HANDBOOK for Integrated Vector Management

IVM

World Health Organization

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PREFACE

The intention of this handbook on integrated vector management (IVM) is to provide guidance to the managers of vector-borne disease control programmes, including comparable officials in health and other sectors involved in vector-borne disease control. The target audience is managers and officials at central, district and lower administrative levels. The handbook provides background information to complement the *Core structure for training curricula on integrated vector management* and associated training materials. A separate document, *Guidance on policy-making for integrated vector management*, was prepared for policy-makers.

The handbook was conceptualized at the first IVM Working Group Meeting on Capacity Building and Training, held 28–30 May 2009 in Washington DC, USA, organized jointly by the World Health Organization (WHO), the United States Agency for International Development and RTI International, a scientific research and development institute. The outline of the handbook was shared at a meeting of stakeholders in Geneva on 11–13 November 2009.

The first draft was prepared by Dr Henk van den Berg (Wageningen University, The Netherlands), Dr M. Kabir Cham (consultant, Gambia) and Dr Kazuyo Ichimori (WHO, Geneva). That draft was reviewed during the Second IVM Working Group Meeting on Capacity Building and Training, held 20–22 October 2010 in Washington DC (Annex 1). Dr van den Berg revised and finalized the document, in consultation with Dr Raman Velayudhan (WHO, Geneva).

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EXECUTIVE SUMMARY

Integrated vector management (IVM) is a rational decision-making process to optimize the use of resources for vector control. The aim of the IVM approach is to contribute to achievement of the global targets set for vector-borne disease control, by making vector control more efficient, cost effective, ecologically sound and sustainable. Use of IVM helps vector control programmes to find and use more local evidence, to integrate interventions where appropriate and to collaborate within the health sector and with other sectors, as well as with households and communities. By reorientating to IVM, vector control programmes will be better able to meet the growing challenges in the control of malaria, dengue and other vector-borne diseases in the face of dwindling public sector human and financial resources.

This handbook presents an operational framework to guide managers and those implementing vector-borne disease control programmes in designing more efficient, cost-effective systems. As a national IVM policy and an intersectoral steering committee are essential for establishing IVM as a national strategy, the handbook begins with the policy and institutional framework for IVM. Policy analysis is a means for identifying options for policy reform and suggesting instruments for implementing policy.

IVM transforms the conventional system of vector control by making it more evidence-based, integrated and participative. This may require changes in roles, responsibilities and organizational links. The transition to IVM involves both reorientation of vector-borne disease control programmes and embedding IVM within local health systems. Intersectoral partnerships and collaboration at both national and local levels will result in cost savings and benefits to other health services. Other relevant sectors, such as agriculture, environment, mining, industry, public works, local government and housing, should incorporate IVM and vector control into their own activities to prevent vector proliferation and disease transmission.

Planning and implementing IVM involve assessing the epidemiological and vector situation at country level, analysing the local determinants of disease, identifying and selecting vector control methods, assessing requirements and resources, and designing locally appropriate implementation strategies. Solid evidence on the cost effectiveness of interventions and their underlying parameters and a comprehensive vector surveillance system are essential for locally appropriate decision-making.

Capacity-building, in particular human resource development, is a major challenge, because the IVM strategy requires skilled staff and adequate infrastructure at central and local levels. The handbook outlines the core functions and essential competence required for IVM at central and local levels, complementing a separate set of documents containing the *Core structure for training curricula on integrated vector management* and associated training materials.

Like any new approach, IVM must be actively advocated and communicated in order to become established. The handbook lays out the elements and processes of IVM to enable policy-makers, donors and implementing partners to use it for vector-borne disease control. During the period of transition and consolidation of an IVM strategy, regular feedback is required on performance and impact in order to ensure continued

support. The general public must also be made aware of the strategy and participate in its implementation. The communication tools for reaching the public are the media and various types of educational interventions to increase their knowledge and skills, which should lead to behavioural change and empowerment.

The final section presents a comprehensive framework for monitoring and evaluation of IVM, covering aspects discussed in the previous sections. Indicators and methods for measuring process, outcomes and impact are proposed.

In conclusion, IVM is the preferred approach to improving vector control in countries. The means for establishing IVM are indicated in the operational framework of this handbook. IVM offers an opportunity and a method, as described in this handbook, for setting up partnerships and developing the capacity to find solutions and implement programmes in an efficient, cost effective, ecologically sound and sustainable manner.

1. INTRODUCTION

Integrated vector management (IVM) is a rational decision-making process to optimize the use of resources for vector control. IVM requires a management approach that improves the efficacy, cost effectiveness, ecological soundness and sustainability of vector control interventions with the available tools and resources. In the face of current challenges to vector control, the IVM approach is vital to achieving the national and global targets set for vector-borne disease control.

A variety of vector-borne diseases,[1] which often coexist in the same environments, impose a heavy burden on human populations, particularly in developing countries in tropical and subtropical zones, as presented in *Table 1.1*. Besides the direct human suffering they cause, vector-borne diseases are also a significant obstacle to socioeconomic development. Vector control[2] is an important component of the prevention and management of these diseases, as, for some diseases, the vector is the only feasible target for control. When well planned and well targeted, vector control can reduce or interrupt transmission. Vector control reduces illness and saves lives: this has been shown repeatedly and convincingly in areas where malaria has been eliminated.

Table 1.1 Human burden of major vector-borne diseases

Infection	No. of countries with active transmission	Population (millions)		Lost DALYs (millions)	
		Infected	At risk	Total	%
Malaria	99	265	3215	45.0	74
Lymphatic filariasis	72	120	1390	5.8	10
Dengue	>100	Episodic or endemic	2500	0.7	1
Schistosomiasis	60	Not available	Not available	1.7–4.5	6
Leishmaniasis	88	Not available	200	2.1	3
Chagas disease	21	10	30	0.7	1
Trachoma	57	Episodic or endemic	Not available	2.3	4
Onchocerciasis	37	Not available	40	0.5	1
Japanese encephalitis	40	Episodic or endemic	Not available	0.4	1
Other arboviruses	150	Episodic or endemic	5000	0.1	0
Enteric diseases	191	Episodic or endemic	6000	Not available	Not available
Human African trypanosomiasis	37	Not available	15	Not available	Not available

[1] "Vector-borne disease" is the collective term for infectious diseases transmitted by insects, snails or rodents, which act as vectors of the actual pathogens.
[2] "Vector control" is defined as activities to reduce the populations of vectors or to reduce human contact with vectors.

1.1 BRIEF HISTORY

Before the Second World War, vector control was conducted predominantly by environmental control of the proliferation of mosquitoes. The measures were often based on information about the distinct preferences of different vector species for breeding habitats; hence, knowledge about disease vectors was used to direct environmental measures to preferred breeding sites. There is evidence that environmental management had a clear impact on disease (*1, 2*); however, elimination of disease was never on the agenda.

The advent of DDT and other organochlorine pesticides during the 1940s changed this situation. Spraying the indoor surfaces of houses and shelters drastically reduced the numbers of malaria mosquitoes and other insects. More importantly, spraying reduced the average longevity of mosquitoes to below the age at which they become infectious (*3*), substantially reducing the transmission of malaria and several other vector-borne diseases. Malaria was even eliminated from a number of countries. Increased resistance of vectors to insecticides, however, resulted in failure to eliminate malaria in others. The focus of vector control on insecticides meant that environmental management and other alternative methods were underexploited or even forgotten. Insecticides other than DDT were developed, the most recent class being the pyrethroids, developed in the 1980s, which are currently the predominant insecticides used for vector control.

The past decade has seen renewed global emphasis on vector control, particularly in relation to malaria. For example, campaigns to deliver insecticide-treated nets have achieved significant coverage in a number of African countries, leading to substantial reductions in the prevalence of malaria, even where the disease was highly endemic. Increased investment and continued effort are needed, however, for the control, elimination or eradication of not only malaria but all vector-borne diseases (*4–6*).

1.2 STATEMENT OF PROBLEM

To achieve global targets for vector-borne disease control, the full potential of vector control must be deployed (*7*). Several factors, however, undermine the effectiveness of vector control, especially when control is being scaled-up.

- Capacity for evidence-based decision-making for and implementation of vector control remains inadequate in most affected countries, often resulting in suboptimal choice or timing of interventions, no monitoring and waste of valuable resources.
- Vector control programmes commonly focus on a single disease and are not fully integrated into health systems, raising concern about their sustainability.
- Vector-borne disease patterns are affected by climate change, environmental degradation and urbanization, pointing to the need for an adaptive management approach to vector control.
- Other sectors, such as agriculture and construction, and communities are often insufficiently aware of the consequences of their actions on the incidence of vector-borne disease.

- Current vector control interventions rely heavily on the use of a limited choice of insecticides; thus, the development of resistance could undermine control efforts unless additional mitigation measures are taken.

The Stockholm Convention on Persistent Organic Pollutants and World Health Assembly resolution WHA50.13 call on countries to design sustainable strategies for vector control that will reduce their reliance on insecticides. These recommendations for addressing environmental concerns were an additional driving force for a new approach to vector control.

1.3 CONCEPTUALIZATION OF INTEGRATED VECTOR MANAGEMENT

Vector control could be more effective, cost effective, ecologically sound and sustainable. These goals can be achieved by basing decisions increasingly on local evidence, by addressing several diseases and by using existing systems and local human resources.

In 2004, WHO adopted the Global Strategic Framework on IVM as a first step towards implementation of a new approach to vector control (*8*). In May 2007, a consultation group assessed the need for IVM and drew up a global strategic plan along the key elements of IVM (*9*). The group recommended the use of advocacy and social mobilization concerning IVM so that the principles would be embedded in all programmes for vector-borne disease control. Furthermore, the group recommended that monitoring and evaluation and operational research be established to generate an evidence base for vector control; they noted that capacity-building was required to provide human resources and infrastructure for IVM, and they recommended that an institutional framework be established to promote and implement IVM.

In 2008, WHO issued a position statement on IVM to support advancement of the concept as a component of vector-borne disease control, and Member States were invited to accelerate the preparation of national policies and strategies (*10*). In December 2008, a global consultation was held to prepare an action plan on IVM for the period 2009–2011. The actions corresponding to the key elements of IVM were: launching a global advocacy strategy, designing a comprehensive modular training package, establishing a network for IVM, and preparing a research agenda and a system for evaluating IVM (*11*).

As the key activities for IVM have been spelt out in the global action plan and countries have been encouraged by WHO to accelerate preparation of IVM, the stage is set for implementation. Hence, countries require assistance in putting IVM into practice. This handbook was commissioned to fulfil that requirement.

1.4 DEFINITION OF INTEGRATED VECTOR MANAGEMENT

IVM is defined as a rational decision-making process to optimize the use of resources for vector control (*10*). It is based on evidence and integrated management, promoting the use of a range of interventions – alone or in combination – selected on the basis of local knowledge about the vectors, diseases and disease determinants. The IVM approach addresses several diseases concurrently, because some vectors can transmit several diseases and some interventions are effective against several vectors. IVM will reduce the pressure imposed by insecticides to select for insecticide resistance.

The conceptualization of IVM benefited from developments in integrated pest management in agriculture, in which insecticide application has become the method of last resort. The action and inaction of other divisions of the health sector and of other public sectors and communities have important implications for disease prevalence and vector populations. Hence, IVM encourages effective collaboration within the health sector and with other public sectors, and the empowerment of communities.

At national level, implementation of IVM requires a public health regulatory framework and an institutional framework. At the international level, a common strategy of support is required from the relevant United Nations agencies and donors, through inter-agency coordination and harmonized activities.

The key elements of an IVM strategy are shown in *Table 1.2*. These elements should be supported by legislation and regulation. IVM is a step towards an integrated disease management approach that incorporates all components of disease control, including vector control, prevention, treatment and human vulnerability.

Table 1.2 Key elements of an integrated vector management (IVM) strategy[a]

N°	Element	Description
1.	Advocacy, social mobilization and legislation	Promotion and embedding of IVM principles in designing policies in all relevant agencies, organizations and civil society; establishment or strengthening of regulatory and legislative controls for public health; empowerment of communities
2.	Collaboration within the health sector and with other sectors	Consideration of all options for collaboration within and between public and private sectors; application of the principles of subsidiarity in planning and decision-making; strengthening channels of communication among policy-makers, vector-borne disease programme managers and other IVM partners
3.	Integrated approach	Ensure rational use of available resources by addressing several diseases, integrating non-chemical and chemical vector control methods and integrating with other disease control methods
4.	Evidence-based decision--making	Adaptation of strategies and interventions to local ecology, epidemiology and resources, guided by operational research and subject to routine monitoring and evaluation
5.	Capacity-building	Provision of the essential material infrastructure, financial resources and human resources at national and local level to manage IVM strategies on the basis of a situational analysis

[a] Source: Global strategic framework for integrated vector management (*8*).

1.5 PROBLEM-SOLVING APPROACH

IVM requires a problem-solving approach to vector control, in which current and past field observations, surveillance and situation analyses form the basis for a plan of action. Because almost every situation is distinct and complex, it is impossible to prescribe standard actions and strategies. Instead, skills and capacity for surveillance, analysis and adaptive management should be fostered at all appropriate levels of administration. The smaller the area for a situation analysis, the more detailed and accurate the data, and the more responsive the mitigating actions are likely to become.

The IVM approach to problem-solving requires appropriate skills and capacities at central, district and village levels. Once established, these skills and capacities will strengthen health systems because they have a direct benefit for other public health divisions. Problem-solving and analytical skills improve resource use and the internal efficiency of the health system, for example by synergistic effects with benefits for more than one sector.

1.6 PURPOSE AND SCOPE

The purpose of this handbook is to provide an operational framework for planning and implementing vector-borne disease control according to the principles of IVM. The handbook also gives background information for preparing training curricula on IVM and could be useful in writing project proposals.

The target audience is managers of vector-borne disease control programmes at provincial, district or lower administrative levels, and comparable officials in health and other sectors who are involved in planning, implementing and managing vector-borne disease control.

The handbook applies, in principle, to all vector-borne diseases. It also applies to diseases in which mechanical transmission by domestic flies plays an important role, such as diarrhoea and blinding trachoma. Although the focus of the handbook is diseases in humans, there is a significant overlap with diseases of livestock, many of which are transmitted by mosquitoes, flies or ticks (*12*). Moreover, zoonotic diseases are transmitted from animals to humans, and animals can also serve as hosts for the vectors of human diseases. IVM is appropriate in settings in which the control of vector-borne diseases in humans and livestock is integrated.

The problem-solving style advocated in this handbook will assist countries in designing an adaptive approach, by drawing on local data and scientific evidence to prepare appropriate strategies. Instead of being prescriptive, the handbook introduces tools and suggests procedures for planning and managing an appropriate strategy. Detailed technical background information on vector-borne diseases, vector control methods and the ecosystem basis for vector control is beyond the scope of this document but will be made available as separate reference material.

2. POLICY AND INSTITUTIONAL FRAMEWORK

This section begins with an analysis of the problems experienced in national systems for vector control and their causes. This is followed by a discussion on policy environments, institutional arrangements and stakeholders.

Vector control can be improved by basing it on local evidence, by integrating interventions where appropriate, and by collaborating with divisions within the health sector and with other public and private sectors, and also actively engaging communities. This implies that significant changes are needed in order for IVM to be effective: changes within the health sector, changes in dealing with other sectors and changes in research.

Support at the national policy level, with a favourable public health regulatory and legislative framework and with appropriate programmes in place, are essential in the success of IVM. Therefore, the need for specific policies should be identified as an early step in developing any IVM strategy. Also, the tasks and roles of institutions and other partners in an IVM strategy must be assessed and specified.

2.1 SITUATION ANALYSIS

To adapt a country's vector control system to IVM, any existing obstacles and their causes should be identified. A situation analysis could be used to identify, for example, factors that reduce the efficiency of vector control operations or the effectiveness of interventions and any adverse side-effects. Situation analysis is a component of the "vector control needs assessment", which is discussed in detail in separate documents (*13, 14*).

The main component of the analysis is the burden of vector-borne diseases. In the problem statement above, a range of possible improvements that influence the effectiveness of vector control were outlined. These could apply to countries at various levels and in many sectors. Common problems include: lack of capacity for evidence-based decision-making, compartmentalized rather than integrated disease control programmes, static rather than adaptive programmes, lack of involvement of other sectors and communities, and resistance to insecticides. These problems are common and cover a range of topics; they therefore usually require an interdisciplinary approach.

Each of these problems has causes, such as low priority given to vector control, lack of communication between ministries and over-dependence on pesticides. Each cause has its own reasons. Vector control may not be a priority because of lack of awareness at the decision-making or implementation level; communication between ministries may be lacking because there are no means or opportunities; pesticides may be used because information on alternative or additional methods is not available. Hence, the perceived problems should be solved by addressing their causes. Some problems may be easy to remedy; some may require a change in national or ministerial policy, and some may require a change in institutional arrangements.

2.2 THE POLICY ENVIRONMENT

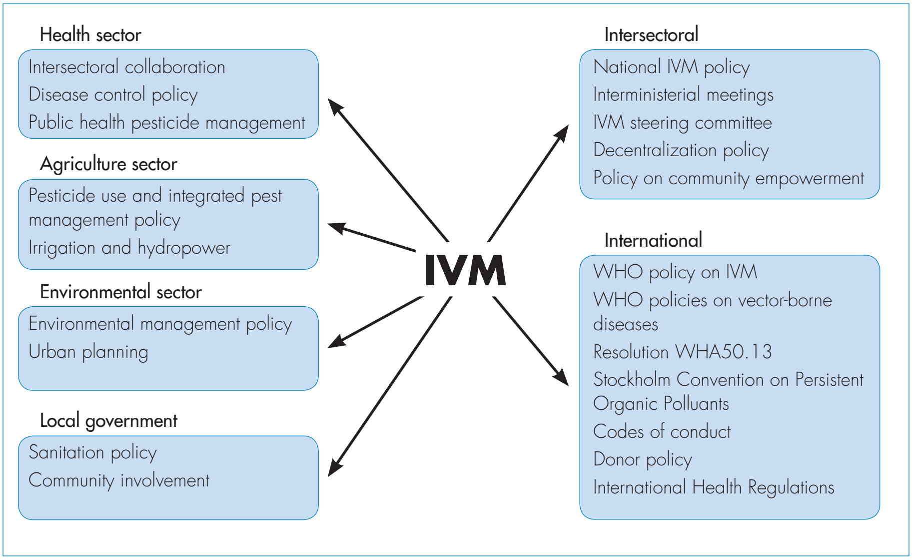
The challenges in vector control cover a wide range of issues, including capacity-building, applied research, within-sector coordination, intersectoral collaboration, decentralization, community empowerment and vector surveillance. To enable the government or its agencies and personnel to take decisions on these issues, policy support is required at national or ministerial level.

2.2.1 Policy analysis

A government's policy is its position or stance on an issue. Policy may be mandatory or advisory; compliance with mandatory policies may have to be enforced. The policy analysis is an interdisciplinary approach to identifying the strengths and weaknesses of the policy environment (*Figure 2.1*) for preparing an IVM strategy. Evaluation of any gaps and inconsistencies in the policy environment will help to improve the policy itself and make the surrounding legal framework effective and supportive for IVM.

Existing policies related to IVM within the health sector are, for example, the national health policy, health system integration of vector control, current guidelines for vector control, legislation and regulation of pesticides and current vector control programmes. These policies might have to be amended or rephrased in order to increase support for IVM. There may be public policies in other government sectors that affect vector-borne diseases, either negatively or positively. For example, in agriculture, policies for pesticide use and integrated pest management and on irrigation or development projects can have a bearing on IVM. In the environment sector, policies for environmental management of waterways, swamps and wastelands are relevant. In the local government sector, policies for sanitation and community involvement and education are important.

Figure 2.1 Policy environment of integrated vector management (IVM), with examples of policies relevant to IVM in the health sector, in other sectors, between sectors and at international level



Examples of IVM-related policies that involve intersectoral arrangements are: a national policy on IVM, a policy for interministerial meetings on IVM, a policy for an intersectoral steering committee on IVM, a macro-adjustment policy on health reform and a policy on community participation. A number of international and regional policies could influence the implementation of IVM locally. For example, WHO has issued policy guidelines on IVM, including a global strategic framework, a position statement on IVM and regional resolutions. The Stockholm Convention on Persistent Organic Pollutants requires its Parties to reduce or eliminate the release of these pollutants, which include DDT, into the environment.

In policy analysis, the favourable and unfavourable aspects of existing policies are explored, and gaps are identified in order to propose options for policy change. Examples of policies that are conducive to IVM are policies on:

- management of public health pesticides,
- integrated pest management in agriculture,
- construction standards that incorporate measures to prevent vector–human contact,
- support of local health systems,
- devolution of decision-making and finances,
- sanitation to prevent vector breeding, and
- public awareness-raising and education.

Policies that do not favour IVM are those for development strategies or irrigation systems that do not take into account the risk for vector-borne diseases. Gaps in policy could also be detrimental to IVM, for instance, if policies on pesticide management or local health systems are lacking. In some countries, policy analyses have been conducted for public health pesticide management in projects operated by WHO. A similar approach could be followed for policy analysis on other components of IVM.

Policy development and policy reform are beyond the scope of this handbook and are dealt with in a separate guidance document for policy-makers (*15*). A strong evidence base is vital to justify new policies or policy reform. Evidence is needed, first of all, on the disease burden; evidence for the presence of multiple parasites could justify a policy for the control of several disease (*16*). Evidence that other sectors and communities are contributing to reducing the risk for vector-borne diseases can help justify new policies on intersectoral collaboration and community participation.

The relevant policies and programmes can have adverse, neutral or beneficial effects on vector-borne diseases; some have both adverse and beneficial elements, which should be specified. The analysis is carried out by associating the identified problems with the items (or missing items) of the policy environment. In many cases, the problem can be traced to a lack of policy for a specific issue. The outcome of the analysis is identification of gaps, shortcomings and inconsistencies in the public policy framework, which provide the basis for solutions, for example amending, rephrasing or creating policies in support of IVM.

2.2.2 Policy instruments

Policies do not automatically result in outcomes. The procedures through which governments implement public policy are called "policy instruments". Typical examples are legislation, regulations, persuasion and programmes. These are the tools that a government can use to establish and implement a national IVM strategy. The policy instruments for IVM could, for example, be used to establish a national strategy and new governing bodies, to adjust institutional arrangements or to establish collaboration between sectors. They could also be used to advise on training and research directions, regulate the use and management of public health pesticides and guide budget allocation.

Table 2.1 gives examples of policy instruments that are available to governments to address each underlying principle of the IVM approach. For example, evidence-based decision-making can be supported by a budget allocation for training, by support for the decentralization of vector control, by a budget allocation for research or by a combination of any of these. Likewise, collaboration between government sectors could be advanced by introducing a national policy, establishing an IVM committee or facilitating interministerial meetings. It might be useful to use in-country expertise in other intersectoral initiatives, such as on avian influenza. Deregulation might be needed, for example to remove rules that stifle local authority and local initiative. One policy instrument, the health impact assessment, is explained in *Box 2.1*.

Table 2.1 Policy instruments that governments could use to implement public policy, listed according to the basic concepts of integrated vector management (IVM)

Basic IVM concept	Policy instrument
Evidence-based decision-making	Allocation for capacity-building and career paths Facilitate decentralized decision-making Allocation for surveillance systems Allocation and strategic direction for research
Combining vector control interventions	Legislation and regulation on pesticide management Legislation and regulation on environmental management Subsidies, tariffs or taxes on vector control products Allocation and strategic direction for research
Adopting a multi-disease approach	Instruction on collaboration between health divisions Allocation for monitoring and evaluation
Collaboration within the health sector	Government position statement on IVM Instruction on collaboration between health divisions Facilitate a "vector control needs assessment" Review job descriptions
Collaboration with other sectors	Government position statement on IVM Establish intersectoral IVM committee Interministerial meetings Instruction in each sector on health impact assessments
Community empowerment	Support for community-based services Community awareness and education programmes Support for decentralized decision-making Incentives programmes

Box 2.1 Health impact assessment

A health impact assessment is a method for identifying, predicting and evaluating changes in the health risk of a population, both positive and negative, due to a policy, programme or development activity (*17*).

The assessment may be based on a combination of quantitative, qualitative and participatory techniques. It is a good way of involving other sectors in the analysis of side-effects of their strategies and programmes, with the aim of avoiding or reducing negative impacts on human health and enhancing the positive impacts.

Clear health impact assessments will stimulate each sector to assume responsibility for preventing adverse health effects, for example, by reducing vector breeding opportunities. Such assessments are vital in programmes for urban or rural development, infrastructure and construction, agriculture and water resources. Moreover, the exercise can lead to collaboration with the health sector.

2.3 INSTITUTIONAL ARRANGEMENTS

An IVM strategy involves various public and private sectors and civil society organizations, and the collaboration requires serious consideration. The success of policy instruments depends on the suitability of such "institutional arrangements", which can be defined as a set of rules about who does what, when and how.

2.3.1 Reinforcing institutional links

In the public domain, tasks have traditionally been divided among clearly defined government sectors, such as health, agriculture, environment and construction. Each sector usually has its own sphere of influence, with linear accountability. As a result, sectors generally work more or less separately, with little interaction or collaboration. Even within a sector, divisions sometimes operate in isolation. This separation works well most of the time, but it is often not the most efficient or the most effective approach to vector-borne disease control. For problems that cross the boundaries of divisions or sectors, like vector control, the rules of different divisions or sectors may not be consistent or might actually conflict. Two sectors might, for example, have conflicting policies in relation to water use, irrigation or construction standards, one sector making production a priority and the other focusing on the prevention of vector breeding. Incompatible standards or rules can hinder collaboration between two sectors; for example, the absence of rules or standards on vector proliferation or environmental sanitation in one sector could conflict with the rules of the health sector. Conflicting rules in relation to health become apparent in a critical analysis of physical and institutional characteristics, such as the health impact assessment. There might also be inconsistencies between research and implementation programmes. Academic research agendas do not necessarily address the pressing problems faced in field programmes. Links between research and implementation should be strengthened in many countries, as discussed in *section 3.3.1*.

The possible inconsistencies within or between sectors and with research can be resolved by identifying constraints and opportunities and taking action in the form of policy reform, capacity-building and increased collaboration. Sectors could formulate common goals, for example, by acknowledging the interaction between economic progress and health status. Sectors should make use of synergistic effects, such as methods that benefit agricultural production and also suppress vector proliferation in crops. Sectors might have to adopt new policies to prevent vector breeding or to reduce the risk for disease transmission in their sector-specific programmes. This could manifest as a specific budgetary allocation for vector control in each sector or, where appropriate, sanctions to enforce compliance.

2.3.2 Intersectoral steering committee

An intersectoral steering committee on IVM with ministerial support is vital to establishing intersectoral collaboration. The steering committee functions as an interministerial governing body with a responsibility to facilitate harmonization of policies and institutional arrangements and to provide strategic direction and coordination for research and implementation in relation to IVM. Main functions of the committee are outlined in *Box 2.2*. A memorandum of understanding could facilitate collaboration. Under this governing body, technical working groups could be set up with specific terms of reference, for example to discuss capacity-building, evidence-based decision-making or monitoring and evaluation. The steering committee would guide the activities of the working groups and evaluate progress in the field.

Box 2.2 Main functions of the intersectoral steering committee on IVM

- Constitute and coordinate technical working groups, including on policy review, monitoring and evaluation, and prioritization for operational research
- Assign partner roles and responsibilities
- Coordinate the mobilization of resources for intersectional action
- Provide oversight to implementation of the national IVM strategy and work plans
- Utilize monitoring data and special studies to regularly review and adjust policies, strategies and work plans on IVM

In order to have sufficient political "clout", the members of the intersectoral steering committee should be senior staff, such as directors or assistant directors of divisions or institutions. They should represent several ministries, such as those of health, agriculture, the environment, commerce and local government, and appropriate agencies. Countries should explore the possibility of using existing intersectoral steering committees for IVM.

2.3.3 Focal person for IVM

In a multi-partner IVM strategy, there should be a single focal person who acts as IVM coordinator. Typically, the person would be within the ministry of health with responsibility for vector control. He or she should have an overview of all IVM-related activities and should have access to each member of the intersectoral steering committee and to the major implementation partners. The main tasks of the focal person would be to manage networking among national partners and to coordinate implementation of the recommendations of the committee. It would also be beneficial to have contact people for IVM in the existing system at district and even village level.

Linkage with policy-makers at all levels is needed to obtain feedback on field implementation and to make recommendations for policy change or resource allocation in each of the relevant public sectors. Recommendations could devolve from the policy analysis and health impact assessment conducted in each of the participating public sectors. Linkage with policy-makers at central level will probably occur through the IVM steering committee, while linkage at local level will occur through district or village authorities.

2.3.4 Stakeholders

The primary stakeholders in IVM are the communities that will benefit from improved vector-borne disease control. Other entities with a direct stake in IVM are sectors such as health, agriculture, environment, commerce and local government, which often share responsibility for planning, implementation and evaluation. Another important stakeholder in field implementation is the private sector, particularly in special economic zones, such as mining areas, tourist or business zones or agriculture. Civil society organizations are involved in advocacy and implementation of IVM at international, national and local levels. Educational institutions are essential for capacity-building in research to strengthen the evidence base for decision-making and in evaluating impact. The media are essential in advocacy and communication. International players in IVM are United Nations agencies such as WHO, the Food and Agriculture Organization of the United Nations, the United Nations Environment Programme and the United Nations Development Programme; international organizations such as Rotary International; and bilateral, technical and funding agencies. Roles and responsibilities are discussed in more detail in *section 3*.

2.4 DECENTRALIZATION

2.4.1 Health reforms

In most countries endemic for vector-borne diseases, health reforms have resulted in decentralization of decision-making and resource allocation. In decentralization, decision-making is brought to the most appropriate lower level of administration, transferring the responsibility for planning, budgeting and implementing certain functions from the central government to district or local units. Hence, health services are transferred from central ministries to districts, and the role of the ministries is limited to policy, guidance and technical support. A prerequisite for decentralization is that the skills and capacity for analysis and decision-making be firmly established at district level. Capacity for vector control at district level often requires further strengthening for the implementation of logistically complex programmes.

2.4.2 Subsidiarity

Decentralization has been guided by the principle of “subsidiarity”, in which the central authority performs only those tasks that cannot be performed effectively at a more immediate or local level. The IVM approach abides by the subsidiarity principle in that it promotes the planning, implementation and evaluation of vector control at the most local level. Decisions made locally are potentially more responsive, flexible, precise and accountable; locally elected representatives are better informed about the needs of their constituents. Decentralized health systems thus provide an appropriate framework for IVM.

2.4.3 Integration into health systems

Coordinating the activities of existing vector-borne disease control programmes can result in more efficient use of resources and sustained support by local authorities and communities. For example, vector control could be included in district health budgets (*18*). Establishing capacity and strategies for IVM in districts is also likely to affect other services and functions of local health units, extending the reach of services or saving costs when services are targeted at the same areas, as discussed in *section 3.4.1*. Hence, IVM could become a platform for the delivery of other strategies and interventions at community level. This provides an opportunity for coordinating health services at this level.

2.4.4 Integration with other partners

It is easier to include other sectors in a joint strategy on IVM at district level, at which there are fewer intersectoral boundaries. The IVM approach requires establishment of a partnership among sectors and with civil society representatives to undertake a joint systems analysis and joint decisions on the course of action to be taken, as discussed in *section 4*.

2.5 MONITORING AND EVALUATION

New policy and institutional arrangements must be monitored and evaluated in order to ascertain the progress made and to identify areas for further attention. *Table 2.2* lists indicators that could be used. A comprehensive framework for monitoring and evaluation is presented in *section 7*.

Table 2.2 Indicators of process and outcome for monitoring and evaluating progress in policy development and institutional restructuring in relation to integrated vector management (IVM)

Process indicator	Outcome indicator
Focal person for IVM identified	National IVM policy in place
Situation analysis completed	National policy on pesticide management in place
Economic impact of vector-borne diseases assessed	Cost-effectiveness studies completed
Mandate and composition of national steering committee on IVM developed	National steering committee on IVM in place
Terms of reference for national coordinating unit on vector control developed	National coordinating unit on vector control in place

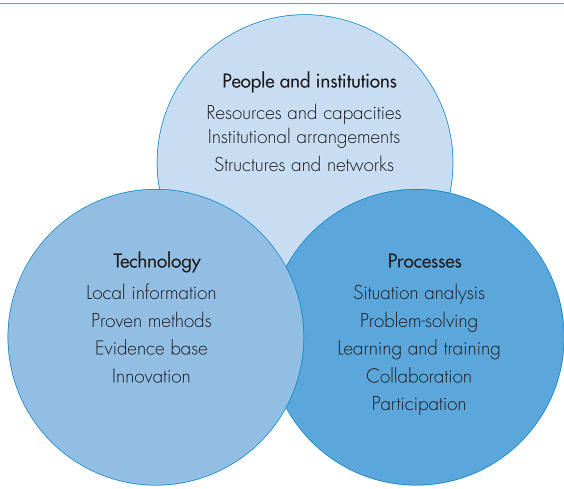
3. ORGANIZATION AND MANAGEMENT

This section indicates how IVM can be incorporated into and organized within health systems, and how partnerships and links for IVM with other public sectors and institutions can be established and managed.

IVM is not another programme; it is a management strategy in which existing systems are reoriented to make them more efficient, cost–effective, ecologically sound and sustainable. As described above, a new set of approaches is used: evidence-based decision-making, integrated vector control methods, addressing several diseases concomitantly, involving existing systems and ensuring the active participation of many partners. This strategy calls for a shift from centrally managed, sector-specific operations to facilitation of multi-partner programmes at local level (*19*). New roles, responsibilities and organizational link are therefore often needed for IVM.

As a general model, three basic components, each with sub-elements, can be identified in the management approach of IVM, as illustrated in *Figure 3.1*. The first element is the people and institutions involved in IVM; these consist of the existing resources and capacities, the institutional arrangements and the structures and networks between people and institutions. The second element is the new processes used in IVM, which are a situation analysis, a problem-solving approach and learning, training, collaboration and participation. The third element is the techniques used in implementing IVM, consisting of local information, methods of proven effectiveness, the evidence base and further innovation. In short, IVM involves optimizing use of these three elements. Some elements might be either inadequate or missing in conventional vector control programmes, so the current situation must be understood and the obstacles and challenges identified. For example, human resources and institutional capacity might require strengthening, the problem-solving approach might be weak, or opportunities for learning and participation might be lacking.

Figure 3.1 Model for managing integrated vector management (IVM), showing three main components, each with sub-components (the area in which all the components overlap indicates conditions suitable for IVM)



This type of analysis forms part of the comprehensive "vector control needs assessment" (*13*), which is summarized in *Box 3.1*.

Box 3.1 Vector control needs assessment

Situation analysis

- Policy framework (policy, plans and practices in the health and other relevant sectors)
- Structure, resources and functions (structure of vector control, integration into disease control programmes, information flow, human resources, infrastructure, financial resources)
- Vector control planning and implementation (major diseases, disease burden, main vectors, methods and strategies, pesticide management, costs)
- Intersectoral collaboration
- Community mobilization

Problem analysis,

- to identify the main constraints to vector control and their causes

Needs assessment

- Political commitment
- Policy requirements
- Requirements for institutional building
- Managerial requirements
- Requirements for technical capacity
- Required resources (human, financial)
- Awareness-raising and education

3.1 WITHIN THE HEALTH SECTOR

3.1.1 Central level

At central level, it is usually the health sector and its vector control units that take the lead in an IVM strategy; however, internal relations determine how vector control is organized, where operational decisions are made and whether vector control and emergency response are incorporated into single-disease programmes. There are two common scenarios. The preferable one is the existence of a substantive unit or core group for vector control at central level (national, state),[3] with a "cross-disease" mandate for optimal coordination. As health systems develop capacity for disease control, opportunities are created for the control of and emergency response to several vector-borne diseases. The less preferable scenario, which exists in a number of countries, is a disease-specific vector control unit attached to each vertical programme, campaign or externally funded project. In this scenario, it would be essential for the success of IVM to establish coordination and collaboration among the individual vector control units.
As discussed in *section 2.3*, a focal person for IVM should be appointed and a multisectoral steering committee established under the leadership of the health ministry at central level. Epidemiological and entomological expertise, epidemic preparedness and research links should also be coordinated at central level.

For implementation in the field, however, IVM adheres to the subsidiarity principle, which is consistent with health sector reform, involving decentralization of health services to district or local units, as discussed in *section 2*. In many countries, human resources

[3] According to a recent WHO survey, 69% of countries at risk for vector-borne disease have a national vector control unit or core group that is responsible for all vector control activities.

for disease control, including vector control, are not sufficient at decentralized levels. Therefore, the IVM approach is supportive of health sector reform.

In a decentralized system, the central ministry maintains an important role in IVM in terms of preparing policy and guidance, reviewing job descriptions and terms of reference, facilitating planning and implementation in districts, preventing and responding to epidemics and providing supplies and technical support. Decisions about implementation and associated management aspects of IVM, however, are transferred and established within health systems at district or village level. The core functions required for IVM at central and local levels are listed in *Table 3.1*.

Table 3.1 Core functions required to establish integrated vector management (IVM) at central and local levels

Level	Functions
National, subnational	Advocacy Setting strategic directions and conducting overall evaluation Advising on policy and institutional arrangements Conducting epidemiological and vector assessment, stratification Supervising decentralized planning and implementation Supervising decentralized monitoring and evaluation Supervising decentralized organization and management Preparing curricula and training trainers Ensuring preparedness to coordinate emergency response Advising on research priorities
District, village	Advocacy Establishing intersectoral partnerships and networking Planning and implementing local IVM strategy Implementing health interventions Monitoring and evaluating Organizing and managing Undertaking local vector surveillance Providing training, education and awareness-raising

3.1.2 Local level

IVM involves integration of disease-specific vector control programmes and surveillance services within a decentralized health system. This embedding of IVM in local health systems requires new skills and capacities for analysis and decision-making. It is not necessary for each district or health unit to have its own medical entomologist, which would be unrealistic in most settings. Nevertheless, public health staff in districts and villages could be trained in the technical, operational and managerial aspects of IVM, giving rise to local leadership of IVM. IVM could thus contribute to making health offices more capable and less dependent on centralized expertise, because it adds analytical and decision-making skills and contributes to partnerships with other sectors and communities.

The reach of health services will be extended through the new structures, partnerships and community participation in the IVM strategy, and this extended reach could result in cost savings and synergies. For example, vector control and vector surveillance activities in villages could become a platform for the delivery of other community health services. This brings health services closer to the community, and these changes will also increase the motivation and status of health staff.

When IVM is incorporated into decentralized health services, vector control becomes more sustainable, as it is less dependent on time-limited external programmes and is recognized by local decision-makers, therefore receiving regular allocations from local budgets.

A number of disease-endemic countries have vertical programmes within decentralized health systems; however, this does not preclude effective establishment of IVM. When the two systems operate side-by-side, effective coordination at district and local level is essential for establishing and maintaining an IVM strategy. For example, coordination could be established by involving the personnel of indoor residual spraying programmes at district and subdistrict levels with local partners at the same administrative level in analysing and making decisions on IVM, resulting in a consolidated implementation strategy and an appropriate division of tasks. The vertical programmes must allow flexibility in bottom-up planning according to local circumstances, with accountability to local leaders and representatives. Thus, vertical programmes could become valuable partners in a decentralized IVM strategy.

Indoor residual spraying programmes under the United States President's Malaria Initiative in several countries have begun to shift responsibility for certain elements of spraying to local authorities. Examples are the establishment of steering committees in districts, the involvement of district administrators and district health offices in situation analysis and local planning and building consensus among local stakeholders about implementation plans. Nevertheless, the programme itself is still responsible for the activities and coordination of spray teams.

3.2 INTERSECTORAL COLLABORATION

An IVM strategy calls for collaboration between the health and other sectors and civil society. This implies new links, roles and responsibilities, which may require changes in job descriptions or terms of reference. As discussed in *section 2*, sectors such as agriculture, local government, environment, construction and tourism, and communities may contribute to vector proliferation or put people at risk for infection. All sectors should be strongly encouraged to conduct a health impact assessment of their activities to identify any risks for vector-borne disease, in order to reduce the risks in each sphere, as discussed in *section 2.2.2*. For example, irrigation management and certain agricultural practices could reduce vector breeding; rural development programmes or construction projects could prevent vector breeding by adopting new standards or educating communities.

3.2.1 Establishing collaboration

Establishing formal collaboration between the health and other public sectors is an important step in increasing the participation of those sectors in vector control. As mentioned above, collaboration at national level could take the form of an intersectoral steering committee on IVM, with a memorandum of understanding. At district, subdistrict and village levels, intersectoral boundaries are less of an obstacle to collaboration. Nevertheless, intersectoral partnerships and collaboration should be backed by policy support.

Partnerships at district or subdistrict levels could include representation from both public sectors and civil society. Partnerships at village level usually consist of civil society organizations, community representatives and village leaders, but with insufficient representation of the public sectors. In order to achieve their vector control objectives in each sector, village-level partnerships should establish strong links with public sector offices and district authorities.

Before conducting IVM activities, most partners will require training in basic IVM, adapted to their roles, as discussed in *section 5*. The purpose of training is to give the participants the necessary knowledge and skills, increase their status and motivation and foster group or team spirit, which is needed to establish partnerships.

When formalizing a partnership, a shared vision should be agreed upon, the goals and scope of work of each partner defined and vested interests identified. The role of partnerships is to conduct joint planning, evaluation and mapping, to collaborate in implementation where appropriate and to comply with the agreed actions and timetables. The partnership conducts systems analysis and decision-making on vector control, as discussed in *section 4*, allocating tasks such as vector control interventions, awareness campaigns, education and vector surveillance, to ensure coverage and to avoid duplication. They would convene regularly to discuss progress.

The partnership, probably with the health office as its leading entity, must ensure that vector control activities are planned, implemented and evaluated in a coordinated way, to ensure that the joint efforts are consistent and complementary for achieving common goals. To reinforce the partnership, measures could be instituted to ensure that all partners adhere to the agreed standards and activities. Formal village-level partnerships should be recognized officially by district authorities and their actions recognized in the context of the national IVM strategy.

3.2.2 Roles and responsibilities

The vector control unit or a similar capable entity would have overall responsibility for the coordination and facilitation of the partnership and for training partners. It is essential that health staff acquire the skills to facilitate the partnership and guide its activities. Facilitation skills are not part of conventional training in the health sector and should be developed.

Other public sectors, civil society organizations and communities would also play roles in implementing the activities and in monitoring and evaluation. Individual entities should assume responsibility for the implementation of particular interventions or actions, as discussed in *section 4.5*.

Monitoring of activities by all partners and evaluation of the outcomes are critical for assessing overall progress and moving the partnership in the right direction. Monitoring and evaluation could be done by the partners themselves or by one partner monitoring the activities of another. Independent monitoring stimulates the accountability of partners for vector control and helps avoid biased results. The results of monitoring and evaluation could be used to adjust planning and implementation.

Technical support can be sought on issues such as disease epidemiology and medical entomology. In most disease-endemic countries, experts in these disciplines are available only at national or subnational level. As appropriate, regular visits of such experts should be arranged to districts and villages to assist in planning and evaluating local IVM strategies.

3.2.3 Management of pesticides

The management of pesticides in particular requires intersectoral collaboration. The issues involved in sound management of public health pesticides include legislative control, procurement, storage, transport, distribution, application, management of resistance, quality control and disposal. In many countries, the ministry of agriculture administers the registration of all pesticides, including those intended for use in public health. Hence, coordination on the requirements for public health is critical.

The use of pesticides in agriculture has important implications for public health, not only in terms of pesticide poisoning but also for vector-borne disease control, and in particular for malaria mosquito control. Pesticides used on crops such as cotton and rice affect immature malaria vectors and could select for resistance to insecticides. Of particular concern is the use of pyrethroids in agriculture, which has been associated with the development of resistance in malaria vectors. Pyrethroids are the only pesticide group available for use on insecticide-treated nets. Therefore, to ensure the continued effectiveness of vector control methods, coordination with the agricultural sector is crucial.

Several documents are available to guide countries in the management of pesticides. The International Code of Conduct on the Use and Distribution of Pesticides (*20*) provides standards to minimize potential risks to human health and the environment. Draft guidelines on pesticide management (*21*) and detailed guidelines on situation analysis of public health pesticide management (*22*) have been prepared by WHO.

3.3 OTHER LINKS

3.3.1 Research institutions

IVM must be guided by research in order to strengthen the evidence base for decision-making. Opportunities should be taken to build capacity for operational research within disease control programmes, as it is applied scientists who identify questions to be addressed by research. As there may be a lack of specialist skills, time and equipment within programmes, links should be formed with local, national and international research institutions. Strong links with research help ensure that the research institutions are targeting key problems in the field, thus increasing the applicability and use of research findings. Operational research conducted within programmes will help ensure shared use of human and logistic resources.

Links with research are built by actively involving research institutions in meetings, workshops and field visits on vector control operations. Consequently, research agendas and career development initiatives will be better adapted to the practical requirements of vector-borne disease control programmes. Funding agencies and donors should recognize research–implementation partnerships in their calls for research proposals and in awarding research grants. Basic research to design and test novel vector control techniques should also reflect problems in the field.

3.3.2 International cooperation

IVM implementation is expanding rapidly. In order to establish cooperation with other countries, international organizations and academic institutions, countries must establish and implement national IVM strategies. International or regional cooperation is useful for sharing expertise and accessing research findings. For example, through the Africa Network on Vector Resistance to insecticides, capacity for resistance monitoring is strengthened and results are shared. Another example is the Lusophone network on vector control involving Angola, Brazil and Mozambique. Existing networks could be expanded to share the local evidence base for decision-making, for example for vector identification, ecology and behaviour. The data could include the results of studies on the efficacy or effectiveness of vector control tools or combinations, and case studies of IVM implementation could be shared.

Cooperation and networking can be done through existing regional networks or through new international networks like the global IVM initiative, facilitated by WHO, and the Global Alliance for Alternatives to DDT, facilitated by the United Nations Environment Programme. These networks increase access to donor funding for IVM and allow sharing of web-based information and list-serves related to IVM. A global website on IVM has been set up by RTI International (www.ivmproject.net), which will have pages on evidence-based decision-making, advocacy and capacity-building. Similar websites could be initiated at regional and national levels to facilitate interaction and information flow.

3.3.3 Private sector, medical associations, media

Other stakeholders include the private sector, medical associations and the media. Each could play a role in implementation, evaluation or communication in an IVM strategy

3.4 MOBILIZING RESOURCES

The available resources should be used for transforming a conventional system of vector control to an IVM strategy. The new capacities, structures and activities of the IVM approach might require start-up funds for their establishment and recurrent funds for maintenance. Some funds might be available from the health sector, and further funds could be provided by other public sectors and the private sector or by external donors. Governments should be encouraged to contribute to IVM rather than relying on short-term donor assistance, to ensure national stewardship and the sustainability of the approach.

3.4.1 Resources from the health sector

In most countries endemic for vector-borne diseases, the health sector is underfunded, and funds to support IVM will not be readily available. IVM should be seen as a strategy for strengthening health systems, not as a separate programme with a separate budget line. Therefore, funds earmarked to support local health systems could become available for IVM as part of a strategy to increase the efficiency of overall disease control.

The IVM strategy will benefit the health system, government and society in several ways. Integrating the resources for disease-specific programmes into one strategy can result in cost savings, for example by combined interventions and joint monitoring and evaluation. The reach of other health services might be extended by combining them with IVM activities at community level, also contributing to more efficient use of resources. IVM could also benefit the health system by increasing the status and motivation of health staff, improving their analytical and decision-making abilities and partnerships with other sectors.

Careful assessment of the synergies and cost savings brought by IVM will help to gain sustained support from local authorities, with local allocation of funds for IVM.

3.4.2 Resources from other public sectors

Other public sectors, often with larger budgets than the health sector, can sometimes mobilize resources for the establishment and maintenance of an IVM strategy. As discussed above, the activities required to stimulate the interest of other sectors in IVM are a policy framework on IVM at national level and evidence of the importance of vector control or preventive measures to each sector through health impact assessments. Once these conditions are met, the stage is set for lobbying for support from the national budget and for allocations in other sectors. The ministries that might be involved in generating funds in their own sectors are those of finance, agriculture, environment, local government, commerce, development, infrastructure and tourism.

Production sectors often have substantial resources and take decisions with important implications for vector-borne disease. Their interaction and collaboration with the health sector could result in greater reach and more efficient delivery of vector control services. Civil society organizations, including international and local nongovernmental organizations, could also collaborate in generating funds for IVM, for example through revolving funds.

3.4.3 Resources from the private sector

Private sector funds have been used to support vector control in special economic zones, such as business zones, tourist areas, plantations and mining zones, where vector control helps avert lost work days, school absenteeism and medical costs due to vector-borne disease, thus increasing profits. Economic zones therefore provide an opportunity for mobilizing funds for an IVM strategy. Involving private sector entities in a health impact assessment, particularly with regard to vector-borne diseases, could assist in fund generation from the private sector.

Civil society organizations, including local clubs and associations, could also mobilize resources for IVM when the benefits on the approach are made clear to them. Communities, civil society organizations and various public or private sector agencies could make in-kind contributions, for example by adopting standards and norms for constructing housing and other buildings, placing drains and other sanitary measures that reduce the risk of vector-borne diseases.

3.4.4 External donor funding

Although funds may be made available for IVM from various sectors, external funding from donor agencies may be required in some countries endemic for vector-borne diseases, especially at the beginning. Initial funds will be needed to conduct a situation analysis and needs assessment, to train staff in IVM at each administrative level and to acquire technical resources for IVM. A start-up investment will facilitate transition from the conventional system of vector control to an IVM strategy. International networking, for example through the global initiative on IVM or through the Global Alliance for Alternatives to DDT, could leverage external funding for IVM.

3.5 INFORMATION MANAGEMENT

IVM is an approach involving evidence-based decision-making and problem-solving methods at all levels. Hence, purposeful information management is central to the overall approach. In an IVM strategy, various types of information are generated by different partners, such as through mapping, situation analysis, planning, monitoring of implementation, vector surveillance, evaluation of outcomes and evaluation of the transition of the system towards IVM.

Local partners should have ownership of the data they collect, because their primary use is to inform local vector control activities. Village-level data should also be used at national level to ensure a more comprehensive analysis and to verify the results against independent evaluations and surveillance data. Therefore, standard data formats should be used in villages. A centralized data management system will help the national ministry to provide appropriate guidance, corrective action and support for IVM to districts.

3.6 MONITORING AND EVALUATION

Organization and management must be monitored and evaluated to ascertain the progress made and to identify issues for further attention. *Table 3.2* lists indicators that could be used. A comprehensive framework for monitoring and evaluation is presented in *section 7*.

Table 3.2 Indicators of process and outcome for monitoring and evaluating progress in organization and management of integrated vector management (IVM)

Process indicator	Outcome indicator
Task force constituted to revise job descriptions and operating procedures	Number (and percentage) of targeted staff with job descriptions that make reference to vector control
Task force constituted to develop professional standards on vector control and public health entomology	Standards for professions and a career track in vector control and public health entomology in place

4. PLANNING AND IMPLEMENTATION

This section covers planning and implementing of IVM, including assessment of the epidemiological and vector situation of the country, analysis of local determinants of disease, selection of vector control methods, assessment of requirements and resources and preparation of locally appropriate implementation strategies. The importance of evidence for cost effectiveness and its parameters and the requirements of a vector surveillance system are also discussed.

To improve the efficacy, cost effectiveness, ecological soundness and sustainability of vector control, better informed decision-making about the course of action is required. Decision-making is therefore central to IVM, in relation to implementation, policy, capacity-building and advocacy. Decision-making necessitates inquiry and analysis and results in a choice or, in the case of IVM, a strategy.

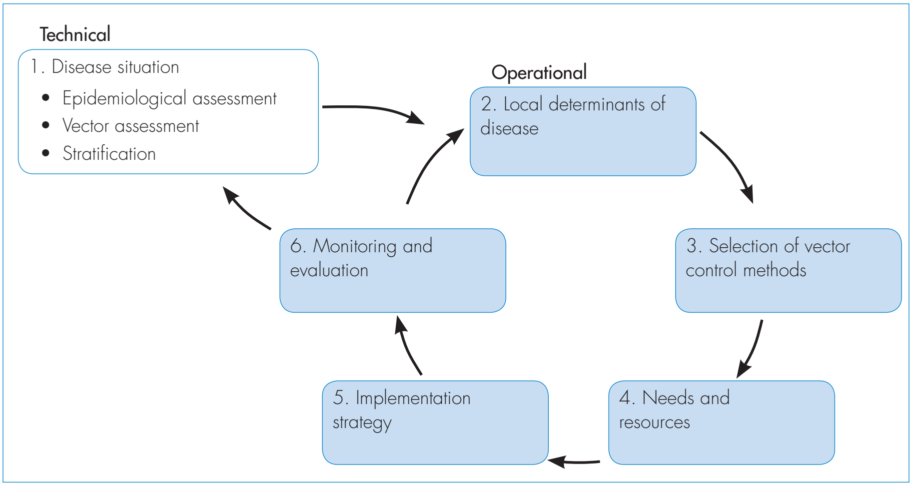
Various decisions must be made in planning IVM, such as the type of intervention, the targets and timing of interventions, management of resources and stakeholder participation (*Table 4.1*). Planning involves continuous adaptation of management choices to a heterogeneous and ever-changing environment.

Table 4.1 Questions to be posed in order to improve planning and implementation of integrated vector management

Aspect	Question
Targets	Which diseases and vectors will be the main targets?
	What are the main vectors?
Mapping	Will subsets of the human population be targeted?
	Which areas are at high risk for disease?
Methods	How can the risks for disease be reduced?
	Which vector control methods are available?
	Which interventions are optimal?
Participation	What contribution will local health services and other sectors make?
	How will communities participate?
Funding	How will the available financial and human resources be used?

Making decisions on any of these issues requires valid, accurate, locally specific information that is accessible to all parties involved. Examination of the questions in *Table 4.1* reveals a sequence for decision-making for IVM, as presented in *Figure 4.1*. Component 1, assessment of the disease situation, is largely technical, depending on the expertise of epidemiologists, entomologists and other trained personnel. As such specialized competence is usually available only at central level in most countries affected by vector-borne diseases, this component might have to be conducted at central level. Components 2–6 have an operational content, requiring the involvement of partners at district or village level in analysing the local situation, selecting options and assessing requirements.

Figure 4.1 Process of decision making in IVM, indicating a technical component and operational steps. The cycle suggests a continuous process of decision making in response to changes in local conditions of disease.



4.1 DISEASE SITUATION

Analysis of a vector-borne disease situation includes epidemiological assessment to determine the incidence and prevalence of all vector-borne diseases, vector assessment to determine the main vector species and their characteristics, and stratification to classify geographical areas according to the burden of vector-borne diseases, in order to guide the allocation of resources to the appropriate areas.

4.1.1 Epidemiological assessment

The first step in decision-making is to determine the burden of vector-borne diseases. This is fundamental for designing and evaluating strategies for vector control and provides the basis for policy formulation at national level. Data on disease should also be relayed to decision-makers at district and village level.

Measuring the burden of disease requires reliable, current data on disease incidence, prevalence and mortality, as well as information on work days lost, school days lost, seasonal variations, subpopulations affected, the proportion of outpatients affected and other issues. Information is needed for each vector-borne disease, with overlay mapping to identify areas in which two or more diseases coexist.

Data on disease are obtained by a combination of passive and active collection methods. Passive data are collected as records of disease diagnoses at health facilities and do not necessarily reflect disease trends in communities (*23*). These data are commonly available in a summarized form in annual reports. In passive data collection, however, cases that are not reported to health facilities are missed, and these might represent a substantial proportion of all cases. Active data collection is conducted during on-site surveillance, such as sampling for symptoms or evidence of pathogens in target populations. Active data collection is continuous and requires dedicated human and financial resources.

Whenever possible, links should be formed with the health management information systems that have recently been set up in many countries. These systems have markedly improved the estimates of disease burden at national and international levels. Furthermore, data are increasingly being made available at weekly or monthly intervals at district level. This reporting provides feedback to programmes and improves the decisions made locally.

An epidemiological assessment contributes to policy formulation and prioritization for individual vector-borne diseases. It is important, however, that diseases of lower priority not be dropped from decision-making at this stage, because it may be seen in subsequent steps that the vectors of diseases of lower priority could be targeted at the same time as those of the diseases of higher priority, making more efficient use of resources.

4.1.2 Vector assessment

Understanding the biology, ecology and behaviour of potential vectors is essential to planning vector control strategies and choosing the most effective methods. This requires the expertise of professional entomologists and other trained personnel, who convey their findings to decision-makers at national, district and village level. The assessment of vectors of disease comprises five aspects: their ecosystem, their role in disease transmission, their habitat and seasonality, their behaviour and their susceptibility to insecticides.

An ecosystem analysis is essential for identifying the diversity and habitats of vector species and the prevalence of diseases in a given ecosystem. The analysis is essential for designing and planning appropriate vector control interventions, as described in *Box 4.1*. Vectors often show clear differences in diversity, biology and disease transmission in, for example, coastal, riverine, savannah, urban, forest, agricultural, high-altitude and plantation ecosystems. Each type of ecosystem, and zone of bordering ecosystems, is usually home to its own species or complex of disease vectors. The way in which vectors exploit breeding habitats and feed are typical of each ecosystem type in each region (*24*).

Box 4.1 The ecosystem basis of integrated vector management[a]

- Irrigated rice ecosystems harbour a different set of vectors and diseases from forest ecosystems within the same region. Malaria could occur in both types of ecosystem but is commonly transmitted by separate vector species in each ecosystem and may occupy strikingly different breeding habitats. Some prefer sunlight rather than shaded areas or standing rather than streaming water for breeding, and vectors may have distinct strategies of host feeding, e.g. indoors rather than outdoors.
- An ecosystem may be inhabited by a number of vectors that transmit several diseases to humans. For example, malaria and Japanese encephalitis are all transmitted by mosquitoes that breed in rice paddies in South Asia.

[a] Source: Malaria: new patterns and perspectives (*24*)

The role of the vector in disease transmission should be ascertained under real-life conditions by studying the association of the vector species with its hosts (human, intermediate or alternative) in space and time, their direct contact with humans and evidence of pathogens inside the vector (*25*). Measurement of the rate of infection helps to distinguish between minor and major vectors, as described in *Box 4.2*. In the absence of disease, or at low disease prevalence, it may not be possible to confirm the ability of species to act as vectors locally. For identification of species, microscopic techniques based on morphological characters usually suffice; however, to differentiate between subspecies and strains of vectors (e.g. the *Anopheles gambiae* complex of malaria vectors), molecular techniques are required.

Box 4.2 Implication of vectors of disease: case study[a]

- In a study in a traditional dry-zone village in Sri Lanka, 14 species of Anopheles were found. There had been uncertainty about the relative contribution of the different species in the transmission of malaria.
- The population densities and seasonal trends of each species were studied. Parasite infection was detected in seven species, and the rate of infectiousness and the rate of feeding on humans were measured. From these parameters, the mean number of infective vectors was calculated as a measure of the transmission potential.
- Although A. culicifacies was fifth in abundance, it was the species responsible for most infective vectors of malaria. A. vagus which was more common but had a stronger preference for feeding on animals, was a distant second, and A. peditaeniatus ranked third.

[a] Source: Malaria vectors in a traditional dry zone village in Sri Lanka (*26*)

The seasonal occurrence of vectors is closely linked to the ecosystem type and climatic conditions. Therefore, the habitats and seasonality of vectors must also be understood. Most vector species have relatively unique associations with their habitat. For example, larvae of malaria vector species may occupy different breeding habitats, some preferring sunlight and others shade or standing rather than streaming water.

Vector behaviour has implications for the risk for pathogen transmission and, consequently, for selection of the appropriate interventions to reduce transmission. The diurnal and nocturnal feeding patterns of some vectors, like mosquitoes, should be studied. Certain mosquito species feed predominantly outdoors, whereas others are adapted to feed indoors where people sleep, thus affecting the effectiveness of, for example, the use of insecticide-treated nets, repellents and house improvements. The preferred harbourage, including the resting sites of flying vectors, should be known, because these are potential targets for control procedures, including the application of residual insecticides. The preference of vectors for feeding on human rather than animal hosts should be ascertained.

Few insecticides have been recommended for insect vector control, and there is a constant risk that vector populations will develop resistance to the pesticides being used. For mosquitoes, the standardized WHO protocol is recommended for testing and monitoring their susceptibility to insecticides (*27, 28*). Susceptibility to insecticides must be monitored regularly wherever insecticides are used in vector control, in order to detect the development of resistance or reduced efficacy at an early stage.

4.1.3 Stratification

In the context of disease control, the term “stratification” refers to the classification of disease-endemic areas by their epidemiological and ecological characteristics. Hence, stratification is conducted to identify areas in which different approaches to disease control are indicated (*29, 30*).

Stratification can range from basic to very complex. In its basic form, stratification is conducted to differentiate between areas with different incidence rates of a disease within a country, in relation to population census data. For instance, the WHO Global Malaria Programme uses stratification to differentiate provinces or districts according to four levels of malaria endemicity: with 100, 1–100, <1 and 0 cases per 1000 population per year (*31*). Overlay maps of individual vector-borne diseases assist in identifying areas in which more than one disease occurs.

Disease incidence is commonly stratified according to the borders of administrative units, not along the iso-lines of disease incidence. For example, district A may be given an incidence of 1 and district B an incidence of 4, even though the incidence within each district is not uniform. The main reason for using administrative borders is that control activities are usually organized by administrative unit. Another reason is that detailed data on vector-borne disease incidence by district are usually not available in affected countries.

An important function of stratifying disease incidence at national level is to provide information for allocation of the national budget to lower levels of administration. Hence, disease control programmes can be planned according to the disease prevalence in a district. Districts with a high prevalence require a different approach from that for districts at risk for epidemics.

In a more complex form of stratification, additional variables are incorporated. Ecological characteristics such as vegetation and altitude can be used to stratify areas according to the presence of known vectors and associated disease. Computer-aided geographical information systems, including remotely sensed images and portable geographical positioning devices, are helpful in stratification, and investment in capacity-building for use of these tools might be warranted.

Certain vector control interventions, such as the use of insecticide-treated nets for malaria control, are applicable in wide-ranging circumstances. For such interventions, a simple stratification process would probably suffice. Other interventions or preventive strategies can be strongly affected by local variables. The main determinants of vector-borne disease are usually not uniformly distributed, showing heterogeneity across the local landscape (e.g. due to concentrations of human habitation or of a vector breeding habitat). Determinants are therefore more appropriately mapped at lower levels of administration, also known as "micro-stratification". This topic is discussed in *section 4.2*.

4.2 LOCAL DETERMINANTS OF DISEASE

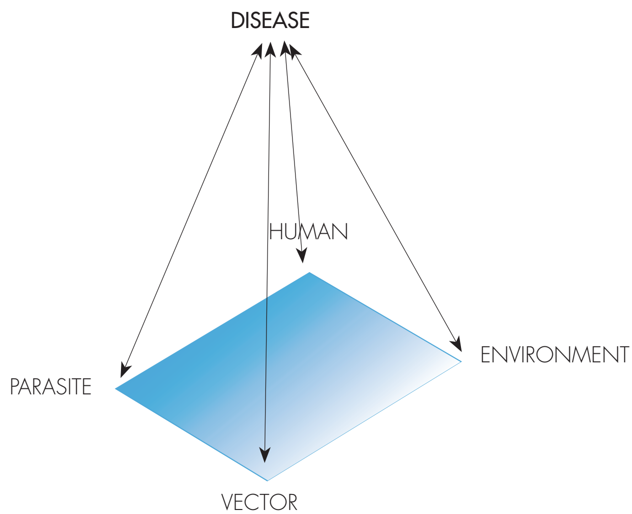
After a technical assessment of vector-borne disease at national level, the operational steps in decision-making are identified. As pointed out earlier, the technical assessment requires study by a team of experts, whereas the operational steps are more appropriately conducted at local level. From this phase onwards, it is crucial that local stakeholders, such as individuals, health workers and local authorities, participate in analysing local conditions and making decisions on vector control.

A number of risk factors, or "determinants of disease", determine the spread of vector-borne disease. It is important that all of the determinants of disease be understood, to ensure a comprehensive approach to disease prevention and for appropriate action to disease control.

4.2.1 Identifying the determinants

An entomological analysis identifies the local determinants of the transmission and prevalence of vector-borne disease. The determinants are related to the parasite, the vector, human activities and the environment, as illustrated in *Figure 4.2*. Vector-borne disease control programmes usually focus on the parasite and the vector; however, if human and environmental determinants are ignored, people will continue to be at risk for infection and the vectors will continue to proliferate in the environment.

Figure 4.2 The parasite, vector, human and environment depicted as four categories of determinants of vector-borne disease (arrows indicate interrelationships)



The answers to the following questions will help in identifying local determinants of disease:

- Parasite-related determinants: Which parasites or pathogens cause disease? What is the status of insecticide resistance? The answers to these questions should be provided by epidemiologists, as discussed in *section 4.1.1*.
- Vector-related determinants: Which are the main local vectors? Where and when do the vectors breed? What are the local densities and fluctuations of the vectors? What are the characteristics of the vectors? The answers to some of these questions should be provided by entomologists, as discussed in *section 4.1.2*, although some questions could be answered by using data from locally conducted vector surveillance.
- Human-related determinants: What is the distribution and structure of the population? Where do vulnerable groups live? Which populations live close to the vector breeding habitat? Where do people meet? What are the patterns of population movement? What are local practices and attitudes towards vector-borne disease? What are the domestic conditions of the population? What is the income of the population? Do people serve as a reservoir of disease? What is their access to treatment? How

effective is the medication they receive?

- Environment-related determinants: What are the rainfall patterns? What are the local ecosystems? How is land used? What is the extent of the aquatic breeding habitat? Are alternative hosts of the pathogen present?

Most of the required information can be collected through local surveys, interviews and participatory exercises. For some aspects, such as vector characteristics and disease parasites, national or subnational expertise and support will be needed, as mentioned above.

4.2.2 Mapping the determinants

Participatory mapping of the determinants is valuable for determining those locations in which there are risks for vector-borne disease and those in which they are greatest. The variables that might be considered in overlay mapping are where people live, the patterns of their movements, infrastructure (e.g. roads, locations of aggregation and schools), vector breeding sites, locations of service providers (e.g. health facilities, district and municipal offices, community clinic), land use, vegetation and water bodies.

By involving local stakeholders, with hand-drawn maps (*Figure 4.3*), participatory mapping results in detailed data for districts or villages. This will allow more precise selection and targeting of vector control. The exercise, called "micro-stratification", can be enhanced by additional information, such as existing maps, geographical information systems and remotely sensed data. Information can be obtained from documents, records, censuses, surveillance data, special studies or interviews, for example, by close collaboration with local leaders and community members.

Figure 4.3 Example of participatory mapping for planning an integrated vector management strategy at village level

Source: ACTMalaria Photo Gallery, 2010

In addition to mapping, a temporal analysis is often useful. This involves construction of a "seasonal calendar" to identify the periods of increased risk for vector-borne disease. This exercise is suitable at district and village level, with the participation of communities. Aspects that could be included in a seasonal calendar are: the timing of peaks of disease incidence, when people move and timing of the main agricultural activities (e.g. planting, harvesting, or movements of livestock).

4.2.3 Tackling the determinants

A local analysis of determinants of vector-borne disease helps to understand in detail where and when the risks for vector-borne disease occur. For example, the analysis could show that communities living at the edge of a village in marginal land or near a flood-prone area are at high risk for infection. This would provide a basis for identifying the options for reducing the risks.

Most determinants can be influenced by human intervention, for example, through vector control, personal protection, environmental management or a change in behaviour or living conditions. Risk factors such as rainfall patterns obviously cannot be controlled.

Many determinants of disease are outside the scope of conventional programmes for vector-borne disease control, such as irrigation systems, urban development, sanitation, and housing. These call for the involvement of other health divisions, other sectors and local communities.

4.3 SELECTION OF VECTOR CONTROL METHODS

4.3.1 Available methods

Vector control methods should be selected from a list of the available methods. Certain

Table 4.2 Methods used to control vector-borne diseases

Category	Question	Chagas disease	Dengue	Trypanosomiasis	Jap.encephalitis	Leishmaniasis	Lymphatic filariasis	Malaria	Onchocerciasis	Schistosomiasis	Trachoma
Environmental	Source reduction		+		+		+	+			
	Habitat manipulation						+	+		+	
	Irrigation management & design				+			+	+	+	
	Proximity of livestock				+			+			+
	Waste management						+				+
Mechanical	House improvement	+			+	+		+			
	Removal trapping		+	+		+					
	Polystyrene beads						+				
Biological	Natural enemy conservation		+		+			+		+	
	Biological larvicides		+		+		+	+	+		
	Fungi										
	Botanicals		+					+			
Chemical	Insecticide-treated bednets	+			+	+	+	+			
	Indoor residual spraying	+				+		+			
	Insecticidal treatment of habitat		+	+			+	+	+		
	Insecticide-treated targets			+							
	Biorational methods		+					+			
	Chemical repellents					+	+	+			

vector control methods are of known efficacy in particular settings (*32*). *Table 4.2* lists the vector control methods and their applicability to each vector-borne disease; however, methods must also be assessed locally.

The four general categories of vector control are: biological, chemical, environmental and mechanical. Most methods can be used to control several different diseases, so that their application is useful when several diseases coexist in the same environment. For example, insecticide-treated nets protect against Japanese encephalitis, filariasis and malaria in areas where these diseases occur together, e.g. in rice cropping systems in South Asia.

In the case of mosquitoes, the larvae are easier to control than adults because they are confined to water bodies. Therefore, wherever practicable, removing water, called "source reduction", should be a primary consideration in mosquito control.

Most non-chemical methods require the participation of communities or other sectors (e.g. to implement environmental management or to improve houses). Some methods, such as use of fungi and genetic methods, are still at an experimental stage. Microbial larvicides, such as *Bacillus thuringiensis israelensis*, are increasingly used for larval control of mosquitoes instead of chemical insecticides, because they are safe for humans and the environment.

The main methods used for reducing vector transmission in malaria mosquito control are insecticide-treated nets and indoor residual spraying, which reduce vector density and longevity. Insecticides also have repellent and irritant effects, however, which limit their killing effect. Space spraying is not usually included in the list of options because it is recommended only in emergency situations to prevent or suppress outbreaks of dengue. Even though space spraying has a clear psychological effect on people in disease outbreaks, the residual effect is limited, the timing of spraying is a major obstacle, the operational costs can be high, and it may have adverse effects on human health and the environment.

4.3.2 Selection criteria

Each vector control method has its advantages and disadvantages, and an appraisal of methods guides selection of the most appropriate one for the local context. The appraisal covers the aspects of effectiveness, human and environmental safety, risk for development of resistance, affordability, community participation and policy and logistic support.

Some methods, such as source reduction to prevent vector breeding, may be moderately effective but affordable with the active participation of communities. Other methods, such as indoor residual spraying, may be effective against malaria and have strong logistic and policy support at national level but may carry risks, such as the development of resistance. Evidence on local vectors (i.e. species, ability to transmit disease, breeding habitat, behaviour and susceptibility to insecticides) should be used to select the most effective interventions.

Obtaining accurate information on the effectiveness of interventions in terms of reducing the incidence of disease is crucial. Insecticide-treated nets and indoor residual spraying have been relatively well studied, and both show high cost effectiveness in controlling malaria in various settings. Although the effectiveness of other methods in reducing vector populations or disease transmission has been studied, their effectiveness in reducing disease prevalence has received less attention.

Data on the effectiveness of combinations of methods is just starting to become available, and two examples showing complementary effects of interventions on human health are shown in *Box 4.3*.

Box 4.3. Case examples of use of different methods of vector control.

In rural villages in the Bolivian Amazon, in an area where vector mosquitoes feed in the early evening, the effectiveness in reducing malaria of insecticide-treated nets and an insect repellent was compared with that of insecticide-treated nets alone. People from a large number of households were randomly assigned to one of the two treatments in a double-blind, placebo-controlled randomized control trial.

The group that used nets in combination with repellents had an 80% reduction in episodes of *Plasmodium vivax* malaria relative to the group who used nets only. Also, the reported episodes of fever were reduced by 58% in the group that used the combination. Therefore, insect repellents can provide additional protection against malaria when combined with insecticide-treated nets. This has important implications in malaria vector control programmes in areas where disease vectors feed in the early evening.

[a] Source: Plant based insect repellent and insecticide treated bed nets to protect against malaria in areas of early evening biting vectors: double blind randomised placebo controlled clinical trial in the Bolivian Amazon (*33*)

Complementary effect of larval control in combination with insecticide-treated nets[a]

The contributions of microbial larvicides and insecticide-treated nets in reducing malaria incidence were studied in an area moderately endemic for malaria in the western Kenyan highlands. Larval control was undertaken in three selected villages, which were compared with three control villages. After baseline data had been collected, the Government supplied insecticide-treated nets to all villages. Larval control consisted of weekly applications of Bacillus-based larvicides to vector breeding habitats over 19 months. Larval and adult vector populations were surveyed weekly, and the incidence of Plasmodium infections in children aged 6 months to 13 years was measured during the long and short rainy seasons each year.

Both interventions substantially reduced the risk for infection in children. It was estimated that use of insecticide-treated nets reduced the risk by 31%, and larviciding reduced the risk by an additional 56%. Hence, the microbial larvicides provided substantial additional protection against malaria. Larval control is thus a promising complementary intervention to insecticide-treated nets, at least in highland settings in Africa.

[a] Source: Integrated malaria vector control with microbial larvicides and insecticide-treated nets in western Kenya: a controlled trial (*34*)

The use of insecticides in public health and agriculture contributes to the development of resistance in disease vectors, which is a particular problem in view of the limited choice of public health pesticides. Moreover, chemical pesticides pose risks to human health and the environment.

Community participation is a key aspect of the effectiveness of most, if not all, vector control methods. Participation ranges from adherence to interventions, such as indoor residual spraying, to active involvement in environmental management. Community participation is often critical for achieving coverage and for the sustainability of control activities.

Affordability is another consideration in selecting vector control methods. Affordability refers not only to national or decentralized budgets allocated to health, but also to the contributions of other sectors and the willingness of communities to invest time and resources.

Finally, the level of logistic and policy support must be taken into account in the selection and planning of local interventions.

Control operations are not mutually exclusive and should be combined whenever possible. In selecting combinations, the methods should be compatible and complement each other's effect. For example, when combining indoor residual spraying and insecticide-treated nets, the choice of insecticides is critical for delaying the onset of resistance. Selection of vector control methods requires making trade-offs among competing objectives related to health, society and the environment (*35*).

Table 4.3 shows an appraisal of vector control methods in the case of malaria. Because appraisal and selection involve technical, managerial and social factors, it is imperative that all relevant stakeholders participate.

Table 4.3 Use of selection criteria for vector control methods against malaria

Category	Question	Effectiveness	Safety	Risk for resistance	Community participation	Affordability	Logistic and policy support	Selected methods*
Environmental	Source reduction	±	+		+	+		+
	Habitat manipulation	±	+		±	±		
	Irrigation management and design	±	+		+	±		
Mechanical	House improvement	+	+		+	–		+
Biological	Natural enemy conservation	±	+	+	+	+		
	Biological larvicides	±	+	+	+	–	±	
	Botanicals		±	+	+	+		
Chemical	Insecticide-treated bednets	++	±	–	+	–	+	+
	Indoor residual spraying	++	±	–	–	–	+	
	Insecticidal treatment of habitat		–	–	–	–		
	Chemical repellents	±	±			±		

++, highly applicable; +, applicable, ±, partly applicable; –, not applicable

* "Selected methods" refers to the vector control methods that have been selected based on the selection criteria in this hypothetical example.

4.3.3 Multiple diseases

When several vector-borne diseases occur together in the same area, decision-making should include an additional step. Decisions must be made not only on the vector control methods to be used for each disease but also on the relative importance of each disease. Where there are several diseases in the same area, opportunities to use synergistic effects must be identified. Thus, vector control could target more than one disease, including low-priority diseases, which, on their own, would not justify the control effort. An example is given in *Box 4.4*. A simple hypothetical situation in which there are three local diseases with three main vectors is shown in *Figure 4.4*. The available methods are identified for each disease. In the final selection, an optimal combination of methods is chosen to cover the entire complex of vector species.

Box 4.4 Case example: Evaluation of vector control methods for more than one disease[a]

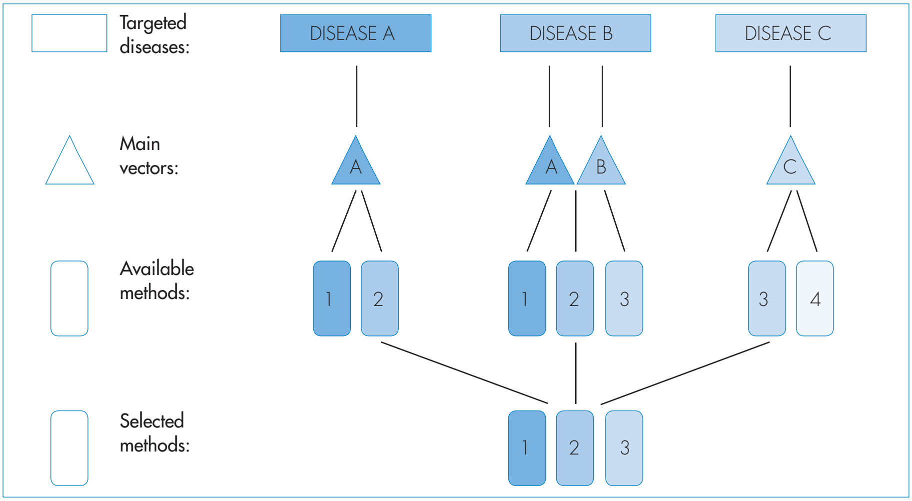
In a study in Colombia, the efficacy of using permethrin-impregnated uniforms for preventing malaria and leishmaniasis was determined in soldiers on patrol. In this double-blinded randomized study, soldiers were issued impregnated uniforms or uniforms washed in water.

Malaria was contracted by 3% of the soldiers wearing impregnated uniforms and 14% of those wearing control uniforms; the difference was significant. In the study of leishmaniasis, 3% of soldiers wearing impregnated uniforms and 12% of soldiers wearing control uniforms acquired the disease; the difference was highly significant.

It was concluded that the intervention provided protection against both malaria and leishmaniasis.

[a] Source: Efficacy of permethrin-impregnated uniforms in the prevention of malaria and leishmaniasis in Colombian soldiers (*36*)

Figure 4.4 Theoretical example of selecting methods against multiple diseases and their vectors. Three diseases are targeted which are transmitted by three vectors; four vector control methods are available of which three are selected to provide the best use of resources.



4.4 REQUIREMENTS AND RESOURCES

When the locally appropriate vector control methods have been selected, an inventory should be made of the financial, human and technical resources available for vector-borne disease control at local level. The organizational structures in which the resources could be used should also be assessed.

The inventory of resources and organizational structures requires the participation of local stakeholders. Possible links and collaboration with other local programmes or government services should be discussed, so that activities are coordinated in order to ensure consistency and avoid duplication. The potential resources include those received from national programmes for vector-borne disease control, district health offices, local government and other public sectors, the private sector, civil society organizations and the community. National implementation plans in accordance with the Stockholm Convention also provide a possible source of funding for vector control activities, according to national priorities.

The amount and type of resources depend on the diseases and vectors targeted. For example, vectors that breed predominantly in irrigated agriculture require strong engagement from the agriculture sector, whereas vectors that breed in the peri-domestic environment might require community participation in the removal of breeding sites. The methods selected for vector control also have implications for the types of resources needed. For instance, indoor residual spraying requires trained spraying teams under proper supervision, which often demand substantial financial and logistic support.

Local requirements for capacity-strengthening should also be identified. The role of community members, community health workers and agricultural extension workers could be enhanced relatively quickly by practical short courses on vector biology, ecology and control methods. The experience of the agricultural sector in training farmers in integrated pest management could be used, as discussed in *section 5.3.4*.

4.5 IMPLEMENTATION STRATEGY

In previous steps, the local ecology and epidemiology of vector-borne diseases were mapped, appropriate vector control methods were selected, and the available resources were assessed. Now, a local strategy for implementing and maintaining vector control can be formulated, which might be composed of targets, activities, roles and responsibilities. As in the previous steps, the participation of stakeholders in devising the strategy is essential.

Any strategy should be responsive to changes in local ecological and epidemiological conditions. Therefore, decision-making, discussed in this section, is not a one-time procedure but should be conducted regularly in order to adapt the strategy as needed. *Table 4.4* gives an example of a situation in which three vector control methods were selected to control malaria and dengue.

Table 4.4 An integrated vector management strategy in a hypothetical situation with targets to control the prevalence of malaria and dengue

	Vector control method			
	Source reduction	Management of wetlands and drains	Insecticide-treated bednets/materials	Irrigation management
Vectors targeted	*Aedes, Anopheles,*	*Aedes, Anopheles,*	*Anopheles, Aedes*	*Anopheles*
When to implement	Year-round but intensified during rainy season	According to cropping season	Continuous	According to periods of rainfall; frequently
Where to implement	Residential areas, streets, markets, woodlands	High-risk areas, wasteland and drains around village	80% of houses within reach	70% of fields under irrigation around village
Who should implement	Communities, local government, ministry of the environment, community health workers, schools	Ministry of the environment, local government, health workers, communities	Nongovernmental organizations, health officers	Farmers' associations, extension officers, local government, community health workers
Responsible body	Health office	Local government	Health office	Agriculture office
Who should monitor and evaluate	Local government	Health office	University	Health office

Setting impact targets, timelines and milestones is essential for planning and implementing a control strategy. The targets should be specific reductions in impact indicators that must be achieved by a certain time. The indicators can include changes in human behaviour or attitudes, vector density, infection rate, transmission rate, parasite prevalence and morbidity and mortality from the disease. Monitoring and evaluation are necessary to establish and confirm whether the targets are being met. Intermediate targets can provide direction during implementation of a strategy. It is important that the targets be consistent with national targets for vector-borne disease control.

The issues to be taken into account in planning vector control are: the target vectors, the timing of implementation, the areas of implementation, the entities involved in implementation and the entities responsible for implementation and external monitoring and evaluation.

4.5.1 Target vectors

Against which vector species and which diseases are the interventions targeted? Some interventions can be used only against specific vectors, whereas others might be effective against several species. This is particularly relevant when several vector-borne diseases coexist.

4.5.2 Timing of implementation

What is the appropriate timing for each vector control method in order to achieve the maximal effect? The timing depends not only on the type of method but also on local conditions. The appropriate timing of methods for environmental management could be the onset of the rainy season, when a new breeding habitat is created, potentially increasing transmission of disease. The appropriate timing might be the dry season, when breeding sites are limited and vector populations are most vulnerable to control measures and vector control can interrupt the cycle of disease transmission. Residual insecticides should be applied before the onset of the transmission season and might have to be reapplied, depending on the length of the transmission season. Use of long-lasting insecticidal nets usually does not need timing, because of their long-lasting effect, although campaigns for bednet use should be conducted before the onset of the transmission season.

Some interventions must be repeated frequently. Reducing the populations of some species of Aedes mosquitoes, which breed in small collections of water, requires frequent interventions when the breeding sites depend on rainfall. Chemical and biological larvicides last only a few weeks at most, after which vector breeding can resume. The frequency of indoor residual spraying depends on the residual action of the insecticides on surfaces that can be sprayed and on the length of the transmission season. Long-lasting insecticidal nets are designed to last for 3–5 years, but conventionally treated nets require regular retreatment. The timing and frequency of vector control also depend on human activities that create vector breeding habitats, such as brick-making, gem mining and road construction.

4.5.3 Areas of implementation

In which locations or areas should interventions be targeted so that the available resources can have the maximum effect? Priority could be given to vulnerable groups, to geographically isolated groups with poor access to health services, or to groups living on marginal lands or near vector breeding habitats. Sustaining high coverage with interventions can be costly and could increase the risk for resistance to insecticides. Once transmission reaches low levels, however, the main interventions might be scaled down, the remaining interventions targeting only those locations at high risk for transmission, combined with active case detection.

4.5.4 Entities involved in implementation

Which partners should play a role in implementing each vector control method? Vector control activities could involve promotion, awareness-raising, social marketing or procurement and distribution of insecticide-treated nets by the district health office or indoor residual spraying by central or decentralized spray teams. Nonetheless, other partners, such as communities, schools, the private sector and public sectors such as agriculture, construction and local government also have important roles in planning and implementing vector control and personal protection. For example, community participation can be crucial for source reduction. Vector control can also involve drainage and sanitation by the local government, maintenance of wastelands by the environment ministry and management of irrigation systems by irrigation authorities and farmers.

4.5.5 Entities responsible for implementation

Which entity assumes responsibility for the implementation and maintenance of each intervention? The health sector has conventionally been responsible for vector control, and interventions that require strong logistic support, such as indoor residual spraying, usually require the specialist skills and capacity of the health sector. Government offices other than health can and should, however, share the responsibility for certain vector control methods or certain areas. For example, environmental management in agricultural areas, irrigation systems, construction sites, waterways and periurban areas could be administered by the agriculture, irrigation and environment sectors and local government. In special economic zones such as plantations, mines and tourist areas, the responsibility might be placed with the private sector, with oversight from the ministry of health. Thus, the responsibility would not rest on the health department alone.

The involvement of multiple stakeholders in vector control requires a functional organizational structure for effective coordination of activities, to ensure that the joint efforts are consistent and have common goals. This structure would be additional to the national steering committee and focal person on IVM (see *section 3*). The local organizational structure could be a committee or task force on IVM at district level, with broad participation of stakeholders, including community members, as discussed in *section 3.2.1*.

4.5.6 Entities responsible for monitoring and evaluation

Local partners should monitor and evaluate the implementation and maintenance of their activities to identify shortcomings and suggest remedial action. Monitoring and evaluation conducted by an external agency (governmental or nongovernmental) is likely to increase accountability for vector control and help to ensure unbiased results, as discussed in *section 7.2.4*

4.6 GENERATING AN EVIDENCE BASE

Continued strengthening of the evidence base for vector control is essential to improving and adapting decision-making in the context of an IVM strategy. The evidence base is the synthesized knowledge about the effectiveness of interventions in a particular setting, and its purpose is to inform decisions on vector control and resource allocation. A systematic approach to generating evidence is required. Knowledge about the characteristics of disease vectors remains fragmented because of the variety of vector species and the number and variety of the determinants of the effectiveness of interventions.

4.6.1 Types of evidence

Broadly speaking, two categories of evidence can be distinguished for establishing or maintaining IVM. First, evidence is needed on the effectiveness and costs of interventions. Secondly, evidence is needed on the parameters that determine the effectiveness of interventions.[4]

Determining the cost effectiveness of interventions can be demanding, because it often requires large-scale trials in the human population. The financial and technical resources required for such trials are beyond the reach of most vector-borne disease control programmes. Moreover, information on effectiveness does not explain the underlying reasons for the observed effects or the lack thereof. Parameters that determine effectiveness can differ according to location, and the results of trials in one location might not be applicable in another.

Vector-borne disease control programmes should prioritize studies of parameters that determine the effectiveness of interventions rather than studying effectiveness per se. For example, before studying the effectiveness of indoor residual spraying on the prevalence of malaria or lymphatic filariasis in a certain location, studies should first be conducted to determine whether the local vector rests indoors, whether the vector is repelled by the insecticide used and whether people leave the sprayed surfaces intact. Evidence about these parameters could significantly improve decision-making on vector control.

Various relevant determinants can be identified in relation to the parasite (or pathogen), the vector, human factors and environmental factors (see example in *Box 4.5*). The status of the parasite has implications for the role of vector control in the disease control strategy. For example, if the pathogen is resistant to drugs or no effective medication exists, disease prevention and control rely solely on vector control.

A number of vector determinants can affect operations. Some require detailed study by entomologists, such as identification, infection rate, human blood index, daily activity pattern, survival, indoor feeding, indoor resting and susceptibility to insecticides. Others can be studied by nonspecialists, including habitats, seasonality of populations, density, human contact and biting rate. The determinants must be monitored regularly to update changes in vector behaviour or susceptibility to insecticides. These vector-related determinants are essential for specific purposes, for example to determine vector status or to select, time or target vector control. Human parameters include personal protection behaviour, compliance with interventions, sanitation, hygiene and housing conditions.

[4] A third, more general category of evidence at system level is the efficacy, cost effectiveness, ecological soundness and sustainability of the IVM approach compared with the conventional system (described in *section 7*).

Box 4.5 Case example: Studying the determinants of dengue vector breeding[a]

A research programme was conducted in six countries in South and Southeast Asia to investigate the ecological, biological and social determinants of dengue vector breeding in urban and periurban areas, and to develop community-based intervention programmes aimed at reducing dengue vector breeding and viral transmission. The sites undertook a situational analysis to characterize and map the urban ecosystem, vector ecology, the social context, and community dynamics.

The situational analysis identified productive container types (i.e. those producing a large proportion of adult mosquito vectors), social and environmental risk factors favouring vector breeding, variation of vector ecology in the dry and wet season and in public and private spaces and developed recommendations for appropriate interventions. The most productive vector breeding sites were found to be outdoor water containers, particularly if uncovered, beneath shrubbery and unused for at least one week. Pupal production was associated with areas of high human density and with the presence of public spaces (e.g. schools, religious facilities).

Household surveys indicated that people's knowledge about dengue and its transmission was negatively associated with vector breeding. Analysis of prevailing practices by communities and public service providers highlighted a number of shortcomings in vector control. In spite of extensive dengue-related national and local guidelines, most vector control interventions were limited to space spraying and selective larviciding in situations of local outbreaks and increased case incidence.

The data obtained were used to design and implement site-specific vector control strategies by using a participatory problem analysis to build consensus on intervention approaches. The programmes had varying impact on vector densities and led to significant outcomes at community level, with the formation of community groups with broad environmental hygiene and sanitation interests. The findings have significance and relevance for defining efficient, effective and ecologically sound vector control needs based on local evidence.

[a] Source: Eco-bio-social determinants of dengue vector breeding: a multicountry study in urban and periurban Asia (*37*) [on the situation analysis during Phase 1 of the research]

4.6.2 Strengthening the evidence base

At country level, strengthening the evidence base on vector control starts with the collection and review of data on all relevant parameters, including the characteristics of the parasites and vectors, human behaviour, attitudes and domestic conditions, and environmental conditions. Surveillance activities will help fill gaps in the existing data and increase local representivity. Some surveillance activities will produce data relatively quickly for parameters that do not require specialized study; however, a number of parameters require study by experts, as discussed above. Identifying the priorities for specialized study is important, because technical resources are generally in short supply.

Information on the characteristics of parasites (e.g. drug resistance) and vectors (e.g. feeding behaviour) should be compared with similar information from other countries in the region. Such regional exchange can result in sharing of methods and technical resources between neighbouring countries, as in the network in the African Region on vector resistance to insecticides, for harmonizing methods, strengthening capacity and building a regional database on resistance to insecticides. Regional networks could therefore be instrumental in building an evidence base on all parameters of relevance to vector control. This approach could begin with the construction of a database of available information to establish what is known, what research methods were used and the strengths and weaknesses of each study.

At the international level, reviews or meta-analyses of studies on vector species or parameters are needed to assist in identifying priorities for research. Initiatives by individual research institutions should be coordinated. Standardized or harmonized methods would increase the consistency of the data and facilitate comparisons between countries. Furthermore, reviews or meta-analyses are needed on the effectiveness of vector control methods in reducing vector populations, transmission intensity and disease incidence.

A strong evidence base is no guarantee of good decision-making. Local decision-makers must have access to the results of surveillance and research activities. They also need the capacity to interpret and use those results in making decisions. Hence, the results of surveillance and research must be documented and sent to the national IVM steering committee and local partners in IVM. Guidance should be given from the national level to local decision-makers on how to interpret and use the new results and how to extrapolate the results to comparable situations. The results should also be communicated to regional and global working groups to be added to their databases.

4.7 VECTOR SURVEILLANCE

Vector surveillance is systematic monitoring of the seasonality and abundance of vector populations. The functions are twofold: response and evaluation. Vector surveillance is used to ensure appropriate, timely responses with vector control interventions; it is also used for evaluating the effect of vector control.

Various possible methods are used to sample vector stages in surveillance, including direct collection, animal-baited traps, human landing catches, entry and exit traps, spray-sheet collections and laboratory techniques (*38, 39*). Each method has its strengths and weaknesses, and a combination of methods is often preferable. Other methods are available for sampling non-mosquito vectors. Additional characteristics of the vectors are often added to a surveillance system, including species composition, vector behaviour, infectivity rate, parous rate and susceptibility to insecticides. Routine monitoring of vector susceptibility to insecticides should be integrated into any programme in which insecticides are used.

A vector surveillance system should cover the vectors of all diseases prevalent in the targeted areas, in line with the multi-disease approach of IVM. This improves the use of resources and helps increase preparedness for epidemics of new disease pathogens.

Use of fixed locations, or sentinel sites, selected to represent the populations at risk for disease, helps to reduce natural variation in the data collected. Vector surveillance can be used for monitoring and evaluation if the sentinel sites are in or near the implementation sites. If they are not, new sentinel sites should be selected in the areas of implementation and in new control areas.

Direct links should be established between vector surveillance and vector control so that the results of surveillance are used in making decisions about vector control interventions. If vector surveillance becomes an isolated activity, detached from vector control activities, it loses its function.

Like vector control, vector surveillance can be conducted at district or village level (*40*).

Monitoring and mapping of vector breeding habitats in particular should be conducted at village level by trained community members formally recognized by village and district authorities. By comparing maps drawn at regular intervals, the emergence and disappearance of breeding and harbourage sites will be revealed. Hence, mapping is important for planning environmental management by villagers and for evaluating the effects of vector control.

Basic training on vector biology, ecology, sampling and mapping is often required, and on-the-job training should be conducted to build the skills of a village surveillance team, consisting of field-based volunteers and a local coordinator. The commitment of village surveillance teams is important for consistent, sustained implementation of vector surveillance. The main use of village-level surveillance data is to guide and evaluate local vector control activities; they should also be used at central level.

4.8 MONITORING AND EVALUATION

Planning, implementation and maintaining IVM must be monitored and evaluated in order to ascertain progress and impacts and to identify areas for further attention. *Table 4.5* lists indicators that could be used. A comprehensive framework for monitoring and evaluation is presented in *section 7*.

In effective vector-borne disease-specific programmes, a system for monitoring and evaluation is commonly in place, specifying the indicators to be observed, the methods to be used, the roles assigned and the timetable to be followed. An example is the monitoring and evaluation framework for malaria control of the Roll Back Malaria partnership (*41*). This and other frameworks are generally set up for a single disease. A more general framework, addressing several diseases, is presented in WHO's global plan to combat neglected tropical diseases (*5*). If more than one disease is covered in one programme, for example when evaluation of lymphatic filariasis is added to a malaria control programme, the data collection methods should be revised.

Table 4.5 Indicators of process and outcome for monitoring and evaluating progress in planning and implementation of integrated vector management (IVM)

Process indicator	Outcome indicator
Required resources for implementation of IVM costed and mobilized	National strategic and implementation plan on IVM in place
Required staffing levels and competencies for IVM identified	Number (and percentage) of targeted staff trained on IVM
Epidemiological data disseminated and utilized by programmes for decision-making and impact evaluation	Epidemiological surveillance system on vector-borne diseases in place
Vector data disseminated and utilized by programmes for decision-making and impact evaluation	Number (and percentage) of targeted sentinel sites with functional vector surveillance and insecticide resistance monitoring
Institutions to carry out operational research identified	Number (and percentage) of operational research priorities on vector control that have been addressed
Technical assistance provided to programmes to utilize results of operational research	Number of operational research outcomes on vector control that have been utilized by implementation programmes

5. ADVOCACY AND COMMUNICATION

IVM must be communicated effectively at all levels to ensure its adoption, to foster collaboration and networking among partners and to empower communities. In this section, the target audiences and the expected outcomes of advocacy and communication during both the initial and later stages of an IVM strategy are described. Tools for advocacy and communication are discussed, and components of an advocacy strategy are proposed.

Several milestones in IVM advocacy have been achieved to date at global level (*Box 5.1*). Global plans have been prepared, which have been used in several WHO regions. Many countries have already initiated policy change in support of IVM or are implementing an IVM strategy. In other countries, however, advocacy on IVM has not yet begun.

Box 5.1 Global milestones in advocacy for integrated vector management (IVM)

2004 →	Global strategic framework on IVM prepared
2007 →	WHO Position Statement on IVM issued
2007 →	Global Plan to Combat Neglected Tropical Diseases 2006–2015 includes promotion of IVM
2007 →	Global Strategic Plan on IVM prepared
2007 →	Regional resolutions on IVM approved
2008 →	Global Action Plan on IVM prepared
2008 →	Conference of the Parties of the Stockholm Convention on Persistent Organic Pollutants encourages introduction of IVM in countries in which DDT is used
2008 →	Global Malaria Action Plan calls for greater emphasis on IVM in both the control and elimination stages of malaria programmes
2010 →	62% of countries report having a national IVM policy

5.1 FRAMEWORK

A framework for advocacy and communication is presented in *Table 5.1*, indicating target groups, tools and expected outcomes. During conceptualization of an IVM strategy, advocacy is required to leverage high-level commitment in policy, funding and research agendas. Hence, the targets of advocacy are policy-makers, donors and researchers, with key messages and case examples. During transition and consolidation of an IVM strategy, continued advocacy and feedback on the performance and impact of IVM will be required to ensure sustained allocation of resources and to expand the strategy to new areas. Early successes or shortcomings identified during monitoring and evaluation and in case studies should be used to demonstrate the feasibility and benefits of IVM and areas that require modification.

Table 5.1 Framework for advocacy and communication, with examples of targets, tools and expected outcomes

Phase	Target audience	Tool	Expected outcomes
Conceptualization	Politicians, policy-makers, donors, researchers	Messages ("What is IVM?", "How will IVM improve the situation") Example cases from other countries	Political commitment, institutional restructuring, revised research agenda
Transition and consolidation	Politicians, policy-makers, donors, researchers	Successful results, including local example cases	Sustained support, expansion
	Staff in public and private sectors, civil society organizations	Handbook and other information materials Training modules on establishing IVM	Operationalization, participation, resource mobilization
	General public	Media Information, education and communication Communication for behavioural change Farmer field schools	Awareness, behavioural change, empowerment

Staff in the public and private sectors and in civil society organizations will be expected to implement and sustain IVM. This intermediate group is the main target audience for this handbook, as they are expected to advocate and communicate for the other target groups of IVM.

Communication with the general public creates awareness, drives behavioural change and empowers people to become involved in analysis and decision-making and adopt practices. Tools for reaching the general public include the media and educational interventions to increase knowledge and skills.

5.2 ADVOCACY

To put IVM on the national agenda, advocacy is needed to present it as a cost-saving and more effective system of vector control. Associating the benefits of IVM with broader developmental issues, such as strengthening health systems and empowering communities, could increase support. The anticipated result is that political leaders raise vector control on the national agenda, shape policy agendas to promote IVM and communicate the policy change to public sectors, health professionals, researchers, civil society organizations and communities.

Advocacy is also needed for adapting research agendas and career development to implementing and maintaining IVM. For example, research on the effects of more than one intervention or on the effect of interventions on more than one disease should be encouraged. In allocating grants, funding agencies and donors could assign credit points to those research proposals that contain elements of an integrated approach. Researchers should also advocate for IVM within their own spheres of influence.

Research is needed to fill the gaps in the evidence base for decision-making in the field; operational research is needed to identify barriers to implementation; systems research is needed on how IVM affects the system of vector control; and basic research is needed to find new techniques for vector control.

During elimination of a disease or in a post-elimination phase, policy-makers may reduce their support for IVM because the strategy has been "successful". Continued advocacy for IVM is particularly critical at this time, in order to avoid "fatigue" among donors and politicians (*42*). In these situations, a disease may no longer be a public health concern but the management of vector populations must be sustained, because low vector populations will reduce the risks for resurgence or reintroduction of disease. Continued investment in IVM is justified, even after elimination, by the very real risks for disease resurgence when prevention efforts are relaxed. One way to ensure continued support is to measure the cost effectiveness of an investment in terms of the disease burden that is prevented after successful elimination. As resurgence of disease could have serious consequences for foreign investment and tourism, sustained investment after elimination might not necessarily be financed from public health budgets.

To make the case for IVM, advocacy must be based on strong evidence, as policy- and decision-makers must be convinced of the benefits of IVM before giving it their full support and high priority in allocation of resources. They will ask: "Why should I support IVM?" Politicians are bound to have reservations about changing the existing vector control system, and they have to know how investment in IVM will pay off in terms of health, social and economic benefits and whether IVM can be sustained financially. Purposeful analysis of the available evidence and effective use of advocacy are essential. Advocacy could be through person-to-person communications and forum meetings with visual presentations.

5.2.1 Advocacy tools

Three tools for use in advocacy are discussed in this section: messages, case examples from other countries, and successful results obtained locally. There may be other valuable tools.

Messages are the most straightforward tool. Although IVM is clearly defined, it is still seen by some as an intangible, somewhat philosophical concept. IVM is not, however, a new programme, nor a new technique, but a management tool for improving existing systems of vector control. This lack of understanding of IVM indicates that advocacy to policy- and decision-makers is required, through tactical packaging in succinct messages to ensure that the concept and principles of IVM are unambiguously communicated. As concern about human health attracts political attention, contemporary data on the burden of every vector-borne disease prevalent in a country should be made available.

Box 5.2 shows one way in which the basic concepts of IVM can be presented. It is a strategy of evidence-based decision-making, with a multi-disease approach, integrating vector control interventions and involving other sectors and communities. A strategy can be called "IVM" if all these features are incorporated. Even if there is only one disease locally and one appropriate method of vector control, if all four features have been taken into account in planning the implementation strategy, the strategy abides by the principles of IVM.

Box 5.2 Key messages on "What is IVM?"

Basic concept	Description
1.Evidence-based decision making	Decision making based on evidence of the local conditions of diseases and disease transmission
2. Multi disease approach	Taking account of all prevalent vector-borne diseases within one strategy of vector control
3. Integrated of vector control interventions	Taking account of all relevant vector control methods to make use of supplementary effects
4. Involving other sectors and communities	Other divisions of health, other sectors and communities playing a major role in vector control and personal protection

The constraints in the conventional system of vector control must be identified. Challenges that might be identified in the absence of an IVM approach are presented in *Box 5.3*. These messages are destined primarily for policy-makers and decision-makers; any local evidence on these problems helps illustrate the points made.

Box 5.3 Messages in answer to the question "How will integrated vector management improve the situation?"

In the absence of integrated vector management (IVM), the following problems might be encountered:

- suboptimal choice or timing of interventions, lack of monitoring and waste of resources;
- vector control programme with a single-disease focus, not integrated into the existing health system;
- vector control programme not optimally adapted to ecological and environmental conditions;
- other sectors and communities insufficiently aware of the consequences of their activities on vector-borne diseases;
- resistance to insecticides increasingly a problem in vector control

IVM increases the efficacy, cost-effectiveness, ecological soundness and sustainability of vector control.

Another advocacy tool is examples from other countries or regions. Cases showing the success of IVM or its components help illustrate the potential benefits of IVM for policy-makers and donors. The basic concepts of IVM have been shown to have positive impacts on the transmission and incidence of vector-borne diseases in studies in different contexts, with different combinations of interventions, interventions against several diseases, environmental management, evidence-based decision-making, collaboration with other sectors and involvement of communities in prevention and self-protection. Although some of the results are generally applicable, most of the evidence is specific to the study area. Cases of successful application of IVM strategies or components of IVM are being collected. Contemporary examples are the IVM strategies in Mexico (*43*) and Zambia (*44*), and research findings from Kenya (*34*).

Another advocacy tool is communicating successful results obtained locally. The results of monitoring and evaluation, which are needed to improve operations, also serve advocacy purposes and can be used to inform policy-makers and donors about early successes, as specified in *Table 5.1*. In-depth analysis of local success stories could be presented as case examples.

5.2.2 Preparing an advocacy strategy

To persuade government policy- and decision-makers to endorse IVM, a strategy for advocacy is needed, with a clear vision and a feasible plan. The following steps are suggested:

- (i) Establish a working group at national level.
- (ii) Collect data on the burden of individual vector-borne diseases.
- (iii) Analyse the situation to identify problems in the current system of vector control (e.g. lack of evidence-based decision-making, lack of capacity, lack of monitoring and feedback, poor integration with the health system, detection of resistance to insecticides).
- (iv) Define a clear position and the expected outcomes of using IVM.
- (v) Set timelines and milestones.
- (vi) Identify the target audience.
- (vii) Prepare messages and other advocacy tools.
- (viii) Acquire the skills and practice needed for strategic advocacy.
- (ix) Plan activities (e.g. interpersonal communication, forums, alliance building).
- (x) Evaluate the implementation and results of the strategy.

5.3 COMMUNICATION AND EMPOWERMENT

To create an enabling environment for IVM at community level, people implementing an IVM strategy should be aware of any sociocultural barriers, so that all opportunities can be best used. The challenges are: changing human behaviour to reduce vector biting and disease transmission, increasing compliance with interventions and motivation for vector control activities and removing misperceptions and misguided methods of vector control. It is important to provide access to information and services on vector-borne disease and ensure mutual interaction and communication. The main challenges are to improve access to information and services and to change behaviour.

Interventions designed to remove sociocultural barriers generally focus on increasing the knowledge and skills of the general public by giving them better access to information and services. This should lead to a change in behaviour and in activities that will reduce vector-borne diseases (*Figure 5.1*). Information and awareness campaigns do not, however, always result in new or modified behaviour.

Many risk factors for vector-borne diseases are within people's sphere of influence, which is the peri-domestic environment. Public services cannot easily reach this environment, and communities must take control and assume responsibility. Clearing roof gutters in order to control dengue vectors, for example, should be the responsibility of household members rather than of health teams. People must therefore be "empowered", not just to be aware of the risks but to take appropriate action of self-protection and vector control when and where needed. Empowerment means that people take more control over their lives (*45*). People need empowerment in areas in which they themselves can contribute to improving their situation, with less reliance on scarce external services such as the health sector.

Figure 5.1 Outcomes of an intervention: increasing knowledge and skills, leading to changed behaviour and activities, resulting in an impact on transmission and disease (measurement of impact, or a lack thereof, provides feedback for adjusting the intervention, which closes the cycle)

It has been suggested (*46*) that empowerment occurs only when two basic conditions are met. First, the necessary means or enabling factors must in place: challenges, responsibilities, opportunities, resources and capabilities must be used to achieve empowerment. Secondly, a process of analysis and decision-making for subsequent action must be accepted and followed. While the "means" refers to capacity-building and a group approach, the "process" refers to active involvement in the planning and implementation of IVM at local level.

Numerous tools have been used for improving access to information and changing the behaviour of communities to reduce vector-borne diseases. Four are discussed in this section: the media; information, education and communication; communication for behavioural impact; and farmer field schools; others may also be relevant. Use of these tools in an overall advocacy plan must be coordinated in order to obtain the desired effect.

5.3.1 Media

The mass media, such as radio and television broadcasts and the print media, can be used to create awareness about IVM in the general public. Videos could be produced locally in support of an IVM strategy, drawing on the experience of rural development programmes (*47*).

5.3.2 Information, education and communication

In the approach of information, education and communication, planned interventions combine information, education and motivation as a component of a national programme e.g. on disease control (*48*). The aim is to increase the role of people in protecting their own health by changing their attitudes and behaviour after a study of their needs and perceptions. Information, education and communication draws on the fields of diffusion theory, social marketing and behaviour analysis. Information messages are prepared to help people understand the causes and consequences of disease; education is given to change attitudes and behaviour and facilitate cooperation among participants; communication is required to form a community-based network. In this approach, the mass media are used in combination with group and interpersonal communication.

5.3.3 Communication for behavioural impact

Communication for behavioural impact is an education- and information-based approach to communication and social mobilization. It is based on the principles of integrated marketing communication used in the private sector to influence consumer behaviour. It is a tool of proven efficacy for achieving desired behaviour in relation to vector-borne disease.

The approach begins with an analysis of the situation to determine behavioural barriers and constraints in a certain group. The outcome of the analysis is a small number of precise behavioural objectives. Next, a strategy for achieving the objectives is designed, with an optimal mixture of activities, such as public relations, community mobilization, advertising and interpersonal communication – all aimed at achieving the desired behaviour. Then, the strategy with its well-planned social mobilization and communication activities is implemented, and progress towards achieving the desired behaviour is monitored.

This approach has been used in many countries in the control of dengue, lymphatic filariasis and malaria and several other infectious diseases to increase the effectiveness of treatment and removal of mosquito breeding sites. A significant purpose of communication for behavioural impact is to ensure that effective methods are effectively used at community level (*49*).

5.3.4 Farmer field schools

"Farmer field schools" were set up by the Food and Agriculture Organization of the United Nations in Asia to educate farmers in integrated pest management. The educational model was based on the concepts of C. Rogers and D.A. Kolb. Rogers (*50*) proposed a learner-centred approach, in which the learner is put in control of directing his or her learning, while the facilitator provides the conditions for learning but does not teach. Kolb (*51*) proposed the "learning cycle" of systematic observation and analysis of the farming situation, leading to understanding of general principles and conceptualization of the actions to be taken. Testing those actions and observing the effects adds experience, resulting in empowerment.

In farmer field schools, farmers learn to adapt their practices to local, contemporary conditions. During a season or crop cycle, a group of farmers meets weekly to make observations on the agro-ecosystem, analyse and present their weekly results for group discussion, speculate about management options and decide on experimental activities, to be evaluated the following week. Hence, learning cycles are completed weekly, resulting in skills- and confidence-building of participants. The participants also conduct simple experiments to study insect life cycles, insect behaviour and plant damage. Group building is encouraged in communication and group dynamics exercises. Strengthened groups will potentially implement the management required to suppress populations of vectors dispersed over a wide area.

Because of the emphasis on observations, analysis and decision-making, farmer field schools are particularly suitable in complex, changing situations or where decisions must be adapted to local contemporary conditions (*Box 5.4*). Since their first use in agriculture in 1989, farmer field schools have spread to 87 countries, and the curriculum has been adapted for use in health and interdisciplinary topics such as disease vector control, nutrition and HIV/AIDS prevention. For further reading on these schools, see (*54, 55*).

Box 5.4 Farmer field schools: synergies between agriculture and health[a]

Integrated vector management strategies could benefit from the rich experience in integrated pest management gained in the farmer field school approach. Farmers are given practical, field-based education during weekly meetings in order to acquire the skills and confidence they need to analyse their ecosystem and make informed, timely decisions on how to grow healthy crops with less reliance on pesticides. Communication skills and strengthening of farmers' groups are important aspects of the training.

Integrated pest management programmes indirectly contribute to disease control by reducing the use of insecticides and thereby the risk for development of resistance in disease vectors, and by raising people's income and thereby their living standards.

In a pilot project in rice ecosystems in Sri Lanka, the farmer field school curriculum was modified by incorporating a component on vector ecology and vector-borne disease control. Trained farmers carried out vector-control activities in their agricultural and home environments, while increasing rice productivity. A 60% increase in the use of bednets was recorded, indicating increased awareness about personal protection.

[a] Source: Evaluation of the integrated pest and vector management (IPVM) project in Sri Lanka (*52*) and Community-based rice ecosystem management for suppressing vector anophelines in Sri Lanka (*53*)

5.3.5 Comparison of tools

Each of these tools has its strengths and weaknesses, and the selection of a tool or a combination should be based on careful consideration of the conditions in which it will be used and the expected outcomes (*Table 5.2*).

Table 5.2 Comparison of three tools for communication for behavioural change and social mobilization

Attribute	Information, education and communication	Communication for behavioural impact	Farmer field schools
Methods	Needs assessment, a strategy, use of mass media, group communication, interpersonal communication	Analysis of problems, definition of behavioural objectives, strategy with optimal mixture of activities, implementation, monitoring achievements	Weekly group session for observation and analysis of local ecosystems, decision-making and experimentation, group exercises
Settings	Those requiring messages with general applicability	Those requiring messages with general applicability	Complex settings requiring locally adapted solutions
Strengths	Relatively low cost, rapid coverage, increases awareness	Focus on outcomes, impact on behaviour and mobilization	Empowering, local adaptation, group-building, possible intersectoral cooperation
Weaknesses	Limited effect on behaviour	Cost, human resources	Cost, human resources

Information, education and communication programmes have had positive effects on knowledge and attitudes, but concern has been expressed about the slow pace of achievements and the lack of documented behavioural impact of this approach. People might understand the behaviour needed to reduce a health risk but fail to act accordingly. Communication for behavioural impact requires considerable effort for specific outputs, but the results suggest that it affects people's behaviour. Both, information, education and communication and communication for behavioural impact are designed for situations in which the messages are general applicable in targeted areas. Farmer field schools are designed to help people design locally appropriate methods or solutions and are applicable in complex, changing settings.

5.4 MONITORING AND EVALUATION

Progress in advocacy and communication must be monitored and evaluated to identify areas for further attention. Indicators that could be used are listed in *Table 5.3*. A comprehensive framework for monitoring and evaluation is presented in *section 7*.

Table 5.3 Indicators of process and outcome for monitoring and evaluating progress in advocacy and communication on integrated vector management (IVM)

Process indicator	Outcome indicator
Advocacy materials prepared; case studies conducted and documented	Advocacy meetings on IVM in place
Major stakeholders have identified the requirements for vector control	Number (and percentage) of targeted stakeholders that have allocated resources for vector control
Targets set for the number of villages to receive campaigns on behavioural change on vector control; resources allocated and persons trained	Number (and percentage) of targeted villages that received campaigns on behavioural change on vector control
Guidance given to villages on organizing and planning of vector control activities	Number (and percentage) of targeted villages where communities have been mobilized on vector control

6. CAPACITY-BUILDING

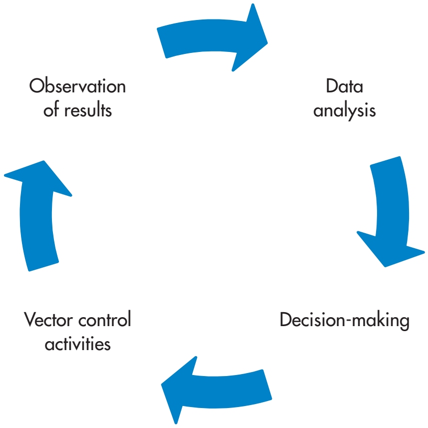
Capacity-building is a significant challenge in implementing an IVM strategy, in view of the dearth of human resources and infrastructure in many countries. The IVM strategy depends heavily on the knowledge and skills of people in functions at national, subnational, district and village level. In this section, ways of developing the appropriate knowledge, skills and infrastructure are discussed.

6.1 LEARNING ENVIRONMENT

The development of human resources requires a supportive environment, with political and financial commitment for training, recruitment and career paths. Substantial investment in training courses will be required to upgrade and maintain the knowledge and skills of people involved in an IVM strategy.

The IVM approach itself provides a supportive environment for learning, as IVM is a problem-solving approach, in which analysis and decision-making are central and participation is vital. Observation, analysis and decision-making are the ingredients of a learning cycle, which stimulates continued learning by interacting participants (*Figure 6.1*). This results in an environment that is conducive to learning and development. Hence, once an IVM strategy is operational, it could serve as a self-enforcing mechanism of generating knowledge and skills.

Figure 6.1 The learning cycle, from observation of results, to data analysis, decision-making and vector control activities, which result in observation of new results



6.2 CORE FUNCTIONS AND REQUIRED COMPETENCE

The planning and implementation of IVM require appropriate knowledge and skills for management, analysis, problem-solving, communication and facilitation. Human resource development begins with an assessment of the current competence of all relevant personnel in order to identify the requirements for others. This is part of a "vector control needs assessment" (*13*).

6.2.1 National and subnational level

At national level, an IVM strategy requires a high-level intersectoral steering committee, as mentioned previously. Specialized agencies and technical working groups could work under the guidance of the steering committee, for example on the components of evidence-based decision-making, capacity-building and monitoring and evaluation. The agencies and working groups should include people with competence in epidemiology, entomology, vector-borne disease control and programme management. This competence is often available in existing systems but might require reorientation or strengthening to address IVM.

The functions and essential competence of IVM partners at national and subnational level are listed in *Table 6.1*. An important function at national level, apart from providing direction and advice, is facilitating activities at lower levels of administration, requiring facilitation skills. Advocacy is a growing responsibility of health professionals and programme managers, and the skills and experience for such active communication strategies should be strengthened in most countries.

6.2.2 District and village level

Reorientation of vector control activities to IVM will often require training or retraining of public health staff to increase their knowledge and give them the required skills for their roles in IVM partnerships. Staff in other sectors and representatives of civil society organizations may also need additional training (*Table 6.1*). In districts or villages,

Table 6.1 Functions and competence of partners in integrated vector management

Level	Function	Type of competence
National, subnational	Advocacy Set strategic direction and conduct overall evaluation Advise on policy and institutional arrangements Conduct epidemiological and vector assessment, stratify Supervise decentralized monitoring and implementation Supervise decentralized monitoring and evaluation Supervise decentralized organization and management Prepare curriculum and train trainers Coordination of emergency response Advise on research problems	Access and communication Planning and evaluation Policy analysis Technical knowledge Facilitation, technical knowledge Facilitation, technical knowledge Facilitation and management Training Management, technical knowledge Technical knowledge
District, village	Advocacy Establish intersectoral partnerships and networking Plan and implement local IVM strategy Implement health interventions Monitor and evaluate Organize and manage Conduct local vector surveillance Train, educate and raise awareness	Access and communication Access and communication Analysis and decision-making Operational Technical Management Technical Training and communication

intersectoral partnerships should be established; consequently, the health sector should have working relations with other public sectors. In particular, analysis and decision-making skills should be developed and maintained in community leaders and local IVM partners to ensure appropriate planning and implementation of local strategies.

6.3 CURRICULUM PREPARATION

6.3.1 Structure

The global action plan for IVM includes a proposal for a comprehensive modular training package on IVM. In response, WHO designed a *Core structure for training curricula on integrated vector management*, consisting of six modules, to provide guidance to WHO regions in preparing their own regional and national curricula on IVM. The structure was adapted to the requirements and conditions of each region and country (*56*). It focuses on the management aspects of IVM and is not a replacement for courses on medical entomology or vector control methods. Most of the modules are consistent with the sections of this handbook.

As analysis and decision-making are considered main conditions for empowerment, the curriculum preparation structure is based on a problem-solving approach, in which methods of analysis and decision-making are used to stimulate active learning in real situations.

The structure can be adapted for use with three target groups, corresponding to three training levels: nonspecialists or basic level, public health professionals or intermediate level, and academics and students or advanced level (*Table 6.2*). Modules can be selected according to the target group. The structure is intended for short training courses of less than 2 weeks, depending on the modules selected and in accordance with people's background and roles.

Table 6.2 Modules of the structure for preparing a curriculum on integrated vector management, by weight given to each module, target group and length

Module	Weight (%)	Target group			
		Community nonspecialists	Village or district nonspecialists	Public health professionals	Academics, students
Introduction to vectors of human disease[a]	15	+	+	+	+
Planning and implementation	30	±	±	+	+
Organization and management	20	–	+	+	+
Policy and institutional framework	10	–	–	+	+
Advocacy and communication	10		+	+	+
Monitoring and evaluation	15	±	+	+	+
Estimated duration (days)		4–8	6–8	8–10	> 15

–, not required; ±, partly required; +, required
[a] Not covered in the handbook

6.3.2 Preparing a national curriculum

In preparing a curriculum for use at national level, the modules should be adapted to local vectors and the diseases they transmit and to the institutional situation, and translated into local languages. Surveys to determine social and cultural perceptions of vectors, vector-borne diseases and vector control in communities and among partners in the public and private sectors can help to identify training requirements. Field-testing of the modules before finalizing the curriculum gives input for improvement before they are used in actual training. Representatives of all target groups should be involved in preparing the curriculum to ensure its relevance and suitability.

6.4 TRAINING AND EDUCATION

The success of an IVM strategy depends largely on the human resources available at decentralized levels. Consequently, the emphasis in training should be on short courses for as many people as practicable in districts and villages. After a national curriculum has been prepared, a cadre of national or provincial trainers can be formed to give the necessary in-service training to public health staff in the health sector, staff in other relevant public sectors, local authorities and civil society organizations. Each target group should be trained with the set of modules indicated in *Table 6.2*. Ideally, epidemiological and entomological experts should be recruited to give technical support in training courses.

Parts of the modules should be adapted for use in health projects in primary and secondary schools to educate schoolchildren in vector biology and elementary epidemiology. This can motivate them to participate in vector surveillance or vector control activities, such as environmental management. IVM should also be added to the curricula of science, medical and engineering faculties of higher educational institutions to foster wider recognition of the importance of vector control in health and other disciplines. Undergraduates and postgraduates should be encouraged to conduct fieldwork on topics related to IVM.

Career paths in vector control are essential in disease-endemic countries. Therefore, a career structure should be designed for entomologists and public health staff, to encourage trained, skilled staff to remain in vector control, with adequate legal protection of their positions.

6.5 PREPARATION OF INFRASTRUCTURE

Another area for capacity-building in IVM is infrastructure. The infrastructure required includes entomology laboratories, insectaries, supplies, equipment, transport and communication technology. Some of these resources may already exist in other sectors, institutions or programmes and might be used for IVM through collaborative agreements.

6.6 MONITORING AND EVALUATION

Progress in capacity-building should be monitored and evaluated in order to identify areas for further attention. *Table 6.3* lists indicators that could be used. A comprehensive framework for monitoring and evaluation is presented in *section 7*.

Table 6.3 Indicators of process and outcome for monitoring and evaluating progress in capacity-building for integrated vector management (IVM)

Process indicator	Outcome indicator
Curricula developed for each required competency institutions for training and certification identified	Certified training courses on IVM and judicious use of pesticides in place at national or Regional level

7. MONITORING AND EVALUATION

The requirements for monitoring and evaluation have been mentioned briefly in each preceding section. In this section, a comprehensive account of monitoring and evaluation is given, covering all aspects of IVM. Methods are also discussed. A separate document is available which gives specific guidance on monitoring and evaluation of IVM (*61*).

Monitoring and evaluation are essential tools in the management of any development activity. The main functions are: to guide in planning of interventions, to measure the effectiveness of the activities, to identify areas requiring improvement, and to account for the resources used. "Monitoring" refers to examining a programme's process or performance, which, in the context of an IVM strategy, consists of the activities or interventions. "Evaluation" refers to assessment of the outcomes and impacts that can be attributed to a programme's activities; sometimes, an evaluation of impacts is referred to separately as an "impact assessment". Hence, monitoring involves examining the cause, which is the intervention, and evaluation involves analysing the effect, which is the outcome or impact.

In combination, monitoring and evaluation aid understanding of the relations between the performance of activities and the observed outcomes or impacts. This permits identification of gaps or weaknesses and their reasons or causes, as the basis for remedial measures. Thus, lack of an outcome in a certain area can often be traced back to inadequate performance or to some other constraint.

7.1 FRAMEWORK

As discussed in previous sections, IVM is a management strategy designed to improve the existing system of vector control and disease prevention. This distinction has important implications for monitoring and evaluation. In a typical disease-specific control programme, monitoring and evaluation are relatively straightforward, addressing mainly implementation of the programme's interventions. Monitoring and evaluating an IVM strategy, however, involve examining whether the existing system of vector control is being transformed as originally intended. This applies to all the components of IVM. Hence, monitoring and evaluation should identify progress made in the following areas (reflected the sections of this handbook): the policy and institutional framework, organization and management, planning and implementation, capacity-building and advocacy and communication.

Different types of indicators are used to determine process, outcomes and impact. Process indicators reflect the performance of a programme (i.e. whether the planned activities were adequately conducted in a timely manner). Outcome indicators show the desirable outcomes of the activities conducted, and impact indicators reflect the impact that can be attributed to the programme's outcomes.

Table 7.1 presents possible process indicators and core outcome indicators of IVM;

Table 7.1 Indicators of process and outcome for monitoring and evaluating progress in each component of integrated vector management (IVM)

Category	Process indicator		Outcome indicator	
Policy	Focal person for IVM identified Situation analysis completed Economic impact of vector-borne diseases assessed	L L L	National IVM policy in place National policy on pesticide management in place	L L
Institutional framework	Mandate and composition of national steering committee on IVM developed Terms of reference for national coordinating unit on vector control developed	L L	National steering committee on IVM in place National coordinating unit on vector control in place	L L
Organization and management	Task force constituted to revise job descriptions and operating procedures Task force constituted to develop professional standards on vector control and public health entomology	L L	Number (and percentage) of targeted staff with job descriptions that make reference to vector control Standards for professions and a career track vector control and public health entomology in place	N L
Planning and implementation	Required resources for implementation of IVM costed and mobilized Required staffing levels and competencies for IVM identified Epidemiological data disseminated and utilized by programmes for decision-making and impact evaluation Vector data disseminated and utilized by programmes for decision-making and impact evaluation Institutions to carry out operational research identified Technical assistance provided to programmes to utilize results of operational research	D D D D L D	National strategic and implementation plan on IVM in place Number (and percentage) of targeted staff trained on IVM Epidemiological surveillance system on vector-borne diseases in place Number (and percentage) of targeted sentinel sites with functional vector surveillance and insecticide resistance monitoring Number (and percentage) of operational research priorities on vector control that have been addressed Number of operational research outcomes on vector control that have been utilized by implementation programmes	L N L N N N
Advocacy and communication	Advocacy materials prepared; case studies conducted and documented Major stakeholders have identified the requirements for vector control Targets set for the number of villages to receive campaigns on behavioural change on vector control; resources allocated and persons trained Guidance given to villages on organizing and planning of vector control activities	L L L D	Advocacy meetings on IVM in place Number (and percentage) of targeted stakeholders that have allocated resources for vector control Number (and percentage) of targeted villages received campaigns on behavioural change that on vector control Number (and percentage) of targeted villages where communities have been mobilized on vector control	L N N N
Capacity-building	Curricula developed for each required competency; institutions for training and certification identified	D	Certified training courses on IVM and judicious use of pesticides in place at national or Regional level	L

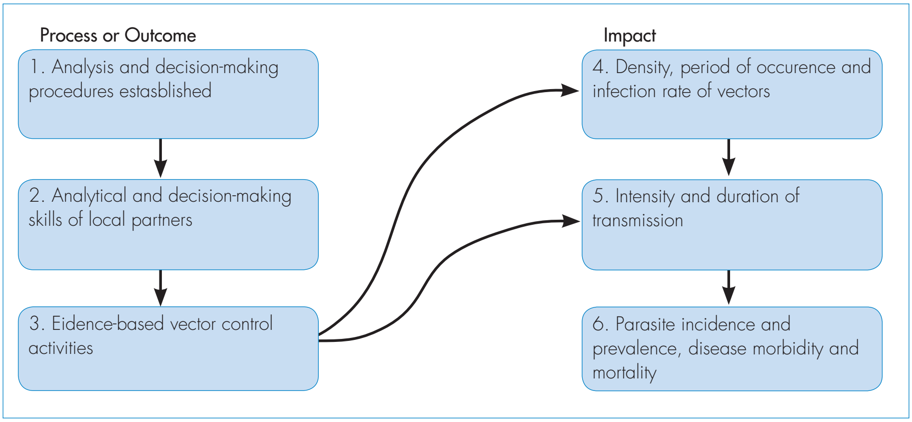
L, logical data (yes/no); D, descriptive data; N, numerical data

it is a compilation of the indicators given in each of the preceding sections of this handbook. *Table 7.2* presents the core impact indicators of IVM, corresponding with the objectives of IVM to improve the efficacy, cost effectiveness, ecological soundness and sustainability of vector control.

Table 7.2 Expected impact and indicators of impact of integrated vector management

Process indicator	Outcome indicator
Reduced risk of transmission	Vector-related parameters
Reduced disease burden	Prevalence rate and incidence rate of vector-bornedisease
Cost effectiveness	Cost per disease case averted per year
Ecological soundness	Toxic units of insecticide used per disease case averted per year
Sustainability	Strategy in place that enables continued mobilization of resources for vector control

Figure 7.1 Health impact model for integrated vector management, showing how analysis and decision-making lead to an impact on health by sequential steps in a cause–effect relation[a]



[a] Source: Evidence-based public health: moving beyond randomized trials (*57*) and Evaluation of integrated vector management (*58*)

The distinction between process, outcome and impact is particularly noteworthy in the category of planning and implementation, in which the process is expected to affect health during a number of sequential steps, in a cause–effect relation (*Figure 7.1*). Analysis and decision-making in districts and villages have been presented as a "process" because they should be established in the IVM strategy and result in increased analytical and decision-making skills of local partners. Evidence-based activity in vector control could be considered as an "outcome" because it is expected to have an impact on the vector, on disease transmission and on morbidity and mortality. From the central perspective, therefore, vector control activity is not a process indicator, as it is in centrally directed programmes, but the outcome of analysis and decision-making established at local level. In other words, implementation is not directed from above but is planned locally. Nevertheless, from the perspective of local partners at district or village level, vector control activity is a process indicator because, for them, it is the planned process of implementation.

7.2 METHODS

7.2.1 Design

Monitoring and evaluation of disease control are generally conducted longitudinally, to record changes over time. Therefore, a baseline is required, and information is collected during interventions. Changes in indicators of progress, outcomes and impact are observed relative to the baseline.

One limitation of this approach is that other changes occurring during the same period can influence the indicators, so that the changes observed might not be attributable solely to the IVM interventions. For example, rural development programmes in the same areas, political unrest, economic progress or climatic change could influence the results; such factors are called "confounding variables". To address this problem, cross-sectional comparisons are made with a control group, i.e. a setting without IVM. When the baselines in both the control and the intervention group are known, the sources of confounding are filtered out and the observed differences can be attributed more reliably to the intervention, especially when the units of the control and intervention groups are chosen randomly (*58*).

One constraint of randomization is that evaluators cannot select the areas to be used as control units. Planners of wide-scale disease control programmes commonly aim for complete coverage, or they may leave out villages because they are at low risk for disease and therefore have conditions that are not comparable to those of the intervention villages. Opportunities for evaluation present themselves when programmes or IVM strategies are implemented in a so-called "stepped-wedge" manner, in which all villages are eventually covered by the interventions, but the timing of the intervention is randomized in a step-wise crossover scheme (*59*). This allows for selection of control units and comparative evaluation for some time, until all control units are also covered by the intervention.

7.2.2 Data collection

For demonstration purposes, three types of data are specified for the indicators in *Table 7.1*: descriptive, numerical and logical (yes/no). A number of indicators cannot be measured numerically or logically and require descriptive data and qualitative assessment. Qualitative data can be obtained by interviews with stakeholders, review of documents, field visits and community or household surveys. Questions for interviews and formats for measuring knowledge and skills should be designed by evaluators, and survey tools or monitoring forms should be field-tested before use. Interviews and surveys are time-consuming and require careful planning.

Vector populations should be monitored at sentinel sites in an established vector surveillance system, as discussed in *section 4.8*, and the data can be used to evaluate the impact of vector control activities. Evaluating impacts on disease transmission requires special studies, with observations adapted to the requirements for each disease. Impacts on parasite incidence, parasite prevalence, disease morbidity and disease mortality can be difficult to assess and reliably attributed to the interventions.

There are several methods for collecting health data. Routine surveillance with health management information systems has been used in a number of disease-endemic countries, in which data are produced weekly or monthly at district level (showing, for example, variations in space and time). Such systems could be used to obtain data on crude death rate, disease-specific death rate, cases of disease, parasite incidence and other parameters. Similar types of data, often of better quality and reliability, are collected in demographic surveillance systems established in certain countries. A more costly but often preferable option is collecting data in a dedicated epidemiological assessment, as described in *section 4*, adapted to the specific requirements of IVM.

Sampling schemes should be designed on the basis of the requirements of each indicator. For an indicator such as household coverage, as wide an area as possible should be sampled. For other indicators, more time-consuming or costly methods might be required, with smaller but properly selected samples or sentinel sites.

7.2.3 Use of results

The results of monitoring and evaluation should be used effectively for their intended purposes, which are to account for the resources used, to learn from the experience and to decide what strategic or operational adjustments are needed. Those who should learn from the experience are stakeholders and partners at all levels of administration. District-level partners and communities, for example, need to know whether the IVM activities were effective. Therefore, those responsible for monitoring and evaluation should document and disseminate the results to several target groups. Lessons can be learnt from monitoring the transition to IVM in a broad sense, supplemented with data on activities, outcomes and health impacts, if available. Aggregation of several data sources, for example by linking data on implementation to data on impact, could reveal the reasons and causes for the observed patterns, although this requires analytical skills.

Monitoring and evaluation are also needed to inform national decision-makers about costs and impacts to help them understand and interpret the results and guide them in deciding whether to support or modify the strategy. Monitoring and evaluation could also serve advocacy purposes by indicating policy change.

7.2.4 Roles

Monitoring is usually done internally by the direct stakeholders, whereas evaluation is done both internally and externally. The advantages of internal evaluation are ready availability, lower cost and knowledge about the context and operations. Internal evaluators may, however, be biased and might hide certain shortcomings because of a conflict of interest. The important advantages of external evaluators are their specialist skills and their presumed objectivity, as they are independent and can raise sensitive issues (*60*). Pressure on either internal or external evaluators to make a positive evaluation can be a barrier, obstructing the efficient identification of a programme's shortcomings and remedial action.

In IVM partnerships at decentralized levels, cross-wise evaluation would be an ideal alternative. In cross-wise evaluation, one partner monitors the activities of another and vice versa. Cross-wise evaluation stimulates the accountability of both partners for their vector control activities, strengthens partnerships and helps avoid biased results; however, it requires training and supervision. In this alternative, monitoring and evaluation become integral to the IVM strategy, leading to improvement and adaptation according to changing circumstances.

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ANNEX

Second IVM working group meeting on capacity-building and training, 20–22 October 2010, RTI International Office, Washington DC, United States of America: List of participants

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Integrated vector management (IVM) is a rational decision-making process to optimize the use of resources for vector control. The aim of the IVM approach is to contribute to achievement of the global targets set for vector-borne disease control, by making vector control more efficient, cost effective, ecologically sound and sustainable. The intention of this handbook is to provide to the managers of vector-borne disease control programmes, other officials in health and other sectors involved in vector-borne disease control with necessary guidance and an operational framework for the implementation of IVM.

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