

# Decision-making for the judicious use of insecticides

Facilitator's Guide

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**TRIAL EDITION**

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**World Health Organization**

Communicable Disease Control,  
Prevention and Eradication  
WHO Pesticide Evaluation Scheme (WHOPES)

DECISION-MAKING  
FOR THE JUDICIOUS USE  
OF INSECTICIDES

**FACILITATOR'S GUIDE**

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TRIAL EDITION

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# Contents

Acknowledgements		i
Preparation		1
Introduction		7
Learning Unit 1	Decision-making for vector-borne disease control	13
Learning Unit 2	Understanding the problem	23
Learning Unit 3	Formulating objectives and approaches	33
Learning Unit 4	Judicious use of insecticides	49
Learning Unit 5	Monitoring performance	59
Case-study 1	Gold-rush area	69
Case-study 2	An urban outbreak	83
Case-study 3	Disease in a rural area	95



# Acknowledgements

The Department of Communicable Disease Control, Prevention and Eradication (CPE) wishes to thank Dr R. Zimmerman, Florida Medical Entomology Laboratory, and Dr M.E. Swisher, Department of Family, Youth and Community Sciences, University of Florida, USA, for drafting the document.

CPE also wishes to thank the following for their valuable contribution to the development of this document.

- Dr M.K. Cham, Roll Back Malaria Department, World Health Organization, Geneva, Switzerland
- Dr K. Krishnamoorthy, Vector Control Research Centre, Pondicherry, India
- Dr M. Nathan, Communicable Disease Control, Prevention and Eradication, World Health Organization, Geneva, Switzerland
- Dr E. Renganathan, Director, WHO Mediterranean Centre for Vulnerability Reduction, Tunis, Tunisia
- Dr H. Vatandoost, School of Public Health, Teheran University of Medical Sciences, Teheran, Islamic Republic of Iran
- Dr R. Yadav, Malaria Research Centre, Gujarat State, India
- Dr M. Zaim, Communicable Disease Control, Prevention and Eradication, WHO Pesticide Evaluation Scheme (WHOPES), World Health Organization, Geneva, Switzerland

CPE's sincere appreciation is extended to the managers of vector control, Ministry of Health, Sri Lanka, where the Guide was first field-tested, for their constructive suggestions.

All the figures in this training manual are taken from Marquardt WC, Demaree RS, Grieve RB, *Parasitology and vector biology*, 2nd ed. San Diego, Academic Press, 2000, and are reproduced by kind permission of the publisher.

The Guide is still a trial edition and will be finalized after further field-testing. CPE greatly appreciates input and suggestions from readers (coordinators, facilitators and participants) that will help to improve future editions.

This publication has been funded by Roll Back Malaria (RBM).



# Preparation

## Why offer this course?

The World Health Organization and its Member States have expressed concern about the depletion in recent years of the arsenal of safe and cost-effective insecticides for vector control. This concern is prompted by growing insecticide resistance and the scarcity of new compounds under development. Costs of insecticides have increased greatly: in some countries, more than half of the total budget for combating malaria goes on insecticide purchases. In addition, there is heightened awareness of the safety issues associated with the inappropriate use of insecticides. These considerations make it critical to use insecticides judiciously in order to prolong the life of the insecticide products available to vector management specialists and to reduce the recurring costs of insecticide application. Judicious<sup>a</sup> use of insecticides requires evidence-based understanding of vector management. Providing vector management personnel with the skills and knowledge needed to apply evidence-based decision-making in vector management programmes is the purpose of this course.

## Who should take this course?

Vector-borne disease control programme managers at national and district levels who are responsible for planning and implementing vector management programmes will benefit from this course.

## What is the goal and what are the objectives of the course?

The goal of this course is to enable participants to make decisions on the safe and judicious use of insecticides in public health. At the end of the course the participants will:

- be able to use evidence-based decision-making for the control of vector-borne diseases and for the selection of vector control methods;
- know the advantages and limitations of vector control options as well as their role in different eco-epidemiological and operational situations;

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<sup>a</sup> Prudent; having, exercising, or characterized by sound judgement.

- be able to make decisions on what insecticides to apply and where, when and how to apply them to maximize effectiveness, minimize cost and ensure safe use;
- be able to develop appropriate indicators for monitoring and evaluating the effectiveness of vector control programmes.

## What materials do you need to present this course?

This course draws heavily on the WHO document, *Malaria vector control – decision-making criteria and procedures for judicious use of insecticides* (WHO/CDS/WHOPES/2002.5), which provides comprehensive coverage of the safe and judicious use of chemicals for vector management. Coordinators, facilitators and participants should all have a copy of this document.

The *Participant's guide* provides the learning objectives for each unit, some background information on the topics that are covered, and instructions for the group exercises. A copy should be given to each participant at the beginning of the course.

The course uses three case-studies as a core mechanism for teaching the principles of evidence-based decision-making for vector management:

- disease in a gold-rush area,
- disease in an urban environment,
- disease in a rural area.

Regional adaptation or development of case-studies on other vector-borne diseases may be required, depending on priorities. The coordinator and facilitators should select the most appropriate case-study or studies for the particular group of participants. *Disease in a gold-rush area* deals with malaria, *Disease in an urban environment* deals with dengue, and *Disease in a rural area* deals with Chagas disease. The case-studies are divided into sections that should be distributed to the participants as the course progresses – **not** at the beginning of the course.

*Readings* are provided for specific exercises. They will help the participants to complete their assignments. These can be distributed at the beginning of the course or given to participants when they are needed during the course.

The *Facilitator's guide* provides the course coordinator and facilitators with guidelines for course delivery and suggestions for answers to the questions posed to participants and for the solutions they should develop during group exercises. Each learning unit of the *Facilitator's guide* corresponds to a learning unit in the *Participant's guide*.

## What approach is used to teach the course?

The course uses a **problem-solving approach** to facilitate the learning of the principal components of decision-making. It is based on a participatory approach to learning, with participants working in teams to solve problems related to vector control and prepare results for presentation in plenary. It offers the participants a step-by-step approach to acquiring the knowledge and skills they need for the tasks involved in the selection of vector control options and their judicious use. The goal of this approach is to improve participants' performance in the workplace. It is **performance-based** or **competency-based** training, designed to produce measurable changes in performance, not simply to impart knowledge.

### **Presentations**

Keep formal presentations by the course coordinator and facilitators to a minimum. In the learning units various sections are marked as overheads which are recommended for use by the course coordinator when delivering this course. They are coded as L1-1 (Learning Unit 1 – Overhead 1), L2-2 (Learning Unit 2 – Overhead 2), etc. A PowerPoint presentation is available on the WHO Pesticide Evaluation Scheme (WHOPES) homepage on the internet at <http://www.who.int/whopes/recommendations>.

### **Group exercises**

Participants will have the opportunity to work in small groups throughout the course. A moderator to lead discussions about particular subjects and a rapporteur to take notes will be chosen by each working group. Work will include formal presentations of each group's work to the plenary on several occasions. Decide on the number of working groups in advance. Groups of 4–6 are recommended, but the size will depend on the number of participants and available facilitators.

### **Case-studies**

Case-studies are an essential part of the problem-based learning approach used in this course. The diseases emphasized in the three case-studies were selected because of the importance of vector control as a component of each global control strategy, the complexity of the decision-making process for the development of control strategies, and the importance of chemical methods of controlling the vectors involved.

Each section in the case-study corresponds to one or more group exercises. These sections may not provide all necessary information for evidence-based decision-making so that participants are challenged to identify the additional information required. The case-studies follow the decision-making steps for the judicious use of insecticides. Possible answers for the group exercises are included in the *Facilitator's guide*.

## What are the roles of the course coordinator and facilitators?

The course coordinator is the overall manager of the course; he or she should be a specialist in vector control and have previous experience with a participatory, problem-solving approach to training. A strong commitment to this approach is essential to presenting the course effectively. The coordinator's job will be made easier and the training more effective if there are facilitators to assist the coordinator. The facilitators should have working experience in vector control, and they too must be committed to the participatory, problem-solving approach to training.

## What preparation is needed?

The coordinator and the facilitators should read all course materials well in advance. They must be very familiar with the material in both the *Facilitator's Guide* and the *Participant's Guide*, as well as the case-studies and readings. The coordinator and facilitators should work together to develop an effective approach for course delivery.

The day before the course, the course coordinator should meet with the facilitators to discuss the goals, objectives, timetable and group discussion dynamics, plus their respective roles. He should emphasize the importance of actively stimulating discussion, and the importance of using visual aids such as flip charts and transparencies in group discussions and plenary presentations.

Following each day's session, the course coordinator and facilitators should meet and discuss the results of the day's work and review the next day's curriculum.

Ideally, the course should be residential to maximize the time available for discussion and interaction among the participants and to avoid external distractions. One large room and one or more smaller rooms should be available for training. The large meeting room can be used for plenary sessions and the smaller rooms ones for group exercises. All participants should sit around the same table.

### Equipment/materials needed

- Overhead projector with spare bulb
- Computer projector for PowerPoint presentations with a notebook computer (optional)
- Screen for slide projection (a white sheet is an adequate substitute, but the whiteboard is unsuitable because it will reflect projected light)
- Flipcharts – one for each working group and one for the main classroom
- Large blackboard or whiteboard

- Chalk for blackboard or marker pens for whiteboard, in a selection of colours
- Acetate sheets for the overhead projector
- Coloured marker pens for acetate sheets
- Photocopier

#### **Participant supplies needed**

- Notebook
- One hand-held calculator for each working group
- Ballpoint pen
- Pencils, eraser and pencil sharpener

#### **How much time is needed to complete the training?**

The course requires 2.5 to 3 days for completion, based on a 7-hour working day. A suggested timetable is provided in the Introduction.

#### **How is the course evaluated?**

A questionnaire is included in the *Facilitator's guide*. It focuses on participants' opinions about how training helped them and how it might be improved. Conduct the evaluation (included in the Course Closure) at the end of the training in order to provide as much feedback as possible.



# Introduction

## INTRODUCTIONS AND MATERIALS

Introduce yourself and write your name on the blackboard or a flipchart. Introduce the facilitators as well, then ask each participant to introduce himself or herself. It might be helpful to divide the participants into pairs and ask them to exchange names, information about jobs, hobbies and hometowns. Each participant can then introduce his or her partner to the whole group. This often has the effect of reducing nervousness, and promotes a relaxed learning atmosphere.

After the introductions are finished, pass out the *Participant's Guide*, readings and supplies to the participants.

## Course goal and objectives

Present the goal and objectives of the course to participants.

### *Overhead I-1*

#### **Goal**

The goal of this course is to enable participants to make evidence-based decisions on the safe and judicious use of insecticides in public health.

### *Overhead I-2*

#### **Objectives**

By the end of this course the participants will:

- be able to use evidence-based decision-making for the control of vector-borne diseases and for the selection of vector control methods at the workplace;
- know what vector control options exist, their advantages and limitations, as well as their role in different eco-epidemiological and operational situations;
- be able to make decisions on what insecticides to apply and where, when and how to apply them to maximize effectiveness, minimize cost and ensure safe use;

- be able to develop appropriate indicators for monitoring and evaluating the effectiveness of vector control programmes.

**Ask the participants** what they expect to get out of the course and what additional objectives they would like to see covered in the course. List their proposed additional objectives on a flipchart. Discuss each of these objectives, its relevance and its possible inclusion in the list of course objectives. Later on, the class can return to this list during the learning unit discussions and see whether some or all of the additional objectives have been met. This process creates *consensus*. It is important that the participants agree on the course objectives and that the objectives fit their expectations of the course. By establishing consensus you can minimize unnecessary disruption and provide a mechanism to resolve conflict.

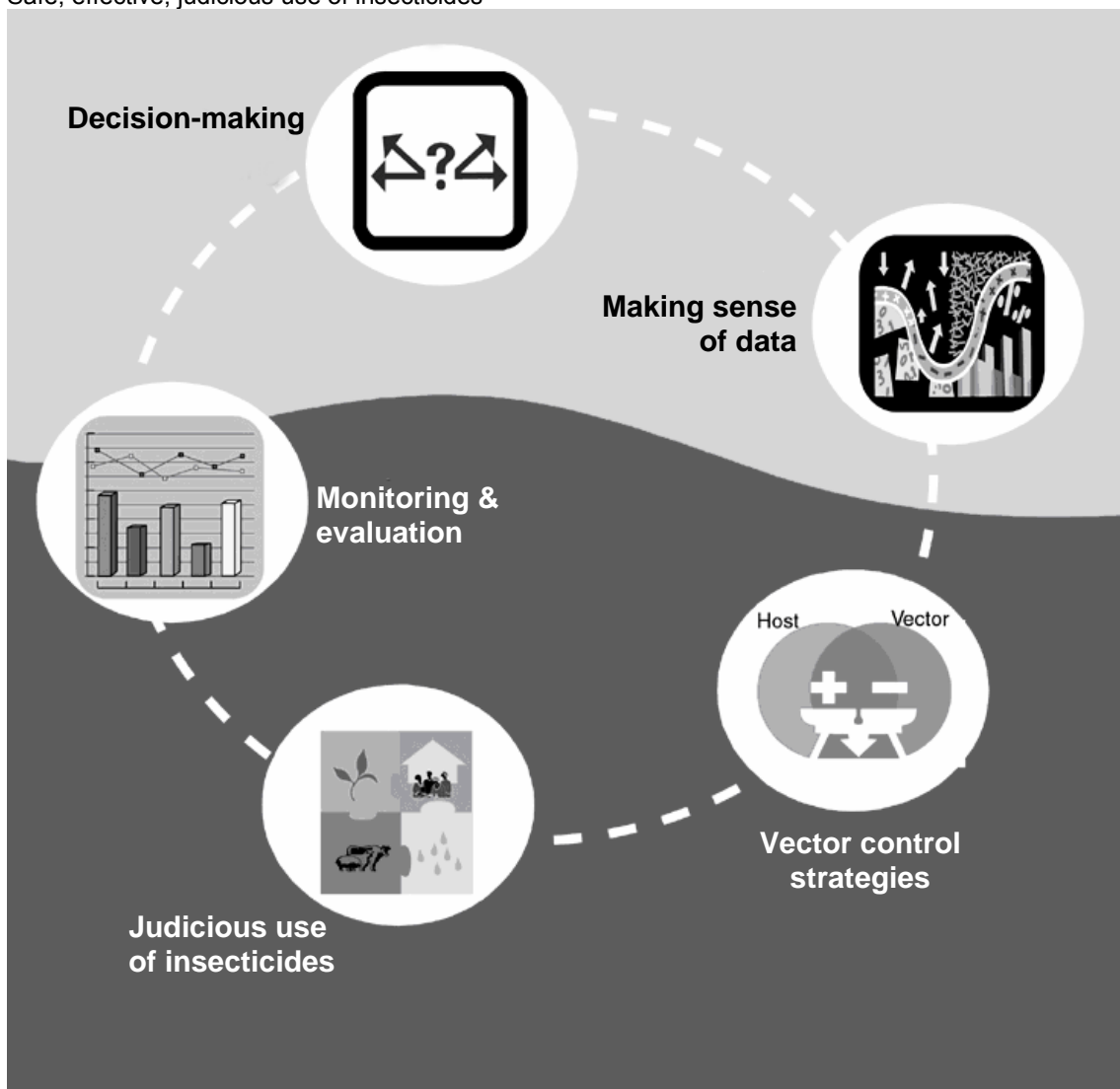
## **COURSE STRUCTURE AND ORGANIZATION**

Explain the learning approach that will be used during the course. Explain briefly how the case-studies will be used and the role of the group exercises. Make sure that participants understand that there is no single “right” answer to the questions that will be asked and encourage them to draw upon their own experiences as they work through the exercises.

Provide an overview of the course structure. Use Overhead 1-3 to describe briefly the content of each learning unit.

Overhead I-3

Safe, effective, judicious use of insecticides



**PROPOSED TIMETABLE  
DECISION-MAKING FOR JUDICIOUS USE OF INSECTICIDES**

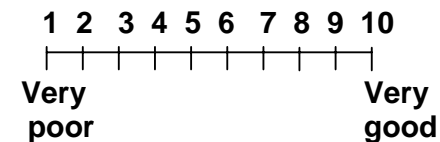
<b>DAY</b>	<b>TIME</b>	<b>SUBJECT</b>
<b>1</b>	09.00–10.00	<b>Opening ceremony</b>
	10.00–10.30	<i>Break</i>
	10.30–12.00	<b>Course introduction</b>
	12.00–13.00	<i>Lunch break</i>
		<b>Learning Unit 1</b>
		<b>Decision-making for vector-borne disease control</b>
	13.00–13.15	Importance of training programme
	13.15–14.00	Concepts and steps
	14.00–14.15	Closure discussions
		<b>Learning Unit 2</b>
		<b>Understanding the problem</b>
	14.15–15.00	Introduction and presentation
	15.00–15.30	Group exercise I
	15.30–16.00	<i>Break</i>
16.00–17.00	Group exercise II	
<b>2</b>		<b>Learning Unit 3</b>
		<b>Formulating objectives and approaches</b>
	08.30–08.55	Introduction on vector control
	08.55–09.10	Indications of role for vector control
	09.10–09.30	Methods of vector control
	09.30–10.00	Advantages and limitations of vector control
	10.00–10.30	<i>Break</i>
	10.30–12.00	Group exercise III
	12.00–12.15	Discussion and closure
	12.15–13.15	<i>Lunch break</i>
		<b>Learning Unit 4</b>
		<b>Judicious use of insecticides</b>
	13.15–13.35	Introduction and large group exercise
	13.35–15.15	Group exercise IV
15.15–15.45	<i>Break</i>	
15.45–16.30	Discussion on safe use of insecticides and closure	
<b>3</b>		<b>Learning Unit 5</b>
		<b>Monitoring performance</b>
	08.30–08.55	Introduction and presentation
	08.55–10.20	Group exercise V
	10.20–10.30	Discussion and closure
	10.30–11.00	<b>Course evaluation and closure</b>
12.00–13.15	<i>Lunch</i>	

## PARTICIPANT'S ASSESSMENT

Date \_\_\_\_\_

Item	Introduction	Decision-making	Understanding the problem	Formulating objectives & approaches	Judicious use of insecticides	Monitoring & evaluation
I was clear about the purpose of this module.						
The content of this module is relevant to my professional development.						
There was adequate coverage of the content.						
The learning activities and exercises added to my understanding of the content.						
The instructors were knowledgeable about the subject.						
The facilitators were effective in assisting our learning activities.						
The learning facilities were appropriate for the activities.						
The learning materials were adequate and appropriate.						
The time allocated was adequate.						

**Assessment using 1 to 10 grading scale:**



## PARTICIPANT'S ASSESSMENT

Module	Comments and suggestions
1. Introduction	
2. Decision-making for vector-borne disease control	
3. Understanding the problem	
4. Formulating objectives and approaches	
5. Judicious use of insecticides	
6. Monitoring and evaluation	

*Thank you for your feedback and cooperation.*

# Decision-making for vector-borne disease control

**Present the objectives (5 minutes)**

*Overhead L1-1*

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## LEARNING OBJECTIVES

After completing this *Learning Unit* you will:

- understand the important steps in decision-making to solve vector-borne disease problems
- 

**Establish the importance of the training programme (15 minutes)**

Introduce this Learning Unit by again emphasizing the urgency of the judicious use of insecticides. Important points include:

- the arsenal of safe and cost-effective insecticides for vector control is rapidly disappearing due to increased insecticide resistance and the scarcity of new compounds under development;
- costs of insecticides have increased greatly; in some countries, insecticide purchases alone account for more than half of the total budget of the vector-borne disease control programme.

These considerations make the judicious use of chemicals essential, both to prolong the life of the insecticides available to vector management specialists and to reduce the recurrent costs of insecticide application.

The use of chemicals for vector control therefore requires a thorough understanding of evidence-based vector management.

An example may clarify the importance of using an evidence-based approach to decisions about vector management.

*Malaria in Brazil.* An outbreak of *Plasmodium falciparum* malaria occurred in a rural area of Brazil. The health authorities immediately ordered indoor residual spraying of all houses in the local community. Approximately 2000 houses were sprayed. One month later the malaria situation was worse. No entomological explanation could be found; there was no evidence to imply either insecticide resistance or inappropriate application methods. More epidemiological data were therefore collected, which showed that 88% of the cases were males between the ages of 17 and 45 years. This indicated that the malaria transmission was not in fact occurring in the village, but almost certainly in the mining areas where the adult males worked and slept. The application of insecticide in the village was therefore inappropriate and wasted scarce resources.

**Class discussion.** Ask the participants to provide similar examples from their own work situations. This will reinforce the importance of evidence-based decision-making and help participants to realize that the training they will receive is directly and immediately applicable to their own work situations.

## **Presentation: Key concepts and steps in evidence-based decision-making for vector management (30 minutes)**

*Overhead L1-2*

### **Three key concepts**

Three concepts are key to effective decision-making, each of which is covered in detail in this Learning Unit:

1. You must be willing to accept outcomes that are less than ideal.
2. You need to break the decision-making process down into logical steps.
3. You need to continually evaluate the outcomes of decisions and change the decisions if needed.

### **Ideal versus best possible decisions**

The following example will help you to explain a complicated concept, the idea of “best possible” or constrained decision-making, to your participants. It relates to an everyday event. Read the following statement to the participants. (This statement is *not* included in the *Participant’s Guide*.) Then ask a few of the participants to tell you what they would do in the same situation and why. In this case, the *best possible* response may be to pull off the road and into the ditch at the

side If the participants fail to mention this response, make sure that you mention it as one alternative.

“Imagine that you are driving to work in your car with busy traffic moving in both directions and a deep ditch on your nearside. As you travel along the road you see a vehicle coming towards you on the wrong side of the road. You must react quickly to avoid being injured or injuring other commuters.”

Use this example of an event requiring rapid decision-making to illustrate the difference between *best possible* and *ideal* outcomes. Point out that, while driving your car into a ditch is not an ideal outcome, neither you nor the other driver is likely to be seriously hurt, nor will you have injured the other commuters around you. Your car may be damaged, but this was the *best possible* outcome in the circumstances.

### **Points to emphasize**

- We all have to make decisions that lead to “best possible” rather than “ideal” outcomes every day.
- The consequences of these decisions, even though they are not ideal, are usually better than the results of failing to act.
- This concept can be applied to any kind of decision, including decisions for vector control.

### **Seven key steps in decision-making**

Decision-makers can simplify a complex situation by breaking it down into a series of simple steps. Use your own experience to give examples of each step, like those provided in the *Discussion suggestions*. Use the *Questions for participants*, or similar questions of your own, to encourage participants to think actively about the seven steps in decision-making and how these steps apply to their own work situations.

*Overhead L1-3*

## **Step 1: Describe and analyse the vector-borne disease situation**

**Discussion suggestions.** Before decision-makers can take effective action, they need to understand the situation that faces them. Good decision-makers identify changes in a situation early. They review the information available to them regularly and draw on their own past experience and that of others to identify changing situations before those changes generate crises. Some changes are easy to identify – such as a twofold increase in the number of reported malaria cases. However, the initial evidence that a situation is changing is often much less clear-cut. For example, the director of a regional health programme may see an increase in the number of individuals reporting to clinics with certain clinical symptoms, such as chills and fevers. This may lead

the director to suspect that the incidence of malaria is increasing. If a vector control programme is already in place, this information could be a warning that the programme is losing effectiveness.

Developing a good monitoring system (the last step in decision-making) is one way to make sure that changes in the effectiveness of vector management programmes are recognized early.

**Questions for participants.** Ask a few of the participants to give examples from their own work situations of early warnings of changes in the effectiveness of vector management programmes. Ask for examples in which someone identified the warning signs early and others in which early signs of change were ignored.

*Overhead L1-4*

## **Step 2: Stratify vector-borne disease problem based on relevant variables**

**Discussion suggestions.** Four pieces of information are critical for decision-makers. *Who* suffers infection from a particular vector-borne disease? *Where* does transmission occur? *When* does transmission occur? *How* does transmission occur (i.e. does a vector transmit the disease or does transmission occur through some other mechanism)? Refer again to the example of malaria in Brazil (page 20), which shows that infection was not uniformly distributed across the population. This information is a strong indication that transmission does not occur in the village, but rather at a site frequented by adult males – not children or women. The timing of transmission – differences in the time of day or season, for example – is equally important.

**Questions for participants.** Ask participants to provide an example from their own work settings of situations in which at least one of the four critical pieces of information was missing. Ask them to explain how the missing information affected the decisions that were taken about vector management.

Overhead L1-5

**Step 3: Determine whether there is a role for vector control in each stratum**

**Discussion suggestions.** Vector control is often an important approach to reducing the morbidity and mortality from vector-borne diseases. However, the relative importance of vector control will vary from situation to situation. Failure to assess realistically whether vector control will contribute significantly to reducing the transmission of a given disease can result in wasted effort and resources. For example, vaccination may be a much more effective approach than vector control for yellow fever because of the difficulty of controlling sylvatic vectors and the very high cost of controlling the vectors of urban yellow fever. The main approach to reducing the incidence of yellow fever has therefore been vaccination rather than vector control.

**Questions for participants.** Ask participants to give some examples from their own work situations of *vector-borne diseases* for which vector control is either one of several approaches to control or for which vector control has proved relatively ineffective.

Overhead L1-6

**Step 4: If there is a role for vector control, determine which vector control method(s) is (are) suitable**

**Discussion suggestions.** Several methods of vector control can usually be used. There are two key aspects of deciding which methods to use.

First, selecting a suitable control method is critical. For example, using a larvicide will be ineffective for vectors that have a wide range of breeding sites and where breeding sites are extensive.

Second, better vector management is often achieved when several different approaches are used together as part of an overall strategy. In many cases, the key to judicious use of insecticides is to determine when and how to use chemicals *as part of an overall management strategy*. For example, an overall strategy for reducing the effects of a mosquito vector may involve a combination of reducing the breeding area available to the vector and site-specific applications of insecticide to critical breeding sites.

The multi-component strategy, in which insecticides are used selectively in conjunction with other approaches, is a much more judicious use of the available chemical methods. Over the long term, a more judicious approach to chemical control results in superior vector management and helps to ensure that the available insecticides for controlling vectors will remain effective longer.

**Questions for participants.** Ask the participants to give examples from their own work situations of over-reliance on a single method of vector control, especially chemical control methods. Ask them to discuss the financial and other consequences of such over-reliance.

*Overhead L1-7*

### **Step 5: Where insecticide use is essential, select method(s) of application**

**Discussion suggestions.** The outcome of the insecticide application requires three important considerations – the effectiveness of the treatment, the cost of the treatment, and the potential risk to the environment or to applicators. A specific vector may be susceptible to chemical control in several settings or at several stages in its life-cycle. The efficacy of chemical control will vary with the susceptibility of the vector under different conditions. Indoor residual spraying will control a vector that enters and rests on the interior walls of the house, for example, and may be more effective, cheaper and of potentially lower risk than applying insecticides outside the home.

**Questions for participants.** Ask participants to give examples from their own work situations of vectors that are susceptible to chemical control methods in different biophysical settings, at different times of the day or year, or at different stages life of their life-cycle. Ask them to explain the most efficacious chemical control method for these vectors in terms of the effectiveness of the insecticide application, the cost and the potential risk to the environment or the applicator.

*Overhead L1-8*

### **Step 6: Determine what insecticide to use and when, where and how to apply it**

**Discussion suggestions.** Implementation plans must include four components:

What insecticides should you use?

Where will you intervene? This may mean selecting certain high-priority geographical areas for interventions – places where the disease is most prevalent, for example. It may also mean identifying particular places within communities, such as areas where mosquito larvae develop. Finally, it may involve identifying groups of people who are particularly vulnerable to the disease (e.g. children, people living in refugee camps).

When do you need to intervene? Again, this may refer to the time of year – for example, an intervention in the rainy season for malaria control – or to the time of day – for example, during the evening hours.

How will you apply the intervention? If you plan to spray an insecticide to control mosquito larvae, for example, will you use backpack sprayers, sprayers mounted on vehicles, boats or aircraft?

**Questions for participants.** Ask a few participants to give examples of implementation plans that failed because these basic questions were not properly answered in advance.

*Overhead L1-9*

## **Step 7: Establish operational outputs and targets and select monitoring and evaluation methods**

**Discussion suggestions.** Monitoring performance takes place on three levels. First, you need know whether your implementation plan is functioning well. This relates to the activities that you described (operational outputs). A basic monitoring system asks “Are we doing what we said we would do?” For example, if you have decided that, for malaria control, you need to apply a larvicide every two weeks during the rainy season, you need to establish a tracking system that tells you whether these activities are taking place in a timely fashion.

Second, you need to know whether your activities are having the desired effects. The monitoring system must therefore also ask “Are we meeting the targets that we established?” If your goal was to reduce the number of mosquito larvae by 80%, you need to make sure that larval surveys are carried out periodically to determine whether this target is being met.

Third, you need to know whether the vector control programme is having the desired impact on health outcomes. Therefore, the monitoring system must also provide continual feedback about the health situation. These data are linked to morbidity and mortality from disease.

**Questions for participants.** Ask a few participants to give examples of monitoring systems they use for each of the three critical aspects of monitoring: completing activities on time, meeting desired targets, and achieving desired health outcomes.

### **Decision-making as a continuous process**

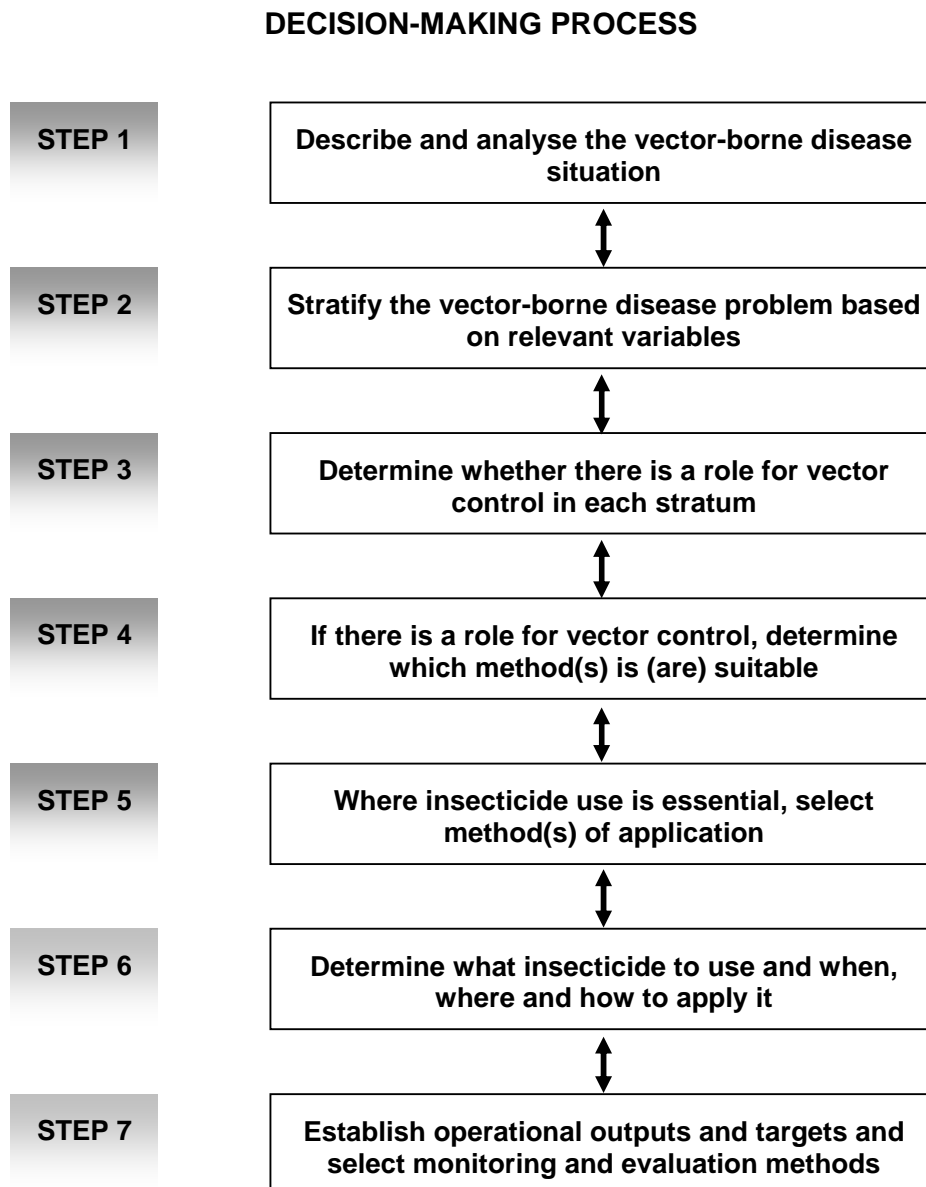
Vector control is an intervention – often major – that affects the health situation in a region. Its ultimate goal is to help reduce the morbidity and mortality from vector-borne diseases. The vector control specialist must remain alert to changes in the health situation in his/her area of responsibility and be willing to change the vector control strategy in response to changing conditions. Stress the following concepts:

- Decision-making is a continuous process. The information gained from monitoring is used to determine whether the decisions that have been made are contributing to the achievement of stated health goals. If they are not, new decisions are needed.
- Effective decision-makers operate on the principle that *all decisions are provisional* – you make a decision, you continually check to see whether it is “working”, and you are always prepared to make a new decision if performance is inadequate. No decision works “once and for all”. The conditions that create health problems will change: organisms become resistant to insecticides; environmental conditions change; people move from one place to another, carrying disease-causing organisms with them.
- Decision-makers must decide ahead of time when a development or change in the health status in an area requires another decision. They must be prepared to act when a decision outcome shifts from “acceptable” or “under control” to “unacceptable” or “out of control”. This requires the development of *performance indicators*, with thresholds that indicate the need to make another decision. If a 10% infection rate for a given disease is acceptable in a given area, for example, you will need to examine your vector control strategy if the rate rises to 15%. It may be time to make a new decision about vector control, or you may find that other factors, outside your field of responsibility as a vector management specialist, are causing the undesired change.

## Closure discussion (15 minutes)

Overhead L1-10

**Briefly review the seven steps in effective decision-making for vector-borne disease control**



**Ask the participants** to take a few minutes to write down three ideas that they have gained from this opening discussion and that they can use in their own work situation to improve the quality of decision-making for the control of vector-borne diseases. (If necessary, participants can work in pairs to encourage better response.)

Ask a few participants (or all of them if there is time) to share with the group their ideas for improving decision-making.

# Understanding the problem

**Present the objectives** (5 minutes)

*Overhead L2-1*

---

## LEARNING OBJECTIVES

After completing this *Learning Unit* you will:

- be able to apply a systematic approach to the analysis of vector-borne disease problems
  - understand the significance of stratification of vector-borne disease problems and incorporate stratification into the decision-making process
- 

**Presentation and discussion** (45 minutes)

Show the seven-step slide (overhead L1-10) and explain to the participants that this learning unit addresses steps 1 and 2 in effective decision-making. It focuses on describing the vector borne disease situation and stratifying it based on relevant variables.

### **Step 1: Describe and analyse the vector-borne disease situation**

Remind participants of the Brazil malaria example (page 14) and ask them to identify the risk factors. Then present definition of a variable (overhead L2-2).

## Definition of variable

“In the context of this training course, a variable is a changeable condition that influences the expression of health risk factors.” Variables act on groups of individuals, households, neighbourhoods, towns, regions, or countries.

Variables can be ecological or environmental, economic and social. Ask participants what circumstances, attributes or events could be classified as variables. Write the responses on a flip chart or overhead transparency as they are mentioned.

### Some possible answers:

#### *Environmental variables*

- Altitude
- Annual mean temperature
- Relative humidity
- Rainfall (amount and pattern)
- Topography
- Hydrology
- Vegetation type and cover
- Number and type of breeding sites available for vectors and parasites
- Drainage
- Land use
- Water quality

#### *Socioeconomic variables*

- Occupation
- Educational level of the community
- Human activity patterns
- Agricultural practices
- Location, type and age of settlements
- Migration patterns and intensity (centres of development: mining, etc.)
- Availability and capacity of the health services
- Availability and use of protective measures (mosquito nets, insect repellents)

This list is not exhaustive, but it does include some of the variables that most commonly affect the occurrence of disease. Be sure to point out any variables that are not mentioned by the class.

### *Overhead L2-3*

## **Variables responsible for leishmaniasis in Sanliurfa, Turkey**

### *Environmental*

1. High temperatures in the summer months caused people to sleep outside and be bitten more often by sandflies.
2. Humidity was high in the cracks and crevices of the houses so that sandflies were less exposed to high temperatures and low humidity.
3. The presence of many animal stables provided excrement for sandfly breeding.

### *Socioeconomic*

1. Poor living conditions were related to leishmaniasis incidence.
2. Housing structure that is conducive to breeding and indoor resting of sandflies.
3. Seasonal migration of agricultural workers was most probably responsible for outbreaks.

### *Overhead L2-4*

These and other variables interact to create the health situation, which should be described in terms of four factors:

**Who** contracts a specific disease? For example, what is the sex, age, ethnicity, or occupation of the individuals who are affected?

**When** do they contract the disease? Does incidence vary by season? Does transmission occur at specific times of day?

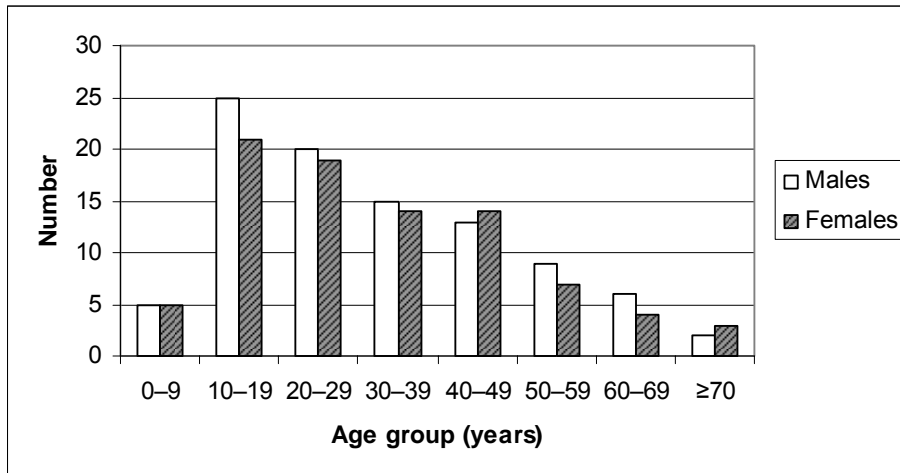
**Where** does transmission occur? For example, does transmission occur outside the community, where people work or when they travel, or at some specific location within the community?

**How** does transmission occur? Does a vector transmit the disease or does transmission occur through some other mechanism?

Overhead L2-5

**Who has leishmaniasis?**

Age distribution of people with visceral leishmaniasis in Ninej



Overhead L2-6

**When does visceral leishmaniasis occur?**

Number of cases	Wet season	Dry season
Female	13	74
Male	6	89
<b>Total</b>	<b>19</b>	<b>163</b>

Overhead L2-7

### Where does visceral leishmaniasis occur?

Distribution of human cases of visceral leishmaniasis in the northern region of country from February 2000 to January 2001

District	Number of cases	% of total cases
Ninej	100	40.9
Oheriej	67	27.5
Teefal	3	1.2
Marklut	31	12.7
Sulban	8	3.3
Hallamar	27	11.1
Sabut	5	2.0
Mehel	3	1.2
<b>Total</b>	<b>244</b>	<b>100</b>

Overhead L2-8

### How does visceral leishmaniasis transmission occur?

Total number of *Phlebotomus* sandflies collected in light traps in Ninej by census tract. Number infected with *Leishmania* parasites are shown in parentheses.

Census tract	<i>P. tobli</i>	<i>P. syriacus</i>	<i>P. perfiliewi</i>	Total
NE	151 (8)	31	6	188
SE	15	8	6	29
SW	10	7	9	26
NW	150 (4)	40	10	200
Central	0	3	1	4
<b>Total</b>	<b>326</b>	<b>89</b>	<b>32</b>	<b>447</b>

Overhead L2-9

## Step 2: Stratify the vector-borne disease problem based on relevant variables

Stratification is a process that permits the decision-maker to characterize geographical areas, groups of people or situations that share important criteria in order to be able to develop solutions to the disease problems in a country, region or local area. Stratification involves three components:

- intensity (prevalence/incidence) of transmission of the disease;
- eco-epidemiological characteristics of the disease;
- ability to intervene to reduce the intensity of transmission, including infrastructure and operational capacity.

Overhead L2-10

### Example of stratification – intensity of transmission

Distribution of human cases of visceral leishmaniasis in the northern region of the country from February 2000 to January 2001

District	Number of cases	% of total cases	Incidence rate per 1000
<b>Ninej</b>	<b>100</b>	<b>40.9</b>	0.5
Oheriej	67	27.5	0.1
Teefal	3	1.2	0.02
Marklut	31	12.7	<b>1.72</b>
Sulban	8	3.3	1.0
Hallamar	27	11.1	1.1
Sabut	5	2.0	0.7
Mehel	3	1.2	0.2
<b>Total</b>	<b>244</b>	<b>100</b>	

Further stratification of human cases of visceral leishmaniasis in Ninej district from February 2002 to January 2003

Subdistrict	Incidence rate per 1000
NE	0.5
SE	0.1
SW	0.2
<b>NW</b>	<b>1.3</b>
Central	0.01

### Discussion point

Even when information is available, we have to make sure that it is “good” information. Good information has two characteristics. First, it is *reliable*. That is, we have confidence that the information is true. We often judge reliability based on who reports the information. We might tend to disregard unsubstantiated rumors about an increase in the reported cases of malaria in a region, for example, but pay close attention to verbal warnings from a trained health care provider. Second, good information is *accurate*. In essence, this means that the numbers are believable; they make sense based on previous experience and trends. We might tend to disregard an increase in the reported cases of malaria from a single clinic, but pay attention to a general trend that appears from several different clinics.

### Group exercise I (30 minutes)

**Instructions for course coordinator.** Assign the participants to working groups. Use a flip chart, blackboard, or overhead transparency to list the members of each working group. Each group will analyse a case-study throughout the course. Stress to the participants that there are no “right” or “wrong” answers to the questions they will discuss during the group exercises. Explain that each of the case-studies takes place in a different setting and deals with a different disease problem. During this workshop, the participants will use the seven steps of effective decision-making to identify the vector-borne disease problem, gather relevant information and choose a vector control strategy. Explain that each case-study has several parts.

**Instructions for facilitators.** Ask the participants in your group to select a rapporteur and moderator for this group exercise. Make sure that these roles are rotated among participants as you proceed through the different group exercises. Explain that one member of the group will make a brief (5 minutes) report to all course participants about your group's decisions during this exercise. The moderator should take notes during the group exercise and help the rapporteur to record key ideas or decisions on a flip chart or overhead transparency for the report to the plenary session.

Provide the participants with **Part 1** of a three-part case-study. The exercise will focus on analysis of vector-borne disease situations – Step 1 in the decision-making process.

After the working groups have read and discussed the information, they should answer the questions below. They should present their conclusions in plenary.

1. What health problem(s) can you identify in Part 1 of the case-study? What evidence is there that these problems exist?
2. What important ecological (environmental) and economic or social variables and factors can you identify that influence the health situation?
3. What other information do you need to be able to understand the situation and decide how to solve these problems?

## **Group exercise II (45 minutes)**

**Instructions for course coordinator.** This exercise will focus on Step 2 of the decision-making process, stratifying and analysing information. Ask the class to divide into the same groups. The facilitators should also work with the same groups.

**Instructions for facilitator.** Hand out Part 2 of the case-study and the fact sheet about “key epidemiological indicators” at the end of this Learning Unit. You can briefly discuss the epidemiological terms and their relevance in decision-making.

Ask the participants to read Part 2 of the study and then answer the following questions. Sample answers have been provided in the case-studies to help you to guide the participants through this exercise.

1. Do the new data confirm your original assessment of the nature of the problem? Why (or why not)?
2. Based on the data you have now, write a brief (250 words or less) explanation of the vector-borne disease problem and its magnitude. Include: (a) **who** has the disease, (b) **where** you believe transmission occurs, (c) **when** you believe transmission occurs, and (d) **how** you believe transmission occurs.
3. Are the data sufficiently stratified to allow an appropriate decision to be made on vector control? Why (or why not)?
4. How would you present your data graphically (using maps, graphs, or charts)?
5. Are the data sufficiently reliable and accurate to allow you to move forward with decision-making? If not, what additional data do you need?

## Closure discussion

Ask the participants to think about a health situation in their own work where better use of stratification would improve their ability to make good vector control decisions. Ask a few participants (all if possible) to share their ideas with the group as a whole.

Ask the participants to read *Control Strategies for Chagas, dengue and malaria*<sup>1</sup>, as a homework assignment before presentation of learning unit 3.

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<sup>1</sup> In: *WHO recommended strategies for the prevention and control of communicable diseases*. Geneva, World Health Organization, 2001 (document WHO/CDS/CPE/SMT/2001.113).



# Formulating objectives and approaches

**Present the objectives** (5 minutes)

*Overhead L3-1*

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## LEARNING OBJECTIVES

After completing this *Learning Unit*, you will be able to:

- determine when vector control has an important role to play in achieving health goals
  - use information about the life-cycle of the disease-causing organism and its vector(s) to determine which of the three main vector control methods are most appropriate to use in a specific situation
  - decide when chemical control is essential and select the most appropriate application method(s)
- 

**Presentation: Overview of vector control** (15 minutes)

The main aim of vector control is to reduce disease mortality and morbidity by reducing disease transmission. Vector control includes activities that reduce the number of infective bites of the vector by reducing the vector density, longevity and/or preventing human–vector contact.

Tell the participants that the principles of vector control have changed over the past 50 years. Public health officials in the mid-twentieth century emphasized disease eradication rather than control. Today's emphasis on integrated vector management both enhances control and makes more efficient use of scarce resources.

#### *Overhead L3-2*

Integrated vector management (IVM) is an evidence-based decision-making process, rationalizing the use of vector control methods and resources and emphasizing the engagement of communities.

**Ask the participants** to explain the difference between IVM and vector control.

**Possible answers.** Vector control is a component of IVM, and the philosophy of IVM influences how vector control is carried out. The point to stress is that indiscriminate or inappropriate chemical use may be a vector control strategy but that it is not consistent with an IVM philosophy. However, most IVM strategies rely on chemical control of vectors to control disease.

### **Presentation and discussion: Indications of an important role for vector control (15 minutes)**

This presentation and discussion focus on Step 3 in the decision-making process.

#### *Overhead L3-3*

### **Step 3: Determine whether there is a role for vector control in each stratum**

- There are six main indications for vector control in controlling vector-borne diseases:
- Prevention and control of epidemics
- Elimination of new foci of infection
- Prevention of seasonal peaks of transmission
- Control of transmission in high-risk situations
- Reduction of transmission in areas of high drug resistance
- Control of an endemic disease.

**Ask the participants**, based on the reading of *Control strategies for Chagas, dengue, and malaria* and their personal experiences, to determine what disease control mechanisms are recommended for each of the diseases in their case-studies. Discuss the importance of vector control for each disease.

*Overhead L3-4*

**Chagas disease**

- Systematic screening of bloods in blood banks.
- Personal protection through housing improvement and reduction / elimination of vectors' hiding places.
- Reduction/elimination of transmission through indoor residual spraying and other appropriate vector control measures.
- Early treatment and case management.
- Capacity building and research.

*Overhead L3-5*

**Dengue**

- Selective integrated vector control, with community and inter-sectoral participation.
- Active disease surveillance based on a strong health information system.
- Emergency preparedness.
- Capacity building and training.
- Vector control research.

## Malaria

- Early diagnosis and prompt treatment.
- Selective and sustainable preventive measures, including vector control.
- Early detection, containment or prevention of epidemics.
- Strengthening local capacities in basic and applied research to permit and promote the regular assessment of a country's malaria situation, in particular the ecological, social and economic determinants of the disease

Now, an additional important consideration is the prevention of the re-emergence of malaria in countries that have either succeeded in reducing malaria incidence to a low level or that have interrupted transmission altogether.

**Ask the participants** to discuss how the six indications of an important role for vector control apply to each of the three diseases, Chagas disease, dengue and malaria. For example, drug resistance is not a concern for either dengue or Chagas disease.

**Possible answers.** All six indicators are important for malaria. Drug resistance is not important for Chagas disease or dengue. Prevention of seasonal peaks of transmission is not important for Chagas disease.

Point out that vector control is usually an important component of any vector-borne disease control programme. The indications of the importance of the role for vector control will vary, however, depending on the specific characteristics of a given disease and the local situation.

**Ask the participants** to identify any vector-borne diseases in their work area for which vector control does *not* have an important role. Have them explain why.

### **Presentation: Methods of vector control (20 minutes)**

When vector control *does* have an important role to play in disease control, identifying the appropriate vector control method is a critical step in decision-making.

**Step 4: If there is a role for vector control, determine which vector control method(s) is (are) suitable**

There are three major vector control methods:

- Reduce human–vector contact
- Reduce vector density
- Increase adult vector mortality

**Reduce human–vector contact.** This method creates a barrier between the vector and humans, thereby reducing or preventing the transmission of disease. Common methods used to reduce human–vector contact include:

- Mosquito nets, insecticide-treated nets and curtains
- Window and door screens, house improvement
- Repellents
- Household insecticide products (e.g. coils, mats and aerosol dispensers)
- Protective clothing

**Reduce vector density.** This method reduces the potential for vectors to transmit disease by lowering their reproductive rate and vectorial capacity. Frequently used methods are:

- Environmental management
- Larviciding
- Biological control
- Adulticiding with space sprays

**Increase adult vector mortality (reduce vector survival).** This method reduces the expectation of life of the adult vector and therefore the probability that a pathogen will complete its extrinsic incubation period. Common methods include:

- Indoor residual spraying
- Community-wide use of insecticide-treated nets.

## Key points to emphasize

### General

- Some of the **bionomic** characteristics of different species make them more or less vulnerable to the various methods of vector control.
- Knowledge of **larval habitats** and **adult behaviour** is necessary for selection of the most appropriate control method.

### Immature forms

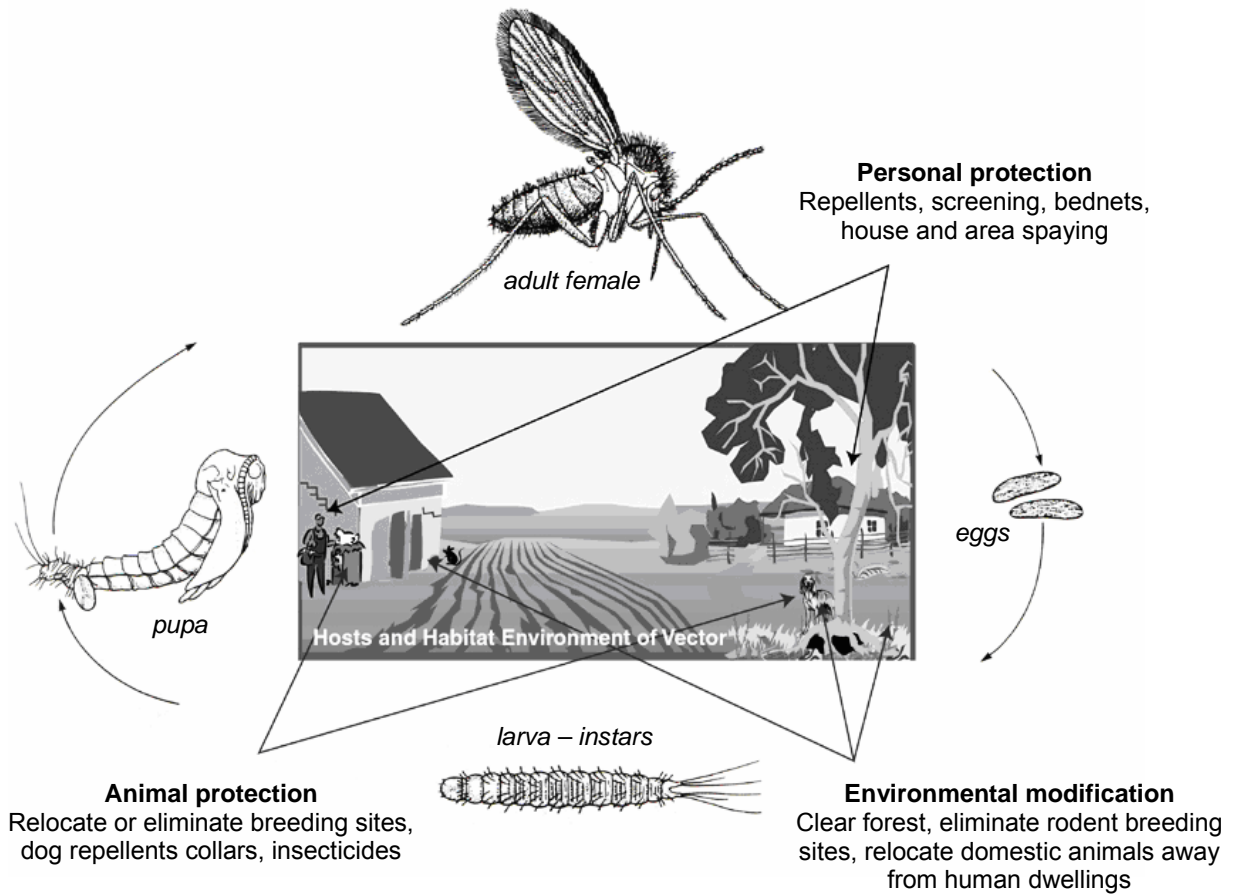
- The habitats of immature forms vary enormously.
- Identifying both permanent and temporary habitats is important.
- The effectiveness of control of immature forms depends on the number, extent and accessibility of breeding habitats.

### Adults

- Biting and resting habits of adults are highly variable.
- Time of feeding influences vector efficiency and effectiveness of control.
- Understanding the resting habits of the vectors is important for ascertaining the feasibility of different vector control methods.
- Understanding the mechanisms of survival during adverse weather conditions is also important.

**Use the example of leishmaniasis to illustrate these points.**

Overhead L3-8



**Discussion: What are the advantages and limitations of each vector control method? (30 minutes)**

This Learning Unit emphasizes the criteria that are used to decide whether chemical control of the vector is essential, and if so, to decide which chemical control methods are most appropriate.

**Step 5: Where the use of insecticide is essential, select method(s) of application**

As a large group activity, using leishmaniasis as an example, have the participants discuss the advantages and limitations of each vector control method (environmental management, biological control, chemical control) and determine expected outcome (reduction of human–vector contact, reduction of vector density and increase in adult vector mortality). Use the following blank table as a template on the blackboard or flip chart to record the outcomes of the discussion.

<b>Approach</b>	<b>Advantages</b>	<b>Limitations</b>
<b>Environmental management</b>		
<b>Chemical control</b>		
<b>Biological control</b>		

### **Group exercise III: Vector control methods (90 minutes)**

**Instructions for coordinator.** Ask the participants to divide into the three working groups.

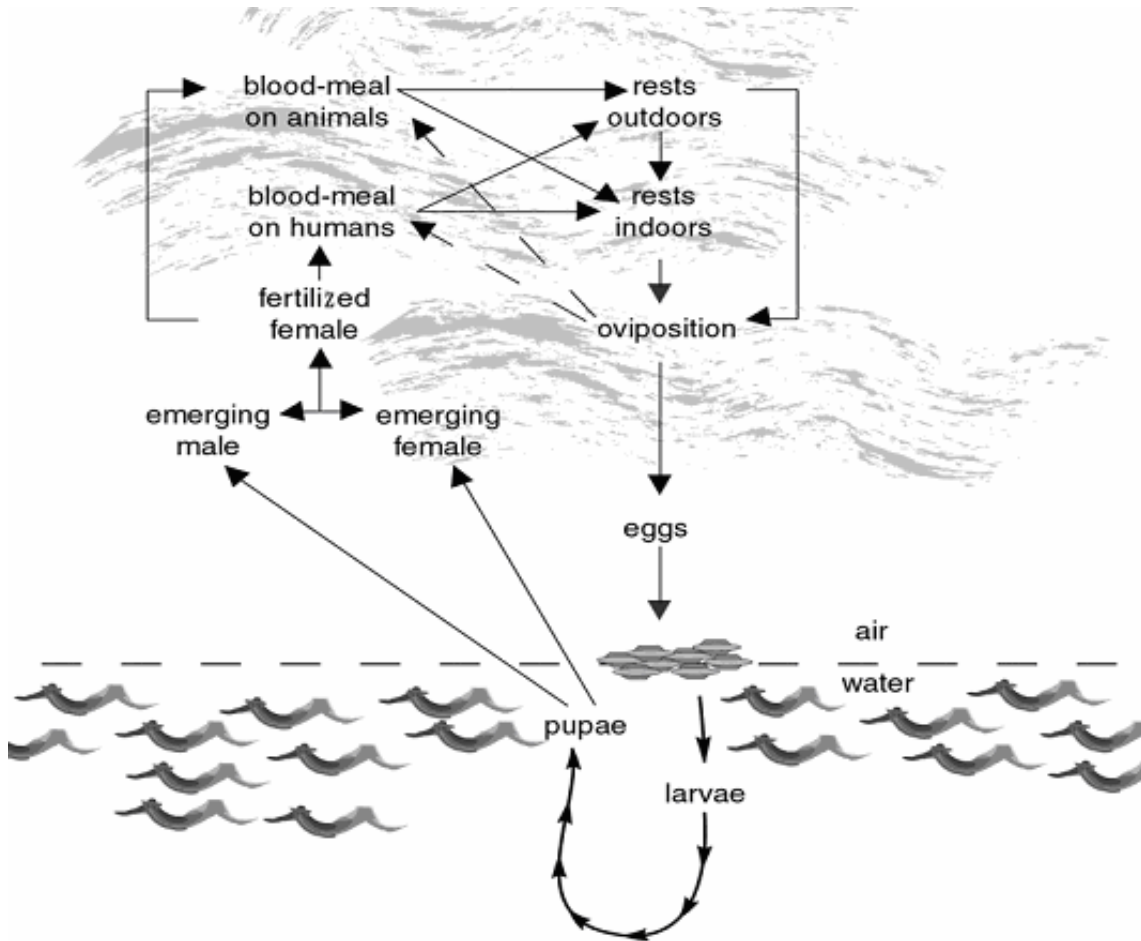
**Instructions for facilitators.** Give each group Part 3 of their case-study and the diagram of the relevant life-cycle. Ask them to indicate which vector control methods may be considered and how they relate to the life-cycle. Then invite them to compare the outcome of their discussions with the diagram showing the life-cycle *and control measures*.

**Ask participants** to discuss the advantages and limitations of each potential vector control intervention in the context of their case-study. They should consider the available resources, including infrastructure, and select the most appropriate vector control method or combination of methods for their case-study. Ask the rapporteur for each working group to present the diagram of the life-cycle and control measures to the plenary session and explain the rationale behind their decisions.

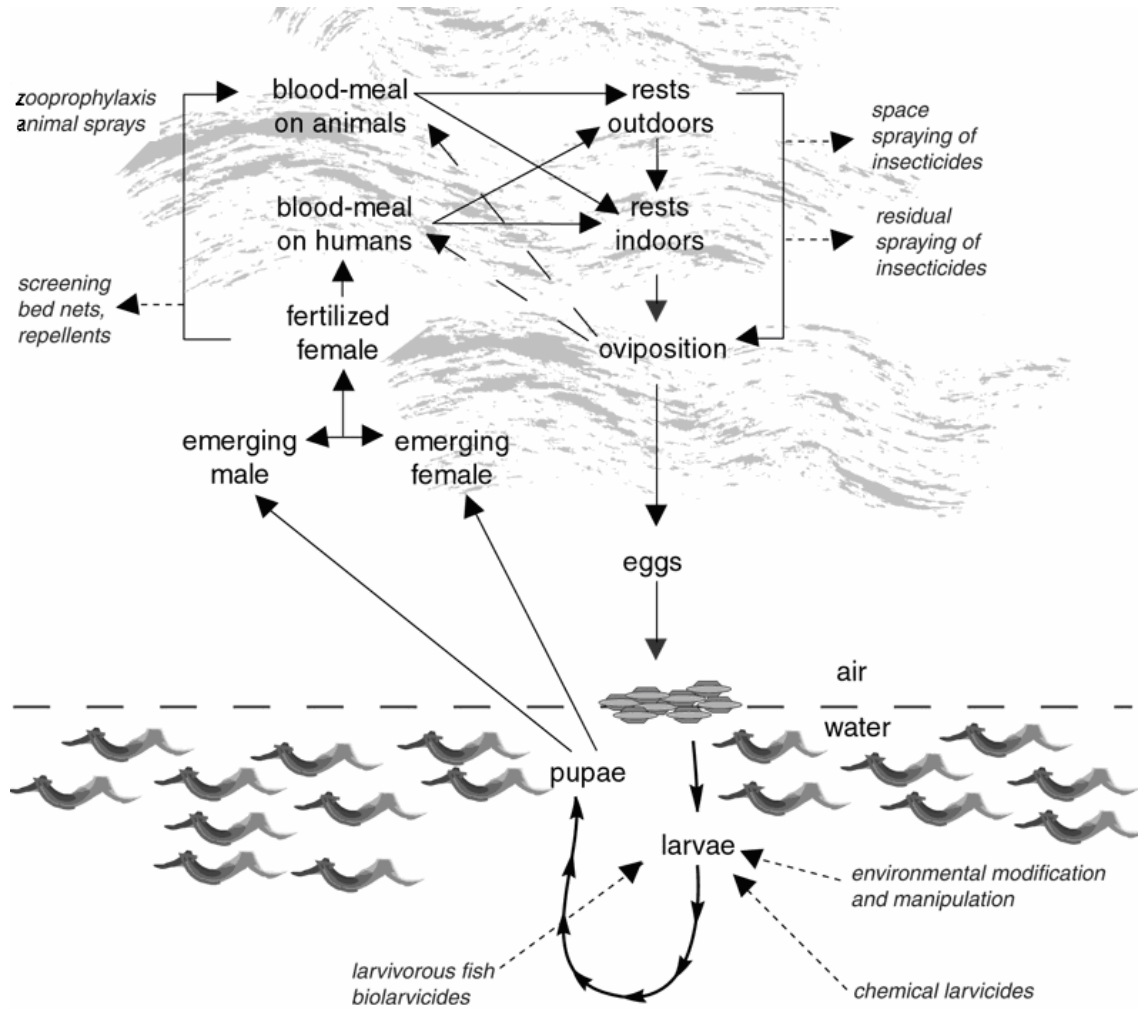
### **Closure discussion (20 minutes)**

**Ask participants** to take a few minutes to think about a specific vector control programme in their work situation. Get them to write down the vector control method or methods that are currently used in the programme. Ask the participants to consider the proposed interventions in Figures 3.1 through 3.3, to think about whether the methods currently used are the most appropriate and to explain why (or why not). Invite a few participants share their conclusions with the group as a whole.

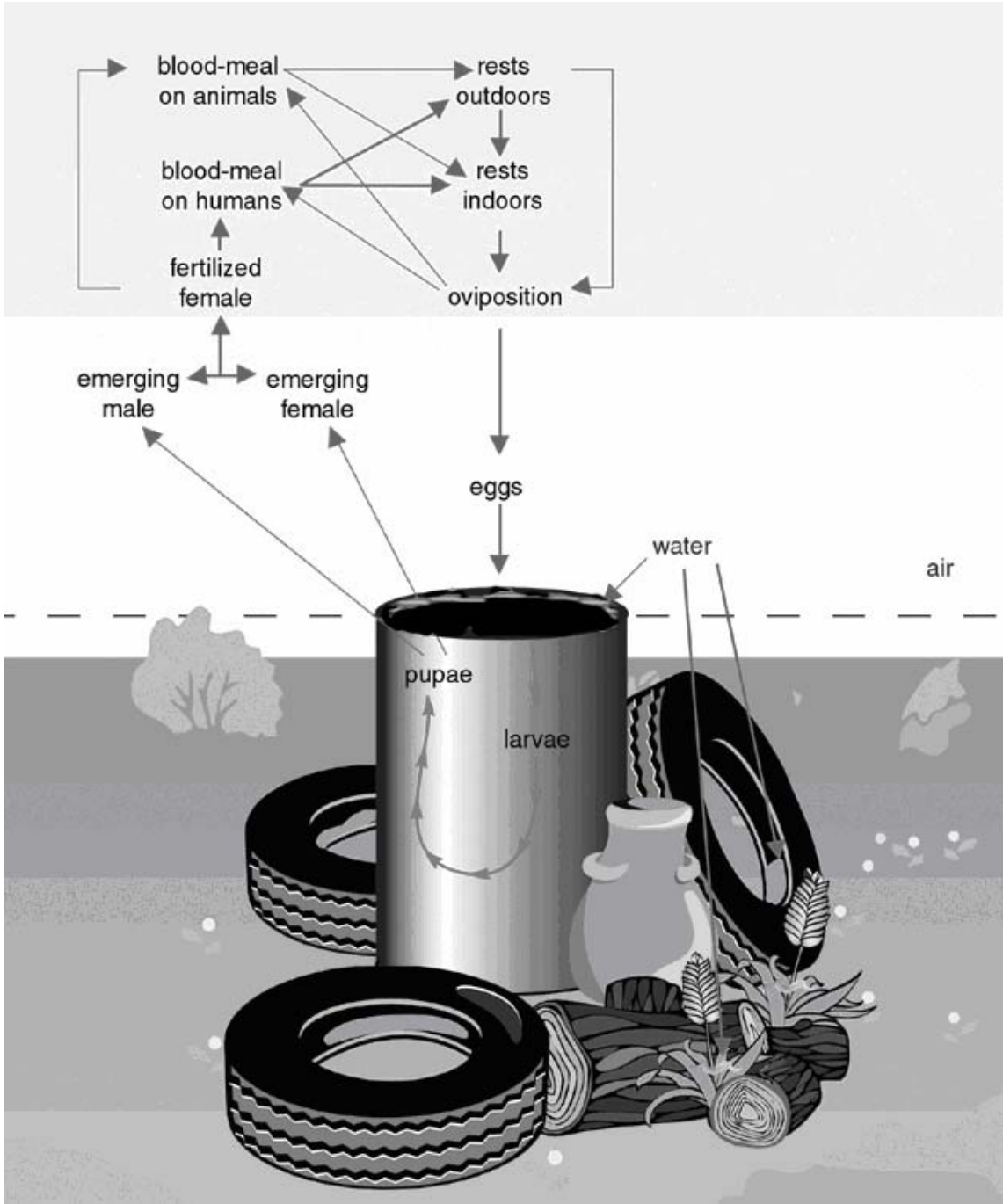
**Figure 3.1a**  
**Malaria mosquito vector life-cycle**



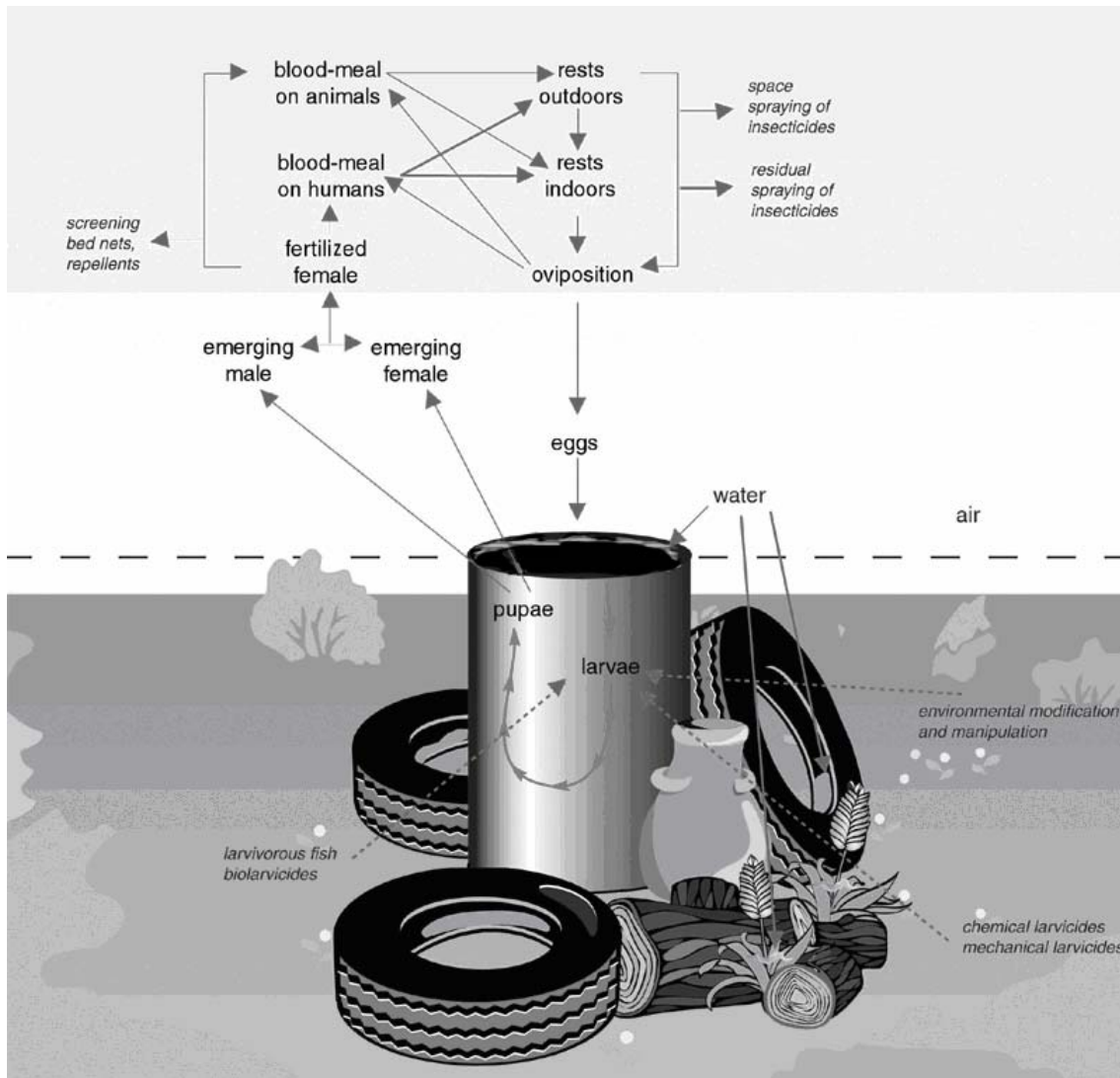
**Figure 3.1b**  
**Malaria vector life-cycle with control measures**



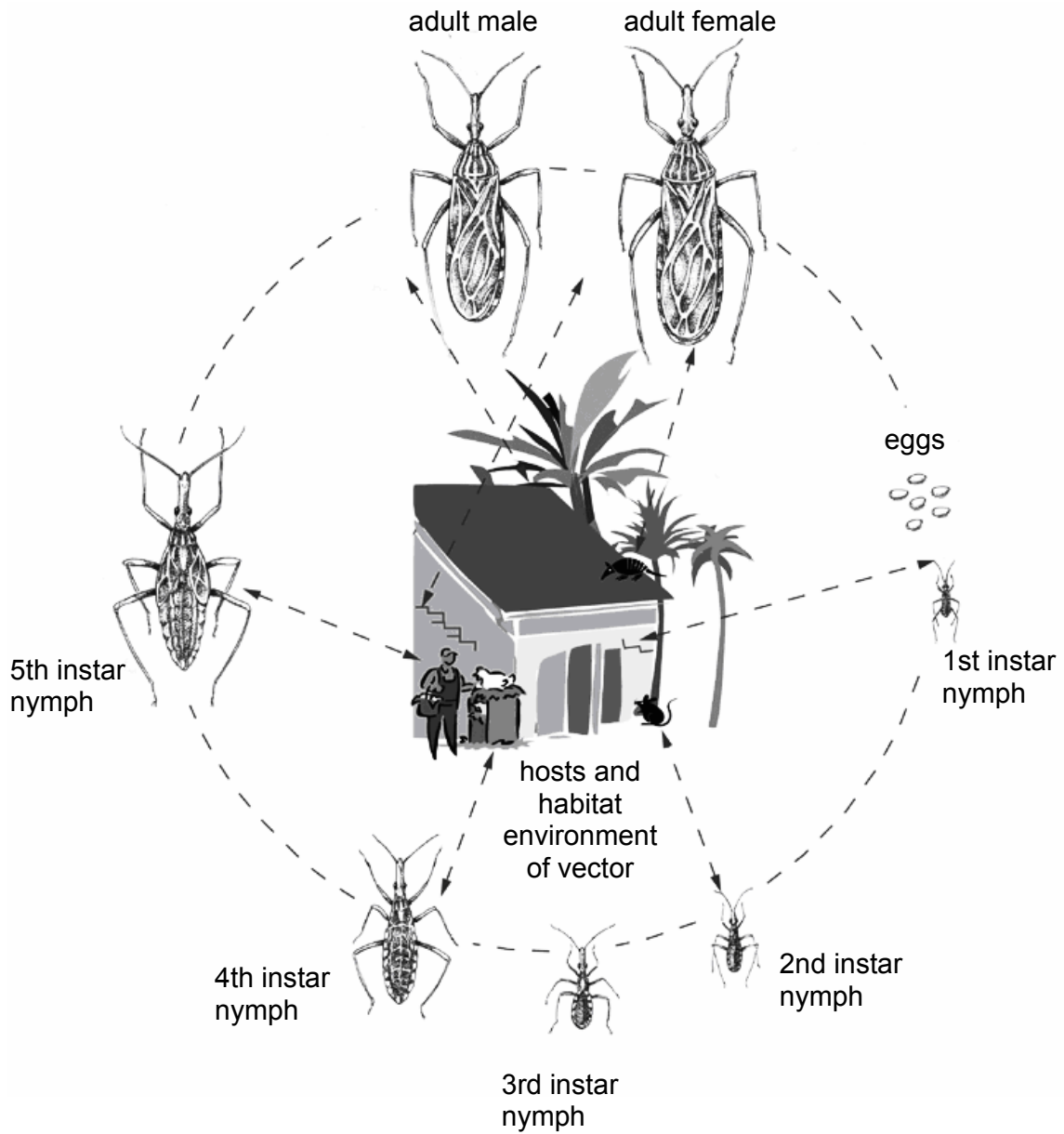
**Figure 3.2a**  
**Dengue mosquito vector life-cycle**



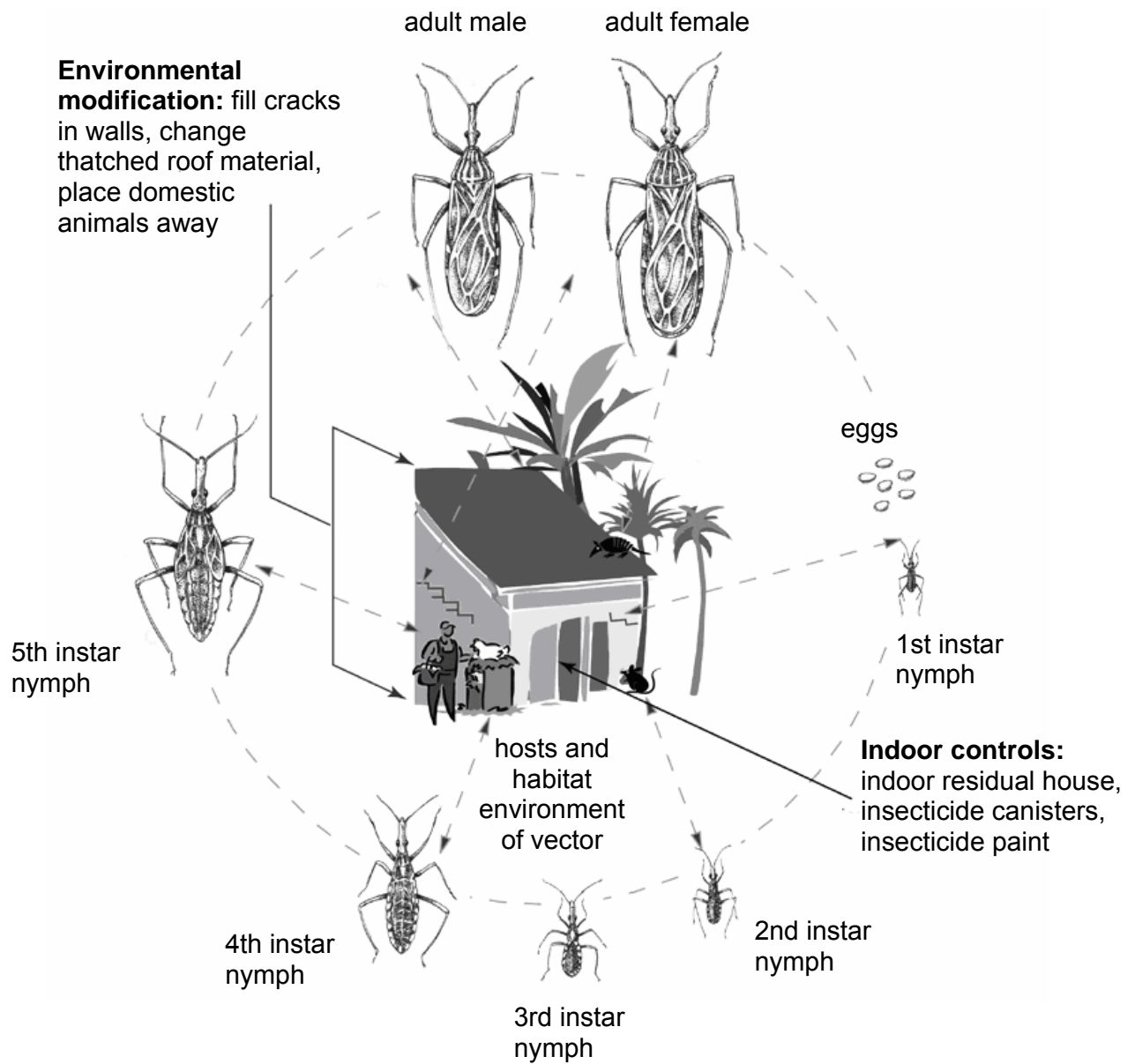
**Figure 3.2b**  
**Dengue vector life-cycle with control measures**



**Figure 3.3a**  
**Chagas disease vector life-cycle**



**Figure 3.3b**  
**Chagas disease vector with control measures**





# Judicious use of insecticides

**Present the objectives** (5 minutes)

*Overhead L4-1*

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## LEARNING OBJECTIVES

After completing this *Learning Unit*, you will be able to:

- determine **what** insecticides are most appropriate to use in a given situation
  - decide **where** insecticides should be applied to ensure their effective and targeted application
  - establish **when** to apply insecticides to maximize their effect
  - make decisions about **how** to ensure that insecticides are applied safely and effectively
- 

**Presentation and large group exercise** (10 minutes)

This Learning Unit focuses on the skills and knowledge needed to apply insecticides judiciously. Briefly introduce the concepts of **what**, **where**, **when**, and **how** in relation to the use of insecticides. Then proceed immediately to the large group exercise described below.

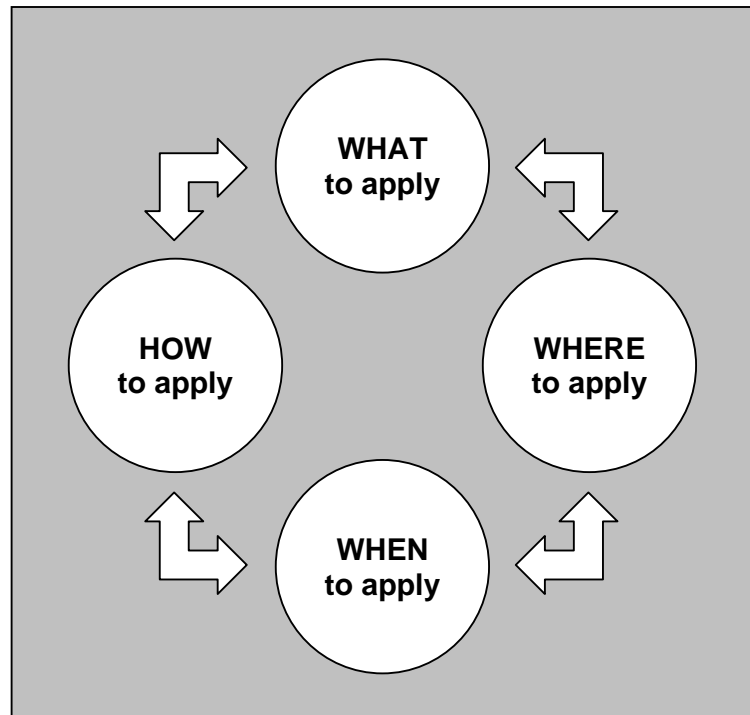
Overhead L4-2

**Step 6: Determine what insecticide to use and when, where and how to apply it**

Explain that Step 6 includes four components of insecticide application and show overhead L4-3. The four components are:

1. **What** insecticide (compound and formulation) should be applied? Which product is most appropriate, taking into consideration its safety, efficacy, acceptability, cost and availability?
2. **Where** to apply? This requires identification of priority geographical areas and specific locations for best targeting and coverage requirements.
3. **When** to apply? This may refer to the time of year or to the time of day and the epidemiological requirements, taking into consideration duration of effect and time required for covering the target area.
4. **How** to apply? What skills and equipment are required to ensure effective and safe application?

Overhead L4-3



## Large group exercise

The objective of this large group exercise is for the participants to become aware, through a process of self-discovery, of the criteria associated with the four major components of the judicious use of insecticides.

Provide a copy of Figure 4.1 to the participants. Prepare four flip charts, one labelled **What**, one labelled **Where**, one labelled **When**, and one labelled **How**.

**Ask the participants** to name and define the criteria that must be addressed for each of the four major components of judicious use of insecticides. Write their suggestions on the appropriate flip chart as the participants raise and discuss them. A complete list of the factors is included below. Make sure that all of the criteria below are mentioned and discussed by the participants.

### Critical factors

#### *What*

- Efficacy
- Cost-effectiveness
- Safety
- Acceptability
- Availability of quality products

#### *Where*

- Coverage requirements
- Best targeting

#### *When*

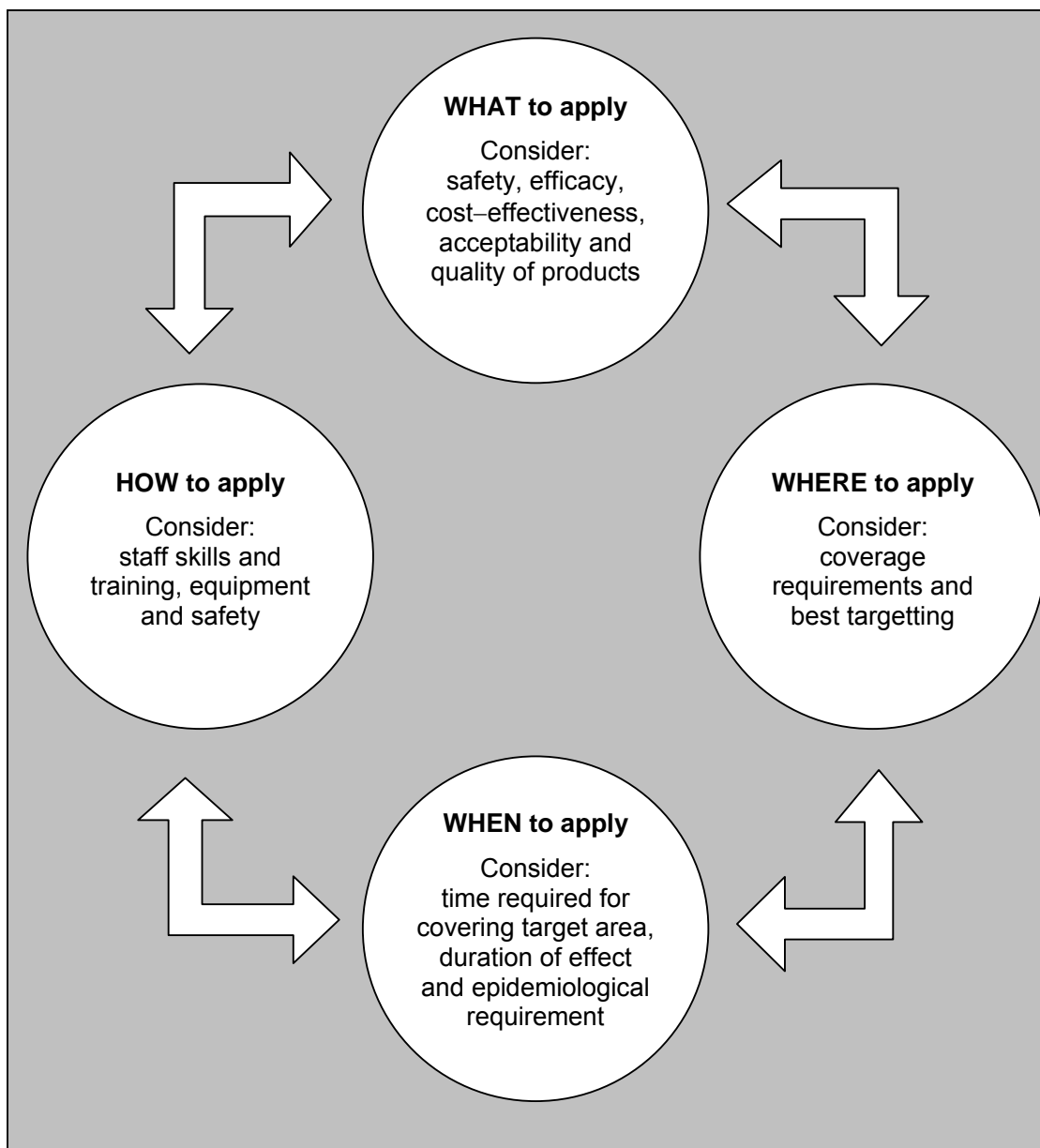
- Time required for covering target area
- Duration of effect
- Epidemiological requirements

#### *How*

- Staff skills and training
- Equipment
- Safety

Show slide L4-4 and summarize the critical factors.

## Issues to consider when applying the four components of insecticide application



## **Cost and cost-effectiveness**

Cost, in terms of economics, is the value of resources used in a particular situation to achieve an objective. Costing is defined as the process by which estimates are made of the costs of an action. Cost-effectiveness is a measure of cost to achieve a level of effectiveness for a predetermined target.

To reduce the cost without affecting the outcome, consider rational use of the limited resources available for a given programme. For example, three cycles of indoor residual spraying with a particular insecticide may be necessary to control malaria in situations where transmission is perennial. If there are seasonal variations in the transmission and the majority of the cases are reported as occurring during the monsoon and post-monsoon seasons, spraying can be restricted to the peak transmission seasons thereby reducing the cost. This will be more cost-effective than spray coverage throughout the year.

### **Group exercise IV: Develop an intervention plan (90 minutes)**

**Instructions for coordinator.** In Learning Unit 3, the participants selected one or more chemical control methods for each case-study. In this exercise they will develop a plan of action based on their selection of chemical control methods. Each working group will present their plan in plenary.

**Instructions for facilitators.** Tell the participants to use the criteria that were developed during the large group exercise to develop an action plan for the chemical control method they selected for their case-studies in the previous Learning Unit.

**Ask the participants** to answer each of the questions presented in the table at the end of this Learning Unit for each method or combination of methods selected.

**Instructions for coordinator.** In plenary, ask the participants questions that will stimulate critical thinking. Ask them whether they were judicious in their decision-making and selection of methods for intervention. Could they have been more judicious? What was needed in order to improve the judicious use of the insecticides? Explore the technical suitability and operational feasibility of the groups' decisions.

## **Presentation: Safe use of insecticides (30 minutes)**

### **Safety**

Human and environmental health are important factors in determining what insecticide to use. A brief discussion on the issues related to the safe use of insecticides is warranted before proceeding with the exercises in this Learning Unit. Use the following information to develop your presentation.

#### *Overhead L4-5*

### **Main risks associated with insecticides**

- Toxicity and adverse health effects for applicators and handlers
- Toxicity and adverse health effects for the population
- Environmental contamination

#### *Overhead L4-6*

### **Lethal dose/lethal concentration**

The amount of a chemical needed to kill a certain percentage of animals. For example, **LD<sub>50</sub>/LC<sub>50</sub>** is the statistical estimate of the number of milligrams (mg) of a chemical per kg of body weight required to kill 50% of test animals.

Discuss the following examples of oxygen and salt (overheads L4-7 and L4-8) and then present the definitions of toxicity and hazard. Oxygen and salt are chemicals that are toxic but not hazardous at the dosage level to which people are normally exposed.

#### *Overhead L4-7*

### **Toxicity vs hazard – Example 1**

Pure (100%) oxygen is toxic and causes harmful effects on lung function in adults and to the eyes of newborn babies.

The concentration of oxygen in air is about 21%. Life is endangered if this concentration falls below about 12%.

Overhead L4-8

## Toxicity vs hazard – Example 2

Salt can be very toxic to babies in the same concentration that might cause an adult to vomit.

Overhead L4-9

### Toxicity

Toxicity is the inherent poisonous potency of a compound under experimental conditions.

- *Acute toxicity* is the toxicity of a chemical from single or limited exposure. Chemicals are considered highly toxic when the LD<sub>50</sub>/LC<sub>50</sub> is low and less toxic when it is high.
- *Chronic toxicity* is the toxicity from a chemical after long-term exposure (i.e. cancer, birth defects and reproductive effects).

An acute effect occurs when the level of insecticide in the body reaches a certain threshold; it continues until the level falls. The threshold dose for chronic toxicity may be lower than that for an acute effect.

Many insecticides are acutely toxic but have no chronic toxicity in humans. These are rapidly excreted or are rapidly broken down after absorption into less toxic compounds.

Overhead L4-10

### Hazard

Hazard is the inherent property to cause a potential harmful effect. The hazard presented by any insecticide depends on the toxicity of the active ingredient, its concentration in a formulation, and the physical form of the formulation.

Overhead L4-11

## Risk

Risk is the probability that a harmful effect might result from exposure to a particular hazard. The key to safe use of insecticides is to minimize the associated risk while handling or using them.

Present these definitions. Ask the participants to give examples of how they use these characteristics when selecting the most appropriate insecticide for use in their own work situations.

The label on an insecticide container provides critical information about the material. Overhead L4-9 provides an example of the kind of information on insecticide labels. Discuss the information with the participants.

Overhead L4-12

## Pesticide product label information to indicate the WHO hazard classification

WHO hazard class	Information on label	Hazard statement	Band colour	Hazard symbol
Ia	Extremely hazardous	Very toxic	Red	Skull and cross-bones
Ib	Highly hazardous	Toxic	Red	Skull and cross-bones
II	Moderately hazardous	Harmful	Yellow	Cross
III	Slightly hazardous	Caution	Blue	
	Unlikely to present a hazard		Green	

## Closure discussion (20 minutes)

In the real world, activities often do not work out as planned. Even if you construct the best possible vector control plan, circumstances beyond your control may prevent you from implementing it. Recall from the first Learning Unit that decision-making is a continual and interactive process. When unpredictable events or circumstances prevail, plans must be adjusted and new decisions made based on these new situations. The closure discussion focuses on such occurrences.

**Instructions for coordinator.** Develop some examples, such as the following, of circumstances that could change in the case-studies. Examples are:

- The funds for vector control are cut by 5%.
- A majority of residents refuse to cooperate with the programme.
- The insecticide formulation you ordered has been stolen from the shipping docks where it was delivered.
- The manufacturer of the chosen insecticide can supply you with only half the amount you need. The other half will not arrive for three months.
- There are indications of insecticide resistance.
- Pieces of equipment are not in working order.

Then, write the statements on strips of paper and place them in a bowl, a hat or some other container. Rotating among groups, ask a participant to select one strip from the hat and read the statement aloud. Invite the participants to make suggestions about how the problem could be overcome. Make sure that you select at least one participant from each working group for this activity.

End this unit by asking each participant to provide one example from their own work situation of how they can improve the quality of their programme by better incorporating one of the four components of judicious use of insecticides into programme planning.

## Group Exercise IV – Develop an intervention plan

<p>What insecticide will be used? Justify the selection based on cost, availability, efficacy and safety.</p>	
<p>Where will the insecticide be applied? Describe the coverage requirements for the method selected and explain why you have selected the specific target area for application.</p>	
<p>When will the insecticide be applied? Explain why you have selected a certain time or times of year and/or of day for application. Discuss the expected duration of effect and describe the treatment cycle that will be necessary.</p>	
<p>How will the insecticide be applied? Describe the type and quantity of application equipment required, and the skills that staff will need to be able to apply the material effectively. Discuss the safety issues involved in application and describe the kinds of safety equipment and precautions that should be used.</p>	

# Monitoring performance

**Present the objectives** (5 minutes)

*Overhead L5-1*

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## LEARNING OBJECTIVES

By the end of this *Learning Unit*, you should be able to:

- develop monitoring and evaluation plans for vector control programmes
  - select process (operational), impact (entomological) and outcome (epidemiological) indicators for vector-borne disease control programmes
- 

**Presentation: Monitoring and evaluation** (15 minutes)

This Learning Unit focuses on the final step in the decision-making process.

*Overhead L5-2*

## **Step 7: Establish operational outputs and targets and select monitoring and evaluation methods**

Present the circular diagram of the seven steps of decision-making and emphasize that this Learning Unit will cover the final step – **Monitoring performance** (L1-11). Also, point out that monitoring performance is not the end of decision-making – it leads once again to Step 1. Decision-making is never finished.

Begin by discussing the meaning of the terms “monitoring” and “evaluation”.

*Overhead L5-3*

## **Monitoring and evaluation**

**Monitoring** is a continual process designed to measure both the quality of the activities carried out and progress in relation to the programmed timetable. It identifies obstacles and provides a basis for identifying aspects of the programme that may need to be modified. It requires the identification of appropriate process indicators – the operational indicators that are assigned to the activities performed and to targets.

**Evaluation** is used to define the periodic assessment of progress towards the achievement of the objectives by measuring impact indicators and the goals of the programme by measuring outcome indicators. The impact indicators are the entomological measurements and the outcome indicators are the health outcomes or epidemiological indicators.

*Overhead L5-4*

## **Goals and objectives**

A goal is an ultimate desired state towards which actions and resources are directed. Goals are not constrained by time or existing resources, nor are they necessarily attainable.

An example of a reasonable goal is to reduce the impact of malaria on health and the social and economic well-being of people.

An objective is a measurable and attainable state that is expected to occur as a result of the application of selected approaches and the expenditure of allotted resources. It should include both a quantitative description of the desired state and a specification of the population to which it refers.

An example of an objective is to reduce malaria mortality among children in province A by 20% by 2010.

*Overhead L5-5*

## **Indicators for monitoring and evaluation**

Three kinds of indicators are used in monitoring and evaluation:

- process (or operational)
- impact (or entomological)
- outcome (or epidemiological)

*Overhead L5-6*

## **Process indicators**

Process indicators:

- tell you whether you and your staff are completing activities in a timely fashion as defined in the operational plan;
- allow you to track the availability and condition of the resources and materials needed for your programme.

*Overhead L5-7*

## **Impact indicators**

Impact indicators:

- measure the effect of your vector control interventions on the vector population, e.g. the extent to which they have reduced human–vector contact, reduced vector density or increased the mortality of adult vectors.

## Outcome indicators

Outcome indicators:

- measure the impact of your vector control programme on morbidity and mortality due to disease.

Indicators may be classified in other ways, such as for routine monitoring (R), selectively for specific purposes (S) or for detecting trends (T).

Label three flip charts: (1) process, (2) impact and (3) outcome indicators. Ask a few participants to give examples from their own work experiences of each of the three types of indicators. As the participants mention different indicators, make sure that they can correctly identify whether they are process, impact or outcome indicators. List the indicators that are mentioned on the appropriate flip chart. For each indicator have the participants decide whether it is measured regularly, at longer intervals for detecting trends or selectively for specific purposes.

## Group exercise V: Monitoring and evaluation (90 minutes)

**Instructions for coordinator.** Ask the participants to return to their working groups. Explain that in this group exercise the participants will select the process (operational), impact (entomological) and health outcome indicators for their case-studies.

**Instructions for facilitators.** Make sure that the group identifies at least one of each of the three types of indicator for each control method selected and that they indicate clearly the type of data that will be collected, who will be responsible for collecting the data, and the frequency of collection (weekly, monthly, etc.).

**Method 1** \_\_\_\_\_

	<b>Process or operational indicator</b>	<b>Impact or entomological indicator</b>	<b>Outcome or epidemiological indicator</b>
<b>What type of data will be collected?</b>			
<b>Who will collect the data?</b>			
<b>When will the data be collected?</b>			

Use Tables 5.1 through 5.3 as a guide to make sure that the participants develop an adequate plan for monitoring and evaluation. Provide copies of these tables to the participants **after** all groups have reported to the plenary session.

**Table 5.1. Operational and impact indicators for monitoring vector control <sup>a</sup>**

<b>Control method</b>	<b>Operational</b>	<b>Impact</b>
<b>Indoor residual spraying</b>	Dosage (R)	Daytime indoor resting (R)
	Coverage (R)	Human biting rate (T)
	Timing (R)	Human blood index (T)
	Persistence (R,T)	Parous rate (T)
	Status of equipment (R)	Sporozoite rate (S)
	Resources utilized (R)	Insecticide susceptibility status (R)
	Cost (R)	Adult mosquito density (T)
<b>Insecticide-treated mosquito nets</b>	Dosage (R)	Biting cycle in relation to sleeping habits (S)
	Coverage (R)	Human blood index (T)
	Use (R)	Insecticide susceptibility status (R)
	Persistence (R, T)	Human biting rate (T)
	Resources utilized (R)	Sporozoite rate (S)
	Cost (R)	Adult mosquito density (T)
<b>Larviciding</b>	Coverage (R)	Presence and density of larvae (R)
	Persistence (R, T)	Adult mosquito density (R)
	Resources utilized (R)	Insecticide susceptibility status (R)
	Cost (R)	
<b>Space spraying</b>	Coverage (R)	Human biting rate (2)
	Area of influence (R)	Adult mosquito density (R)
	Resources utilized (R)	Parous rate (2)
	Cost (R)	Insecticide susceptibility status (R)

R = routine monitoring, S = selectively for specific purposes, T = for detecting trends.

<sup>a</sup> Modified from: *Vector control for malaria and other mosquito-borne diseases: report of a WHO Study Group*. Geneva, World Health Organization, 1995 (WHO Technical Report Series, No. 857).

**Table 5.2. Selected outcome indicators for monitoring vector control operations <sup>a</sup>**

<b>Vector control method</b>	<b>Target population</b>	<b>Outcome indicator</b>
<b>Indoor residual spraying</b>	Number of people in the area of spray operations	Percentage reduction in malaria incidence (fever, severe malaria, parasitaemia) in target areas or groups
	Number of people in the houses sprayed	Infant parasite and spleen rates in endemic areas
		Percentage reduction in malaria mortality
<b>Insecticide-treated mosquito net</b>	Number of people in the area of bednet operations	Percentage reduction in malaria incidence (fever, severe malaria, parasitaemia)
	Number of people living in houses in which nets are used	Percentage reduction in malaria incidence in target groups (e.g. children)
	Number of people using nets	Percentage reduction in malaria mortality and all-cause mortality
<b>Larviciding</b>	Number of people in the operational area	Percentage reduction in malaria incidence (fever, severe malaria, parasitaemia)

<sup>a</sup> Modified from: *Vector control for malaria and other mosquito-borne diseases: report of a WHO Study Group*. Geneva, World Health Organization, 1995 (WHO Technical Report Series, No. 857).

**Table 5.3. Other potential indicators used in specific situations**

Type of measures used	Indicator to be used for operational evaluation
<b>Community participation</b>	Proportion of people using personal protection measures; proportion of people protecting water storage containers.
<b>Partnership approach</b>	Proportion of partners participating in coordination meetings; amount of resources generated through the partnership; human resources donated to the programme through the partnership; amount of materials contributed to the programme; task performance.
<b>Information, Education and Communication (IEC)</b>	Change in attitude and perception of the community (KAP survey); proportion of people participating in an education campaign.
<b>Screening of houses and/or site selection, protective clothing</b>	Percentage of houses screened, degree of screening (partial or complete), percentage of houses built following site selection and of population protected according to plan, proportion of the population using protective clothing.
<b>Sero-epidemiological surveys</b>	Techniques and specificity of the antigens used. Percentage population (by age groups) covered by sero-epidemiological surveys in relation to plan.
<b>Parasitological data</b>	Percentage of established functioning laboratories, number of microscopists employed and number of slides examined in relation to plan. Backlog. Time delay between making a slide and starting radical treatment.
<b>Entomological laboratories and field teams</b>	Percentage of established entomological laboratories, number of entomological teams employed, and number and frequency of entomological surveys carried out in relation to plan.
<b>Entomological surveys</b>	Frequency, regularity and coverage of surveys carried out in fixed indicator villages and/or villages selected at random.
<b>Monthly infant surveys (conversion rates)</b>	Adequacy of the sample size. Monthly coverage. Regularity of rounds.
<b>Other epidemiological studies</b>	Average number of epidemiological investigations, mass blood surveys, follow-up of confirmed cases, and special surveys carried out during the reporting period.

## **Closure discussion (20 minutes)**

Ask several participants to provide examples of inadequate monitoring and evaluation systems that they have seen used in their work experience. In each case, ask the group as a whole to provide suggestions for how the system could be improved.



# Gold-rush area

## **PART 1**

### **The setting**

You have been asked by the director of health services in the northern part of the country to review the health situation in a gold rush area. He is concerned about the potential for an epidemic. About 25 000 people live in this area. Many of the residents have lived there all their lives, working on agricultural projects or cultivating subsistence plots to support their families. Small private companies carry out timber extraction in the southern zones of the municipalities. Privately owned ranches are increasing in the area and are slowly penetrating the tropical forest, converting it to cattle pastures. Each ranch covers about 7000 hectares. An indigenous population, the Xinguano, occupies a large reserve in the western region.

The director's primary concern is the two northernmost municipalities. They are accessible only by dirt road and are located 200 km from the regional administration in Ponis. Ponis is 600 km from the state capital. One municipality has a small dirt airstrip for light aircraft. The River Peixoto runs between the two municipal towns and transportation across the river is by ferry. The roads and rivers are sometimes impassable during the rainy season.

The annual mean temperature ranges from 23 to 25 °C, with the months from April to August being the hottest. Mean annual rainfall is 2500 mm, 80% of which falls between September and April. Relative humidity is 80–95%. The area is in a transition zone between the central high savannah and the tropical rainforest. The region has a hydrological network with two large rivers, the Turuema and the Teles Pires. There are five tributaries in the region, including the River Peixoto.

### **Recent changes in patterns of disease and illness**

In the mid-1990's, the world market price for gold doubled. Gold mining became very lucrative and as a result 10 000 miners and their families immigrated to the two northern municipalities. The sudden influx of people created a chaotic situation. Without adequate housing, the miners constructed makeshift houses in settlements outside the town

limits. You have heard rumours that these settlements, as well as the mining camps are lawless and disputes tend to be settled by the groups involved rather than the local police. With cash in hand, the miners patronize local businesses including small supply stores, bars and nightclubs. The miners are reputed to drink alcohol regularly and frequently spend their money in brothels.

The miners came from the north-east coast and southern regions of the country, which were economically depressed areas with inadequate health services. They brought with them little immunity to the tropical diseases present in the region. The ethnic mix of the miners is diverse and men outnumber women and children 2 to 1.

Previously the area was free of major outbreaks of communicable diseases, but now the chaotic situation caused by the sudden influx of miners, their families, merchants, prostitutes and private medical professionals has made the health situation worse. The disease case report for the past 3 months from the Miners Hospital, the government clinic in Azevedo and the Sisters of the Faith clinic in Matura is shown in Table 1.

**Table 1. Cases and deaths reported (total population ca. 25 000)**

<b>Diagnosis</b>	<b>No. of cases 7 years ago</b>	<b>No. of cases this year to date</b>	<b>No. of deaths this year to date</b>
Fever	50	345	9
Pneumonia	50	66	4
Diarrhoea	147	210	5
Sexually transmitted infections	7	72	0
Anaemia	10	11	0
Hepatitis	1	7	4
Other <sup>a</sup>	43	75	8
<b>Total</b>	<b>307</b>	<b>786</b>	<b>30</b>

<sup>a</sup> Mainly trauma resulting from acts of violence between miners.

The 30 deaths that have occurred in the past 3 months are of major concern to the local public health officer. He considers his programme understaffed and lacking the resources to manage serious illnesses in the health clinics.

## **PART 2**

### **What you found out**

Together with the local health authorities, you organized a rapid assessment of the health situation under the coordination of the National Health Foundation, Ministry of Health (MOH), and obtained the following information:

On arrival in the area you discovered that the miners continue to search for gold in areas increasingly distant from the two towns, abandoning the mining pits as they go along. There are 14 major gold mining camps near the two towns and 10 more further into the forest. The mean number of miners per camp is 250. There are an unknown number of individual mining operations, each involving up to 5 persons, at the fringe of the outward exploration. Others mine the spoils from the abandoned mines. Spoil mining is done by family groups or on weekends by people coming from the towns. All camps are located near water. There are a small number of women in the camps (< 2%). The families of the miners live either in the two towns or in the small makeshift settlements at the crossroads between the mines and the towns. The settlements and the two towns have an active mercantile business with small supply stores, nightclubs, prostitutes and alcohol. Private pharmacies are located in the two major towns, but medicine is sold illegally in the settlements and at the larger mining camps.

Camp shelters consist of four supporting poles with plastic roofs and walls. In the makeshift settlements the houses are made of wood with tin roofs. Walls are incomplete and have many holes and gaps in them. In the two towns the houses are more substantial, with concrete or wooden walls.

Miners work 14 hours a day from 06:00 to 20:00. The women in the mining area wash clothes in the river during the day and all members of the community use the river for bathing during the evening hours. The children have no school to attend and no basic health care. In Matura and Azevedo there is electricity and water in most houses and there are primary level schools.

Adults sleep between 20:00 and 23:00 and children usually go to bed at 20:00. Most people do not sleep under bednets and only 10% of the population use personal protection such as insect repellents. In the company camps, however, the miners are required to use bednets and many children sleep under nets. The pharmacies also sell bednets but they are expensive and of poor quality.

No toilets were not seen, but there are said to be open pits in the forest.

The gold is in alluvial deposits near the rivers and streams. Mining is done by excavation of soil: water is pumped into the excavation and the soil–water mixture is then pumped out into barrels using gas-operated pumps. The gold settles out and the excess water and mud are

dispersed into the rivers or over the land. Further gold extraction is done with a burning process that uses mercury.

When pits are no longer productive they are abandoned but not filled in. This creates artificial ponds, which are used by miners for bathing and washing. The government health authority suspects that the abandoned pits are major breeding sites for the vectors of malaria.

Matura has one health clinic operated by the Sisters of the Faith, and Azevedo has a large government-operated clinic and a miners' hospital. One private doctor works in Matura and there are several in Azevedo. All clinics are overcrowded and lines of waiting patients form outside the clinics every day. Most patients are suffering from fever with chills, the symptoms of malaria, and are tested for malaria using thick and thin blood smears. Slides are read at the clinics and treatment is given for malaria if the blood smears are positive. *Plasmodium vivax* and *P. falciparum* are treated with chloroquine.

Health authorities consider malaria to be the major communicable disease in the area. However, the number of cases is thought to be underestimated because many patients seek treatment in the larger mining camps, at the pharmacies or in private clinics. Health authorities are convinced that there is now an epidemic. They also suspect that many patients are not responding to the first-line treatment for malaria, but this has not been confirmed. More deaths are caused by gunshot wounds during arguments on weekends over gold or at night clubs than by malaria. Morbidity is much higher for malaria than for any other disease.

The government immunization programme has recently vaccinated all children under 5 years of age for measles and other childhood diseases. No vector control strategy has ever been implemented in the region, although two full-time operators carry out space spraying in the towns and mining camps when requested. They have one truck with a small space sprayer mounted on the back. The insecticide used is malathion, which is stored in the maintenance garage at the health authority compound in Matura.

The Sisters of the Faith clinic provided an estimate of the population by age and sex for the area around Matura (Table 2). They emphasize that it is a rough estimate made during the immunization programme.

The malaria in this area is seasonal, with close to 70% of the cases occurring at the beginning of the rainy season or at the beginning of the dry season.

**Table 2. Estimate of the population in and around Matura, by age and sex**

Age (years)	Male	Female
0–5	348	352
6–10	240	260
11–15	700	500
>16	6500	1500

The number of malaria cases by age group is shown in Table 3. These data were also obtained from the Sisters of Faith clinic and include information from an outreach programme conducted by the clinic. No data were readily available from the public health clinic or the hospital in Azevedo; records were all sent to the regional capital, Ponis.

**Table 3. Number of reported malaria cases in the mining area of Matura**

Age	Sex		<i>P. falciparum</i>		<i>P. vivax</i>		Total
	M	F	M	F	M	F	
0–5	11	10	7	8	4	2	21
6–10	9	10	7	6	2	4	19
11–15	90	60	66	42	24	18	150
> 16	1325	441	928	309	397	132	1766

In addition, an entomological study is in progress in the area to identify the vectors of malaria and to study their ecology and behaviour; so that appropriate control methods can be recommended.

Preliminary data show that the principal vector bites between 22:00 and 01:00. This anopheline species is thought to prefer feeding on humans to feeding on other animals (anthropophilic), rests outside houses (exophilic), and bites slightly more outdoors than indoors (exophagic). Its breeding sites are restricted to shaded areas along rivers, backwaters and small man-made reservoirs.

Several secondary vectors are present in the area. They tend to bite mainly around dusk and are exophagic. The senior entomologist said they are opportunistic feeders and feed on a wide range of mammals and birds.

## PART 3

### Additional information from the rapid assessment

An entomology team was sent to the area to examine the vectors, including their larval ecology, adult resting sites, blood-feeding behaviour, activity periods and insecticide susceptibility. A summary of their findings follows.

#### Larval habitats

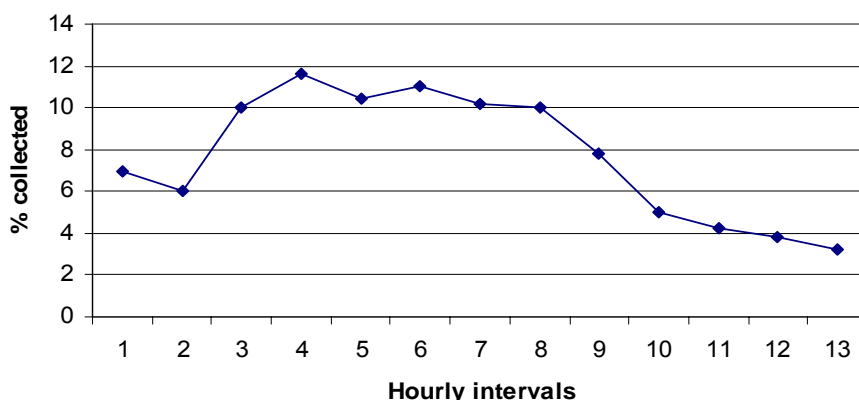
Potential larval habitats were examined in and around the two towns and around 14 of the mining sites. Anopheline larvae were not abundant in the abandoned gold mines, roadside ditches or puddles, but were common along the shaded banks of the streams and river backwaters. Larval densities were higher at the beginning of the rainy season and at the beginning of the dry season. Two vector species were found, *Anopheles duni* and *An. trivisi*. *An. duni* was by far the most abundant species with a mean number of larvae per sample of 1.7. *An. trivisi* was present in the same habitats as *An. duni*, but also in roadside ditches and puddles. The mean number of *An. duni* larvae per sample was only 0.01.

#### Adult biology

To determine the biting behaviour of the two anopheline species, human landing catches were conducted inside and outside the houses from 30 minutes before sunset until 30 minutes after sunrise. The biting activity is shown in Figure 1.

Sixty-five percent of *An. duni* females were collected inside houses. Eighty percent of the *An. trivisi* females were collected outside houses. The numbers of each species collected are shown in Table 4.

**Figure 1**  
**The biting activity of *Anopheles* in the mining camp, Raimundo**



(1 = 30 min before sunset, 13 = 30 min after sunrise)

**Table 4. Number of *Anopheles* females collected per three-day observation, by species, at Camp Raimundo**

Species	Epidemiological week							
	W18	W22	W26	W30	W35	W39	W43	W52
<i>An. duni</i>	229	1436	3320	7908	2823	2152	1558	1092
<i>An. trivisi</i>	0	35	63	19	58	41	38	14

Resting collections were made inside houses. *Anopheles duni* were found to rest on the interior walls and eaves of the houses before and after taking a bloodmeal. Although *An. trivisi* entered the houses, no females were observed resting on the inside walls.

Bloodmeal identifications were carried out on engorged females collected resting in houses and near to the larval habitats. Of the 121 *An. duni* collected, bloodmeals were identified in 81 and of these 51 had fed on humans, 21 on bovines and 9 on equines. Only 10 *An. trivisi* were collected and all of them were positive for bovine blood.

### **Insecticide resistance**

Standard WHO insecticide-impregnated papers and procedures were used to test for insecticide resistance. Neither *An. duni* nor *An. trivisi* showed any signs of resistance to pyrethroids or to malathion.

### **Vector control operations**

A member of the vector control team from the regional office in Ponis reviewed the operational vector control capacity in the area and their needs in the event of an epidemic. The two full-time operators are certified to use insecticides, but have never taken a course in equipment maintenance and operations. They hire four daily paid labourers when they are ready to carry out fogging operations. The one spray truck is also used to transport other supplies and equipment throughout the municipalities. The fogging machine is small enough to be taken off the truck but it is seldom removed. Three 200-litre drums of malathion are stored at the far end of the garage in a locked and secure area. Safety equipment consists of six sets of masks, boots and gloves.

Few spare parts are on hand and it takes 5–7 working days to get new parts when needed. The droplet size from the sprayer has not been calibrated nor has the flow rate been checked in the past 2 years.

Two knapsack cold fogging machines are stored next to the insecticide. They have not been used for at least 3 years. No spare nozzles are available, but those in use are appropriate for spraying in and around towns.

## POTENTIAL ANSWERS FOR CASE-STUDY 1 – GOLD-RUSH AREA

### (Learning Unit 2 - Decision-making process, Steps 1 and 2)

***What health problem(s) can you identify in Part I of the case-study? What evidence is there that these problems exist?***

There seem to be three important indicators of increasing health problems. First, the increase in fever cases, with nine deaths, indicates that there is a serious problem with one or more diseases, which are potentially fatal. This increase in fever cases could also indicate that the health services are inadequate or that patients arrive at the clinic when they are close to death. The doubling of diarrhoea cases also indicates that something serious is affecting the health of the community now that there is an influx of miners.

Diseases that can cause fever, diarrhoea and death in mining areas of a tropical forest fringe include malaria, and bacterial infections such as *Salmonella enteritidis*, *S. typhimurium* and *Escherichia coli*. However, the most severe outbreaks of diarrhoea are caused by *Shigella dysenteriae* type 1 and *Vibrio cholerae*.

Sexually transmitted infections are known to increase in gold mining areas, where men outnumber women and money is available for prostitution. The substantial rise in sexually transmitted infections is probably attributable to this situation.

The "other" category is dominated by gunshot wounds, which probably occur resulting the course of arguments over gold, women or mining claims.

***What important ecological (environmental) and economic or social variables and factors can you identify that influence the health situation?***

*Ecological factors*

- High temperatures and humidity
- High rainfall
- Tropical rainforest
- Potential vector breeding sites nearby
- River system and associated waterborne diseases

### *Economic factors*

- Gold mining
- Long distance to nearest commercial center
- Lack of resources for public health

### *Social factors*

- Intense migration
- Lack of health services
- Low education level

### *Other factors*

- Lack of immunity to diseases

### **What other information do you need to understand the situation and decide how to solve these problems?**

There should be a more thorough analysis of clinical symptoms to determine whether they are consistent with any of the above-mentioned diseases. This should be supported by parasitological confirmation of malaria (blood smears) and laboratory culture of *Shigella dysenteriae* type 1 or *Vibrio cholerae*.

The effectiveness of the health infrastructure can be an important determinant of the change in the health situation. A review of all aspects of the health service is needed, including personnel, equipment, and resources; such as medicines, beds, budget, and preventive and control measures. For vector-borne diseases in particular one would like to review the public health control programme; where, when, what and how they are applying control measures.

A breakdown of cases by sex, age, location, time and occupation would be helpful in determining whether any risk factors need to be investigated more thoroughly.

### ***Do the new data confirm your original assessment of the nature of the problem? Why (or why not)?***

The answer depends on the original assessment. If the participants chose malaria they were correct. If they were thinking of cholera or other bacteria that cause diarrhoea they may not have been wrong. Diarrhoea can also be a symptom of malaria but is usually less severe. A laboratory test was necessary in order to confirm this possibility.

***Based on the data you have now, write a brief (250 words or less) explanation of the vector-borne disease problem and its magnitude. Consider: (a) who has the disease, (b) where you believe transmission occurs, (c) when you believe transmission occurs, and (d) how you believe transmission occurs.***

The major vector-borne disease problem in this case is malaria. It is caused by the influx of miners into the region, which has destabilized the endemic malaria situation and made it epidemic. The major risk factor is mining and the conditions associated with it. The savannah/tropical forest ecotone provides favourable conditions for transmission and an association with a river-breeding species. The gold is alluvial in origin, occurring in the riverbeds of old streams, and it is best to dig where water from existing rivers can be used to filter the gold out of the soil. Thus, miners' camps are located close to vector breeding sites. Mining activities in the evenings coincide with the outdoor biting activity of the vectors. The housing conditions in the mining camps offer little protection against biting mosquitoes. Sleeping in hammocks in houses with incomplete walls exposes the miners to vectors. In the towns there is much greater protection against mosquitoes trying to enter houses to feed.

Continuous migration of people in and out of the mining area is contributing to the malaria epidemic. Although little is known about the educational level of the people, most other studies have shown that miners are not well educated. The low educational levels may be contributing to the problems of sexually transmitted infections and gunshot wounds. With the influx of miners, the local health system is clearly overburdened.

Diagnostic capacity must be very low and many illnesses are treated, if at all, outside the public health system. No public or privately operated vector control measures are in place at the mines. It appears that support from other sectors needs to be strengthened in order to improve the health system.

## **Summary**

Gold mining area in the savannah/tropical forest ecotone:

- Outbreak of malaria
- Population of about 10 000 miners
- Malaria most prevalent in males over 15 years of age
- Health system inadequate to cope with malaria and other diseases

**Are the data sufficiently stratified to allow an appropriate decision to be made on vector control? Why (or why not)?**

The malaria data could be stratified as in Table 3. For Matura, using the population size estimates in Table 2 and the number of malaria cases in Table 3, it is also possible to determine the annual parasitic incidence

$$\text{API} = \frac{\text{No. of cases by age, sex or parasite species}}{\text{total population or age group or sex}} \times 100$$

For example:

$$\text{API for males} > 16 \text{ would be } (1325 / 6500) \times 100 = 20.4$$

$$\text{API for males} < 5 \text{ would be } (11 / 348) \times 100 = 3.16$$

$$\text{API for the total population would be } (1956 / 10\,500) \times 100 = 18.6$$

Then, you would want to look at the potential risk factors and variables that may be causing the problem, such as occupation, location of housing, location of work, access to public health services, etc. For example, it may be the case that the towns have little or no malaria transmission. Knowing this would direct your vector control operations to other locations, save costs and be more efficient. In one actual situation, 2000 houses were sprayed in two towns where the children under 15 years of age had 0.1% of the malaria. This fact in itself indicates that transmission is not occurring inside houses in the town – so why apply vector control measures in the town?

**How would you present your data graphically (use maps, graphs, or charts)?**

Data can be presented in tables like those above. A graph of the data by week or month could be used to demonstrate seasonal patterns of transmission. A map that shows where the malaria cases are occurring would also be important for improving understanding of the epidemiology and for operational planning purposes. A map of larval breeding sites would help in directing operations and associations with malaria cases.

**Are the data sufficiently reliable and accurate to allow you to move forward with decision-making? If not, what additional data do you need?**

There is sufficient information to allow the planning of a malaria control programme to start, based on who has malaria and on the behaviour of the vector. The participants should have filled out Table 5 below and made some estimates for malaria by species and age group. Total number of cases = 1956 (1373 *P. falciparum* and 529 *P. vivax*). By

percentage: *P. falciparum* cases 70.2%; malaria cases in males 73.3%; malaria cases in individuals aged > 16 years 90.3%; malaria cases in males > 16 years = 67.7%.

These results indicate that falciparum malaria is currently causing most of the sickness (and deaths). Also, individuals over 16 years of age, particularly males, are most likely to contract malaria. It is therefore highly probable that malaria transmission is taking place close to the mines. Further epidemiological analysis would be needed to confirm this. One would want to stratify by location where malaria was most likely to be contracted and proceed from there.

The data collected on vector behaviour, particularly when and where biting occurs, will be an important consideration when deciding on the most appropriate control measures. One would probably want to review the literature on the biology and behaviour of these species in other parts of the country, and to expand the larval surveys to include more areas near the towns.

**Table 5. Reported malaria cases, by age, sex and parasite species**

Age	Sex		<i>P. falciparum</i>		<i>P. vivax</i>		Total
	M	F	M	F	M	F	
0–5	11	10	7	8	4	2	21
6–10	9	10	7	6	2	4	19
11–15	90	60	66	42	24	18	150
> 16	1325	441	928	309	397	132	1766
<b>Total</b>	1434	522	1008	365	427	156	1956



# An urban outbreak

## **PART 1**

### **The setting**

The local health authorities have requested your help in assessing a communicable disease outbreak. The following information was provided to you from last year's annual report and a recent memo from the municipality concerning the current outbreak.

The affected area is in a semi-arid coastal municipality, 16 m above sea level. The tropical environment has an average annual temperature of 27 °C (24–33 °C). The mean annual rainfall is 1200 mm and the wettest months are from May to October. Little if any rain falls during the remainder of the year.

There has been a severe drought in the interior of the country over the past 3 years which has resulted in large-scale migration of families to the urban centre to find work. This has contributed to a deterioration of public services that affects the reliability and availability of the potable water supply: potable water is available to 70% of the population but only intermittently to 20% of them. Hospital and health clinic staff and resources are overburdened. Forty percent of the population are living in poverty in slums near the beach and along the riverfront.

A similar situation occurred 10 years ago and brought with it an increase in communicable diseases, particularly cholera, typhus, and yellow fever. There were two suspected – but unconfirmed – cases of relapsing fever. Dengue has twice been a problem in the past, during long periods of abundant rainfall, but it was not considered severe. At present, it has been raining on and off for 2 months.

No active disease surveillance programme is in place, but there is passive and infrequent reporting of clinical illnesses. No data linking the present outbreak to a vector-borne or waterborne disease are available, but the chief medical officer at the hospital does not think it is due to cholera or leptospirosis.

## Recent changes in patterns of disease and illness

A review of the overall health status from the local health department yielded the data summarized in Table 1.

**Table 1. Symptomatology and/or diagnoses, reported cases and deaths (total population of the urban area ca. 550 000)**

Symptomatology/ diagnosis	Number of cases	Deaths
Fever	345	9
Pneumonia	29	2
Diarrhoea	27	0
Sexually transmitted infections	72	0
Anaemia	11	0
Hepatitis	7	4
Haemorrhaging	15	5

Further discussions with the medical officers at the hospital revealed that other signs and symptoms have been commonly observed during the outbreak, including undifferentiated fever, headaches, severe joint pain, bleeding from the gums and nose, and a rash that spread over the trunk and limbs. So far only two patients have shown signs of jaundice. The five patients who presented with haemorrhaging, and who subsequently died, also manifested a rapid and weak pulse or hypotension with cold clammy skin and restlessness.

Because a recent small outbreak of *P. vivax* malaria had occurred in a settlement along one of the rivers in the interior of the country, where some of the migrants came from, many of the patients were given antimalarials. However, they did not respond to treatment.

Twenty-two of the patients with diarrhoea were under 5 years of age.

Three months ago there was a dengue fever/dengue haemorrhagic fever (DF/DHF) outbreak in a neighbouring country. At that time, your government's response was to spray all vehicles that entered the country with insecticide. You have also heard that an outbreak is currently occurring in an urban centre along the north coast of the same country. Approximately 18 000 cases have been reported so far, many confirmed by laboratory diagnosis; 20% of the cases are DHF and 49 people have died.

## PART 2

### What you found out

You visited the local health department and discovered that the first clinical cases were reported 6 weeks earlier. Since then the number of outpatients at the health centres and admissions to the local hospital has been increasing week by week. Only last week an additional emergency ward was set up to help cope with the extra patient load and all staff leave was cancelled. Your team assisted in arranging for serum samples of hospitalized patients to be sent to the national reference laboratory for serological and virological testing. Results showed that dengue serotypes 1 and 2 were circulating. No infections with yellow fever, relapsing fever or typhus were identified. Active surveillance did not begin until 3 weeks after the outbreak was first reported.

The numbers of clinical dengue cases, by age group, as reported by the local hospital in the most highly populated district (ca. 123 000 people) are presented in Table 2 below. Almost equal numbers of males and females were affected and the highest number of reported cases was in the 10–19-year age group. The living conditions of the people in this neighbourhood are the poorest in the urban centre.

**Table 2. Clinical dengue cases reported from the local hospital**

Age group (years)	Number of cases	Incidence rate (%)
0–9	2700	7.0
10–19	3500	12.1
20–45	1900	11.4
46–99	1900	5.1

The hospital administrator is new to the town, but she had previously worked in a nearby city where two outbreaks of dengue had occurred over a period of 4 years. She recalled that dengue 1 was isolated during the first outbreak but no DHF cases were reported. During the second outbreak, dengue 1 and 2 were isolated and there were several DHF cases.

Because laboratory investigations had confirmed that dengue virus was circulating, you visited the vector control programme in the urban centre. You learned that the local health authority maintains a vector surveillance programme in which they periodically inspect a cluster of 100 houses in each neighbourhood for the presence of *Ae. aegypti* larvae.

The surveillance programme uses a house index to measure the level of *Aedes* infestation, calculating the percentage of houses infested with larvae as follows:

$$\text{House index} = \frac{\text{No. of houses infested}}{\text{No. of houses inspected}} \times 100$$

At times they also use a Breteau Index, calculating the number of positive containers per 100 houses inspected:

$$\text{Breteau index} = \frac{\text{No. of positive containers}}{\text{No. of houses inspected}} \times 100$$

A review of the survey data showed an increase in the House Index from 2 to 21 over the past 6 months. The programme normally carries out a number of vector control activities, including source reduction, larviciding with temephos in permanent water storage containers, and the introduction of fish to abandoned cisterns. Before the outbreak, however, control measures had been suspended for 2 months because of a shortage of funds and larvicide.

The chief inspector showed you data from the vector surveillance programme at the time of the previous outbreaks. The vector was identified as *Ae. aegypti*, which was first found in the region 10 years ago. Larval indices increased before the two previous dengue outbreaks. The research group at the Federal University isolated dengue virus from 2% of adult mosquitoes collected during the second outbreak ( $n = 700$ ). Larval habitats were identified as domestic water storage jars, barrels and cisterns, flower vases and old tyres. Vector control was part of the routine dengue control programme.

In addition, you were also advised that, only a few months ago, the government had increased the cost of using landfills, so that illegal dumping was taking place along the roadsides and in vacant lots. The chief inspector said this was providing additional mosquito breeding sites.

Water supply services were also currently being disrupted for several days each week while repairs were being carried out at the municipal pumping station.

Three weeks after the present outbreak began, the local health authority received some funds that enabled them to launch a space spraying campaign, using malathion applied from their two truck-mounted cold aerosol fogging machines. Educational materials were printed and distributed throughout the affected neighborhoods. However, there was a general distrust of the government among the residents and they frequently refused to cooperate with the authorities. Many house owners closed their windows when the spray trucks passed, and others refused to allow the larval inspectors onto their property to assist with source reduction efforts. Many of the educational leaflets were seen to be littering the streets. The vector control campaign had so far cost US\$ 20 000. No monitoring of the impact on the adult mosquitoes had so far been carried out during these operations.

## **PART 3**

### **Additional information obtained by the rapid assessment**

An entomology team was sent to the area to examine the vector's natural history, including larval habitats, adult resting sites, biting behaviour, flight activity and insecticide susceptibility.

#### **Larval habitats**

Larval sites were surveyed in and around the houses in the neighbourhood where most of the dengue cases were reported. The results of the survey are shown in Table 3.

#### **Adult biology**

To determine the biting behaviour of *Ae. Aegypti*, human landing catches were made inside houses and on outdoor patios. At hourly intervals over a 24-hour period, collections were made for 10 minutes. Two houses were surveyed with two people inside and two people on the patio. Collectors had 6-hour shifts. Six such collections were made during the course of 1 month. Very few adults were collected ( $n = 122$ ). Most were collected during the day at dawn, midday and dusk; 71 were collected inside the houses and 34 on the patios. Only 17 were collected at night.

Adults resting in and around houses were also collected on six occasions over the same 1-month period using a motorized backpack aspirator. A total of 150 houses were sampled. The results are given in Table 4.

**Table 3. Larval habitats of *Aedes aegypti* identified from 650 houses surveyed**

Container type	Number inspected	Number infested	Number of larvae	Number of pupae
Water barrels	300	94	1500	149
Water jars	151	59	318	53
Used tyres	29	16 (8 dry)	143	28
Flower vases	541	54	89	14
Others	391	41	42	0

**Table 4. Adult *Aedes aegypti* collected in and around houses ( $n = 150$ )**

Location	Number collected
Patio	200
Living room	110
Kitchen	87
Closets	420
Bedroom	250

*Blood meal identifications were not done in this survey.*

### **Insecticide resistance**

Standard WHO adult insecticide susceptibility tests were carried out on the local *Ae. aegypti* population. There was no indication of resistance to either pyrethroids or malathion.

## Operations

One of the entomologists reviewed the vector control operations and made the following observations:

- There was one entomological assistant in charge of all operations. He was trained in vector control at an international WHO course given 20 years ago. He had a secretary, a mechanic and four full-time inspectors. The inspectors had participated in a short national course on vector control operations. There was a small entomology laboratory next to the hospital which the team used for laboratory work as part of the vector surveillance activities. The laboratory was equipped with two microscopes and basic supplies.
- Two drivers were available when needed for spraying areas with high larval indices. Each of the two pick-up trucks had a cold aerosol fogging machine mounted in the back. Eight portable cold aerosol foggers were found in the maintenance shed. There were two 200-litre drums of malathion and one of deltamethrin in the store. It was not clear whether the drums were leaking or the insecticide had been spilled during the course of operations. Safety equipment consisted of masks and gloves. An examination of the spray equipment revealed that the team did a thorough job of cleaning and preparing the machines. However, the truck-mounted machines had not been calibrated for more than 3 years.
- Although routine source reduction and larviciding operations had been interrupted because of the shortage of funds, the team was able to continue with a small pilot project that emphasized community involvement for the elimination or treatment of the larval habitats of both *Culex* and *Aedes* mosquitoes. This was a secondary school health project, financed by the local Rotary Club, in which the older students were responsible for treating stored water with tablets of the entomopathogen, *Bacillus thuringiensis israelensis*.

## POTENTIAL ANSWERS FOR CASE-STUDY 2 – AN URBAN OUTBREAK

### (Learning Unit 2 – Decision-making process, Steps 1 and 2)

***What health problem(s) can you identify in Part I of the case-study? What evidence is there that these problems exist?***

From your conversations with the health officials and the reports you have examined, the likely health concerns seem to be cholera, typhus, yellow fever, malaria and dengue. Cholera may be excluded because most of the diarrhoea cases have been in children under the age of 5 years. Fever cases make you suspect malaria as a major problem; however, the patients given antimalarials do not respond so you can exclude malaria from your list (unless there is widespread drug resistance). A classic symptom of yellow fever is jaundice: only two patients appear to have jaundice so you can probably rule out this disease. Also, mortality is usually higher when there is a yellow fever outbreak.

This leaves relapsing fever, typhus and dengue, which have similar symptoms but differ with respect to fever and chills, which occur more frequently in the first two diseases than with dengue. No indication of chills was recorded in the health charts. Another indication that the disease is probably dengue is shock syndrome (rapid weak pulse or hypotension with clammy skin and restlessness), which is typical of DHF.

The reported outbreak of dengue in the neighbouring country and the previous occurrence of dengue 1 and 2 in your region would further suggest that dengue is the likely cause of the outbreak.

***What important ecological (environmental), economic or social variables and factors can you identify that influence the health situation?***

#### *Ecological factors*

- Drought – low rainfall
- Hot climate

#### *Social factors*

- Mass migration
- Irregular supply of potable water

*Economic factor*

- Lack of resources for public health

*Other factors*

- Potential drug resistance to malaria

***What other information do you need to understand the situation and decide how to solve these problems?***

Laboratory tests are needed to confirm the suspicion of dengue.

You would also like to have more detailed information on distribution of the illness, including incidence by location, city block, age and sex, and to ascertain the ecology and abundance of *Ae. aegypti* in the affected areas.

The effectiveness of the health infrastructure is an important determinant of why the health situation is like it is. You would want to review all relevant aspects of the health services, including personnel, equipment, resources such as medicines, beds, budget, and preventive and control capabilities. With particular reference to vector-borne disease, you would like to review the vector control operations, including what control measures are being applied and where, when, and how.

***Do the new data confirm your original assessment of the nature of the problem? Why (or why not)?***

Yes. You have laboratory confirmation of dengue and not of the other suspected diseases.

***Based on the data you have now, write a brief (250 words or less) explanation of the vector-borne disease problem and its magnitude. Consider: (a) who has the disease, (b) where you believe transmission occurs, (c) when you believe transmission occurs, and (d) how you believe transmission occurs.***

The major vector-borne disease problem in this case is dengue. Laboratory investigations and clinical observations indicated that DF and DHF are present in the urban centre. Several events have occurred that may have contributed to the outbreak. First, the influx of migrants from the countryside into neighbourhoods with poor living conditions put them at greater risk of infection. Their arrival also overburdened the public health infrastructure. The irregular supply of potable water may have led people to store water in containers for drinking and other household purposes – these containers are potential breeding sites of

*Ae. aegypti*. The illegal dumping may also be creating new larval habitats. In addition, the interruption of vector control operations just before the outbreak probably contributed to the high vector infestation rates and more favourable conditions for virus transmission. Indeed, the House Index increased dramatically during the past 6 months.

Past exposure of the population to more than one dengue serotype increases the risk of DHF, which occurred in this outbreak. The movement of people may also have introduced the virus, either from the neighbouring country where dengue was occurring on the north coast or from elsewhere.

Preliminary data showed a higher incidence in the 10–19-year age group but these data were collected from only one neighbourhood. It is recommended that the affected neighbourhoods be stratified by age group. The neighbourhood from which the data were examined was poor and may not be representative of the entire city. Moreover, dengue is seldom restricted to the lower socioeconomic groups.

### **Summary**

- Urban centre with immigrant population and peri-urban slums
- Dengue outbreak (DF and DHF)
- Population is about 525 000
- High dengue incidence in all age groups in the sampled neighbourhood

### ***Are the data sufficiently stratified to allow an appropriate decision to be made on vector control? Why (or why not)?***

They are not. You do not know which neighbourhoods, or blocks within neighbourhoods, are at greatest risk because of high vector infestation rates, nor do you know the main breeding sites of *Aedes aegypti*. Also, without knowing which neighbourhoods have already had high incidence rates and which are yet to be affected, it is not possible to stratify the area according to risk. Therefore, you would most probably waste resources. You need a rapid assessment of incidence rates and the vector's larval ecology and abundance.

***How would you present your data graphically (use maps, graphs, or charts)?***

At present, the data are too general to present as graphs – but, with additional information you can present them in various ways. Most important for operational vector control is a map that shows where the dengue cases have so far occurred, overlaid with a map of the larval indices of *Aedes aegypti*. House and Breteau Indices can also be represented in tables or bar graphs once you have them.

**Are the data sufficiently reliable and accurate to allow you to move forward with decision-making? If not, what additional data do you need?**

In general terms you could begin to make decisions on how to tackle the outbreak, including controlling the vector. However, it is important that you stratify the disease by risk factors, including incidence by neighbourhood.



# Disease in a rural area

## PART 1

### The setting

It is national agriculture policy to colonize the savannah/forest eco-region of the country. The policy includes an evaluation of the diseases that occur in and around new areas designated for colonization. The area of interest is located in Chaco State in a subtropical savannah with secondary growth vegetation. The annual mean temperature is 24 °C with a high of 39 °C and a low of 10 °C. Mean annual rainfall is 1700 mm, and there is a distinct dry season from September until January.

There is a health post in one of three existing communities near the colonization area. Getting to the site involves flying to the regional capital and then travelling overland for 240 km on dirt roads. During the rainy season the journey takes up to 13 hours.

Agriculture is mainly subsistence farming, with crops such as manioc, beans and plantains being grown. There are some larger farms where soybeans are cultivated and the local residents work as hired hands on these farms.

Your responsibility is to review the communicable disease situation in the area and organize an assessment programme.

You visit the Health Ministry to see whether there are any reports on the health status of the area. Last year's health report is presented in Table 1, which summarizes the major disease concerns for the region.

According to a report you have found on the recently launched Chagas disease elimination programme, the incidence rate for the southern section of Chaco State has dropped from 38.1% to 21.3% over the past 5 years. There was no Chagas disease elimination programme in the area where the colonization programme was planned. The programme manager is adamant in his opinion that Chagas disease is the most important disease in Chaco State and the most debilitating of all the diseases in the country – if not this entire area of the continent!

**Table 1. Major communicable diseases reported from the north-eastern region of Chaco state**

Disease	Number of reported cases	Number of deaths
Malaria	345	4
Dengue	1 (suspected)	1
Chagas disease	371 (1–5 years old)	0
Sexually transmitted infections	72	0
Yellow fever	11	0
Hepatitis	31	4
Cholera	8 (suspected)	0
Leishmaniasis:		
- visceral	10	1
- cutaneous	37	0
Leprosy	8 (suspected)	0
Machupo virus	10	3

During a brief conversation with the head of the national malaria control programme you learn that the malaria risk is high due to the presence of the main vector *Anopheles darlingi* and the continual movement of indigenous people who transport and sell goods and materials across the country's borders. He also fears an outbreak of dengue but gives no reason for this. Concern is also expressed about a possible outbreak of Machupo virus and new emerging viral diseases such as Hanta virus pulmonary syndrome in the colonization area.

These concerns are puzzling because none of the reported communicable diseases appears to warrant more than the introduction of a health surveillance system.

Since you are new to the area and know little about Chagas disease, and the manager of the Chagas elimination programme is so adamant about the extent of the problem, you decide to review this disease further. You do some background reading to improve your understanding (Boxes 1 and 2).

### Box 1

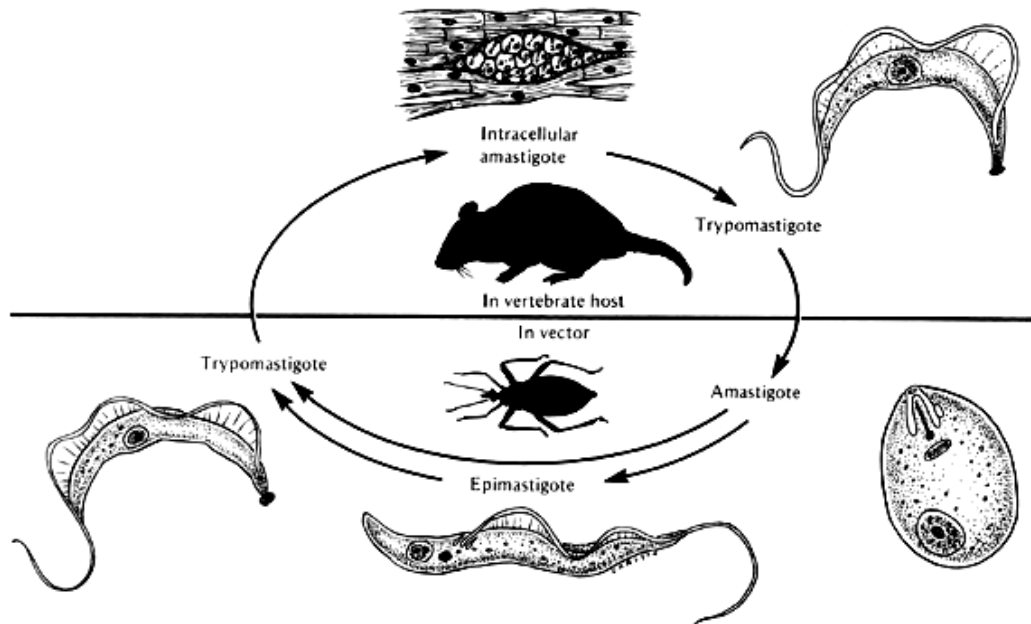
**Chagas disease** is caused by *Trypanosoma cruzi*, a flagellated protozoon (see Fig. 1). It is a rural disease associated with poor socioeconomic conditions and inadequate housing. It was initially an enzootic that circulated exclusively among wild animals and was transmitted by wild triatomines. When humans entered the natural foci and altered the equilibrium of the triatomine ecosystem, domiciliary invasion became possible. Domiciliation of some triatomine species infected by *T. cruzi* extended the disease to artificial ecotopes where the domiciliary cycle was established with humans and domestic animals. According to conservative estimates by WHO, 90 million individuals are exposed to the risk of acquiring Chagas disease in Latin America, while 16–18 million are already infected. Chagas disease ranges in distribution from the southern United States to southern Argentina.

Your curiosity takes you to the Department of Indigenous Affairs to see whether there is any additional information on malaria or other communicable disease problems among the indigenous population near the colonization area. You confirm that malaria is endemic, with a few deaths being reported from this area, and that leishmaniasis is common. The director of the health programme for indigenous peoples gives you a report of a recent research study carried out under contract with the Federal University.

The research team for that study visited an indigenous population living in relatively small and isolated communities near the area of colonization 2 years earlier and determined that 37.7% (256 of 679 people) were infected with *T. cruzi*. The prevalence of seropositivity for *T. cruzi*, as determined by the composite results of three serological tests, was 34% among 338 persons in another community, which had been established 10 years ago. The new colonization area is 94 km from the indigenous population and 100 km from the settlement community.

Information was also collected on house infestations by the vector *Triatoma infestans*; 15 adults and 23 nymphs were collected from a total of 41 houses. No tests were carried out to determine positivity for *T. cruzi* and none of the triatomines with blood was tested to identify the origins of the blood-meals.

**Figure 1**  
**Life-cycle of *Trypanosoma cruzi***



## PART 2

### What you collected during your first field visit

You went to the three villages to survey all the potential diseases listed in the Health Ministry report. However, on consulting the local medical officer and his staff you found out that, in their opinion, as well as the health effects of poverty, poor nutrition, violence and lack of education, Chagas disease had a devastating impact because of its chronic nature. More than 20% of the young men leaving the area to join the military as a way of gaining employment were found to have enlarged hearts. Your medical team conducted a serological survey using finger-prick blood and an immunofluorescent antibody test (IFAT) and reported the numbers and percentages of seropositive individuals in the three villages (Table 2). Approximately 25% of the population was sampled.

**Table 2. Seropositivity rates for Chagas disease in three villages**

Village	Male	Female
<b>Cativi</b>	12.0% (15/125)	14.1% (10/71)
<b>Santos</b>	8.5% (11/130)	15.0% (12/80)
<b>Rio del Gato</b>	6.1% (7/115)	5.6% (5/90)

The seropositivity rate in children under 10 years of age was 3.0%. The inhabitants had lived in the settlements for an average of 6.1 years; most of them came from Chagas disease-endemic areas. There was no indication of Chagas disease transmission by blood transfusion or congenitally. Further studies would be needed to confirm this.

The entomologist on the team sampled 20 houses in each village as well as the corrals, chicken houses and palm trees in peridomestic areas. Results are shown in Table 3.

**Table 3. Distribution of *Triatoma infestans* captured in the villages of Cativi, Santos and Rio del Gato**

Stage	Cativi		Santos		Rio del Gato	
	Domestic	Peri-domestic	Domestic	Peri-domestic	Domestic	Peri-domestic
Adult male	12	4	14	5	7	1
Female	21	6	24	5	6	0
5th nymph	19	7	16	6	8	2
4th nymph	17	1	14	3	12	1
3rd nymph	10	3	11	1	6	0
2nd nymph	4	1	3	0	2	1
1st nymph	2	1	4	1	0	1
<b>Total</b>	<b>85</b>	<b>23</b>	<b>86</b>	<b>21</b>	<b>41</b>	<b>6</b>

In addition, the proportion of *T. infestans* infected with *T. cruzi* was determined for domestic and peridomestic collections. Vector gut contents were stained using the May–Grünwald–Giemsa technique and checked for metacyclical trypomastigotes. In Cativi and Santos the infection rates from domestic collections were 25.6% ( $n = 44/171$ ) and 20.5% ( $n = 9/44$ ), respectively. In Rio del Gato, the infection rates for domestic and peridomestic triatomines were 12.2% ( $n = 5/41$ ) and 0% ( $n = 6$ ).

A precipitin test for blood-meal determination was conducted on 75 adults and 41 nymphs of *T. infestans* from Cativi and Santos. Results are shown in Table 4.

**Table 4. Blood-meal identification by precipitin test for *T. infestans* from the communities of Cativi and Santos**

Stage	No. tested	No. identified		Host				
		Total	%	man	bird	rodent	dog	cat
Adult	75	65	86.7	18	6	33	3	5
Nymph	41	37	90.2	10	9	14	4	0
<b>Total</b>	<b>116</b>	<b>102</b>	<b>87.9</b>	<b>28</b>	<b>15</b>	<b>47</b>	<b>7</b>	<b>5</b>

Each village had a central plaza, but most people lived on 1-hectare plots allotted to them by the agrarian reform project. A review of the living conditions of the three communities showed similar types of housing with areas of thatched roofs made from palm leaves and incomplete adobe walls with many cracks and crevices. Most houses in the centre had a water supply. On the 1-hectare plots the owners carried water for drinking and washing dishes from a nearby stream. The communities of Cativi and Santos survived on subsistence farming, with cassava being the only true cash crop. Many men were hired seasonally to work on the local cattle ranches. In Rio del Gato, the community had subsistence agriculture, but fishing was also a major activity and the community's main source of income.

Domestic animals lived more frequently in close proximity to – and sometimes inside – the houses, in Cativi and Santos than in Rio del Gato (57% vs 17%). This may have been due to the greater reliance of Rio del Gato inhabitants on fish as a source of protein – the other communities kept large numbers of chickens.

A large clinic was located in Santos, staffed by a doctor, a nurse and two medical technicians. The other communities had only a resident medical technician in each of their clinics. The doctor from Santos visited these clinics weekly. The Santos clinic had electricity, water and refrigerators to store vaccines and other medical supplies. There was an elementary school in Rio del Gato and another located between the villages of Caviti and Santos, shared by both communities. There was

no health education programme in the schools. At the clinics, no information on Chagas disease and its control was available to the public.

Each community was surrounded by open pastures with secondary vegetation, particularly palm trees. Most plots were a combination of primary forest and secondary vegetation.

You insisted on carrying out an active case detection survey for malaria in at least two villages to see whether the medical doctor's appraisal of the situation was accurate. Perhaps the cases were asymptomatic or the people did not go to the clinic for treatment. Five cases of malaria were detected, four of which were among fishermen who had recently returned from a trip downriver.

The entomology team collected mosquitoes in the village of Cativi. Four collectors captured mosquitoes attracted to human bait inside and outside houses from 30 minutes before sunset until midnight on four nights. The results are shown in Table 5.

**Table 5. Number of anopheline mosquitoes captured from human bait on four nights by two collectors outside houses and two collectors inside houses in Cativi**

Species	Inside houses	Outside houses
<i>An. darlingi</i>	50	61
<i>An. oswaldoi</i>	3	23
<i>An. albitarsis s.l.</i>	8	12
<i>Anopheles species</i>	0	13
<b>Total</b>	<b>61</b>	<b>109</b>

The mosquitoes were tested for the presence of *Plasmodium falciparum*, *P. vivax* and *P. malariae* in the laboratory using the ELISA method. Results showed that 2 (1.8%) of the *An. darlingi* were infected with *P. vivax*, and 2 (7.7%) of the *An. oswaldoi* were infected with *P. malariae*.

In addition, in the early morning mosquitoes were collected resting inside houses and on vegetation outside. Only 10 mosquitoes were collected; none had blood-fed. They were all *An. darlingi*. The sample was lost, so these mosquitoes were not included in the ELISA test.

## PART 3

### What you found out

An entomology team was sent to the area to examine the natural history of the vectors.

Many of the necessary data were collected in the initial assessment. However, since you wanted to determine what control measures you would use, if any, it was essential to obtain a more detailed stratification of the area.

Knowing that there are two main strategies for the control and prevention of Chagas disease (Box 3) it was clear that more work was needed on the numbers and clustering of infested houses and any concentration of bugs within the houses. The relationship between the environment and non-human hosts also warranted further investigation.

#### Box 3

##### **Main control strategies for Chagas disease vectors**

1. Eliminate intra- and peridomiciliary triatomine foci using residual insecticides, and
2. Prevent the vector from living in the houses by improving housing conditions.

Your team did not want to exclude the possibility that, in many instances, the close relationship between domestic animals, in particular chickens and dogs, could be modified to reduce Chagas disease in this rural setting.

The first survey was carried out (Table 6) to examine the possible association between house structure and triatomine infestation and infection of inhabitants.

**Table 6. Seropositivity rates among residents of the three villages in relation to housing conditions**

Village	Seropositivity rate	House structure	Living conditions
Cativi	12.8% (25/196)	50% with cracks in walls	substandard
Santos	11% (23/210)	45% with cracks in walls	substandard
Rio del Gato	8.3% (17/205)	46% with cracks in walls	above average – clean

One of the biggest risk factors for Chagas disease seen in Cativi and Santos was that more than 30% of households kept chickens next to or inside the houses. The birds ran freely in and out of the houses. In Rio del Gato, the villagers kept their chickens at the far end of their yards in enclosures. Also, toilets were placed over a canal, whereas in Cativi and Santos they were mostly situated less than 10 metres from the houses. The proximity of the chickens and the toilets may explain the high number of triatomines that were positive for rodent blood in these two villages compared to Rio del Gato (see Table 4).

### Entomology

Further collections were made in the houses and in the peridomestic areas to see where the triatomines were breeding. No additional breeding sites were found in any of the villages. In all three villages a significant correlation was found between the presence of a chicken coop as an integral part of the house and the number of triatomine bugs in the house ( $p = 0.05$ ). A search for other triatomine species was unsuccessful. Palm trees did have colonies of *Triatoma infestans* and rats, but there was no correlation between their presence and seropositivity.

An additional 20 houses in each village were stratified by type of room to see whether there was any association with the level of infestation with triatomines. None was found.

### Insecticide resistance

Standard WHO insecticide susceptibility tests were carried out with cypermethrin. *Triatoma infestans* showed no sign of resistance to this insecticide.

## POTENTIAL ANSWERS TO CASE-STUDY 3 – DISEASE IN A RURAL AREA

### (Learning Unit 2 – Decision-making process, Steps 1 and 2)

***What health problem(s) can you identify in Part I of the case-study? What evidence is there that these problems exist?***

The health data from Chaco State indicated that there are several potential vector-borne disease problems in the region. Chagas disease could be the most important disease in the region and perhaps for the colonization area in the long term. The data from the regional Chagas disease elimination programme and the research on the indigenous population support this possibility. Malaria in areas of instability should also be of concern, but at present there are insufficient data to allow proper evaluation of the situation. Emerging viral diseases should be considered when a health surveillance programme is introduced. Hepatitis should also be a concern because of the four reported deaths.

***Q. What important ecological (environmental) and economic or social variables and factors can you identify that influence the health situation?***

#### *Ecological factors*

- Semi-dry savannah
- Hot climate
- Dirt roads

#### *Social factors*

- Colonization
- Non-immune migrants
- Isolated sites

#### *Economic factors*

- Lack of resources for public health
- Likelihood of more than one disease to treat and monitor
- Distance to nearest commercial centre

***What other information do you need to understand the situation and decide how to solve these problems?***

There should be a more careful analysis of the clinical symptoms of the reported diseases to confirm the suspicion that those mentioned above are indeed the main health problems in this community. The clinical diagnoses should be supported by laboratory tests.

You would also like to have additional information on the distribution of the diseases based on epidemiological and entomological risk factors, including disease incidence by location.

***Do the new data confirm your original assessment of the nature of the problem? Why (or why not)?***

If the participants chose Chagas disease they are probably correct. If they did not select Chagas disease they may have been more cautious because few data are available on other diseases to confirm or refute their importance. A rapid assessment of the other diseases through active case detection and analysis of blood samples is recommended.

***Based on the data you have now, write a brief (250 words or less) explanation of the vector-borne disease problem and its magnitude. Consider: (a) who has the disease, (b) where you believe transmission occurs, (c) when you believe transmission occurs, and (d) how you believe transmission occurs.***

The data presented in the annual report and the results of the research study in the indigenous population indicate that Chagas disease would be the most important disease for a colonization project in the area. However, because of the number of vector-borne diseases recorded in the Chaco, one would want to set up an active case detection and surveillance system to determine the occurrence and frequency of such diseases and to monitor changes in Chagas disease.

Seropositivity rates in the villages of Cativi, and Santos are twice as high as that in Rio del Gato. The reason for this may be the lower number of domestic triatomines in Rio del Gato compared with the two other villages. Also, the *T. cruzi* infection rate in Rio del Gato was half that in the other two villages.

Thatched roofs made of palm fronds and walls with cracks and crevices permit triatomine bugs to colonize houses and increase the host–vector contact. The close proximity of domestic animals in Cativi and Santos compared with Rio del Gato may also be a factor contributing to the higher seropositivity in Cativi and Santos.

## Summary

- Interior savannah region with subsistence agriculture and indigenous groups
- Region highly endemic for vector-borne diseases, and Chagas disease in particular
- Seropositivity of villagers in proposed colonization zone = 9.8%
- Low mortality

### ***Are there any inconsistent or abnormal data? If so how do you explain them?***

All the data appear to be within reason at this point.

### ***Are the data sufficiently stratified to allow an appropriate decision to be made on vector control? Why (or why not)?***

The data are sufficiently stratified if you assume that the risk of infection is the same for all houses in each village. If the infestation and disease are not evenly distributed within the villages you would want to analyse the data by risk factors and stratify areas of high incidence before implementing a control strategy.

### ***How would you present your data graphically (use maps, graphs, or charts)?***

You would want a survey map of each village with all houses identified and details the environments around them, including location of animal houses and seropositivity. For now, you could present the results for seropositivity by sex and village and the blood-meal identification by host in tables or a graph.

### ***Are the data sufficiently reliable and accurate to allow you to move forward with decision-making? If not, what additional data do you need?***

More precise information by village and risk factors is desirable. In general terms, however, you could begin to make decisions on how to prevent and control Chagas disease based on the aims of the Chagas disease elimination project.



