

Operational Manual for Integrated Vector Management in India

DIRECTORATE OF NATIONAL VECTOR BORNE DISEASE
CONTROL PROGRAMME (NVBDP)
DIRECTORATE GENERAL OF HEALTH SERVICES
MINISTRY OF HEALTH & FAMILY WELFARE
GOVERNMENT OF INDIA

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GOVERNMENT OF INDIA**

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1st February, 2016

दिनांक/Dated.....

MESSAGE

Vector management has been a priority in one or the other ways among society. The Government has been supporting its different components in different ways through different departments. The scattered way of implementation has not been able to satisfy the community to its desired level. The visibility has also been lost. The timely and synchronized efforts within available resources can be productive provided doers and service providers own the responsibility and avoid/control vectors in their vicinity.

The Integrated vector Management is to provide variety of options to be used in isolation or in combination depending on situation. The consolidation of all the tools, methodology and precautions has been a great effort to facilitate the generations to come.

This can be one of the important referral Manual and will be useful to all the stake holders of health and non-health sectors.

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(Directorate General of Health Services)

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PREFACE

Integrated vector management (IVM) is a rational decision-making process to optimize the use of resources for vector control. This manual has been attempted as operational framework to guide implementers of vector-borne disease control programme in planning more efficiently. Though IVM is being implemented and its various components and strategies are available in disease specific documents, it was felt necessary that one comprehensive document will facilitate all for reference. IVM offers an opportunity to find solutions and implement programmes in an efficient, cost effective, ecologically sound and sustainable manner.

The intention of this manual on integrated vector management (IVM), therefore, is to provide guidance to the state and district level programme officers of vector-borne disease control programme along with other stake holders including NGOs, Civil society etc. The target audience is officials at central, district and grass-root levels. The manual provides background concept of IVM, relevant information about entomological surveillance, techniques, analysis, interpretation and decision making process at local level to use available tools and adopt feasible methods to combat the vectors. Emphasis on IVM may involve both reorientation of vector borne disease control programme and involvement of local health authority to implement IVM. Capacity-building, in particular human resource development has always been a challenge but because the IVM strategy requires skilled staff and adequate infrastructure for its implementation, the available human resource need to be mobilized and trained. The Inter-sectoral collaboration will result in cost savings and benefits to other health services also.

The continuous guidance and support from Dr A.C. Dhariwal, Director, NVBDCP has kept the spirit up while writing and compiling the manual. The support of colleagues from NVBDCP Directorate, NCDC, ICMR, NIMR, WHO and states are greatly acknowledged because this compilation would not have been possible without their support.

Dr. P. K. Srivastava
21/2/2016
(Dr. P. K. Srivastava)



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Foreword

The Vector-borne diseases (VBDs) are a group of communicable diseases transmitted by mosquitoes and other vectors. Generally, these Vector borne diseases are local and focal in nature and therefore, the epidemiology of these vector borne diseases varies considerably on account of ecology, vector bionomics, economic, socio-cultural and behavioral factors. The planning for vector management thus requires proper knowledge about bionomics of local vectors and their response to control measures. Integrated Vector Management (IVM) is the most recent approach to vector control. IVM is a decision-making process for the management of vector population to reduce or interrupt transmission of vector-borne diseases. The role of entomologists in such decision making process is very crucial as without them it will be difficult to generate the relevant data for analysis and correlation with epidemiological data.

In disease control or elimination, vector management is one of the main pillars. The main intervention measures are Indoor Residual Spray (IRS), Long Lasting Insecticidal Nets (LLINs), source reduction and anti-larval measures. The decision of insecticide for use in different areas is based on results of vector susceptibility studies and epidemiological impact. The use of larvivorous fish for larval control is expanded as an eco-friendly and effective vector control measure. The entomological data and knowledge about tools for vector control therefore help in suggesting for what tools to be used, where, when and how.

Integrated Vector Management (IVM) manual is an effort of compiling various aspects of vector control. This manual specifically addresses situation analysis, different vector control tools and its use in areas with different endemicity of diseases or in the areas co-endemic with more than one VBDs. Effective coordination among other stakeholders and departments including community participation has also been addressed for optimal use of resources to benefit prevention and control of vector borne diseases in the area.

It is my hope that epidemiologist, entomologists, public health and social workers will find this manual most useful in tackling vector borne diseases and this will be used as reference for many years to come.

A.C. Dhariwal
3/2/2016
(Dr. A.C. Dhariwal)



Swachh Bharat : An opportunity for Dengue and Malaria Control.
Website: www.nvbdcp.gov.in



ACKNOWLEDGEMENT

The Operational Manual for Integrated Vector Management in India has been a dream of many working for prevention and control of vector borne diseases in country. Dr A. C. Dhariwal, Director NVBDCP has been the motivating force in bringing out this manual.

The experience and contribution made by Shri C.K. Rao, Ex. Dy. Director, NVBDCP and Ex. National Professional Officer, WHO Country Office for India in finalizing the manual is been greatly acknowledged.

The many valuable suggestions and comments which facilitated in improving the draft and made the finalization of the manual easier are sincerely appreciated. Special thanks are due to scientists of NCDC and various ICMR institutes during compilation of this manual.

Sincere thanks are also due to the support of WHO Country Office for India, especially efforts of Dr Saurabh Jain in conducting the Brainstorming Workshop on IVM by NVBDCP and inviting Dr R.S. Yadav from WHO, Geneva and Dr Graham Mathew, Prof. Steve Lindsay and Ms Anne Wilson from United Kingdom which created a momentum in finalizing the manual.

The publication of the book has been possible due to the hard work put in by support staff namely Ms Sharmila Gupta, Ms Preeti, Ms Manvinder Kaur, Ms Gurpreet Kaur Basra and Sh Sandeep of NVBDCP and various officers of states for their contributions.

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Introduction

Integrated Vector Management (IVM) is a rational decision-making process to optimize the use of resources for vector control. It requires a management approach that improves the efficacy, cost effectiveness, ecological soundness and sustainability of vector control interventions with the available tools and resources. Integrated approach is vital in successfully combating vector-borne diseases. Various key elements of IVM are advocacy, social mobilization, strengthening of regulatory and legislative controls for public health, empowerment of communities, collaboration within health and other sectors in planning and decision-making, use of available resources for vector control, implementation of evidence-based strategies and capacity-building[1]. WHO has identified the five major elements of an IVM strategy as an integrated approach; evidence-based decision-making; collaboration within the health sector and with other sectors; advocacy, social mobilisation and legislation; and capacity-building . These elements are summarized in Table 1.

Table 1. Elements of an integrated vector management (IVM) strategy

Element	Description
Integrated approach	<ul style="list-style-type: none">• Addresses several diseases with vector control tools, often in combination and synergistically• Involves use of chemical and non-chemical methods• Integrates other disease control methods, viz. drugs & vaccines
Intra- and inter-sectoral collaboration	<ul style="list-style-type: none">• Collaboration within the health sector and with other sectors (public and private)• Planning and decision-making delegated to the lowest possible level (Districts and Blocks)
Advocacy, social mobilization and legislation	<ul style="list-style-type: none">• Principles of IVM promoted and integrated into policies in all relevant ministries, organizations and civil society• Establishment or strengthening of regulatory and legislative controls for public health• Community engagement and empowerment for sustainability
Capacity-building	<ul style="list-style-type: none">• Adequate infrastructure, financial and trained human resources at central and local levels• Training and education in place according to IVM curricula

Collaboration within the health sector and with other non-health sectors

IVM should be collaborative, involving elements of the health sector, as well as other sectors, such as government ministries (e.g. agriculture, education, housing and public works), local government, community groups and non-governmental organisations (NGOs). Intra and inter-sectoral collaboration should be coordinated at central level followed at state and district level comprising representatives of different ministries, local government, industry, research and academic institutions, NGOs, civil society and community organisations.

Advocacy, social mobilisation and legislation

IVM must be communicated effectively, promoted and integrated into policies in relevant ministries, organizations and civil society. Regulatory and legislative controls for public health should be established or strengthened. The involvement and engagement of communities can help to ensure the sustainability of IVM; therefore, communities should be made aware of the risks of vector-borne disease and take action themselves in the use of preventive measures or vector control around their domestic environment.

Capacity-building

IVM relies on the availability of skilled personnel at national, subnational, district and village levels. It must therefore include a capacity-building programme to upgrade and maintain the knowledge and skills of personnel.

What is the I in IVM?

The term 'integrated' in integrated vector management can refer to several things. Firstly, integration refers to integration of tools used for disease control. Chemical and non-chemical vector control tools and vector control tools attacking the adult and immature vector are used in combination where possible. Vector control tools are used in combination with other tools for disease control such as vaccines, drug administration or diagnosis and treatment. Vector control tools are used that are effective against more than one disease, where possible.

Secondly, integration refers to integration within the health sector and across sectors. Within the health sector, resources are shared for planning, surveillance, delivery and monitoring and evaluation of interventions. IVM makes use of other stake holders from non-health sector such as other line ministries, communities and the private sector, particularly for implementation of interventions.

Though different integrals of IVM have been under implementation in isolation or in combination in different situations, there is a felt need that a comprehensive document describing IVM concept, its components and strategy for different diseases are compiled. The NVBDCP aims to achieve effective vector control by the appropriate biological, chemical and environmental interventions of proven efficacy, separately or in combination as appropriate to the area through the optimal use of resources. Efforts are made for collaboration with various public and private agencies and community participation for vector control. IVM is done by using similar vector control methods to control vector borne diseases malaria, kala azar, Japanese encephalitis, dengue, chikungunya and Lymphatic filariasis. The IVM includes implementation of all feasible strategies safely with or without insecticides to manage vector population in such a way so that disease transmission is kept under check. It also includes management of insecticide resistance. The measures of vector control and protection include mainly IRS to control adult mosquitoes, source reduction, treatment of breeding sites with chemical, biological agents and personal protection using bed nets (LLINS/ITNs).

At central level, Directorate, NVBDCP facilitate in framing policy and strategic plan for implementation by states/UTs which is based on situation analysis of disease considering transmission and vector prevalence. The infrastructure for implementation is provided by states/UTs and financial resources are shared by both central and state governments as per policy.

The existing disease-specific vector control programmes and surveillance services need emphasis on integration within the decentralized health system. This approach requires new skills and capacities for analysis and decision-making. The availability of medical entomologist is crucial for each district but often it is not the reality. In such situation, health or public health staff in districts, PHC, sub-centre and villages needs to be trained in the technical, operational and managerial aspects of IVM in making them more capable and less dependent on centralized expertise. However, there has to be a linkage of vector control and vector surveillance activities under integrated vector management (IVM) at central and local levels. This brings health services closer to the community and will increase the motivation of health staff. Vector control becomes more sustainable in this process as local decision-makers are then more accountable.

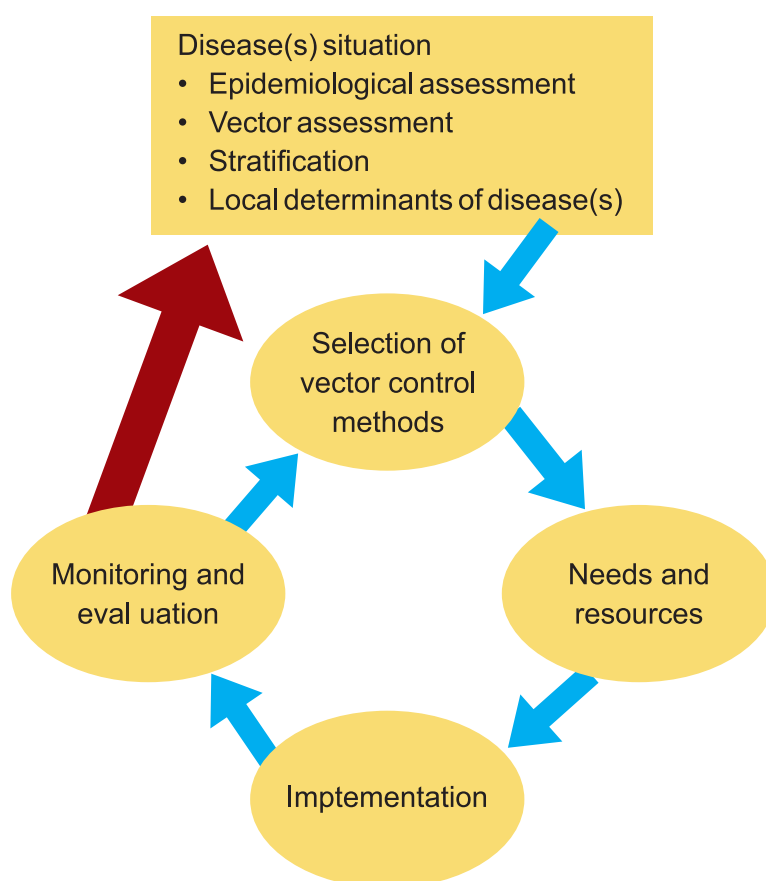
Even within decentralized health systems, vertical programmes or its activities with effective coordination at district and local level is essential for establishing and maintaining an IVM strategy. For example, the personnel of indoor residual spraying programmes at district and subdistrict levels can work together with local authority or partners in implementation of other strategy at different time. The vertical programmes must allow such flexibility in planning, based on local circumstances, with accountability to local leaders and representatives.

IVM strategy also requires collaboration between the health and other sectors and civil society with roles and responsibilities and terms of reference for all stake holders. Health impact assessment of ongoing or new projects is very crucial to identify any risks for vector-borne disease and tackle it. Various departments with construction activities need to be sensitized and so as to prevent vector breeding by adopting appropriate strategy or technology. Partnerships at state, district levels with their active participation require intensive capacity building and advocacy. This does not mean that responsibility of vector control unit will be shifted. They will have overall responsibility and should continue to acquire the skills to facilitate the partnership and guide its activities. Other stake holders like civil society organizations and communities would also play roles in implementing the activities. Technical support on IVM strategy should be with central and state Governments. The inclusion or exclusion of tools or technologies is guided by research with documentary evidence. Operational research conducted for programmes supports in ensuring amendments in guidelines and managing resources. The support from ICMR institutions and NCDC in operational research is taken and deliberations through expert group are considered by TAC before a final decision taken under implementation of strategy or new tools under programme. Internationally WHO, BMGF, World Bank and GFATM etc extend their support.

Most of diseases under programme are being targeted for elimination but during elimination of a disease or in subsequent post-elimination phase, reduced financial support cannot be ruled out which will affect the success gained through IVM. Further, the disease may no longer be a public health problem but the management of vector populations need to be sustained to avoid any outbreak or upsurge due to weak surveillance and vector control. There are many examples where such outbreaks or upsurge are noticed due to complacency of health officials. The officials responsible for this are either non-existent or looking after other jobs resulting in loss of skill to tackle the problems. IVM, therefore should be considered as investment and not expenditure especially in public health programme.

Planning Integrated Vector Management

IVM should involve a cycle of several rounds of situational analysis including understanding of vectors, disease transmission and situation, tools, planning, design, implementation, monitoring and evaluation. A comprehensive assessment of the disease situation, including epidemiological and vector assessment, identification of local determinants of disease and stratification of areas at risk is essential for ensuring that the programme corresponds to the local situation. Vector control interventions should be selected on the basis of this assessment, knowledge of the efficacy of vector control methods and other considerations, such as insecticide resistance and cost–effectiveness. Implementation strategies should be planned and needs and resources assessed. The programme should be monitored and evaluated to determine its effect on the disease for programme improvement. The impact on disease situation needs to be reassessed subsequently.



Steps in IVM planning, implementation and monitoring and evaluation loop

Situation Analysis: Disease, Transmission & Vector

What should a situation analysis cover?

It is important to understand the distribution of vector-borne diseases, about transmission and their vectors in order to plan control and prioritise resources. Disease endemicity is determined by four or five factors; the pathogen, vector, human, environmental and in some case animal determinants, all of which need to be considered by the programme.

A situation analysis should be performed which assesses diseases, vectors and determinants of disease at different administrative levels. A broad-level analysis looks at disease and vectors present at state and district level, while a sub-district level analysis looks at disease, vectors and factors in more detail for appropriate intervention. The situation analysis should be re-visited on a regular basis using the most up-to-date information available as disease incidence will change over time, vectors or diseases may be introduced or re-introduced and disease determinants will vary over geographic areas with time. A situation analysis should address the following:

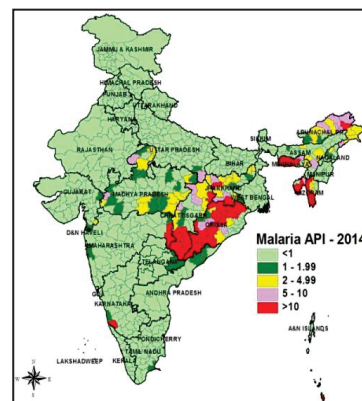
- At state and district level:
- What vector borne diseases are endemic, and where are infections/cases occurring? Where are the risks for infection?
- Are there differences in burden by geographic area (state and district) and over time?
- Are some diseases or infections co-endemic? If so, where are they found?
- Local vectors responsible for transmission, their bionomics?
- Stratify at state and district level - what are the priority diseases and geographic areas for intervention?

At sub-district level:

- Looking at sub-district level, are there hotspots of disease (in time or space)? Are there other determinants of disease (vector, human, environmental, animal) that are apparent at this level and need to be taken into account?
- Stratify at sub-district level - what are the priority diseases by geographic areas and population group? Are there disease determinants which lend themselves to specific interventions?

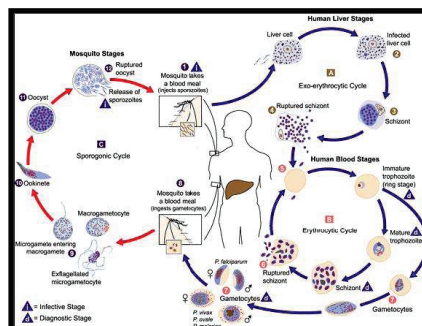
Considering above facts, disease wise situation, transmission and related vectors in brief are described:

Malaria: Malaria in India is mainly caused by two major malaria parasites namely *Plasmodium falciparum* and *Plasmodium vivax* (though cases of malaria from *Plasmodium ovale* and *Plasmodium malariae* have also been reported from some parts of the country). *P. falciparum* (Pf) and *P. vivax* (Pv) are the most common species causing malaria in the country. While *P. vivax* is more prevalent in the plains, *P. falciparum* predominates in forested and peripheral areas.



Disease Situation: At present(2014), the incidence of malaria stands at 0.08% of the population with 1.1 million cases and 562 deaths in a population of nearly 1.25 billion. In 2014, 26 states/UTs with 492 districts are with API of less than or equal to one in 2014.

Malaria transmission: Malaria is transmitted by a female Anopheles mosquito bite which has been infected through a blood meal taken from an infected person. A single infected vector, during her lifetime, may infect several persons. After about a week of taking infected blood meal, mosquito is able to transmit malaria. This is known as vector transmission. The malarial parasite undergoes 2 cycles of development - the human cycle (asexual cycle) and the mosquito cycle (sexual cycle). Human is the intermediate host and mosquito the definitive host. The disease is transmitted by 9 Anopheline species out of which six primary vectors are *Anopheles culicifacies*, *Anopheles stephensi*, *Anopheles dirus*, *Anopheles fluviatilis*, *Anopheles minimus* and *Anopheles epiroticus* (previously known as *Anopheles sundaicus*). Salient points of each of these vector species are described for field purposes and planning vector management.



An. culicifacies

Distribution: Widely distributed in India.

Breeding places: Breeds in rainwater pools and puddles, borrowpits, river bed pools, irrigation channels, seepages, rice fields, wells, pond margins, sluggish streams with sandy margins. Extensive breeding of *An.culicifacies* is generally encountered following monsoon rains.

Resting habits: Rests during daytime in human dwellings and cattlesheds.

Biting time: Biting is throughout night but peak biting is from 19.00 to 04.00 hrs.

Feeding habits: Azoophilic species but with high density it feeds on human.

Flight range: About 1-3 kms.



An. fluviatilis

Distribution: Widely distributed in the foothill areas including both peninsular and north-east India.

Breeding places: Breeds typically in slow running streams, seepages and irrigation channels; also recorded from rice fields and shallow wells. During heavy rains the breeding of *An.fluviatilis* is often flushed out.

Resting habits: Rests indoors in human dwellings and cattlesheds.

Biting time: Generally enters houses at dusk and completes feeding before midnight with peak from 09.00 to 11.00 hrs.



Feeding preferences: This species is in general highly anthropophilic; may be mainly zoophagic in northern India.

Flight range: Limited flight range.

An. minimus

Distribution: Distribution is restricted to the north-eastern states. This species was thought to have been eliminated as a result of insecticidal spraying in 1950's and 1960's but reappeared in late 1970's.

Breeding places: *An. minimus* breeds in shaded slow flowing streams with grassy margins, swamps, ditches, channels, shallow earth wells; occasionally found to breed in borrowpits, rice fields and seepage from flowing water.

Resting habits: Rests in houses and cattlesheds, preferring to rest on the lower portions of walls.

Biting time: Peak biting activity occurs from 18.00 to 19.00 hrs outdoors and 24.00 to 02.00 hrs indoors. Biting time may vary from locality to locality and seasonally.

Feeding habits: A highly anthropophilic species, and as a consequence a very efficient vector of malaria.

Flight range. Normally 0.5 km but can disperse upto 2 kms from the original locality.



An. philippinesis

Distribution: Distributed in West Bengal, North Eastern states and Andaman and Nicobar Islands. Breeding places. Breeds in tanks, swamps, ditches, rice fields, pools, leaf axils, shaded lake margins, inundated drains and water bodies with generally good growth of vegetation.

Resting habits: During daytime adults rest in cattlesheds and human dwellings.

Biting time: Biting outdoors and indoors throughout night with two biting peaks from 20.00 to 22.00 and 02.00 to 04.00hrs.

Feeding habits: Predominantly zoophagic but also bites man.

Flight range. Normally upto 0.8 km.



An. dirus

Distribution: Distribution restricted to the forested areas of the seven north eastern states.

Breeding places: Breeds in pools and rain water collections in deep forest and forest fringes, stream margins with decaying organic matter, and animal foot prints during high monsoon.



Resting habits: Enters human dwellings to bite and rest but has a tendency to leave houses soon after blood meal.

Biting time: The peak biting activity is from 22.00 to 02.00 hrs.

Feeding habits: High preference for human blood but also bites monkey, other primates and cattle.

Flight range: Flight range varies from 1 to 2.5 km in forests.

An. stephensi

Distribution: Distributed throughout India except at higher altitudes; found sporadically in the north-east.

Breeding places: Breeds in wells, overhead and ground level water tanks, cisterns, rain water collections in roof gutters, peridomestic containers, and underground water storage tanks. In Rajasthan desert it breeds and rests in the water storage tanks called Tankasi in the rural areas.



Resting habits: Rests in human dwellings and cattlesheds. Inside human dwellings it may rest on hanging objects, behind curtains etc. Outdoor resting has been observed in wells and underground cement tanks.

Biting time: Biting varies from area to area and seasonally, but peak biting activity is generally from 22.00 to 24.00 hrs.

Feeding habits: An indiscriminate feeder and bites both man and animals.

Flight range: Limited flight range in the urban areas but in rural areas the flight range may be upto 3 kms.

An. annularis

Distribution: Occurs all over the country. Not found in the Andaman and Nicobar and Lakshadweep islands.

Breeding places: Breeds in still waters with abundant vegetation in a variety of water bodies; also breeds in wells, moats, tanks, borrowpits, rice fields and other water bodies such as lakes and stream margins with vegetation.

Resting habits: During day time rests in houses, cattlesheds and mixed dwellings, and also rests outdoors in small numbers.

Biting time: Peak biting activity takes place from 22.00 to 24.00 hrs.

Feeding habits: Azoophilic mosquito; biting on man is infrequent.

Flight range: Normally upto 1 km.

An. varuna

Distribution: Distributed widely in the country from north east plains, peninsular India, and the Lakshadweep islands.

Breeding places: Breeds in rain water pools, tanks, ponds, rice fields, drains, irrigation channels, wells and slow moving streams with plenty of shade provided by overhanging vegetation.

Resting habits: Rests indoors during daytime in human dwellings, cattlesheds and mixed dwellings. Rests outdoors near stream banks.

Biting time: Biting goes on throughout night, but the peak biting activity is from 24.00 to 02.00 hrs.

Feeding habits: Resting habits may differ from area to area.

Flight range: About 1 km.

An. sundaicus

Distribution: Reported from coastal Orissa, Andhra Pradesh and West Bengal in 1950's. At present it is restricted to Andaman and Nicobar Islands.

Breeding places: Breeds in brackish water pools with algae, margins of mangroves and lagoons and swamps. *An. sundaicus* can tolerate salinity levels from 0.08 to 2.6 percent and pH from 7.7 to 8.5.

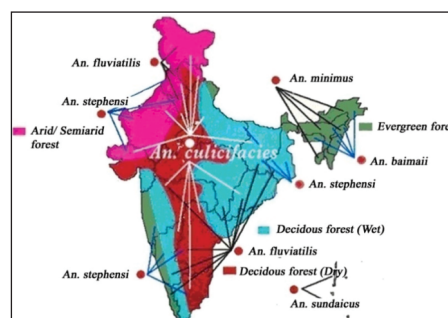
Resting habits: Rests indoors in human dwellings, cattlesheds and mixed dwellings.

Biting time: Biting goes on throughout the night but peak biting is from 20.00 to 02.00 hrs.

Feeding habits: An opportunistic feeder, prefers to bite man.

Flight range: About 1-3 kms.

Vector Situation: *An. Culicifacies* is the main vector of rural and peri-urban areas and is widespread in peninsular India. It is highly zoophilic and therefore a high density of cattle limits its vectorial capacity. *An. culicifacies* is a complex of 5 sibling species designated as A, B, C, D and E. Species A has a relatively higher degree of anthropophagy as compared with species B. Species A is an established

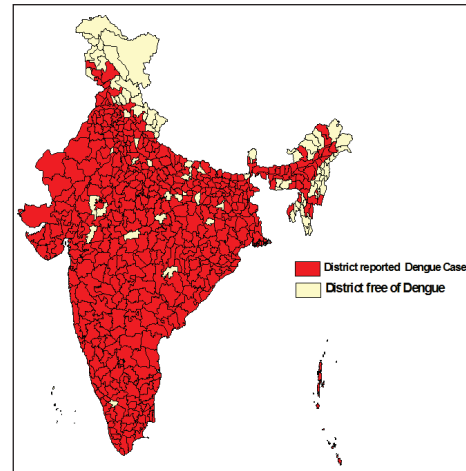


vector of *P. vivax* and *P. falciparum*, whereas species B is completely refractory to *P. vivax* and partially refractory to *P. falciparum*. It has been demonstrated that species B, however, may play a role as a vector of *P. falciparum* in areas where the cattle population is very low or absent. *An. Stephensi* is responsible for malaria in urban areas and is a complex of 3 variants, i.e. type form, intermediate form and mysorensis form. The type form is found in urban areas; intermediate form in urban and semi-urban localities and mysorensis form in rural areas. Both type form and intermediate form act as vectors whereas the mysorensis form is not a vector. *An. fluviatilis* is the main vector in hilly areas, forests and forest fringes in many states, especially in the east. *An. fluviatilis* is a complex of 4 sibling species designated as S, T, U and V, of which species S is highly anthropophagic and an efficient vector of malaria. *An. Minimus* is the vector in the foothills of north-eastern states. *An. dirus*

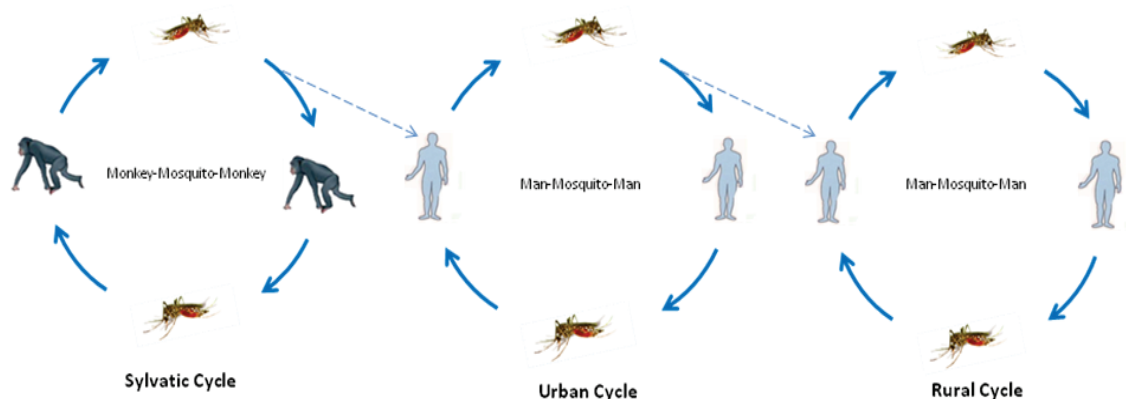
is an important forest vector in the north-east, and is well known for its exophilic behaviour. *An. epiroticus* (formerly *An. sundaicus*), a brackish-water breeder in India is now restricted to the Andaman and Nicobar Islands.

Dengue:

Disease Situation: Dengue fever is rapidly emerging in India and is now present in both urban and rural areas. The Dengue virus genus *Flavivirus* has four serotypes viz., DENV-1, DENV 2, DENV-3 and DENV-4. Dengue is endemic in 35 states (except Lakshadweep) which have reported dengue cases from time to time. In 2014, a total of 40,571 cases and 137 deaths were reported from 26 States and 6 UTs.



Transmission: Dengue viruses are transmitted from infected person to others by the bite of female *Aedes* mosquitoes. Transmission of Dengue depends upon a complex relationship between epidemiological factors viz., agent (virus), host (man and mosquito), and the environment (abiotic and biotic factors). The complexity of relationship among these factors eventually determines the level of endemicity in an area. In India, *Ae. aegypti* is the main vector in most urban areas; however, *Ae. albopictus* is also incriminated in many states. *Ae. albopictus* has posed serious threats of dengue transmission in southern states and NE states. The chain of dengue transmission is shown in the figure:



The female *Ae. aegypti* becomes infected with Dengue virus when it takes blood meal from a person during the acute febrile (viraemia) phase of Dengue illness. The Extrinsic Incubation Period (EIP) is 8 to 10 days and afterwards mosquito becomes infective. Intrinsic incubation period is about 5-7 days. The viraemic period ranges from 2 to 12 days with an average of 4-5 days. During this period, a dengue-infected person is capable of transmitting dengue viruses to *Aedes* mosquitoes. Transmission dynamics of dengue is correlated to the abundance of vector density. During Monsoon and post-monsoon the preponderance of vector increases due to abundance of breeding habitats in rain fed containers. The disease has a seasonal pattern i.e., the cases peak after monsoon and it is not uniformly distributed throughout the country. However, the states in southern and western parts of the country

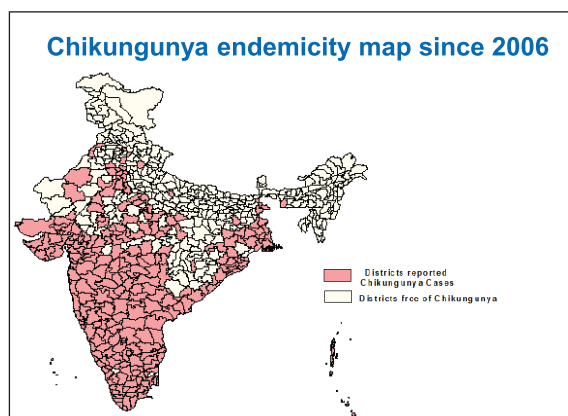
report perennial transmission. The *Ae. aegypti* mosquito prefers to bite humans, and is easily disturbed by the movement of host during feeding. Thus, an Aedes mosquito has to bite several persons to complete a blood meal. During the process Aedes infects several persons in the same household or in close proximity resulting in clustering of cases.

Chikungunya

Disease Situation:

Chikungunya fever is viral disease, caused by an arbovirus and transmitted by Aedes mosquito. Chikungunya virus (CHIKV) is a single-stranded RNA Alphavirus from the family Togaviridae. It is a debilitating but non-fatal viral illness. In India a major epidemic of Chikungunya fever was reported during the last millennium (during 60s & 70s). After quiescence of three decades in 2006, Chikungunya outbreak occurred again in India. Total 1.39 million clinically suspected cases were reported from 16 states/UTs out of 35 in the country which were reduced in 2015 to 26308 cases. Both the urban and rural areas were affected. All age groups were affected and no sex differentiation reported from any of the states.

Transmission: It is spread by the bite of Aedes mosquitoes, primarily Aedes (*Ae.*) *aegypti*. Humans are the major source, or reservoir of Chikungunya virus for mosquitoes. The Chikungunya virus is transmitted from human to human by the bites of infected female mosquitoes. Most commonly, the mosquitoes involved are *Ae. aegypti* and *Ae. albopictus*, two species which also transmit dengue.



The Extrinsic Incubation Period is about 8 to 10 days, and Intrinsic Incubation Period of Chikungunya virus is 5-7 days.

Vectors of Dengue and Chikungunya:

Aedes aegypti is common vector for dengue and chikungunya.

Distribution: The density of Aedes mosquito is more during monsoon and post-monsoon season. In dry area or water scarcity areas, the vector density is linked to water storage practices.

Breeding places: *Ae. aegypti* is the main vector in urban, semi-urban and rural areas. *Ae. aegypti* mosquitoes prefer to breed in man-made containers, viz., , i.e water storage containers, water tanks (cement tanks, overhead tanks, underground tanks), exterior extensions of building, coolers, discarded buckets, bottles, tyres, and coconuts shells etc. in which water stagnates for more than a week. In



unfavorable conditions, the eggs can be viable for over a year in a dry state, which allows the mosquito to re-emerge after winter or dry spell. The eggs (upto 100-120) are laid singly on damp surfaces just above the water line.

Resting Habits: *Ae. aegypti* prefers to rest in dark corners of the houses, on dark clothes, umbrellas, under furniture & beds, shelves, coolers, behind hangings, shoes, besides house hold articles, curtains etc but rarely on walls.

Biting time: This is a day biting mosquito has to bite many times to complete blood meal as during day time mostly humans are active. These are therefore known as indiscriminate feeder.

Feeding habits: The species is strongly anthropophilic having high preference for human blood.

Flight range: Average flight range of *Aedes* is 100-300 meters. The flight range for *Aedes* is generally 100 meters but it can fly upto 400 meters.

Aedes albopictus

Distribution: It is the secondary vector in sylvatic areas. It is a feral species & spread disease in built-up areas, particularly in parks and gardens. It also co-breeds in peri-domestic locations in Trash. The species feeds on human & also on other animals.

The *Ae. albopictus* can be easily separated from *Ae. aegypti* on the basis of presence of white strips down the center beginning at the dorsal surface of the head & continuing along the thorax of *Aedes albopictus*.



Breeding places: *Aedes albopictus* mosquitoes prefer to breed in natural habitats like tree holes, latex collection cups of rubber plantations, leaf axils of pine apple plants, coconut shells etc.

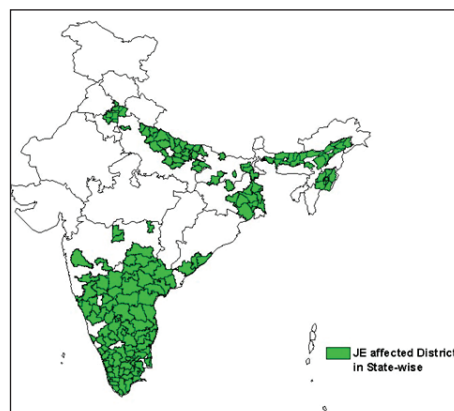
Resting Habits: *Ae. albopictus* mosquito rests outside in bushes, shrubs, long grasses in and around peri-domestic situations but sometimes found in domestic conditions as well.

Biting habits: The *Ae. albopictus* feeds on different vertebrate hosts including human being. It is also a day-biter.

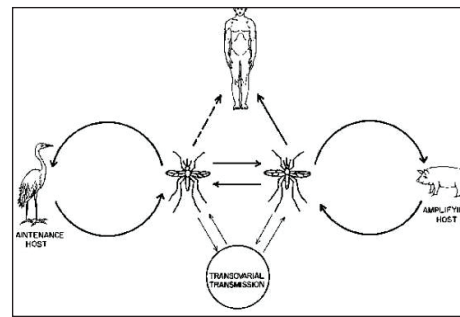
Flight range: The flight range for *Ae. albopictus* is upto 400 meters. It may also disperse to newer areas through passive transportation (especially eggs).

Japanese Encephalitis

Disease Situation: Japanese encephalitis (JE) is a viral disease of major public health importance in India because of its epidemic potential, high case fatality rate and presence of life-long complications in survivors. It is a single-stranded RNA virus that belongs to the genus *Flavivirus*. Disease is prevalent in most of south central, northern and northeast states of India, predominantly in rural areas, although some urban areas also report cases. JE is a paediatric problem affecting mainly 1-15 years olds. However, in areas where JE has not been reported earlier, all age groups may be affected during an outbreak due to lack of immunity.



Transmission: In areas at risk, Japanese encephalitis is primarily a disease of children, but it can occur in a person of any age. JE virus is transmitted to humans through the bite of infected *Culex vishnui* group of mosquitoes, particularly *Culex tritaeniorhynchus*. The main reservoirs of the JE virus are pigs and water birds, and in its natural cycle, virus is maintained in these animals. Man is an accidental host and does not play a role in JE transmission. After



9-12 days (extrinsic incubation period), mosquitoes transmit disease to other vertebrate hosts. Epidemics occur during monsoon and post monsoon period because the vector density is high. However, in endemic areas, sporadic cases may occur throughout the year.

Vectors

Culex vishnui subgroup mosquitoes, comprising *Cx. tritaeniorhynchus*, *Cx. vishnui* and *Cx. pseudovishnui*, have been implicated as major vectors of JE in India. *Cx. tritaeniorhynchus* as the primary vector. *Cx. pseudovishnui*, *Cx. whitmorei*, *Cx. gelidus*, *Cx. epidemus*, *Anopheles subpictus*, *An. Peditaeniatus* and *Mansonia uniformis* are suspected to play some role in the epidemiology of JE in Gorakhpur.



Distribution: These mosquitoes are usually found in rural rice growing and pig-farming regions but can also be found at the outskirts of cities in close proximity to human populations..

Breeding places: They prefer to breed in rice fields. A conducive ecosystem comprising of irrigation canals, rice fields, ponds, ditches and lakes favour JE vector breeding particularly in rural areas. However in semi urban areas, breeding of *Culex vishnui* group of mosquitoes found in small ponds and ditches with water hyacinth and other aquatic plants. JE is reported under AES in the country. During 2015, out of total 8794 cases with 1192 death due to AES, JE cases were 1623 with 281 deaths.

Resting habits: Main vectors of JE are outdoor resting.

Biting time: JE vectors are crepuscular in nature.

Feeding habits: JE vectors are mainly exophilic and endophagic in nature.

Flight range: Flight range varies from 1 to 3 km.

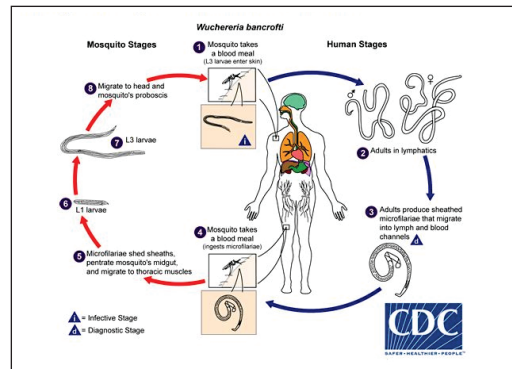
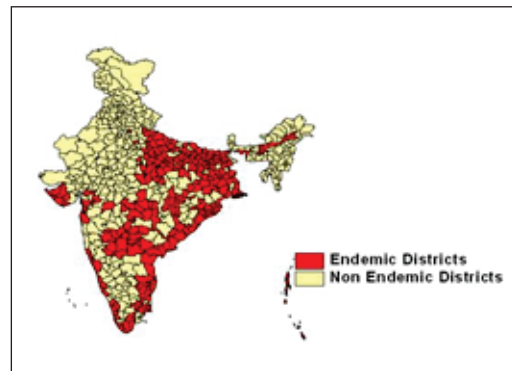
Lymphatic Filariasis

Disease Situation

In India, 255 districts in 21 states/UTs covering about 630 million population, were identified as endemic for lymphatic filariasis (LF). There has been a gradual decline in the microfilaraemia rate nationwide from 1.24 in 2004 to 0.4 in 2015. 222 out of 255 LF endemic districts have already achieved microfilaria rate less than 1%. LF is slated for elimination in

India by 2015. Out of 255 districts, 55 has been validated successfully through Transmission Assessment Survey (TAS) and 63 are in process. Remaining 137 districts were covered under Mass Drug Administration with DEC + Albendazole in 2015. About 8 lakhs Lymphodema and 4 lakhs Hydrocele cases have been linelisted and more than 1 lakh hydrocele cases have been operated since 2005 till 2015.

Transmission: Lymphatic filariasis is caused by three species of parasitic worm, *Wuchereria bancrofti*, *Brugia malayi* and *B. timori*, which have generally similar life cycles. In the human body, adult worms (male and female) live in nodules in the lymphatic system and, after mating, produce numerous microfilariae, which circulate in the bloodstream. The lifespan of adult worms is 4-6 years. Microfilariae migrate between the lymph system and blood channels to reach the peripheral blood vessels, often at times that coincide with the peak biting activity of local vectors. The microfilariae are picked by mosquitoes while feeding and these develop in thoracic muscles. The larvae grow and moult into second-stage (L2) and again to produce third-stage larvae (L3). This process takes 10-12 days from the L1 stage to the L3 stage. The infective larvae migrate to the mosquito's proboscis and are deposited on the skin and find their way through a bite wound. The L3 develop to fourth-stage larvae (L4) as they migrate through the human body to the lymphatic vessels and lymph nodes, where they develop into adult worms.



The transmission dynamics of lymphatic filariasis are complex, involving two genera of parasite (*Wuchereria* and *Brugia*) and a number of genera of mosquito carriers. The four main genera are *Anopheles*, *Culex*, *Aedes* and *Mansonia*. The biological features of the vector-parasite relationship should be understood in order to define the entomological variables critical to lymphatic filariasis transmission and the threshold for interrupting transmission. Unlike the transmission of malaria and arboviruses, that of lymphatic filariasis is inefficient, and a large number of bites from infectious mosquitoes is required to initiate a new infection with microfilaraemia.

Many factors contribute to the inefficient transmission of lymphatic filariasis. Firstly, microfilariae do not multiply in the mosquito body; hence, the number of L3 is limited by the number of microfilariae ingested. Second, only those mosquitoes that survive more than 10 days will contribute to transmission of the parasites. Those mosquitoes that die before the L3 develops, cannot play a role in the transmission cycle. Third, the L3 are deposited on the skin and have to find their way into the bite wound (rather than being injected with the mosquito saliva like malaria sporozoites).

Vectors

Distribution: *Culex quinquefasciatus* breeds in association with human habitations. It is the most common house frequenting mosquito.

Breeding places: Breeds in any type of habitat ranging from fresh and clear to brackish, turbid and polluted water in ground pools, ditches, drains, sewages, Septic tanks etc. and in various kinds of artificial containers (bottles, cans, flower pots, vases, bowls, jars, cement tanks etc.), (Indoor / outdoor).

Resting Habits: Enter houses for feeding at night and for resting during daytime. These mosquitoes rest in dark corners of walls, on hanging objects, cobwebs, inside shoes, cupboards, under cots, tables and chairs etc.

Biting time: Blood feeding takes place within 24-48 hrs after mating from sun set until dawn. Highest peak is in late night or third quarter of night. It is endophagous as well as exophagous.

Feeding habits: Highly anthropophilic; but also attacks birds such as fowls and other domestic animals.

Flight range: Average flight range of *Cx. quinquefasciatus* is about 2-3 km. Males are weak fliers.



Mansonia Species:

Important vector spp are *Mn. annulifera*, *Mn. uniformis* and *Mn. indiana*

Distribution: Both species are found throughout year and their presence is associated with presence of Pistia plants which are water plants and act as host for larvae.

Breeding places: Breeding of *Mansonia* spp. is restricted to fresh water ponds, lakes, swamps & channels with floating



vegetation and high organic pollution with a pH range of 6.2-6.8. *Pistia stratiotes* is the most preferred plant for breeding of *Mn. annulifera* but *Salvinia* plant is preferred by *Mn. uniformis*. *Mansonia* spp. lay eggs (clusters of 80-120) on under surface of floating water plants. Tips of pupal breathing trumpet is modified for attachment. Larvae & pupae get available oxygen from air spaces of the floating vegetation.

Resting Habits: *Mn. annulifera*, endophilic & endophagous, rest in dark corners of house, *Mn. indiana* mostly confined to cattle sheds & other outdoor situations.

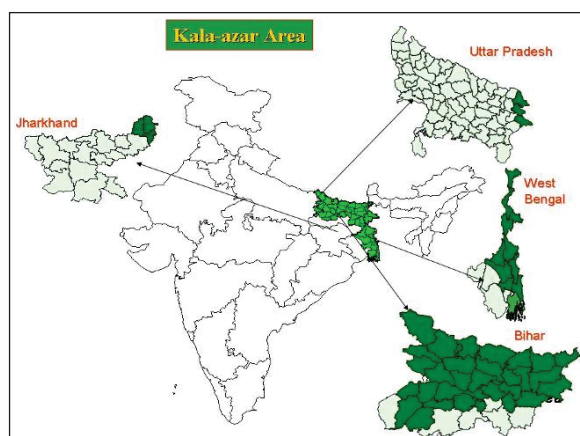
Biting time: Active throughout night with peak biting activity in I & II quarters of night. Endophagous in nature.

Feeding habits: *Mn. annulifera*, highly anthropophilic; *M. uniformis*, more zoophilic.

Flight range: Dispersal: Not strong fliers, easy to catch since hop about like sandflies. Silent in flight with limited flight range.

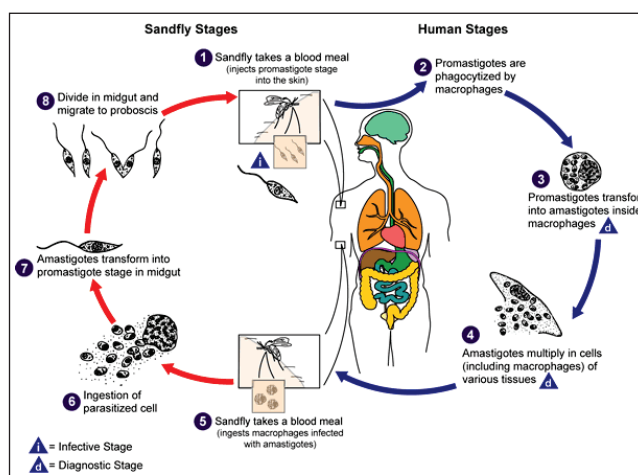
Kala azar

Disease Situation: Kala azar (*visceral leishmaniasis*) due to *Leishmania donovani* is restricted to the eastern India where it is endemic in 54 districts in 4 states: 31 districts of Bihar, 4 districts of Jharkhand, 11 districts of West Bengal besides occurring in sporadic form in 6 districts of eastern Uttar Pradesh. An estimated 130 million people are at risk from Kala-azar in endemic districts of 4 states. In 2015, reported cases in country are 8223 with 5 deaths. Kala-azar affects the socially marginalised and poorest communities. The kala azar has been targeted for elimination by 2015.



Transmission: Visceral Leishmaniasis or Kala-azar is transmitted by the bite of infected sandflies. *Phlebotomus argentipes* is the only known vector of Kala-azar in India. The seasonal prevalence of this species varies from area to area depending upon the ecological conditions. Disease transmission is highest in the rainy season.

Kala-azar in India has a unique epidemiological feature of being anthroponotic, i.e. human beings are the only known reservoirs of infection. The female sandflies pick up the amastigote stage (LD bodies) of the parasite while feeding on an infected human host.



The parasites undergo development and multiplication in the gut of sand flies to become numerous flagellates (Promastigote or Leptomonad stage) which migrate to their mouthparts. The cycle in the sand flies is completed in about 8 days. Infection is transmitted to healthy human beings when such infective sand flies bite them.

Kala-azar being a chronic disease has a long incubation period which varies from 1-4 months, however, in India the range varies from 4 months to 1 year. The extrinsic incubation period in the vector sand flies vary from 4-25 days which is the time required for the vector to become infective after an infective blood meal. The parasite primarily infects reticulo-endothelial system and may be found in abundance in bone marrow, spleen and liver. Post Kala-azar Dermal Leishmaniasis (PKDL) is a condition in which the *Leishmania donovani* invades cells of skin and develops lesions. This results in skin manifestations of PKDL. Some of the Kala-azar cases manifest PKDL after a few years of treatment.

Vectors

Kala azar Vector - *Phelbotomus argentipes*, commonly known as sand fly is the only vector of VL in India. Adult sand fly small, fuzzy, delicately proportioned, 1/4th the size of mosquito. Length ranges from 1.5 to 3.5 mm.

Distribution: In India distribution mostly on the eastern half of the country though reports of its prevalence have also emerged from other parts as well. *Ph. argentipes* found throughout the year in majority of areas of prevalence with complete absence in winter months. Though sand flies are not found at the altitude above 600 meters, sporadic occurrence in India has been recorded in Kasauli at a height of 1200 meters and at 1300 meters in Pauri Garhwal in Himalayas.

Breeding places: Humid soil rich in organic matter and near cattle sheds and mud- houses

Resting Habits: Resting sites include cracks and crevices, burrows, tree holes, termite hills, earthen mounds, under stone and foliage etc

Biting habits: Opportunistic feeder and mostly zoophilic in nature. Longevity under lab conditions ranges from 23-27 days but in field conditions from 16-20 days.

Flight range: These are poor fliers and mostly hop covering a distance of less than than ½ metre.



Integrated Vector Management- Implementation

Integrated Vector Management (IVM) is a rational decision-making process to optimize the use of resources for vector control. It requires a management approach that improves the efficacy, cost effectiveness, ecological soundness and sustainability of vector control interventions with the available tools and resources. Integrated approach is vital in successfully combating vector-borne diseases. Various key elements of IVM are Advocacy, social mobilization, strengthening of regulatory and legislative controls for public health, empowerment of communities, collaboration within health and other sectors in planning and decision-making, use of available resources for vector control, implementation of evidence-based strategies and capacity-building. The basic concepts for IVM implementation are:

- Which mosquito species are locally important as vectors of human diseases?
- Which mosquito species are important as the primary source of annoyance?
- What are the important breeding sites of different mosquito species?
- What is the seasonal pattern of mosquito breeding?
- What are the resting places of adult mosquitoes?
- What are the feeding preferences of vector mosquitoes?
- To map out and locate all potential larval development habitats
- To identify the mosquito species present
- To predict the time and location of effective control strategies.

Though different integrals of IVM have been under implementation in isolation or in combination in different situation, there is a felt need that a comprehensive document describing IVM concept, its components and strategy for different diseases are compiled. The NVBDCP aims to achieve effective vector control by the appropriate biological, chemical and environmental interventions of proven efficacy, separately or in combination as appropriate to the area through the optimal use of resources. Efforts are made for collaboration with various public and private agencies and community participation for vector control. Integration of IVM is done by using identical vector control methods to control vector borne diseases malaria, kala azar, Japanese encephalitis, dengue, chikungunya and Lymphatic filariasis.

STRATEGY: The IVM includes implementation of all feasible strategies safely with or without insecticides to manage vector population in such a way so that disease transmission is kept under check. It also includes management of insecticide resistance either by rotation within the same group or different group

TOOLS: There are many tools available and recommended for vector control. Some are used for personal protection and some are their combination are used as public health measures

1. Source reduction & Environmental management
2. Personal Protection
3. biological (fish)
4. chemical
 - a. larvicide
 - b. Adulticide

Environmental methods to control *Ae. aegypti* and *Ae. albopictus* and to reduce man-vector contact are source reduction, solid waste management, modification of man-made breeding sites, and improved house design.

IVM will be implemented with:

- entomological surveillance in sentinel and random sites at monthly/quarterly/annual intervals. This has been described in detail in separate chapter
- promotion of source-reduction, minor engineering etc, by involvement of panchayati raj institutions at village level.
- Scaling up use of larvivorous fish with involvement of NGOs under PPP model;
- appropriate use of insecticides for supervised IRS with full support from NVBDCP;
- scaling-up use of LLIN;
- treatment of community owned bed-nets;
- intensified anti-larval operations in urban and peri-urban areas within the states/districts;
- supportive interventions including IEC and BCC activities through village health and sanitation committee meetings on monthly basis, inter-sectoral collaboration meetings in district and blocks with API more IEC and BCC activities through village health and sanitation committee meetings on monthly basis, inter-sectoral collaboration meetings in district and blocks with API more than 1 and involvement of other sectors for social mobilization towards prevention and control with coordinated efforts of district programme managers. Training, monitoring and supervision for the activities will be undertaken as well as monitoring towards timely performance of activities.

Each of the above activities is detailed below;

- **Source reduction and Environmental management** involves any change that prevents or minimizes vector breeding thereby reducing human-vector contact.

The major environmental management methods used for the control of the immature stages of dengue vectors are summarized as below:

- **Improved water supply:** In deficient and irregular piped water supply is inadequate and available only at restricted hours or at low pressure, the storage of water in varied types of containers is encouraged, thus leading to increased *Aedes* breeding. The majority of such containers are large and heavy (e.g storage jars) and can neither be easily disposed of nor cleaned. It is therefore essential that potable water supplies be delivered in sufficient quantity, quality and consistency to reduce the necessity and use of water storage containers that serve as the most productive larval habitats.

- **Mosquito-proofing of overhead tanks/ cisterns/ underground reservoir/wells:** These structures should be mosquito-proofed either with tight lid or with proper mesh.
- **Flower pots/vases and ant traps:** Flower pots, flower vases and ant traps are common sources of *Ae. aegypti* breeding. They should be punctured to produce a drain hole. Alternatively, live flowers can be placed in a mixture of sand and water. Flowers should be removed and discarded weekly and vases scrubbed and cleaned before reuse. Ant traps to protect food storage cabinets can be treated with common salt or oil.
- Desert water coolers, condensation collection pans under refrigerators, and air conditioners should be regularly inspected, drained and cleaned.
- **The design of buildings** is important to prevent breeding. Drainage pipes of rooftops sunshades/porticos often get blocked and become breeding sites for mosquitoes. There is a need for periodic inspection of buildings during the rainy season to locate potential breeding sites.
- **Mandatory water storage for fire fighting:** Fire prevention regulations may require mandatory water storage. Such storage tanks need to be kept mosquito-proofed. In some municipalities in India, timber merchants are required to maintain full of water for fire fighting. These drums should also be mosquito proof.
- **Solid waste disposal:** Solid wastes, namely tins, bottles, buckets or any other waste material scattered around houses, should be removed and buried in landfills. Scrap material in factories and warehouses should be stored appropriately until disposal. Household and garden utensils (buckets, bowls and watering devices) should be turned upside down to prevent the accumulation of rain water. Plant waste (coconut shells, cocoa husks) should be disposed of properly and without delay.
- **Tyre management:** Used automobile tyres are of major importance as breeding sites for *Aedes*, and are therefore a significant public health problem. Tyre depots should always be kept under cover to prevent the collection of rain water.
- **Filling of cavities of fences:** Fences and fence posts made from hollow trees such as bamboo should be cut down to the node, and concrete blocks should be filled with packed sand, crushed glass, or concrete to eliminate potential *Aedes* larval habitats.

Personal Protection

- **Protective clothing:** Clothing reduces the risk of mosquito biting if the cloth is sufficiently thick or loosely fitting. Long sleeves and trousers with stockings protect the arms and legs, the preferred sites for mosquito bites. Schoolchildren should adhere to these practices whenever possible.
- **Mats, coils and aerosols:** Household insecticidal products, namely mosquito coils, electric vaporizer mats and liquid vaporizers, pyrethrum space spray and aerosols have been used extensively for personal protection against mosquitoes.

- **Repellents are** a common means of personal protection against mosquitoes and other biting insects. These are broadly classified into two categories, natural repellents and chemical repellents. Essential oils from plant extracts are the main natural repellent ingredients, i.e. citronella oil, lemongrass oil and neem oil. Chemical repellents such as DEET (N, N-Diethyl-m-Toluamide) can provide protection against *Ae. albopictus*, *Ae. aegypti* and anopheline species for several hours.
- **Insecticide-treated mosquito nets and curtains:** Insecticide-treated mosquito nets (ITMN)/LLINs are used under programme since many years in high malarious areas. Though LLINs have limited utility in dengue control due to day biter vector, it can be effectively utilized to protect infants and night workers who sleep during day. Impregnated curtains can be used as mosquito nets are not used by all in every area due to weather conditions.

Biological Control: The application of biological control agents against the larval stages of mosquitoes used under programme are mainly fish or bacteria.

- **Fish:** Larvivorous fish (*Gambusia affinis* and *Poecilia reticulata*) have been extensively used for the control of *An. stephensi* and/or *Ae. aegypti* in large water bodies or large water containers in many parts of countries.
- **Bacteria:** Two species of endotoxin-producing bacteria are recommended under programme which are *Bacillus thuringiensis* serotype H-14 and *Bacillus sphaericus*. These are effective mosquito control agents and do not affect non-target species. Bt.H-14 has been found to be most effective against *An. stephensi* and *Ae. aegypti*, while Bs is the most effective against *Culex quinquefasciatus* which breeds in polluted waters.

Chemical Control: Chemicals have been used to control vector borne diseases by attacking both larvae and adult of vector species.

- **Larviciding:** Larviciding has to be done at weekly/fortnightly interval to avoid emergence of adults. Its application is difficult and expensive on a long-term basis, therefore chemical larvicides are best used in situations where the disease and vector surveillance indicate the existence of certain periods of high risk and in localities where outbreaks might occur. The rural areas with extensive breeding sites covered under adulticiding programme are traditionally not covered under larviciding in India except in certain situations where dengue cases are reported or rural areas have been urbanized. Control personnel engaged in anti-larval programme should always encourage house occupants to control larvae by environmental sanitation. The larvicides used under programme are described below:

Temephos: Temephos is an organophosphorous compound with very low mammalian toxicity. It is used as 50% emulsion concentrate in programme. The product acts as a contact poison and has a prolonged residual effect. If used in the recommended doses it is not toxic to fish and other aquatic life. One per cent Temephos sand granules are applied to containers using a calibrated plastic spoon to administer a dosage of 1 ppm. This is used in coolers for control of dengue vectors

Insect growth regulators: Insect growth regulators (IGRs) interfere with the development of the immature stages of the mosquito by interference of chitin synthesis during the molting process in larvae or disruption of pupal and adult transformation processes. Most IGRs have extremely low mammalian toxicity. Two such compounds have been recommended in the programme i.e. pyriproxifen and diflubenzuron.

One per cent Temephos sand granules are applied to containers using a calibrated plastic spoon to administer a dosage of 1 ppm. This is used in coolers for control of dengue vectors

- **Adulticiding**

Insecticidal Residual Spray (IRS): Insecticidal Residual Spray is one of the most cost-effective control measures for Malaria and Kala-azar in India. To maximize the impact of IRS, it should be synchronized with case detection. The objective of IRS is to interrupt the transmission by reducing numbers of infective vectors. This can be achieved by ensuring safe and correct application of the insecticide to indoor surfaces of houses and animal shelters. For malaria only human dwelling and for kala azar both human dwelling and animal shelters are covered.

The success of IRS operations depends on the planning and implementation. IRS plans should be developed before end of the year so that there is no last minute rush during implementation. IRS planning should be made, based on the capacity for achieving complete and uniform coverage. When there is resource constraints it is preferable to limit the size of the operation and achieve quality coverage.

IRS for Malaria: IRS at present is carried out in high risk areas ($API \geq 2$) with coverage of about 80 million population. DDT is used in areas where the vector has shown resistance to DDT, the alternatives are malathion and synthetic pyrethroids. Two rounds of spraying are done for DDT and synthetic pyrethroids to provide protection during the entire transmission season; in the case of malathion, three rounds of spraying are required.

About 60% of the high risk areas targeted under IRS are under coverage with DDT. The real coverage by IRS is however limited by the low community acceptance due to the white marks left on plastered surfaces, acrid smell associated with malathion, re-plastering of wall after completion of IRS, etc.

As the programme intends to expand the use of LLINs in high risk areas targeted for vector control, it would not expand the use of IRS further. The focus would be on improving the quality of IRS with meticulous microplanning and intensive monitoring and supervision. With quality IRS, there is every chance that disease control would be possible in these areas in the coming 2-3 years and areas previously qualifying as high risk would shift to low risk. This would bring about a decline in the requirement of insecticides for spray in the following years. The first round of spray in an area is usually done to coincide with the time of build-up of vector populations which precede the malaria transmission season.

Surveillance on insecticide resistance will form a critical component for taking decision on the choice of insecticide to be used. Therefore, the surveillance of resistance by ICMR NIMR and Zonal entomologists will be strengthened.

DDT will continue to be used but efforts will be made to progressively scale down its use. Research for alternative insecticides will be intensified in adherence to Stockholm Convention. The state health services will be responsible for safe disposal of DDT and other insecticides. Environment management plan will be implemented to minimize the damage to the environment due to insecticides. The prioritization made in India for implementation is as below:

API of area	Major activities according to API
Areas with API <1	Vector control by minor engineering measures like desilting, removal of weeds and cleaning of canals and irrigation channels, control by use of larvicides and environmental management
Areas with API between 1-2	Vector control by source reduction and biological control. The LLIN shall be distributed in the areas having API>1 in identified districts based on priority and availability of resources (LLIN)
Areas with API between 2-5	Vector control by distribution of LLIN if acceptability of IRS is low @ 1.8 LLIN per household of 5 members. For areas which can be supervised and accessible, quality IRS for selective vector control based on epidemiological impact of earlier vector control measures, if needed; these areas can also be provided with LLINs
Areas with API >5	Areas with perennial transmission (>5 months in a year) <ul style="list-style-type: none"> • 2 rounds of IRS with DDT and 3 rounds with malathion • Priority distribution of LLINs as per the guidelines • Vector bionomics studies for future change of strategy For areas having seasonal transmission (less than 5 months in a year) <ul style="list-style-type: none"> • 1 round of IRS with DDT before start of transmission • Focal spray in and around 50 houses of positive cases. • Priority distribution of LLINs as per the guidelines
While this stratification based on API is useful on a crude level, it is less useful to determine what sort of vector control interventions will be applicable in a particular area. Areas can also be stratified according to their ecotype as follows which can be used for decision making on vector control interventions :	

Type	Ecotype / paradigm	Recommended vector control measures
1.	Tribal areas with malaria associated with forest (NE states, Orissa, Jharkhand, Chhattisgarh, some foci in other states) Undulating hills/foothills with perennial rain in North East, hilly rainforest with <i>An. dirus</i> Hilly partially deforested cultivated forest fringe (<i>An. dirus</i> , <i>An. minimus</i>) Undulating, sometimes deforested with rice cultivation (<i>An. fluviatilis</i> , <i>An. minimus</i> ,) Peninsular deep forest or forest fringe (<i>An. fluviatilis</i> , <i>An. culicifacies</i>)	IRS / ITNs / LLINs; Limited role for larval control
2.	Malaria in organized sector/army/road construction/tea gardens	Same as above & personal protection, chemoprophylaxis
3.	Epidemic prone areas (Punjab, Haryana, Western UP and Rajasthan) Plain tube-well irrigated areas Plains with sandy soil and no water-logging Deserts (especially Rajasthan)	Anti-larval including larvivorous fish in some areas; One round of IRS Space spray & IRS in outbreaks
4.	Economic development project areas	Mass screening of incoming labourers, anti-larval measures, IRS / ITNs / LLINs
5.	Urban malaria	Chemical and biological larviciding, environmental measures, ITNs / LLINs, house screening, other personal protection measures and focal IRS in areas where this is possible (mainly single-story buildings).
In areas with perennial transmission (>5 months in a year), LLINs should be in place all year round and 2 rounds of IRS with DDT or 3 rounds with malathion are required. In areas with seasonal transmission LLINs should be distributed before start of transmission season and 1 round of IRS with DDT is required before transmission. Source reduction by environmental management and larviciding can be done as per feasibility. Waste removal and channelization for water flow should be done before rainy season. It does not make sense to larvicide during periods of exceptionally heavy rainfall since many larvae will be washed away and the larvicide diluted.		

IRS for Kala azar: The entire village needs to be covered if selected for IRS. Following criteria are applied while selecting areas for IRS:

- All villages within a Block PHC which reported Kala-azar cases in the past three years;
- New villages which reported cases during year of spray;
- Villages free of Kala-azar, but on search were found to have cases conforming to the case definition.

Two rounds of IRS with DDT 50 % at a dose of 1gm/sq meter are carried out in a year. Spraying should be started before onset of Kala-azar transmission season which coincides with time of build-up of vector populations. The build-up in vector population starts in March and peak Kala-azar transmission season is from June to October. The effectiveness of DDT lasts for about 10 weeks. Therefore, two rounds of DDT are done, the first in February - March and the second in May - June, to control the vector population and for providing protection during entire transmission season. As it is difficult to conduct spray operations during monsoon, it may sometimes be necessary to delay the 2nd round till the monsoon subsides.

For Kala-azar elimination, the insecticidal spray is done up to a height of 6 feet only as the sand fly vector cannot hop above this height. Cattle sheds are also to be covered for interrupting transmission of Kala-azar. The veranda and areas with full sun light should be avoided for spray.

The average requirement of DDT is 150 grams per house in the rural areas and the average surface area for spray per house is 75 square meters. For one million population the requirement of DDT is 75 metric ton (MT) for both the round ie 37.5 MT for each round of spray.

Use of Synthetic Pyrethroid (SP) has been recommended in areas showing DDT resistance in pursuit to achieve the goal of elimination. The change is based on studies of RMRI, NCDC and CARE India in some districts of Bihar.

Vector Management for Dengue/Chikungunya

A package of vector control interventions against dengue and chikungunya is advised, targeting both the immature and adult stages of the vector and ideally combining chemical and environmental methods. Unfortunately the evidence base on vector control against dengue and chikungunya is poor. This is due to a lack of well-conducted studies that are unable to attribute declines in cases to vector control interventions or studies that have only entomological endpoints. A critical review of dengue control tools by an expert panel convened by the Partnership for Dengue Control Initiative was not able to recommend specific interventions. Nonetheless in the absence of convincing data we recommend that control programmes should monitor the effectiveness of their interventions. Larval source management should be in place for routine control. If there is an outbreak then these interventions should be intensified with additional interventions implemented such as indoor space spraying, fogging or ultra-low volume (ULV) spray. However, the evidence base for aerial or truck mounted ULV is limited since this intervention has no sustained impact on mosquito populations, is not cost effective for routine delivery during outbreaks and efficacy is variable because droplets may not penetrate inside houses to where *Ae. aegypti* are resting, especially if householders do not comply with requests to open their doors and windows. Vector control interventions are similar whether the disease is in urban or rural areas, although container types are likely to differ e.g. air conditioning units in urban areas.

Tools recommended	Tools with some evidence / or evidence to recommend their use in certain settings or populations	Tools for which there is currently insufficient evidence to recommend their use in public health but could provide individual protection
ROUTINE CONTROL		
Container larviciding using insecticides (e.g. temephos) or microbial larvicides	LLINs (particularly for dengue patients but also infants/children sleeping during the day)	Topical repellents, long-sleeved shirts and long trousers, protective clothing & household insecticides
Environmental modification e.g., improved water supply, mosquito proofing of overhead tanks, cisterns or underground reservoirs	Indoor residual spraying (IRS)	
Environmental manipulation e.g., container removal, emptying and cleaning containers, puncturing containers, expanded polystyrene beads in water cisterns, checking for blocked gutters and flat roofs	Perifocal insecticide spraying e.g. tyres with residual insecticides	
Social mobilisation campaigns		
Insecticide-treated curtains		
Screening of doors and windows		
Legislation e.g. Model Civic Byelaws, Building Construction Regulation Act, Environmental Health Act etc		
EPIDEMIC CONTROL		
Indoor space spraying using pyrethrum	LLINs (for dengue patients)	
Fogging or Ultra Low Volume (ULV) spray using malathion or cyphenothrin	IRS	
Intensified social mobilisation campaigns		
Epidemic control legislation (e.g. Model Civic Byelaws)		
Where to implement these interventions? When to implement?		
<p>As mentioned, a background of interventions should be established in dengue and chikungunya endemic areas and some additional interventions added and existing ones scaled up when an outbreak occurs. Early warning systems are needed to predict dengue and chikungunya outbreaks. In India this is based on case reporting at sentinel hospitals or Integrated Disease Surveillance Project (IDSP), but also informed by vector surveillance (larval and pupal indices). Dengue cases in epidemic prone areas generally upsurge in July-November, so here cooperation with the meteorological department may also be helpful to predict conditions that might trigger epidemics. Cases are generally perennial in peninsular states and western parts of the country. Chikungunya cases increase in the post-monsoon period that is May onwards with a peak between July and September, before declining.</p>		
By whom will they be delivered and how?		
Intrasectoral activities		
Sector	Activity	
Private and faith hospitals and health facilities	Pass regulations to raise quality standards of private facilities and bring them on board with case surveillance	
All hospitals and health facilities	Encourage use of LLINs for dengue patients	
Municipalities, urban centres, Panchayati Raj	Enforce handing out fines for mosquitogenic sites found on premises	
Urban VBD Scheme	Link with Urban VBD Scheme for shared surveillance, implementation and monitoring and evaluation	

Intersectoral activities	
Sector	Activity
Ministry of Drinking Water and Sanitation Water supply companies	Emphasise need for sufficient quantity, quality and consistency of potable water supplies to minimise the need for water storage
Ministry of Housing and Urban Poverty Alleviation	Setting and enforcing building standards for new housing to reduce <i>Aedes</i> breeding sites including covering tanks, door and window screening etc
Plantation owners Ministry of Agriculture and Farmers Welfare	Encourage reduction of breeding sites in plantation areas: - rubber plantations e.g. latex collecting cups should be covered, turned upside down or removed when not in use. - coconut/arecanut: e.g. clean plantation area, remove leaves weekly. - pineapple e.g. neem-cake powder (also a manure) sprinkled in the plantation area to avoid vector breeding in leaf axils.
Ministry of Information and Broadcasting Mass media e.g. newspapers etc	Increase awareness of dengue and its prevention through mass media outlets. Appropriate and transparent risk communication during outbreaks.
Municipalities Waste collection companies	Rubbish collection and disposal
Dept. of public works, contractors, municipalities	Removal of obsolete concrete water storage containers used for building
Research institutions	Insecticide resistance monitoring
MHO/DHO	Encourage promulgation and enforcement of legislation against mosquitogenic environments and for increasing access to premises and lots during outbreaks
NGOs, faith-based organisations, community and civil society groups e.g. Residents Welfare Organizations, Women's Self-Help Groups etc.	Groups to supplement and reinforce efforts at household level - launch awareness campaigns - mobilising households to check for breeding sites, comply with IRS, spraying or fogging and encourage use of LLINs by infants and small children sleeping during the day - vector control by environmental management, applying larvicide to containers and encouraging recycling - camps for insecticide treatment of pre-owned mosquito nets and curtains
Schools and workplaces	- encourage checking for <i>Aedes</i> habitats - encourage implementation of vector control activities such as screening of doors and windows, larviciding of containers, covering tanks etc - encourage notification of staff/student absences due to dengue or chikungunya to appropriate local health authorities
Schools	- school projects on dengue to raise awareness - enlist assistance of school children in checking for <i>Aedes</i> breeding sites and larviciding containers - encourage school children to wear long pants and sleeves
India Meteorological Department (IMD)	Share information on rainfall and temperature trends to inform early warning for dengue outbreaks
Tyre manufacturers and sellers	Encourage proper storage and recycling of tyres to minimise breeding sites and movement of eggs. For example, this could be done through incentivising return of used tyres by discounting new purchases.
Municipalities	Encourage management of public spaces e.g. parks to prevent vector breeding

Fishermen Ministry of Agriculture and Farmers Welfare (Dept. of Animal Husbandry, Dairying and Fisheries)	<ul style="list-style-type: none"> - Encourage storage of canoes and boats upside down to prevent vector breeding. - Institutional help/training in mass production of larvivorous fish
Village Health Sanitation & Nutrition Committee	<ul style="list-style-type: none"> - Carry out weekly cleanliness drive in villages.
Coverage of interventions Due to the large number of dengue breeding sites and productivity of some cryptic sites, efforts should be put into identifying and treating (whether through removal, covering or larviciding) as many breeding sites as possible.	
IEC/BCC activities IEC and BCC campaigns play an important role in routine and epidemic control of dengue because breeding sites are numerous and close to homes. Campaigns may be carried out through mass media including local vernacular newspapers/magazines, radio and TV, especially using local cable networks as well as outdoor publicity like hoardings, miking, drum beating, rallies, etc. Health education materials should be developed and widely disseminated in the form of posters, pamphlets, handbills, hoardings. Inter-personal communication through group meetings, traditional / folk media particularly must be optimally utilised. Activities should be intensified during anti-dengue month (July).	

By whom will they be delivered and how?

Intrasectoral activities	
Dengue and Chikungunya control programmes	Link with dengue and chikungunya control in urban areas for surveillance and vector control
Integrated Disease Surveillance Project (IDSP)	Early warning signals on malaria outbreaks
Antenatal services / Mother and child clinics Janani Suraksha Yojana	Distribution of LLINs to pregnant women / young children
State government MOHFW	Encourage promulgation and enforcement of legislation against mosquitogenic conditions
Municipalities, urban centres, Panchayati Raj	Enforce handing out fines for mosquitogenic sites found on premises
Intersectoral activities	
Research institutions	Insecticide resistance monitoring
Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) Panchayati Raj Institutions Village Health and Sanitation Committees	<ul style="list-style-type: none"> - Involve in vector control activities e.g., LSM, net re-treatment - Advocate for community involvement in vector control and compliance with personal protection
Ministry of Information and Broadcasting Mass media e.g. newspapers etc	<ul style="list-style-type: none"> - Increase awareness of malaria and its prevention through mass media outlets - Appropriate and transparent risk communication during outbreaks
Industry Contractors Plantations Mining	<ul style="list-style-type: none"> - Ensure Health impact assessment (HIA) performed for new industry and development projects - Safe water storage/disposal and improvement of drainage - Safe disposal of solid waste and used containers - Malaria chemoprophylaxis for at-risk workers - Mosquito proofing of dwellings and buildings - Use of LLINs by labourers, especially migrants
Ministry of Agriculture and Farmers Welfare Farmers cooperatives Farmers Plantations	<ul style="list-style-type: none"> - Encourage use of dry-wet irrigation system - Appropriate pesticide management - Education of farmers for integrated pest and vector management e.g. farmer field schools

Ministry of Drinking Water and Sanitation Water supply companies	<ul style="list-style-type: none"> - Intermittent irrigation and maintenance of canal system - Design modification and lining of canals - Weeding for proper flow of water in canals - Creation of small check-dams away from villages -Health impact assessment prior to large dam construction - Timely repair of leakages and restoration of taps to prevent water pooling and wastage - Diversion of waste water to natural or artificial ponds/pits - Staggering water supply - Encourage mosquito-proofing of water harvesting devices, repair of sluice valves
Ministry of Road Transport and Highways Road and building contractors	<ul style="list-style-type: none"> - Proper planning as per bye-laws - Merging pits/breaking bunds - Excavations in line with natural slope/gradient, making way for water to flow into natural depression/pond/river - Follow up actions after excavation - Conduct HIA
Ministry of Urban Development	<ul style="list-style-type: none"> - Implementation of building bye-laws. - Improved design to avoid undue water logging. - Building use permission after clearance from health department. - Safe rain water harvesting e.g. covered tanks etc - Mosquito proofing of houses.
Ministry for Railways	<ul style="list-style-type: none"> - Proper excavations. - Maintenance of yards and dumps. - Anti-larval measures within their jurisdiction. - Conduct HIA.
Ministry of Environment, Forest and Climate Change	<ul style="list-style-type: none"> - Pesticide and environment management policy. - Reclamation of swampy areas. - Social forestry (management and protection of forests and afforestation on barren lands).
Ministry of Agriculture and Farmers Welfare (Dept. of Animal Husbandry, Dairying and Fisheries)	<ul style="list-style-type: none"> - Institutional help/training in mass production of larvivorous fish. - Promotion of composite fish farming schemes at community level.
Private pest control agencies	<ul style="list-style-type: none"> - Judicious use of insecticides - Promotion of IVM-based sustainable preventive and control methods
Ministry of Planning	<ul style="list-style-type: none"> - Involvement of health agencies at planning stage for HIA. - Incorporation of risk-mitigating actions in development projects.
Sea / air ports	<ul style="list-style-type: none"> - Vector surveillance and control.
Ministry of Human Resource Development (Dept. of School Education & Literacy and Department of Higher Education)	<ul style="list-style-type: none"> - Educate about malaria and its control - Involve students in vector control particularly LSM. - LLINs and screening of dwellings for boarding students. - Anti-larval measures within their jurisdiction.
Local government	<ul style="list-style-type: none"> - Update public health bye-laws - Mandatory case reporting in epidemic situation
Community	<ul style="list-style-type: none"> - Use of LLINs, acceptance of IRS and household sanitation.

NGOs / civil society	<ul style="list-style-type: none">- Community mobilisation for use of LLINs, acceptance of IRS and timely health seeking behaviour- Training at community level- Distribution of IEC material- Encourage re-treatment of existing nets and curtains- Distribution of LLINs to pregnant women / young children e.g. UNICEF, Caritas		
Coverage of interventions			
High coverage of interventions is required to have maximum effect on malaria vector populations. NVBDCP has specific targets for coverage as follows [17]:			
Intervention	Category 1	Category 2	Category 3
IRS	Not recommended unless indicated by entomological surveillance	95% coverage	95% IRS coverage in identified foci
LLINs	For travellers to Category 3 states and for personal protection	85% of people in targeted communities sleep under LLINs	100% targeted LLIN coverage in identified foci
Larviciding	Not recommended unless indicated by entomological surveillance	95% coverage of identified breeding sites	95% coverage of identified breeding sites
IEC/BCCactivities			
BCC activities are implemented by campaigns during the pre-transmission and transmission season especially, (peaking during anti-malaria month (June) on weekly/fortnightly basis) and as routine (monthly / once in two months, as appropriate) during low transmission season. At sub-national level, BCC relies mainly on inter-personal communication and community outreach, supported by mass media where appropriate. This is because populations in high risk areas such as tribal and rural areas are unlikely to have access to mass media. Activities include a) counselling/one to one direct communication between patient/family members and volunteer, ASHA, health worker, doctor in public and private sector and change agents (religious leader/community leader, educator, traditional healers, etc.); b) peer group interactions between members of associations, youth clubs, etc.; c) community/group meetings of civil society organizations, SHGs, Panchayats, RogiKalyanSamitis, Village Health and Sanitation Committees, etc.; d) infotainment by popular folk song and drama, skits, puppetry, etc. by local groups, animators, etc.; e) village level rally, miking, wall writing, etc.; and f) school activities.			

Japanese Encephalitis: Stakeholder-wise Activity Plan

Tools recommended	Tools for which there is some evidence to recommend their use or their use in certain settings or populations	Tools for which there is currently insufficient evidence to recommend their use in public health but could provide individual protection
ROUTINE CONTROL		
Vaccination of children	Segregation/improved habitation of pigs away from human populations	Topical repellents, long-sleeved shirts and long trousers, protective clothing & household insecticides
ULV fogging	Mosquito proofing of pigsties	
EPIDEMIC CONTROL		
ULV fogging		Topical repellents, long-sleeved shirts and long trousers, protective clothing & household insecticides

Where to implement these interventions? When to implement?	
Vaccination, ULV fogging, IEC/BCC and measures to improve habitation of pigs should be in place routinely. However, identification of one clinical case (since there can be many asymptomatics) can signal an outbreak of JE and here control measures need to be intensified. Cases meeting the case definition at sentinel sites and other health facilities should be reported and the information passed to district and state health authorities. Case investigation should follow whereby suspected cases are tracked back to their villages and appropriate control measures taken (ULV fogging to reduce the adult population, strengthened IEC).	
By whom will they be delivered and how?	
Intersectoral activities	
Meteorological department	Rainfall information which usually precedes an increase in vector population
Coverage of the village reporting cases should be 100% with ULV.	
IEC/BCC IEC/BCC materials should emphasize the importance of vaccination, reporting of cases, compliance with fogging, segregation and improved habitation for pigs and personal protection. Approaches can be used such as printed materials, community education by traditional healers and ASHA/ AWW, Nukkad Naatak (street theatre) at block PHC and prominent places and advocacy workshops.	

Lymphatic Filariasis stakeholderwise Activity Plan:

By whom will they be delivered and how?

Intersectoral activities	
NGOs	- NGOs working in health should be encouraged for advocacy on source reduction
Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) Panchayati Raj Institutions Village Health and Sanitation Committees Civil society groups	- Involve in vector control activities e.g., IRS, peridomestic cleaning - Community mobilisation for acceptance of IRS, larvicide and peridomestic cleaning for collateral benefit.
Ministry of Information and Broadcasting Mass media e.g. newspapers etc	- Increase awareness of LF and its prevention through mass media outlets.

Coverage

Programmes should aim for high coverage of all breeding sites with anti-larval measures.

IEC/BCC

IEC/BCC activities should emphasise the role of vector control against LF, as well as promoting uptake of MDA and disease management. The most effective IEC channel should be used, for example miking, street plays, skits and dramas, banners (cloth or digital), hoardings, advertisements in local print media, TV spots in local cable network, All India Radio and Doordarshan, slides in cinema theatres, pamphlets and leaflets. IEC/BCC activities should be continued all year round, but intensified at the time of MDA (National Filaria Day).

Kala azar stakeholder wise Activity plan

By whom and how?

The main vector control method against leishmaniasis is IRS which is generally carried out by the vector control programme. However, there is scope for the involvement of other sectors in activities.

Intrasectoral activities	
Ministry of Health and KA control programmes in Bangladesh, Nepal, Bhutan, and Thailand	- Cross border collaboration (data sharing, training and capacity building) towards elimination
Intersectoral activities	
Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) Panchayati Raj Institutions Village Health and Sanitation Committees Civil society groups	- Involve in vector control activities e.g., IRS, peridomestic cleaning - Community mobilisation for acceptance of IRS and peridomestic cleaning.
NGOs	- Piggy back on case surveillance camps for vector control and IEC/BCC
Research institutions NGOs	- Training and supervision of IRS - Logistic and equipment support for IRS - Insecticide resistance monitoring - GIS mapping of cases for targeting vector control - Support in preparing IEC/BCC strategies and materials
Ministry of Information and Broadcasting Mass media e.g. newspapers etc	- Increase awareness of KA and its prevention through mass media outlets.
Ministry of Human Resource Development (Dept. of School Education & Literacy and Department of Higher Education)	- Educate about leishmaniasis and its control - Involve students in vector control for KA, particularly environmental modification.
Meteorological department	- Monitoring of weather conditions to determine optimal timing of IRS
Ministry of Rural development Indira AwasYojna	- Make use of 'Housing scheme for underprivileged' to improve housing in areas with high KA caseloads - Lobby for improved housing and cleaning of household and peri-domestic environment

Coverage

Above 90% coverage with IRS in kala azar affected villages is recommended. IEC/BCC coverage with IRS is often falling below the recommended levels and therefore BCC around IRS acceptance is imperative. At least a week before the spraying is due, the programme should visit the village and explain to community leaders and key persons about IRS and emphasise their role in ensuring that the spraying is complete and thorough. Audio announcements and flyers in the local language can be distributed to villagers explaining the purpose of the spraying and including the common do's and don'ts such as safety precautions and emphasising that walls should not be plastered for 3 months. Announcements and meetings should also be held the day before spraying to remind villagers and community leaders.

Households should also be encouraged to clean their house and peridomestic environment on a weekly basis and make use of insecticide-treated materials where possible. Guidance should be provided by the health workers and health volunteers and supervised by staff responsible for the elimination of kala azar. Local folk media, NGOs and civil society groups can also enforce these messages on vector control.

Cross-disease vector control

In areas where diseases are co-endemic, vector control interventions that are effective against multiple diseases should be used. Malaria and kala azar are co-endemic in a few districts of Jharkhand. Here, control measures such as IRS can be effective against both diseases as long as spraying of the whole wall is performed (rather than only to 2 m as for kala azar) and both vectors are susceptible. LLINs, insecticide-treated curtains or screening are also likely to be effective against both vectors as long as vectors are susceptible and the mesh size of the material does not allow sandflies to pass through. Dengue and chikungunya share the same vector and so here control measures will be effective against both diseases. Urban malaria vectors can also be targeted by the same measures as for dengue and chikungunya.

Needs and resources

The methods selected for vector control will define the types of human resources needed. For instance, IRS requires trained spraying teams under proper supervision, which often demand substantial financial and logistic support. Training, support and career structures are required to effectively plan, monitor, evaluate and manage IVM programmes. It is essential that there are skilled staff at national, central and local levels and that good workers do not leave the programme. These personnel need clear career structures based on their competence and opportunities for advancement. Sharing of human resources within and outside the health sector should be explored.

Insecticide selection and its Requirement

Selection of insecticides: Several factors need to be considered in the selection of an insecticide for spraying, including availability, cost, residual effectiveness, safety, vector susceptibility and excito-repellency. The insecticides used as adulticides for IRS must be registered for use and comply the conditions of regulatory authority i.e. Central Insecticide Board.

Insecticides used under NVBDCP: The following formulations/compounds are used under the NVBDCP for control of malaria:

DDT (Dichloro-diphenyl-trichloroethane): In India, DDT has been in use for malaria control since 1946. Recently there has been a tendency to curb the use of DDT due to its persistence in the environment. It is a fact that if DDT is applied in agriculture, it contaminates water resources, enters the bio-chain and at each step of the bio-chain, it gets more concentrate (bio-magnification) till it reaches human beings. In the human body, it is stored in the body fat and is excreted in milk. Since DDT persists for a long time in the environment, there has been apprehension that it will produce adverse effects on human health. Based on scientific data and studies, WHO and DDT Expert Group of Stockholm Convention in November 2014 has deliberated the issue and recommended use of DDT for indoor residual Spraying (IRS) in specific settings for disease vector control where locally safe, effective and affordable alternatives are still lacking.

The quantity of DDT for use in public health in country is decided annually by a high level Mandate Committee under the Chairmanship of Secretary (Health). The group to mandate use of DDT was constituted in pursuance of the directives of Committee of Secretaries in 1997. The group comprises representative member from Deptt. of Agriculture & Cooperation, Deptt. of Bio-Technology, Neeti Ayog and DGHS.

Change of insecticide: If a change of insecticide is warranted, the state government should support documentation of data on vector resistance studies and field observations on epidemiological impact of spray in respect of insecticide in use. The change of insecticide will always be decided in mutual consultation between SPO, ROH&FW and the Directorate of NVBDCP with concurrence of state and central governments. The proposal for any such change of insecticide should follow the following steps:

- The state government submits the proposal for change of insecticide to Directorate of NVBDCP in the month of January-February. All technical data on vector resistance, epidemiological impact of the current insecticide in use, along with financial outlay, quantity of alternative insecticide chosen, with comparative cost difference for spray operations should be included in the proposal. The proposal should be discussed in the annual action plan meeting in Directorate of NVBDCP.
- Mutual consultations between the SPO, ROH&FW and Directorate of NVBDCP in the month of March-April and report prepared in this regard for submission to Technical Advisory Committee (TAC) for approval under the chairpersonship of the DGHS, GoI.
- Plan of Implementation is approved in PIP appraisal based on NVBDCP concurrence and accordingly logistic arrangements are made

Requirement of Insecticides with Formulation and doses for IRS is as below:

S.No.	Name of insecticide	Amount of insecticide to prepare 10 litres of suspension	Dosage per sq. metre of active ingredient	Residual effect in weeks	Area (in sq. m) to be covered by 10 litres of suspension	Requirement of insecticide per million population (in MT)
1	DDT 50% WP	1.000 kg	1 gm	10-12	500	150.00
2	Malathion 25% WP	2.000 kg	2 gm	6-8	250	900.00
3	Deltamethrin 2.5 WP	0.400 kg	20 mg	10-12	500	60.00
4	Cyfluthrin 10% WP	0.125 kg	25 mg	10-12	500	18.75
5	Lambdacyhalothrin 10% WP	0.125 kg	25 mg	10-12	500	18.75
6	Alphacypermethrin 5% WP	0.250 kg	25 mg	10-12	500	37.50
7	Bifethrin 10% WP	0.125 kg	25 mg	10-12	500	18.75

For Malathion, two coats are to be sprayed

Requirement of Insecticides with Formulation and doses for Indoor Space Spray

S.No	Name of Insecticide	Commercial formulation	Preparation of formulation	Equipment required	Remarks
1	Pyrethrum Extract	2.0% extract	1:19 i.e.1 part of 2% Pyrethrum Extract in 19 parts of Kerosene (50 ml in 1 litres K.Oil)	Pressurised Spray machine or fogging machine	Used for Indoor Space Spray
2	Cyphenothrin	5% EC	0.5 mg a.i per sq.mt.(20 ml in 1 litres K.Oil)		

Requirement of Insecticides with Formulation and doses for Outdoor Spray

S.No	Name of Insecticide	Commercial formulation	Preparation of formulation	Equipment required	Remarks
1	Malathion	Technical Malathion	1:19 i.e.1 part of Malathion Tech in 19 parts of Diesel (50 ml in 1 litres diesel)	Shoulder mounted Fogging machine or Vehicle mounted thermal Fogging	Used for Outdoor Thermal Fogging
2	Cyphenothrin	5% EC	3.5 g a.i per hectare (70 ml in 1 litres diesel)		

Requirement of larvicides with Formulation and doses

Larvicide	Formulation	Preparation of ready to spray formulation	Dosage			Frequency of application	Equipment	Remarks
			1 sq. meter	50 Linear meter	Per Hectare			
MLO	100% petroleum project product	As it is	20 c.c.	1 Litre	200 Litres	Weekly	Knapsack/ HC Sprayer	along shore of water body
Temephos	50% EC	2.5 c.c. in 10 Lit of potable water	20 c.c.	1 Litre	200 Litres	-do-	Knapsack/ HC Sprayer	clean water
BTI WP	Wettable Powder	5 Kg in 200 litres of Water	-	-	5 Kg.	Fort-nightly	Knapsack/ HC Sprayer	clean and non-potable polluted water
BTI 12 AS	Aqueous Suspension	1 litre in 200 Lit of water	-	-	1 Litres	Weekly	Knapsack/ HC Sprayer	Clean Water
		2 litre in 200 Lit of water			2 Litres			Polluted Water
Diflu-benzuron	25% WP	100 gms in 100 Lit of water	-	-	25 gm a.i	Weekly	Knapsack/ HC Sprayer	Clean Water
		200 gms in 100 Lit of water			50 gm a.i			Polluted Water
Pyriproxyfen	0.5% Granular	Ready-to-use	-	-	2 kg.	3 Weekly	Granular Applicator / Hand Broadcast	Clean Water
					4 kg.			Polluted Water

Infrastructure Requirement

India's excellence in information technology needs to be harnessed to strengthen the collection of information recorded at all levels so that data entered at the district level can be instantly accessed at the state and national levels. Strong surveillance systems are particularly important for epidemic preparedness, monitoring the effectiveness of interventions and assessing the status of insecticide resistance in vectors. Resources available under programme and under National Health Mission need to be utilized. To effectively accomplish the task, concerned district officials heading all health programmes need to be sensitized about the importance of quick information sharing.

Human Resource

The Expert Committee 1995 recommended that 52 squads are required for 5 months spray period to cover a population of one million with DDT /synthetic pyrethroids and 87 squads for 4.5 months for 3 rounds of Malathion spraying. Each spray squad consists of 5 field workers working with two stirrup pumps and one Superior Field Worker. It is expected that a spray squad can on an average, cover 60 to 80 houses per day. One squad will take 12 to 17 days to cover a subcentre area with an average population of 5,000. Hand Compression Pumps requirement is one per person so either with same numbers of spray workers, spraying can be completed quickly or number of spray workers can be reduced.

The governance and monitoring is affected when designated personnel are less than requirement. There are sanctioned strengths at district, block and subcentre level and these should not be allowed to remain vacant. Making adhoc arrangements through contractual engagements or redeployment from other areas is not a long term solution. States should take initiative in filling the vacant positions of Multipurpose health workers (male), malaria/filarial/health inspectors or supervisors, District VBD officers (earlier known as DMO), Technicians, insect collectors and entomologists.

The optimum utilization of state and district consultants, VBD supervisors (MTS or KTS) for all vector borne diseases are required.

Training

Useful training resources include the WHO Core structure for training curricula on IVM, which gives advice to regions and countries for preparing their own training curricula for IVM. The training document does not duplicate existing specialized courses in medical entomology or vector control, as vector-borne disease programmes are likely to be familiar with these topics. The training provided should be based on an assessment of what is required by the ministry of health, to ensure that it is directly relevant to the expected skills of the cadre. Gaps in capacity may include project management skills, geographical information systems, mobile communication technology and information communication technology, which are required for effective data collection and entomological and epidemiological response. These skills are increasingly being used to refine strategies, to target interventions in space and time and to monitor and evaluate their impact. Capacity-building in entomological surveillance is essential for deploying interventions correctly according to vector ecology and behaviour and for evaluating the impact of interventions, including on insecticide resistance.

Capacity building

Collaboration between vector-borne disease control programmes and national universities and other training institutions should be strengthened, perhaps by formal agreements. National universities or institutions or overseas research institutions could give training in research and other activities). It is important to establish a network of training and mentoring opportunities for staff, including public health entomologists and monitoring and evaluation staff. Cross-state collaboration can also be useful for capacity-building, in which the training resources are shared. Retention of staff and institutional memory on IVM should also be considered. IVM activities cannot depend only on individuals, and training documents and standard operating procedures should be prepared.

Supervision and quality control

Supervision is an essential and integral part of insecticide application to ensure its efficacy and safety. This should be thorough to produce an impact and ensure that there are no ill effects. To be effective, supervision should be carried out at all levels. There should be a written plan for supervision and supervisory checklists are to be developed and used. Supervision will be effective if problems are identified and they are solved by the supervisors as soon as they are detected. The salient points, steps in spray, fogging and equipments are given in annexures which will help in improving quality performance.

Monitoring & Evaluation

IVM programming should be based on evidence, ideally from sound efficacy trials, operational research and surveillance.

Evaluation and introduction of new public health pesticides including microbial larvicides should be conducted according to the relevant NVBDCP SOPs. Importers or manufacturers of new pesticides or formulations of pesticides should apply to NVBDCP to initiate generation of relevant data through laboratory/ field trials by ICMR institutes or NCDC. Funding for these research studies is provided by the manufacturer/importer. Once the data has been generated, manufacturers/importers can apply to the Central Insecticides Board (CIB) for product registration. With the registration certificate from the CIB in hand, manufacturers/importers can apply to the NVBDCP whose Technical Advisory Committee (TAC) can make recommendations for inclusion of the product in the programmes activities.

Routine vector surveillance should be conducted throughout the life of an IVM programme. The purpose and objectives of entomological surveillance depend on the stage of the programme and can be split into preliminary surveys, trend observations, foci investigations and vigilance.

For example, rapid, short-term preliminary surveys with a limited number of techniques can be used to delineate areas with vector-borne disease and allow planning of control measures. Trend observations can be used to establish more detailed baseline information on vectors or monitor and evaluate the effect of programmes on the vector where vector control measures are in place. Foci investigations are short-term and reactive and in general are used to determine why the vector or disease is not responding to control measures. For example, due to reduced susceptibility to an insecticide or operational shortcomings in vector control measures. Lastly, vigilance refers to entomological surveillance for identifying and responding to the introduction or reintroduction of vectors or disease risks in receptive areas.

Vector surveillance in India is organised around 72 entomological zones and Research institutes of ICMR and NCDC. All the zones are not fully functional and need to be strengthened.

Surveillance for vector is important in determining the distribution, population density, larval habitats, and susceptibility to insecticides in order to prioritize vector control in terms of time and space. These data will enable the selection and use of the most appropriate vector control tools, and can be used to monitor their effectiveness. There are several methods available for the detection and monitoring of larval and adult populations.

Collection of adult mosquitoes

Several methods for sampling of mosquitoes are available which are undertaken alone or in combination with others depending on objective of survey.

Hand collection of mosquitoes

Mosquitoes feeding on host Species or resting on different surfaces (indoor and outdoor) can be collected by a test tube or suction tube (aspirator). Adult mosquitoes in indoor situations should be searched in dark corners of houses, ceilings, amongst thatch and cobwebs, on the underside of shelves, amongst clothing and other hanging articles with the help of torch light. Large number of mosquitoes may be collected from sheds used for cattle, horses and pigsties, etc.

(I) By Suction tube (Aspirator): This is the most widely used and convenient method for mosquito collection. Aspirator tube is generally having a length of 30-45 cms (internal diameter, 8-12 mm) and is made up of glass or plastic tubing. A piece of mosquito netting fixed over a short piece of smaller diameter rubber tubing, which is inserted into the end of larger tubing. A 50 cm long rubber tubing is slipped over the end of glass tubing provided with mosquito netting. The resting mosquito seen under torch light are sucked gently and the other end of tube is closed with a finger or cotton plug before transferring to a cage/ test tube. Not more than 10 mosquitoes should be collected at a time to avoid injury to the mosquitoes.

(II) For outdoor collection, mosquitoes can be searched in bushes, shrubs, in wall cracks, under bridges, culverts and in tree holes, etc.

(III) By test tube: Test tube is the old methodology for which a test tube without rim having a length of about 100 mm (20 mm diameter) is used. After locating a mosquito with torch light, a test tube is held in the middle and its mouth is brought slowly over the insect to dislodge the mosquito. Immediately after entry of the mosquito into the test tube, the opening is plugged with a finger and later by cotton. The tubes are wrapped in a wet towel till identification and processing.

Adult surveys for Aedes

Resting collections of Aedes spp is slightly difficult as they are very active, however, during periods of inactivity, adult mosquitoes typically rest indoors, especially in bedrooms, and mostly in dark places, such as clothes closets and other sheltered sites. During such period, these can be collected.

Landing/biting collections on humans are a sensitive means of detecting low-level infestations, but are very labour-intensive. The collections are usually done by aspirators as mosquitoes approach or land for biting and are expressed in terms of landing counts per man hour.

As there is no prophylaxis for dengue or other viruses transmitted by Aedes mosquitoes, it is highly desirable, for ethical reasons, that adult captures of Aedes vectors should be based on "landing collections" only with the instruction to avoid being bitten by mosquitoes.

(IV) Bait collection: Mosquitoes are collected directly off the human or animal baits using suction tube while they land on the host to bite or while in the process of biting a human or an animal host. This method is one of the most important for understanding the host preference and feeding time.

(V) Spray sheet collection: The method is applied during the daytime, usually early in the morning between 06.30 and 10.00 hours. The rooms are vacated by removing foodstuff, drinking water, furniture, etc. All doors and windows should be closed. The floor of the room should be covered with white sheets. The room space is sprayed with hand-pump with 2% pyrethrum extract in kerosene oil (1:19). The spray application is started from one corner of the room and after filling the entire room space with insecticide mist, the applicator leaves the hut and closes the doors. After ten minutes of spray, the doors are opened and the sheets are lifted with four corners and brought outside in daylight. The mosquitoes are collected with entomological forceps and transported to the laboratory. The mosquito thus collected can be used for dissection of malaria/ filarial parasites, ovarian age grading and precipitin test, etc.

(VI) Trap collection-Traps are used for collecting mosquitoes and some of the important traps used for collection of adult mosquitoes are window trap, magoon trap, light trap, etc.

- (i) Window trap – The window trap consists of a wooden frame, a cube of six sides of one foot each, five sides of which are closed with mosquito nettings while to the sixth side a deep conical funnel of netting is provided. The frame of the trap should fit exactly into the window frame of the house so that no space is left to escape from it or the open areas around window trap should be plugged with cotton or cloth etc.
- (ii) Magoon trap – These are essentially portable/detachable wooden huts, in which the upper half of the standing wooden panels is fitted with wire gauze netting and an entry slit about 2 cm wide and V-shaped in appearance is provided all around. A convenient size of the trap is 8 mts x 8 mts and it should be high enough for the collector to stand up inside. The roof of the trap should be sufficiently slanting to shed water. The trap is baited with a calf, goat or some other animal in the evening. Large number of mosquitoes can be collected next morning in a single catch.
- (iii) Light trap – The basic principle of the light trap is that the mosquito attracted at night to the bright electric light enters under the hood of the trap where they are exposed to a strong downward air current produced by a fan operated by an electric motor. The mosquitoes are collected in a holding cage attached to it. Light traps have mostly been used for collecting outdoor flying mosquitoes. CDC light trap is very common.

Collection of adult sandfly

(I) Hand collection- This is the most common method wherein sandfly sitting on a surface are caught with the help of an aspirator or test tube and a torch light. This method is particularly useful for longitudinal monitoring of man-hour densities. However, in sandfly collection, the ordinary mosquito barrier netting between glass tube and rubber tubing of the aspirator must be replaced by a muslin cloth as the smaller size of sandflies enable them to escape through ordinary mosquito net.

(II) Trap collection: Usually 4 types of traps are used:

- a. **Sticky trap:** This is the most extensively used trapping device wherein sandflies are trapped in a layer of castor oil. Suspended arched sticky papers/foils of standard size (20 x 30 cms) are placed at a height of about 4-5 cms from ground with convex sticky side towards ground. Traps are usually laid in the evening and collected on following morning. Sandfly density per trap is calculated for comparisons. Sticky traps are particularly useful in collecting sandflies from hidden shelters like burrows, cracks, tree holes, etc. For some species showing repellency to castor oil, other vegetable oils are required to be used. However, in India, these can be safely used against *Ph. argentipes*.
- b. **Illuminated Sticky trap:** Box shaped batteries are hung on the walls facing sticky traps to make them illuminated. In some studies, these traps have provided higher catch as compared to ordinary traps.
- c. **Light traps:** CDC miniature light traps are often used for sandfly collections. However, nylon mesh cage suspended in a rigid frame are better than the collapsible cages provided with the traps. Further, for sandflies they are modified to give UV light or white light.
- d. **Funnel traps:** These are particularly useful in collecting flies from rodent burrows. Traps are placed just at the mouth of the burrow to catch the flies emerging out of burrows. The inner side is provided with sticky paper or foil. Other traps used in mosquito collection like double bed net, stable net, malaise trap, magoon trap, etc. can also be used but the effectiveness is not yet well demonstrated.

III. Bait collections- Both human and animal baits can be used. However, the fact that sandflies are well known for their patchy distribution must be kept in mind while designing bait sampling. Due to clustering habit of sand flies, bait sampling must be extended to cover all parts of a village.

Oviposition traps: “Ovitrap” are devices used to detect the presence of *Ae. aegypti* and *Ae. Albopictus* with low population density. They are particularly useful for the early detection of new infestations in areas from which the mosquitoes have been previously eliminated. For this reason, they are used for surveillance at international ports of entry, particularly airports, which comply with international sanitary regulations and which should be maintained free of vector breeding.

The standard ovitrap is a wide-mouthed, pint-sized glass jar, painted black on the outside. It is equipped with a hardboard or wooden paddle clipped vertically to the inside with its rough side facing inwards. The jar is partially filled with water and is placed appropriately in a suspected habitat, generally in or around homes in the environment.

The “enhanced CDC ovitrap” has yielded eight times more *Ae. aegypti* eggs than the original version. In this method, double ovitraps are placed. One jar contains an olfactory attractant made from a “standardized” seven-day-old infusion, while the other contains a 10 percent dilution of the same infusion.

Ovitrap are usually checked on a weekly basis. The paddles are examined under a dissecting microscope for the presence of *Ae. aegypti* eggs, which are then counted and stored. In areas where both *Ae. aegypti* and *Ae. albopictus* occur, eggs should be hatched and larvae or adults identified, since the eggs cannot be reliably distinguished from each other. The percentage of positive ovitraps provides a simple index of infestation levels, or if the eggs are counted, it can provide an estimate of the adult female population.

Larval collections: larvae are collected with the objectives to establish the breeding habits of different species, its geographical distribution, study the development of aquatic stages and to evaluate the impact of anti-larval measures on the larval density. This also helps in rearing adults for taxonomic studies or biological observation (bioassay/susceptibility tests.)

Larval collection methods

- A. Dipping: The dipping method is the most frequently used for the collection of mosquito larvae. The collecting equipments viz. Enamel bowl, flying pan or ladle should be immersed in the breeding places (edges of swamps, ditches, streams, rice fields other bodies of waters) at an angle of 45°. If the dipper is immersed too slowly the larvae are disturbed and go to the bottom. There should be an interval of 2-3 minutes between each dip to allow stage III IV larvae and pupae to come to the surface again. In case surface should be agitated to cause the larvae to sink, clear away the vegetation and then wait for 3-4 minutes for larva to come to the surface and collect them with dipper. The larval density is assessed in terms of average larval density per dip.
- B. Netting: Larvae may be collection from large stretches of water along the edge of streams, ponds, wells, and other large water bodies. A larval net consists of a ring of iron frame of 25 cm in diameter with nylon / muslin cloth net measuring about 10 cm long. A long wooden handle is attached to the ring. For collecting larvae, the net is held at an angle of 30° and skimmed rapidly through the surface water near emerging or floating vegetation. The net is inverted and washed out in a bowl of water to collect and count larvae. The density is measured in terms of density per larval net.
- C. Pipetting: Small pipettes or small spoons may be used for collecting larvae from the shallow breeding sites like hoof prints, etc. The larvae can be collected from the small, narrow tree holes or from the axils of leaves using a wide pipette or a siphon. The water can be siphoned off with a piece of rubber tubing and the holes may be washed two or three with extra water to retrieve left over larvae.
- D. Collection of *Mansonia* aquatic stages: For collection of *Mansonia* larvae, a one-foot square bottom tin/wooden tray is kept over floating vegetation and the number of plants is counted. The plants are then removed to an enamel tray with water and the plants are then well shaken to disentangle the *Mansonia* larvae from the roots. Then the number of larvae and number of plants are counted and the average number of larvae and pupae per plant estimated.
- E. Collection of immature stages of Sand fly: Sand flies breed in cracks, crevices and other places with soils rich in organic contents. The resemblance in soil and larval coloration makes it difficult to detect larvae visually in their habitat. The soil is collected, kept in a Petri dish and then examined under microscope (40 x magnification). To facilitate screening of larger soil samples, a floatation technique is often practiced. The soil samples are immersed in a saturated sugar solution i.e. 3 parts sugar + 5 parts water. Larvae and pupae float in this solution. These are then passed through a series of sieves and finally the residues are examined under the microscope.

Xenomonitoring or xenosurveillance

Entomological techniques are also useful for Lymphatic Filariasis (LF) programmes in a more indirect way. Direct assessment of worms in vector mosquitoes with polymerase chain reaction (PCR) techniques is increasingly used to detect recurrence of new infections during post-MDA surveillance. This tool is called xenomonitoring or xenosurveillance. As the threshold of antigenaemia prevalence for LF in the human population is very low (1–2%), large numbers of mosquitoes need be collected and processed for testing with for infection with this method. The samples are usually examined in pool. The standard protocol for sampling and testing needs to be made available.

Entomological Parameters;

The major methods for Anopheles surveillance in India are human landing catches, resting collections using aspirator, pyrethrum spray catches (whenever mosquito densities are low or more mosquitoes are required), animal baited traps (depending on species host preference) and larval sampling. Aspirator collections should be performed in all index villages, while whole night human landing catches on indoor and outdoor human baits should be performed in one of the index villages in a district during the transmission season and every quarter thereafter. Animal bait collections should be done in the same village twice a year (once during transmission and once during non-transmission season). Other methods which could be used are CO₂-baited CDC light traps, window exit trap, odour-baited trap or tent trap. Double-bednet traps should be evaluated alongside human landing catches since with the netting trap collectors are protected from potentially infective bites.

Insecticide resistance testing on both adult anophelines should be performed at least yearly in all districts, with priority given to those districts where no information has been collected during the preceding 5 years. The tests should be done with diagnostic doses of DDT, malathion and pyrethroids and LD₅₀ values ascertained by changing the exposure time if sufficient mosquitoes are available. Larval susceptibility tests should be performed once a year in every district where larvicides/biocides are in use, but particularly in urban areas where organophosphorus compounds such as temephos and fenthion are being used as larvicides. Contact bioassay should be conducted during spray season at 2-weekly intervals to determine the residual efficacy of IRS.

Table ----: Surveillance tools and indicators for malaria.

Indicator	Definition	Sampling technique	Formula
Adult			
Indoor resting density	Number of adult female mosquitoes per house per night	Pyrethrum spray catch	$= (\text{No. of females} \div \text{No. of houses}) \div \text{No. of nights}$
		Aspirator	
Human-biting rate	Number of bites a person receives from a specific vector species per night	Human landing catch (collections throughout the night, i.e. 12 h)	$= \text{No. of mosquitoes collected} \div \text{No. of collectors}$
		Human landing catch (collections for a few hours in the night)	$= (\text{No. of mosquitoes} \div \text{No. of collectors}) \div \text{No. of collection hours}$
		Pyrethrum spray catch	$= \text{No. of blood-fed females} \div \text{Total no. of occupants in rooms used for collection}$
Human blood index	Proportion of blood-fed mosquitoes that fed on humans	Pyrethrum spray catch	$= \text{No. of mosquitoes feeding on human blood} \div \text{Total no. of blood-fed mosquitoes}$
Sporozoite rate	Proportion of mosquitoes of a given species carrying sporozoites in the salivary glands	Salivary gland dissection, ELISA or PCR	$= \text{No. of positive mosquitoes} \div \text{No. of mosquitoes analysed}$
Entomological inoculation rate	Number of infective bites received per person per night	Human-landing catches	$= \text{Human-biting rate} \times \text{Sporozoite rate}$
Endophagic index	Indicates preference for indoor biting	Human landing catch,	$= \text{Human-biting rate indoors} \div (\text{Human-biting rate indoors} + \text{Human-biting rate outdoors})$
Exophagic index	Indicates preference for outdoor biting		$= \text{Human-biting rate outdoors} \div (\text{Human-biting rate indoors} + \text{Human-biting rate outdoors})$
Insecticide susceptibility			
Immature			
Mosquito breeding index	Measure of larval density		$= \text{Total no. of larvae and pupae collected} \div (\text{Total no. of dips performed})$
Habitat occupancy	Percentage of positive larval habitats		$= \text{No. of habitats with larvae or pupae} \div \text{Total no. of habitats found}$

Entomological surveillance is carried out in 72 entomological zones. Guidelines for carrying out entomological work are circulated to the zones from the Directorate of NVBDCP. The calendar of activities by the entomological zones for the year should be drawn up in December of the previous year and sent to the State Health Directorate with copies marked to ROH&FW and Directorate of NVBDCP.

All the districts under the entomological zones should be visited by the zonal team at regular intervals throughout the year. The entomological teams will be visiting 4 PHCs every month irrespective of the number of districts in their jurisdiction, spending 3-4 days in each PHC.

The frequency of entomological sampling depends on incidence of disease

Category 1: States with API less than one, and all districts in the state have API less than one, entomological surveillance in sentinel and random sites at quarterly intervals

Category 2: States with API less than one and one or more districts reporting API more than one, entomological surveillance in sentinel and random sites at quarterly intervals

Category 3: States with API more than one, entomological surveillance in sentinel and random sites at monthly intervals

The selection of PHCs as well as index villages will be based on:

- High incidence of malaria with predominance of *P. falciparum* infection
- Vulnerability to epidemics and 3) high vector density.

Monitoring of entomological data in an index village will continue for 3-5 years. After collection of data from a particular PHC for 5 years the PHC should be changed.

Aedes surveillance is predominantly for immatures (larvae and pupae) although adults can also be surveyed. Oviposition traps are recommended where the vector population density is low and larval surveys are unproductive (e.g. Breteau index < 5). They are particularly useful for the early detection of new infestations in areas from which the mosquitoes have been previously eliminated. Human landing catches are not performed for dengue vectors.

Table -----: Surveillance tools and indicators for dengue & chikungunya.

Surveillance method	Index	Calculation
Immatures		
Dipping for larvae or pupae	House index (HI)	Number of houses infested / Number of houses inspected x 100
	Container index (CI)	Number of positive containers / Number of containers inspected x 100
	Breteau index (BI)	Number of positive containers / Number of houses inspected x 100
	Pupal index	Number of pupae / Number of houses inspected x 100
Adults		
Resting collections (aspirator or handheld net)	Man hour density	Number of <i>Aedes</i> mosquitoes caught x Number of minutes collected / 60
Oviposition traps or tyre section larvitrap	Mosquitoes/trap	Number of <i>Aedes</i> mosquitoes caught / Number of traps

Sentinel sites need to be established in areas endemic or epidemic for dengue. These should be surveyed at least monthly during the dengue season.

Insecticide resistance

Definition

"Insecticide resistance" is the term used to describe the situation in which vectors are no longer killed by (i.e. are no longer susceptible to) the standard dose of insecticide or avoid coming into contact with the insecticide. Selection pressure for development of resistance

results from insecticides used under public health and agriculture and may also be driven by household use of insecticides and hydrocarbon pollution. Resistance to DDT and malathion is common in *An. culicifacies* and *An. stephensi* in India. Insecticide resistance in other vectors is thought to be patchier, and information on this aspect is collected by entomological teams of programme as well as research institutions in various parts of the country.

Four mechanisms of resistance have been identified: target-site, metabolic, cuticular and behavioural. Target-site resistance involves a genetic mutation that directly reduces binding of the insecticide, e.g. on the surface of nerves, and thereby reduces or eliminates its effect. Metabolic resistance involves a change in the amount or specificity of a metabolic enzyme, so that it detoxifies an insecticide before it reaches the target site. Cuticular resistance consists of modifications in the insect cuticle that prevent or slow the adsorption or penetration of insecticides. In behavioural resistance, a vector adapts its feeding or resting behaviour to avoid contact with the insecticide. For example, there is some suggestion that malaria vectors have adapted to bite outside houses and earlier in the evening when people are not protected by LLINs.

Cross-resistance occurs when resistance to 1 insecticide confers resistance to another insecticide, even when the insect has not been exposed to the second. Cross-resistance often occurs when insecticides have a common mode of action; for example, organochlorines and pyrethroids are acetylcholinesterase inhibitors, and kdr mutations in malaria vectors can confer cross-resistance to insecticides in both these classes, such as DDT and deltamethrin. When a vector has 2 or more different resistance mechanisms, they may combine to result in resistance to multiple classes of product. This monitoring is required regularly on yearly basis and WHO supports through diagnostic kits and insecticide impregnated papers. ICMR is in process of validating indigenously made impregnated papers by VCRC to support the programme. The methodology in brief is indicated below:

Principle of the test

The purpose of the susceptibility test is to evaluate the level of susceptibility of adult mosquitoes to an insecticide or measurement of resistance. This type of test also makes it possible to compare the efficacy of various insecticides with respect to a given species or conversely the susceptibility of several species of mosquitoes with concentrations of a given insecticide. The results will be expressed as percentage mortality after 24 h holding, and if it is pyrethroid, assessment of mortality and knockdown effect (effective KD) will be determined. It also makes it possible to determine the diagnostic concentration necessary for the evaluation of resistance of the mosquitoes in the field. The WHO standard methods [13-17] are used. Guidelines are also available for conducting insecticide resistance testing in sandflies[18].



Green dot and red dot tubes for adult susceptibility test

1. Materials required

- A. Holding tubes with “green dot”
- B. Exposure tubes with “red dot”
- C. Two (2) metal rings per tube (silver or copper)
- D. Stages
- E. One (1) mesh/tube
- F. One (1) suction tube (mouth aspirator)
- G. Data sheet “Adult susceptibility test”

Preparation for the test

Use “green dot tubes” for the preparation of control

- a) Prepare four tubes for test and one tube for control.
- b) Insert a control filter paper (without insecticide), held by two silver rings.
- c) Close one end of the tube with mesh and other end by inserting the stage.
- d) Collect the mosquitoes directly from the cage by means of a suction tube and release gently into the test tubes @ 25 females/ tube and close the stage of the holding green dot tube.
- e) Label the tube with number and details about the strain
- f) Hold the mosquitoes in tube for one hour in a chamber whose temperature is between 26°C and 28°C and the relative humidity between 80 and 100%.
- g) If possible replace the dead mosquitoes before keeping them for exposure, or note number of mosquitoes dead or with less number of legs.

Use “red dot tubes” for the preparation of test

- a) Use disposable gloves.
- b) Insert insecticide impregnated paper in the red dot tubes.
- c) Note: place impregnated surface inside (inscription readable through the tube)
- d) Hold the paper with 2 copper rings, and then close the tube with a mesh.

2. Procedure of the test

- a) Prepare a data sheet with a name of test (adult susceptibility test).
- b) Screw the exposure tube (control/test) on to the other side of stage of the holding tube with mosquitoes in green dot tube and label the same number as on holding tube.
- c) Slide the stage plate in a manner that it will open entirely into the exposure tube
- d) Blow the mosquitoes gently from the holding tube into the exposure tube



Preparation of exposure tubes (Red dot)



Blowing of mosquitoes into the tube with test paper (red dot tube)



Holding tube with sucrose soaked cotton kept in diminished light

- e) Close the stage by pushing back the plate.
- f) Detach the holding tube from the assembly and place it in such a way that the mesh should be on top
- g) Hold the mosquitoes in exposure tube for 1 hour under moderate diffuse lighting.
- h) Note the number of mosquitoes knocked-down (KD) at regular intervals in exposures with pyrethroids.
- i) At the end of exposure period, transfer the mosquitoes from exposure tubes into the holding tubes in the same way as previously done.
- j) Hold the mosquitoes in holding tubes for 24 hours in a chamber/room with controlled temperature of 26 to 28°C and RH of 80 to 100%, in dark.
- k) Provide 10% glucose/honey solution in a swab while holding.
- l) After 24 hours of holding, count the number of dead mosquitoes.



Placing of holding tubes in a climatic chamber maintained at $27 \pm 1^\circ\text{C}$ and relative humidity of 60-80%

Criteria for acceptance

The test is accepted, if the mortality in the control tubes is <5%, if this lies between 5 and 20%, mortality is corrected using the Abbott's formula (Page 4). If the mortality is >20% in control replicates the test should be repeated and the reasons for the same should be explored and rectified.

Larval Susceptibility Test

Principle of the test

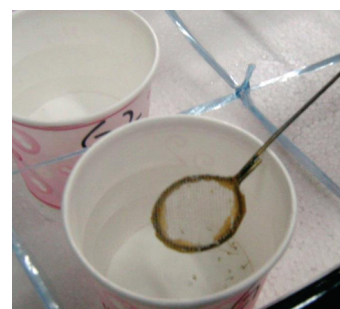
The purpose of the larval test is to determine and follow the level of susceptibility/resistance of larval stages of a given species of mosquitoes to a given insecticide. This test also makes it possible to compare the effectiveness of several insecticides (formulation or active ingredient) with respect to a given species or to compare the susceptibility of several mosquitoes species to given insecticide. In the case of entomopathogenous bacteria, a biological titration makes it possible to compare the formulations to be titrated in comparison to an international standard.

Materials required

- a) Plastic/Paper cups (volume 200 ml)
- b) 3 ml pasteur pipette
- c) Small strainer to pick the larvae
- d) Data sheet

Procedure of the test

Prepare 5–6 serial dilutions in water in plastic bowls with a range of concentration from the stock solution in ethanol such that two concentrations will give a mortality lower than 50%, and two concentrations will give mortality more than 50%, and another one 100% mortality (lethal concentration).



Transfer of larvae with strainer

- a) The concentrations used are noted on the data sheet.
- b) Fill the bowls with 99 ml distilled water and add 1 ml of insecticidal solution to give the desired concentration of insecticide.
- c) Prepare a series of 5–6 control cups containing 1 ml of ethanol in 99 ml water.
- d) Collect 20, L3 / early L4 stage mosquito larvae using pasteur pipette on a small strainer.



Arranging the test bowls with larvae in a tray

- Introduce 20 larvae in each bowl
- The cups are then placed in a controlled climatic chamber having temperature between 26 and 28°C.
- The reading will be recorded after 24 h of holding.
- Certain insecticides require an additional reading at 48 h, in this case one should add food after 24 h.

For Bti H-14, the standard of reference is the IPS 82 containing 15 000 ITU / mg lyophilized powder with respect to of *Aedes aegypti* strain Bora Bora. For *Bacillus sphaericus*, which is the SPH 88 strain 2362 containing 1700 ITU/mg in *Culex pipiens pipiens* strain Montpellier (Anonymous, 1999. Guideline specifications for bacterial larvicides for public health use)

Criteria of acceptance

The test is accepted only when mortality in the control is less than 5%, and if mortality lies between 5 and 20%, it is corrected following the Abbott's formula. Moreover, it is necessary to obtain a minimum of four points (results of mortality vs concentration) for further analysis to determine the relative dose/effect (using Log Probit analysis software).

Safe Handling & Disposal of Insecticides/ Interventions

Each year thousands of public health insecticides containers are emptied and become waste items that require disposal. All these insecticides are registered by Central Insecticide Board for public health use in the country with safety levels. The Insecticides Rules, 1971 has a provision (Rule 44) that sets clear cut guidelines for disposal of used packages, surplus materials and washings of insecticides. FAO/WHO recommends that the practice of disposal of insecticide packaging at the place of use by burying or burning be prohibited. For many years, the laws and regulations governing the safe use of insecticides also have placed some restrictions upon their disposal. Label instructions include warnings about container and rinse water disposal, and caution against the contamination of foods, feeds and water supplies. Disposal inconsistent with label instructions is a violation. Newer product labels show more extensive disposal instructions. The NVBDCP aims to achieve effective vector control by the appropriate biological, chemical and environmental interventions of proven efficacy, separately or in combination of tools including insecticides, larvicides and LLINS etc. The state health departments as end user are responsible for safe disposal of such insecticides or commodities. General safety precautions while handling insecticides and guidelines for proper storage, transportation and safe disposal of insecticides and insecticide containers are described in this chapter for further reference.

General safety precautions while handling insecticides

Exposure to insecticides may occur when handling and spraying insecticides. The exposures to insecticides may occur in following situations:

- ☐ When handling the insecticide product during opening of the package, mixing and preparation of the spray.
- ☐ When spraying the insecticide.
- ☐ When disposing the insecticide solution and containers

General precautions:

1. The operator should also wear a protective hat and face shield or goggles.
2. Do not eat, drink or smoke while working.
3. Wash hands and face with soap and water after spraying and before eating, smoking or drinking
4. Shower or bath at the end of every day.s work and wear new clean clothes
5. Wash overall other protective clothing at the end of every working day in soap and water and keep them separate from the rest of the family.s clothes.
6. If the insecticide touches the skin, wash off immediately with soap and water.
7. Change clothes immediately if they become contaminated with insecticides.
8. Inform the supervisor immediately if one feels unwell

Protective clothing and equipment

Absorption of insecticide occurs mainly through the skin, lungs and mouth. Specific protective clothing and equipment given below must be worn in accordance with the safety instructions on the product label

- Broad-rimmed hat (protects head, face and neck from spray droplets).
- Face-shield or goggles (protects face and eyes against spray fall-out).
- Face mask (protects nose and mouth from airborne particles).
- Long-sleeved overalls (worn outside of boots).
- Rubber gloves.
- Boots.

Storage

- Insecticide storehouses must be located away from areas where people or animals are housed and away from water sources, wells, and canals.
- They should be located on high ground and fenced, with access only for authorized persons. However, there should be easy access for insecticide delivery vehicles and, ideally access on at least three sides of the building for fire-fighting vehicles and equipment in case of emergency.
- Insecticides must NOT be kept where they would be exposed to sunlight, water, or moisture which could affect their stability.
- Storehouses should be secure and well ventilated.
- Containers, bags or boxes should be well stacked to avoid possibility of spillage. The principle of first expiry first out should be followed.
- Stock and issue registers should be kept upto date. Access to the insecticides should be limited to authorized personnel only.
- The store room should have a prominently displayed mark of caution used for poisonous or hazardous substances. It should be kept locked.
- Containers should be arranged to minimize handling and thus avoid mechanical damage which could give rise to leaks. Containers and cartons should be stacked safely, with the height of stacks limited to ensure stability.

Transportation

1. Insecticides should be transported in well sealed and labeled containers, boxes or bags.
2. Insecticides should be transported separately. It should NOT be transported in the same vehicle as items such as agricultural produce, food, clothing, drugs, toys, and cosmetics that could become hazardous if contaminated.
3. Pesticide containers should be loaded in such a way that they will not be damaged during transport, their labels will not be rubbed off and they will not shift and fall off the transport vehicle onto rough road surfaces.
4. Vehicles transporting pesticides should carry prominently displayed warning notices.
5. The pesticide load should be checked at intervals during transportation, and any leaks, spills, or other contamination should be cleaned up immediately using accepted standard procedures. In the event of leakage while the transport vehicle is moving, the vehicle should be brought to a halt immediately so that the leak can be stopped and the leaked product cleaned up. Containers should be inspected upon arrival at the receiving station. There should be official reports to the national level and follow-up enquiries in the event of fires, spills, poisonings, and other hazardous events.

Disposal of remains of insecticides and empty packaging

1. At the end of the days work during IRS activities, the inside of the spray pump should be washed and any residual insecticide should be flushed from the lance and nozzle.
2. The rinsing water should be collected and carefully contained in clearly marked drums with a tightly fitted lid. This should be used to dilute the next days tank loads or disposed properly by the supervisor at disposal sites like pits or digs.
3. Never pour the remaining insecticide into rivers, pools or drinking-water sources.
4. Decontaminate containers where possible. For glass, plastic or metal containers this can be achieved by triple rinsing, i.e. part-filling the empty container with water three times and emptying into a bucket or sprayer for the next application.
6. All empty packaging should be returned to the supervisor for safe disposal according to national guidelines.
7. Never re-use empty insecticide containers.
8. It shall be the duty of manufacturers, formulators of insecticides and operators to dispose packages or surplus materials and washing in a safe manner so as to prevent environmental or water pollution.
9. The used packages shall not be left outside to prevent their re-use.
10. The packages shall be broken and buried away from habitation.

Disposal of Expired Insecticides

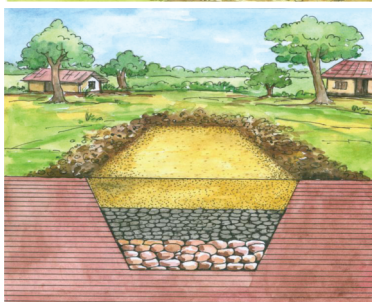
1. Adequate measures should be undertaken to avoid expiry of stocks in storehouses.
2. First Expiry First Out. principle should be strictly followed during stock movements.
3. Information about near expiry stock, should be provided to Dte. of NVBDCP, Delhi well in time so that the stock can be re-allocated to other locations.
4. The expired stock should be returned to manufacturer for disposal as per guidelines preferably through incineration process.
5. The chemical efficacy should be tested before disposal of expired insecticide to find out possibility of usage. The efficacy and active ingredient percentage of insecticide is tested and certified by the authorized testing laboratory.

Design of Soak Pits

A soak pit is a specially designed hole in the ground for disposing of insecticide remnant after the day's IRS activities. A properly sited and constructed soak pit protects the environment from getting contaminated with insecticides.

Location of Soak Pit

The soak pit should preferably be located within the unused areas of Sub-Centre/ Panchayat/government offices of a village. However, such pits should not be within 100 meter of any water body or drinking water source. The soak pit should be constructed only in areas where ground water table is at a depth of more than 5 meter below ground level.



Construction of the Soak Pit

A soak pit measuring 1 meter by 1 meter by 1 meter is usually sufficient to absorb the effluent produced from one round of spraying operation. The bottom of the pit is lined with a layer of coarse gravel followed by a layer of stone aggregate. It is then filled with 1.5 to 2 bags of charcoal (where feasible) and 1.0 to 1.5 bags of saw-dust/sand/ morrum/coarse soil. This would create a filter one meter in depth. As the effluent percolates through this filter medium, the insecticides filter out.

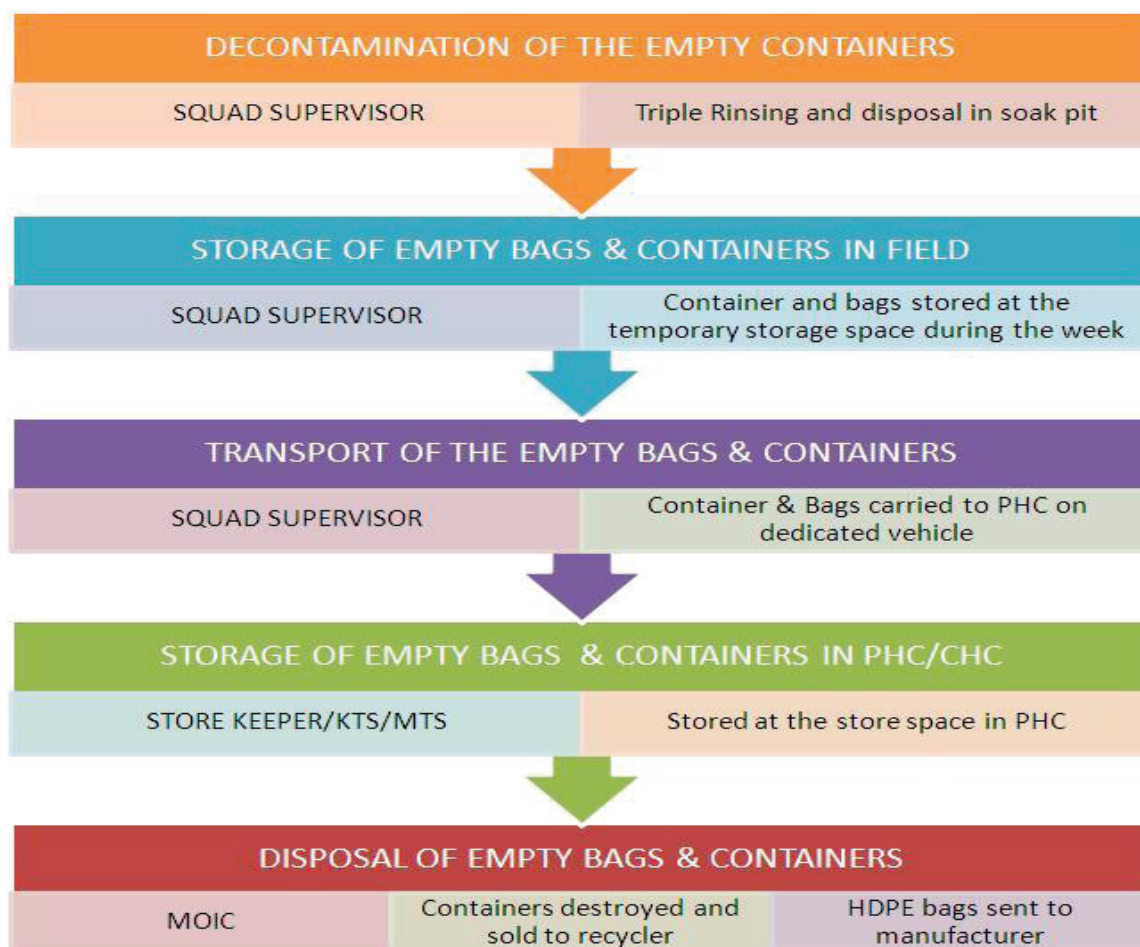
Disposal of spilled insecticide residue

At the end of a spraying round, the chemicals/ insecticide left on the surface of the pit or around area of spray preparation should be scrapped by the spraying squad and disposed off into the waste pit of the PHC.

Disposal of Bags/Containers

Empty bags or containers used for packing insecticide are contaminated with insecticides and have to be disposed properly. These wastes are generated in the field during IRS spray and, thus, needs to be collected and decontaminated before they are disposed. However, type and size of containers varies depending upon the insecticide used in a particular area and manufacturer of the insecticide. The process of decontamination, collection and storage disposal is provided in Figure Below:

Schematic diagram of handling and disposal of empty bags and containers



Collection and transportation to the PHCs

The Spray Supervisor would be responsible for collecting the empty bags and containers generated from the week's operations and would carry it back to the PHC. Empty containers should be rinsed (triple-rinsing) before they are transported to the PHC. The container wash water should be disposed of in the soak pit designed for disposal of waste water. A dedicated transport, e.g. cycle rickshaw, van rickshaw/ auto rickshaw, should be used for transporting the bags/containers of insecticides. During transportation of the contaminated bags and containers, the load should be covered up with polythene sheets and tied up so that they are securely fixed. The vehicle should not be overloaded at the time of transportation

The empty bags and containers have to be deposited to the storekeeper. The storekeeper should verify the quantity and also maintain an account of the bags and containers returned. The empty bags and containers would be stored along with the insecticides before it is disposed. The following precautions should be adopted while handling empty bags/containers:

- The personnel handling the empty bags and containers should wear their PPEs (consisting of gloves, mask, apron and goggles and shoes).
- The empty containers and bags should be stacked properly and should not be strewn in the storage area.
- Any spill of the remaining insecticide should be contained and subsequently cleaned.

Disposal of the bags and containers at the PHCs

- The following guidelines should be followed for proper disposal of bags and containers from the PHC. Since jute bags, HDPE bags, HDPE containers and MS Containers are used for the packing of insecticides, the guidelines for disposal of each of these have been specified separately.
- Gunny bags: Gunny bags used for the packing of insecticides are usually double ply jute cloth lined with an impermeable liner. There is an LDPE bag inside the double ply jute bag in which the insecticides are packed. The LDPE bag is extracted and the jute bag can be allowed to decompose. The LDPE bags should be disposed in the deep burial pit at the PHC.
- HDPE bags: The bags should be returned to the PHC by the spray supervisor after being cut into two pieces. The store in-charge should maintain record of the bags which have been returned. The bags can then be disposed off to a hazardous waste recycler. Alternatively, The HDPE can either be sent back to the district during cycle/year in the vehicle which supplies the insecticides to the PHC. These bags can subsequently be sent back to the manufacturer.
- Containers: The containers once rinsed can be used for as collection containers for hazardous wastes. Alternatively, PWD crushers (like JCB)/bulldozers could be used at each PHC to crush these containers. The crushed containers can be sold off to an authorised recycler.

Health Monitoring

- In case of accidental exposures or appearances of symptoms of poisoning, medical advice must be sought immediately.
- In case of organophosphorus (Malathion), regular monitoring of cholinesterase (CHE) level should be carried out and spraymen showing decline in CHE to 50% should be withdrawn and given rest and if needed medical aid

Long Lasting Insectidal Nets

Both the bags for individual nets and the packaging used to wrap bales of nets are made of various materials including low density polyethylene (LDPE), LDPE coated with polyethylene terephthalate (PET, polyester), linear low density polyethylene (LLDPE), biaxially oriented polypropylene (BOPP), oxodegradable (OXO) plastic bags, paper bags and various strapping bands.

Having been in direct contact with the pesticides present in the enclosed LLIN, an individual net bag is an "Empty Pesticide Container" as defined by the FAO/WHO Guidelines on Management Options for Empty Pesticide Containers. The bags should therefore be handled in a manner consistent with that guidance. The Guidelines, which specify methods for the disposal of pesticide-contaminated packaging material, indicate that "unless empty pesticide containers are managed correctly, they are hazardous to both mankind and the environment". In particular, "burning plastics and pesticides in an uncontrolled fire will not destroy the hazardous components completely and may generate dangerous persistent toxins".

WHO Recommendations for the Management of LLIN Packaging Material -

Options for the management of LLIN bags and baling material must be evaluated on a case by case basis. "Reuse" is currently not an option since no manufacturer produces reusable LLIN bags and baling material and it is unsafe to use them for any other purpose as such. The following recommendations apply only to the safe disposal and recycling of LLIN waste packaging (bags and baling material) and do not cover the LLINs themselves. Where possible, and with no reduction in the public health benefit, distribute LLINs without leaving any packaging with the intended LLIN user;

1. Recycle LLIN packaging: recyclers processing used LLIN bags and baling material should apply proper controls of their materials and processes to ensure the bags are only recycled into appropriate products which have "limited potential for human contact and are not likely to be recycled again;"
2. Ensure proper personal protective equipment (PPE) are used and measures strictly followed by workers involved in all stages of operations for collection, sorting, recycling and disposal of LLIN bags and baling material
3. Incinerate LLIN bags and baling material ONLY if specified high temperature incineration conditions for pesticide-tainted plastic can be assured following Basel Convention Technical Guidelines and in accordance with national regulations and requirements;
4. Store used LLIN packaging awaiting future safe recycling, disposal or other processing in dry, well ventilated and secure facilities;

5. If recycling or incineration is not possible, and if LLIN producers provide directions on methods for safe disposal, follow the manufacturer's recommendations. Alternatively, land-filling of bags and baling material in a properly engineered landfill is an option, as detailed in the FAO/WHO Guidelines on Management Options for Empty Pesticide Containers
6. National pesticide registration authority to make mandatory that manufacturers provide recommendations on the safe disposal and/or recycling of LLIN packaging. This will include information on labels of LLIN bags regarding the material used in the production of such bags;
7. Assure that disposal of LLIN packaging is included as a condition in the procurement of LLINs;

Basel Convention Technical Guidelines for the Identification and Environmentally Sound Management of Plastic Wastes and for their Disposal specify that "The condition for the optimal incineration of material is: Temperature of 850°C-1100°C for hydrocarbon wastes and 1100°C-1200°C for halogenated wastes; sufficient (gas) residence time in the incinerator (EU legislation requires 2 seconds as a minimum); good turbulence; and excess of oxygen

8. Develop national LLIN packaging management protocols for these wastes and assure that all stakeholders are aware of proper packaging disposal procedures that is aligned with national regulations and requirements;
9. Integrate good practice recommendations on the sound management of LLIN packaging into the existing national malaria strategy and related frameworks; and ensure that recommendations are aligned with national regulations concerning the safe handling and disposal of chemical waste (or pesticide-tainted waste).

Health Impact Assessment (HIA)

Health Impact Assessment (HIA) is defined as "a combination of procedures, methods, and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population."

HIA is intended to produce a set of evidence-based recommendations to inform decision-making. HIA seeks to maximise the positive health impacts and minimise the negative health impacts of proposed policies, programs or projects.

HIA is a practical approach used to judge the potential health effects of a policy, programme or project on a population, particularly on vulnerable or disadvantaged groups. Recommendations are produced for decision-makers and stakeholders, with the aim of maximising the proposal's positive health effects and minimising its negative health effects. The environmental factors such as terrain features (plain, desert, hilly and forests), ecology, climatic features, rainfall, humidity influence the presence of vector mosquitoes helping thereby in the transmission of a particular disease. The developmental project namely irrigation, dam, hydro-electrical projects, jhoom cultivation (deforestation) lead to direct health impact on the population in that area in terms of vector borne diseases.

Under the National Vector Borne Disease Control Programme, insecticides and larvicides are being used which are registered with Central Insecticide Board based on the toxicity data to ensure safe standard of human safety. However, Environmental Code of Practises (ECoP) envisaged under the orbit of the programme implementation. But, there is need for health impact assessment of the spraymen handling insecticides and irrational use of fogging operations in the municipal corporations on the spraymen and community.

The procedures of HIA are similar to those used in other forms of impact assessment, such as environmental impact assessment or social impact assessment. HIA is usually described as following the steps listed, though many practitioners break these into sub-steps or label them differently:

1. Screening - determining if an HIA is warranted/required
2. Scoping - determining which impacts will be considered and the plan for the HIA
3. Identification and assessment of impacts - determining the magnitude, nature, extent and likelihood of potential health impacts, using a variety of different methods and types of information
4. Decision-making and recommendations - making explicit the trade-offs to be made in decision-making and formulating evidence-informed recommendations
5. Evaluation, monitoring and follow-up - process and impact evaluation of the HIA and the monitoring and management of health impacts

The main objective of HIA is to apply existing knowledge and evidence about health impacts, to specific social and community contexts, to develop evidence-based recommendations that inform decision-making in order to protect and improve community

health and wellbeing. Because of financial and time constraints, HIAs do not generally involve new research or the generation of original scientific knowledge. However, the findings of HIAs, especially where these have been monitored and evaluated over time, can be used to inform other HIAs in contexts that are similar. An HIA's recommendations may focus on both design and operational aspects of a proposal.

HIA has also been identified as a mechanism by which potential health inequalities can be identified and redressed prior to the implementation of proposed policy, program or project. A number of manuals and guidelines for HIA's use have been developed

Department of Health

The proposition that policies, programs and projects have the potential to change the determinants of health underpins HIA's use. Changes to health determinants then leads to changes in health outcomes or the health status of individuals and communities. The determinants of health are largely environmental and social, so that there are many overlaps with environmental impact assessment and social impact assessment.

Level of HIA

Three forms of HIA exist:

- Desk-based HIA, which takes 2–6 weeks for one assessor to complete and provides a broad overview of potential health impacts;
- Rapid HIA, which takes approximately 12 weeks for one assessor to complete and provides more detailed information on potential health impacts; and
- Comprehensive HIA, which takes approximately 6 months for one assessor and provides a in-depth assessment of potential health impacts.

It has been suggested that HIAs can be prospective (done before a proposal is implemented), concurrent (done while the proposal is being implemented) or retrospective (done after a proposal has been implemented). This remains controversial, however, with a number of HIA practitioners suggesting that concurrent HIA is better regarded as a monitoring activity and that retrospective HIA is more akin to evaluation with a health focus, rather than being assessment per se. Prospective HIA is preferred as it allows the maximum practical opportunity to influence decision-making and subsequent health impacts.

HIA practitioners can be found in the private and public sectors, but are relatively few in number. There are no universally accepted competency frameworks or certification processes. It is suggested that a lead practitioner should have extensive education and training in a health related field, experience of participating in HIAs, and have attended an HIA training course. It has been suggested and widely accepted that merely having a medical or health degree should not be regarded as an indication of competency.

Why use HIA?

Values

HIA is based on four values that link the HIA to the policy environment in which it is being undertaken.

1. Democracy – allowing people to participate in the development and implementation of policies, programmes or projects that may impact on their lives.
2. Equity – HIA assesses the distribution of impacts from a proposal on the whole population, with a particular reference to how the proposal will affect vulnerable people (in terms of age, gender, ethnic background and socio-economic status).
3. Sustainable development – that both short and long term impacts are considered, along with the obvious, and less obvious impacts.
4. Ethical use of evidence – the best available quantitative and qualitative evidence must be identified and used in the assessment. A wide variety of evidence should be collected using the best possible methods.

HIA and policy making

In this section we investigate how HIA contributes to policy making.

HIA can be a valuable tool for helping to develop policy and assisting decision-makers. The usefulness and need of HIA within policy and decision making is clear, HIA:

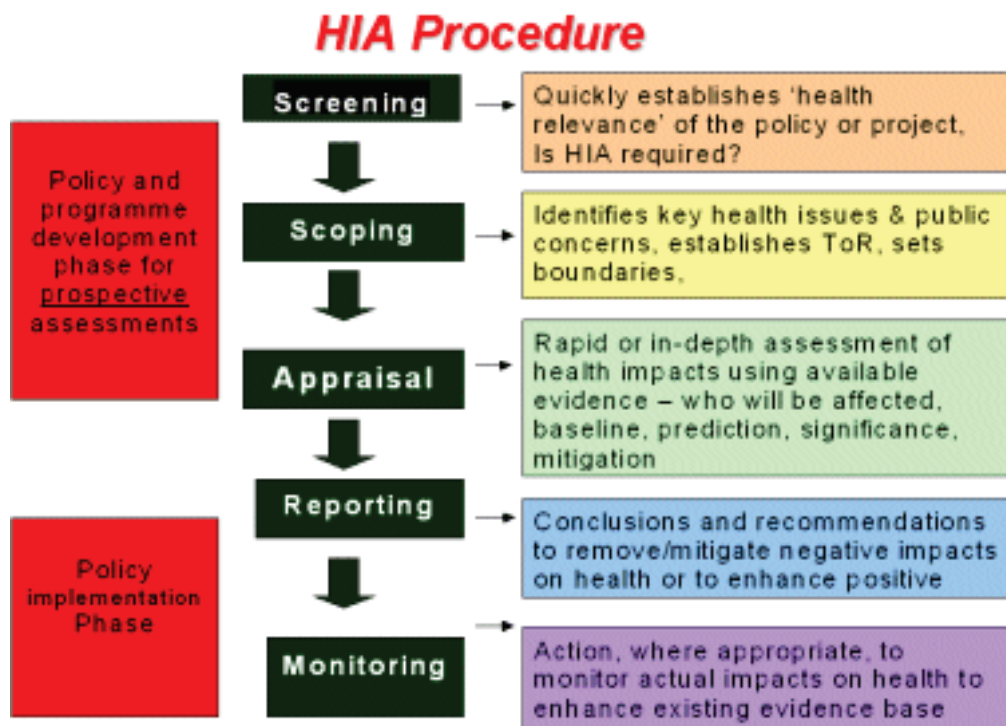
- is used in projects, programmes and policies
- assists policy development
- brings policies and people together
- involves the public
- provides information for decision makers
- addresses many policy making requirements
- recognises that other factors influence policy apart from HIA.
- is a proactive process that improves positive outcomes and decreases negative outcomes
- can provide what policy makers need

Suggestions for how an HIA practitioner might interact with the policy process and policy makers, a description of the different stages in policy making, plus some key steps for HIA practitioners, are also provided.

Tools and methods

How to undertake an HIA

This section will draw on a number of case studies to briefly describe the theory and practice of carrying out an HIA. Many HIA guidance documents have been produced, from all regions of the world and we encourage you to use these for detailed work. While there is no single agreed method for undertaking HIA, a general pattern has emerged amongst methods and there is much overlap between them.



Guidance documents often break HIA into four, five or six stages. Despite the differing number of stages, it is important to note that there are no significant differences between the methods. Also, the theoretical stages often overlap and intermingle, and a clean separation is not often obvious in practice. The stages are:

Using evidence within HIA

One of the key values of HIA is the ethical use of evidence. A wide variety of evidence should be collected and assessed, using appropriate and effective methods. This will provide the basis for evidence-based recommendations that can be provided to decision-makers, who can then make decisions about accepting, rejecting, or amending the proposal in the knowledge that they have the best available evidence before them.

HIA considers several types of evidence. It goes beyond published reviews and grey literature to include the knowledge of stakeholders who are involved in or affected by a proposal. Where evidence of the quality and quantity demanded by decision-makers is not available, a note of this is made within the HIA.

Legislative Measures & International Health Regulation (IHR)

For management of domestic and extra-domestic mosquito breeding places, adoption and enforcement of by-laws for use under Urban Malaria Scheme are framed as under:-

Control of malaria and other mosquito borne diseases.

Draft provisions suggested for adoption under appropriate section/rule prevailing in the State.

Application of this Provision

1. The State Govt./local authority constituted under any act may enforce the following provisions to the whole or any part of the State/local authority area.
2.
 - (1) If the provisions have been extended, no person or local authority shall, after such extension:
 - (a) have, keep, or maintain within such area any collection of standing or flowing water in which mosquitoes breed or are likely to breed, or
 - (b) cause, permit, or suffer any water within such area to form a collection in which mosquitoes breed or are likely to breed, unless such collection has been so treated as effectively to prevent such breeding.
 - (2) The natural presence of mosquito larvae, in any standing or flowing water shall be an evidence that mosquitoes are breeding in such water.

Treatment of Mosquito Breeding Places

3.
 - (1) The Health Officer may, by notice in writing, require the owner or the occupier of any place containing any collection of standing or flowing water in which mosquitoes breed or likely to breed, within such time as may be specified in the notice, not being less than 24 hours, to take such measures with respect to the same, or to treat the same by such physical, chemical or biological method, being measures or a method, as the Health Officer may consider suitable in the circumstances.
 - (2) If a notice under sub-section (1) is served on the occupier, he shall in the absence of a contract expressed or implied, to the contrary, be entitled to recover from the owner the reasonable expenses incurred by him in taking the measures or adopting the method of treatment, specified in the notice and may deduct the amount of such expenses from the rent which is then or which may thereafter be, due from him to the owner.

Health Officer's Power in Case of Default

4. If the person on whom a notice is served under provision 3 fails or refuses to take the measures, or adopt the method of treatment, specified in such notice within the time specified therein, the Health Officer may himself take such measures or adopt such treatment, specified in such notice within the time specified therein, and recover the cost of doing so from the owner or occupier of the property, as the case may be, in the same manner as if it were a property tax.

Protection of Anti-mosquito Works

5. Where, with the object of preventing breeding of mosquitoes in any land or building, the Govt. or any local authority or the occupier at the instance of the Govt. or local authority, (have constituted any works) in such land or building, the owner for the time being as well as the occupier for the time such land or building shall prevent its being used in any manner which causes or is likely to cause the deterioration of such works, or which impairs, or is likely to impair the efficiency.

Prohibition of Interference with such works

6. (1) No person shall, without the consent of the Health Officer, interfere with, injure, destroy, or render useless any work executed or any material or thing placed in under or upon any land or building, by the orders of the Health Officer with the object of preventing the breeding of mosquitoes therein.

(2) If the provisions of sub-section (1) are contravened by any person, the Health Officer may re-execute the work or replace the materials or things, as the case may be, and the cost of doing so shall be recovered from such person in the same manner as if it were a property tax.

Section in Respect of Household Cans and other Containers

7. The owner or occupier of any house, building, or shed or land shall not therein keep any bottle, vessel, can or any other container, broken or unbroken, in such manner that it is likely to collect and retain water which may breed mosquitoes.

8. All borrow pits required to be dug in the course of construction and repair of roads, railways, embankments, etc. shall be so cut as to ensure that water does not remain stagnant in them. Where possible and practicable the borrow pits shall be left clean and sharp edged and extra expenditure not exceeding 1 per cent of the cost of the earth work in any project may be incurred to achieve this. The bed level of borrow pits shall be so graded and profiled that water will drain off by drainage channels connecting one pit with the other till the nearest natural drainage nullah is met with. No person shall create any isolated borrow pit which is likely to cause accumulation of water which may breed mosquitoes.

9. In case of any dispute or difference of opinion in the execution of any antimosquito scheme or in its operation or any work under these provisions in which the jurisdiction of the Govt. of India, or Govt. of any other State is involved, the matter shall be referred to the Govt. of India for final say in the matter.

10. Powers of Health Staff to enter and inspect the premises

For the purpose of enforcing the provisions, the Health Officer or any of his subordinate not below the rank of Health or Sanitary Inspector may, at all reasonable times, after giving such notice in writing as may appear to him reasonable, enter and inspect any land or building within his jurisdiction and the occupier or the owner as the case may be, of such land or building, shall give all facilities necessary for such entry and inspection, and supply all such information as may be required of him for the purpose aforesaid.

International Health Regulations (IHR)

In today's connected world, health security is a global issue. The International Health Regulations (IHR) are legally binding regulations aiming to a) assist countries to work together to save lives and livelihoods endangered by the spread of diseases and other health risks, and b) avoid unnecessary interference with international trade and travel.

The Twenty-Second World Health Assembly (1969) adopted, revised and consolidated the International Sanitary Regulations, which were renamed the International Health Regulations (1969). During the Forty-Eighth World Health Assembly in 1995, WHO and Member States agreed on the need to revise the IHR (1969) against the backdrop of the increased travel and trade characteristic of the 20th century. The IHR (2005) entered into force on 15 June 2007 and are currently binding on 194 countries (States Parties) across the globe, including all 193 Member States of WHO. The purpose and scope of IHR 2005 are to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade. (Art. 2, IHR 2005). WHO plays the coordinating role, through the IHR, WHO keeps countries informed about public health risks, and works with partners to help countries to build capacity to detect, report and respond to public health events.

Core obligations for Member Countries

- Designate a National IHR Focal Point as the operational link for urgent communications concerning the implementation of the Regulations.
- Develop, strengthen and maintain the surveillance and response capacity to detect, assess, notify, report and respond to public health events, in accordance with the core capacity requirements under the IHR (2005).
- Notify WHO for all events that may lead to a Public Health Emergency of International Concern (PHEIC) within 24 hours of assessment by using the decision instrument [an algorithm].
- Respond to requests for verification of information regarding public health risks.
- Provide WHO with all relevant public health information, if a State Party has evidence of an unexpected or unusual public health event within its territory, which may constitute a PHEIC.
- Control urgent national public health risks that may threaten to transmit diseases to other Member Countries.
- Provide routine inspection and control activities at international airports, ports and some ground crossings to prevent international disease transmission.

- Make every effort to fully implement WHO-recommended temporary and standing measures and provide scientific justification for any additional measures.
- Collaborate with other Countries Parties and with WHO in implementing the IHR (2005), particularly in the area of assessment, provision of technical and logistical support, and mobilization of financial resources.

Core obligations for WHO

- Designate WHO IHR contact points as operational links for urgent communications concerning the implementation of the IHR (2005).
- Support Member Countries' efforts to develop strengthen and maintain the core capacities for surveillance and response in accordance with the IHR (2005).
- Verify information and reports from sources other than official notifications or consultations, such as media reports and rumors, when necessary.
- Assess events notified by Member Countries (including on-site assessment, when necessary) and determine if they constitute a PHEIC.
- Provide technical assistance to Countries in their response to public health emergencies of international concern.
- Provide guidance to Countries to strengthen existing surveillance and response capacities to contain and control public health risks and emergencies.
- Provide all Member Countries with public health information to enable Member Countries to respond to a public health risk.
- Issue temporary and standing recommendations on control measures in accordance with the criteria and the procedures set out under the Regulations.
- Respond to the needs of Member Countries regarding the interpretation and implementation of the IHR (2005).
- Collaborate and coordinate its activities with other competent intergovernmental organizations or international bodies in the implementation of the IHR (2005).
- Update the Regulations and supporting guides as necessary to maintain scientific and regulatory validity.

Role of WHO in global system for alert and response

When a significant public health event takes place, WHO's comprehensive global alert and response system ensures that information is available and response operations are coordinated effectively

Country capacity building

To help countries review and, if necessary, strengthen their ability to detect, assess and respond to public health events, WHO develops guidelines, technical materials and training, and fosters networks for sharing expertise and best practice.

International Health Regulations in Ports, Airports and Ground Crossings

In case of arboviral / Vector Borne Diseases, all international air/sea ports and ground crossings with a perimeter of 500 meters should be kept free from vector of yellow fever/Dengue/Plague, if present, their density should be less than one to limit the spread of health risks to neighboring countries, and to prevent unwarranted travel and trade restrictions so that traffic and trade disruption is kept to a minimum.

International transport, travel and trade contribute to economic development and welfare of populations, pose great public health risks. Today's high traffic at airports, ports and ground crossings – points of entry, can play a key role in the international spread of diseases through persons, conveyances and goods. The International Health Regulations (2005) provide a public health framework in the form of obligations and recommendations that enable countries to better prevent, prepare for and respond to public health events and emergencies.

Under the IHR, Member Countries are requested to maintain effective sustainable public health measures and response capacity at designated ports, airports and ground crossings, in order to protect the health of travelers and populations; keep ports, airports and ground crossings running as well as ships, aircrafts and ground transportation travelling in a sanitary condition; contain risks at source, respond to emergencies and implement public health recommendations, limiting unnecessary health-based restrictions on international traffic and trade.

In India an International Health Division under Directorate General of Health Services (Dte.GHS) monitors the IHR related activities in the country.

Activities undertaken for vector control in air/sea port and ground crossings:

- Strengthen regular epidemiological/entomological surveillance at international air/Sea ports and ground crossings. The National Vector Borne Disease Control Programme (NVBDPC) and National Centre for Disease Control (NCDC) has regularly monitor the Aedes breeding at International airports and sea ports to maintain Aedes breeding free status. If any breeding is detected actions need to be taken immediately through port health authority to eliminate the source and prevention for future. The observations/actions taken has to be shared with the IH division of Dte.GHS with suggestions, if any.
- Support the Ministry of Health and Family Welfare in the development of regular feedback reports and early warning systems for the diseases.
- Co-ordinate activities to review the legislative framework of the IHR implementation.
- NVBDPC and NCDC to organize and facilitate training on core capacity for entomological surveillance as identified in the field of VBDs.
- Support implementation of the IHR (2005) action plan.

Gol Policy for Yellow Fever

Yellow Fever (YF) does not occur in India. The conditions for transmission of YF are very conducive in India (presence of Aedes vector and susceptible population). Gol has been following a strict YF vaccination programme to prevent its entry to India. Strategy of Gol for prevention of entry of YF disease into India has been screening of all international passengers for vaccination against yellow fever disease at all points of entry in compliance of the IHR 1969 & 2005 and Aircraft Health Rules 1954 and Port Health Rules 1955. All passengers coming to India or passengers going from India to countries endemic for YF should have a valid International Vaccination Card for YF or they are quarantined for a period of 6 days or till the YF vaccination become valid (whichever is earlier).

YF disease will be treated as disease of Public health significance and all health measures being applied presently like disinsection of conveyance by spraying Aerosol (Aircrafts and Ships), vaccination requirements and quarantine of passengers and crew (as may be required) (as per Article 7, P.2(b), 42 and relevant annexure) will be continued as has been stipulated under Annex-II of IHR-1969.

Source: <http://www.who.int/ihr/ent>

For details of India's perspective on IHR refer : <http://www.mohfw.nic.in/index1>

Community Participation

Community participation and social mobilization in preventing vector borne diseases have always been felt of utmost importance. The first and foremost important aspect of community participation is change in their mind set towards individual and social responsibility rather than it is the responsibility of concerned department. In order to achieve that, the community need to be updated through IEC and this should be followed with Behaviour Change Communication (BCC). This is being used as a supportive strategy is an integral part of National Vecisease Control Programme. The ultimate goal of communication is to bring behavioural change through information and empowerment of people for community participation. Various steps are recommended and need to be followed

1. National task force to sensitize different stake holder ministries and departments in meeting and designate nodal person in member organizations for monthly coordination
2. State task force to identify local stake holder and advise for monthly coordination meetings to flag issues and suggest remedial measures
3. District co-ordination committee/Block co-ordination committee /Urban Area co-ordination Committee/Village Health Committee meetings and identifying nodal activists/champions in member organizations for monthly coordination.
4. Besides print and electronic media, Inter-personal Communication (IPC) works best when there is one-on-one contact between the heath worker and/or health educator and the person whose behaviour is sought to be changed to adopt new skills and practices to ensure the welfare of their families and children. One-on-one contact facilitates comprehension of new concepts and demonstration of new practices. Over a period of time, if done consistently, this method can result in adoption of new practices on a sustainable basis.
5. Tool kit for IPC be developed to enable the communicator /health worker to easily demonstrate any concept through visual aids like manuals, demonstration devices such as role plays, flash cards, flip books etc. for desired activities.

The community participation in certain places has demonstrated visible impact in various activities of vector management and these may be shared.

Supervision

Supervision is an essential and integral part of IRS to ensure its efficacy and safety. This should be thorough to produce an impact and ensure that there are no ill effects. To be effective, supervision should be carried out at all levels. There should be a written plan for supervision and supervisory checklists are to be developed and used. Supervision will be effective if problems are identified and they are solved by the supervisors as soon as they are detected. Any unsolved problems should be referred to district authorities for resolution. All supervisory reports should be sent to the district to facilitate follow up action. The supervisory reports should be kept safely in the district and referred to whenever needed.

- Availability of plan with the spray squad. Review of the plan to ensure that the plan is being followed.
- Ensure that all members of the spray squad are present and are doing the job.
- Checking that the spraying is being done correctly according to the norms prescribed in the work manual of the spray squad.
- Examination of the spray equipment to ensure that it is in working condition and is being properly maintained as per the guidelines provided.
- Going with the squad to the households where there is refusal or reluctance for spraying
- Checking the records of the spray squads
- Discussions of plans for mopping up to cover the households where there was refusal or the houses were locked.
- Assessing the consumption of insecticides and making arrangements for additional supplies if required.
- Review of time schedule for the following week
- Visit randomly selected households and ask whether the house was sprayed or not.
- If the house was sprayed, then check for grey white deposits as evidence for spray.
- Check whether the deposits are uniform or not. Uniform deposits indicate that the spraying was satisfactory.
- Check to see if any portions of the dwelling or the cattle shed were skipped.
- Check whether the walls have been plastered with mud. If the walls have been plastered then determine when this was done to determine the time interval between the IRS and the plastering.
- Visit the households that were not covered and find out the reasons for non-coverage. Try to convince them to get their houses sprayed as a part of special mop up drive.
- Prepare a written report along with recommendations and share with the spray squads to ensure that the mistakes are corrected as soon as possible.

In case of Synthetic Pyrethroids, it is difficult to see the deposits on the wall during concurrent supervision. The droplets may be seen on the wooden structures in the rooms/ cattle sheds where insecticide has been sprayed.

Informing and involving the community

The supervisors should inform the community leaders and key persons in the villages about the plans for the spraying at least a week before the spraying is done. The spray team members should remind them at least one day before the operation. During the first visit discuss the following issues with the community leaders and key persons in the community.

- Distribution of a simple flyer explaining the purpose of the spraying and including the common do's and don'ts developed in local language. Simple illustrations should be included to facilitate easy understanding of the people. This should be a part of BCC. The flyer should be left with several key persons in the village for distribution and briefing amongst the sections/segments they represent or influence. Tell the key persons to share the contents of the flyer to others in the community.
- What is proposed to be done and why. Explain that this is the most effective way of eliminating a dreaded disease Kala-azar. Their cooperation will be a key to success of the efforts.
- Inform the proposed date for spraying the village
- Discuss what specific role the community leaders and key persons can play to ensure that the spraying is complete and thorough. This would require that no household is missed and the spraying done must be complete.
- Explain that if all surfaces are not sprayed the sand fly would fly to the uncovered areas and the desired effect of spraying will not be obtained.
- The insecticide is harmful for the food items. Foods must not be exposed to the insecticides.
- The households must not do any mud plastering of the walls and the sprayed surfaces for 3 months after the spraying.
- One day prior to the spraying audio announcement for masses might be a useful way of informing and reminding the villagers. Other suitable options may be taken up in place of above source if that is not available.

Analysis and Reporting

Daily Summary, reporting of information

At the end of each day, the spray squads should prepare the summary of day's work. This includes information on the households targeted, households sprayed, insecticide consumed, insecticide left, and the problems encountered in the work. A daily summary of spray operations and daily consumption record of insecticide should be maintained.

The daily report should be sent to the supervisor by all the spray squads for review and feedback by the supervisor in order to take corrective actions if required. The supervisors in turn should send the consolidated report to the focal point in the district once every week.

Monthly Reporting

Reporting of compiled data as per formats provided by NVBDCP needs to be ensured. The Vector control forms as VC1 to VC6 and Entomological surveillance forms are on websites and are annexed for reference.

These may be referred by State and Zonal entomological teams. IDSP and district level entomologists should also use this formats for reporting and analysis purposes.

Annual Reporting

Compiled monthly data on Vector control and Entomological surveillance must be analysed and compared with previous year for onward submission to NVBDCP.

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Material for Further Reading on Integrated Vector Management

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Annexure-I Reporting Format

NATIONAL VECTOR BORNE DISEASE CONTROL PROGRAMME

EF - I

List of code no. of vectors & insecticides for different proformae for entomological data computerization			
CODE NO.	MALARIA VECTORS	CODE NO.	TYPE OF SURFACE
01	<i>Anopheles culicifacies</i>		Mud plastered surface
02	<i>Anopheles stephensi</i>		Cemented surface
03	<i>Anopheles fluviatilis</i>		Wooden surface
04	<i>Anopheles philippinensis</i>		Bamboo surface
05	<i>Anopheles sundaicus</i>		Thatched surface
06	<i>Anopheles dirus</i>		Others
07	<i>Anopheles minimus</i>		
08	<i>Anopheles varuna</i>		
09	<i>Anopheles annularis</i>		
	FILARIA VECTORS	Code	INSECTICIDE
10	<i>Culex quinquefasciatus</i>	DDT	DDT
11	<i>Mansonioides (M) annulifera</i>	MLN	Malathion
12	<i>Mansonioides uniformis</i>	BHC	BHC (HCH)
	JE VECTORS	DLD	Dieldrin
01	<i>Culex vishnui</i>	FEN	Fenthion
02	<i>Culex pseudovishnui</i>	PIP	Pirimiphos-methyl
03	<i>Culex tritaeniorhynchus</i>	DEL	Deltamethrin
04	<i>Culex gelidus</i>	CYF	Cyfluthrin
05	<i>Culex fuscocephala</i>	ICO	Lambdacyhalothrin
06	<i>Culex whitmorei</i>	TEM	Temephos
07	<i>Culex epidesmus</i>	PRO	Propoxure
08	<i>Culex bitaeniorhynchus</i>	FTO	Fenitrothion
09	<i>Anopheles barbirostris group</i>		
10	<i>Anopheles hyrcanus group</i>		
11	<i>Anopheles subpictus</i>		
12	<i>Mansonioides (M) annulifera</i>		
KALA AZAR VECTORS			
01	<i>Phlebotomus argentipes</i>		
02	<i>Phlebotomus papatasi</i>		
03	<i>Phlebotomus sergenti</i> (Vector of cutaneous leishmaniasis)		

NATIONAL VECTOR BORNE DISEASE CONTROL PROGRAMME

Malaria & Filaria Vector Mosquito (Adult) Density

EF - II

State _____ Record Type – 01

1 District Code

--	--	--	--	--	--	--	--	--

PHC
Name _____
and Population under
2 spray

3 Locality

4 Date of collection

D	D	M	M	Y	Y		
---	---	---	---	---	---	--	--

5 Time of collection

--	--

 morn.

--	--

 eve.

6 Insecticide sprayed
(code of insecticide)

--	--	--

7 Spray coverage%

--	--	--

 Population

--	--	--

 Room

--	--	--

 House

--	--	--

 CS

--	--	--

8 Date of Spray

D	D	M	M	Y	Y		
---	---	---	---	---	---	--	--

9 Time spent in
hours

--	--	--	--

 HRS

--	--	--	--

 MTS

--	--	--	--

 HRS

--	--	--	--

 MTS

10 Vector of
Malaria

 Code

 Male

 Female

 10 man-
hour
density

11 Other
Anopheles
(specify
species)

12 Vectors of
Filaria

N.B.- when in a PHC more than one insecticide is used, code of other insecticide(s) also to be written with plus mark

NATIONAL VECTOR BORNE DISEASE CONTROL PROGRAMME

Density of Vectors of JE and Kala azar

EF - III

State _____

1 District Code _____

2 PHC Name _____ and population under spray

3 Locality _____

4 Date of collection

D	D	M	M	Y	Y		
---	---	---	---	---	---	--	--

5 Time of collection

--	--	--	--

morn. eve.

6 Insecticide sprayed

--	--	--	--

7 Spray coverage%

Population			Room			House		CS		

8 Date of Spray

D	D	M	M	Y	Y
---	---	---	---	---	---

9 Time spent in hours

Indoors				Outdoors			
HRS		MTS		HRS		MTS	

10 Vector of JE

Code	Male	Female	10 man-hour density

12 Vectors of Kalaazar

NATIONAL VECTOR BORNE DISEASE CONTROL PROGRAMME **Susceptibility test adult mosquito form** **EF - IV**

State _____

District code:

--	--	--	--	--	--	--	--	--	--

PHC Name or Name of locality _____ Date of test

--	--	--	--	--	--	--	--	--	--

Exposure period:

--	--	--	--

Species code <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td> </td><td> </td></tr></table>			Species code <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td> </td><td> </td></tr></table>			Species code <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td> </td><td> </td></tr></table>			Species code <table border="1" style="display: inline-table; vertical-align: middle;"><tr><td> </td><td> </td></tr></table>		

	TT	D	% MOR`T	TT	D	% MOR`T	TT	D	% MOR`T	TT	D	% MOR`T
OC - Control	:			:			:			:		
DDT 4%	:			:			:			:		
DL 0.4%	:			:			:			:		
OP - Control	:			:			:			:		
MLN 5%	:			:			:			:		
FENITRO 1%	:			:			:			:		
CB - Control	:			:			:			:		
Propoxur	:			:			:			:		
SP - Control	:			:			:			:		
Deltamethrin	:			:			:			:		
Cyfluthrin	:			:			:			:		
Lambdacyhalothrin	:			:			:			:		
Temperature	:			:			:			:		
Relative humidity	:			:			:			:		
			Maximum:			Minimum:						

NATIONAL VECTOR BORNE DISEASE CONTROL PROGRAMME **Susceptibility test (Larval) form** **EF - V**

State

District code:

PHC Name or Name of locality

Date of test

Minutes

Exposure period:

Species code		Species code		Species code		Species code	
TT	D	% MORT	TT	D	% MORT	TT	D

OP Control

Fenthion 1.25 mg/L :

Fenthion 6.25 mg/L :

Fenthion 31.25 mg/L :

Temephos 1.25 mg/L :

Temephos 6.25 mg/L :

Temephos 31.25 mg/L :

Temephos 156.25 mg/L:

Other larvicides :

Temperature

Minimum:

Relative humidity

TT = Total taken, D- Dead, Maximum: MORT = Mortality

[illegible][illegible]

■
■

■
■

conditions (Tick mark) Windy

☐ Rain☐ No wind☐ Fog☐ Cloudy☐

Vectors collected per human bait	Indoor	Outdoor
Vectors codewise	Vectors codewise	Vectors codewise

Vectors collected per human bait	Indoor	Outdoor
Vectors codewise		Vectors codewise

Aedes collected per bait

[illegible]

19-20 Hours

20-21 Hours

22-23 Hours

23-00 Hours

00-01 Hours

01-02 Hours

02-03 Hours

03-04 Hours

04-05 Hours	05-06 Hours
<p>1. 04-05 Hours</p> <p>2. 05-06 Hours</p>	<p>3. 06-07 Hours</p> <p>4. 07-08 Hours</p>

Space spray total catch (Pyrethrum spray)

EF - VIII

82

[illegible]

Month Year

PHC name:

--

--	--	--	--	--

Date sprayed :-		Exposure period:-				

Abdominal condition (Female):	Full fed:		Gravid:		Unfed:	
Control:	No. exposed:		No. Dead:		% Mort:	
On contact surface:	No. exposed:		No. Dead:		% Mort:	
Temperature:			Relative Humidity:			

NATIONAL VECTOR BORNE DISEASE CONTROL PROGRAMME
Mosquito larval collection form
EF - X

State

1 District Code

2. Locality

3. PHC Name

4. Date of collection

Date	-	Month	-	Year
------	---	-------	---	------

5. Distance from nearest house (in metres)	Morning	Evening
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
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47		
48		
49		
50		

6. No. Checked

[illegible]

- Sullage water drains
- Cess pits
- Cess pools
- eptic tanks
- OHT
- Cisterns (Fresh water)
- Barrels
- Earthen pitchers/
containers
- Rejected Tyres/Utensils
- Ornamental tanks
- Wells-unused
- Wells-used Fresh water channels
- Irrigation canals
- Seepage water
- Rice fields
- Lakes
- Pit/low lying water collections
- Rain water collection

Annexure-II

Mosquitoes and its life-cycle

The life cycle of mosquitoes consist of four stages i.e. Egg, Larva, Pupa and Adult. The cycle can be divided in aquatic and terrestrial phases. The Egg, Larva and Pupa are aquatic stages, whereas, adults are terrestrial.

Egg: Anophelines lay their eggs separately over the surface of water. Each egg has lateral air floats to keep it afloat. Culicines (Culex and Mansonia) lay their eggs on the water, in a boat-shaped mass referred to as an egg raft; whereas those to the genus Aedes are laid separately, often in dry hollows or containers which become flooded after rain. These “dry-laid” eggs are able to retain their viability without water for very long periods.

Larva: Eggs of mosquitoes generally hatch after 2-3 days in water. During growth the larva casts its skin four times, the stages between successive moults being known as instars.

Pupa: The pupa is a non-feeding stage, providing for morphological and physiological changes of the larva to the adult. The general appearance of the pupa is of a comma with an exaggerated “dot” and small “tail”. In general, culicine pupae can be distinguished from Anopheline pupae by their considerably longer respiratory trumpets.

Adult: The adult mosquito emerges from pupa which after emergence rests for a few minutes on the discarded pupal skin for its wings to expand and harden prior to flight. The adults of both sexes feed on plant juices but only the female feeds on blood because egg development is dependent on blood meal.

Annexure-III

Mosquitoes and its bionomics

Bionomics deals with the relationship between the species and its environment, feeding, resting and breeding. An understanding of mosquito bionomics is therefore of key importance in planning methods of mosquito control. Climatic factors play an important part in species distribution, behaviour, survival and vectorial status. Water is an essential component of the mosquito environment, whether it is running, standing, clean or polluted, sweet or brackish, shaded or sunlit. . The environments of the immature stages and adult mosquito are interdependent since the adult mosquito must have access to water for egg laying. The adult mosquito environment is, however, largely aerial and terrestrial because the former environment is necessary for mating and dispersal whereas the latter provides habitats for feeding, resting and completion of reproductive cycle. Adult mosquitoes mate usually within 24-48 hours after emergence. Swarming is a common phenomenon before mating. Swarming usually occurs at dawn or dusk. Females entering the swarm are seized and the pair drops out of the swarm. Mosquitoes usually have a flight range of 1-3 km. However, dispersal depends on wind velocity and direction.

Mosquitoes feed on vertebrate host. Mosquitoes feeding on human are referred to as anthropophilic, and those on animals as zoophilic. Most of the species bite during night except *Aedes* spp. Mosquitoes, which feed inside houses, are described as endophagic and those that feed outdoors as exophagic. The prevalence of mosquito generally depends on favorable climatic conditions such as temperature and humidity and breeding potential in an area. These biotic and abiotic factors also play crucial role in longevity of the mosquito which is important for transmission of the disease.

Widespread use of insecticides leads to the development of insecticide resistance which necessitates the understanding of tools under IVM to be used judiciously and effectively. Therefore, understanding the resistance level in the vector population is important. There are very few alternative groups of chemical insecticides and there is a need for IVM using different available tools.

Annexure-IV

Kala azar vector and its Bionomics

The vectors of various Leishmaniasis worldwide over belong to Order Diptera of class Insecta (Phylum Anthropoda). Sand flies are grouped in two sub-families namely Psychodinae and Phlebotominae. Only the members belonging to family Phlebotominae are transmitting agents for different types of Leishmaniasis. Life cycle is completed in four stages, egg, four instars of larva, pupa and adults and total time taken from egg to adult is reported to be 20-36 days.

Egg: The freshly laid eggs are creamy white in colour which later becomes dark. The eggs are usually deposited in cracks and crevices with high organic content, humidity and darkness. Sometimes eggs are also found in loose soil. The eggs are glued to the surface through flattened while the convex side faces upwards. A wide range has been observed for total number of eggs laid per female (5-68). The eggs hatch in 3-4 days at 26+ 2°C.

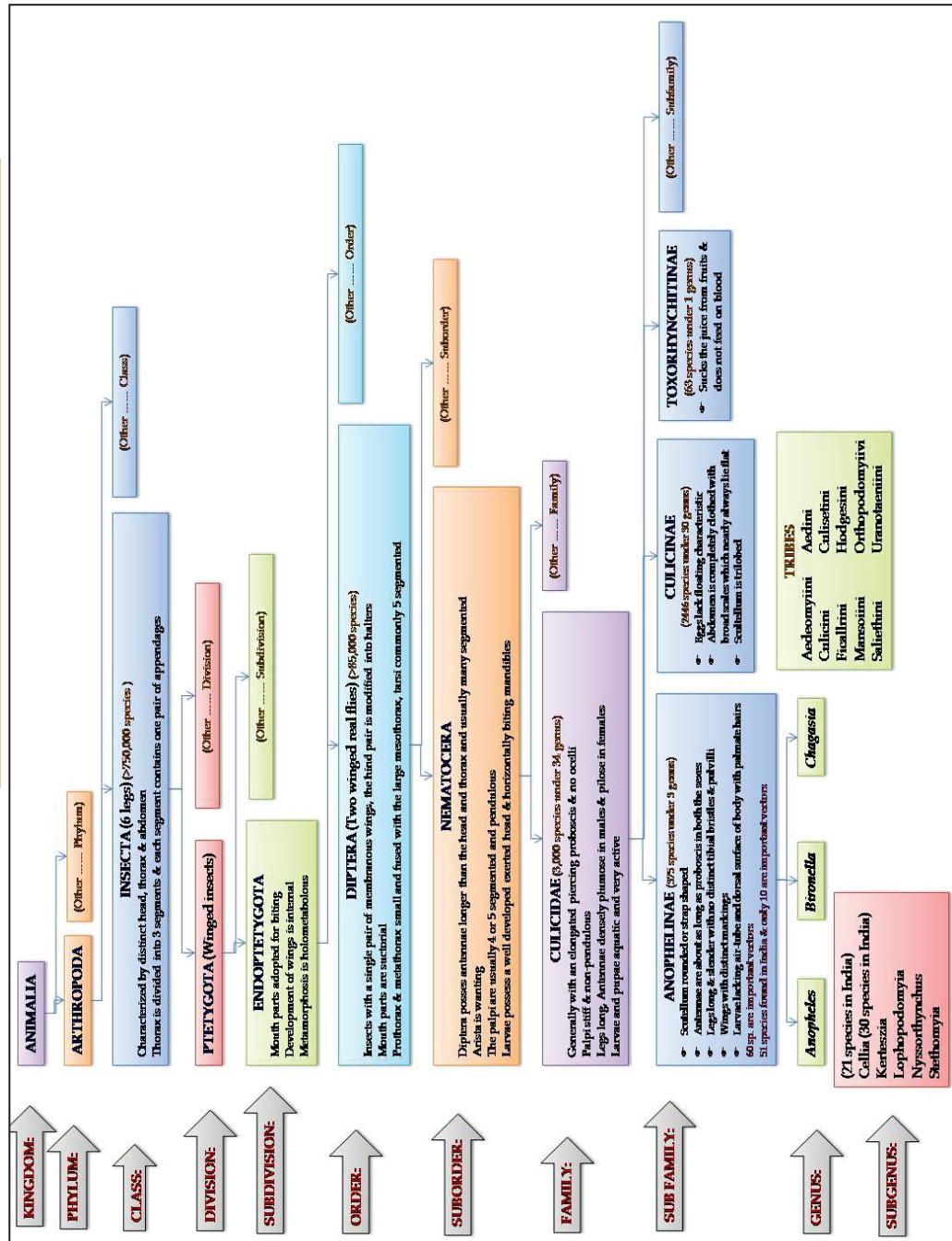
Larva: The creamy white larva with distinct head, thorax and abdomen has numerous hairs on its body. The larva feeds on organic matter available in the soil. There are four larval stages with about 2-4 days for 1st, 2-5 days for 2nd, 3-4 for 3rd and 4-7 days for 4th instar stages. The total larval period may vary from 11-29 days.

Pupa: The elongated comma shaped pupa is milky white in the beginning and turns brown. It is a non feeding stage lasting for about 6-10 days. The sexes are differentiated in this stage. The total life cycle from egg to adult is reported to take about 20-36 days.

Adults: *P. argentipes* have been reported to undergo 5 gonotrophic cycles under laboratory conditions, duration each cycle being 4 to 5 days at 26+ 2°C i.e a minimum longevity up to 23-27 days under laboratory conditions. Longevity under field conditions is about 16-20 days which is directly dependent on ecological factors.




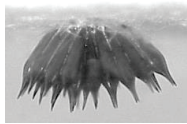
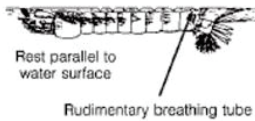
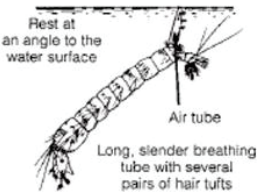
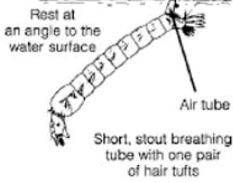
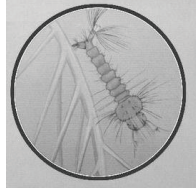
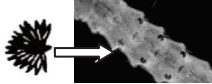




Bionomics of Sandfly: In India, *Phlebotomus argentipes* is only vector for Visceral Leishmaniasis. The adult sand fly is a small, fuzzy, delicately proportioned fly, usually 1/4th of the size of the mosquito. The factors favorable for transmission of Visceral Leishmaniasis or Kala-azar are Alluvial soil, High sub-soil water, temperature below 37°C, Annual rainfall 1250mm, Relative Humidity of 70% or more with more than 80% for at least 3 months, Abundant vegetation and altitude below 600 meter. These factors inter-alia favour *Phlebotomus argentipes*, the only known vector of Visceral leishmaniasis in India, to survive with high prevalence through greater part of the year facilitating transmission.

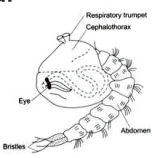
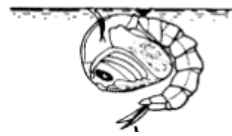





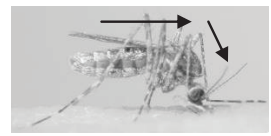
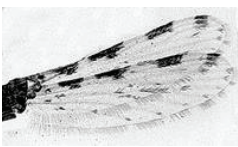
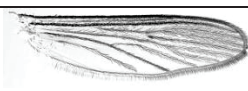

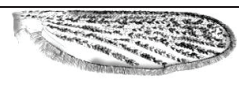




Mosquitoes: Taxonomic Position






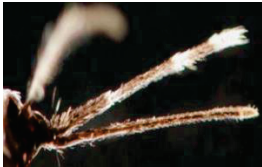

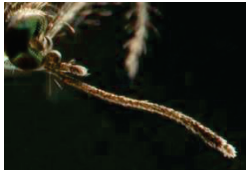




Annexure-VI

Identification characteristic of Anophilines and Culicines

Anopheline	Culicine		
	<i>Culex</i>	<i>Aedes</i>	<i>Mansonia</i>
Eggs:  <p>Eggs laid singly, are boat shaped with lateral air floats</p>	 <p>Egg laid in cluster as raft with no lateral floats</p>	 <p>Eggs are cigar shaped with no lateral floats and laid either on the ground or above the water line</p>	 <p>Eggs are laid in star shaped clusters on the undersurface of leaves of aquatic plants</p>
Larva:  <p>Rest parallel to water surface Rudimentary breathing tube</p> <p>Floats horizontally parallel to water surface, exclusively surface feeder</p> <p>Very active with swift movement</p>	 <p>Rest at an angle to the water surface Air tube Long, slender breathing tube with several pairs of hair tufts</p> <p>Hangs down at an angle of 45° to the water surface with head downwards</p> <p>Whip-like or 'figure C' snake like movement</p>	 <p>Rest at an angle to the water surface Air tube Short, stout breathing tube with one pair of hair tufts</p> <p>Hangs down at angle of 45° to water surface with head downwards</p> <p>Characteristic 'S' shaped or 'figure 8' movement, which involves all parts of the body</p>	 <p>Larvae are attached to the rootlets of aquatic plants by theisiphon tubes. They obtain their air supply from these rootlets</p>
 <p>Presence of palmate/ float hair on abdominal segments</p>	No palmate hair	No palmate hair	No palmate hair
 <p>Tracheal gills</p> <p>No siphon tube i.e., rudimentary breathing tube</p>	 <p>Tracheal gills Comb Respiratory siphon</p> <p>respiratory siphon tube is long slender/ narrow, 3 times as long as wide with several pairs of hair tufts</p>	 <p>siphon/ breathing tube dark in color short, stout i.e., about twice as long as wide with one pair of hair tufts</p>	 <p>Siphon is characteristically modified for piercing plant tissue</p>

Pupa:  Short broad breathing/ respiratory trumpet, distally expanded	 Paddle at 9th segment	 Long narrow breathing trumpet, tubular	 Pupae are attached to rootlets of aquatic plants by theisiphon tubes.
Adult: Resting  Rests indined at an angle of 45° to the surface, proboscis and body in same straight line	 Rests parallel to the surface, probosics and body at an angle to one another	 Rests parallel to the surface, probosics and body atan angle to one another	 Rests parallel to the surface, probosics and body at an angle to one another
Wings  Generally spotted with white and dark scales	 Generally unspotted with only dark scales	 Dark scales with brown/ black color	 Dark brown and pale scales; scales broad with cutoff tip
Scutellum  Half moon shaped with a uniform row of hairs along the margin	 Trilobed, with three bunches of hairs on the lobes	 Trilobed, with three bunches of hairs on the lobes	 Trilobed, with three bunches of hairs on the lobes

<p>Abdomen & legs</p>  <p>Abdomen Completely or largely devoid of scales</p>	 <p>Uniform layer of over lapping flat white and dark scales on the abdomen</p>	 <p>Black and white basal band on abdomen and legs</p>	 <p>Big, black or brown mosquitoes with sparkling on their wings and legs</p>
<p>Palpi</p>   <p>Proboscis dark and palp has white rings. Palpi long nearly equal to proboscis. Antennae shorter than proboscis</p> <p>Male – Palpi dub-shaped at the distal ends. Antenna plumose (many feathery hairs)</p> <p>Female – Palpi long slender. Antenna pilose (few spidery hairs)</p>	  <p>Proboscis and palp dark and short. Antennae about same size as proboscis.</p> <p>Male – Palpi usually longer than the proboscis long, pointed and bent. Antenna plumose (many feathery hairs)</p> <p>Female – short stub like reduced. Antenna pilose (few spidery hairs)</p>	 <p>Proboscis is dark and palps have silvery white scales at the tip</p> <p>Male – Palpi usually longer than the proboscis long, pointed and bent. Antenna plumose (many feathery hairs)</p> <p>Female – Palpi short stub like reduced. Antenna pilose (few spidery hairs)</p>	 <p>Palps not more than 1/3rd as long as proboscis 'club-like'</p> <p>Male – Palpi usually longer than the proboscis long, pointed and bent. Antenna plumose (many feathery hairs)</p> <p>Female – Palpi short stub like reduced. Antenna pilose (few spidery hairs)</p>

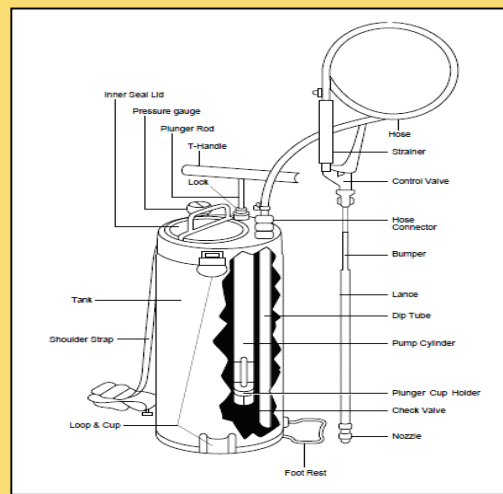
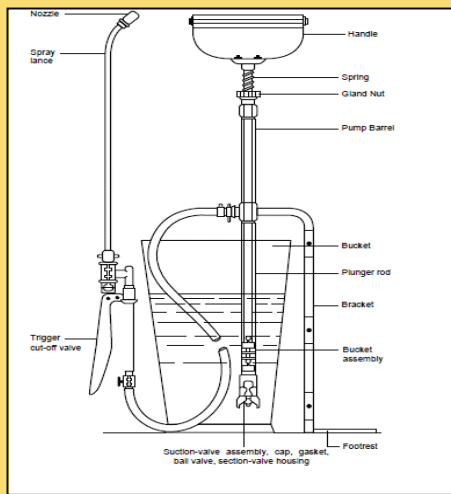
Annexure-VII Standard Operating Procedure for Spray

- The preparation of the spray suspension is made just before the start of the spray operations every day.
- It is important that the suspension is made correctly so that the correct dosage is applied on the sprayed surfaces.
- The required quantity of the insecticide is measured with a plastic mug and poured into a 15 litre bucket. A paste is made with a small quantity of water. The remainder of water is then poured slowly into the bucket and the insecticide water mixture is stirred vigorously to obtain a uniform suspension.
- The suspension is then poured into another bucket through a cloth sieve to remove any particulate matter that might clog the nozzle of the spray pump. The insecticide suspension should be stirred vigorously at least every hour. In case of HC pumps, pumps can be shaken.
- All food, cooking utensils, must be removed and bedding and clothes must be protected with plastic sheet to protect from the insecticide before spraying.
- The barrel of the stirrup pump is put in the bucket containing the spray suspension. One man operates the pump and the other man sprays. The spray lance should be kept 45 cms (18 inches) away from the wall surface.
- The swaths should be parallel. Spray is applied in vertical swaths 53 cm (21inches) wide. Successive swaths should overlap by 7.5 cm (3 inches).
- Spray is done from roof to floor, using downward motion, to complete one swath; then stepping sideways and spraying upwards from floor to roof.
- Do not let the spray drip to the floor. Spraying is done only on inner surfaces, including eaves and roofs.
- The discharge rate should be 740 to 850 ml per minute. To obtain the above discharge rate, the pump man should give 20 to 26 strokes per minute with 10-15 cms plunger movement at a pressure of 10 PSI (0.7 kg/sq.cm) at the nozzle tip. Hand compression pumps are operated by one persons and pressure gauge is to be noticed and maintained.
- Spraying into a bucket for one minute and measuring the quantity of the suspension in a graduated mug will check the correct discharge rate (740 to 850ml / minute).
- The nozzle tip should be discarded if the discharge rate exceeds 850 ml per minute.
- It takes about 5 minutes to spray a house with an average surface area of 150 sq. metres.
- A summary of spray operations in each village should be recorded by SFW and verified by health supervisor/health worker showing the areas covered and room coverage.

Annexure-VIII

Equipment for Indoor Residual Spraying (IRS)

Each squad of 5 persons will require the following equipment which must be available well in time before spray operations:



Stirrup pumps – 2/ HC Pumps-3	Straining cloth - 1 metre	Bucket 15 litres - 1	Asbestos thread - 3 metres	Pump washers - 2
Spray nozzle tips for spray pumps - 2	Protective equipments- Apron, Goggles, Gloves, Cap	Bucket 10 litres - 1	Measuring mug - 1	Plastic sheet (3x3 metres) – 1

Annexure-IX

Knapsack sprayer commonly used for larvicides

This is carried on the back and a shield is provided so that it does not come into actual contact with the back. A skirt is usually fitted to the bottom of the container to prevent the direct contact with the ground. Knapsack sprayer is a continuous type of Sprayer and the discharge rate is fairly constants.



Annexure-X

Space spraying equipment

1. Portable and vehicle mounted motorized aerosol generators;
2. Portable and vehicle-mounted motorised mist blowers
3. Portable and vehicle-mounted thermal foggers
4. Aircraft-mounted ULV systems.



Commonly used hand operated fogging machine

Annexure-XI

Thermal Fogging and ULV Space Spray Operations

Basic steps: The steps listed below are to be followed in carrying out the space spraying of a designated area:

1. The street maps of the area to be sprayed must be studied carefully before the spraying operation begins.
2. The area covered should be at least 300 metres within the radius of the house where the dengue case was located.
3. Residents should be warned before the operation so that food is covered, fires extinguished, and pets are moved out together with the occupants.
4. Ensure proper traffic control when conducting outdoor thermal fogging since it can pose a traffic hazard to motorists and pedestrians.
5. The most essential information about the operation area is the wind direction.
6. Spraying should always be done from downwind to upwind, i.e. going against the direction of the wind.

Vehicle-mounted spraying

1. Doors and windows of houses and buildings in the area to be sprayed should be opened.
2. The vehicle is driven at a steady speed of 6-8 km/hr (3.5-4.5 mile/hr) along the streets. Spray production should be turned off when the vehicle is stationary.
3. When possible, spraying should be carried out along streets that are at right angles to the wind direction. Spraying should commence on the downwind side of the target area and progressively move upwind.
4. In areas where streets run parallel as well as perpendicular to the wind direction, spraying is only done when the vehicle travels upwind on the road parallel to the wind direction.
5. In areas with wide streets with houses and buildings far from the roadside, the spray head should point at an angle to the left side of the vehicle (in countries where driving is on the left side of the road). The vehicle should be driven close to the edge of the road.
6. In areas where the roads are narrow, and houses are close to the roadside, the spray head should be pointed directly towards the back of the vehicle.
7. In dead-end roads, the spraying is done only when the vehicle is coming out of the dead-end, not while going in. The spray head should be pointed at a 45° angle to the horizontal to achieve maximum throw of droplets.
8. Vector mortality increases downwind as more streets are sprayed upwind in relation to the target area.

Annexure-XII

Portable thermal fogging

1. Thermal fogging with portable thermal foggers is done from house to house, always fogging from downwind to upwind.
2. All windows and doors should be shut for half an hour after the fogging to ensure good penetration of the fog and maximum destruction of the target mosquitoes.
3. In single-storey houses, fogging can be done from the front door or through an open window without having to enter every room of the house. All bedroom doors should be left open to allow dispersal of the fog throughout the house.
4. In multi-storey buildings, fogging is carried out from upper floors to the ground floor, and from the back of the building to the front. This ensures that the operator has good visibility along his spraying path.
5. When fogging outdoors, it is important to direct the fog at all possible mosquito resting sites, including hedges, covered drains, bushes, and tree-shaded areas.
6. The most effective type of thermal fog for mosquito control is a medium/dry fog, i.e. it should just moisten the hand when the hand is passed quickly through the fog at a distance of about 2.5-3.0 metres in front of the fog tube. Adjust the fog setting so that oily deposits on the floor and furniture are reduced.

Back-pack aerosol spraying with ULV attachments

1. Each spray squad consists of four spraymen and one supervisor.
2. Each sprayman sprays for 15-30 minutes and then is relieved by the next sprayman. For reasons of safety, he must not spray when tired.
3. The supervisor must keep each sprayman in his sight during actual spraying in case he falls or needs help for any reason.
4. Do not directly spray humans, birds or animals that are in front of spray nozzles and less than five metres away.
5. Spray at full throttle. For example, a ULV
6. Fontan nozzle tip 0.4 can deliver 25 ml of malathion per minute, and a 0.5 tip, 65 ml. The smaller tip is usually preferred unless spraymen move quickly from house to house. Some machines can run for about one hour on a full tank of petrol.

Annexure-XIII

House spraying technique

1. Do not enter the house.
2. Stand 5 metres in front of house and spray for 10 to 15 seconds, directing the nozzle towards all open doors, windows and eaves. If appropriate, turn away from the house and, standing in the same place, spray the surrounding vegetation for 10 to 15 seconds.
3. If houses are very close and space is less, the spray nozzle should be directed towards house openings, narrow spaces and upwards.
4. While walking from house to house, hold the nozzle upwards so that particles can drift through the area. Do not point the nozzle towards the ground.
5. Spray particles drift through the area and into houses to kill mosquitoes which become irritated and fly into the particles.
6. This technique permits treatment of a house with an insecticide ranging from 1 to 25 grams in one minute. The dosage depends on the discharge rate, concentration of insecticide applied, and time it takes to spray the house.

Information to be given to inhabitants

1. Time of spraying, for example 0630 to 1000 hours.
2. All doors and windows should be open.
3. Dishes, food, fish tanks, and bird cages should be covered.
4. Stay away from open doors and windows during spraying, or temporarily leave the house and/or the sprayed area until the spraying is completed.
5. Children or adults should not follow the spray squad from house to house.

Timing of application

1. In the early morning and late evening hours, the temperature is usually cool. Cool weather is more comfortable for workers wearing protective clothing. Also, adult Aedes mosquitoes are most active at these hours.
2. In the middle of the day, when the temperature is high, convection currents from the ground will prevent concentration of the spray close to the ground where adult mosquitoes are flying or resting, thus rendering the spray ineffective.
3. An optimum wind speed of 6 km/hr enables the spray to move slowly and steadily over the ground, allowing for maximum exposure of mosquitoes to the spray. Air movements of less than 3 km/hr may result in vertical mixing, while winds greater than 13 km/hr disperse the spray too quickly.
4. In heavy rain, the spray generated loses its consistency and effectiveness. When the rain is heavy, spraying should stop and the spray head of the ULV machine should be turned down to prevent water from entering the blower.
5. Spraying is permissible during light showers. Also, mosquito activity increases when the relative humidity reaches 90, especially during light showers.

Frequency of application

1. Earliest after a DF/DHF case from that area is reported. Repeat after 7-10 days to cover one breeding cycle of the mosquitoes

