COMPENDIUM ON ENTOMOLOGICAL SURVEILLANCE & VECTOR CONTROL IN INDIA

National Vector Borne Disease Control Programme
Directorate G.H.S., MOH & FW,
Government of India
22, Sham Nath Marg, Delhi–110 054

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दिनांक/Dated.....

MESSAGE

This gives me an immense pleasure that Directorate of NVBDCP has developed a "Compendium on Entomological Surveillance and Vector Control in India" The compilation of entomological surveillance with a brief description of vector control tools and available products prescribed in the book will be useful for making reference by the end users.

It is also encouraging to know that this compendium contains a comprehensive list of entomologist and vector control experts working at various National and State level organizations as well as Apex Research Institutions and Universities of India. This list of experts will help to contact them locally in different parts of the country so that a good network can be established later in vector management and share their experiences.

I am sure that this will be quick guide for referring the relevant study materials already published by NVBDCP and other academic or research institution in the field of vector control. This will also be beneficial for budding entomologists, research Scholars and students who are pursuing their carrier in public health entomology or vector control.

I wish success to Directorate of NVBDCP for developing this compendium which will be used as ready reckoner in the field.

(Dr. Jagdish Prasad)

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MESSAGE

The entomological information in general and particularly for vector borne diseases has been compiled and published earlier mostly basing on detail studies in southern and central India. There were some studies in North east and eastern India also.

It has been well recognized that entomology is an integral part of epidemiology of vector borne diseases. The vector control policy especially for programme has been formulated and amended from time to time based on the available entomological informations.

There have been many paradigm shifts in vector control strategies during last 5-6 decades i.e. from vector control to integrated vector control, then to Comprehensive vector control and finally to Integrated vector management. These strategic changes have been disseminated to states/UTs at different time intervals, however, this compilation giving historical glimpse of entomological progress along with currently used vector control tools and technologies are greatly appreciated.

I expect that this document will facilitate all stake holders involved in implementation of programme activity. The reference made for household products even though not included in programme will also be of immense help for NGOs, Corporate sectors and community.

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FOREWORD

National Vector Borne Disease Control Programme (NVBDCP) being an umbrella programme under National Health Mission covers six vector borne diseases namely malaria, Lymphatic Filariasis, Kala-azar, Japanese Encephalitis, Dengue and Chikungunya. Three out of these six vector borne diseases, are targeted for elimination whereas other three arboviral diseases are under control phase. Considering the threat of Zika and its spread in other parts of the world, the surveillance including entomological component have been intensified especially at port of entries. Vector control has been one of the main pillar for vector borne diseases which is also evident from the fact that the about 60% of financial allocations of NVBDCP is provisioned towards vector control.

The role of entomologists/vector control experts has been recognized since beginning and has regularly being emphasised at various levels. Even in review of Cabinet Secretary during 2011, the issue of availability of entomologists and their proper utilization were flagged and all States were emphasised to ensure the availability of such experts.

Various guidelines and manuals on different aspects of vector control are available and also hosted on our website www.nvbdcp.gov.in. These guidelines are also updated from time to time and disseminated among states/union territories. Even after that, many issues related to simple solutions are raised by administrators, implementers, community, new product formulators and inventors etc. as to know about recommended products for use under programme with its detail, procedure for inclusion of new products under programme and instruments etc.

The brief compilation of existing guidelines with recommended tools and techniques presented in this book is an attempt to empower State Programme Officers and others to undertake the vector control services through Entomologists, Biologists and other Public Health Experts etc.

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(Dr. A.C. Dhariwal)

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PREFACE

The control of vector borne diseases depends on two major pillars i.e. treatment of parasites and management of vectors. Vector control need adequate financial and skilled human resources. To plan vector control measures in any given area, entomological components including vector surveillance and mobility support are very crucial. The infrastructure for entomological monitoring with adequate facility and skilled human resource are so crucial for entomological surveillance as without vector control experts and entomologists, it is very difficult to dream of controlling or eliminating vector borne diseases.

Though various literature and guidelines are available for use of different tools of vector control under public health programme as well as for household use, many general issues are flagged from time to time about different tools, recommended products, entomological information and available experts in different parts of the country for seeking their advices locally.

This Book is an effort to address these issues so that State and District Programme Officers, Corporations/ Municipal Health Officers and Entomologists may use this as handbook for guidance. Efforts have also been made to compile the product details which are recommended for use under National Vector Borne Disease Control Programme. The list of experts available from programme side as well as from the research organisations has also been included for ready reference with their contact details.

The Public Health Act for empowering the State Programme Officers and Corporation/Municipal Health Officers has also been emphasised in one of the chapter of this book so that provision of penality on deliberate creation or maintaining the mosquitogenic conditions can be made in the local acts and exercised.

It is expected that this will be used as reference for the implementation of programme activity in the field and will be helpful for all those who are involved in prevention and control of vector borne diseases.

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Valuable inputs and suggestions given by Prof. A.P Dash, Vice Chancellor, Central University of Tamil Nadu and former Regional Advisor, WHO, SEARO is highly acknowledged.

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ACRONYMS

AST	Adult Susceptibility Test
BCC	Behavior Change Communication
BI	Breteau Index
BIS	Bureau of Indian Standards
Bti	*Bacillus thuringiensis* var *israelensis*
CDC	Centers for Disease Control and Prevention
CI	Container index
CIB	Central Insecticides Board
CMB	Central Malaria Bureau
CPM	Corrected Percentage Mortality
CRME	Centre for Research in Medical Entomology
DDT	Dichloro-diphenyl-trichloroethane
DGHS	Directorate General of Health Services
EC	Emulsifiable Concentrate
EIR	Entomological Inoculation Rate
ELISA	Enzyme-linked immunosorbent assay
GCMU	Genetic Control of Mosquitoes Unit
GoI	Government of India
Govt.	Government
GR	Granules
HBI	Human Blood Index
HI	House Index
ICMR	Indian Council of Medical Research
IGR	Insect Growth Regulator
IRFA	Indian Research Fund Association
IRS	Indoor Residual Spraying
ISO	International Organization for Standardization
ITN	Insecticide-Treated Nets
ITU	International Toxic Units
JE	Japanese Encephalitis
JH	Juvenile Hormone
KD	Knockdown
LF	Lymphatic Filariasis
LLIN	Long Lasting Insecticidal Nets
LST	Larval Susceptibility Test
MDA	Mass Drug Administration
MHD	Man Hour Density
MII	Malaria Institute of India
MLO	Mosquito Larvicidal Oil
MPO	Modified Plan of Operation
MRC	Malaria Research Centre
NAMP	National Anti Malaria Programme
NCDC	National Centre for Disease Control
NFCP	National Filaria Control Programme
NICD	National Institute for Communicable Diseases
NIMR	National Institute of Malaria Research
NMCP	National Malaria Control Programme
NMEP	National Malaria Eradication Programme
NVBDCP	National Vector Borne Disease Control Programme
PCR	Polymerase Chain Reaction
PHC	Primary Health Centre
POPs	Persistent Organic Pollutants
ppm	Parts per million
ROHFW	Regional Office for Health & Family Welfare
SIT	Sterile Insect Technique
SOP	Standard Operating Procedure
ULV	Ultra-Low Volume
UMS	Urban Malaria Scheme
VCRC	Vector Control Research Centre
WHO	World Health Organization
WP	Wettable Powder

INTRODUCTION

Vector management can play a crucial role in control or elimination of vector borne diseases. The different control methods and tools can be used as per their suitability for the area and vectors as all the vector control methods are not equally effective. Integrated vector Management is defined as a “rational decision making process for the optimal use of resources of vector control”.

Vector control experts are one of most important assets in vector control process right from planning stage of elimination or control of vector borne disease(s). The entomologists have to be careful about effectiveness of methods which depends on vector prevalence, biting and resting habits of vectors, local breeding ecology, human behaviour for personal protection and acceptability of services provided under public health programmes.

Anopheles and *Culex* generally nocturnal and therefore are targeted with residual insecticidal spray and/or Long lasting insecticidal nets (LLINs). *Aedes* species usually bite during day time and hence personal protection, larval control and changes in domestic environment are considered as better option.

In India, insecticides are introduced into public health programmes based on entomological parameters and their impact on disease incidence/ prevalence. Insecticides are used in the programme for indoor residual and space spraying, treatment of mosquito nets and larval control for containment of vector borne diseases. The revised protocol is to be adopted for the introduction of newer insecticides or insecticide formulations for public health use under National Vector Borne Disease Control Programme (NVBDCP). The NVBDCP considers introduction of new insecticides and amendment to the list of insecticides or deletion of insecticides in usage on the basis of data on bio-efficacy, vector susceptibility and epidemiological impact generated by state health departments, National Centre for Disease Control (NCDC), or Indian Council of Medical Research (ICMR) institutes. The insecticides used under programme must have the registration of Central Insecticide Board (CIB) as this is mandatory clause

Spray equipments are procured by states/UTs as per recommendations of NVBDCP. The other devices available in market for house hold use are though referred sometimes to us but are not included in NVBDCP. However, such

equipments should follow or comply the specifications of Bureau of Indian Standard, GoI.

Indoor residual spraying (IRS) has been in use since last 6 decades and sown the impact if used appropriately. It is useful mainly in areas of malaria transmission with collateral benefit for control of lymphatic filariasis transmission. The areas with high disease burden of malaria with inadequate coverage of LLINs should also be covered with IRS.

LLIN/ITN, curtain nets are used by the community. While untreated nets provide a barrier to human – vector contact, nets treated with insecticide maintain a barrier even if they have some holes. The killing and contact repelling effect of the insecticide improves the efficacy of nets for both individual prevention and area –wide reduction in transmission. These nets are one of the main tool used to control malaria vectors and are highly effective. LLINs and other impregnated materials for malaria control can be delivered through community based public health activity. Mass campaigns to deliver a certain number of nets per household or per person are effective in achieving high coverage and replacement. LLINs provide a long-term solution, as they last for about 3 years. As only one class of insecticide (pyrethroids) is used on mosquito nets, however, the development of pyrethroid resistance threatens their long-term efficacy.

Insecticide-treated curtains or wall linings may be suitable in areas where the predominant vectors for lymphatic filariasis are *Culex* mosquitoes. Curtains should be adapted to the type of house. Wall linings or curtains will require reimpregnation with insecticides.

Space spraying is used mainly during outbreaks, as the effects are not long-lasting and the procedure must be repeated frequently. It is usually applied in or around houses, some outdoor resting places and dense vegetation or salt marshes.

House screening is useful in the control of *Anopheles* and *Aedes* mosquitoes which is a physical barrier and should be placed on all openings, including windows, door and eaves. Householders should be encouraged to improve the conditions of their house (closing holes, filling crevices in walls), as this will also decrease the opportunity for mosquitoes to enter or rest.

Household insecticides such as aerosol insecticide sprays or flit guns are commercially available for use by individuals and households. The spray should be applied within a room with all exits closed. The person who is spraying should leave

the room and wait for a few minutes while the mosquitoes are being knocked down. The method has limitations as opening a window or door again may re-introduce vectors. It also has no residual killing effect. The impact of household insecticides on transmission of lymphatic filariasis is unknown.

Repellents, coils and vaporizing mats are popular, inexpensive method of vector control. They burn slowly and steadily release insecticide into the air over 6-8 hours. Vaporizing mats work on the same principal but are powered by electricity, and their advantage over coils is that they release no visible smoke. The porous paper pad is impregnated with an insecticide (usually a pyrethroid), which both repels and kills mosquitoes. Repellents are also available in the form of creams, lotions, patches, wrist-bands and sprays, which can be bought and applied as required by individuals.

Natural methods include certain fast-growing, densely foliated plants that repel mosquitoes. Production of the plants is cheap and self – sustaining, but botanical toxins may have health effects, and the efficacy of these methods need to be explored and documented.

Larvicides are used in mainly in urban areas and also in rural areas affected with dengue or chikungunya as per programme guidelines.

Public Health Act or building bye laws are already in force in some states and towns but it needs revision so as to empower the programme officers to enforce. A draft model civic By-laws need to be adopted as per local rules and regulations in the state.

2. ENTOMOLOGICAL SURVEILLANCE IN INDIA – A HISTORICAL PERSPECTIVE

In the 17th century, Entomology began to develop as a science and in middle of 18th century Danish scientist Johan Fabricius produced comprehensive studies which made beginning of medical entomology in other parts of world. After specialized academic studies on insect anatomy, physiology, behavior, biology, ecology and economic aspects of entomology, scientists had speculated in 19th century that some disease might be transmitted by insect. In 1879, when Patrick Mansion – a physician in China discovered that mosquitoes transmit the agents that cause filariasis. Twenty years later i.e. in 1897 the great physician Sir Ronald Ross in India (Secunderabad) showed the relationship between Malaria and *Anopheles* mosquitoes. Again, in the same year rat to rat and rat to man plague transmission by flea was confirmed by Simond. These discoveries led to the development of discipline of "Medical Entomology".

During the same period the vector incrimination studies and vector control aspects of malaria were initiated by the commission of Royal Society of London and other eminent scientists like Christophers, Stephens, Norton, James etc. By the end of the first decade three more Anopheline species i.e. *An. culicifacies. An. annularis and An. fluviatilis* were incriminated as malaria vectors. Central Malaria Bureau at Kasauli was established in 1909 to undertake studies on entomological aspects of malaria.

Later, the Central Malaria Bureau was converted to Malaria survey of India and anti-malaria activities by environmental management got momentum. The experience of successful control of mosquito breeding by channelizing the seepage of Sarda Canal and control of rural malaria in Mysore by Paris green as a larvicides was published. The first provisional list and reference catalogue of Anopheline mosquitoes was prepared by Christopher in 1924. In 1929 records of Malaria survey of India was published as first journal in India. In the middle of third decade Kala-azar Ancillary Enquiry financed by the Indian Research Fund Association led to the appointment of Kala-azar Commission by Govt. of India and by 1930, the enquiry was terminated due to decline of kala-azar. Bulk of initial studies on the entomological aspects of kala-azar was completed during this period although man to man transmission was not established in forties. Malaria Survey of India was shifted from Kasauli to Delhi in 1938 and renamed as Malaria Institute of India (MII).

Haffkine Institute, Bombay established department of Entomology in 1938 and during the same period Entomology Laboratory was established in Malaria Institute of

India. Training in Entomological, Epidemiological and parasitological aspects was initiated since inception of Central Malaria Bureau and continued regularly by NICD now known as NCDC.

Covell and Afridi in thirties did field trial of Pyrethrum for anti-malaria operation in Delhi. Aeroplane dusting with paris green in the reverine belt of Yamuna was also piloted for the control of mosquito larvae. Paul F. Russel and his team-mate during fifth decade of the 20th century collected useful informations on entomological aspects of malaria in Southern Peninsula. Also, an important discovery was made by Swaminathan confirming the man to man transmission of kala-azar by sandfly *Phlebotomus argentipes*. In the same decade, DDT was, first time, used in India by Armed Forces in 1944.

National Malaria Control Programme(NMCP) In 1953 was established which was converted into National Malaria Eradication Programme (NMEP) in 1958. The programme had very important component of vector control for residual application of DDT. Planning, execution, supervision and evaluation of residual spray of DDT became the main responsibility of entomologists working under MII and other State Health Organisations. Six NMEP regions with strong entomological teams were created to co-ordinate the entomological and epidemiological activities of NMEP. Side by side entomological infrastructure was also fast coming up under the patronage of ICMR. National Filaria Control Programme (NFCP) under the Directorate of Malaria Institute of India was also established in 1955. Although DDT was introduced under NMCP and NMEP during this decade the entomologists discovered the development of DDT resistance in malaria vectors in 1955 and since then the entomologists are monitoring insecticide resistance all over India.

Entomological infrastructure of NICD was established as separate division and NICD branches all over the country with strong entomological inputs. At the end of seventh decade, Genetic Control of Mosquito Unit (GCMU) was established with the collaboration of ICMR and WHO with the main objective of studying the feasibility of the mosquito control by introducing laboratory reared sterile male in a defined natural ecosystem. Under this project many senior entomologists/ scientists were engaged in research studies for sterilization of male mosquitoes using Sterilization Insect technique (SIT). GCMU was established where first time only entomological and vector control aspects were given prominence in the realm of Public Health. GCMU was disbanded in 1975 but all the experienced Scientists and staff members of this unit were absorbed in newly created Entomological Centers under ICMR viz. Malaria Research Centre at Delhi and Vector Control Research Centre at Pondicherry to carry out in-depth studies on Malaria including entomological/Vector Control aspects. The entomologists of VCRC are engaged in research activities pertaining to vector

control with special reference to filariasis. VCRC introduced specialized master degree course in Medical Entomology in collaboration with Central University of Pondicherry during 1982. Another Centre of Research in Medical Entomology Centre for Research in Medical Entomology (CRME) was created by ICMR in 1985 which is contributing in the field of entomological aspects of JE, Dengue and their control methodology. Apart from MRC, VCRC and CRME, many regional centers were created by ICMR at Jodhpur, Jabalpur, Bhubaneswar, Dibrugarh etc. with sufficient entomological infrastructures to carry out entomological surveillance of Vector Borne diseases prevalent in those regions.

Besides, all the health Directorates have entomological components at State Level which supervise the entomological surveillance and vector control activities of entomologist and biologist working under them. The State entomological infrastructure has been rendering immense service in coordinating the entomological activities carried out in their respective States with the central counterpart. Certain states like Tamil Nadu, Karnataka, Gujarat, Maharashtra, Madhya Pradesh and Andhra Pradesh with strong entomological infrastructure are showing better performance in vector control. In 1977, entomological infrastructure was further expanded under NMEP as a result of resurgence of Malaria. Seventy two entomological zones were created under Modified Plan of Operation (MPO) with a view to undertake detailed entomological surveillance and applied research on malaria. By this time important vectors of malaria had developed resistance to many organochlorine and organophosphate insecticides necessitating the need for monitoring insecticide resistance among malaria vectors. In addition, under the Urban Malaria Scheme (UMS) now known as urban VBD scheme and National Filaria control programme (NFCP), many posts of biologists were created. These entomological infrastructures are being utilized in many towns and metropolitan cities in India for entomological surveillance and vector control of malaria, Filariasis and other vector borne diseases.

Many Universities and colleges are also engaged in entomological surveillance, insecticide resistance monitoring and studying effect of plant products on mosquito larvae etc. These are also being used for vector control and such institutes can be brought on same platform for operational research under programme.

3. ENTOMOLOGICAL SURVEILLANCE – METHODS & PARAMETERS

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. Routine vector surveillance is advocated under programme.

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 tuning, 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 mosquitos 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 mid**dle and its mouth is br**ought 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.

(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 spary 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 is 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, malaise, light trap, etc.

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.

- 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 whiles to the sixth side a deep conical funnel of netting or 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.

- Magoon trap –These are essentially portable/detachable wooden huts, in which the upper half of the standing wooden panels in fitting 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.

- 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 trap 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 devise 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.

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 45^0. 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 30^0 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 a**re 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. Xenomonitoring is also helpful in studying presence of virus in pools of mosquitoes. Recently it is being done by ICMR for presence of Zika virus.

Entomological surveillance is carried out in 72 (currently 78) entomological zones. Guidelines for carrying out entomological work are circulated to zones from NVBDCP, Delhi. There are 40 zones functional and support for other zones is taken from ICMR institutes and NCDC branches to generate data. The districts under the entomological zones should be visited by zonal team at regular intervals throughout the year.

Insecticide resistance monitoring through susceptibility test:

Adult Susceptibility:

The purpose of the susceptibility test is to evaluate the level of susceptibility of adult mosquitoes to an insecticide or measurement of resistance. The results are expressed as percentage mortality after 24 hours holding, and if it is pyrethroid, assessment of mortality and knockdown effect (effective KD) are determined. The

WHO standard method is used. Guidelines are also available for conducting insecticide resistance testing in sand flies.

Materials required

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

Preparation for the test

Use “green dot tubes” for the preparation of control

- Prepare four tubes for test and one tube for control.
- Insert a control filter paper (without insecticide), held by two silver rings.
- Close one end of the tube with mesh and other end by inserting the stage.
- 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.
- Label the tube with number and details about the strain
- 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%.
- 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

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

Procedure of the test

- Prepare a data sheet with a name of test (adult susceptibility test).
- 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 same number on holding tube.
- Slide the stage plate in a manner that it will open entirely into the exposure tube
- Blow the mosquitoes gently from the holding tube into the exposure tube
- Close the stage by pushing back the plate.

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

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. 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 detemine and follow the level of susceptibility/resistance of larval stages of a given species of mosquitoes to a given insecticide. This test also gives 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.

Materials required

- Plastic/Paper cups (volume 200 ml)
- 3 ml pasteur pipette
- Small strainer to pick the larvae
- 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.

a) The concentrations used are noted on the data sheet.
b) Fill the bowls with 99 ml distilled water and add 1ml 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 mosquitoe larvae using pasteur pipette on a small strainer.

- Introduce 20 larvae in each bowl
- The cups are then placed in a controled 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)

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).

Entomological Parameters- The various parameters used for entomological monitoring is consolidated in following tables:

Surveillance tools and indicators for malaria

Indicator	Definition	Sampling technique	Formula
Adult			
Resting collections (aspirator or handheld net)	Man hour density (MHD)	Aspirator	Number of mosquitoes collected ÷ Actual man hours spent i.e. number of persons collecting X time spent in hours
Indoor resting density	Number of adult female mosquitoes per house per night	Pyrethrum spray catch Aspirator	= (No. of females ÷ No. of houses) ÷ No. of nights
Human-biting rate (ethical clearance required)	Number of bites a person receives from a specific vector species per night	Human landing catch (collections throughout the night, i.e. 12 h)	= No. of mosquitoes collected ÷No. of collectors
Human blood index (HBI)	Proportion of blood-fed mosquitoes that fed on humans	Resting/Pyrethrum spray catch	= No. of mosquitoes positivefor human blood ÷ Total no. of blood-fed mosquitoes tested X100
Sporozoite rate	Proportion of mosquitoes of a given species with sporozoites in salivary glands	Salivary gland dissection, ELISA or PCR	= No. of positive mosquitoes ÷ No. of mosquitoes analyzed X 100
Insecticide susceptibility	Per Cent Mortality of insect against insecticide	WHO Method	Number killed÷ Number exposed X 100 Use Abbott's formula if mortality in control is between 5-20% (% test mortality-% control mortality) ÷ (100-% control mortality) X 100
Immature			
Density of Immatures	Measure of larval+ Pupal density		= Total no. of larvae and pupae collected ÷ Total no. of larval dips taken X 100
Larval Density	Measure of larval density		= Total no. of larvae collected ÷ Total no. of larval dips taken X 100
Pupal Density	Measure of Pupal density		= Total no. of Pupae collected ÷ Total no. of larval dips taken X 100

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 useful for the early detection of new infestations in areas from which the mosquitoes have been previously eliminated. Human biting catches are not recommended for dengue vectors.

Surveillance tools and indicators for *Aedes*

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 mosquitoes collected ÷ Actual man hours spent i.e. number of persons collecting X time spent in hours
Oviposition traps	Mosquitoes/trap	Number of *Aedes* 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.

4. VECTOR CONTROL UNDER NVBDCP

The vector control is implemented under strategy of Integrated Vector Management (IVM) which 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. Effective vector control strategies are based on four facts:

(i) Knowledge and understanding of vector biology
(ii) Surveillance of vector species
(iii) Incrimination of vector species
(iv) Public education and implementation of effective control measures.

Vector control programme in India has progressed with the experiences gained under anti-malaria programme and mostly rely on usage of natural and synthetic chemical molecules, which have potential to kill the target insects.

Strategy -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

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 firefighting:** 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 a**re 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 r**epellents 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:** Larvivorus 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 o*f* 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:

  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.

- **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.

Presently different formulations of synthetic chemical insecticides are in the use for vector control. Wettable powder (WP) formulations are used for indoor residual sprays while emulsion concentrate (EC) formulations are used for larval control. For Indoor Residual spray (IRS) insecticides in use are DDT 50% WP, malathion 25% WP and synthetic Pyrethroid (WP). Synthetic Pyrethroids include deltamethrin 2.5% WP, Cyfluthrin 10% WP, lambdacyhalothrin 10% WP, alphacypermethrin 5% WP, Etofenprox 10% WP and Bifenthrin 10% WP. Synthetic pyrethroid insecticides are also used for impregnation of bed nets.

Indoor Residual spray (IRS): Most of the insecticides having residual effect are sprayed indoors, so that mosquitoes after having bite on an infective person will rest in the house and will pick up sufficient insecticide particles sprayed on the walls and other indoor surfaces of the house and its longevity will be reduced so much so that it does not survive to become infective. In areas where the vectors are strongly endophilic, i.e. they tend to rest indoors, indoor residual spraying of human dwellings can give very effective control. Vectors that are exophillic i.e. they tend to rest outdoor but tend to feed or rest indoors briefly, can be effectively controlled by indoor

residual spraying with insecticides that have good airborne effect. In areas where vectors are strongly exophilic and/or exophagic, i.e. they rest and bite outdoors, other control methods, such as use of insecticide treated mosquito nets or exterior space spraying (for emergency control), should be considered.

In practice, the effectiveness of house spraying for malaria control depends on adherence to the specified criteria of the insecticide and application procedure, public acceptance of spraying, the availability of well maintained equipment, adequately trained spraying personnel, efficient supervision and strong financial support. The size of the area depends on local circumstances and is influenced by the distribution of malaria and malaria vectors; distance from important breeding sites, the flight range of the vectors and demographic features.

In malaria, subcentres are taken as unit and only human dwellings are covered whereas IRS for Kala azar is done in all structures taking entire village as unit and is covered if following criteria are met:

- 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.

Target area: Generally, all the interior walls and ceilings are treated. In addition to permanent human dwellings, field huts where people sleep during the planting or harvesting season should be sprayed depending on local vector behaviour. The underside of furnitures, back of the doors, outside caves and porch may need to be treated. It should be noted that the residual effect of insecticides may be short on some surfaces, e.g. porous mud walls, oil painted wood and alkaline white wash.

Selection of Insecticides: Several factors need to be considered in the selection of an insecticide spraying, including availability, cost, residual effectiveness, safety, vector susceptibility and excito -repellency. There are large number of insecticides, which are used as aduliticides for indoor residual spray. These are DDT, Malathion and different formulations of synthetic pyrethroids. In India, insecticides are introduced into public health programmes based on entomological parameters and their impact on disease incidence/ prevalence. Therefore if the change of insecticide is warranted, the state Govt. should support their choice of alternative insecticide by 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 is decided in mutual consultation between State Programme Officer for NVBDCP, ROH&FW and the Dte. Of NVBDCP with concurrence of State and Central Governments. The proposal for any such change of insecticide should follow the following steps:

(i) State Govt. submits the proposal for change of insecticide to Dte. Of NVBDCP in annual plan meeting with 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 operation.
(ii) Consultations between the State Progamme Officer NVBDCP, ROH&FW and Dte. of NVBDCP are done and accordingly approval is obtained from DGHS.
(iii) Approval of MOH&FW for procurement plan is processed accordingly which is usually done in preceding year to ensure its availability well before starting the first round of spray operation.

For dengue and chikungunya, a package of vector control interventions against and ideally combining chemical and environmental methods. Larval source management should be in place for routine control. If there is an outbreak then dengue and chikungunya is advised, targeting both the immature and adult stages of the vector 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. Vector control interventions are similar whether the disease is in urban or rural areas. In case of JE affected areas ,coverage of the village reporting cases should be 100% with ULV. Malathion technical is recommended for outdoor fogging.

IEC and BCC campaigns play an important role in routine and epidemic control of VBDs for improved acceptability of programme activities among communities. 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 utilized.

5. RECOMMENDED PRODUCTS UNDER NVBDCP

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

DDT 50% WP - DDT is an organochlorine insecticide used mainly to control mosquito-borne malaria. In 1943, Paul Muller was awarded the Noble Prize for Medicine as a result of his work with DDT. The chemical name is Dichlorodiphenyltrichloroethane. It was extensively used during the Second World War among Allied troops and certain civilian populations to control insect typhus and malaria vectors. DDT is in use in India since early 1950's and has been very effective in controlling vector borne diseases especially malaria of late in early 60's. Resistance was one of the reason for resurgences of malaria in 1970's and 90's but alternate insecticide such as BHC and malathion were effective for small periods though the reliance on DDT continued. DDT has an intrinsic chemical nature of excito-repellency that makes the mosquitoes to exit from the sprayed houses immediately after contact apart from its ability to kill mosquitoes. The Stockholm Convention on Persistent Organic Pollutants (POPs) is global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of humans and wildlife. Exposure to Persistent Organic Pollutants (POPs) leads serious health effects. The Convention which entered into force in 2004, requires Parties to take measures to eliminated or reduce the release of POPs into the environment. India is a party to the Stockholm Convention which uses DDT. In terms of this convention, the use of DDT for agricultural purposes is not allowed. The convention has given an exemption for the production and public health use of DDT for indoor application to vector borne diseases, such as malaria and Kala-azar, mainly because of the absence of equally effective alternatives. The use of DDT for public programme is also restricted upto 10,000 MT per year except in case of major outbreak or epidemics. World Health Organization (WHO) also allowed the use of DDT for public heath interventions for disease vector control. WHO recommends the use of DDT only for Indoor Residual Spraying (IRS) provided that the guidelines and recommendations of WHO and the Stockholm Convention are met. DDT may be used until locally appropriated and cost-effective alternatives are available for a sustainable transition from DDT.

Malathion 25% WP- Malathion is an organophosphate insecticide. The chemical name is (Diethyl[(dimethoxyphosphino -thioyl)thio]butanedioate). Malathion is used in public health mosquito control and fruit fly eradication programs.

Synthetic Pyrethroids- These are new insecticides introduced for control of vector borne diseases in India. The cost of these insecticides is much higher than the cost of DDT and Malathion. Currently there are five insecticides of this group registered with Central Insecticide Board for use in the programme. These are (i) Deltamethrin2.5% WP, (ii) Cyfluthrin 10% WP, (iii) Alphacypermethrin 5% WP (iv) Lambdacyhalothrin 10% WP and (v) Bifenthrin 10 WP.

Deltamethrin 2.5% WP - Deltamethrin is a pyrethroid composed of a single stereoisomer, of a possible 8 stereoisomers, selectively prepared by the esterification of (1*R*,3*R*)- or *cis*-2,2-dimethyl-3-(2,2-dibromovinyl)cyclopropanecarboxylic acid with (*alpha*,*S*)- or (+)-*alpha*-cyano-3-phenoxybenzyl alcohol or by selective recrystallization of the racemic esters obtained by esterification of the (1*R*,3*R*)- or *cis*-acid with the racemic or (*alpha-R*, *alpha-S*, or *alpha-R*/*S*)- or + or − alcohol. The chemical name is [(S)-Cyano-(3-phenoxyphenyl)-methyl] (1R,3R)-3-(2,2-dibromoethenyl)-2,2-dimethyl-cyclopropane-1-carboxylate

Cyfluthrin 10% WP - Cyfluthrin is a pyrethroid insecticide and common household pesticide. It is a complex organic compound and the commercial product is sold as a mixture of isomers. The Chemical name is [(R)-cyano-[4-fluoro-3-(phenoxy)phenyl]methyl] (1R,3R)-3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane-1-carboxylate.

Lambdacyhalothrin 10% WP- Lambda-cyhalothrin is a mixture of isomers of **cyhalothrin.** Lambdacyhalothrin is available as 10% wettable powder in preweighed sachets. The Chemical name of Lambda-cyhalothrin is (RS)-alpha-cyano-3-phenoxybenzyl3-(2-chloro-3,3,3-trifluoropropenyl) -2, 2,-dimethyl cyclopropane carboxylate.

Alphacypermethrin 5% WP- Alphacypermethrin is a synthetic pyrethroid. Alphacyperrnethrin is the common name accepted by International Organization for Standardization (IS0) for recemate comprising two isomers R and S of rx-cyano-(3-phenoxyphenyl) methyl (1R)-cis-3-(2-2 dichlorovinyl)- 2-2-dimethyl-cyclopropane carboxylate.

Bifenthrin 10% WP - Bifenthrin is a pyrethroid insecticide with its chemical name of 2-Methyl-3-phenylphenyl)methyl (1S,3S)-3-[(Z)-2-chloro-3,3,3-

trifluoroprop-1-enyl]- 2,2-dimethylcyclopropane-1-carboxylate. Bifenthrin 10% WP is also approved for Public Health use in India.

Pyrethrum Extract - It is the oldest effective insecticide that has been used in several countries. Its safety for use is unparallel and has been used as anti-helminthic and also introduced in urban water supply with not toxic hazards to the consumer. Pyrethrum is a contact poison. The active ingredients are pyrethrins. It may be formulated as a solution, immulsion, dust or granules. Pyrethrum extract is the extract of commercial pyrethrum flowers (Chrysanthemum cineraraefolium Linn.) in amineral oul with or without a minute quantity of added anti-oxidant but without a synergist. It is a clear transparent liquid free from sediment, suspended matter or other extraneous impurity, greenish in colour and possesses the characteristic odour of pyrethrum flowers.

Malathion Technical – Malathion is an organophosphate insecticide. The chemical name is (Diethyl[(dimethoxyphosphino -thioyl)thio]butanedioate). The Malathion technical with 95% purity is used for outdoor fogging.

Cyphenothrin 5% EC- Cyphenothrin is a synthetic pyrethroid insecticide and has been registered for use to control cockroaches, housefly and mosquitoes in houses. This is used for indoor and outdoor fogging.

Larvicides- Larviciding has to be done 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:

Mosquito Larcidal Oil (MLO) - This oil was and continues to remain the classic larvicide. The oil not only suffocates but also poisons the mosquito larvae. Its action on larvae is due to Causing suffocation by producing a surface film which cuts off their supply of air, blocking of respiratory tubes by particles of oil, and reduction of surface tension, making difficult for larvae to remain at surface and thus causing them to be drowned. The oiled breeding sources tend to deter the adults from depositing their eggs.

Temephos 50% EC - The chemical name is O,O,O′,O′-Tetramethyl O,O′-sulfanediylbis(1,4-phenylene) diphosphorothioate. 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. The product should be as per ISI specification i.e. IS:8498/1977.

Temephos1% GR- One per cent Temephos sand granules are applied to containers using a calibrated plastic spoon to administer a dosage of 1 ppm. This is recommended for use in stored water like coolers etc for control of vectors of dengue/chikungunya.

Bacillus thuringiensis var israelensis - 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 effective against *An. stephensi and Ae. aegypti*, while Bs is the effective against *Culex quinquefasciatus* which breeds in polluted waters. Currently two formulations of *Bacillus thuringiensis* var. israelensis i.e. wettable powder and aqueous suspension is being used.

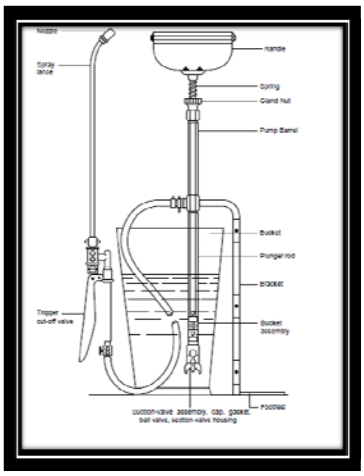
Insect growth regulators: Insect growth regulators (IGRs) interfere with the development of the immature stages of the mosquito by interference of chitin synthesis during the molting process in larvae or disruption of pupal and adult transformation processes. Most IGRs have extremely low mammalian toxicity.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

Pyriproxifen 0.5% GR - Pyriproxyfen is an **insect growth regulator**. It mimics natural insect hormones that stop young insects from maturing into adults. This product Pyriproxyfen 0.5% GR is recommended for larval control of *An. stephensi*, *An. subpictus, Culex quinquefasciatus* and *Ae. Aegypti*.

Diflubenzuron 25% WP - Diflubenzuron is a benzoylurea-type insecticide of the benzamide class. The chemical name is 1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl)urea. Diflubenzuron is a chitin synthesis inhibitor, which is another type of insect growth regulator. Unlike juvenile mimic hormones, the chitin synthesis inhibitors interfere with the normal synthesis of insect exoskeletons during molting or at hatching of eggs.

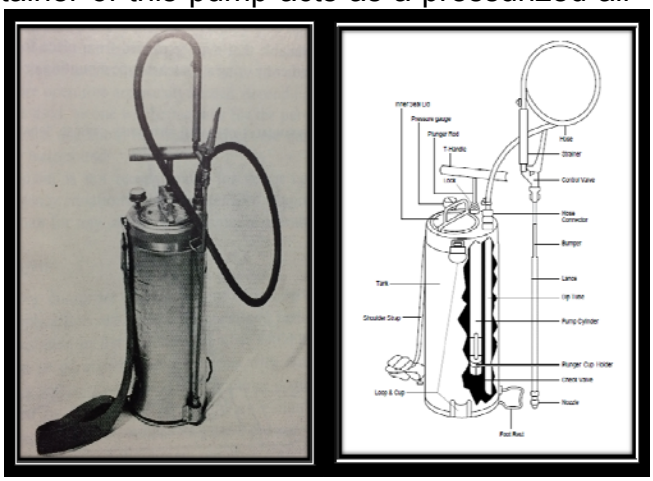
Long Lasting Insecticidal Nets (LLINs) or Insecticide-treated mosquito nets (ITN) are used under programme since many years in high malarious areas.

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.

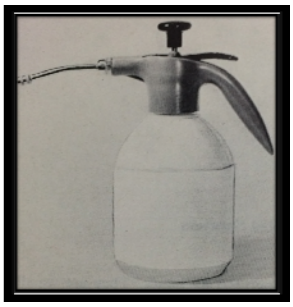


Stirrup pump- These pumps are bucket sprayers as the container for spray is bucket. The stirrup pump is traditional one being used in vector control and consists of a pump, attached discharge hose, spray lance with a bracket and foot-rest or stirrup. The spray discharge is continuous because an air chamber is incorporated in the pump system to maintain spraying pressure during suction stroke. Two persons are required during operation i.e. one for pumping and other for holding spray lance. Relatively little skill is required for operating and maintaining this pump as it works even with rough handling in field. However, great care is required to avoid spillage of insecticide suspension from open buckets.

Hand Compression pump- The container of this pump acts as a pressurized air-chamber and the air pressure impels the liquid. These pumps are fitted with pressure gauze and safety device to release excess pressure. Compression pumps used for vector control are usually of 10 litre capacity. These are simple to use and save human resource as one person is required per pump. The only disadvantage of this pump is that pressure falls with discharge of liquid. Control flow valve has been designed as remedial measure but it can be fitted in few branded pumps only. The most important thing to care is to ensure that material of pump will withstand the pressure otherwise it may burst and harm the spray worker.



Automizer – These are operated on principle of compression pump. The three-quarter of container is filled with spray liquid and then air in remaining space is compressed through built-in air pump of plunger type. The trigger valve is used to release the spray. These are useful for small scale larviciding or aerial spray of liquid like pyrethrum extract etc.



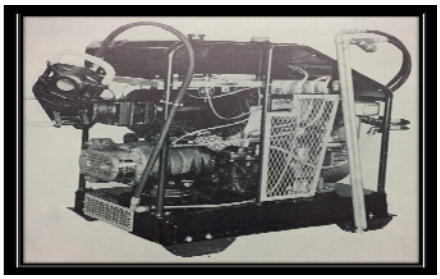
Knapsac sprayer - This is used for larvicide application and carried on the back. A shield is provided so that it does not come into actual contact with the back. A skirt is usually fitted to the bottom of the container to prevent the direct contact with the ground. Knapsack sprayer is a continuous type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

Fogging Machine – Hand Operated- In such devices, insecticide is dissolved in an oil of suitably high flashpoint which is vaporized into a high-velocity stream of hot gas. When discharged into atmosphere, the mixture containing insecticide condenses in the form of fog. Two basic methods are employed for production of fog.

In one type, mixture is injected into the exhaust gas of a pulse-jet internal combustion engine at a point it will be completely vapourised and then immediately discharged. This is used generally for hand operated ones.

In the second method, petrol is burnt in a specially designed that is constantly supplied with large volume of heated air at low pressure. The formulation is injected into a discharge tube through which air is passing and is emitted as dense fog. This is used in vehicle mounted ones.

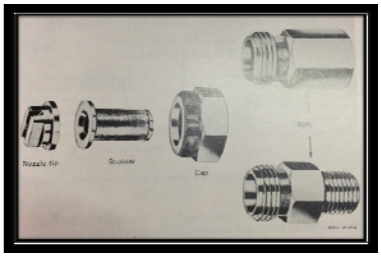
Fogging Machine – Vehicle mounted

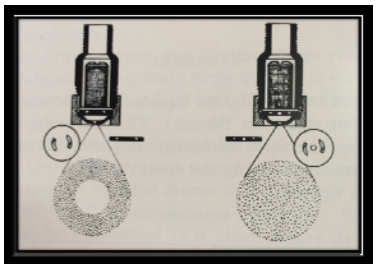


Nozzles- There are different type of nozzles but for vector control under programme, two types are used- Flat Fan for IRS and cone nozzle for larviciding.

Fan nozzle produces a spray in the form of flat sheet and its orifice governs the discharge rate. Ordinary nozzles spoil the spray if the discharge rate is not governed properly.

Cone nozzles are used mainly for anti-larval work. Liquid is discharged from orifice either as a hollow cone or as a solid cone of spray drops. This nozzle contains a swirl plate with helical slots and a small whole in centre.





Products available for personal protection- These are generally used to avoid bites from mosquitoes and other insects.

- **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 a**re 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 r**epellents such as DEET (N, N-Diethyl-m-Toluamide) can provide protection against *Ae. albopictus, Ae. aegypti and anophel*ine 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.

- Mosquito repellents, attractants and insect killing devices like rackets, traps etc

Requirement of insecticide & its calculations

Requirement of DDT: 150 MT per million population for two rounds of spray is required. In areas where third round is proposed in selected villages, additional requirement of 75 MT per million population should be estimated.

Requirement of Malathion25% WP: 900 MT per million population for three rounds of spray are required. If in some areas a further round is required in selected villages, 300 MT per million population for the special round for the population of selected villages only

Requirement of Synthetic Pyrethroids:

(i) Deltamethrin 2.5% WP: 60 MT per million population for two rounds of spray. In some areas, where a further round is required in selected villages, additional requirement of 30 MT per million for the population of selected villages is estimated.

(ii) Cyfluthrin 10% WP: 18.75 MT per million population for two rounds of spray.
(iii) Lambdacyhalothrin 10% WP: 18.75 MT per million population for two rounds of spray.
(iv) Alphacypermethrin 5% WP 37.5 MT per million population for two rounds of spray.
(v) Bifenthrin 10% WP: 18.75 MT per million population for two rounds of spray.

Insecticide formulations and dosages for IRS- Different Insecticides used for IRS, fogging and anti-larval purposes have different dose and frequency. The formulations are also different. All these are indicated in Annexure II,III and IV.

6. MODEL CIVIC BY-LAWS IN URBAN AREAS

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. (I) 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.

(II) 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. (I) 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.

(II) If a notice under sub-section (I) is served on the occupier, he shall in the absence of a contract expressed or implied, to the contrary, be entitled to recoer 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 Antimosquito 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. (I) 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.

   (II) If the provisions of sub-section(I) 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 anti-mosquito 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 premised.

For the purpose of enforcing the provisions, the Health Officer for 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.

7. LIST OF NATIONAL EXPERTS

The need of knowing about experts working under National Vector Borne Disease Control programme at central level has been flagged many times at different forums. The compilation of such experts including retired ones from programme has been done with a view to facilitate the readers for consultation and seeking expert opinion.

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10. SUGGESTED READING

The suggested material for reference are indicated below which can be seen on NVBDCP website: www.nvbdcp.gov.in

1. **Manual on Integrated Vector Management India 2015**

   http://www.nvbdcp.gov.in/Doc/IVM10_March_2016.pdf

2. **Operational Guidelines for Urban VBDs Scheme - 2016**

   http://www.nvbdcp.gov.in/Doc/OPERATIONAL-GUIDELINES-FOR-URBAN-VBD-SCHEME-2016.pdf

3. **Guidelines for Introduction of Insecticides in NVBDCP**

   http://www.nvbdcp.gov.in/Doc/guidelines-Insecticides-NVBDCP.pdf

4. **Standard Operating Procedure (SOP) for Introduction of Public Health Pesticides including Biolarvicides in the National Vector Control Programme**

   http://www.nvbdcp.gov.in/Doc/Standard-Operating-Procedure-2014.pdf

5. **Guidelines for Indoor Residual Spray (IRS)-**

   http://www.nvbdcp.gov.in/Doc/Director%20Desk/Indoor%20Residual%20Spray%20-%205.doc

6. **Guidelines of Larvivorous Fish for Vector Control**

   http://www.nvbdcp.gov.in/Doc/Guidelines-larvivorous-fish.pdf

7. **Guidelines on Proper Storage, Safe Handling and Disposal of Insecticides**

   http://www.nvbdcp.gov.in/Doc/Guidelines-Proper-Storage-Safe-handling-Disposal-Insecticides.pdf

8. **Operational Guidelines on Kala-Azar (Visceral Leishmaniasis) Elimination in India - 2015**

   http://www.nvbdcp.gov.in/Doc/opertional-guideline-KA-2015.pdf

9. **Kala-azar Road Map 2014**

   http://www.nvbdcp.gov.in/Doc/Road-map-KA_2014.pdf

10. **Mid Term Plan for Prevention & Control of Dengue and Chikungunya**

    http://www.nvbdcp.gov.in/Doc/Mid-Term-Plan-Dengue-Chikungunya-%202011-13.pdf

11. **Strategy for Effective Community Participation for Prevention and Control Of Dengue**

    http://www.nvbdcp.gov.in/Doc/Strategy-Effective-Community-Participation-Version-1-DRAFT.pdf

ANNEXURE I

Subject: MINUTES OF COS MEETING THROUGH VIDEO CONFERENCE WITH VARIOUS STAES HELD ON THE SUBJECT `INCIDENCE OF DENGUE AND CHIKUNGUNYA – (REVIEW OF ENTOMOLOGICAL SUPPORT IN THE STATES)'.

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A meeting of the Committee of Secretaries (COS) under the Chairmanship of Secretary (Co-ordination) was held on 10.08.2011 at 3.30 PM in the Committee Room, Cabinet Secretariat, Rashtrapati Bhawan, New Delhi. During the meeting, a video conference was held with the Chief Secretaries of the States/UTs. Secretary (C) welcomed the members and requested Secretary, Ministry of Health & Family Welfare to conduct the video conference with the States/UT.

2. Secretary, MoH&FW, while initiating the discussion, given a brief picture of overall situation of Dengue/Chikungunya in the country and also the entomological support system available in the States/UTs. He also highlighted the role of Urban and Rural bodies in controlling these diseases and steps taken by few urban bodies in terms of amending Bye-laws of construction of building etc. A detailed discussion on the above mentioned subject was held and States/UTs were requested to fill up the vacancy of Entomologists urgently. States/UTs wise detailed deliberations are as follows:-

Sl. No	States/UTs	Comments from States/UTs and Action to be taken
	Andhra Pradesh	➢ **State is in process of filling up of vacant posts of Zonal Entomologists, State entomologist and insect collectors.** ➢ **Regarding the hiring of vehicle for zonal entomological units, state would sort out very soon,** ➢ **State demanded more LLINs as more than 80% area of the State is endemic area. State also informed that they have to still receive diagnostic kits which were supplied to them.** ➢ **Secretary, Health stated that Andhra Pradesh is one of the highest recipients of LLINs in the country and it needs to be more vigilant about Malaria in the State in view of high endemic area. However Ministry will look into its demand.**
	Assam	➢ **Regarding the filling of vacant entomologist posts, Chief Secretary, Assam, informed that they were in process of filling up of the posts. He also requested supply of Deltamethrin for bed-net impregnation and LLINs.** ➢ **State informed about the JE problem in the upper Assam area (Dibrugarh)** ➢ **Secretary, Health stated that Assam need to be vigilant in PF Malaria cases. However, the State is one of the highest recipients of LLINs in the country which has got 25.72 lakhs LLINs so far. He informed that Ministry will look into the request of supply of Deltamethrin.**
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	A & N Island	➢ **Chief Secretary, A&N Island informed about the current situation of Chikungunya, Dengue and Malaria in the Island and requested for the supply of LLINs.** ➢ **Health Secretary assured to look into the demand of the LLINs for the Island and suggested the Island to take all possible steps to control malaria as the 50% cases are of PF and the Island is high endemic area.**
	Bihar	➢ **State assured to fill up all the entomological vacant posts at the earliest.** ➢ **State mentioned about Kala-azar treatment project, where alternate protocol of treatment has been successful.** ➢ **State requested further investigation of Muzaffarpur outbreak which was similar to JE and which causative organism has not been confirmed yet, through various agencies.** ➢ **There had been malaria cases but no deaths in the state.** ➢ **Health Secretary stated that the team sent by Ministry to ascertain the cause of Muzaffarpur outbreak, could not ascertain the disease and its cause. However, the Ministry would request NIV, Pune and ICMR ti have further investigations done in the matter. Regarding alternate protocol of Kala-azar, he informed that the Ministry would communicate with the State shortly.**
	Chandigarh	➢ **Action being taken to fill up vacant posts of entomologists and insect collectors.** ➢ **DDT sprays are continued.**
	Chattisgarh	➢ **State is in process of filling up all the vacant entomological posts.** ➢ **Malaria and PF cases are very high.** ➢ **State was requested to be vigilant.**
	Dadar & Nagar Haveli	➢ **State requested for supply of LLINs and insecticides.** ➢ **Health Secretary assured to look into the demands.**
	Delhi	➢ **The post of Zonal Entomologists and Insect Collectors are in process of filling up.** ➢ **No cases of Dengue this year. Due to effective measures taken and IEC launched by Delhi Govt. Dengue has been controlled.** ➢ **Health Secretary appreciated the effective measures taken by Delhi Government last year to control Dengue, Chikungunya and Malaria which has shown good result this year also.**

	Jharkhand	➢ **Regarding the filling of entomological posts, the state assured that recruitment would be done by the end of the year.** ➢ **State demanded 20 more ELISA kits for the state and also requested for supply of LLINs.** ➢ **Health Secretary informed that Jharkhand has been supplied 6.6 lakhs LLINs in the year 2010 and 6.5 lakhs LLINs are being sent this year. He also requested the state to be more vigilant about Malaria as PF case were 44% in the State.**
	Goa	➢ **All the entomologist posts are filled up by the state. Malaria is declining.** ➢ **State was requested to be vigilant about Dengue problem.**
	Gujarat	➢ **State informed that state has already taken steps fof filling of entomological vacant posts.** ➢ **There has been decline in Dengue and Chikungunya cases.** ➢ **State was requested to be vigilant about Malaria cases.**
	Haryana	➢ **State assured that the vacant entomologist posts would be filled up soon.** ➢ **No JE cases reported due to massive immunization.** ➢ **No death due to Malaria. However Gurgaon is very prone to Dengue/Malaria cases. IEC campaign would be launched by Haryana Govt.** ➢ **Haryana Govt. has notified By-laws wherein a medical officer can enter in to any house and check the stagnant water and take the action.** ➢ **State informed that 17 biologists are working in the state and other vacant posts would be filled up at the earliest.**
	Himachal Pradesh	➢ **State in process of filling the vacant entomological posts.** ➢ **State was requested to be vigilant regarding the Dengue/DHF & Chikungunya.**
	Karnataka	➢ **State assured that the vacant entomologist posts would be filled up soon.** ➢ **No JE cases reported in 2010-11. The cases of Dengue/ Chikungunya have come down due to steps taken by State Govt.** ➢ **State was requested to be vigilant about PF cases.**

	Kerala	➢ All the entomologist posts are in position. ➢ State was requested to be vigilant regarding the Dengue/ DHF & Chikungunya.
	Madhya Pradesh	➢ State informed that it was in the process of filling up of the vacant Entomologist Posts. ➢ State informed that there was a down trend in Dengue, Chikungunya and Malaria in the State. State also requested for LLINs. ➢ Health Secretary informed that the State has been allocated 15.78 lakhs LLINs so far out of which remaining 7 lakhs LLINs are being supplied to the State shortly.
	Maharashtra	➢ The state has requested the state selection board to fill up vacant post of entomologists at the earliest. ➢ State assured to complete the process by year end. ➢ State informed about the problems faced by them in coordinating with Railways, Defence, AAI and other GOI organizations for control of Malaria and Leptospirosis on coastal region of state and requested that GOI should take steps to advise these departments/ministries in extending cooperation to Mumbai Municipal Corporation. It was decided that MoH&FW would take steps in this regard.
	Manipur	➢ Mentioned about the JE problem as piggeries are more in the state. ➢ State requested for supply of LLINs. ➢ State assured to fill up entomologist posts. ➢ Health Secretary informed that the State has been allocated 4.5 lakh LLINs so far. The remaining LLINs would be sent to the State shortly.
	Puducherry	➢ State assured that action is already taken to fill up vacant posts ➢ No cases of Chickungunya only 71 cases of Malaria reported. ➢ State demanded supply of diagnostic kits and LLIN. ➢ Health Secretary assured to look into the demand of diagnostic kit and LLINs.
	Punjab	➢ State assured to fill up vacant posts of entomologist very soon. ➢ Dengue has shown cyclic pattern. Malaria cases are also very low.

	Rajasthan	➢ State informed that state in the process of filling the remaining vacant posts and is also to take care of mobility of entomological teams. ➢ 39 Dengue cases are reported this year but no deaths so far. ➢ Malaria situation is better this year, PF cases are also on downside. ➢ State was advised to be vigilant in Jaisalmer and Bikaner districts for Dengue cases.
	Sikkim	➢ No dengue cases this year. There was slightly rise in malaria cases due to migrant work forces. No cases of Chikungunya / JE. ➢ State was requested to be vigilant about the Malaria, Dengue, Chikungunya problem. ➢ State to fill entomological posts
	Tamil Nadu	➢ State assured to fill up vacant Insect Collector posts. ➢ State reported problem of malaria and JE from Chennai and pilgrimage cities. ➢ State requested for supply of LLINs for Ramanathapuram.
	Tripura	➢ Requested to be vigilant about Malaria because 91% cases are PF ➢ State requested to fill up the vacant posts of entomologists.
	Uttar Pradesh	➢ State is in process of filling up of the vacant posts. ➢ No cases reported in Dengue/ Chikungunya. Eastern part of Gorakhpur is affected by JE and Kala-azar. ➢ State is planning replacing of 3000 deep pumps. ➢ State requested for supply of DDT, Malathion, RDTs, ELISA kits and anti-malaria drugs. ➢ LLINs for Sonbhadra District were demanded by the state (state otherwise does not fulfill criteria of receiving LLINs). ➢ Health Secretary assured that he would look in to the demand of LLINs in certain areas of the state where malaria cases are very high (IPIs). He further stated that the request of the state to supply DDT, Malathion, RDTs etc. would be addressed to shortly.

	Uttarakhand	➢ **State is in process of filling up vacant posts of Entomologists and Insect Collectors.** ➢ **There have been two deaths and 22 dengue cases reported. These are mainly border areas of UP. There have been no cases of Chikungunya.**
	West Bengal	➢ **State is in process of filling up of vacant entomological posts.** ➢ **Chief Secretary, West Bengal informed that there had been 6 deaths due to Malaria in the State and requested to supply more LLINs to the State.** ➢ **Health Secretary assured to look into the demand of the State.**

Annexure II

Requirement of Insecticides with Formulation and doses for IRS

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 polulation (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	500	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	Bifenthrin 10% WP	0.125 Kg	25 mg.	10-12	500	18.75

Note: The above calculation is for conventional stirrup and compression pumps as per NVBDCP guidelines. For new hand compression pumps with CFV, the calculation will be based on discharge rate.

Annexure III

Requirement of Insecticides,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,Formulation and doses for Outdoor Space 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 hactare (7 ml in 1 litres diesel)		

Annexure IV

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 Heactare			
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