

1985	1.25
1986	1.43
1987	0.98
1988	0.87
1989	1.49

a(2). 1.(b). The API by Province is:

	1987	1988	1989
Punjab	0.64	0.51	0.79
Sindh	1.69	1.06	3.74
NWFP	1.86	1.75	2.03
Baluch.	0.28	0.85	0.63

a(3). Summary: The Baluchistan and Punjab Provinces have generally maintained adequate level of control but Sindh Province shows an increase. The national API has not been maintained at the 0.5 API target.

b. Contain the infections of *P. falciparum* to less than 20 percent of all cases.

b(1). The falciparum percentage by province is as follows:

	Punjab	Sindh	NWFP	Baluch.
1985	37	59	19	66
1986	32	61	14	49
1987	28	51	28	58
1988	28	55	25	80
1989	36	77	32	42

b(2). 2(a) The program has not contained *P. falciparum* to less than 20 percent of all cases. The Sindh Province has shown a major rise in cases which in part may be attributed to better PCD at health institutions.

c. Improve the malaria surveillance system by increasing the proportion and number of the blood smears collected through Passive Care Detection (PCD) to up to 70 percent of the total number of slides collected for malaria detection.

c(1). The percent of PCD slides collected in national program were:

1985	13%
1986	16%
1987	19%
1988	18%
1989	22%

c(2). Percent of PCD slides out of total collected for:

	Punjab	Sindh	NWFP	Baluch.
1985	8.53	24.88	19.17	32.67
1986	11.02	24.91	26.98	33.70
1987	12.16	28.62	32.97	35.35
1988	11.04	29.49	31.81	21.56
1989	14.55	48.05	25.11	11.32

c(3). Summary: PCD institutions have improved the collection of blood slides, but the target of 70 percent by 1992 is clearly unobtainable at the present rate of surveillance development.

d. Reduce household spraying to less than 20 percent of all houses of the country by determining foci for spraying on a sound epidemiological basis; attainment of 95 percent or more spray coverage of houses targeted.

d(1). The percent of total houses covered by province is:

	Punjab	Sindh	NWFP	Baluch.
1986	35	26	23	11
1987	28	27	20	8
1988	21	20	16	6
1989	10	12	20	5

The target has been met by the provincial MCPs.

d(2) 4(a) The percent coverage of target houses is:

	Punjab	Sindh	NWFP	Baluch.
1985	94	89	87	88
1986	92	85	77	63
1987	91	89	82	56
1988	92	72	91	65
1989	92	71	98	59

d(3) In general, the reported spray coverage has been less than 95 percent, with the Punjab meeting the FY 88/89 target of 92 percent.

e. Initiate and assist operational research (OR) at the National Institute of Malaria Research and Training (NIMRT), targeting operational problems identified by the DOMC and or provincial programs.

e. NIMRT is conducting several research projects, such as determining effective, economical spraying regimens in the field, biological control and larviciding. *A. stephensi's* role in malaria transmission is a priority issue.

f. Support the proposed network of village health auxiliaries and voluntary village health workers to more than double the number of PCD posts.

f. The Voluntary Collaborator (VC) activity is in the pilot project stage in Punjab Province in the Districts of Sheikhupura and Kasur. Five sub-sectors in each district have been selected and the work is in progress. The VC target is obtainable, but will be difficult to meet by 1992.

3. Target Outputs:

Specific target outputs were identified for the project for the period 1987/88 - 1991/92. The targets for FY 1987/88 and FY 1988/89 and the achievement is as follows:

a. Administration:

	FY 87/88		FY 88/89	
	Target	**Achieved**	**Target**	**Achieved**
Staff Vacancies	5%	Less than 5	5%	Less than 5
Provinces	5%	Less than 5	5%	Less than 5

*HDQS lacks one Medical Officer and Director.

b. Program Planning:

Annual Plan of Actions	Achieved	Achieved
Annual Plan and Schedule per insecticide safety training and testing	Achieved	Achieved

c. Transport:

Target for total fleet out of service is less than 10 percent.

	Total	Out of service	%
NHDQS	8	5	60
Punjab	*	*	*
Sindh	84	42	50
NWFP	58	38	95
Baluch.	32	10	30

* Vehicles mixed with GHS and not easily identified.

This target has not been achieved and there is little likelihood that it will be by 1992.

d. Training:

		Target		Achieve	
		1988	1989	1988	1989
1.	Long-term	1	3	2	5
2.	Short-term	6	29	11	9
3.	NIMRT	200	200	240	194
4.	Provincial	200	400	NA	NA

e. Spray Operation:

	FY 87/88	FY88/89
% of houses targeted	20%	20%
% of houses selected	approx. 15%	approx. 13%
% of targeted houses sprayed	90%	92%
% of targeted actually covered	was achieved in the Punjab and Sindh	

f. Surveillance:

	FY 87/88		FY 88/89	
	Target	Achieve	Target	Achieve
1. Passive case detection produces % of total of country's slides	20%	18%	29%	22%
2. Average turn-around time from taking slides to treatment	14 days	not uniform average may be from 3-30 days	12 days	not uniform same as FY 87/88
3. Laboratory services with less than 1% error rate in cross-checking	1%	yes	1%	yes

g. Evaluation:

	Target	Achieved	Target	Achieved
Annual program-wide evaluation (external review)	1	1	1	0

The project was designed to include one long-term contract malaria advisor. An advisor (Dr. William Chin) was contracted for a five-year period and left in January of 1988. USAID/Pakistan has not recruited a replacement. If a long-term advisor cannot be identified, it is suggested that a number of short-term consultants be identified and contracted for multiple visits over the life of project to assist DOMC with specific tasks in operations, epidemiology, entomology parasitology and field research.

In summary, the output indicators detailed in the Project Paper are generally being met, but there are shortfalls, particularly in the development of PCD in some areas. Spray operations were generally in accordance with the targets of the project and sound epidemiological methods were being used to select spray areas. There were shortfalls in transportation and making U.S. technical assistance available to the project.

As mentioned elsewhere, it is the team's considered opinion that with the specific target output indicators provided in the Project Paper for spray operations, limiting houses sprayed to 20 percent and 18 percent in future years may go beyond the level at which the current degree of malaria control can be preserved. It is thought that the exceptionally dry weather during the years 1987 and 1988 helped prevent a serious resurgence of malaria, but the 1989 figures clearly indicate that the number of malaria cases in all provinces is increasing. It should be noted that the increase is largely due to increased levels of falciparum malaria, which may be due to increased resistance to chloroquine.

Therefore, it is suggested that the current criteria for the introduction of indoor spraying be modified and that insecticide be sprayed in any locality where a case of *P. falciparum* has been transmitted.

The proportion of total slides to be collected through PCD appears to be acceptable and has more or less been achieved by the program. The target figures given for subsequent years are, however, quite unrealistic. They will not and cannot be reached by the program, and a readjustment of the target figures is required.

11. Recommendations

1. Malaria surveillance and data management

The level of malaria surveillance is being maintained well. However, since the reporting base is being changed from ACD to PCD, new methods of managing data must be introduced to avoid errors, facilitate analysis and increase the relevance of decisions. We recommend that data collection be automated at the district and provincial level in a pilot project using several districts in either Punjab or NWFP, with expansion of the system if it proves valuable.

We also recommend that the plan to train a microscopist for each BHU, which we believe is impractical and unnecessary, be reviewed and revised. (Joint action by MCP, USAID AND VBC.)

2. Chloroquine-resistant falciparum malaria

There is need for more complete, careful treatment of detected malaria cases. For this we have two recommendations. First, the distribution of antimalarial drugs, particularly to outpatient clinics, should be improved so that all suspected cases can be treated when they seek help. The MCP and the GHS must cooperate to achieve this objective. (Joint action by MCP and GHS.)

Second, we recommend that mefloquine be used at the dosages recommended in the body of this report for radical treatment of apparent drug-resistant falciparum malaria. Mefloquine may have to be provided by A.I.D. (MCP to initiate action with support from GHS and USAID.)

3. Use of insecticides

We believe that the use of residual insecticide has decreased below the level necessary to contain malaria. We therefore recommend that the criteria used in 1988 be reinstituted immediately. It is also imperative that every effort be made to fully spray each and every targeted house and that an amount of insecticide equal to 20 percent of the annual requirement be held in reserve for emergency use. (MCP action, support from USAID.)

4. Insecticide resistance

The effectiveness of malathion in Pakistan remains somewhat unclear. Resistance tests show that it continues to be effective against *A. culicifacies* but, in many locations, not very effective against *A. stephensi*. However, the question of *A. stephensi's* importance as a vector of malaria in Pakistan is still largely unresolved. Without more information, any change in the insecticide used must depend on epidemiological evidence of disease prevalence, ideally data derived from localities known to have been well-treated with malathion. However, such data are available only in the 81 districts, not at the province or federal level. Therefore, we collected district data on malaria cases from the provincial offices.

After reviewing the district data on current prevalence of the disease, we have concluded that there is no justification for replacing malathion with fenitrothion in the Punjab province, which has the most convincing mosquito-resistant data. However, because of the high levels of malaria in some NWFP districts and accumulated scientific opinion that *A. stephensi* is an important vector of malaria there, we recommend that fenitrothion replace malathion in selected localities of NWFP, provided effective disease and vector surveillance programs can be implemented to monitor its effect.

Because of the vital need for entomologic monitoring of vectors, the research on the vectorial capacity of *A. stephensi*, and density studies designed to measure the effect of particular insecticide applications and other control measures, we also recommend an immediate reorganization and strengthening of entomologic activities (also see 5.a, p. 27). A senior entomologist must be appointed to assist the DMOC Director, who now is also responsible for entomologic services. The senior entomologist should be responsible for planning, organizing and coordinating entomological surveillance with provincial and district entomologists. (MCP action, with support by USAID or other donors.)

5. Environmental objectives

Although carefully developed standard procedures for handling and applying insecticides are in use in the MCP, we recommend intensified effort to completely train all spraymen and applicators. A qualified environmental monitor should be appointed to oversee spray operations when they are underway. (MCP responsible with support from USAID.)

6. Operational research

We were disappointed with the lack of progress on research topics that have been identified and emphasized as critical for so many years and in so many previous external reviews. The malaria control strategy defined in the A.I.D. Project Paper and the GOP PC-I Form places enormous responsibilities on the NIMRT -- apparently more responsibilities than it can meet.

We recommend that USAID/Islamabad appoint a consultant capable of working with the NIMRT for an extended period to aid the staff in implementing all possible important operational research and report on the measures necessary to strengthen the institution. (USAID to request action by VBC; GHS responsible for promoting improvements.)

7. Training needs

The major training need is to identify and prepare for leadership the next generation of senior MCP staff. Of these two tasks, identification is the more difficult. We recommend that only those who appear in every way to be future leaders in malaria control in Pakistan be selected for overseas training and that these individuals be given extensive training in both academic and operational programs. (GHS, MCP, WHO and USAID all responsible.)

Because students sent to the NIMRT for in-service training are sometimes not paid allowances, it is recommended that all provincial and district officials be held accountable for supporting staff training. It is particularly important that courses on monitoring drug resistance be well attended by participants from areas where *P. falciparum* is a serious problem. (GHS responsibility with help from NIMRT, MCP).

8. Sustainability

We are forced to conclude that the MCP is not prepared to go it alone. The strategy of reducing insecticide use and dependency in favor of alternative control measures is sound in every way but it's current timetable. We are convinced that donor support will be necessary beyond 1992 if this dependency is to be cured in an orderly manner without a suspension in operations. We recommend that the GOP discuss the needs of the program with current and prospective donors so that this well-conceived and diligent effort can continue until success is more assured. (GOP responsible with assistance from USAID.)

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2. An Analysis of Insecticide Resistance in Malaria Vector Mosquitoes in Pakistan and Recommendations for Future Action. George Georghiou. January 19, 1990.

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5. Punjab Task Allocation Study PRICOR/Pakistan. September 19, 1989.

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11. Government of Pakistan Planning Commission Proforma for Development Project, Malaria Control Project Pakistan for 1982-83 to 1986-87 Under an Extension of Ongoing Malaria Control by the Directorate of Malaria Control, MOH, Special Education & Social Welfare, Government of Pakistan. Revised: June, 1987.

12. Report of the Terminal Evaluation of the Pakistan Malaria Control Project (391-0472) April 4, 1987 - May 3, 1987.

13. Report of the External Review of the Pakistan Malaria Control Programme. October 6-24, 1985.

Annex 2. People Interviewed

March 4 - 26, 1990

USAID/Islamabad

Mr. James Norris, Director
Dr. Anne Aarnes, Chief, Office of Health, Population and Nutrition
Dr. Rifaq A. Ismail, Project Officer
Mr. Wally Alberton, Environmental Officer
Mr. M. Yawar, Program Assistant
Ms. L. Mailloux, Project Committee
Mr. M. Ashraf, " "
Ms. J. S. Ruan, " "
Mr. I. A. Khan, " "
Mr. B. Qadir, " "
Mr. M. Ilyas, " "
Mr. H. Aquil, " "

Directorate of Malaria Control, Islamabad

Chaudhary A. A. Mujahid, Director
Dr. G. Hashim, Epidemiologist
Mr. M. Noor Alam, Statistical Officer

UNHCR, Islamabad

Dr. Richard Nesbit, Senior Health Coordinator

Punjab Secretariat, Lahore

Mr. Mohammad Ashraf Chaudhary, Health Secretary
Dr. Mohammad Aslam Malik, Addl. Secretary Health

Health Directorate, Lahore

Dr. Mazahar Ali Hashmi, Director General Health
Dr. Farrukh Hussain Trimzi, Director Health Services (CDC)
Dr. Mahmood Afzal, Assistant Director (Malaria)
Mr. Javed Iqbal Malik, Assistant Entomologist
Mr. Mukhtar Ahmed Shah, Parasitologist
Mr. M. A. Ashraf, CDC Officer
Mr. Mohammad Azam, CDC Officer
Mr. Matin ul Haq Khan, CDC Officer
Mr. Sana A. K. Mahmood, CDC Officer

Lahore Municipal Corporation

Dr. M. Hanif Sheikh, Chief Medical Officer
Dr. Assad ur Rehman Khan, Medical Officer (Malaria)
Dr. M. Aslam Khan, Advisor in Malaria

Diagnostic Centre, Samanabad

Dr. Mrs. Nasim Salim, Senior Medical Officer
Mr. Mohammad Iqbal, Laboratory Technician

NIMRT, Lahore

Dr. Imtiaz Hussain Shah, Director
Mr. S. D. Pervez, Entomologist
Mrs. Ghazala Nadeem, Entomologist

DHO Office, Kasur

Dr. Masood Akhtar, District Health Officer
Dr. Ashfaq Ahmed, Assistant District Health Officer
Mr. Mushtaq Ahmed Mian, Administrative Officer
Mr. S. Iftikhar Hussain, Assistant Entomologist
Mr. Farhat Mahmood, CDC Officer

BHU, Rao Khan Wala (Kasur)

Dr. Tahir Amjad Saleem, Medical Officer
Mr. Mohammad Asghar, Dispenser
Mr. Shafqat Ali, Sanitary Inspector
Mrs. Kubra Khanum, Lady Health Visitor

Village Kot Hakeem Khan (Kasur)

Mr. Mohammad Ali (Retd. Teacher), Voluntary Collaborator

BHU, Ram Thama

Dr. Shahid Fayyaz Ali, Medical Officer
Mrs. Rifat Sultana, Lady Health Visitor

Village Malloke

Mr. Abdul Hafeez, Voluntary Collaborator
Mr. Abdul Majeed, Voluntary Collaborator, (Assistant)

Village Shaikhum

Mr. Farmaish Baig, CDC Supervisor
Mr. Mohammad Suleman, Vaccinator (EPI)

Multan District

Dr. Altaf Hussain Gardezi, District Health Officer
Mr. Hafiz A. Qadir, CDC Officer

RHC, Dunyapur

Dr. Mohammad Ilyas Anjum, Medical Officer

Muzaffar Garh District

Dr. Abdul Ghafoor Rana, District Health Officer
Rana Mohammed Salim, Assistant Entomologist
Syed Chiragh ul Hassan, CDC Officer

Bahawalpur District (Punjab)

Mr. Aziz Muhammad Khan, Assistant Entomologist
Mr. Sami Ullah, CDC Officer
Chaudhary Abdul Ghafoor, Senior Microscopist

BHU, Khanowali

Mrs. Naeema Bibi, Assistant Technician

RHC, Khangah Sharif

Dr. Syed Tasneem Mahmood, Medical Officer
Dr. Habid Ahmed Khan, Medical Officer

Village Gharib Abid

Mr. Aslam Saleh, CDC Supervisor

Tehsil Hospital, Ahmadpur East

Mr. Talib Hussain, Microscopist
Mr. Mukhtar Ahmed, Laboratory Assistant

Khaniwal District

Dr. Syed Zia ud Din Zaidi, District Health Officer
Mr. Mohammad Sarwar, Assistant Entomologist
Rana Abdul Rashid, CDC Officer
Mr. Mohammad Rafique, Senior Microscopist

Civil Hospital, Jahanian

Dr. Abdul Khaliq, Medical Officer

Sahiwal District

Dr. Khurshid Ahmad Khan, District Health Officer
Mr. Mohammad Ashraf, Assistant Entomologist

Tehsil Hospital, Sahiwal

Mr. Baddar Gill, Laboratory Assistant

N.W.F.P. Province

Health Secretariat

Dr. Tariq A. Nishtar, Secretary Health.
Dr. Sardar Ali Khan, Director Health Services

Malaria Control Program, Peshawar

Dr. Mohammad Iqbal, Assistant Director (Malaria)
Mr. Fazle Raziq, Entomologist
Mr. Shaukat Parvez, Assistant Entomologist
Mr. Khurshid Ali Nasir, Assistant Entomologist (Urban)
Mr. Abdul Aziz Khan, Malaria Superintendent
Mr. Waris Khan Afridi, Health Education Officer

Khazana Afghan Refugee Camp

Dr. Fazale Rabb, Medical Officer
Mr. Nazaar Mohammad, Dispenser
Mr. Abdul Ghayyas, Malaria Supervisor

Peshawar District

Dr. Mohamaad Yaqub, District Health Officer
Dr. Sher Bahadur Khan, CDC Officer.
Mr. Abdul Rahim Khan, Assistant Entomologist
Mr. Qibad Mohammad Khan, Administrative Officer

Rural Health Centre, Nahaq

Dr. Ali Gaohar Khan, Medical Officer
Mr. Razi Gul, Assistant Malaria Superintendent
Mr. Siraj ul Haq, Microscopist

BHU, Gulbela

Mr. Riaz Ahmed, Microscopist
Mr. Ghulam Sarwar, Malaria Supervisor
Mr. Riyaz Ahmad, Medical Technician

Baluchistan

Civil Dispensary, Kuchlak

Dr. Fazal Mahmood, Medical Officer
Dr. Mrs. Shahida Mohammad Nawaz, Lady Medical Officer
Mr. Abdul Qayyum, Vaccinator (EPI)
Mr. Abdul Bari, Vaccinator (EPI)

Malaria Staff

Mr. Shabbir Haider, Assistant Malaria Superintendent
Mr. Abdul Mannan, Medical Superintendent

BHU, Bostan

Dr. Iftikhar ul Haq, Medical Officer
Mr. Abdul Ghani, Rural Health Inspector
Mrs. Mumtaz Athar, Lady Health Visitor
Mr. Asmatullah, Assistant Medical Superintendent
Mr. Abdul Wahid, Malaria Supervisor

District Headquarters Hospital, Pishin

Mr. Fazal Karim, Medical Superintendent
Mr. Naseer Ahmed, Assistant Medical Superintendent
Mr. Lal Mohammad, Malaria Supervisor
Mr. Mohammad Yousaf, Microscopist

DHO Office, Pishin

Dr. Capt. Imtiaz Ahmed, District Health Officer
Dr. Mohammad Ashraf, Assistant District Health Officer

Baluchistan Secretariat, Quetta

Dr. Mohammad Akbar Khan, Health Secretary
Dr. Mohammad Iqbal, Director

Malaria Provincial Headquarters, Quetta

Dr. Fazal ur Rehman, Deputy Director CDC
Dr. M. Mahmood Piracha, Epidemiologist
Mr. Abdul Sattar, Senior Malaria Superintendent
Mr. M. Sadiq, Malaria Superintendent
Mr. Ali Ahmed, Entomologist
Hafiz M. Mahmood Akhtar, Assistant Entomologist
Mr. Noorullah Khan, Health Education Officer

Sindh

Sindh Secretariat, Karachi

Syed Saeed Hussain, Health Secretary
Dr. Sajjan Memon, Director Development & Planning Health

DHO/DD Office

Dr. Abdul Razzaq Bugti, Deputy Director Health
Dr. Uhmer Baluch, District Health Officer
Dr. Nazir A. Kulachi, Assistant District Health Officer
Mr. Asad Ullah Khan, Non-Medical Evaluator
Mr. Naveed Ahmed Hashmi, Assistant Entomologist
Mr. M. Khalid Siddiqi, Malaria Superintendent

Malaria Provincial Headquarters, Hyderabad

Dr. Ghulam Rasool Sheikh, Provincial Chief
Mr. Sumar Sadruddin, Epidemiologist
Mr. Abdul Majid Khan, Senior Malaria Superintendent
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Mr. Austin Bhatti, Malaria Supervisor
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Karachi Metropolitan Corporation

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Mr. Altaf Hussain, Entomologist

Shaheed Rafiq Hospital

Dr. Arif Jamil, Pathologist
Mr. Saleem Raza, Laboratory Technician
Mr. Ansar Haidar Malik, Laboratory Technician

Mianwali Colony

Mr. Niazi, Councilor

Annex 3

National, Provincial and District Data

Table 1

Malaria in Pakistan: 1975–1989

Year	Population	Slides Examined	Slides Positive	SPR	API
1975	48,395,324	3,205,689	238,315	7.44	4.92
1976	49,789,303	2,857,854	122,219	4.28	2.45
1977	51,279,670	2,667,315	47,571	1.78	0.93
1978	52,737,019	2,588,257	16,160	0.62	0.31
1979	53,929,411	2,682,351	12,304	0.46	0.23
1980	55,103,689	3,006,264	17,704	0.59	0.32
1981	56,934,577	2,523,426	13,629	0.54	0.24
1982	58,067,409	3,303,067	56,360	1.71	0.97
1983	58,468,028	2,587,920	51,596	1.99	0.88
1984	60,746,320	3,255,853	73,996	2.27	1.22
1985	62,133,283	3,119,695	77,607	2.49	1.25
1986	63,997,281	2,919,894	91,289	3.13	1.43
1987	65,757,289	2,961,881	64,271	2.17	0.98
1988	67,894,715	2,960,786	59,386	2.01	0.87
1989	69,931,557	3,098,759	104,447	3.37	1.49

Table 2

Annual Parasite Incidence for Pakistan Provinces: 1980–1989

Year	Punjab	Sindh	NWFP	Baluchistan
1980	0.25	0.40	0.42	0.24
1981	0.45	0.54	1.16	0.21
1982	0.51	0.36	1.73	0.18
1983	0.58	0.57	0.58	0.26
1984	1.37	0.98	0.68	0.34
1985	1.43	1.43	1.75	0.41
1986	1.29	1.68	2.72	0.28
1987	0.64	1.69	1.86	0.28
1988	0.51	1.06	1.75	0.85
1989	0.79	3.74	2.03	0.63
Mean	0.78	1.24	1.47	0.37

Table 3

Methods of Case Detection: 1985–1989, Pakistan

	Source and Number of Slides				
Year	ACD	PCD	Other	Total	Percent PCD
1985	2,359,739	404,737	355,219	3,119,695	12.97
1986	2,109,845	478,942	331,107	2,919,894	16.40
1987	2,184,867	555,711	221,303	2,961,881	18.76
1988	2,188,313	528,052	244,421	2,960,786	17.84
1989	1,960,969	691,426	446,364	3,098,757	22.31

Table 4

Number of Cases Detected: 1985–1989, Pakistan

	Source of Positive Slides					
Year	ACD	PCD	Other	Total	Percent PCD	Percent PCD+
1985	37,322	26,598	13,687	77,607	34.27%	6.57
1986	40,912	38,833	11,544	91,289	42.54%	8.11
1987	28,469	28,274	7,528	64,271	43.99%	5.09
1988	22,524	30,422	6,440	59,386	51.23%	5.76
1989	28,600	62,404	13,443	104,447	59.75%	9.03

Table 5

Falciparum Cases Detected: 1985–1989, Pakistan

	Number of Cases			
Year	vivax	falciparum	Total	Percent falciparum
1985	48,556	29,051	77,607	37.43
1986	61,685	29,604	91,289	32.43
1987	41,650	22,621	64,271	35.20
1988	37,407	21,979	59,386	37.01
1989	49,437	55,010	104,447	52.67

Table 6

Provincial PCD Efforts: 1989

Province	Slides Taken	PCD	PCD+	Percent PCD	Percent PCD+
Punjab	1,877,589	273,240	13,385	14.55	4.90
Sindh	511,771	245,925	30,881	48.05	12.56
NWFP	666,763	167,436	17,609	25.11	10.52
Baluchistan	42,636	4,825	529	11.32	10.96
TOTALS	**3,098,759**	**691,426**	**62,404**	**22.31**	**9.02**

Table 7

Provincial Malaria Cases: 1989

Province	Slides Taken	Slides Positive	vivax	falciparum	Percent falciparum	SPR
Punjab	1,877,589	33,584	21,388	12,196	36.32	1.79
Sindh	511,771	44,168	10,123	34,045	77.08	8.63
NWFP	666,763	24,279	16,524	7,755	31.94	3.64
Baluchistan	42,636	2,416	1,402	1,014	41.97	5.67
TOTALS	**3,098,759**	**104,447**	**49,437**	**55,010**	**52.67**	**3.37**

Table 8

District Malaria Cases: 1989

Province	District	Population	Slides and Results Taken	Positive	SPR	ABER	API	% Houses Sprayed
NWFP	Mohmand Ag.	71,771	3,345	1,462	43.71	4.66	20.37	13.7
NWFP	Bajaur Ag.	81,755	7,743	455	5.88	24.38	14.33	4.0
Sindh	Khairpur	996,665	78,377	13,785	17.59	7.87	13.86	NA
Sindh	Dadu	923,185	66,090	10,872	16.45	7.16	11.78	NA
NWFP	Chitral	88,669	6,490	719	11.08	7.24	8.02	8.2
Sindh	Shikarpur	445,679	23,044	2,839	12.32	5.17	6.37	NA
NWFP	Malakand	303,854	12,603	1,411	11.20	4.15	4.64	27.7
NWFP	Swat	914,142	36,489	4,106	11.25	3.99	4.49	30.8
NWFP	S. Wazi	317,945	39,440	1,309	3.32	12.40	4.12	13.1
Punjab	Muzaffargarh	1,764,245	104,977	7,158	6.82	5.95	4.06	7.0
Baluch.	Gwader	106,636	5,831	426	7.31	5.47	3.99	NA
Baluch.	Loralai	236,562	13,043	847	6.49	5.51	3.58	NA
Sindh	Larkana	1,193,844	29,509	4,219	14.30	2.47	3.53	NA
Sindh	Tharparkar	1,282,360	66,878	4,276	6.39	5.22	3.33	NA
NWFP	Karrak	330,535	25,905	1,048	4.05	7.84	3.17	8.2
NWFP	Bannu	656,146	34,794	2,031	5.84	5.30	3.10	11.9
NWFP	D.I. Khan	668,209	52,541	1,996	3.80	7.86	2.99	16.6
Sindh	Jacobabad	794,106	34,349	2,225	6.48	4.33	2.80	NA
Baluch.	Quetta	355,711	9,985	878	8.79	2.81	2.47	NA
NWFP	Khyber Ag.	307,819	7,300	748	10.25	2.37	2.43	15.0
NWFP	Marden	1,629,956	71,777	3,693	5.15	4.40	2.27	32.4
Sindh	Hyderabad	843,408	44,421	1,757	3.96	5.27	2.08	NA
Punjab	D.G. Khan	889,451	57,038	1,848	3.24	6.41	2.08	21.7
Baluch.	Jafferabad	208,821	6,721	427	6.35	3.22	2.04	NA
Sindh	Karachi	205,884	45,533	391	0.86	22.12	1.90	NA
Sindh	Thatta	756,116	44,122	1,400	3.17	5.84	1.85	NA
Punjab	Sheikhupura	1,955,956	69,174	3,617	5.23	3.54	1.85	11.3
Punjab	Sargodha	1,671,778	86,702	2,968	3.42	5.19	1.78	11.6
Sindh	Sukkur	894,345	30,151	1,499	4.97	3.37	1.68	NA
Sindh	Sanghar	664,065	34,076	1,111	3.26	5.13	1.67	NA
NWFP	Peshawar	2,149,608	48,936	3,358	6.86	2.28	1.56	46.1
NWFP	Dir	513,740	10,940	780	7.13	2.13	1.52	25.9
NWFP	Kohat	613,152	46,313	888	1.92	7.55	1.45	15.4
Baluch.	Sibi	135,499	4,944	190	3.84	3.65	1.40	NA
Baluch.	Tamboo	132,239	2,868	163	5.68	2.17	1.23	NA
Baluch.	Panjgur	121,244	2,888	142	4.92	2.38	1.17	NA
NWFP	Kurrum Ag.	184,066	9,776	213	2.18	5.31	1.16	7.4
Punjab	Bahawalpur	1,349,827	74,898	1,487	1.99	5.55	1.10	6.0
Punjab	Gujranwala	1,829,347	64,768	1,960	3.03	3.54	1.07	16.8
Punjab	Jhang	1,752,354	79,000	1,839	2.33	4.51	1.05	15.0
Punjab	Rajanpur	626,502	29,739	639	2.15	4.75	1.02	5.8

Table 8 (continued)

District Malaria Cases: 1989

Province	District	Population	Slides and Results Taken	Positive	SPR	ABER	API	% Houses Sprayed
Punjab	Layyah	760,593	26,779	773	2.89	3.52	1.02	7.0
Baluch.	Kalat	284,696	2,205	289	13.11	0.77	1.02	NA
NWFP	Abbottabad	878,647	42,742	867	2.03	4.86	0.99	13.5
Sindh	Nawabshah	1,285,630	37,360	1,186	3.17	2.91	0.92	NA
Punjab	Mianwali	626,518	33,089	540	1.63	5.28	0.86	4.0
Punjab	Sialkot	2,557,343	110,536	2,204	1.99	4.32	0.86	2.9
Punjab	Khushab	594,634	25,500	501	1.96	4.29	0.84	5.5
Baluch.	Pishin	317,029	7,798	254	3.26	2.46	0.80	NA
Sindh	Badin	680,757	27,131	526	1.94	3.99	0.77	NA
Punjab	Rawalpindi	1,229,658	78,734	883	1.12	6.40	0.72	5.0
Punjab	Okara	1,320,000	70,108	939	1.34	5.31	0.71	20.5
NWFP	N. Wazi.	244,770	6,024	162	2.69	2.46	0.66	7.0
Baluch.	Zhob	273,314	3,449	164	4.76	1.26	0.60	NA
Baluch.	Khuzdar	319,880	6,820	175	2.57	2.13	0.55	NA
Baluch.	Chaghai	131,546	1,102	71	6.44	0.84	0.54	NA
Punjab	Guirat	1,998,958	82,390	1,016	1.23	4.12	0.51	5.4
Punjab	Attock	895,693	50,639	433	0.86	5.65	0.48	1.9
Baluch.	Turbat	197,498	1,834	76	4.14	0.93	0.38	NA
Punjab	Raisalabad	2,666,252	87,785	1,005	1.14	3.29	0.38	2.6
Punjab	R.Y. Khan	1,798,028	100,062	661	0.66	5.57	0.37	10.2
Punjab	Bhakkar	656,265	38,767	230	0.59	5.91	0.35	NA
Punjab	Bahawalnagar	1,364,032	70,636	422	0.60	5.18	0.31	5.8
NWFP	Mansehra	532,409	31,390	157	0.50	5.90	0.29	7.0
Punjab	Vehari	1,317,948	65,528	334	0.51	4.97	0.25	4.5
Punjab	Lahore	683,057	29,405	169	0.57	4.30	0.25	2.7
Punjab	Khanewal	1,346,743	57,170	328	0.57	4.25	0.24	1.4
Punjab	Jhelum	778,944	27,692	180	0.65	3.56	0.23	4.8
Punjab	Chakwal	835,650	27,847	181	0.65	3.33	0.22	4.2
Baluch.	Bela	167,251	2,907	86	1.24	1.74	0.22	NA
Baluch.	Kachhi	338,429	3,398	72	2.12	1.00	0.21	NA
Punjab	Kasur	1,446,508	80,862	304	0.38	5.59	0.21	NA
Punjab	Sahiwal	1,980,274	97,081	400	0.41	4.90	0.20	8.9
Punjab	T.T. Sing	1,111,930	45,165	191	0.42	4.06	0.17	8.1
Punjab	Multan	2,062,090	91,480	120	0.13	4.44	0.06	1.6
NWFP	Orakzai Ag.	141,794	4,476	3	0.07	3.16	0.02	3.1
Baluch.	Kharan	126,171	461	0	0.00	0.37	0.00	NA
Baluch.	Kohlu	31,283	0	0	0.00	0.00	0.00	NA

Table 9

Number of Cases Detected: 1985–1989, Baluchistan

	Source of Positive Slides					
YEAR	ACD	PCD	Other	Total	Percent PCD	Percent PCD+
1985	363	620	215	1,198	51.75	3.75
1986	193	655	12	860	76.16	4.95
1987	444	374	28	846	44.21	2.82
1988	1,997	1,187	0	3,184	37.28	8.10
1989	584	529	1,303	2,416	21.90	10.96

Table 10

Number of Cases Detected: 1985–1989, NWFP

	Source of Positive Slides					
YEAR	ACD	PCD	Other	Total	Percent PCD	Percent PCD+
1985	5,855	9,100	1,773	16,728	54.40	10.03
1986	6,366	17,832	2,036	26,234	67.97	12.80
1987	4,035	11,626	3,148	18,809	61.81	7.22
1988	5,007	13,830	1,516	20,353	67.95	9.22
1989	5,416	17,609	1,254	24,279	72.53	10.52

Table 11

Number of Cases Detected: 1985–89, Punjab

	Source of Positive Slides					
YEAR	ACD	PCD	Other	Total	Percent PCD	Percent PCD+
1985	244,151	11,674	9,327	45,416	25.71	6.43
1986	27,116	13,296	6,694	47,106	28.23	6.38
1987	15,286	9,225	2,298	26,809	34.41	3.96
1988	11,326	6,548	2,855	20,729	31.59	3.12
1989	14,499	13,385	5,700	33,584	39.86	4.90

Table 12

Number of Cases Detected: 1985–89, Sindh

	Source of Positive Slides					
YEAR	ACD	PCD	Other	Total	Percent PCD	Percent PCD+
1985	6,689	5,204	2,372	14,265	36.48	4.49
1986	7,237	7,050	2,802	17,089	41.26	5.97
1987	8,704	7,049	2,054	17,807	39.59	4.75
1988	4,194	8,857	2,069	15,120	58.58	5.77
1989	8,101	30,881	5,186	44,168	69.92	12.56

Table 13

Methods of Case Detection: 1985–89, Baluchistan

	Source and Number of Slides				
YEAR	ACD	PCD	Other	Total	Percent PCD
1985	26,365	16,540	7,717	50,622	32.67
1986	21,745	13,220	4,265	39,230	33.70
1987	21,813	13,262	2,443	37,518	35.35
1988	53,338	14,662	0	68,000	21.56
1989	14,000	4,825	23,811	42,636	11.32

Table 14

Methods of Case Detection: 1985–89, NWFP

	Source and Number of Slides				
YEAR	ACD	PCD	Other	Total	Percent PCD
1985	346,337	90,716	36,140	473,193	19.17
1986	313,705	139,305	63,230	516,240	26.98
1987	260,986	160,918	66,203	488,107	32.97
1988	265,773	150,066	55,991	471,830	31.81
1989	289,586	167,436	209,741	666,763	25.11

Table 15

Methods of Case Detection: 1985–89, Punjab

	Source and Number of Slides				
YEAR	ACD	PCD	Other	Total	Percent PCD
1985	1,694,917	181,614	253,562	2,130,093	8.53
1986	1,485,370	208,349	196,642	1,890,361	11.02
1987	1,584,395	233,200	100,460	1,918,055	12.16
1988	1,568,664	209,865	122,020	1,900,549	11.04
1989	1,404,227	273,240	200,122	1,877,589	14.55

Table 16

Methods of Case Detection: 1985–89, Sindh

	Source and Number of Slides				
YEAR	ACD	PCD	Other	Total	Percent PCD
1985	292,120	115,867	57,800	465,787	24.88
1986	289,025	118,068	66,970	474,063	24.91
1987	317,673	148,331	52,197	518,201	28.62
1988	300,538	153,459	66,410	520,407	29.49
1989	253,156	245,925	12,690	511,771	48.05

Table 17

Falciparum Cases Detected: 1985–89, Baluchistan

	Number of Plasmodium Cases			
YEAR	vivax	falciparum	Total	Percent falciparum
1985	425	792	1,198	66.11
1986	447	424	860	49.30
1987	362	491	846	58.04
1988	609	2,575	3,184	80.87
1989	1,402	1,014	2,416	41.97

Table 18

Falciparum Cases Detected: 1985–89, NWFP

	Number of Plasmodium Cases			
YEAR	vivax	falciparum	Total	Percent falciparum
1985	13,616	3,139	16,728	18.76
1986	22,400	3,918	26,234	14.94
1987	13,489	5,365	18,809	28.52
1988	15,150	5,212	20,353	25.61
1989	16,524	7,755	24,279	31.94

Table 19

Falciparum Cases Detected: 1985–89, Punjab

	Number of Plasmodium Cases			
YEAR	vivax	falciparum	Total	Percent falciparum
1985	28,527	16,979	45,416	37.39
1986	32,063	15,098	47,106	32.05
1987	19,054	7,770	26,809	28.98
1988	14,854	5,882	20,729	28.38
1989	21,388	12,196	33,584	36.32

Table 20

Falciparum Cases Detected: 1985–89, Sindh

	Number of Plasmodium Cases			
YEAR	vivax	falciparum	Total	Percent falciparum
1985	5,988	8,417	14,265	59.00
1986	6,775	10,444	17,089	61.12
1987	8,745	9,195	17,807	51.64
1988	6,794	8,361	15,120	55.30
1989	10,123	34,045	44,168	77.08

Annex 4

Drug Resistance

Table 1

Consolidated Results of Antimalarial Drug Sensitivity Tests in Local Strains of P. falciparum in Pakistan from 1976 to 1988 (Conducted by NMTC/NIMRT)

Date	District	Locality	Code No.	Drug used	Sensitive	RI	RII	RIII	Absent	Total
Jan.-Feb. 1976	D.G. Khan	Jhang Muzaffargarh		Chloroquine	50	-	-	-	-	50
Dec. 1977-Jan. 1978	D.G. Khan	Malkani Kalan Gajjani	b-16-01 b-2-08	Chloroquine	58	-	-	-	-	58
Oct.-Nov. 1980	Gujrat	Randiali	e-15-02	Chloroquine	60	-	-	-	-	60
Jan.-Feb. 1981	Sukkur.Sindh	Rakhial-Ji Wandh	J-4-06	Chloroquine	27	-	-	-	-	27
Oct.-Nov. 1981	Sheikhupura	Tarey-da-kot	e-3-02	Chloroquine	58	2	-	-	-	60
Feb. 1982	Sheikhupura	Thatta Parvaira Chak No. 10	b-13-12 b-13-13	Chloroquine	39	-	-	-	-	39
Nov.-Dec. 1983	Jhang	Laliana Chak No.440	c-14-06	Chloroquine	56	4	-	-	-	60
Dec. 83-Jan. 84	Bajawalnagar	Mohammadpur	b- 7-14	Chloroquine	17	15	1	-	-	33

Table 1 (continued)

Consolidated Results of Antimalarial Drug Sensitivity Tests in Local Strains of P. falciparum in Pakistan from 1976 to 1988 (Conducted by NMTC/NIMRT)

Date	District	Locality	Code No.	Drug used	Sensitive	RI	RII	RIII	Absent	Total
October 1984	Lahore	Gajju Mata	b-7-0	Chloroquine	6	10	-	-	-	16
Nov. 1984	Kasur	Rajji-Wala Arain	c-13-09	Chloroquine	16	24	2	-	1	43
Dec. 1984	Karachi	Hub-Dam-Colony	e-5-10	Chloroquine	2	-	-	-	-	2
Dec. '84-Jan. '85	Okara	Puran	e-3-18	Chloroquine	6	9	-	-	-	15
				Amodiaquine	3	8	3	-	1	15
				Fansidar	13	-	1	-	1	15
Dec. '85-Jan. '86	Sialkot	Garowal	d-14-01	Chloroquine	5	28	2	-	3	38
				Amodiaquine	10	13	-	-	3	26
				Fansidar	8	8	1	-	-	17
Nov.-Dec. 1986	Sargodha	Mateela	B-21-06	Chloroquine	36	28	1	-	2	67
Oct.-Nov. 1987	Muzafargarh	Bait Rai Ali	M-8-16	Chloroquine	11	16	9	-	3	39
				Amodiaquine	15	6	0	-	2	23
Dec. '87 Jan. '88	Mardan, N.F.W.	Taja	-	Chloroquine	3	39	7	-	2	51
				Amodiaquine	1	8	1	-	0	10
Dec. '88-Jan. '89	Faisalabad	Chak No. 104 (Harmoey)	F-123-01	Chloroquine	10	18	5	-	0	33
				Amodiaquine	9	18	1	-	0	28
Dec. '88-Jan. '90	Vehari	Islam Head Works		Chloroquine	19	19	2	-	0	40
	Mohmand Agency	Yakka Ghund (Afghan Refugees)		Chloroquine	9	23	6	-	0	38

Table 2

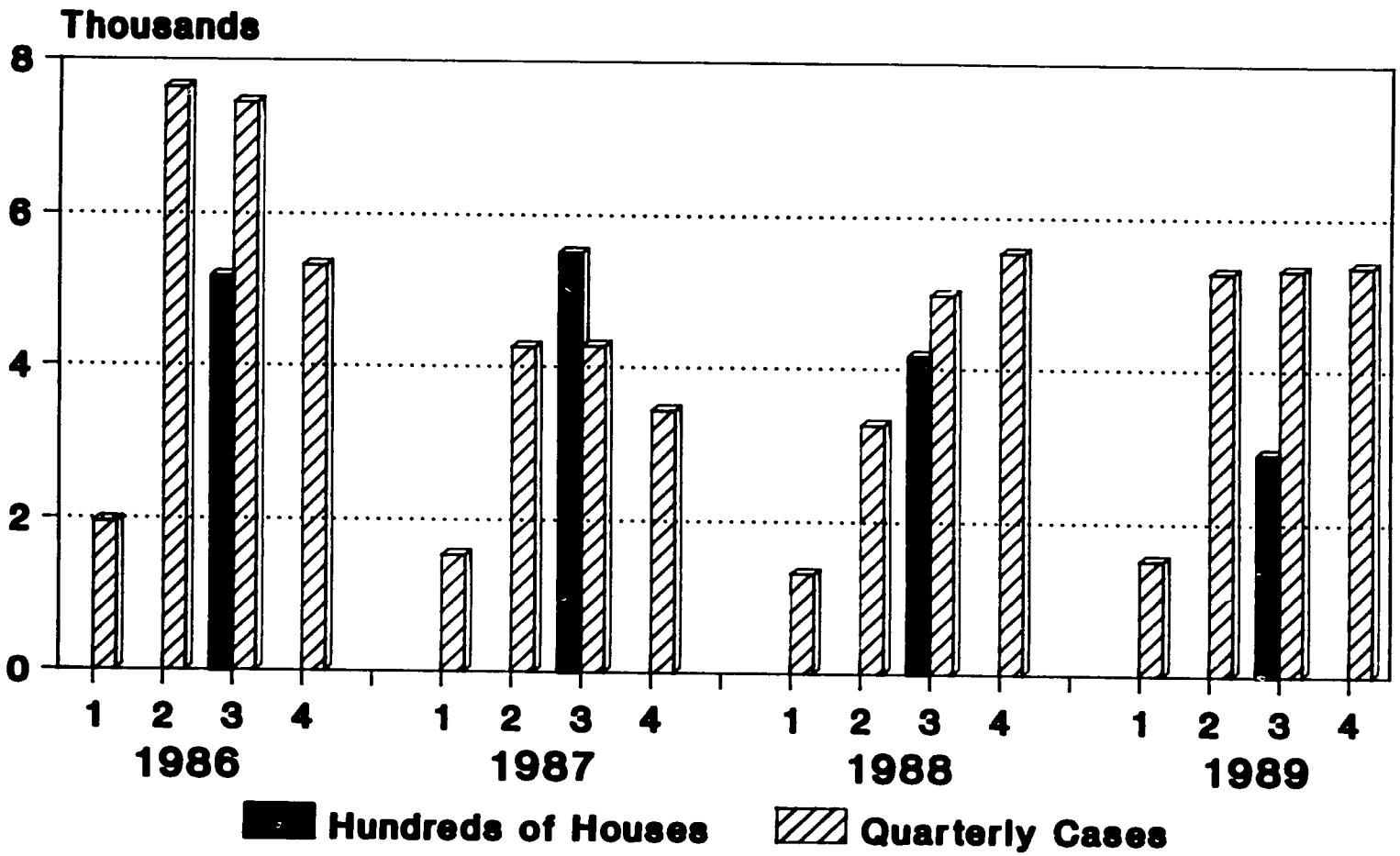
Results of Antimalarial Drug *in Vivo* Sensitivity Tests in Local Strains of *P. falciparum* Conducted by MCP (CDC) Personnel in Punjab and NWFP

Date	District	Drugs Used	Sensitive	RI	RII	RIII	Absent	Total
	PUNJAB							
Jan.-Feb. 1985	Lahore	Chloroquine	1	34	22	0	0	57
Feb.-Mar. 1985	Kasur	Chloroquine	1	11	32	0	0	44
1985	Sheikhupura	Chloroquine	15	16	0	0	0	31
1985	Muzaffargarh	Chloroquine	0	4	30	0	0	34
Dec. '85-Feb. '86	Gujranwala	Chloroquine	19	29	3	0	0	51
		Amodiaquine	19	7	5	0	0	31
		Fansidar	12	1	0	0	0	13
Jan. '87-Mar. '87	Sheikhupura	Chloroquine	19	60	0	0	0	79
		Amodiaquine	17	26	9	0	0	52
		Fansidar	40	1	0	0	0	40
	N.W.F.P.							
Nov. '85	Mardan	Chloroquine	18	32	0	0	0	50
Nov. '86	Bannu	Chloroquine	14	18	0	0	0	32

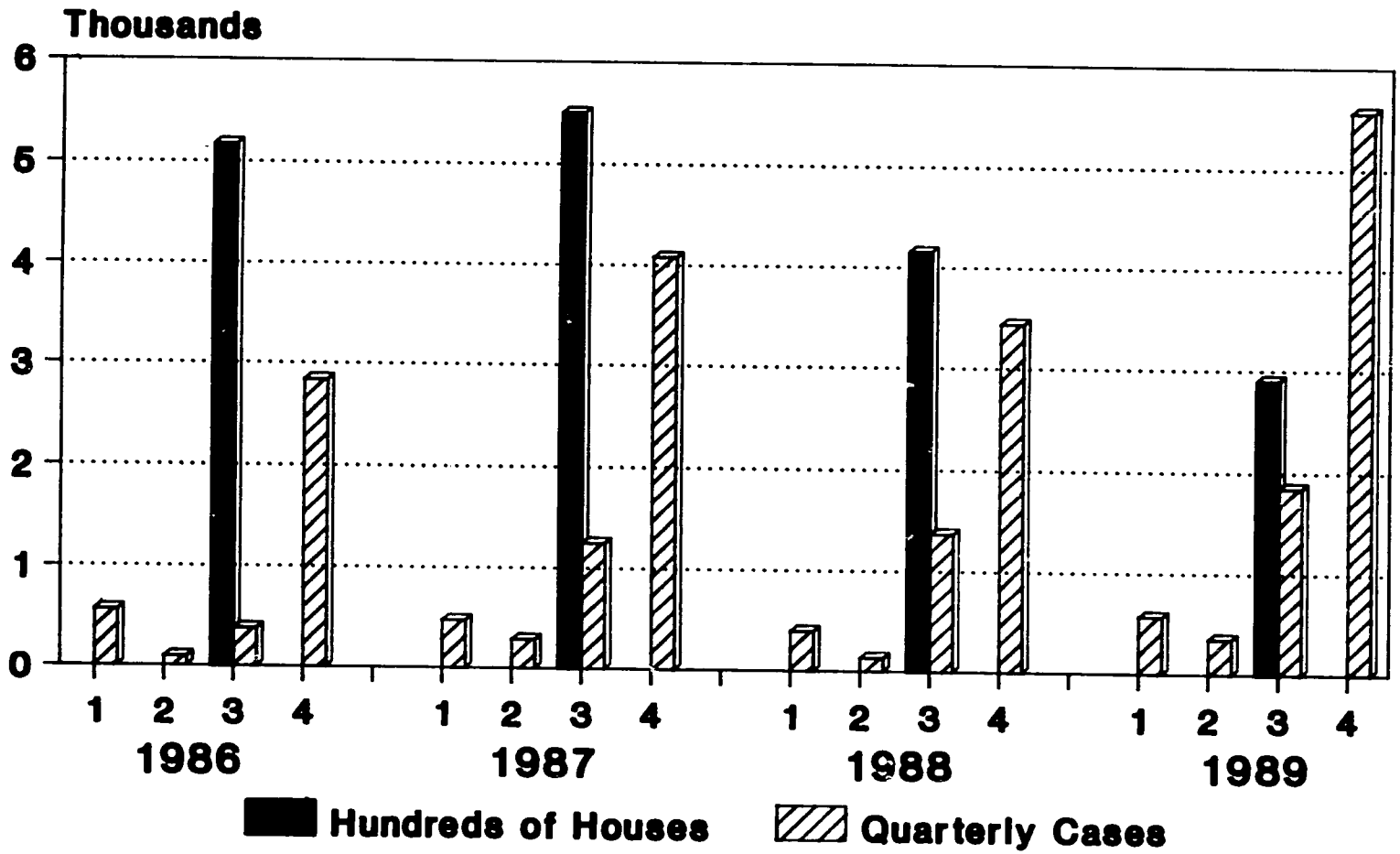
Annex 5

Figures

Quarterly Vivax Malaria Cases and Houses Sprayed:NWFP 1986-1989

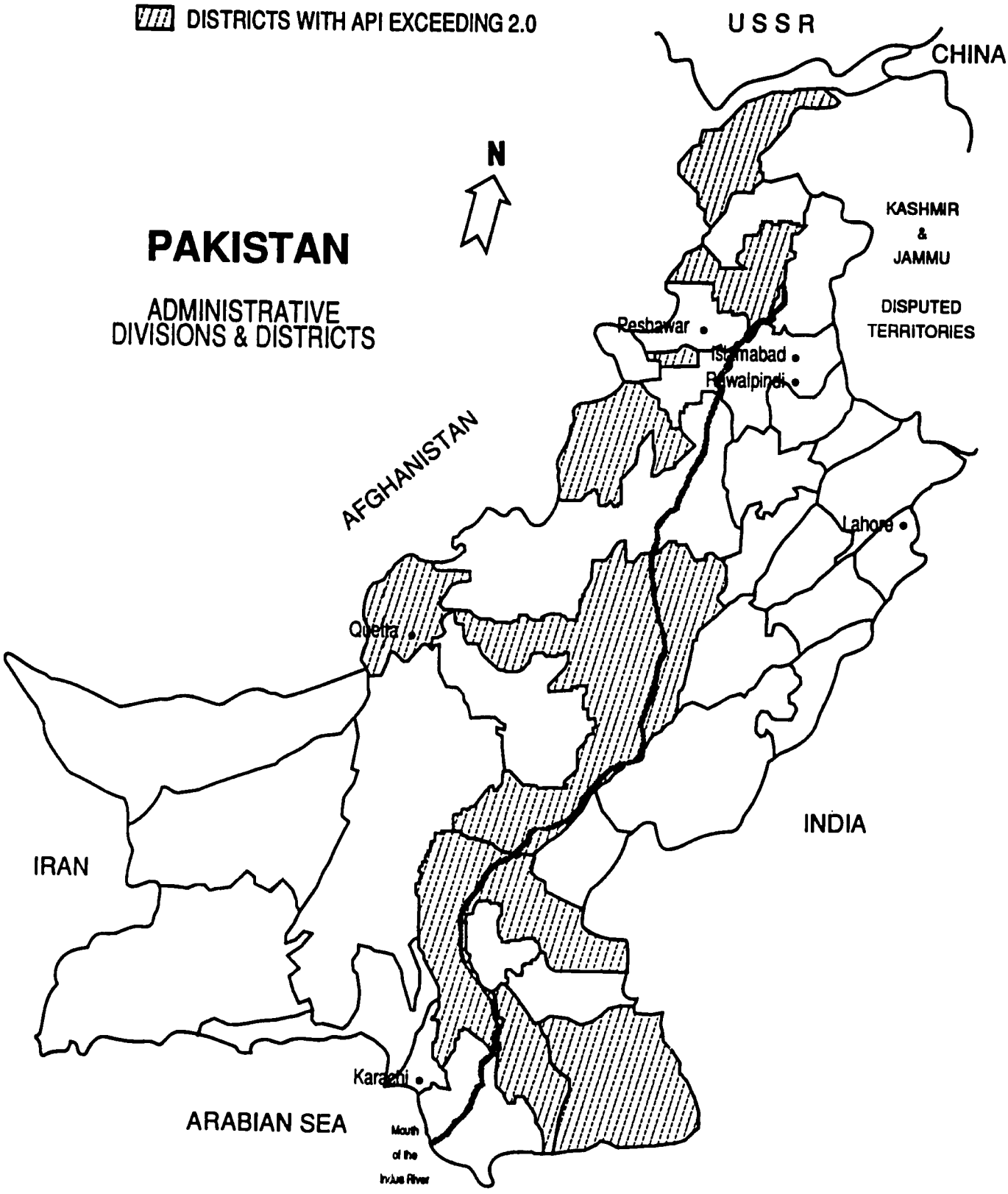


Quarterly Falciparum Malaria Cases and Houses Sprayed:NWFP 1986-1989



Annex 6

Districts with API Exceeding 2.0


DISTRICTS WITH API EXCEEDING 2.0
U S S R
CHINA
N
PAKISTAN
ADMINISTRATIVE
DIVISIONS & DISTRICTS
KASHMIR
&
JAMMU
DISPUTED
TERRITORIES
Peshawar
Islamabad
Rawalpindi
AFGHANISTAN
Lahore
Quetta
INDIA
IRAN
Karachi
ARABIAN SEA
Mouth
of the
Indus River

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Annex 7

MCP Criteria for the Selection of Areas/Localities for 1990 Spray Planning*

1. Two or more indigenous cases of *P. falciparum* in a locality with the following reservations:

    a. Complete locality will be given insecticidal coverage having less than 2,000 population.

    b. Focal/peripheral spray around the *P. falciparum* cases will be given to the locality exceeding population of 2,000.

2. Localities having up to 2,000 population with more than six **indigenous** *P. vivax* cases will be considered for spray. The localities exceeding population 2,000 will be treated according to malariogenic potential and peripheral spray may be considered.

3. Areas/localities with drug resistance even with one indigenous case of *P. falciparum* will also be given priority for spray.

4. Negative localities surrounded by positive localities may be included on epidemiological grounds.

*Handout used in MCP meetings, January 1990.