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# Pakistan: Environmental Assessment of A Comparative Field Trial of the Insecticides Bendiocarb, Pirimiphos-methyl, Lambda Cyhalothrin, and Deltamethrin as Residual Sprays for Malaria Control

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by

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## Acronyms and Abbreviations

| | |
|---|---|
| ACD | Active case detection |
| AI | Active ingredient |
| A.I.D. | Agency for International Development |
| API | Annual parasite incidence |
| CDC | Centers for Disease Control |
| CFR | Code of Federal Regulation |
| DOMC | Directorate of Malaria Control |
| EA | Environmental Assessment |
| GOP | Government of Pakistan |
| HPN | Health, Population and Nutrition |
| IPM | Integrated Pest Management |
| MCP | Malaria Control Project |
| NIMRT | National Institute of Malaria Research and Training |
| NWFP | Northwest Frontier Province |
| OP | Organophosphorus compound |
| PCD | Passive case detection |
| SOW | Scope of Work |
| PSI | Pound per square inch |
| ULV | Ultra low volume |
| USA | United States of America |
| USAID | United States Agency for International Development |
| USEPA | United States Environmental Protection Agency |
| VBC | Vector Biology and Control Project |
| WHO | World Health Organization |
| WDP | Water dispersible powder |

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# 1. Executive Summary

USAID/Islamabad intends to continue its support of in-country operational research in malaria control, an important component of the Malaria Control Project II (MCP). USAID's assistance will include funds for carrying out a comparative field trial of four insecticides, one or more of which may be used in the future as a replacement for malathion, the insecticide now being applied as a house spray for malaria control. Village-scale field trials will be carried out in rural Punjab Province by the National Institute of Malaria Research and Training (NIMRT) in collaboration with the Directorate of Malaria Control (DOMC). The insecticides to be evaluated are bendiocarb, pirimiphos-methyl, lambda cyhalothrin, and deltamethrin (see section 2).

This environmental assessment (EA) analyzes the strategy of using residual insecticides for anti-malaria spraying. The conclusion is that this strategy is the most efficient and cost-effective method for reducing malaria incidence in the rural areas of Pakistan. Alternative insecticides must be evaluated now so that they can be used in the future if malathion fails to control malaria due to the development of vector resistance to this compound, or if malathion is not available for any reason in the future (see section 3).

This EA was prepared in compliance with the U.S. Agency for International Development's (A.I.D.'s) Environmental Procedures 22 CFR 216. It identifies and analyzes the health, safety and environmental issues specific to the proposed field trials. The requirement for this EA stems from concerns about worker safety and environmental protection associated with the use of toxic insecticides in operational research projects carried out within the framework of MCP II (see section 4).

The anticipated adverse short-term and long-term effects of the proposed insecticides on humans, domestic animals, birds, fish, honeybees, wildlife and the abiotic environment are considered minimal based on the relatively small quantities of insecticides to be used and the contained nature of use (intradomiciliary application) (sections 4.5, 4.7, 4.8), provided the recommended staff training, safety precautions, mitigating measures and monitoring are fully implemented (sections 4.11, 4.12).

A detailed mitigation plan is presented to further minimize potential acute poisoning of spray crew, inhabitants and domestic animals; contamination of surface and groundwater; and poisoning of fish, birds, and wildlife (section 6). The plan makes recommendations for training, use of protective clothing, cholinesterase monitoring, education, house preparation, and proper disposal of insecticide rinsate, waste and empty containers.

The remaining risks would be far offset by the potential benefits derived from malaria control. Therefore, the following insecticides should be approved for the USAID-financed operational research trials to be carried out by the NIMRT: bendiocarb, pirimiphos methyl, lambda cyhalothrin and deltamethrin.

# 2. Background

## 2.1 Purpose

The purpose of this activity was to conduct an Environmental Assessment (EA) of the field testing of four insecticides that had not previously been used for malaria control by house spraying in Pakistan. The EA team reviewed the proposed use of bendiocarb (FICAM®), pirimiphos-methyl (ACTELLIC®), lambda cyhalothrin (ICON®) and deltamethrin (K-OTHRIN®). These insecticides are considered appropriate replacements for the currently used malathion. Although malathion is still an effective insecticide for malaria control, some resistance to this compound has appeared. Should this resistance reach high levels and malathion spraying fail, it would be necessary to apply alternative insecticides in the future.

Although this assessment focuses on the environmental impact of the use of these insecticides in small-scale field trials, the same conclusions and recommendations would apply if any of the insecticides were used on a wider scale in selected localities as a replacement for malathion. This replacement with one of the backup insecticides would take place only in those areas where the failure of malathion to control malaria had been proven by entomological and epidemiological investigations.

## 2.2 Objectives

The objective of this activity was to prepare an environmental assessment document to determine whether the proposed use of bendiocarb, pirimiphos-methyl, lambda cyhalothrin and deltamethrin conformed to A.I.D. Regulation 22 CFR Part 2, 216.

## 2.3 Scoping Process and Scope of Work (SOW)

According to A.I.D. Environmental Procedures, 22 CFR Part 2, 216.3 (4), a written statement of the scope of an Environmental Assessment that identifies potentially significant issues is prepared and cleared through the Bureau Environmental Officer and the Mission. The SOW for this activity is presented in Annex A.

## 2.4 Project Description

The Malaria Control Project II (371-0472) was designed to help the Government of Pakistan (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 began in 1982 and is scheduled to end in 1992.

The NIMRT, located in Lahore, is the operational research and training institution supporting the MCP II. This institute has successfully carried out research on distribution of chloroquine resistance in Pakistan, insecticide resistance in anopheline vectors, and a field trial of application of pyrethroid insecticides to the tents of Afghan refugees in NWFP. Field trials (WHO stage III) were also conducted using the insecticides RELDAN® and CARBOSULFAN®, with no problems of toxicity to workers or environmental contamination (NIMRT 1991).

The NIMRT has developed a scientifically sound protocol for the trials of bendiocarb, pirimiphos-methyl, lambda cyhalothrin and deltamethrin, the insecticides that are evaluated by this EA. These trials are scheduled to begin in late July or early August 1992.

## 2.5 Previous EA Findings

An Environmental Assessment of the MCP II Extension was carried out in August 1988. The anticipated adverse impacts of project extension pesticides were considered minimal, and were to be mitigated by continued safe use, transport, storage and disposal. The pesticides under study in the 1988 EA were malathion and fenitrothion.

The GOP was found to have in place a strong institutional structure for managing malaria control operations. The 1988 EA team believed that the program would continue to operate safely and in full compliance with A.I.D. environmental procedures.

## 2.6 Need for EA

Even though the four insecticides under consideration are being tested in small-scale field trials only, the trials are being supported financially by USAID/Islamabad as a part of the technical assistance component of MCP II. This EA is mandated by Section 216 for a "substantive amendment or extension of an ongoing project." Preparation of an EA is thus required.

# 3. Analysis of Alternatives to the Proposed Actions

## 3.1 No Action

The discontinuation of comparative field trials of candidate insecticides would be inappropriate and even harmful to the future of malaria control in Pakistan. Through the cooperative efforts of USAID and the GOP, malaria has been reduced to manageable levels by the application of residual insecticides. Backup insecticides are needed in case insecticide resistance of the vectors to malathion increases to the point that the insecticide no longer controls malaria in sprayed areas. If this happens, then malaria rates could increase to the formerly high levels. The use of effective alternative insecticides could provide continued control of malaria in these areas.

## 3.2 Use of Alternative Methods, such as Biological Control and Environmental Management

House spraying with residual insecticides has been a successful malaria control measure in Pakistan. Biological control or environmental management approaches to malaria control have not been considered viable or economical substitutes for residual house spraying in Pakistan, mainly because of the vast extent of static water collections during the rainy season and the scattered nature of the many small villages. These methods are, however, cost-effective and appropriate in urban areas, and perhaps in certain desert areas, and should be considered in future malaria control plans.

## 3.3 Malaria Control through Chemotherapy Alone

Malaria control through chemotherapy alone is already in practice in areas with low malaria incidence or low risk of transmission. House spraying is stopped when the annual parasite incidence (API) has been reduced to 2 cases per 1,000 population and in localities where falciparum malaria has disappeared. In the unsprayed localities, malaria is controlled through case detection and radical treatment.

The objective of antimalarial drug therapy is not only the prompt clinical cure of malaria patients but also the reduction of the infective reservoir. When these objectives are met through efficient treatment of malaria cases, combined case detection and treatment activities may serve as a useful control method, particularly in areas where the malariogenic potential is not high.

## 3.4 Conclusion

Based on consideration of available options, the EA team believes that the current malaria control program, using residual spray insecticides in combination with chemotherapy, is the most balanced approach to environmentally acceptable, economical and efficient malaria control in Pakistan.

# 4. Pesticide Use Assessment

## 4.1 USEPA Registration Status of the Selected Insecticides

The U.S. Environmental Protection Agency (USEPA) registration status, WHO recommendation and USAID approval of each insecticide selected for field testing are summarized in Table 1.

### Methyl-carbamate

Bendiocarb (FICAM®) is registered by the USEPA for the control of mosquitoes, household pests, ornamental pests and imported fire ants. An EA was conducted and bendiocarb was subsequently approved as a residual house spray for malaria vector control in the USAID-sponsored program in El Salvador (Arata and Breeland 1989). An EA was also conducted for the Bolivian Chagas disease control program and bendiocarb was recommended for trial by USAID (Arata 1991). Bendiocarb has been tested for malaria control in Zimbabwe (Mpofu et al. 1991) and Mexico (Loyola et al. 1991).

### Organophosphorus compound

Pirimiphos-methyl (ACTELLIC®) is registered by the USEPA for stored grains and household pests control. The ICI Americas, Inc., has not applied for its use in mosquito control in the USA. Pirimiphos-methyl, however, is approved by WHO and widely used in other countries for vector and nuisance insect control. Its efficacy was evaluated for mosquito control in the Gambia as a bed net treatment (Miller et al. 1991) and in a field spray trial in India (Das et al. 1987).

### Pyrethroids

Lambda cyhalothrin (ICON®) is registered in the USA for the control of public and animal health pests, including mosquitoes, and for agricultural and horticultural pest control. The VBC Project recently completed an EA for Chagas' disease control in Bolivia, and lambda cyhalothrin was one of several compounds recommended for trials (Arata 1991). This insecticide has been tested for mosquito control through bed net

**Table 1. Registration, Recommendation and Use Status of Insecticides to be Evaluated**

| Insecticide | Manufacturer | EPA Registration | WHO Recommendation | USAID Approval |
|---|---|---|---|---|
| **Carbamate**<br><br>Bendiocarb<br>FICAM 80 wdp | Nor-Am Chem. Corp. USA (originally Schering Ag, Germany) | Registered for mosquito, household and structural pest control | Malaria vector control in Indonesia, Mexico, Nepal, India, Zambia, South Africa, etc. | Approved and purchased for malaria vector control in El Salvador & recommended for Chagas' vector control in Bolivia |
| **Organophosphorus**<br><br>Pirimiphos-Methyl<br>ACTELLIC 40 wp | ICI (UK) | Registered for stored cereal grains and household pests | Approved for malaria vector control in Nepal, the Gambia, India, etc. | None |
| **Pyrethroids**<br><br>Lambda cyhalothrin<br>ICON 10 wp | ICI (UK) | Registered for mosquito control. Restricted Use Pesticide | Approved for vector control in the Gambia, Uganda, Tanzania, etc. | Recommended for Chagas' vector control in Bolivia |
| Deltamethrin<br>K-OTHRINE<br>25 wp (2.5%) | Roussel Uclaf (French) | Not registered; widely used outside the U.S. for vector control, animal health, public health and agricultural pest control | Malaria vector control in Mexico, Kenya, Indonesia, Guatemala, Philippines; bed net impregnation in the Gambia, Burkino Faso & Tanzania | None |

impregnation in the Gambia (Lindsay et al. 1991, Miller et al. 1991) and for effects on spraymen and inhabitants in Tanzania (Moretto et al. 1991) and Pakistan (Chester et al. 1990).

Deltamethrin (K-OTHRIN®) registration in the U.S. is pending. It is used worldwide outside of the USA for vector, agricultural, public health and animal health pest control. Deltamethrin studies were conducted in Mexico for *Anopheles* control using intradomiciliary low-volume spray (Vaca-Marin et al. 1991). Bed nets impregnated with deltamethrin were successfully tested for malaria vector control in Burkino Faso (Robert et al. 1991), Burundi (Barutwanayo et al. 1991), and the Gambia, Burkino Faso and Tanzania (Carnevale et al. 1991).

## 4.2 Basis for Selection of Insecticides

House spraying with DDT for malaria control began in Pakistan in the 1960s and continued until widespread resistance to this compound was discovered during the 1970s. Malathion was chosen as the replacement insecticide for DDT because of its low mammalian toxicity, reasonable cost and unique mechanism of resistance. This mechanism, based on the enzyme carboxylesterase, is highly specific for malathion. Mosquitoes that become resistant to the insecticide by this means are not cross-resistant to other insecticides.

During the early 1980s, test results began to show that certain populations of *Anopheles stephensi*, a known malaria vector, were developing resistance to malathion in some parts of Pakistan. After the required field trials and environmental impact studies in 1989, criteria were established for the replacement of malathion with fenitrothion in localities with resistant vectors. The criteria for replacement of malathion were:

a. that there be 60 percent or less average mortality of *An. stephensi* in susceptibility tests conducted in several localities during the preceding two years according to standard WHO procedure; and

b. that there be an unacceptably high level of malaria transmission compared to the norm for the district.

As of the beginning of the spraying season of 1992, fenitrothion has not been used as a replacement for malathion in any of the provinces of Pakistan because high levels of malathion resistance have not appeared in *An. culicifacies*, the principal vector in most of the country. In addition, malathion spraying appears to be effective in controlling malaria even in areas with high resistance in *An. stephensi*. At this time there seem to be no epidemiological reasons for switching from malathion to another insecticide.

At the same time, officials of DOMC and NIMRT and their technical advisors believe it would be prudent to have alternate insecticides to use in case malathion resistance reaches such levels in the future that this compound is no longer effective for malaria control.

In order to have backup insecticides, it is necessary to conduct small-scale field trials in Pakistan and to consider the potential environmental impact of these pesticides. The directors of DOMC and NIMRT chose to test four insecticides that had not been applied previously for malaria control in Pakistan. These are bendiocarb, pirimiphos-methyl, lambda cyhalothrin and deltamethrin.

The NIMRT in fully capable of carrying out small-scale field trials of these insecticides. Protocols have been developed and study sites chosen. Insecticide manufacturers have donated sufficient quantities of each of the four compounds for the trials.

## 4.3 The Extent to which the Proposed Insecticide Use is Part of an Integrated Pest Management Program

House spraying for malaria control in Pakistan is performed according to the principles of integrated control in that spraying is done only when malaria cases in any given locality reach a certain level. For example, project personnel base their decisions to use or not use insecticides on whether infections exceed an API threshold of 2.0 for *Plasmodium vivax* or when any *P. falciparum* is detected. If any of the four candidate insecticides are used in the future as a replacements for malathion, they will be used with the same restrictions that currently apply to malathion application.

Two of the goals of IPM are to reduce reliance on chemical insecticides and to include the use of non-chemical methods in the control strategy. Pakistan's malaria control program uses chemotherapy in combination with spraying to reduce the API in positive localities.

The use of selective spraying plus the alternative method of chemotherapy has brought about an eight-fold reduction in the amount of insecticide used over the past two years.

## 4.4 Application Methods and Equipment

Residual spray will be applied once to the inside walls, ceilings and roof eaves of houses and animal shelters. Insecticide will be sprayed using Hudson X-Pert hand compression sprayers (8-L capacity) fitted with HSS-8002 nozzle tips at 40 PSI, giving a discharge rate of 757 mL/min and at an approximate spraying rate of 19m$^2$ coverage per minute. Applications will be made at the USEPA or WHO approved rates, which are marked on the labels, or at lower efficacious dosages (Table 2).

The water dispersible powder (WDP) formulation should mix readily with water and should not clog nozzle tips, especially if the insecticide is thoroughly mixed in a bucket and strained into the spray tank. The pH of the water used should be checked and ideally buffered around pH 7. Alkaline conditions (>pH 8) degrades these insecticides readily through hydrolysis. If insecticide is packed in a water-soluble sachet with the correct amount for one spray tank, direct mixing in a spray tank is preferred, according to label directions (e.g., ICON 10 wp).

Spray personnel should use a toothpick or toothbrush (well-marked "for pesticide use only") to unclog plugged nozzles instead of using wire, which will enlarge the nozzle opening, or blowing by mouth, which results in oral exposure to insecticide. Before spraying starts, all sprayers should be checked for leaks and line cracks, all defective parts should be replaced, and sprayers should be calibrated to ensure correct flow rate, spray pattern and coverage.

**Table 2. Application Rates of Indoor Residual Spray for the Insecticides to be Evaluated**

| Insecticide | Formulation | Rate Applied g ai/m$^2$ | *Product (g) per 10-L water | Spray Concentration |
|---|---|---|---|---|
| Malathion | 50% wdp | 2.0 | 1,000 | 5% |
| Bendiocarb | FICAM® 80% wdp | 0.4 | 125 | 1% |
| Pirimiphos-methyl | ACTELLIC® 40% wp | 1.0 | 625 | 2.5% |
| Lambda cyhalothrin | ICON® 10% wdp | 0.03 | 78.1 | 0.08% |
| Deltamethrin | K-OTHRINE® 25 wp (2.5%) | 0.025 | 250*** | 0.0625% |

* Estimates based on 40 mL of liquid spray per square meter of wall surface.

** ICON 10wp packed in sachet of 62.5g product in water-soluble bag for 8-L water.

*** Deltamethrin label rate (spray volume): Porous substrate 100 mL/m$^2$; non-porous substrate 50 mL/m$^2$.

## 4.5 Acute and Long-Term Toxicological/Environmental Hazards

Toxicological and environmental hazards of bendiocarb, pirimiphos-methyl, lambda cyhalothrin and deltamethrin can best be discussed in comparison to malathion, an insecticide used in Pakistan since 1976 with no major adverse effects or hazards.

In general, acute toxicity to inhabitants of sprayed houses is minimal, particularly because 1) houses are prepared by moving beds, furniture, utensils and food items outside before spraying; 2) a reentry interval of one hour is observed; 3) the inhabitants sleep outdoors during the summer months when the spraying occurs (July-September); and 4) all precautions on the labels are followed.

### 4.5.1 Acute hazards - bendiocarb

The oral toxicity of bendiocarb is 10 times greater than that of malathion, and its dermal toxicity is three times greater than malathion's. The high percentage of active ingredient (80% wdp) in bendiocarb poses acute intoxication risk to the person mixing and loading the pesticide. However, because of the low rate at which the insecticide is applied, the spray concentration needed is eight-fold less than for malathion. Therefore, if spray personnel wear protective clothing and follow the directions on the label, bendiocarb should pose no new hazard to them during spray operation.

If swallowed, absorbed through skin, or inhaled, bendiocarb is harmful or fatal. Bendiocarb, a carbamate, reversibly inhibits acetylcholinesterase. Symptoms of intoxication include headache, dizziness, blurred vision, stomach cramps, tearing, twitching, tremor, nausea, salivation and pin-point pupils. Without treatment, severe intoxication will result in respiratory paralysis and death.

Bendiocarb is highly toxic to wildlife, domestic fowls, fish and honeybees (Table 3). In well-contained intradomiciliary spray for malaria vector control, bendiocarb poses negligible hazards to these non-target species. Ducks, chickens and other domesticated fowls could be seriously

## Table 3. Comparative Toxicity of the Insecticides to be Evaluated

| Insecticide | Rat | | | Bird (mallard) | Fish | Honeybee | Safety* Coefficient |
|---|---|---|---|---|---|---|---|
| | Oral LD50 mg/kg | Dermal LD50 mg/kg | Skin/eye effect | Oral LD50 (ppm) | LC50 (ppm) | Oral LD50 (μg/bee) | |
| Malathion | 1,500-2,000 | 72,000 | mild | 1,485 | 200 | 0.71 | 50 |
| Bendiocarb | 40-156 | 566-600 | mild | 3.1-137 | 1.55 | 1 | 10 |
| Pirimiphos-methyl | 800-2,000 | 72,000 | high | 76.6 | 0.4 | 0.6 | 177 |
| Lambda cyhalothrin | 56-79 | 632-696 | high | >3,950 | 0.24 | 0.97 | 3,545 |
| Deltamethrin | 135-5,000 | >2,000 | mild | >4,640 | <0.24 | 0.05 | 5,560 |

*Safety Coefficient = ratio of rat LD50 (acute oral mg/kg)/house fly LD50 (topical μg/g)

*Sources:* *Pesticide Manual: A World Compendium*
*Pesticide Fact Sheet, USEPA*
*Pesticide Database, VBC Project*
*Manufacturer Technical Data*

intoxicated or killed if they are allowed to enter treated houses and feed on dead insects such as cockroaches and bed bugs. Bendiocarb could pose hazards for fish and aquatic organisms if aquatic habitat became contaminated from the washing of spray equipment or disposal of rinse-water or waste.

Precautions should be observed for any potential toxicity to honeybees resulting from drift to hives near houses and animal shelters. Bendiocarb has low water solubility and a short half-life (2 weeks) in the environment. It is rapidly hydrolyzed (degraded), particularly under alkaline (>pH 8) conditions; hence, bendiocarb does not accumulate in the environment and poses little potential for groundwater contamination or rain water runoff, especially if label directions for cleaning spray equipment and disposing of rinsate are followed.

### 4.5.2 Acute hazards - pirimiphos-methyl

Pirimiphos methyl is an organophosphorus compound that inhibits cholinesterase. The symptoms of acute intoxication are similar to those caused by bendiocarb poisoning. The toxicity of pirimiphos-methyl is also similar to that of malathion (Table 3), except that pirimiphos-methyl, which acts as a fumigant (Table 4), has a high vapor pressure and is an eye and skin irritant. The lower application rate and lower concentration in spray solution (Table 2) required, coupled with a ventilation period of an hour and the outdoor sleeping habits of the inhabitants, should minimize exposure to pirimiphos-methyl vapor. The strong mercaptan odor serves as a warning for prolonged exposure (Table 4). Inhabitants of sprayed houses, however, might find the odor objectionable.

When all precautions and label directions are followed, the intradomiciliary application of pirimiphos-methyl at half the rate and concentration of malathion (Table 2) should pose negligible risk to wildlife, fish, aquatic invertebrates and birds.

Pirimiphos-methyl has a very low water solubility (1) and a short half-life (30 days) in water and soil (Table 4). There should be no environmental persistence or accumulations, or groundwater contamination. Pirimiphos-methyl is slightly corrosive to milled steel and tinplate.

## Table 4. Physico-chemical Properties of Insecticides to be Evaluated

| Insecticide | Odor | Water Solubility (mg/L) | Vapor Pressure (mPa) | Half-life water (day) | Half-life soil (day) |
|---|---|---|---|---|---|
| Malathion | mercaptan-like | 145 (25°C) | 5.28 (30°C) | 7 (pH9) | <7-14 |
| Bendiocarb | slight odor | 40 (25°C) | 0.66 (30°C) | 10 (pH7) | 3-21 |
| Primiphos-methyl | strong mercaptan odor | 5 (30°C) | 13 (30°C) | 1 | 30 |
| Lambda cyhalothrin | mild odor | 0.005 | 0.2 (20°C) | 7 (pH9) | <12-50 |
| Deltamethrin | odorless | 0.002 (20°C) | 0.002 (25°C) | 2 | 11-72 |

*Sources:* *Pesticide Manual: A World Compendium*
*Pesticide Fact Sheet, USEPA*
*Pesticide Database, VBC Project*
*Manufacturer Technical Data*

### 4.5.3 Acute hazards - lambda cyhalothrin

Lambda cyhalothrin is a pyrethroid that consists of two of the more active racemic mixtures (1:1) of the four isomers of cyhalothrin. Lambda cyhalothrin and other pyrethroids interfere with the sodium channels' gating mechanism, which is essential for nerve conduction, resulting in prolonged sodium leakiness of the nervous membrane during depolarization. The effect on the sodium channels is a reversible reaction.

Indoor use of lambda cyhalothrin at a very low rate (50 times less than that of malathion) poses extremely low risk to non-target species and domestic animals. The risk of systematic toxicity in spray crew and inhabitants is remote because lambda cyhalothrin is rapidly metabolized in humans to much less toxic metabolites (safety coefficient of 3545, Table 3). Acute exposure can result in headaches, nausea, muscular twitching and convulsions, but concentrations in the circulatory system fall quickly and recovery is rapid (WHO 1991).

The major health effects have occurred in workers after exposure to spray drifts on non-protected skin, especially on the face when spraying ceilings?. The symptoms of exposure are skin sensations (paraesthesia) described as itching and burning and, less frequently, nose and throat irritation, sneezing and coughing (WHO 1991, Moretto et al. 1991). Cutaneous sensation is reduced if the skin is washed immediately with cold water, and symptoms disappear 24 hours after exposure. Lambda cyhalothrin is also a mild eye irritant. Inhabitants entering houses one hour after spraying should not experience any adverse effects (Moretto et al. 1991)

Lambda cyhalothrin is applied at very low doses (Table 2) on confined interior walls of houses. Therefore, its adverse impact on bird, wildlife, fish and honey bees is negligible, especially when precautions in spraying and handling of equipment rinsate and waste are followed to prevent contamination of aquatic habitat.

Lambda cyhalothrin has very low toxicity to ducks. Although it is highly toxic to fish under laboratory conditions, the toxicity is mitigated by the low rate used, rapid adsorption on suspended soil sediment in water, and rapid photodegradation and hydrolysis.

Hazards to honeybees are minimal when caution is taken to prevent drifts to any nearby beehives.

Lambda cyhalothrin poses no hazards of air contamination, groundwater contamination, or environmental persistence or accumulation because of its extremely low volatility, low water solubility, strong soil adsorption, and short half-life in water and soil.

### 4.5.4 Acute hazards - deltamethrin

Deltamethrin, a pyrethroid, has a mode of toxic action similar to that of lambda cyhalothrin, and hence has high mammalian safety (safety coefficient of 5560, Table 3). As is the case with certain other alpha-cyano pyrethroids, including lambda cyhalothrin, cypermethrin, cyfluthrin and fenvalerate, deltamethrin can cause temporary tingling, burning or numbing sensations. It is also a slight skin irritant.

Although deltamethrin is extremely toxic to fish, aquatic organisms, and honeybees under laboratory conditions, in the environment its toxicity is mitigated by the low rate used, rapid adsorption on suspended soil sediment in water, and rapid photodegradation and hydrolysis, as discussed for lambda cyhalothrin.

Deltamethrin also poses minimal air, surface and groundwater, and soil contaminations because of its extremely low volatility, low solubility and high soil adsorption. The impact on outdoor environment should be negligible in intradomiciliary residual spray of houses.

### 4.5.5 Long-term hazards

No long-term human toxicity is foreseen in the use of all four insecticides. There are no findings of delayed neurotoxicity, oncogenicity, teratogenicity, reproductive effects or mutagenicity in test animals. In humans these compounds are rapidly metabolized and excreted, and no evidence of bioaccumulation has been noted. Indoor house spraying of small quantities of insecticide once a year for a spray period of a month should not result in chronic toxicity for spray personnel and should pose negligible long-term hazard to the inhabitants.

## 4.6 Efficacy of Proposed Insecticide for Malaria Control

Residual spraying for malaria control is based on the fact that most anophelines enter houses seeking a blood meal at night when people are usually inside. After taking a blood meal, mosquitoes rest on inside walls for varying periods of time before escaping from the house. When these inside wall surfaces are covered with a coating of residual insecticide, mosquitoes die as a result of contact with the insecticide. If a mosquito has taken an infective blood meal, then the chain of transmission is broken when the mosquito is killed.

Both of the recognized vectors in Pakistan, *An. culicifacies* and *An. stephensi*, are known to enter houses to feed and to rest on inside surfaces after feeding. Residual spraying reduces malaria incidence when an effective insecticide is applied at the correct dosage and when the spraying is timed to be effective during the transmission season. Selective spraying invariably reduces malaria cases in endemic areas where vectors bite indoors.

Bendiocarb, one of the candidate compounds that will be tested as a future replacement for malathion, has been used successfully and on a large scale in several malaria programs worldwide. It is currently in use in programs in South Africa, Mexico and Nepal, and has been reported to be a safe, effective insecticide by malaria officials of these countries.

Pirimiphos-methyl has not been used by USAID-supported malaria programs, but has been tested by WHO in large-scale trials with entomological and epidemiological assessment as well as safe-use assessment. It has been approved for use in malaria spraying by WHO. Since there is no cross-resistance between malathion and other OP compounds, it is appropriate to test pirimiphos-methyl as a candidate replacement insecticide. Because of its effectiveness against other insects and its safety for use against household pests, pirimiphos-methyl should be a candidate for malaria-control house spraying.

Deltamethrin is an appropriate pyrethroid insecticide for use against anopheline mosquitoes in these trials because of its long history of use for house spraying in malaria programs in other countries. Even though pyrethroid insecticides are now expensive, their low-dosage application rates may make them cost-effective for use in malaria programs. Low dosages also make these compounds very safe for field use.

Use of another pyrethroid insecticide, lambda cyhalothrin, has the same advantages mentioned above for deltamethrin. There is an advantage in including two synthetic pyrethroid insecticides in these trials since they may be different in their length of residual action and their tendency to develop cross-resistance to DDT. A choice between these two pyrethroids can be made on the basis of the field trial results.

## 4.7 Compatibility of the Proposed Insecticides with Target and Non-Target Ecosystems

The selected insecticides have been widely used in other countries for mosquito control with human and environmental safety because of the three major characteristics of the insecticides and application methods: 1) sprays are confined to and directed on the indoor walls and ceilings of houses and animal shelters; 2) sprays are applied at very low dosages; and 3) sprays have relatively high insect/mammal selectivity, particularly for pyrethroids (3545 - 5560 x safety) (Table 3). Residual spraying is effectively aimed at having a contact poisoning effect on the targeted mosquito species based on its endophilic resting behavior.

Major non-target species affected by house spraying will be arthropods resting on or living in the cracks and crevices of inside walls and ceilings, such as flies, fleas, bedbugs, cockroaches, ants, scorpions, centipedes, spiders and other insect predators. Toxicity could also occur if domestic animals feed on dead insects, especially those killed by bendiocarb spray. Because of the controlled and contained nature of the spray, non-target species found outdoors have negligible or no risk of exposure.

Pakistan has seven national parks, 69 wildlife sanctuaries and 73 game reserves varying in size from four hectares to 2.7 million hectares. Endangered species listed are 31 species of mammals, two species of birds, and five species of reptiles. Five animal species are listed as threatened with extinction in Pakistan (Hobbs and Larew 1988). No endangered or protected species has been reported inside or near homes to be treated by insecticides. There are no national parks or wildlife preserves near the areas to be treated.

Significant environmental risk is associated with transport, storage and mixing/loading of pesticides, and in the washing of buckets and sprayers

and disposal of waste. These activities could result in contamination of wells and aquatic habitats. Risk can be mitigated through safe practices in transport, storage, use and disposal of the insecticides (see section 6).

## 4.8 Conditions Under which Insecticides are to be Used

Insecticides will be applied indoors at recommended rates (Table 2). Spray crews will use specified equipment and application methods (section 4.4) and follow label directions. The MCP will implement mitigating measures for human and environmental safety and provide training, supervision and monitoring of spray crew (section 6).

The field trial will be conducted in the Sheikhupura District, the major ricegrowing district of the Punjab province. The trial area has a highly developed irrigation system. The annual rainfall in this region ranges from 50 to 100 cm with major monsoon rains in the summer months of July and August, which provide abundant breeding sites for vector mosquitoes. The houses are constructed with mud (approx 60%) or bricks (approx 40%), with ceilings made of thatch and wood (NIMRT 1991). The houses are mostly grouped in villages with a few dwellings scattered in farm fields. Common livestock in this region are buffalo, sheep, goats, horses, mules and chickens.

The soil in this region is clay-loam and slightly alkaline, with a shallow water table (average 3-6 m) providing drinking water from mechanical tube-well pumps.

## 4.9 Availability and Effectiveness of Other Insecticides or Non-Chemical Control Measures

In addition to the four insecticides under consideration here, other compounds are commercially available and have shown themselves to be effective in malaria control through house spraying. Among the carbamates, propoxur has been used successfully in several countries for many years. Fenitrothion, an OP compound, is available and has been employed with success when adequate safe-handling practices were observed by malaria program users. Other pyrethroid insecticides are available as well. Any decision to use these compounds in the future should be based

on careful analysis of field trials carried out in Pakistan as well as in other countries.

Non-chemical malaria control methods, such as source reduction by drainage and improved water management, are not being employed by the MCP. These methods might be considered for inclusion in the program in the future, particularly in urban or periurban areas, villages located in arid areas with restricted water sources, or in selected rural areas where malaria has been reduced to manageable but persistent foci of transmission.

## 4.10 Ability of the Government of Pakistan to Regulate or Control the Distribution, Storage, Use and Disposal of Pesticides

The DOMC has many years of experience in the distribution, storage and safe use of insecticides. Insecticides from abroad are unloaded at Karachi. Technical officers of DOMC, and sometimes of USAID, supervise the unloading and distribution of insecticides to the provinces where spraying is to take place.

Three of the four insecticides to be tested by small-scale field trials are already on hand and stored in the facilities of NIMRT, or in the study areas at storerooms of the basic health units nearest the field study sites. The fourth insecticide, deltamethrin, is in Pakistan under the control of the local agent of the manufacturer. This donated insecticide will be delivered to NIMRT in the near future.

Disposal of unused insecticide should not be necessary, since the number of houses to be sprayed is relatively small. Approximately 4,000 houses, or 1,000 houses per insecticide, will be sprayed, and supplies should be completely used up.

As is the current practice with malathion containers in Pakistan, plastic box liners will be rinsed and buried, and outer paper boxes will be burned.

## 4.11 Provision of Training of Malaria Control Insecticide Users

Spray personnel will be recruited from the localities where the trials will take place. The spray-squad supervisors as well as the general field supervisors of the operation are long-time employees of NIMRT, and also have experience in the regular spraying operations of the malaria control program.

Newly recruited spray personnel will be given a one-week training course before the operation begins. Training will cover correct mixing of finished insecticide spray, equipment maintenance and cleaning, and safety precautions to take while spraying or otherwise handling insecticides. Symptoms of poisoning will be explained to the users, as well as first aid measures to be taken if signs of intoxication appear.

This training is similar to the training the MCP gives newly employed spray personnel before the spraying cycle starts.

## 4.12 The Provision Made for Monitoring the Use and Effectiveness of the Insecticides

The correct use of the insecticides in the field will be monitored through direct supervision by spray squad leaders, field supervisors and the project manager of the field trials. The insecticide will be applied only to indoor walls and ceilings of houses and animal shelters. Spraying technique will be checked frequently to make sure that the correct dosage of insecticide is applied to the walls. The hand-pressure sprayers will be inspected daily to ensure that they are not leaking or dripping insecticides. Cleanup at the end of the day will be closely supervised to ensure proper disposal of wash water.

The effectiveness of the spray will be monitored with both entomological and epidemiological techniques. Human-vector contact will be measured before and after spraying by biting captures indoors and outdoors, and mosquito population densities will be measured by captures of anophelines resting in houses and animal shelters. Dissections for age grading will be done on the house-resting component of the population to

determine if the age of this group has been altered by the spraying. Exit traps will be installed in the houses of the trial area, and exit-trap densities will be established before and after the spraying. All vector anopheline females captured will be dissected for sporozoite rates.

As for the epidemiological assessment of these trials, a baseline survey will be carried out prior to the spraying in indicator villages. This survey will consist of taking blood slides from:

a. all infants less than one year of age;

b. 20 percent of all children aged one to 10 years; and

c. 20 percent of all adults.

Follow-up surveys, sampling the same age groups, will be carried out at six monthly intervals after spraying. Epidemiological investigation of all microscopically confirmed cases obtained in follow-up surveys will be carried out to determine where actual transmission took place.

# 5. Environmental Impacts of the Proposed Action

This section summarizes the environmental impact of the proposed use of the alternative insecticides: bendiocarb, pirimiphos-methyl, lambda cyhalothrin, and deltamethrin. Sections 4.5, 4.7 and 6 contain specific discussions of the environmental impact of these insecticides.

## 5.1 Unavoidable Adverse Environmental Impact

Non-target species, primarily arthropods inhabiting or resting on the indoor walls and ceilings of houses, will be poisoned along with the targeted mosquitoes. Domestic animals, particularly ducks and chickens, will also be acutely intoxicated if they feed on dead insects, especially those killed by bendiocarb and pirimiphos-methyl sprays. Sweeping floors and burying dead insects should eliminate this danger. Animals such as water buffaloes, goats, cows and donkeys will receive some contamination through oral, dermal and inhalation routes if animal shelters are sprayed. This exposure will be minimized by removing animals before spraying and maintaining a one-hour reentry period. Honeybees can be intoxicated or killed if they are exposed to trace amounts of insecticide during spraying. A detailed mitigation plan is discussed in section 6.

Mixer and spray crew personnel will receive some acute exposure through dermal and inhalation routes. Inhabitants will also be exposed to trace amount of insecticides through contact with sprayed surfaces or inhalation of vapor (particularly pirimiphos-methyl) or spray aerosols. Safety measures to reduce exposure are discussed in section 6.

Outdoor contamination of surface and groundwater will be minimized if pesticide mixing and cleaning of sprayers occur far from wellheads and open bodies of water, and if rinse water is used for the next spray or buried in a shallow hole away from water sources.

## 5.2 Positive Environmental Aspects

Indoor residual spraying of insecticide is still the most cost-effective method of malaria vector control in Pakistan. Current evaluation of alternative insecticides for efficacy as well as human safety and environmental impact will provide more choices for mosquito resistance management and for using the insecticide with lowest risk under particular environmental and socio-economic conditions.

The pyrethroids have a high mammalian safety margin, are applied at an extremely low rate and have low potential for environmental contamination under normal use conditions. These characteristics and easily implemented precautions will further lessen the pesticide load and reduce the negative impact on the environment in comparison with the effects of other classes of insecticides.

## 5.3 Relationship between Short-term Impact and Long-term Productivity

The long-term benefits of malaria control, such as increased human productivity, enhanced health and vigor, and reduced premature mortality far outweigh the short-term impact of insecticide use. Eradication of malaria in Pakistan is probably not a feasible short-term goal for the following reasons: 1) the population is large, dispersed, and mobile; 2) there is a continuing influx of new malaria cases from migratory Afghanistan refugees and workers, 3) diverse, temporal and inaccessible breeding niches for malaria vectors present logistical problems.

## 5.4 Irreversible or Irretrievable Commitments of Resources

The proposed project will result in irreversible and irretrievable consumption of petrochemicals in the form of insecticides and motor fuel for transport. In the unlikely event that environmental contamination occurred, temporary loss of biota would result. This loss, however, would be rapidly replenished by migration and recolonization from unaffected habitat, since these insecticides dissipate and degrade rapidly in the environment to non-toxic levels and non-toxic metabolites.

# 6. Environmental Impact Mitigation Plan

This section highlights priorities for safety, safety protocols, safety training, and compliance monitoring of a plan to mitigate any environmental impact that might result from this project.

The malaria control personnel in Pakistan, with the exception of spray personnel who are recruited for piecework, are well-versed and experienced in the use of malathion in intradomiciliary spray. The permanent staff are familiar with general safety precautions and procedures for safe transport, storage, mixing, spraying, cleaning and maintenance of equipment, and waste disposal.

This mitigation plan focuses on the more unique properties and toxicities of the four proposed insecticides that might result in adverse impact on human health and the environment.

## 6.1 Priorities

The actions listed below should be priorities for field trial managers:

- Obtain pesticide use labels specifically for mosquito control and a material safety data sheet (MSDS) on each compound. Read and understand the directions for use, emergency treatment, handling of spills and fire, disposal of rinsate and container, and human and environmental safety measures.

- Train the permanent staff on the physico-chemical properties, toxicology, environmental fate, and potential environmental impact of these compounds.

- Train the new spray crew in 1) proper handling, mixing, spraying and disposal of insecticides; 2) proper use of protective clothing and equipment; 3) proper decontamination procedures in case of exposure to spills or drift, 4) proper personal hygiene; 5) proper calibration (by supervisor), spraying technique and maintenance of spray equipment.

- Maintain a cholinesterase monitoring program for spray crew for bendiocarb and pirimiphos-methyl only and not for pyrethroids. Establish baseline levels and perform periodic tests depending on exposure load.

- Prevent excessive insecticide exposure to inhabitants.

- Prevent groundwater and surface-water contamination.

- Prevent contamination of food, drink and animal feeds, clothing, bed, furniture and other household items.

- Prevent poisoning of domestic animals, birds, fish, aquatic invertebrates, honeybees and wildlife (especially endangered or protected species.)

- Monitor compliance with safety protocols and record incidents of human illnesses or injuries or of adverse environmental impact as a result of insecticide use.

## 6.2 Safety Protocols

### 6.2.1 Applicators

Personnel responsible for applying insecticide should take the following precautions and comply with the guidelines listed below:

- Wear protective clothing (coveralls, rubber gloves, rubber boots, masks, face shield, head cover) as specified by the product label and as appropriate to local conditions.

- Beware of heat prostration and heat stroke. Work during the cooler part of the day, take frequent breaks, and keep hydrated. Avoid a long work day.

- To avoid excessive exposure and spills that could occur during pre-mixing in a bucket, mix insecticide directly in the spray tanks (especially when it is packed in water soluble sachets) unless another mixing method is specified on product label.

- Observe good personal hygiene: do not smoke, eat, or drink while using pesticide. Wash hands and exposed skin before going to the bathroom (to prevent dermal transfer to genital area) and before meals. Keep fingernails trimmed.

- Do not rub eyes or mouth or scratch body with contaminated hands or nails.

- Do not unclog a nozzle by blowing into it but use a soft tooth-pick or toothbrush (see section 4.4). Filter the water and well-mixed insecticides if clogging is a problem.

- Stop spraying if the nozzle is blocked and depressurize the pump before attempting to clear the nozzle.

- If insecticide is splashed on your eyes, immediately rinse them with clean water for 10 to 15 minutes.

- Wash concentrate from skin immediately with soap and water. (Note: be aware of special procedures for certain pyrethroid formulations.)

- Wash clothing immediately if splashed; change clothing and wash it immediately if it becomes soaked in insecticide.

- Avoid spraying the floors of houses.

- Avoid spraying electrical fixtures: a short-circuit might result.

- Discontinue spraying if signs and symptoms of intoxication occur; remove yourself from sources of exposure, and decontaminate and treat accordingly. Resume spray work only after full recovery (see section 6.4).

- Wash thoroughly after work and change into clean clothes. Wash work clothes separately from household laundry.

Field trial managers should ensure that:

- Applicators are in good health: free of skin lesions, open wounds, dermatitis or skin allergies, and respiratory ailments;

- Applicators are given information on preventing the hazards of acute intoxication, especially from the more toxic bendiocarb and pirimiphos-methyl, and the dermal effects caused by pyrethroids and skin eye irritation by pirimiphos-methyl;

- Spray crews work under direct supervision to ensure compliance with safety precautions and the availability of first aid in the event of an accident;

- Crew members who mix and load sprayers, handling concentrate materials for all four insecticides, are provided with eye and face protection (mask and face shield) and rubber gloves; and

- A clean bucket of water (no pesticide) and soap for hand washing and emergency decontamination are available.

### 6.2.2 Household occupants

Spray crew personnel should protect household occupants by following the steps listed below:

- Inform occupants about the pesticide sprayed, its toxicity to humans and animals, and the safety precautions/mitigation efforts required.

- Remove all items from houses before spraying.

- Keep people and animals away from the house or work site during mixing and spraying.

- Block the doorway immediately after spraying in a way that prevents entry of people and animals, yet provides ventilation.

- Open windows to enhanced drying of spray deposit and ventilation of any vapor and aerosols.

- Prohibit reentry of people and animals for at least one hour after spraying.

- Sweep the floor after one hour and bury sweepings away from the house. Wear a dust mask while sweeping to minimize inhalation of dust particles.

- Post a card on each house to record visits, inspections, and date, dosage and material sprayed.

### 6.2.3 Environment

Spray crews should protect against environmental contamination by taking the following precautions:

- Avoid groundwater contamination. Mix pesticides and wash spray equipment at least 10 meters from drinking water wells and pumps to prevent point source contamination.

- To avoid fish kills, do not spray directly on bodies of water and do not clean spray equipment or dispose of waste in bodies of water.

- To avoid killing honeybees, do not spray or allow spray to drift on beehives or blooming plants. Advise beekeepers to move or close hives during spraying.

- Triple rinse empty containers or plastic liners and dispose of them by burning (preferred) or burying according to label directions. Do not stand downwind of burning containers. Only burn a few containers at a time and burn them in an open field. Do not reuse containers.

- Minimize exposure during mixing. Use prepackaged insecticide in water-soluble sachets designed to be mixed directly in a sprayer.

- Store pesticide in its original container away from houses, food, beverages, and animal feed in a separate, lockable shelter. Store away from potential flood or fire hazards.

## 6.3 Safety Training

All personnel should have hands-on training in:

- proper mixing, handling and spraying of insecticide;
- proper fitting and wearing of protective clothing;
- proper personal hygiene;
- first aid for splashes, spray, spills and drift;
- proper cleaning and maintenance of sprayers;
- proper disposal of empty containers and rinsate; and
- the signs and symptoms of poisoning from organophosphorus compounds, methyl carbamates, and pyrethroids.

The supervisors and permanent staff should have training and knowledge in the following areas in addition to those listed above:

- calibration of sprayers to ensure that the correct dosage is applied and correct volume of water is used for each type of spray surface, according to the label;
- emergency response and treatment;[1] and
- the basic principles of toxicology, mode of action, environmental fate, and potential adverse environmental effects of the insecticides used.

## 6.4 Program to Monitor Performance and Compliance

The monitoring program should follow a good laboratory practices protocol that includes a quality assurance and quality control program for

[1]It is critical to note that pyrethroids are not cholinesterase inhibitors. Pyrethroid intoxication should not be treated with atropine sulphate.

assessing the efficacy of insecticides in vector and disease control (detailed in section 4.2).

Cholinesterase monitoring should be maintained for spray crew applying OP and methyl carbamates (Hobbs and Larew 1988). Direct supervision should be maintained during field operations. Any spray crew member exhibiting signs and symptoms of poisoning or significant (25-50 percent) cholinesterase depression should be removed from further exposure to the pesticide and, if he is able to work, given other duties such as house preparation until he recovers.

Supervisors should have a copy of the pesticide label with instructions on first aid and emergency treatment information, which are found on U.S. labels under the headings: "Statement of Practical Treatment" and "Note to Physician," so that this information is available to the attending physician in case of accidental poisoning.

The human and environmental effects of insecticide use should be assessed immediately after and one day after spraying through follow-up interviews and observation of inhabitants and the environment. Any complaints, illnesses or injuries exhibited by inhabitants or spray personnel should be recorded. Reports should include: 1) a case description: species, age, sex, illness or injury type; and 2) insecticide type, dosage, and time applied, route of exposure, duration of exposure, when exposure occurred, and the activity engaged in during exposure. These are critical data for determining whether mitigating measures are adequate. Ideally environmental monitoring of pesticide residues in the air and swipe samples of walls and floors could be measured to establish more accurate reentry interval and ventilation requirements for the OP and methyl carbamate. Biomonitoring of spray crew for insecticides or metabolites should be considered in the future to assess the extent of exposure and the adequacy of protective clothing and safety practices.

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# Annex A. Scoping Statement

## 1. Introduction

This scoping statement was prepared as a result of briefing held in Washington, D.C., and Pakistan, and a field visit in Pakistan in July 1992. It was written by the EA team in accordance with 22 CFR 216.3(a)(4)(a)-(d). The purpose is to identify the issues that will be analyzed in an EA of pesticide use in the field trials of four insecticides (bendiocarb, pirimiphos-methyl, lambda cyhalothrin and deltamethrin) that will be tested in small-scale field trials beginning in August 1992. The purpose of these field trials is to select compounds that might, in the future, be employed as replacements for malathion. This scoping statement will also describe how the EA will be conducted.

## 2. Project Description and Proposed Pesticide Use in Field Trials and in the Malaria Control Project II

The MCP II consists of four components:

1. **Program Management:** technical assistance to strengthen the MCP in the areas of program management, entomology, epidemiology, safe handling of insecticides, evaluations, surveillance, urban malaria control and environmental management;

2. **Training:** short-term technical assistance to strengthen the training capability of NIMRT to meet the needs of the MCP in specific areas of malaria control;

3. **Operational Research:** short-term technical assistance to strengthen the capabilities of NIMRT and provincial malaria control programs to conduct operational research and field studies, to obtain supplies and equipment for research, and to provide budgetary support for operational research and field studies; and

4. **Commodity Support:** for residual insecticide, spray equipment, malaria control vehicles, ULV spray and fogging machines, adulticide, microscopes and other necessary commodities.

A limited amount of insecticide spraying of rural dwellings will continue to be a part of malaria control in Pakistan. The GOP is now directing its insecticidal spray operations to areas where malaria transmission is occurring. Future surveillance will restrict spraying to limited areas within each district. Under the MCP's selective spraying approach, only villages with an API of 2.0 or more cases per thousand population or villages with any incidence of falciparum malaria are targeted for spraying.

## 3. Scope and Significance of Issues

For the small-scale field trials of the insecticides being considered in this EA, the pesticides will be applied as intradomiciliary sprays. Although it is possible that these four insecticides will have a detrimental impact on the environment, the EA team believes that any negative environmental effects should be minimal both because of the focused nature and because house spraying limits outdoor impacts. The EA team believes that the greatest potential negative impact is to people involved in pesticide application, such as spray personnel, mixers and spray-squad supervisors.

The following issues were identified for further assessment:

1. The USEPA registration status of the requested pesticide;

2. The basis for selection of the requested pesticides;

3. The extent to which the proposed pesticide use is part of an integrated pest management program;

4. The proposed method or methods of application, including availability of appropriate application and safety equipment;

5. Any acute or long-term toxicological hazards, whether human or environmental, associated with the proposed use and measures to minimize such hazards;

6. The effectiveness of the requested insecticides for the proposed use;

7. Compatibility of the proposed pesticides with target and non-target ecosystems;

8. The conditions under which the insecticides are used, including climate, flora, fauna, geography, hydrology and soils;

9. The availability and effectiveness of other pesticides on non-chemical control measures;

10. The country's ability to regulate or control the distribution, storage, use and disposal of the requested pesticides;

11. Provisions made for training users and applicators;

12. The provisions made for monitoring the use and effectiveness of the insecticides.

## 4. Timing and Planning

The EA will be written as a result of a two-person team review of the field trial plans, protocols and test sites in Pakistan. The team will visit Pakistan in July 1992 for three weeks. Team members will discuss the issues with key personnel in the GOP and USAID/Islamabad and visit the field trial areas in the Punjab. They will also visit NWFP and Baluchistan to observe training in safe handling of pesticides given to malaria control personnel.

Before leaving Pakistan the team will submit a draft EA to USAID/ Islamabad and brief Mission personnel on EA recommendations. Upon returning to the United States, the team will complete the EA for submission to USAID.

## 5. Team Composition

The EA team will be composed of a malariologist with wide experience in the conduct of malaria control programs, and an environmental toxicologist with expertise in pesticide safety and in A.I.D. environmental regulations.

# Annex B. Persons Contacted

**USAID Islamabad**

Dr. Rifaq Ismail, Project Officer, HPN
Dr. Lois E. Bradshaw, Acting Chief, HPN
Mr. Mark Ward, Mission Director (A), USAID
Mr. John B. Swanson, Deputy Chief, O/ARD
Mr. Shahabuddin Khan, Project Monitoring, O/PDM
Mr. Joe Ryan, Chief Economist, USAID
Mr. Laiq Ali, Environmental Officer, USAID

**Ministry of Health, GOP, Islamabad**

Dr. Syed Mohsin Ali, Director General

**Ministry of Health, Directorate of Malaria Control**

Mr. Chaudhary A.A. Mujahid, Director
Dr. G. Hashim, Epidemiologist

**National Institute of Malaria Research and Training, Lahore**

Dr. Imtiaz Hussain Shah, Director
Mr. S.D. Pervez, Assistant Entomologist
Mr. Mushataq Ahmed Rai, Assistant Scientific Office
Mrs. Ghazala Nadeem

**Baluchistan Province**

Dr. Mohammed Iqbal, Secretary of Health
Dr. Rehman Khan, Director General of Health
Dr. Hussain Baloch, Provincial Chief, Malaria
Dr. Mehmood Piracha, Epidemiologist

**North West Frontier Province**

Dr. M. Iqbal Khan, Provincial Director, Malaria
Mr. A. Aziz Khan, Sr. Malaria Superintendent
Mr. Shaukat Pervez, Assist. Entomologist
Mr. Fazle Razique, Entomologist

**Jaffer Brothers (Private) Limited**

Mr. M. Naziruddin, Manager, Public Health Dept., Karachi
Mr. Syed Muserrat Ali, Baluchistan
Mr. Mohammed Altaf, Rawalpindi

**Roussel Uclaf**

Mr. Jean Pierre Trijau, Senior Development Manager, Paris
Mr. H.H. Dupont, Chief Executive, Pakistan

# Annex C. Insecticide Product Labels

# ICON 10 WP

ENDORSED BY icon WHO

Contains 100 g lambdacyhalothrin per kg as a wettable powder.

Each sachet contains 62.5 g product.

**Before you open the sachet read the safety advice**

'ICON' 10WP is a broad spectrum insecticide. The active ingredient, lambdacyhalothrin, is a novel synthetic pyrethroid developed as a result of extensive research. It is exceptionally active against all insects of public health importance. 'ICON' 10WP is SUITABLE FOR USE INDOORS for the control of insects in industrial and domestic premises including restaurants, hotels and kitchens AND FOR OUTDOOR TREATMENTS in public areas such as market places or refuse collection points.

**Directions for Use**

'ICON' 10WP is intended for dilution in water for application as a residual spray using conventional compression sprayers. The sprayer should be operated at a maximum pressure of 40 psi. Fill the sprayer with 8 litres of clean water. Peel open the outer sachet of 'ICON' 10WP and carefully tip the inner water soluble sachet into the sprayer. Close the sprayer and shake well before use.

8 litres of spray solution should treat approximately $200m^{-2}$.

**Vector Mosquitoes** (Anopheles sp).

Apply to provide an even coverage to all inside walls and ceilings of houses and out buildings such as animal shelters. For good control all houses in the area should be treated.

Two applications per year should be made.

**Cockroaches and Crawling Insects**

Apply as a coarse low pressure spray to areas where the insects hide such as corners, around water pipes and drains, behind and under refrigerators, cupboards and similar areas. Particular care should be taken to treat all cracks and crevices thoroughly. Re-treatment should be made as necessary, but is unlikely to be required at intervals of less than 12 weeks.

**Flies**

Apply to all surfaces where flies congregate and rest. Out of doors apply as a residual treatment around refuse dumps and other breeding sites where adult flies congregate.

Icon is a registered trade mark of Imperial Chemical Industries PLC, England.

Gen. Ovs. 799225/1 VIII88

# ICON 10 WP

**Safety Precautions**

Do not smoke, drink or eat while using this product.

**For Safety When Mixing**

If you get it in your eyes, wash it out at once. See FIRST AID.
If you get it on your skin, wash it off at once.
If you spill it on your clothes, change and wash them.
Wear a mask covering nose and mouth.

**For Safety When Spraying**

As with all chemicals, AVOID CONTACT WITH THE SPRAY as much as you can.
Wear a mask covering nose and mouth.
Do not spray directly on to food.
To avoid harming fish, do not spray over water.

**For Safety After Spraying**

WASH YOURSELF.
Change and wash your work clothes.
Do not dump unwanted ICON in water.
Keep unused 'ICON' 10 WP in original container, locked up out of reach of children and away from food.
Burn or bury empty packets.

**FIRST AID**

Eye splashes: wash out for 10-15 minutes. Go to a doctor.
IF 'ICON' 10 WP IS SWALLOWED MAKE THE PERSON VOMIT.
Take person, and this pack, to a doctor at once for treatment.
MEDICAL TREATMENT: Perform gastric lavage, taking care to prevent aspiration of gastric contents. Then treat symptomatically.

ICON is a registered trade mark of Imperial Chemical Industries PLC, England.

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**contains:**

Deltamethrin ..... 25 g/kg
inert ingredient ..... 975 g/kg
and formulation additives

**directions for use:**

For control or mosquito vectors of malaria K-Othrine WP 25 should be applied twice per season, each time at an application rate of 20 mg/m² i.e 80 g of K-Othrine WP25 should be mixed with 6 litres of water and the suspension applied to surfaces at a rate of 6 litres per 100 m² or until surfaces are thoroughly wetted.

As an alternative a single spray per season at 25 mg/m² may suffice i.e 100 g of K-Othrine WP 25 should be mixed with 5 litres of water and the suspension applied to surfaces at a rate of 5 litres per 100 m² or until surfaces are thoroughly wetted.

**normal storage stability:**

2 years.

The batch number and manufacturing date are shown on the top of the drum.
The date of test is the same than the date of manufacture.
Expiry date: 2 years from date of manufacture.

# K-Othrine®

## wp 25

**INSECTICIDE FOR RESIDUAL TREATMENT**

Wettable powder

**Net content: 25 kg**

ROUSSEL UCLAF
*Division Agrovet*
*163, avenue Gambetta, 75020 Paris France*
*Tel.: (1) 43.60.01.65 - Telex: 210167 Agrov*

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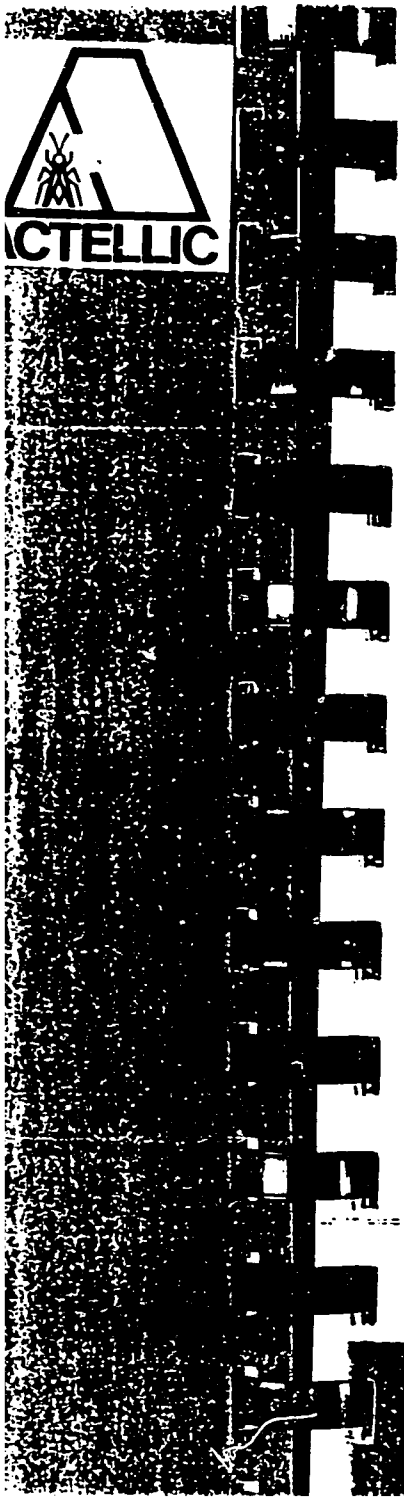


# ACTELLIC 40 WP

A residual organophosphorous wettable powder insecticide with a nominal content of 400g/Kg pirimiphos-methyl. (WHO/OMS 1424)

A LONG ACTING FORMULATION OF THE BROAD-SPECTRUM INSECTICIDE "ACTELLIC" FOR TREATMENT OF SURFACES TO CONTROL ADULT VECTOR MOSQUITOES.

**BEFORE YOU OPEN THE PACK read the safety advice**

**FOR USE ONLY AS A PUBLIC HEALTH INSECTICIDE IN MALARIA CONTROL CAMPAIGNS**

THIS PRODUCT IS CLEARED UNDER THE UK GOVERNMENT'S CONTROL OF PESTICIDES REGULATIONS (1986) FOR USE AS DIRECTED (HSE 1297)

**IRRITATING to eyes and skin**

**PRECAUTIONS**
PIRIMIPHOS-METHYL IS AN ORGANOPHOSPHOROUS COMPOUND
DO NOT USE this product if a doctor has told you not to work with such compounds.

WEAR SUITABLE SYNTHETIC GLOVES WHEN HANDLING CONCENTRATE

WASH SPLASHES OF SPRAY FROM SKIN OR EYES IMMEDIATELY
DO NOT BREATHE SPRAY MIST if necessary wear a mask for personal comfort. As with all chemicals, avoid contact with the spray as much as you can

COVER WATER STORAGE TANKS BEFORE APPLICATION

HARMFUL TO FISH. Do not contaminate ponds, waterways or ditches.

WHEN USING, DO NOT EAT, DRINK OR SMOKE

WASH HANDS AND EXPOSED SKIN BEFORE MEALS AND AFTER WORK. Change and wash work clothes.

DISPOSE OF EMPTY CONTAINERS CAREFULLY — DO NOT USE AGAIN

STORE UNUSED PRODUCT IN CLOSED CONTAINERS LOCKED UP AND AWAY FROM CHILDREN, FOODSTUFFS AND DOMESTIC ANIMALS.

IF YOU FEEL UNWELL Seek medical advice and show the doctor this label.

**FIRST AID/ANTIDOTE:**
**Pirimiphos-methyl is a cholinesterase inhibitor**
**The specific antidote is ATROPINE, PAM OR TOXOGONIN**

For further advice contact your nearest 'Poison Centre' or the 'Safety Department' at ICI Public Health, Fernhurst, Haslemere, Surrey GU27 3JE, England.
Telephone number: (0428) 644061 Telex: 858270

Iran 706614/2 181 BP20578

Systems 8002 (or equivalent) nozzle and apply Actellic 40 WP at the recommende rate to walls, ceilings and other surfaces where mosquitoes are known to rest

**INSTRUCTIONS FOR USE:**

1. Place two litres of water in a 15 litre mixing bucket and slowly add one measure (625g) of Actellic wettable powder. Mix the wettable powder to a smooth cream paste. Add a further six litres of water until the powder is suspended to a creamy consistency. Pour the suspension into the spray pump through the supplied filter funnel, carefully dispersing any unmixed lumps of wettable powder still remaining. Carefully rinse from the filter any debris or sand originally present from the water supply. Make up the spray volume in the pump to ten litres with filtered water. Close the sprayer securely and shake to thoroughly mix the contents. (If for any reason spraying is discontinued for more than five minutes then shake the spray tank again prior to continuing work).

2. Pressurize the spray pump to a maximum of 55 pounds per square inch (3.8kg/cm²). Stop spraying in the event of a blocked nozzle and de-pressurize the pump before attempting to clear the nozzle jet.

3. Apply the spray with an overlapping swath at a rate of 40 ml per square metre of sprayable surface to leave a deposit of 1.0 grammes of active ingredient per square metre. Surfaces such as mud and brick are highly absorbent whilst others such as finished concrete, metal and tile are much less absorbent and may cause the spray to run off.

4. After spraying is completed de-pressurize the tank, dispose of un-used spray safely and rinse out the tank with clean water. Flush through the hose, hand-set and nozzle with clean water and remove and inspect the in-line filter in the hand-set. Replace filter.

5. Actellic 40 WP will also control many other domestic health pests including flies, fleas, bedbugs, cockroaches, ants and scorpions.

Actellic is a trademark of Imperial Chemical Industries PLC
Actellic 40 WP is manufactured by ICI Public Health
Fernhurst, Haslemere, Surrey GU27 3JE, England.
"Ordered by I.P.I. for the Islamic Republic of Iran."

Bx No.
Date of Man

**Public Health**

**Irritant**

SPECIMEN LABEL

Note: This is a new label for bendiocarb. The 80% wdp formulation is no longer sold (NOR-AM comm., 8/20/92).

# Ficam® W

## 76% WETTABLE POWDER INSECTICIDE

RECOMMENDED FOR USE ONLY BY PEST CONTROL OPERATORS

| | Percent by Weight |
|---|---|
| ACTIVE INGREDIENT: | |
| Bendiocarb (2,2-dimethyl-1,3-benzodioxol-4-yl methylcarbamate*) | 76% |
| INERT INGREDIENTS: | 24% |
| TOTAL | 100% |

EPA Reg. No. 45639-1

PRECAUCION AL USUARIO: Si usted no lee ingles, no use este producto hasta que la etiqueta haya sido explicada ampliamente.

KEEP OUT OF REACH OF CHILDREN

## WARNING — AVISO

### STATEMENT OF PRACTICAL TREATMENT

**IF SWALLOWED:** Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person. Get medical attention.

**IF INHALED:** Keep patient strictly at rest and transfer to hospital immediately to get medical attention.

**IF ON SKIN:** Wash with soap and warm water.

**IF IN EYES:** Rinse thoroughly with clean water.

**NOTE TO PHYSICIAN:** Contains anticholinesterase carbamate insecticide. In cases of overexposure atropine sulfate—2mg. (equivalent to 1/30 grain adult dose) should be given and repeated as necessary until fully atropinized.

NOR-AM
NOR AM CHEMICAL COMPANY
A Schering Berlin Company
SPECIALTY PRODUCTS DIVISION
3509 Silverside Road, P.O. Box 7495
Wilmington, DE 19803

NET CONTENTS

Protected by U.S. Patent No. 3,736,338

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## PRECAUTIONARY STATEMENTS
## HAZARDS TO HUMANS AND DOMESTIC ANIMALS
## WARNING

Harmful or fatal if swallowed. May be absorbed through the skin. Avoid contact with the eyes, skin, and clothing. If contact occurs, wash skin and clothing immediately with soap and warm water, and eyes with clean water.

Do not rub eyes or mouth with hands. If you feel sick in any way, STOP WORK and get help right away. See First Aid (Practical Treatment) section.

Avoid breathing and working in spray mist or dust.

When applying in outdoor sites keep all unprotected persons, children, and animals away from treated area or where there is danger of drift.

Wash hands and exposed skin before eating, drinking or smoking and after spraying or handling. Wash all contaminated clothing thoroughly before re-use.

Do not apply to humans, their clothing or bedding.

Do not permit children or pets to contact treated surfaces until spray has dried completely.

With proper spraying, FICAM W does not result in a visible deposit.

However, if unevenly applied, or sprayed to run-off, a visible deposit may occur on some dark surfaces. Do not spray where electrical short circuits might result.

Do not use or contaminate fruit, vegetables or other feed or food crops.

Do not store near food or food products and do not contaminate these or food preparation surfaces, dishes, kitchen utensils and food containers with either concentrate or spray.

## ENVIRONMENTAL HAZARDS

This pesticide is toxic to fish and wildlife. Do not apply directly to water or wetlands (swamps, bogs, marshes, and potholes). Runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water when disposing of equipment washwaters.

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.

# STORAGE AND DISPOSAL

**STORAGE:** Stable at normal temperatures. Store in a dry place.

**PESTICIDE DISPOSAL:** Do not contaminate water, food, or feed by storage or disposal.

Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

**DO NOT REUSE ORIGINAL CONTAINERS.**

**CONTAINER DISPOSAL:**

- Packet—Completely empty packet into application equipment. Then dispose of empty packet in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.
- Poly Jar—Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

**IN CASE OF FIRE, LEAKY OR DAMAGED CONTAINERS, OR OTHER EMERGENCY, REPORT AT ONCE BY TOLL-FREE TELEPHONE TO: 800-424-9300.**

**GENERAL INFORMATION:** FICAM W is a wettable powder containing 76% by weight active ingredient which has given effective knockdown and residual control of those insects listed below.

FICAM W does not damage paints, plastics, fabrics or other surfaces where water alone causes no damage.

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Do not apply this product through any type of irrigation system.

Thoroughly wash out sprayer and strainer with water and detergent before using FICAM W.

For use by Professional Applicators for residual pest control in and on buildings and structures and their immediate surroundings and on modes of transport. Permitted areas of use include, but are not limited to, stores, warehouses, industrial buildings, houses, apartment buildings, mausoleums, greenhouses, laboratories, schools, nursing homes, hospitals, restaurants, hotels and food manufacturing, processing and servicing establishments and on vessels, aircraft, rail cars, buses, trucks and trailers.

Applications should be made to hiding places, runways, and other places where pests are found.

Pay particular attention to: cracks and crevices; around water and sewer pipes; under and behind cabinets, refrigerators and sinks; around window and door frames; along baseboards; in attics and crawl spaces.

FICAM W is intended for dilution with water for application with hand or power-operated sprayers. If water pH is greater than 8, add a commercial buffering agent to adjust water pH to 7 or less. The activity of FICAM W at pH 8 or greater may be reduced. Do not use strainers finer than 100 mesh size. When using hand sprayers, fill with the desired volume of water, add FICAM W, close tightly, and invert sprayer several times before use to insure proper suspension of the wettable powder. Re-invert sprayer before use if spraying is interrupted.

**Repeat treatments as necessary to maintain adequate control.**

**Dosage Chart: For Conventional Spray Volumes**

Use the white scoop provided for measuring from the poly jar. Each level scoopful contains 0.4 oz. FICAM W, which equals one packet.

1. One packet or scoop (0.4 oz.) of FICAM W mixed in one gallon of water yields 0.25% ai bendiocarb.
2. Two packets or scoops (0.8 oz.) of FICAM W mixed in one gallon of water yields 0.50% ai bendiocarb.
3. One pound of FICAM W mixed in forty gallons of water yields 0.25% ai bendiocarb.

**INDOOR USE**

**Cockroaches (Including both nonresistant and organophosphate and organochlorine resistant strains), Ants, Crickets, Silverfish and Firebrats:** Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai) and apply as a coarse low pressure spot or crack and crevice spray to areas where these pests hide, such as baseboards, storage areas, closets, around water pipes, doors and windows, behind and under refrigerators, cabinets, sinks and stoves, the underside of shelves, drawers and similar areas. For ants, apply to ant trails, around doors and windows and other places where ants enter premises.

**Adult Mosquito Control:** Residual indoor spray to reduce annoyance from mosquitoes. Mix 4 packets or 4 scoops of FICAM W per gallon of water (1.0% ai) and spray around doors, windows and screens and other places where mosquitoes may enter the premises. Mosquitoes coming to rest on treated surfaces will be killed.

Repeat treatment when effectiveness diminishes.

**Carpenter Ants:** Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai) and apply to ant trails, around doors and windows and other places where ants enter premises. Where possible, apply FICAM W directly to ant nest or infested wood.

**Termites:** Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai) and apply to voids or channels in damaged wooden members of a structure, or to cracks, spaces or bearing joints between wooden members of a structure or between such members and the foundations. In locations vulnerable to termite

attack such as crawl spaces. Drilling may be necessary prior to applying FICAM W to voids, cracks or joint spaces in vulnerable locations and to channeled sections of wood but it must be recognized that such drilling and treating of a timber in place may not result in complete coverage of infested and vulnerable voids or galleries. All treatment holes drilled in construction elements in commonly occupied areas of structures must be securely plugged.

The purpose of such applications of FICAM W is to kill workers or winged reproductive forms which may be present in the treated channels and spaces at the time of treatment and to impart a temporary resistance at these places to termite attack which may aid, in some part, in the prevention of immediate reinfestation by termites. Such applications are not a substitute for mechanical alteration, soil treatment or foundation treatment but merely a supplement, particularly where use of other insecticides may pose an odor problem.

Do not apply solution until location of heat or air conditioning ducts, vents, water and sewer lines and electrical conduits are known and identified. When located, applications may be made around these structures. However, caution must be taken to avoid contamination of these structural elements and airways.

**Brown Dog Ticks and Fleas in Buildings:** Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai) and thoroughly apply spray to infested areas such as pet beds and resting quarters, nearby cracks and crevices, rugs and floor coverings, and under their edges, between and under cushions of upholstered furniture and other areas where these pests may be present. Entire rugs may be treated. Apply the spray evenly (approx. 1 gal/800 ft.$^2$) to rugs and furniture. Old bedding of pets should be removed and replaced with clean fresh bedding after treatment of pet areas. Additionally, insure that pets are treated with an EPA approved product registered for such use. Do not treat pets or their bedding with this product. Do not permit children or pets to contact treated surfaces until spray has dried completely.

**Japanese Beetles—Aircraft:** Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai). Apply to areas where beetles may enter or be found such as carpets, under seats, storage areas, closets, around doors, behind and under galley equipment, in cargo holds and wheel wells.

**Spiders (Including Black Widow Spiders):** Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai) and apply to infested baseboards, window and door frames, corners, pipes, storage localities, attics and under eaves. Make spot applications to other areas over which these pests may crawl.

**Wasps and Bees:** Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai) and thoroughly spray nest and entrance and surrounding areas where insects alight. It is generally advisable to spray the nests in the evening when the insects are less active and have returned to the nest. For best results, check nest carefully one or two days after spraying to insure complete kill, then remove and destroy nest to prevent emergence of newly hatched insects.

**Sowbugs, Pillbugs, Ground Beetles, Earwigs, Millipedes, Centipedes and Scorpions:** Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai) and apply around doors and windows, and other places where these pests may enter premises. Spray baseboards, storage areas and other locations where these pests are found.

**Pantry Pests—Grain Beetles (Rusty, Merchant and Saw-toothed), Flour Beetles (Red and Confused), Drugstore Beetles, Rice Weevils, Lesser Grain Borers, Spider Beetles and Tobacco Moths:** Treat exposed stages. Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai). Remove all foodstuffs, shelving paper and utensils from area to be treated. Apply FICAM W to cupboards and shelves and allow to dry. Cover with shelving paper prior to replacement of food and utensils. Infested foodstuffs should be destroyed.

**Carpet Beetles (Black, Furniture and Varied):** Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai). Apply as spot applications on and under edges of floor coverings, under rugs and furniture, and in closets or other localities where these insects are found. Entire rugs may be treated.

**Note:** Where it is desired to obtain a longer period of control of all of the above pests in areas where access is difficult or where deposits will not be quickly removed by cleaning, apply FICAM W at a rate of two packets or two scoops per gallon of water (0.50% ai). This rate may also be used to quickly reduce heavy infestations of cockroaches.

**Webbing Clothes Moths:** Mix two packets or two scoops of FICAM W per gallon of water (0.50% ai) and apply spray as spot application in closets and other storage areas where webbing clothes moths are found. This treatment is an adjunct treatment and will not control moth larvae already on the clothes. Do not apply FICAM W to clothing.

FICAM W at 0.25% ai has consistently provided control of all of the above insects for 30 and often for 60 days.

**Interior Plants:** Refer to the ornamental pests recommendations in the Outdoor Use section.

**Food Handling Establishments:** Places other than private residences in which food is held, processed, prepared or served.

**Food Areas:** Application limited to spot or crack and crevice treatments only. For spot treatments, no individual spot will exceed two (2) square feet.

Includes areas for receiving, storage, packing, (canning, bottling, wrapping, boxing), preparing, edible waste storage and enclosed processing systems (mills, dairies, edible oils, syrups). Serving areas when food is exposed and facility is in operation are also considered a food area.

Prepare a spray solution as directed above and apply in small amounts directly into cracks and crevices using equipment capable of delivering a pinstream of insecticide in points between different elements of construction, between equipment and floors, openings leading to voids and hollow spaces in walls, equipment legs and bases where cockroaches, ants, silverfish, firebrats, spiders and crickets hide. Spot treatment using coarse spray may also be made to areas where any of the above pests hide or inhabit such as baseboards, storage areas, closets, around water pipes, doors and windows, behind and under refrigerators, cabinets, sinks, stoves and other equipment, the underside of shelves, drawers and similar areas.

Make applications using low pressure to avoid possible atomization or splashing of the spray. Avoid contamination of food or food processing surfaces.

**Non-Food Areas:** FICAM W may be used as a crack and crevice treatment or as a spot application in non-food areas. All areas where insects hide or through which insects may enter should be treated.

**This product is authorized for use in non-food areas of Federally Inspected Meat and Poultry Plants.**

## OUTDOOR USE

**Perimeter Treatment:** Residual spray for control of ants, bees, brown dog ticks, centipedes, cockroaches, crickets, earwigs, firebrats, fleas, ground beetles, millipedes, pillbugs, scorpions, silverfish, sowbugs, spiders (including Black Widow Spiders), and wasps. Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai) and apply as a residual spray or with a paint brush to surfaces of buildings, porches, screens, window frames, eaves, patios, garages and other areas where these pests congregate.

To help prevent infestations of buildings by the above pests, treat a band of soil and vegetation 6 to 10 feet wide around and adjacent to the building. Also, treat the building foundation to a height of 2 to 3 feet where pests are active and may find entrance. Mix one packet or one scoop of FICAM W per gallon of water (0.25% ai) and apply as a coarse spray to thoroughly and uniformly wet the band area.

**Yard Treatment:** For the control of nuisance pest populations of ants, crickets, spiders, ground beetles, ticks, sowbugs, and pillbugs, mix one packet or one scoop of FICAM W in FIVE gallons of water (0.05% ai) and apply as a coarse spray to thoroughly wet the treated areas.

**Ornamental Pests:** Use FICAM W to control specified pests on nonedible ornamentals such as: Ageratum, Asarina, Azalea, Baby's-breath, Begonia, Boxweed, Calendula, Cedar, Celosia, Chrysanthemum, Coleus, Daffodil, Dahlia, Dianthus, Euonymus, Ferns, Ficus, Flowering almonds, Flowering crab apples, Four-o'clock, Fuchsia, Gazania, Geranium, Holly, Hydrangea, Hypoestes, Impatiens, Iris, Ivy, Japanese yew, Juniper, Kalandra, Lilac, Lily of Valley, Marigold, Mimosa, Nasturtium, Nicotiana, Oleander, Pachysandra, Pansy, Petunia, Pine, Portulaca, Pyracantha, Rhododendron, Rose, Salvia, Schefflera, Shasta daisy, Snapdragon, Spirea, Taxus, Verbena, Vinca and Zinnia.

This product is highly toxic to bees exposed to direct treatment or to residues on plants.

Do not use on Cardoon, since plant injury may occur.

**IMPORTANT:** FICAM W has demonstrated excellent plant safety; however, all species and varieties have not been tested. When treating large numbers of plants of a single variety, treat a few plants and observe prior to full-scale application.

Apply FICAM W to point of run-off using recommended rates indicated below:

**GYPSY MOTH**

**Egg Mass Treatment:** Mix 4 oz. of FICAM W per 100 gallons of water and apply to egg masses until saturation. Applications can be made up to 3 weeks before gypsy moth hatch.

**Larvae Treatment: Residual Foliar and Contact Spray:** Mix 3 oz. of FICAM W per 100 gallons of water and apply to the whole tree (wood and leaves). This will control all larvae stages. If required for optimum control in heavily infested areas, applications can be made every two weeks.

**Supplementary Residual Trunk Spray:** When large larvae (1–2½", 4–6 instars) are mobile and seeking resting places and a foliage spray is impractical, mix 2.5 lbs. (.25% ai) of FICAM W per 100 gallons of water and apply to tree trunks until fully saturated, making sure to treat cracks and crevices. A harborage (burlap or tape bands) is recommended to keep the larvae on the treated surface. If required for optimum control in heavily infested areas, applications can be made every two weeks.

**DOSAGES AND DIRECTIONS FOR USE ON ORNAMENTAL PLANTS**

| PEST | AMOUNT OF FICAM W[1] per 100 gallons of water |
|---|---|
| Chrysanthemum aphid, Eastern tent caterpillar, Green apple aphid, Hemispherical scale, Florida wax scale | 3 oz. |
| Green soft scale, Spirea aphid, Tea scale, Citrus mealybug, Hawthorne lacebug, Fall webworm, Euonymus scale | 6 oz. |
| Japanese beetle, Thrips, Azalea lacebug, Azalea caterpillar, Taxus mealybug (adults), Elm leaf beetle, Willow leaf beetle (larvae), Poplar tent maker, Yellownecked caterpillar, Spring Cankerworm, Bagworm, Sycamore lacebug, Oleander caterpillar, Oleander aphid | 11 oz. |
| Mimosa webworm, Obscure root weevil (adults) | 1 lb. |
| Greenhouse whitefly, Citrus blackfly (larvae), Black vine weevil, Pine spittlebug, Azalea caterpillar, Bronze birch borer[2] | 1 lb. 5 oz. |
| Nantucket pine tip moth[3] | 2 lbs. |
| Pales pine weevil, Northern pine weevil, Azalea leafminer | 2 lbs. 10 oz. |

[1] When measuring small amounts of product, use the 1 oz. scoop provided.
[2] Bronze Birch Borer: Use 3 sprays, spaced two weeks apart.
[3] Spray at the time of moth flight (w each generation.
Consult local Cooperative Extension Authorities regarding time of moth flights in your area.

**Home Turf Pests:** Apply FICAM W as a coarse, low-pressure spray in sufficient water to obtain complete and uniform coverage of pest-infested areas, according to the directions in the table below:

| PEST | DOSAGE | APPLICATION PROCEDURE |
|---|---|---|
| White grubs of: Japanese beetle, Black turf grass Ataenius, European chafer, Northern masked chafer, Green June beetle, Annual white grub, Mole crickets | 1–2 oz. per 1000 sq. ft. | Apply when pests become evident. Control of grubs is best when they are still small, therefore late summer treatments are preferable to spring. Apply in adequate water to assure coverage, then irrigate thoroughly with ½–¾ inch of water. |
| Chinch bugs, Sod webworm, Leafhoppers | 0.5–1 oz. per 1000 sq. ft. | Apply when pests are evident. Use adequate quantity of water to thoroughly moisten grass and thatch. |

**Fire Ants:** Mix FICAM W as recommended in the table below. Two gallons of mixture are recommended for mounds 8 inches or larger in diameter. Less mixture can be used on smaller mounds; however, thorough penetration of insect galleries must be achieved. Apply a small amount of material around the perimeter of the mound. Apply the remaining volume directly on the mound so as to penetrate insect galleries. A second treatment may be necessary if complete control is not obtained.

Do not disturb the mound prior to application. If possible, make applications after a recent rainfall. Applications may not be as effective during hot, dry periods. If possible, treat all colonies in the vicinity. Also, treat colonies which have not yet constructed a mound.

**DOSAGE TABLE**

| AMOUNT OF FICAM W | AMOUNT OF WATER |
|---|---|
| 2-3 teaspoons | 2 gallons |
| 1 pkg. or 1 scoop (0.4 oz.) | 8 gallons |

**IMPORTANT: READ BEFORE USE**

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