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July 12 - August 1, 1993**

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**VBC PROJECT**

*Tropical Disease Control for Development*

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**Malaria Vector Control In Belize**  
**Training Program and Manual Development**  
**July 12 - August 1, 1993**

by

**Robert J. Tonn**

**VBC Report No. 82141**

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## **Abbreviations**

**MOH: Ministry of Health**

**OP: Organophosphorus pesticide**

**PAHO: Pan American Health Organization**

**ULV: Ultra-Low-Volume**

**VC: Voluntary Collaborator**

**VCP: Vector Control Program**

**WHO: World Health Organization**

## **Author**

**Robert J. Tonn, Ph.D., is adjunct professor of parasitology at the University of Texas-El Paso and a technical consultant for the Vector Biology and Control Project.**

## **Acknowledgements**

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**Preparation of this document was sponsored by the Vector Biology and Control Project under Contract No. DPE-5984-Q-00-9031-00 to Medical Service Corporation International, Arlington, Virginia, U.S.A., for the Agency for International Development, Office of Health, Bureau for Research and Development.**

## **Executive Summary**

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The purpose of this consultancy was to obtain an overview of the DDT house spraying program, safe handling and storage of pesticides, available equipment in the Vector Control program, possibility of stratification as it relates to vector control, and insecticide resistance status among the anopheline vectors. Courses on spraying technique and safe handling of pesticides were given in Punta Gorda (Toledo District) and Concepcion (for Cayo and Corozal Districts). From these courses, a draft of a manual for spraymen was developed.

Observations were that 1) all equipment including vehicles is in poor conditions and much of it should be replaced; 2) preventive maintenance of all equipment is lacking and there is a shortage of spare parts; 3) the spraymen lack uniforms and protective clothing which would be essential should a more toxic pesticide be selected; 4) shortage of DDT has delayed spraying activities and only one cycle will be possible in 1993; 5) the ban on DDT will place a financial burden on the MOH; 6) serious thought must be given to the selection of a new pesticide, with consideration given to insecticide resistance, product cost, human acceptance of the product, and safety; 7) facilities in some districts may not be adequate to store and handle a more toxic pesticide; and 8) there is a need for greater communication between senior staff and field staff. Unusable DDT is being stored in at least two districts. Arrangements should be made for its disposal.

A serious management problem exists in the Program. This is not recent, but it may be evident now because of the condition of the equipment and lack of supplies. The problem may reflect a lack of commitment of MOH to the Program, which is understandable because the vector control program has little to show for the resources that have been invested over the years. There is a lack of discipline and pessimism about the future. Perhaps now is time to consider new strategies for containing malaria, bearing in mind advances in both the community health worker system and the voluntary collaborator projects. These advances complement the most recent WHO recommendations for malaria control, and may lessen the burden of expensive pesticides for Belize.

**The MOH should review all activities of the Vector Control program and decide its fate. If the Program is to continue, adequate funding must be found. Preventive maintenance of all equipment must be put into operation. More training and supervision are required for field staff, especially if a pesticide more toxic than DDT is selected. If DDT is replaced, field testing of candidate pesticides should be done. In my opinion, a pyrethroid would be best from the standpoint of safety. And if the Program is to function efficiently, more senior supervisory staff should be recruited.**

**Thirty-one spraymen, squad leaders, supervisors, and drivers attended the two courses. The pretest indicated that these individuals knew little about the fundamentals of safe handling of pesticides and application equipment. The two to three day courses did little to improve the situation. The reasons for this failure were 1) the application equipment was in such poor condition that proper application of pesticides could not be demonstrated, nor could much hands-on training be given; 2) the future use of DDT is uncertain and the type of pesticide that might replace it is unknown; 3) spraymen lacked the protective clothing and equipment required for safe handling of pesticides; and 4) the education of some spraymen was extremely poor. (I had the impression that some of them could not read basic English. Nevertheless, they were able to spray houses correctly.)**

**Only minor progress was made on stratification as the majority of time was spent on courses and the manual. It was not possible to do insecticide resistance testing as the test kits from WHO were not available. Entomologists from Mexico recently completed a small survey of DDT resistance on the Mexico/Belize border. They found the vector population was still found to be susceptible to DDT. Stratification will require an in-depth study of the distribution of vector species, epidemiological information, and discussions with senior VCP staff. These activities could take place during the visit in September of Dr. David Bown, PAHO entomologist. The Uniformed Services University of the Health Sciences epidemiological/entomological group could also be asked to help in stratification. For these reasons a consultant from USAID might not be necessary.**

**At the final debriefing at USAID/Belize, additional comments on the future of vector control operations in Belize were requested. The consultant's comments are included in the report following the conclusions.**

# **1. Information and General Background**

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## **1.1 General information**

The consultant was contacted late in June 1993 to assist the Vector Control Program of the Ministry of Health of Belize to prepare a training manual and to give a course to spraymen on insecticide spray operations, with emphasis on the safe handling of pesticides. The consultancy took place from July 11 to August 1, 1993.

## **1.2 Objectives and Terms of Reference**

A course and manual for spraymen on spray operations which would establish common operating procedures for the safe use and handling of pesticides (specifically DDT, with mention of other insecticides) was developed. The objectives and terms of reference changed slightly from the original discussions because only one district had pesticide available and not all of the spraymen had been recruited. The original plans were to visit each squad team and observe them work for one or two days, after which a short course would be given, guided by what had been observed. However, only the team near the Mexican-Belizian border had pesticide and were house spraying. As a result, observations were limited to that team. A three day course was given in Punta Gorda, and a similar course was given in Concepcion for spray teams from Corozal and Cayo Districts.

Subject matter covered in lectures and practical field work included biological effects of pesticides, regulations governing the use of pesticides, proper spraying techniques, personal protection, and health risks. Materials used in the course/workshops served as a basis for a manual. A draft of the manual used in the courses is included in the Annex. Copies of the lecture outline, background literature and visual aid materials were left with the Vector Control Program.

**Insecticide susceptibility testing was included in the terms of reference, but the test kits were not available during the visit. PAHO is being contacted to assist in this testing at a later date. Stratification as it pertains to vector control activities was also discussed. Some thoughts on this subject are presented in the body of this report.**

### **1.3 Background**

USAID/Belize has provided technical assistance for vector control for a number of years. This assistance will end on 30 September 1993. During the life of the project, a number of senior staff have received training, and a number of consultants have visited the Vector Control Program on various assignments. In 1983, a operations manual with the goal of malaria eradication was produced. The present goal is vector control and as a result the manual is no longer used. A request was made to USAID/Belize to assist in writing a new manual to fit the conditions as they now exist and to include material on pesticides other than DDT.

DDT has been banned from Belize. The MOH has a small supply on order and has received a small donation from the Government of Mexico for spraying houses along the border. The future of house spraying with DDT is unknown. The Pesticide Control Board may ask the legislature to lift the ban on DDT for public health purposes, but many believe this will not happen. In addition, susceptibility of malaria vectors to DDT has been questioned. As a result the Vector Control Program is exploring the possibility of selecting an alternative pesticide (see Annex D).

The VCP has prepared the groundwork for malaria stratification. PAHO consultants are said to have done a study for stratification in Belize a number of years ago. Since PAHO will continue to be involved in vector control, it was suggested to wait until a PAHO malaria consultant visits Belize in September 1993 to finalize any changes in vector control strategy.

A contingency plan for pesticide emergencies was part of the assignment. However, a similar project that will include a number of ministries is planned to begin in August 1993. To avoid duplication, only suggestions on handling emergencies have been included in the manual.

## 2. Findings

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Turnover of spraying staff is frequent. Some staff have been in the VCP for a number of years, and they train new staff. Most of the supervisors, however, have not received sufficient training. Many trained by PRAGMA are no longer working with the Program. Some supervisors have gained good working experience helping PAHO, USAID/Belize, and US military consultants. Each new staff member is assigned to work with an old staff member until he is considered to be trained. As a result, the new worker inherits many of the faults as well as the skills of the more senior staff. On-the-job and refresher training of all supervisory staff will be essential if a pesticide other than DDT is used.

Squad leaders know the basics of spray operations, but do not seem to pass this information on to the spraymen effectively. Part of the problem is that spraymen begin work immediately after recruitment. Observations of spraying activities show that a number of errors are routinely being made. Among them are spraying further or closer than the recommended 18 inches from the wall surface, applying the pesticide too fast, and having the wrong overlap distance. All staff, including the squad leaders, demonstrated these errors when applying the pesticide.

Very few of the field staff understand the basics of malaria entomology or epidemiology. As a result, they can not always answer questions posed to them by the householder. Such information would help the spraymen in their general approach to the householder. The squad leader should provide the spraymen with the name of the local Voluntary Collaborator and the name of the family occupying each house to which spraymen are assigned.

Spraymen are concerned about the safe use of pesticides but have little information about pesticides other than DDT. The handling of DDT is safe enough, but the chance for accidents would be great if a different pesticide were used. A squad leader is unable to adequately supervise the number of spraymen in a team. This could place the spraymen and

householders at risk should a pesticide other than DDT be used. In the 1983 manual, fewer sprayers were in a team and about two helpers were added to the team to assist the householder get the house ready for spraying. This was a better but more expensive approach.

Not a single sprayer was found to be in adequate working condition. All had parts that were worn or no longer working. No matter how well the men are trained, the poor condition of the equipment would still be great risk if a more toxic pesticide were used. The Toledo District squad did not have tools to repair the sprayers. The two other districts used tools that came with the ULV vehicles. PAHO has reportedly been approached to purchase new sprayers and spare parts.

The 1983 manual is adequate for the work being done by the sprayers, but copies of the manual are not available. The educational level of the sprayers is limited, and great care is required when finalizing a new manual. The course participants requested information about malaria, an opportunity to see malaria parasites, and the life cycle stages of mosquitoes. They requested a manual with simple drawings. It should be small enough to fit easily in a pocket. They requested that the manual be revised if and when a different pesticide is introduced. The Toledo District office had copies of an old voluntary collaborator manual which was fairly good. None were seen in the other districts.

A number of errors in handling pesticide and in care and maintenance of equipment were observed. The equipment is in very poor condition. VCP officials said that USAID/Belize has ordered new hand-operated compression sprayers, but there seems to be a question about whether the sprayers were actually ordered. New sprayers and spare parts are needed.

Although the storage facilities in Cayo were not visited, the sprayers explained that there is a contamination problem and a quantity of DDT which needs to be destroyed. Unusable DDT was observed in storage in Punta Gorda. The old warehouse in the dock area of Belize City is also said to hold unusable DDT. Pest Control Board staff should investigate this and a method of disposal found.

**Stratification of spray activities is possible. Areas such as Blue Creek can be dropped from routine spraying. This locality and others with good health care centers, improved housing, especially with screened windows and doors, and householders with a higher standard of living can be handled with drug treatment, health education, and community involvement.**

**Sparsely populated areas with voluntary collaborators can be handled with drug treatment as long as the voluntary collaborator and community health workers have a constant supply of drugs and health education materials. Providing more small health centers with the capacity to identify malaria parasites would speed up treatment and make malaria statistics more reliable.**

**Larger populated areas that are still sprayed should be checked for location of malaria cases. It is possible that only the peripheral areas will require spraying.**

**Because of transport problems, it is difficult to cover all the areas where spraying is now recommended. The large trucks used by the Cayo and Toledo Districts are in Belize City for repair. Several vehicles broke down on the road during the consultant visit. It is hard to see how the Vector Control Program can continue without substantial assistance to maintain their vehicles and purchase new ones. On July 30, for example, the VC Program had only one vehicle in running order.**

**It is reported that many in the countryside do not like to have their houses sprayed. Some have obtained certificates from physicians and nurses exempting them from spraying for medical reasons, although it is hard to believe that so many medical problems stem from DDT. Others object to the environmental impact of DDT, even if that impact is minimal for house applications. Others object because DDT is banned in the USA. Many of these points are only half valid and greater education is needed. The staff even cited times when the voluntary collaborators worked against them.**

**In addition to the constraints mentioned above, certain other factors hinder progress in malaria control. One of these is the movement of people, both movement within Belize and refugees and migrant labor coming into the country. Another constraint, stemming from the history of the program, is uncertain program direction: the Directors over the years have had varying conceptions of how the Program should be structured and should function.**

### **3. Conclusions**

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It is extremely difficult to provide training in insecticide spraying because 1) the present equipment is in poor working condition (the pressure regulators are broken, for example, and many sprayers leak air and pesticide); 2) the type of pesticide to be used in the future is unknown; and 3) the educational level of the spraymen is limited (some can barely read). Because of the latter problem, the final draft of the manual should be tested on the three squad leaders to identify words and phrases the spraymen might not understand.

Field supervision is lax. There are insufficient supervisory staff; their vehicles are in poor condition or lacking; of vehicles, and communication by roads and telephone is difficult. There is a general lack of discipline throughout the Program. Peripheral staff need more visits from senior staff and the opportunity to learn more about the Vector Control Program. All the teams expressed a desire for workshops and other training in which senior staff participate actively.

At this point in time a change to a more toxic pesticide would be dangerous. The spraymen have not had sufficient training; they do not have adequate supervision; and they do not have the protective clothing required for handling insecticides more toxic than DDT.

The 1983 manual was adequate, but it is not available. The new manual may well have the same fate.

Spraymen should be able to identify all life stages of anopheline mosquitoes, separate anopheline species from culicine species, know the life cycle of mosquitoes and the malaria parasite, know that there is more than one type of malaria parasite, and know certain details of malaria transmission. The spraymen requested a workshop covering these points and that the material be outlined in their manual. (Senior staff maintain that some Friday afternoons are devoted to training sessions conducted by district supervisors. There has been no follow-up on this.)

**Because spraymen are one of the closest links to the general public, spraymen should know the basics of health education, duties of other malaria workers, and be given the opportunity to improve their communications skills.**

**More training will be necessary if a more toxic pesticide is used. New spraying equipment should be obtained. However, the latter will be of little value unless a system of preventive maintenance is developed. Preventive maintenance should include vehicles and other equipment of the Vector Control Program. Whenever new equipment is ordered, a supply of spare parts should be included, and they should be routinely included in budget planning.**

#### **4. Comments on the Future of the Vector Control Program**

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USAID/Belize requested a frank appraisal of the present status and future of vector control in Belize. From an epidemiological standpoint, here has not been much change in malaria for years. This is in spite of a large migration of refugees and others into the country and the settlement of isolated areas. On the other hand, this is a poor showing considering the cost of the Program.

The Program has deteriorated to a point where it is not functioning effectively or efficiently. Vehicles and application equipment are practically unusable and must be replaced. DDT has been banned. The Program is running on a small donation from Mexico and waiting for a six month supply to arrive. The likelihood that another purchase will be possible is questionable. The first cycle for 1993 was missed, and spraymen and squad leaders estimate that even when spraying was on schedule about 25 per cent of the houses went unsprayed because of refusals or they were missed.

Staff morale is poor at all levels. Field staff complain about the lack of equipment and supplies as well as the lack of communication and interest on the part of senior staff. Senior staff in turn point to discipline and other problems from field staff, and a lack of real commitment on the part of higher governmental officials.

The Program is poorly organized and managed. There is considerable waste. Senior officers either lack management skills or have not been given the authority to act effectively.

There is a belief in the Program that a number of golden opportunities have been missed to gain further cooperation from the Government of Mexico and the Uniformed Services epidemiological group. They see lack of interest in the government's failure to request assistance from these sources.

DDT will eventually have to be replaced, but little consideration has been given to the selection of a new pesticide. There are a number of technical steps, including limited field trials, that should be taken. Furthermore, an in-depth examination of the total costs and implications

of changing pesticides is lacking. In all probability donor support will be required. This will limit the selection of pesticides and may saddle the Program with a pesticide too toxic to handle safely under the conditions in the country.

It is evident that the Program should not continue in its present state. The MOH has options for redirecting the Program. The Aedes and Malaria Sections could be combined and staff retrained to work in either field. The quality of recruits could be upgraded and their training improved. At present, there is not one junior supervisory staff member who has the education or training to step into a senior position. Career opportunities are nil.

At the same time that the VC Program is deteriorating, the community health worker and voluntary collaborator systems are improving. New rural health centers are being established and there are more opportunities to expand malaria control to effective treatment of cases.

It is suggested that the MOH review the Program in the light of the financial situation and the needs of the country. Perhaps an economist familiar with malaria control and a technical consultant from USAID could assist a MOH task force to review the Program and develop a plan of action.

## **5. Recommendations**

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- 1. To insure that any new manual does not suffer the same fate as the 1983 manual, USAID/Belize should explore ways in which adequate copies can be made available. A small pocket size manual would be best.**
- 2. Depending on the pesticide selected, additional and improved protective equipment (hats, uniforms, gloves, visors, respirators) should be made available to the spraymen. The spraymen should have new sprayers, and the vehicles should be equipped with holders to carry them. An improved means of storing sprayers at the district offices should be found. If the alternative pesticide is a moderately to highly toxic organophosphorus compound, cholinesterase monitoring of handlers is recommended for spraymen, squad leaders, and drivers doing ULV spraying (some vehicles lack windows making contamination possible). For some organophosphorus and carbamate pesticides, it might be necessary to reduce the contact time (actual spraying time) per day to about 5 hours. Some pyrethroids will require the use of disposable face masks.**
- 3. The manual should be revised and additional training provided to all staff handling the new pesticide. PAHO should be consulted on the protective clothing and specific equipment needs required for the pesticide selected. When ordering pesticides, the chemical and its formulation should conform to WHO specifications for the method of application. (Note: The label of the DDT received as a gift from Mexico does not have all the information usually required for a pesticide label.)**
- 4. Before spraymen begin a new spraying year, a few days should be devoted to refresher training, especially on safe handling of the pesticide being used and proper spraying technique. In addition to this training, newly recruited spraymen should be assigned to work with senior spraymen until the squad leader is satisfied with their work.**

- 5. Storage and transport facilities required for a more toxic pesticide should be reviewed. Purchasing pesticide packaged as pesticide per pump charge should be considered. If this is not done, consideration must be given to construction of adequate storage and repacking facilities in one centralized location. Although scientific documentation is not available to recommend selection of a new pesticide, a pyrethroid should probably be considered for safety reasons.**
- 6. At least one poison center within Belize should be created, and poison treatment training provided to at least one physician at every hospital. Safety regulations for the use of public health pesticides with the Pesticide Control Board should be coordinated. If possible, program staff should participate with other ministries in developing regulations for the safe handling and use of pesticides and a contingency plan to handle pesticide emergencies. The CDC of the USPHS and PAHO have literature on emergency treatment of pesticides. Copies of this material should be available at all district hospitals and the major health clinics. One physician could be trained at a center such as the one at the University of Miami. He or she could train others locally.**
- 7. Considering the present condition of vehicles and spraying equipment as well as the possible need for additional protective clothing should another pesticide be used, USAID/Belize and the Ministry of Health should do a serious evaluation of the Vector Control Program. A priority point is that little is being done properly because of the poor condition of equipment. An alternative pesticide will probable increase the cost of the Program because of the increased cost of the product, treatment cycles, and the need for protective equipment and clothing. Part of the cost might be recovered through stratification of vector control and better utilization of all VCP staff. Some type of vector control activities may be necessary because of tourism, the refugee situation, and public demand. However, all aspects of the Program, including management and government commitment, should be examined.**

## **Annex A**

### **Itinerary**

#### **July**

- 12 Arrive Belize City. Briefing at AID/Belize.**
- 13 Briefing AID/Belize and Vector Control Program (MOH).**
- 14 VCP. Course and manual requirements.**
- 15 Orange Walk and Blue Creek. Observe spray operations.**
- 16 Orange Walk and Blue Creek. Observe spray operations.**
- 17 Belize City. Preparation of draft of manual and course.**
- 18 Open**
- 19 Belize City. Photocopy manual and Lecture outline**
- 20 Belize City. Visit Vector Control Program and AID offices.**
- 21 Concepcion. Course for spraymen.**
- 22 Concepcion. Course for spraymen.**
- 23 Concepcion. Course for spraymen.**
- 24 Belize City. Revision of course and manual.**
- 25 Belize City. Open**
- 26 Punta Gorda, Course for spraymen.**
- 27 Punta Gorda, Course for spraymen.**
- 28 Punta Gorda, Course for spraymen.**
- 29 Belize City, Prepare Report and AID Office**
- 30 Belize City, Prepare Report and VCP and AID Offices**
- 31 Belize City, Final draft of manual/report and return to USA**

## **Annex B**

### **Persons Contacted**

#### **AID/Belize:**

**Mr. Patrick McDuffie, General Development Officer**

**Ms. Amelia Cadle, Health Project Manager**

#### **International Organizations:**

**Dr. Rathouser, WHO/PAHO Representative**

#### **Hospital, Punta Gorda:**

**Dr. Raju**

#### **Vector Control Program, Government of Belize:**

**Dr. Jorge Polanco, Director**

**Mr. Frank Westby, Administrator/Program Technical Supervisor**

#### **Workshop Participants, Concepcion:**

**Mr. Alejandro Gonzales, Sprayman**

**Mr. Pedro Rodriguez, Squad Leader: Cayo District**

**Mr. Alexander Navarro, Sprayman**

**Mr. Alfred Chavarria , Sprayman**

**Mr. Thomas Caretala, Sprayman**

**Mr. Edwin Tzul, Sprayman**

**Mr. Victor Alvarez, Sprayman**

**Mr. Rodolfo Guzman, Sprayman**

**Mr. Francisco Aldana, Sprayman**

**Mr. Cecil Alvarez, Sprayman**  
**Mr. Kenrick Ferguson, Sprayman**  
**Mr. Felix McKay, Sprayman**  
**Mr. Darwin Riveroll Sprayman**  
**Mr. Eugene Arzu, Sprayman**  
**Mr. Sammy Zunniga, Squad Leader: Corozal Town**  
**Mr. Hilman Manzanilla: Supervisor/ Aedes aegypti**  
**Mr. Doninger Duñeane: Supervisor/ Malaria**  
**Mr. Clive Erskine, Squad leader**  
**Mr. Conrad Thomas, Supervisor/ Malaria**  
**Mr. Cristino Pena, Driver**

**Workshop Participants, Punta Gorda:**

**Mr. Marion Lewis, Sprayman**  
**Mr. R. Palacio, Sprayman**  
**Mr. Santos Avila, Squad Leader**  
**Mr. Edison Roches, Sprayman**  
**Mr. H. Azu, Sprayman**  
**Mr. Charles Roches, Sprayman**  
**Mr. Mateo Teul, Sprayman**  
**Mr. Glenford Archer, Driver**  
**Mr. Eugene Lopez, Aedes Inspector**  
**Mr. Orlando Chan, District Supervisor**  
**Mr. Timothy Magdaleno, Aedes Inspector**

## Annex C

### Pre- and Post- Tests

#### Pretest: Vector Control-Safe Use of Pesticides

Name a common insecticide belonging to each of the following classes of chemicals.

1. Carbamates \_\_\_\_\_
2. Pyrethroids \_\_\_\_\_
3. Organophosphorus \_\_\_\_\_
4. Organochlorine \_\_\_\_\_

Define the following:

1. Larvicide \_\_\_\_\_
2. ULV \_\_\_\_\_
3. Target insect \_\_\_\_\_
4. Treatment cycle \_\_\_\_\_
5. Formulation \_\_\_\_\_
6. Biological Control Agent \_\_\_\_\_
7. Emulsifiable Concentrate \_\_\_\_\_
8. Technical Grade Insecticide \_\_\_\_\_

Name 5 personal hygiene or safety precautions followed in handling pesticides.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

**Post-test: Vector Control-Safe Use of Pesticides**

**1. What 3 parts of the pump are most likely to need replacement after long use?**

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_

**2. If a hose breaks, what can you do to stop the flow of pesticide out of the tank as fast as possible? (Select the correct answer.)**

- a. Immediately turn the tank upside down.
- b. Try to get the cap loosened fast.

**3. Name 2 parts of your sprayer that are most likely to clog during use.**

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_

**4. In case of pesticide poisoning, what is of highest priority to the patient?**

\_\_\_\_\_

**5. Pesticides may enter the body in 3 ways. Name the ways.**

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_

**6. Name three factors influencing the hazard of a pesticide.**

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_

**7. Name 2 formulations of DDT used for residual spraying.**

- 1. \_\_\_\_\_
- 2. \_\_\_\_\_

## **Annex D**

### **Selection of an Alternative Pesticide**

Eventually it will be necessary to select a pesticide other than DDT for use in Belize. Belize should first investigate the status of insecticide resistance in nearby countries as well as the experience these countries have had with alternative pesticides. Several factors should be considered. Among these are changes in application management strategies, assessment of environmental factors which might affect the pesticide as well as the effect the pesticide might have on the environment, acceptability of the new insecticide to the people, risk factors involved, and whether the pesticide will influence malaria transmission. Field trials to test the pesticides should be completed before final selection. When the field trial is done, cost estimates of the various aspects of the control activities should be made. Regardless of field trials, insecticide susceptibility tests should be done using for insecticides under consideration using WHO test kits and specifications.

All spraymen and supervisors should then be trained on the safe handling of the new pesticide and on any changes in application procedures. Everyone involved with field activities should know the signs and symptoms of overexposure to the pesticide and procedures for emergency treatment. This includes issuing any special protective clothing and protective supplies for the field. If an organophosphorus pesticide is selected, cholinesterase levels of staff should be monitored. Copies of the pesticide label should be available to all field staff as well as any other safety information pertaining to the pesticide. When a new pesticide is used, it is important to make follow-up visits to all households to check for any symptoms of overexposure among the occupants or death of domestic animals. Guidance should be obtained from the literature on the proper disposal of different types of pesticide containers used.

**Additional supervision will be needed the first few weeks after a new pesticide is introduced. Special care should be given to inspecting equipment for leaks and other problems. Clothing should be inspected daily. Spraymen who do not follow recommended safety procedures should be dismissed or transferred to other duties.**

**Special emphasis should be given to health education and close contact should be maintained with everyone in the spray area. Supervisors and squad leaders should note any real or potential problem seen or reported to them from the field. These problems should be brought to the attention of the Director of Vector Control Program.**

**It should be kept in mind that the PAHO Representative can serve as an important technical link. WHO/PAHO has specifications on application equipment and pesticides. USAID/Belize also maintains contacts in the USA to assist in selection of pesticides and equipment and to help with any problems regarding pesticide application that might arise.**