National Guidelines for *Aedes* vector surveillance and control in Sri Lanka

2nd edition

National Dengue Control Unit
Ministry of Health, Sri Lanka

NATIONAL GUIDELINES FOR *AEDES* VECTOR SURVEILLANCE AND CONTROL IN SRI LANKA

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Ministry of Health,
Public Health Complex,
555/5, Elvitigala Mawatha, Narahenpita, Colombo 05.
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NATIONAL GUIDELINES FOR *AEDES* VECTOR SURVEILLANCE AND CONTROL IN SRI LANKA

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This authoritative document is the second edition of the essential resource on *Aedes* vector surveillance and control in Sri Lanka published by the National Dengue Control Unit in May 2025

This guideline was developed and revised based on the best available scientific evidence at the time of writing. The guideline will be reviewed periodically when new evidence becomes available. Please forward your comments and suggestions to the following address by post or email.

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Message from the Director General of Health Services

Dengue fever and Dengue haemorrhagic fever have significantly impacted disease morbidity and mortality in the country in the recent past. Prevention and control of arboviral diseases are accomplished most effectively through a comprehensive, integrated vector management (IVM) program, which applies the principles of integrated pest management and real-time epidemiological and entomological surveillance to reduce and prepare for outbreak mitigation.

The revised "National Guidelines on *Aedes* Vector Surveillance and Control in Sri Lanka", developed by the National Dengue Control Unit of the Ministry of Health, is expected to improve further the existing knowledge and practices on *Aedes* vector surveillance and control in Sri Lanka.

I hope this document will serve as a valid reference for programme managers in planning and rolling out prevention and control programmes on *Aedes* mosquitoes.

Dr. Asela Gunawardena

Director General of Health Services

Message from the Deputy Director General (Public Health Services)1

Dengue is a communicable disease that remains a significant public health concern in the Asian region, including Sri Lanka, where it frequently occurs in Epidemic proportions.

The "National Guidelines on *Aedes* Vector Surveillance and Control in Sri Lanka," developed by the National Dengue Control Unit of the Ministry of Health in 2016, have been instrumental in reducing the morbidity and mortality associated with dengue. The National Dengue Control Unit has updated the guidelines to address emerging issues related to vector control and adopt an integrated approach to eliminating dengue as a public health problem, with support and commitment from all stakeholders. These revised guidelines replace the previous document.

I thank the National Dengue Control Unit for their leadership in this timely endeavor.

Dr. S.M. Arnold

Deputy Director General (Public Health Services) 1

Message from the Director of the National Dengue Control Unit

In Sri Lanka, dengue remains a persistent challenge significantly that affect social, health and economic conditions of the country significantly.

Currently, efforts are being guided by the principles of integrated vector management to control mosquito vectors through a coordinated approach. This includes source reduction via environmental management, targeted vector control, health education, and law enforcement. The implementation of this combined strategy aims to substantially diminish the *Aedes* mosquito population in vulnerable regions, thereby enabling early prevention and control of disease outbreaks.

The "National Guidelines on *Aedes* Vector Surveillance and Control in Sri Lanka, "initially developed in 2016, have played a significant role in vector control, reducing the dengue burden. In light of emerging issues and recent scientific evidence in vector control, the National Dengue Control Unit of the Ministry of Health has revised these guidelines.

The revised guidelines for *Aedes* Vector Surveillance and Control in Sri Lanka have been formulated based on the best available evidence, incorporating integrated vector management practices from both local and international sources. These updated national guidelines aim to inform all stakeholders and effectively reduce the incidence of dengue.

I hope that these guidelines will assist national and subnational entomology teams and researchers in designing and implementing effective *Aedes* vector surveillance systems within the country.

I express my gratitude to all members of the Expert Committee for their unwavering effort and dedication in making these revised guidelines a success and a reality.

Dr. Sudath Samaraweera

Director, National Dengue Control Unit

PREFACE

Revised National Guidelines for Aedes Vector Surveillance and Control in Sri Lanka

The menace of *Aedes*-borne diseases, primarily dengue fever, has posed a significant public health challenge in Sri Lanka for several decades. The impact on public health and the socio-economic well-being of the nation has been substantial, necessitating a comprehensive and dynamic response.

The emergence of new challenges, including the development of insecticide resistance in *Aedes* mosquitoes, climate change impacts, and increasing urbanization, has made it imperative for the National Dengue Control Unit to revisit and revise the existing guidelines with the collaboration of World Health Organization. These guidelines serve as the cornerstone of the national strategy to mitigate the risk of *Aedes*-borne diseases.

This revision, brought about through collaborative efforts and multidisciplinary expertise, reflects a commitment to staying ahead of the evolving *Aedes* mosquito threat. Our approach encompasses not only the surveillance and control of *Aedes* vectors but also education and community engagement to empower individuals and communities in the fight against these diseases especially dengue.

The meticulous work and dedication of experts, researchers, and public health professionals have culminated in these revised guidelines, which incorporate the latest scientific evidence, technological advancements, and best practices in vector surveillance and control. We acknowledge the invaluable input of international partners and organizations who have shared their experiences and knowledge to enrich these guidelines.

The adoption of these revised guidelines is not merely a formality but a pledge to safeguard the health and well-being of the people of Sri Lanka. They provide a roadmap for government agencies, healthcare providers, researchers, and communities to collaboratively combat Aedes-borne diseases. These guidelines will not only help reduce the burden of these diseases, but also pave the way for a more resilient and healthier future.

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CHAPTER 1

INTRODUCTION

Dengue is a neglected tropical disease that has become the fastest growing mosquito-borne disease, with almost half the world's population living in countries where dengue is endemic. Due to its detrimental health, social and economic consequences, the disease has become a significant public health concern throughout tropical and sub-tropical regions of the world.

The World Health Organization (WHO) estimates that around 50–100 million dengue infections occur yearly. Other estimates indicate 390 million dengue virus infections annually, of which 96 million (67–136 million) manifest clinically (with varying severity of the disease). Another study on the prevalence of dengue estimates that 3.9 billion people are at risk of infection with dengue viruses. Dengue is a global concern, with a steady increase in the number of countries reporting the disease, while close to 70% of the global population exposed to dengue resides in the Asian region.

The first dengue patient in Sri Lanka was reported in 1962. Since 2000, dengue has become endemic in the country with periodic epidemics. Although the disease was first reported in the western province, it is currently widely distributed throughout the island, including rural areas. Hence, dengue has become the communicable disease of most significant public health importance in the country. In Sri Lanka, cyclic dengue epidemics occur every one to two years in the background of endemicity. Hence, the number of patients may increase during the second and fourth quarters of the year, along with the monsoonal rains. A significantly high epidemic occurred in 2009, comprising 35,008 patients and a Case Fatality Rate (CFR) of 0.99%. Since then, a steady increase in the disease has been noticed over the years, and the year 2017 marked the highest incidence, 865.9/100,000) with 186,101 dengue cases and 440 deaths.

The impact of Covid-19 on disease distribution was significant and worth exploring further. The year 2020 reported the lowest number of cases since 2016, with an incidence of 142/100,000. Further in 2021 the caseload was coming down where the change in the epidemiology is probably due to the mobility restrictions implemented during the Covid-19 pandemic. The relationship between the mobility of the people and the disease transmission became even more vivid as in 2022 more than 76,000 cases were reported after the travel restrictions were lifted.

Dengue infection causes a wide spectrum of diseases. This can range from subclinical disease to severe flu-like symptoms in those infected. Although less common, some people develop severe dengue(DHF/DSS), which can have any number of complications; plasma leakage, severe bleeding, organ impairment, etc. Infection can be caused by any of the four closely related but serologically distinct dengue viral serotypes (DENV-1, DENV-2, DENV-3 and DENV-4) constituting one genus subgroup, *Flavivirus*, family *Flaviviridae*. Since there is only transient cross-protective immunity between the four serotypes, people living in a dengue-endemic area can be infected up to four times during their lifetime. Recovery from infection by one serotype provides lifelong immunity against that particular serotype. However, cross-immunity to the other serotypes after recovery is only partial and temporary. Subsequent infections by different serotypes increase the risk of developing severe dengue (DHF/DSS).

Humans are infected with dengue viruses by the bite of a mosquito; *Aedes aegypti*, the primary vector, and *Aedes albopictus*, the secondary vector. These species are highly domesticated tropical mosquitoes that lay eggs mainly in artificial water containers in and around high-risk premises (such as residential houses, schools, construction sites, government and private institutions, fisheries harbours etc.). Adult mosquitoes rest indoors and prefer to feed on humans during daylight hours, with peak biting activity in the morning and late afternoon. Adult female mosquitoes may get a single blood meal from several persons, making *Ae aegypti* a highly efficient epidemic vector. Multiple virus serotypes often cocirculate within the same high-risk areas causing periodic epidemics.

Dengue Fever/Dengue Haemorrhagic Fever has no specific treatment or an effective vaccine, and vector control is the mainstay of dengue prevention and control. However, the application of appropriate vector control interventions depends on vector ecology, biology, behaviour (bionomics), efficacy, and effectiveness of vector control methods that are generated through vector surveillance. Therefore, this document will provide updated evidence and practical guidelines on the implementation of dengue vector surveillance and control in Sri Lanka.

CHAPTER 2

BIOLOGY AND IDENTIFICATION OF DENGUE VECTORS

Vector biology, identification and study of the ecology and behaviour of dengue vectors are of paramount importance in targeting vector control interventions for dengue prevention and control. This chapter discusses the life cycle and key external morphological characters for identification of different stages of the life cycle of the dengue vector mosquitoes; *Ae. aegypti* and *Ae. albopictus.*

2.1. Life cycle of *Ae. aegypti* and *Ae. albopictus*

The life cycle has 4 distinct stages, namely; egg, larva, pupa and adult (Fig 2.1). The first three stages are aquatic and the adult is terrestrial. The time taken to complete the life cycle is usually 7-10 days depending on the environmental factors.

Eggs

The female mosquito lays eggs (oviposit) singly on damp inner surface of wet containers above the water level, preferably with clear water. The eggs are smooth, long, ovoid shaped and about 1mm long. When first laid, the eggs appear white but within minutes they turn shiny black. Within about 2 -3 days, the eggs hatch to larvae. The eggs can withstand dry weather conditions and retain viability for up to six months or longer.

Larva

The larval stage consists of 4 stages, namely, 1st, 2nd, 3rd and 4th instar larvae (Fig 2.2). Larvae feed on organic matter contained in the water except late 4th instar. All the larval instar stages are mobile with a characteristic "s" shape movement of the body. At the end of larval period of 4 - 5 days, the 4th instar larva develops in to a pupa. The mosquito larval body consists of three major parts; head, thorax and abdomen (Fig.2.3).

Pupa

The pupa is comma shaped and mobile. This stage is the final aquatic stage of the mosquito's life cycle and it develops into adult mosquito within 1-2 days. Pupa is a non-feeding stage. Pupal body consists of cephalothorax and abdomen (Fig 2.4). The density of pupae is a crude proxy to the adult mosquito density.

Adult

Adult mosquitoes are small to medium-sized (approximately 4 -7 mm), dark with white markings/ bands on the body (Fig. 2.5). The adult life span (longevity) can range from 02 - 04 weeks depending on environmental conditions such as temperature and humidity.

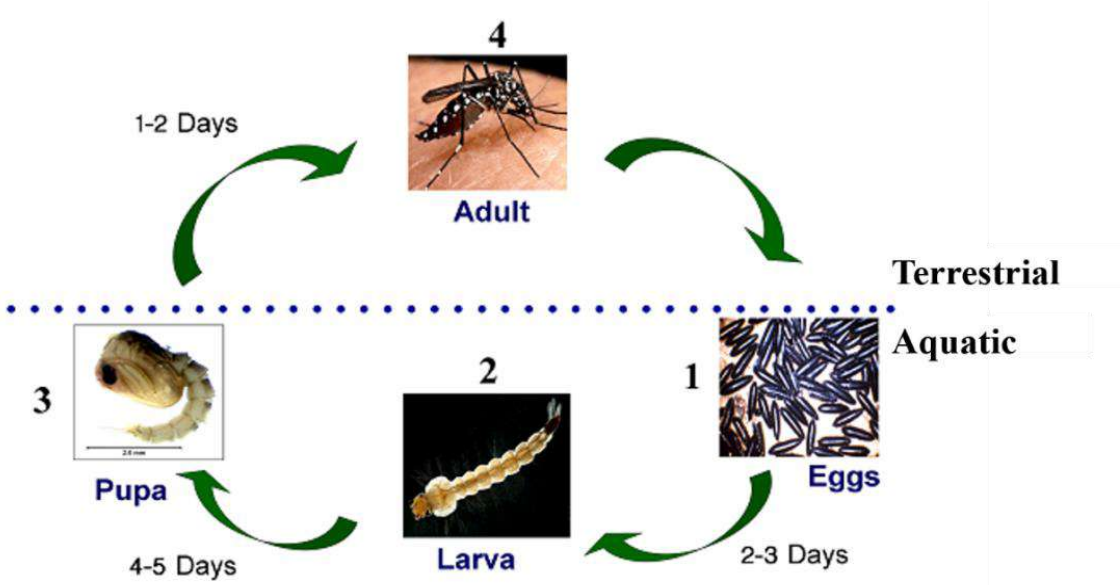


Fig. 2.1. Life cycle of the dengue vector (7 – 10 days)

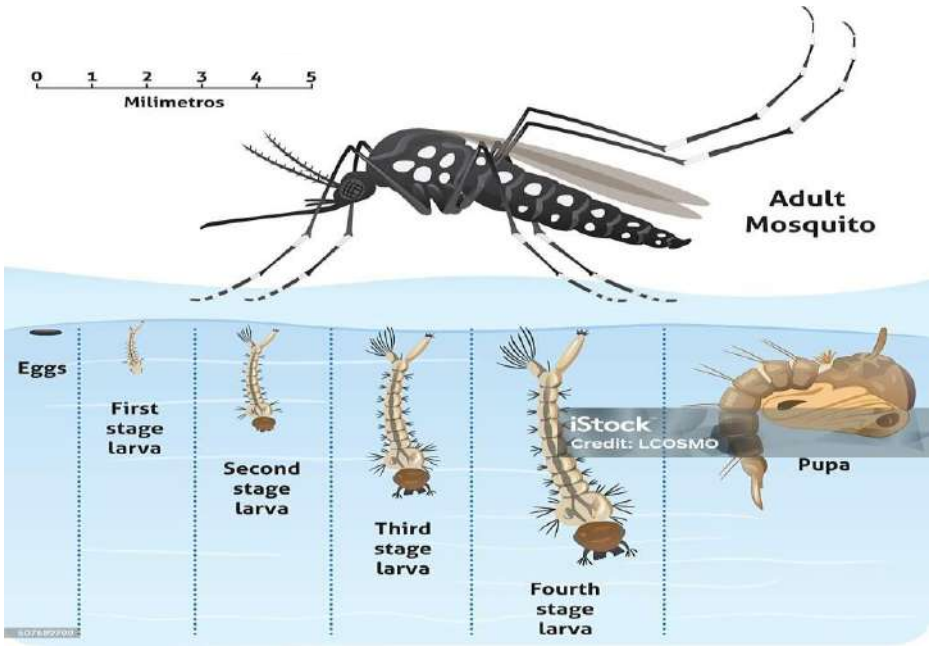


Fig 2.2. Life cycle of *Aedes* showing different stages (Including Larval stages), Source: istockphoto.com

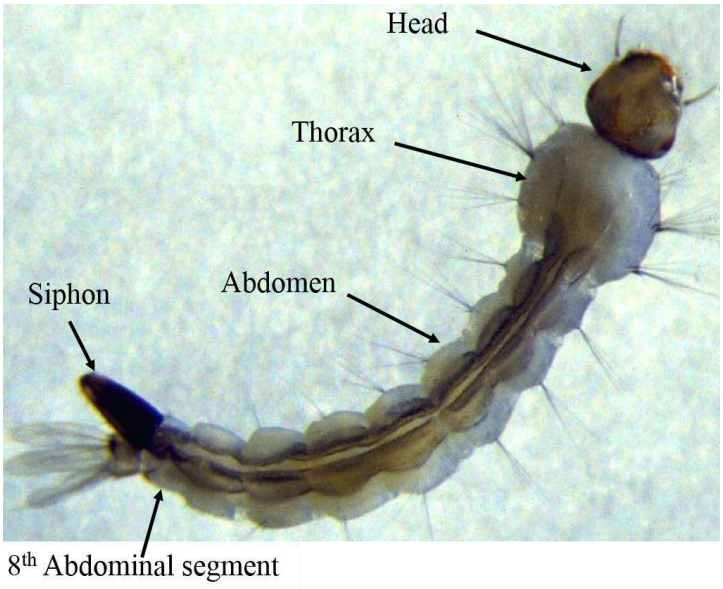


Fig. 2.3. Major body parts of the *Aedes* larvae

Source: Florida Medical entomology laboratory, University of Florida

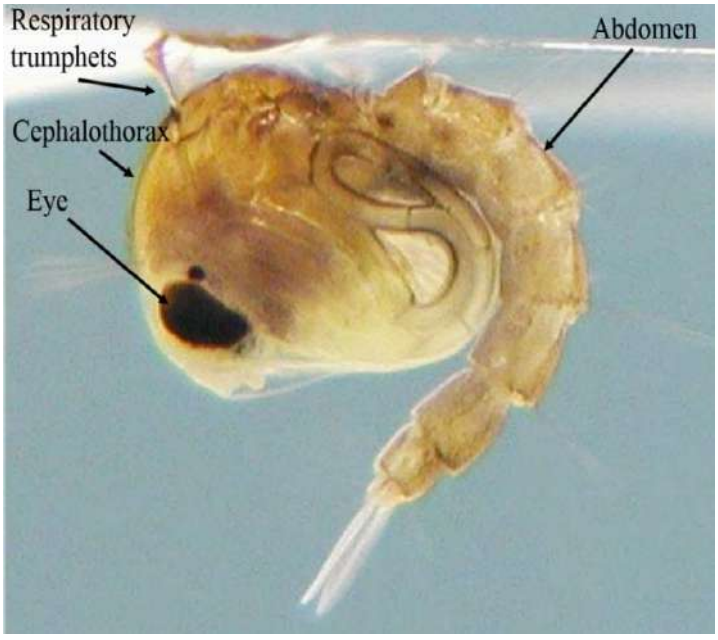


Fig. 2.4. Major body parts of the *Aedes* Pupa

Source: Florida Medical entomology laboratory, University of Florida

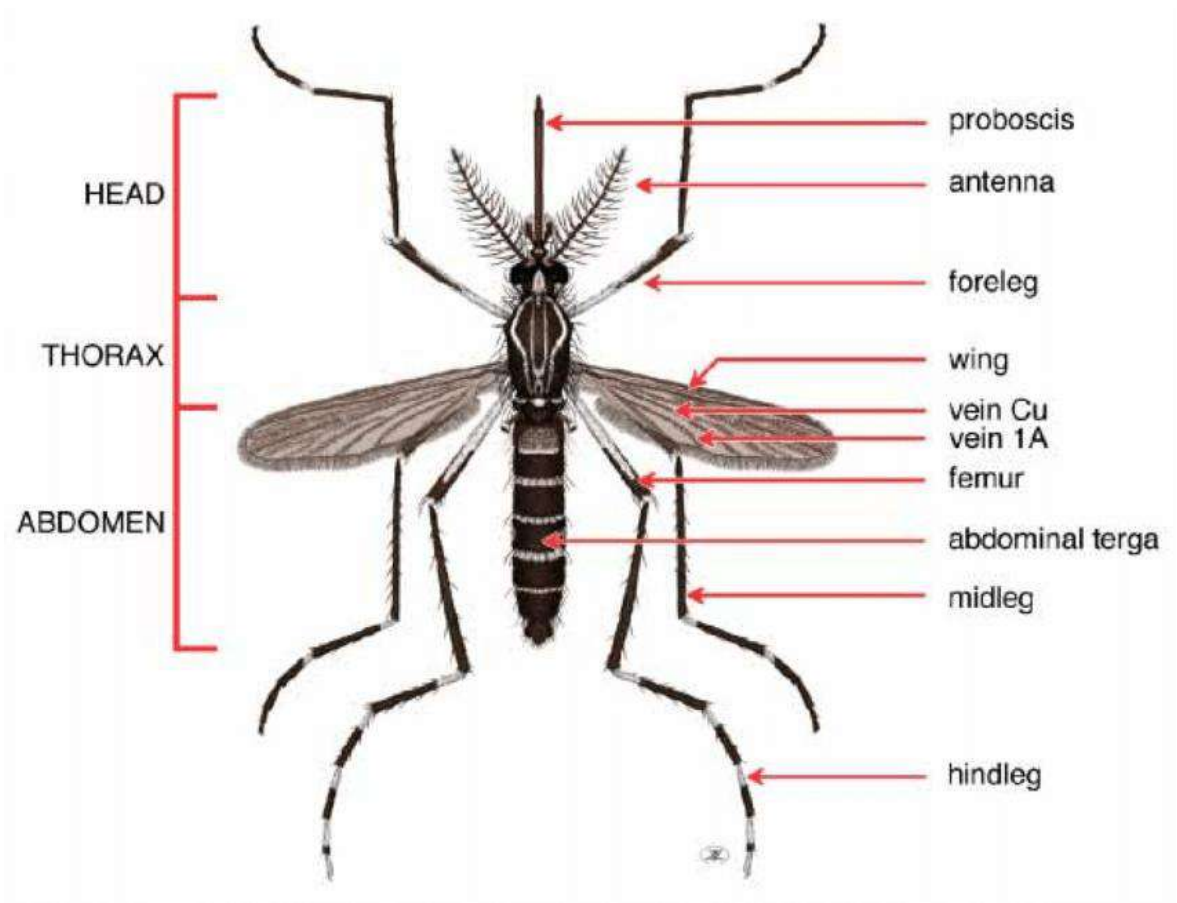


Fig. 2.5. major body parts of the adult *Aedes* mosquito

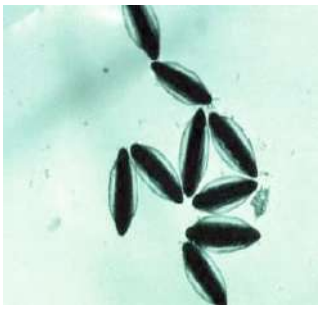
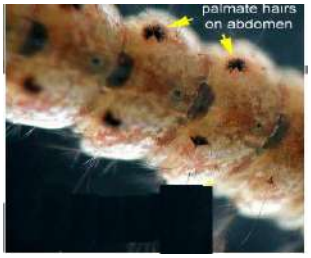
Source : Rueda, L. M. (2004)

2.2. Characteristic features of *Aedes, Anopheles* and *Culex* mosquitoes

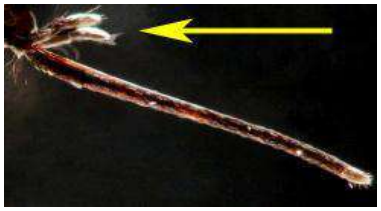
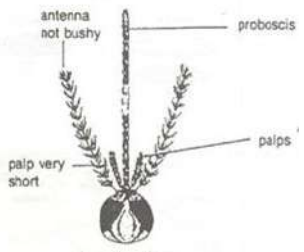
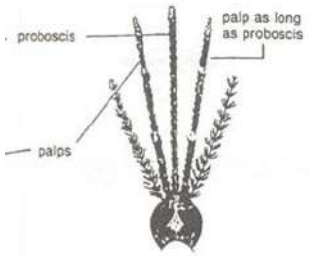
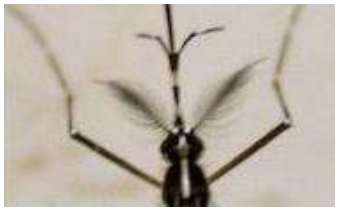
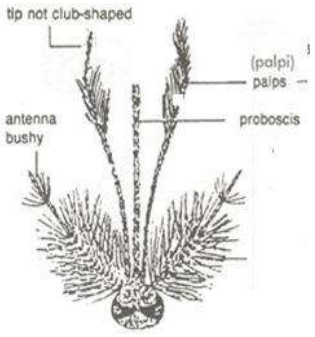
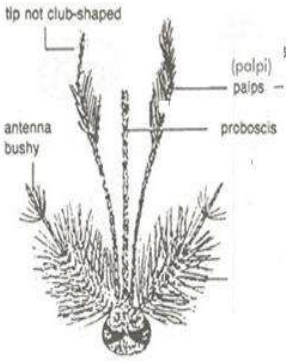
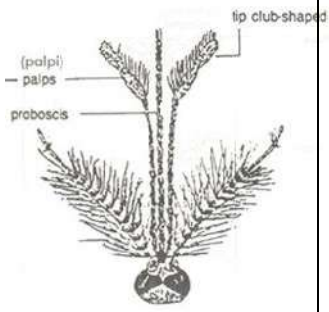
The major differences between *Aedes* (that includes vectors of dengue, zika and chikungunya), *Anopheles* (that includes vector of malaria) and *Culex* (that includes vectors of filariasis and Japanese encephalitis) are shown in Table 2.1.

Aedes mosquitoes can be differentiated from *Anopheles* and *Culex* mosquitoes by the external morphological features, ornamentation and resting positions of this genus at different stages of the life cycle. Adult male mosquitoes of all three genera can be differentiated from females as the males have a pair of plumose (bushy) antennae and female mosquitoes bear pilose (less hairy) antennae.

Table 2.1. Differentiation of *Aedes*, *Anopheles* and *Culex* mosquitoes at different stages of life cycle

Stage of the life cycle	*Mosquito genera*		
	Aedes	*Culex*	*Anopheles*
Eggs	• Black in colour, Laid singly on damp surface of wet containers above the water level 	• Laid in the form of egg raft that floats on the surface of water • Never possess lateral floats 	• Laid singly on the surface of water • Have lateral floats 
Larvae	• Body has comparatively less hairs • Siphon present. The siphon is comparatively short, barrel shaped and more chitinous with a single pair of siphonal tufts • No palmate hairs • No tergal plates on the abdominal segments • Rest with an angle to the water surface. 	• Body has many hairs • Siphon present and the siphon is comparatively long and slender with more than one pair of siphonal tufts. • No palmate hairs or tergal plates • Rest with an angle to the water surface. 	• Body has many hairs • Siphon absent • Has palmate hairs • Have tergal plates on the abdominal segments • Rest parallel to water surface.  Tergal plates 

Stage of the life cycle	*Mosquito genera*		
	Aedes	***Culex***	***Anopheles***
Pupae	• Breathing trumpet is long and slender with a narrow opening. • No spines on abdominal segments 2-7  Source:elp.tamu.edu	• Breathing trumpet is long and slender with a narrow opening. • No spines on abdominal segments 2-7  Source:www.diptera.info	• Breathing trumpet is short with a wide opening apically. • Short peg like abdominal spines on segments 2 or 3-7  Source: medent.usyd.edu.au
Adults (both sexes)	•Rests more or less parallel to the surface. •Black and white scales on the body and legs arranged in different patterns  	• Rests more or less parallel to the surface. • Scales on wing veins are not arranged in blocks, scales frequently all brown or blackish  	• Rests at an angle between 50˚ and 90˚ to the surface.   In most species dark and pale scales on wing veins arranged in distinct blocks

Stage of the life cycle	*Mosquito genera*		
	Aedes	*Culex*	*Anopheles*
Adult females	• Palpi much shorter than proboscis 	Palpi much shorter than proboscis  	• Palpi are as long as proboscis  
Adult males	• Palpi are longer than proboscis with tapered tips  	Palpi are longer than proboscis with tapered tips  	• Palpi are as long as proboscis and the tips of palpi are club-shaped (swollen)  

2.3. Identification of *Ae. aegypti* and *Ae. albopictus*

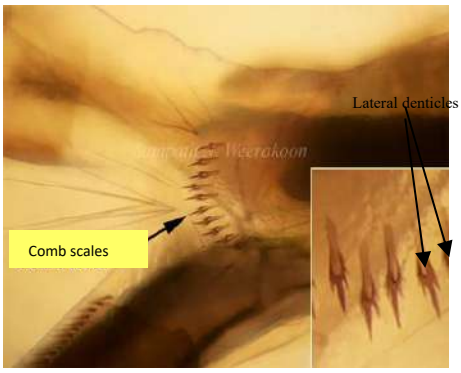
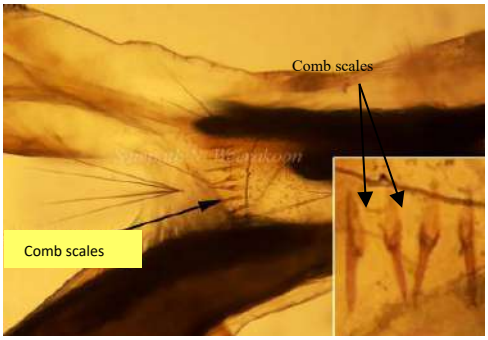
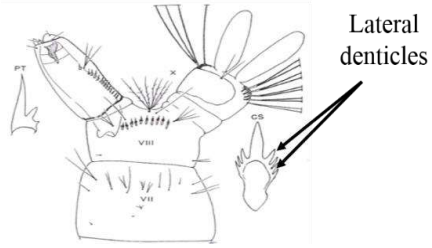
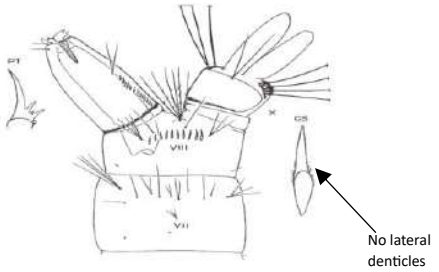
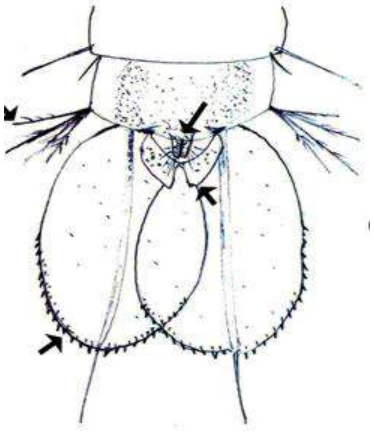
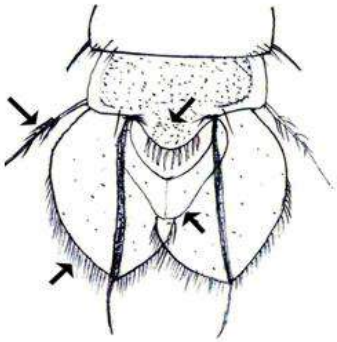
In Sri Lanka, 52 *Aedes* (Meigen) species belonging to 11 subgenera have been reported whereas over 900 *Aedes* species are identified worldwide. *Ae. aegypti* and *Ae. albopictus* belong to the subgenus *Stegomyia* (Theobald) of the genus *Aedes*. In Sri Lanka, in addition to these two species, 4 other *Aedes* species belong to this subgenus as shown in Fig. 2.6. have been identified.

Kingdom : Animalia
Phylum : Arthropoda
Class : Insecta
Order : Diptera
Family: Culicidae
Genus : *Aedes*
Subgenus : *Stegomyia*
Species: *Ae. aegypti* (Linnaeus)
Ae. albopictus (Skuse)
Ae. novalbopictus (Barraud),
Ae. krombeini (Huang),
Ae. w-albus (Theobald) and
Ae. mediopunctatus (Theobald).

Figure 2.6: Taxonomical state of *Aedes* mosquitoes

Different stegomyia species can be identified by external morphological characters, both at the larval and adult stages, using available identification keys. However, *Ae. aegypti* and *Ae. albopictus* larvae can be identified by the shape of comb scales on the 8th abdominal segment of the body. The adult stages of these two species can be differentiated by the colour patterns (ornamentation) of white scales on the body (Table 2.2).

Table 2.2: Characteristics for differentiation of *Ae. aegypti* and *Ae. albopictus*

Stage of life cycle	*Ae. aegypti*	*Ae. albopictus*
Larva	• Comb scales have lateral denticles  Source : Mr.Sampath Weerakoon, Entomologist/Badulla	• Comb scales have no lateral denticles  Source : Mr.Sampath Weerakoon, Entomologist/Badulla
		
Pupa	Mid rib of paddle not reaching apex, submarginal serrations	Mid rib of paddle reaching apex, margins with visible setae
	 • Source : Mr.Sampath Weerakoon, Entomologist/Badulla	 • Source : Mr.Sampath Weerakoon, Entomologist/Badulla

Stage of life cycle	*Ae. aegypti*	*Ae. albopictus*
Adult	Mesonotum has a pair of lateral curved (lyre-shaped) white markings and usually a pair of submedian yellowish lines.	Mesonotum has a median longitudinal white stripe of narrow scales extending from anterior margin to about level of wing root
	 Lyre shape markings	 Straight line markings

2.4. Vector competency and Vectorial capacity of *Ae. aegypti* and *Ae. albopictus*

Ae. aegypti is the more efficient, and epidemic causing vector of DF/DHF. This is explained by the vector competency and vectorial capacity of the vectors.

2.4.1. Vector competency

Vector competency is the vector's capability to transmit a pathogen. It denotes high susceptibility of the vector to the virus, ability to replicate the virus within the vector and ability to transmit the virus to another host (human). Both *Ae. aegypti* and *Ae. albopictus* are susceptible to the dengue viruses, viruses are replicated within both species and both species can transmit the viruses to man. Thus, both *Ae. aegypti* and *Ae. albopictus* have high vector competency for dengue viruses.

2.4.2. Vectorial capacity

Vectorial capacity is a measurement of the efficiency of a vector for disease transmission. It is governed by environmental and biological characteristics of the vector species. There are a number of factors that contribute to the vectorial capacity of a mosquito towards an arbovirus

including mosquito survival, density, proportion of infected mosquitoes that are feeding on human, longevity, vector susceptibility to the virus, and density of susceptible hosts.

Ae. aegypti is a highly domesticated, strong anthropophilic mosquito which may take several blood meals before resting to allow their eggs to mature (discordant species). This attributes to the high vectorial capacity of *Ae. aegypti* resulting in cross infections and clustering of dengue cases which makes this species a more epidemiologically important vector of DF/DHF. *Ae. albopictus* feeds on both humans and animals, it usually takes one blood meal to complete the gonotrophic cycle (concordant species). Hence, *Ae. albopictus* has poor vectorial capacity.

CHAPTER 3

VECTOR ECOLOGY AND BEHAVIOUR

Bionomics is that part of the biology (often called autecology) which deals with the relationships between a given species and its environment (WHO 1975). Knowledge on the bionomics of *Ae. aegypti* and *Ae. albopictus* is important for dengue vector control. This chapter describes oviposition (breeding) sites, resting and feeding habits, and flight range of *Ae. aegypti* and *Ae. albopictus.*

3.1. Common oviposition sites of dengue vectors

The dengue vectors, are container breeders; they breed in a wide variety of artificial and natural wet containers/ receptacles, preferably with dark coloured and holding clear (unpolluted) water.

Dengue vector oviposition sites are found within and outside houses/ premises, at ground level as well as above ground level in places such as roof gutters, overhead tanks and receptacles on slabs, and in small and large containers/ receptacles. These containers/ receptacles are found at any type of premises including residential houses, government and private institutions, hospitals, commercial sites, yards containing automobile parts, schools, religious places, bare lands, construction sites and fisheries harbors. Furthermore, water holding discarded containers along river/ stream banks and railway lines are also possible oviposition sites for *Ae. aegypti* and *Ae. albopictus*. However, in some instances, the oviposition sites are area specific (e.g. shallow cemented wells and tube wells in certain localities).

Ae. aegypti prefers to oviposit in artificial containers. This species frequently engages in 'skip oviposition' and lay eggs in multiple containers in a single oviposition cycle. Although *Ae. albopictus* is considered as a sylvatic species and breeds in natural containers such as leaf axils and tree holes, it also breeds in artificial containers in urban and peri-urban areas. *Ae. aegypti* shares its habitat with other *Aedes* species including *Ae. albopictus*, non-*Aedes* species and occasionally with some *Anopheles* species.

The common oviposition sites of *Ae. aegypti* and *Ae. albopictus* in Sri Lanka given in broad categories

a. Discarded receptacles (plastic containers, tins, clay pots, yoghurt and ice cream cups, bottles, damaged ceramic items, coconut shells etc.).

b. Water storage containers (water storage cement tanks, barrels and other containers),
c. Automobile tyres and machinery parts
d. Building structures (roof gutters, concrete slabs/ wet cement floors etc.)
e. Household /institutional appliances (refrigerator and air-conditioner trays, ornamental ponds, pet feeders, non-functional cisterns, non-used squatting pans/ commodes of washroom and containers under leaking sinks)
f. Temporary removed items and temporary covering items (eg: polythene sheets) that can collect water
g. Natural oviposition sites e.g., tree holes, leaf axils

3.2. Indoor and outdoor oviposition sites of dengue vectors

Dengue vectors oviposition sites are found both indoors and outdoors. Indoor and outdoor oviposition sites of *Ae. aegypti* and *Ae. albopictus* that have been detected during vector surveillances are:

3.2.1 Indoor oviposition sites

- Water storage tanks, barrels, buckets, containers in the toilets, bathrooms, kitchen and mop buckets etc.
- Non-functional cisterns and squatting pans of toilets
- Containers used to collect water leakages from sinks
- Refrigerator trays/ water dispenser trays
- Flower vases
- Ornamental ponds
- Ant traps
- Abandoned fish tanks
- Lift wells in partly constructed buildings

3.2.2. Outdoor oviposition sites

- Discarded containers
- Water storage tanks/barrels /buckets
- Shallow cemented wells/tube wells
- Roof gutters
- Ornamental items and ponds
- Tyres
- Cemented floor

- Bamboo stumps
- Coconut shells
- Leaf axils and tree holes
- Water collecting unused items and damaged equipment
- Water collecting building materials and equipment in construction sites
- Temporary removed items (e.g.: roof tiles, broken household items, water storage containers etc.)
- Covering items (Plastic / polythene sheets)
- Pet feeder

➢ Discarded receptacles

➢ Ground level water storage cement tanks (outside of premise)

➢ Overhead cement tanks

- Ground level water storage cement tank (Inside of premise)

- Water storage barrel

- Indoor water storage tank and barrel

- Water storing plastic barrel

- Water storing plastic containers

- Rainwater harvesting drums and cement tanks

- Unprotected used automobile tyres

- Machinery parts

- Blocked roof gutters

- Roof cover with polythene

- Concrete roof/ slab

- Fences with open poles and cut bamboo stumps

- Hardened soil contained flower pots

- Saucer of a flower pot

- Ornamental ponds of a house

- Refrigerator trays

- Temporary removed items e.g.:

Boots

- Animal feeding trays

- Bird baths

- Abandoned boats

- Unused seesaws in play grounds

- Tree holes

- Leaf axils of plants

- Clear water contained drain

- Wet cement floors

- Abandoned toilets

- Water filter tray

- Pan kala

- Lift well

Fig. 3.1. Common oviposition sites of *Ae. aegypti* and *Ae. albopictus* in Sri Lanka

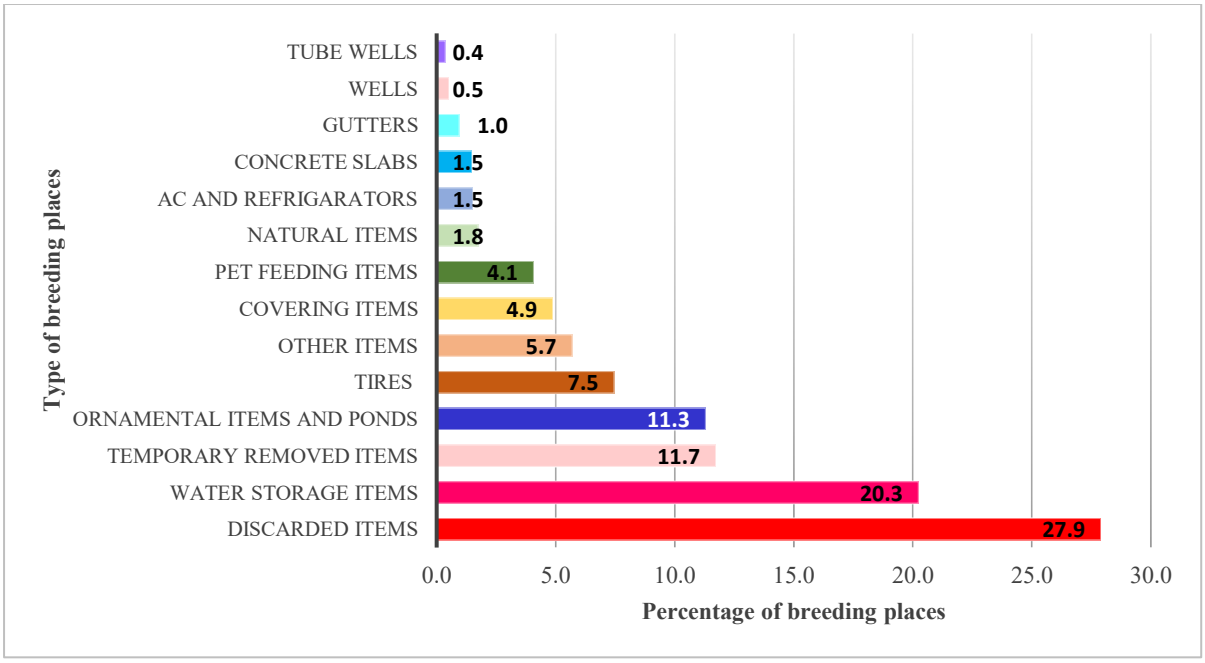
- Any container which can hold water more than 5-7 days can serve as oviposition sites for dengue vectors.

3.3. Important dengue vector oviposition sites in Sri Lanka in 2022 ,2023 and 2024

Major Oviposition sites of dengue vectors in the years 2022, 2023 and 2024 are shown in Fig. 3.2.

Fig. 3.2. Three-year average percentage positivity of dengue vector oviposition sites generated from the acquired data in 2222,2023 and 2024 in Sri Lanka. (Source: NDCU)

*Other: Non-used cisterns, commodes, squatting pans, wet cement floors, wells, tube wells, gutters earth pipes.



N=138,301

Fig 3.2. *Aedes* vector breeding sites in Sri Lanka 2022, 2023 and 2024

Ae. aegypti and *Ae. albopictus* breed in a wide variety of containers, however, the productivity (the number of larvae/ pupae/ adults produced) of vectors in different containers varies.
E.g. 1. In the rainy season, roof gutters and discarded containers become significantly positive for *Aedes* larvae, thus contributing to seasonal outbreaks; in the dry season, water storage containers and indoor cryptic breeding places are important oviposition sites of *Ae. aegypti* and *Ae. albopictus.*

In an area with interrupted water supply, water storage tanks are a major oviposition sites of *dengue* vectors while discarded containers are the most productive oviposition site in an area where solid waste management is poor. This shows that the most productive containers are area specific and seasonal specific.

3.4. Vector behaviour

In this section, resting and feeding behaviour and the flight range of dengue vector are discussed.

3.4.1. Resting behaviour

Ae. aegypti primarily rests inside houses or buildings in dark and humid surroundings on secluded hanging objects including curtains, clothes, shoes, bed nets, underside of furniture

and empty containers. Less often this species is found outdoors in vegetation or other hidden places. *Ae. albopictus* generally rests outdoors including vegetation, empty containers such as pots and tyres and in other hidden places.

3.4.2. Feeding behaviour

Female *Ae. aegypti* is highly anthropophilic and tends to feed on more than one person for a full blood meal (multiple feeder). This species shows gonotrophic discordance (takes more than one blood meal to complete the gonotrophic cycle). This multiple feeding habit and gonotrophic discordant behaviour increases the man-biting rate and thereby greatly increases the epidemic transmission efficiency. *Ae. albopictus* is an aggressive feeder and takes a full blood meal in one go. It is a concordant (takes one blood meal to complete the gonotrophic cycle) species and therefore, considered a less efficient vector.

Dengue vectors are primarily day time biters with two peaks of biting activity. i.e. one in the morning for few hours after day break (dawn) and the other in the afternoon for few hours before dark (dusk). The morning peak of biting activity falls between 0600 -1000 hours and the afternoon peak falls between 1500 – 1900 hours. However, the actual peaks of biting activity may vary slightly, within these ranges, depending on the location and season of the year. These vector species may bite humans in between these peaks, especially in shady places and when the light and dark conditions are conducive for their activity. These species generally do not bite at night, although some may feed at night in well-lit rooms.

3.4.3. Egg laying pattern

Female *Ae. aegypti* mosquito produces on average 100 to 200 eggs per batch. The females can produce up to five batches of eggs during its lifetime. Eggs are laid singly. The mosquito will not lay the entire clutch at once at a single site, but rather spread out the eggs over many sites over several hours depending on the availability of suitable substrates (Skipped Ovi-positioning). Eggs will most often be placed at varying distances above the water line.

3.4.4. Flight range and dispersal of adult

Dispersal of adult female depends on a on the availability of oviposition sites and human hosts to feed on. Generally, the dispersal is short, the horizontal dispersal usually being about 100 - 200m from the oviposition site. However, when oviposition sites and/ or human hosts are not available, dispersal may be wider, Vertically, these species are found up to many floors in multi storied buildings including condominiums.

CHAPTER 4

AEDES VECTOR SURVEILLANCE

Vector Surveillance is the analysis and interpretation of systematically collected entomological data to facilitate appropriate decisions on vector control. It is an important and essential component of the dengue control programme, as the information generated from vector surveillance guides the vector control programme and helps with early warning and epidemic forecasting.

4.1. Objectives of *Aedes* vector surveillance

1. To determine the oviposition sites of dengue vector mosquitoes
2. To describe the temporal and spatial distribution of vector mosquitoes
3. To describe seasonal fluctuations of vector population
4. To determine the feeding and resting habits of vector mosquitoes (vector bionomics/ behaviour)
5. To forecast outbreaks and early warning
6. To determine the effectiveness of vector control interventions used for dengue vector control.

4.2 Types of surveys

Entomological surveys encompass three primary types: routine surveys, spot checks, and focus investigations. Routine surveys are conducted at designated sentinel sites on a regular schedule. Spot checks are implemented regularly in targeted sites where the risk of disease transmission is deemed to be elevated, as a supplement to routine observation. Focus investigations are undertaken in particular areas and under specific circumstances, guided by environmental and epidemiological data (Table.4.1).

4.2.1. Routine survey

Routine surveys are conducted regularly in pre-arranged and designated areas (at sentinel site) which are endemic to dengue transmission to collect entomological data that are useful to make trend observations on vector density, dynamics of vector oviposition sites, changes in vector behaviour and monitoring vector susceptibility/ resistance status to insecticides that are

used in dengue vector control. Routine survey facilitates early warning and forecasting of dengue outbreaks.

Table 4.1: The description of different types of entomological surveys

Type of survey	Previous nomenclature	When to use	Type of site	Description
Routine survey	Sentinel survey	Continual	Sentinel	Regular long-term observations (monthly) in pre-arranged and designated areas (which are endemic to dengue transmission)
Spot check	Routine survey	To answer a specific question	Targeted site	Ad hoc assessments carried out in selected locations as a supplement to routine observations
Focus investigation	Spot check	when cases are reported in new area or any sites with special environmental conditions	Case and contact locations, and surrounding houses or sites with special environmental conditions	Short-term reactive investigations in areas of new, persistent or resurgent dengue transmissions

Selection of sentinel sites

1. Sentinel sites are identified at the district level and monitored monthly. It is recommended that one sentinel site be established and monitored per district.
2. The sentinel site should be

   (i) an area with high dengue transmission over a period of time

   (ii) an outbreak-prone area (areas experiencing/potential for periodic or seasonal outbreaks (it may be a one or two adjacent Municipal wards/ one or two adjacent Grama Niladari areas).

Entomological techniques to be carried out in sentinel site surveillance

1. Larval/ pupal(immature) surveys - Monthly

2. Ovi trap surveys - Monthly
3. Indoor and outdoor adult mosquito resting collections - Monthly
4. Human bait collections (using the double net method) - Quarterly
5. Insecticide susceptibility/ resistance tests - Annually
6. Bio-efficacy tests for larvae and adult *Ae. aegypti* and *Ae. albopictus.* – On requirement

4.2.2. Spot survey

Spot survey involve risk area assessments conducted at targeted sites, primarily those with a high incidence or potential for dengue outbreaks, to complement regular monitoring efforts. These surveys aim to gather entomological data that informs and guides dengue vector control interventions and contributes to epidemic prevention efforts.

Larvae and pupae (immature) surveys are the commonly used entomological surveillance method in spot survey. Monitoring larval/pupal density helps to identify (i) potential dengue transmission areas and seasons well ahead of the outbreak period and (ii) area and time-specific vector oviposition sites that facilitate the application of the most appropriate and cost-effective vector control interventions.

Selection of targeted sites

1. Targeted sites are identified at the regional and institutional (e.g. NIHS, CMC), sub-regional (Medical Officer of Health-MOH), level and monitored monthly.

2. A targeted site is (i) an area where high dengue transmission is present over a period of 3 years or (ii) an outbreak-prone area.

3. **Entomological techniques to be performed in a targeted site**
    - Larval/ pupal (immature) surveys – Monthly
    - Ovi trap surveys – Based on the situation
    - Indoor and outdoor adult mosquito resting collections – Based on the situation

4.2.3. Focus investigations

Focus investigations are conducted at specific locations, such as the residences of confirmed cases, areas where cases have been identified (foci of transmission), or sites with special environmental conditions. These investigations are short-term reactive investigations in areas of new, persistent or resurgent dengue transmission. Focus investigations are carried out

1. In areas where there are outbreaks of dengue
2. In contact places of reported dengue cases

3. In institutions such as schools, government and private institutes, public places, religious places, harbors, areas where development projects are carried out, and construction sites where single ownership is not recognized due to increased population movements.
4. In new localities where dengue cases are reported.
5. In an area where there is an increase in the reporting of fever /suspected dengue cases
6. When environmental changes occur favoring vector breeding (e.g. flooding, development projects, etc.)
7. To identify the new establishment of *Ae. aegypti* or *Ae. albopictus* in areas with no reports of dengue vectors previously
8. When there is a need to evaluate the impact of control measures (e.g. cleaning programs, fogging, etc.)

Entomological techniques to be performed during Focus investigations

1. Larval/ pupal (immature) surveys
2. Indoor and outdoor adult mosquito resting collection, based on the situation

In order to carry out *Aedes* vector surveillance more efficiently, it is important to define priority areas for surveillance.

4.3. Prioritization of geographical areas for *Aedes* vector surveillance types

Dengue is a focal and local disease; intensity, season and localities of dengue transmission/ epidemics depends on the temporal and spatial prevalence and density of the vectors, primarily, *Ae. aegypti*. Therefore, knowledge on the temporal and spatial distribution of dengue vectors is important for prevention and control of DF/DHF transmission. However, to work with the limited manpower and the logistics of the dengue control programme, priority areas need to be identified for vector surveillance (Table 4.2).

4.4. Sampling procedures and sample size in dengue vector surveillance

The number of premises/ sampling units to be inspected in a locality depends on the level of precision required, the total number of houses in the area and the surveillance method. Use of a proper sampling method would minimize the bias in the selection of premises/houses. Following sampling methods can be used in selection of houses. In dengue vector larval surveys preferably 100 or more premises should be surveyed to calculate the vector indices with more accuracy.

Table 4.2. Type of surveys to be conducted in different geographical areas

Adobe	Type of survey	Frequency of surveys
Dengue endemic areas Dengue endemic areas are areas with reporting of indigenous cases throughout the year. Such areas have a potential to cause outbreaks when conducive to vector breeding. The endemicity of the area and the baseline figures can be assessed for the MOH area by going through past data (3-5 years)	Routine survey Spot survey Focus investigation	Monthly Monthly On requirement
Receptive/ vulnerable areas for dengue transmission such as: a. In an area where there is an increase in the reporting number of fever/suspected dengue cases, in areas where there are outbreaks of dengue in spite of regular vector control interventions. Premises such as hospitals, schools, construction sites, bus depots, hostels, condominiums, camps, public places, religious places, new developmental projects and areas with migrant population, large population gatherings (perahera/procession, religious events)	Spot survey Focus investigations	Monthly On requirement
Localities with current and past outbreaks within the immediate past 3 years	Spot survey	Monthly
Localities where there are no indigenous dengue cases but have perceived transmission (areas with imported dengue cases and areas with low *Aedes* indices).	Focus investigations	On requirement

4.4.1. Simple random sampling:

In simple random sampling, houses (premises) to be surveyed are selected using a list of random numbers (either from the random number tables or from the computer-generated number). This method would require detailed house lists or location maps for identifying selected houses.

4.4.2. Systematic sampling

Systematic sampling of every 'nth house throughout a community or along a street: For example, in an area of 400 premises if a sample of 25% of the houses of 400 houses to be inspected, every 4th house (=400/4) would be inspected.

4.4.3. Stratified random sampling:

The area intended to be surveyed is stratified to a few strata; each is more or less epidemiologically homogeneous. Houses (survey units) are selected from each stratum randomly for the survey.

4.4.4. Cluster sampling:

The survey area is divided into several clusters of a fixed number of houses (e.g. each cluster of 100 houses). A set of clusters are randomly selected. From each cluster, a sample of houses is selected randomly and surveyed.

Note: Frequent and regular visit to a sentinel surveillance site would result in low vector density indices over time, thus, the houses in the sample should be changed in subsequent visits.

4.5. Planning of vector surveillance activities and commonly used entomological techniques

Dengue prevention and control is a decentralized programme in Sri Lanka. The National Dengue Control Unit (NDCU) provides technical guidance and necessary logistic support while planning is done at the Provincial, District and Medical Officer of Health (MOH) area levels. Planning of surveys for the forthcoming month should be done in advance.

In Sri Lanka immature surveys (both larvae and pupae), adult mosquito surveys, ovi-positioning trap surveys are the most commonly used survey technique in dengue vector surveillance. For special and research purposes, gravid trap surveys, BG trap surveys and light trap surveys are conducted.

4.6. Larval / Pupal (Immature)

In larval surveys, the basic sampling unit is the house or premise. During the larval survey, all potential dengue vector oviposition sites that are in and around the selected houses/ premises (Approximately 100 - 200 m around the reported case or designated number of houses) should be examined for *Aedes* larvae.

Following equipment should be carried for the larval survey (Fig.4.1)

- Dippers (Plastic and aluminium)

- Pipettes
- Ladle
- Vials and labels
- Torch (to use when dipping the water storage tanks inside the houses)
- Siphoning pipette
- Strainer
- Relevant formats

Pipettes

Larval Vials

Ladle

Strainers

Torch

Dipper

Fig. 4.1. Larval collections using dipping and pipetting techniques

From each *Aedes* larvae/ pupae positive container, a minimum of 10 larvae and 10 pupae (if present) are collected by dipping, pipetting and/or siphoning (Fig. 4.1). In instances where 10 larvae/ pupae are not present, all larvae/ pupae are collected (since mixed breeding/ habitat sharing of *Aedes* and non *Aedes* species is common in Sri Lanka, collection of only one larva results in underestimating of the vector density). The collected larvae are placed in a labelled plastic vial labelled with date, location and code number and the species are identified in the laboratory using standard identification keys.

It is important to note that if there are multiple oviposition sites of the same type in one place (eg. heaps of tyres, coconut shells), larvae should be collected at least from 10 randomly selected such containers.

Larval collection by dipping - When sampling larvae from water storage tanks and barrels, it is recommended to use a strainer instead of a standard dipper, since larvae when disturbed, have a tendency to leave the surface to rest on the bottom and become out of reach for sampling.

Fig.4.2 Checking roof gutters for water collections

Fig. 4.3 Larval collection in a roof gutter by pipetting

4.6.1. Immature Stage identification

Third and fourth instar larvae can be identified at the laboratory immediately after the field survey. However, 1st and 2nd instar larvae should be allowed to develop to 3rd and 4th instar larvae and identified. Pupae could be identified (table 2.2) or pupae are allowed to develop to adults and identified.

4.6.2. Calculation of Larval/Pupal (immature) density indices

The relevant format should be used for reporting (Annexure II; Dengue Entomological Survey-Immature Survey Report). Once identification of larvae/ pupae is completed, larval density indices are calculated for *Ae. aegypti* alone, *Ae. albopictus* alone, and for *Ae. aegypti* and *Ae. Albopictus* combined, in order to determine the vector density in the area. If a particular container is positive for both *Ae. aegypti* and *Ae. albopictus* (mixed breeding), this particular container is considered as two containers (01 for *Ae. aegypti* and 01 for *Ae. albopictus*) when calculating vector density indices separately for *Ae. aegypti* and *Ae. albopictus.*

4.6.3. Larval/pupal(immature) density indices

Three indices, viz. Container index (CI), House/premise index (HI or PI Index) and Breteau index (BI) are used to give vector larval density. The method of calculation of these indices with examples is given below.

Breateau Index (BI): Number of positive containers for *Ae. aegypti/ Ae. albopictus* larvae and/or pupae per 100 houses inspected.

BI = Number of positive containers for *Ae. aegypti/ Ae. albopictus* larvae and/ or pupae X 100
Number of houses inspected

Premise Index (PI): Percentage of premises infested with *Ae. aegypti/ Ae. albopictus* larvae and/ or pupae.

PI = Number of positive premises for *Ae. aegypti/ Ae. albopictus* larvae and/ or pupae X 100
Number of premises inspected

Container Index (CI): Percentage of water-holding containers infested with *Ae. aegypti/ Ae. albopictus* larvae and/ or pupae.

CI = Number of positive containers for *Ae. aegypti/ Ae. albopictus* larvae and/ or pupae X 100
Number of wet containers inspected

By definition, BI is the number of positive containers for *Ae. aegypti/ Ae. albopictus* larvae and/ or pupae per 100 houses/ premises inspected. Thus, preferably inspection 100 or more houses is necessary to calculate accurate BI in a particular area.

An example for calculating the larval density indices using hypothetical data are shown in Tables 4.3 and 4.4

Table 4.3. Results of a hypothetical larval/pupal (immature) survey

No. of houses Examined	No. of houses/premises positive for			No. of wet containers examined	No. of containers positive for		
	Ae. aegypti alone	*Ae. albopictus* alone	Both *Ae. aegypti* and *Ae. albopictus*		*Ae. aegypti* alone	*Ae. albopictus* alone	Both *Ae. aegypti* and *Ae. albopictus*
100	5	3	2	85	6	5	3

A-*Ae.aegypti* B-*Ae.albopictus*

Table 4.4. Calculation of larval/pupal(immature) density indices using data in Table 4.3.

Name of the index	Formula	Use of data in the formula data	Index
CI (A)	Number of containers positive for (A alone+both A and B) x 100 / Number of wet containers examined	$=\frac{(6+3)}{85}\times 100$	10.6%
CI (B)	Number of containers positive for (B alone+both A and B) x 100 / Number of wet containers examined	$=\frac{(5+3)}{85}\times 100$	9.4%
Combined CI	Number of containers positive for (A alone +B alone+both A and B) x 100 / Number of wet containers examined	$=\frac{(6+5+3)}{85}\times 100$	16.4%
PI (A)	Number of houses/premise positive for (A alone+ both A and B) x 100 / Number of premises examined	$=\frac{(5+2)}{100}\times 100$	7.0%
PI(B)	Number of houses/premise positive for (A alone+both A and B) x 100 / Number of premises examined	$=\frac{(3+2)}{100}\times 100$	5%
Combined PI	Number of premises positive for A alone + B alone + both A and B×100 / Number of premises examined	$=\frac{(5+3+2)}{100}\times 100$	10%
BI (A)	Number of positive containers for A alone + both A and B *x 100* / Number of houses / premises examined	$=\frac{(6+3)}{100}\times 100$	9
BI (*B*)	Number of positive containers for *A* alone + both A and B x100 / Number of premises examined	$=\frac{(5+3)}{100}\times 100$	8
Combined BI	Number of containers positive for (A alone + B alone + both A and B x 100 / Number of premises examined	$=\frac{(6+5+3)}{100}\times 100$ $=\left(\frac{14}{100}\right)\times 100$	14

4.6.4. Importance and interpretation of Larval/Pupal (immature) indices

In dengue prevention and control, all three larval density indices, especially of *Ae. aegypti*, need to be considered. High container index indicates the important container types a dengue vector oviposition site and the vector control interventions need to be directed to eliminate such types of containers immediately. These larval indices are important for decision-making on elimination of the most common habitats, developing educational messages and orientation of community-based initiatives. and BI are useful proactive indicators of predicting

dengue outbreaks/ epidemics and assessing the effectiveness of the application of appropriate dengue vector prevention/ control interventions. However, it is difficult to give a single country-wide cut-off of larval density indices as the larval productivity depends on the area, container types and the most productive container types. Such cut-off points for the regional and sub-regional level should be calculated using the past vector and epidemiological data collected over a period of time.

4.6.5. Limitations of Larval/Pupal (immature) indices

Container index provides information on the percentage of wet containers that are positive for dengue vectors and the most important container types. House index (HI)/premise index(PI) provides information on the percentage of houses that are positive for vector species, and the Breteau index(BI) provides information on the number of positive containers per 100 houses. The larval density indices are a crude indication of adult production. For example, the larval productivity of a water storage tank is likely to differ markedly from that of a discarded coconut shell. However, in the calculation of CI, HI/PI or BI, productivity of these containers is not considered. Instead, it is taken as positive or negative for vector breeding. Thus, the transmission potential of dengue may be quite different in localities with similar larval indices but with different container profiles.

4.6.6. Reporting and communication of Larval/Pupal (immature) survey results

Standard entomological surveillance formats for daily and weekly reporting of surveillance data are given in annexures (I), (II) and (III) respectively. Format for reporting of surveillance at the institutions/ construction sites etc. is given in annexure IV. The daily report is an interim report which has to be submitted to the respective Medical Officer of Health (MOH) after the day's work. (Annexure I). Breeding places summary mention in Annexure II. Although format II and III are for weekly reporting of surveillance data, separate sheets of formats II and III should be used if more than one survey/ locality is surveyed within a week. The weekly report/s should be submitted to the MOH, Entomologist and Regional Epidemiologist (RE) of the district and the National Dengue Control Unit in Colombo. Where the HEOs are attached to RMO or AFU, the reports should be sent through the same authorities adopting to the proper channel.

4.7. Pupal surveys

Pupal density in *Aedes* vector breeding sites provide a reliable measure of adult emergence. Due to the high survival rate of pupae and their proximity to the adult stage, these counts accurately reflect the potential for adult mosquito production.

Pupal count data will be used to calculate the following indices,

$$\text{Percentage of each breeding site} = \frac{\text{Total number of pupae found in a given category of container}}{\text{Total number of pupae in all containers in the area}} \times 100$$

Using these indices, the most productive containers for *Aedes* vector breeding can be determined

$$\text{Pupal premise index} = \frac{\text{Number of houses/premise positive for } \textit{Aedes} \text{ pupae}}{\text{Number of premises examined}} \times 100$$

$$\text{Pupal container index} = \frac{\text{Number of containers positive for } \textit{Aedes} \text{ pupae}}{\text{Number containers inspected}} \times 100$$

The formats for the pupal survey is provided in the attached Annexure V & VI

4.8. Adult mosquito survey

Adult vector surveys provide information on the seasonal trends of mosquito density, peaks of biting activity, resting places, potential dengue transmission areas, transmission risk, and the effectiveness of vector control interventions.

Objectives of adult vector surveys

- To estimate the adult vector populations in a locality
- To determine seasonal fluctuations of vector density
- To study vector behaviour such as biting times and resting places
- To determine the effectiveness of vector control interventions, including evaluation of larvicidal and adulticidal interventions

Adult vector survey methods include:

- Human bait collections using double nets,
- Indoor and outdoor resting collections.

4.8.1. Human bait collections using double net traps

Fig.4.4. Indirect catch using double trap method

(Source: NDCU)

Human bait collection using a double net method can be used for adult vector surveys. In this method, a human bait is allowed to rest on a folding bed or a chair inside the inner mosquito proof net and another net is hung around this net. The outer net is arranged in such a way to keep a space of about 6 inches between the bottom edge of the net and the ground and with sufficient space between the two nets is maintained for the mosquito collector to move around. The mosquito collector collects the mosquitoes attracted to the bait (the adult mosquitoes trapped between the two nets) using a sucking tube or a battery powered aspirator. Mosquito collections are made hourly during the collection period and the mosquito density is given as the (a) number of adult *Ae. aegypti* and *Ae. albopictus* mosquitoes per trap and (b) number of adult mosquitoes per bait per hour.

4.8.2. Indoor resting collections of dengue vectors

Adult dengue vector mosquitoes rest indoors on different surfaces including under the furniture, on hanging objects such as clothes, closets and other sheltered places such as inside empty containers and domiciliary objects (Fig 4.5).

In resting collections, sites are checked for adult mosquitoes with the aid of a flashlight, mosquitoes are collected using mouth or battery powered aspirators. The flying mosquitoes are collected using sweep nets (Fig 4.6).

Battery operated aspirators and back-pack/ Prokopack aspirators are also used in collections of indoor and outdoor resting mosquitoes (Fig 4.7).

Fig.4.5. Collection using sucking tube
(Source: NDCU)

Fig 4.6. A sweep net

Fig. 4.7.Adult resting mosquito collections using a back pack/ Prokopack aspirator
(Source: NDCU)

In resting collections, Adult House Index (AHI), Adult Density (AD) and Resting Rate (RR) can be calculated to determine the adult mosquito density of a particular area as follows.

$$\text{Adult House Index (AHI)} = \frac{\text{Houses positive for } \textit{Aedes} \text{ adult mosquitoes*}}{\text{Total houses inspected}} \times 100$$

Adult Density (AD) = Number of *Aedes* adult mosquitoes* found X 100
Total houses inspected

Resting Rate = Number of female *Aedes* mosquitoes found X 100
Total houses inspected

AHI is the percentage of houses positive for *Aedes* mosquitoes. AD is defined as the number of *Aedes* mosquitoes per 100 houses examined. RR is defined as the number of female *Aedes* mosquitoes per 100 houses examined (Janaki et al., 2022). Collection data can be recorded as the given format in the annexure VII.

Adult mosquitoes surveys are time consuming, labour intensive. When the collection technique involves human baits, extreme care should be taken to prevent the individual being bitten by mosquitoes.

4.8.3. The BG sentinel traps

BG Sentinel Traps use a combination of attractive visual and olfactory cues for collection of adult *Ae aegypti* and *Ae. albopictus* mosquitoes. This trap is comparatively light and the mosquitoes trap in it due to the suction created by the built-in fan within the trap. BG-Sentinel traps are more effective in capturing *Ae. aegypti*, and also collect adult females in all physiological states.

Fig.4.8. BG Sentinel trap

Thus, it is more advantageous as compared to the traditional ovipositional trap. The efficiency of BG traps can be increased by baiting them with lures (e.g., CO_2, BG-Lure®).

4.9. Oviposition trap surveys

Oviposition traps (commonly referred to as ovitraps) are simple but effective tools which are commonly used to collect evident data on distribution and density of mosquito species. The oviposition habit (Container breeders) of the dengue vector species leads to have high positive results to detect the presence of *Ae. aegypti* and *Ae. albopictus* through this technique especially even when and where the other vector density indices (larval and adult densities) are not providing enough evidence.

Objectives and uses of ovitrap collections

- To assess dengue vector density and distribution in a particular area
- To detect new areas of infestations of dengue vectors early
- To determine the effectiveness/ efficacy of vector control interventions
- To collect eggs of dengue mosquitoes for susceptibility and bio-efficacy tests
- To assess vector population fluctuation over long-term
- To assess dengue vector density when and where larval surveys produce low vector indices (e.g. when the BI (*Ae. aegypti*) is ≤ 3)

The standard ovitrap is a wide-mouthed plastic cup of approximately 250 ml which is painted in black on the outside to attract the *Ae. aegypti*/ *Ae. albopictus* females to oviposit. A piece of hardboard or a wooden paddle is placed diagonally inside the cup as an oviposition substrate and the cup is partially filled with clean water to provide the right ovipositing medium for the female mosquito (hay infusion attracts *Culex* and *Armigeres* mosquitoes, thus tap water is preferred for the ovitraps). Instead of the wooden paddle, white towelling of filter paper strips can be placed inside the cup and attached by paper clips (Figure 4.9).

The ovitraps are placed appropriately in a suspected mosquito frequenting place, both indoors and outdoors. Collection of ovitraps is made once in 5-6 days, and the paddles/ paper strips are examined under a dissecting microscope for the presence of eggs of *Aedes*. The numbers of eggs are counted to give the egg density as (a) the number of eggs per ovitrap, and (b) the percentage of positive ovitraps. In areas where both *Ae. aegypti* and *Ae. albopictus* are present, eggs should be allowed to hatch and then the larvae or adults should be identified since the eggs of both species cannot be reliably distinguished from each other.

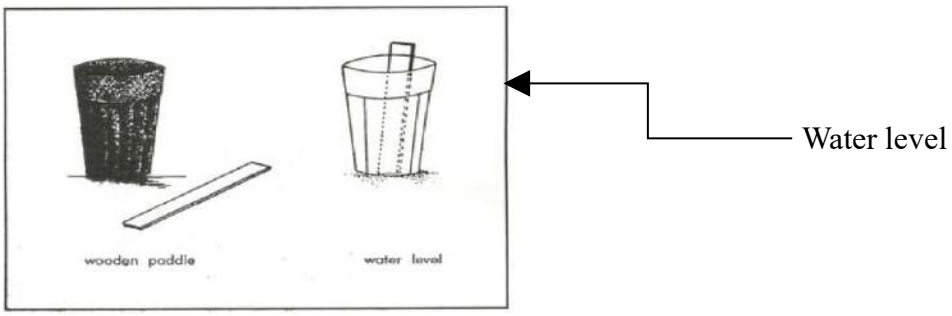


Fig. 4.9. Ovitrap settings

a. Ovitrap Index (OI) = $\frac{\text{Number of positive ovitraps}}{\text{Number of ovitrap placed}} \times 100$

b. Egg density Index = $\frac{\text{Total no. of egg}}{\text{Total no. of positive ovistrips}}$.

(Burroni et at., 2013)

Collection of data can be recorded as the given format in the annexure VIII

4.10. Insecticide resistance monitoring

Insecticide resistance is "the development of ability in a strain of insects to tolerate doses of toxicants which would prove lethal to the majority of individuals in a normal population of the same species". Development of resistance is a complex and dynamic process and it depends

upon genetic, biological and operational factors. Currently, dengue vector population in Sri Lanka have showed resistance and possible resistance level for currently used insecticides in some areas in certain instances.

The purpose of the susceptibility test is to detect the presence of resistant individuals in an insect population early to preserve the effectiveness of available insecticides. If the use of insecticide continues without knowing the presence of resistance, percentage of selected survivors will increase and the susceptibility of the population will decline to a point that the insecticide no longer provides an acceptable level of control. Therefore, susceptibility monitoring will help to plan alternative control strategies to deal with the situation when the insecticide in question is no longer having the desired effect.

Insecticide resistance monitoring needs to be conducted as per WHO guidelines (WHO, 2022 a and b).

CHAPTER 5

CONTROL OF *AEDES* VECTORS

Aedes mosquitoes serve as primary vectors for several viral diseases, including dengue, chikungunya, Zika, and yellow fever. Within the context of Sri Lanka, however, dengue and chikungunya are the only endemic diseases. Vector control strategies in Sri Lanka are directed at both the immature (larval and pupal) and adult life stages of *Ae. aegypti* and *Ae. albopictus*. These interventions are implemented through an Integrated Vector Management (IVM) framework, which synthesizes environmental, biological, and chemical control methods mitigate disease transmission.

5.1. Integrated vector management

Integrated vector management (IVM) is a rational decision-making process for the optimal use of resources for vector control. IVM uses the available resources, existing health system and evidence based appropriate vector control interventions singly or in combination to suppress the vector population. Key elements of IVM strategy are shown in Table 5.1.

Table 5.1. Key elements of IVM strategy

No.	Key Element	Description
1.	Advocacy, communication, social mobilization and legislation	• Promotion and embedding of IVM principles in designing policies in all relevant agencies, organizations and civil society • Establishment or strengthening of regulatory and legislative controls for public health • Empowerment of communities
2.	Collaboration within the health sector and with other sectors (partners across various sectors)	• Consideration of collaboration within and between public and private sectors including the engagement with local communities and other stakeholders; application of the principles of subsidiarity in planning and decision-making; strengthening channels of communication among policy-makers, vector-borne disease control programme managers and other IVM partners
3.	Integration of control method	• Ensure rational use of available resources by addressing several diseases, integrating non-chemical and chemical vector control methods and integrating with other disease

		control methods; use of a range of interventions, often in combination and synergistically.
4.	Evidence-based decision making	• Adaptation of vector control strategies and interventions guided by the knowledge of local vector biology, bionomics and ecology, disease epidemiology and resources, and subject to routine monitoring and evaluation.
5.	Capacity-building	• Provision of the essential material infrastructure, financial resources and human resources at national and local level to manage IVM strategies on the basis of situational analysis.

5.1.1. Operationalizing of IVM to local situation

a. Selection of vector control methods based on knowledge of local vector biology, bionomics, ecology, climatic parameters and the epidemiology of dengue (Evidence based decision making).

In Sri Lanka, there are two peaks of dengue transmission each year in association with the South- West and North-East monsoonal rains. The major peak falls in June/ July while the other peak falls in November/ January (Fig 5.1).

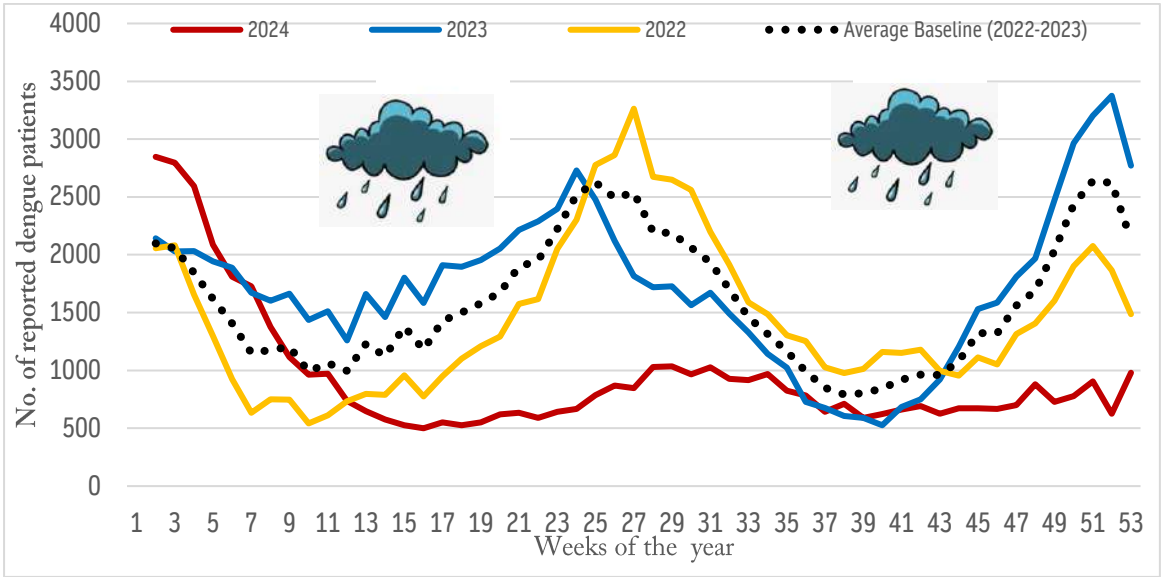


Fig. 5.1. Seasonal variations of reported dengue patients (2022 - 2024)

The current National Dengue Surveillance system (NaDSys), hosted by the National Dengue Control Unit, primarily relies on hospital notifications submitted to the respective Medical

Officer of Health through a centralized web-based platform. In parallel, a routine paper based system is still in use.

The reported dengue patients are investigated by the Public Health Inspectors to identify the source of infection and to implement suitable vector control methods. Field -level response activities are also documented and reported via the NaDSys web platform, which is accessible to public health staff at various administrative levels. Additionally, responses to notified cases are communicated to the Epidemiology Unit through the conventional paper -based system. The integrated system enables the identification of high risk Grama -Niladhari (GN)divisions, allowing public health staff at the grassroot levels to maintain vigilance and respond effectively.

The entomological surveillance data are summarized to identify the GN area wise distribution of *Ae. aegypti* and *Ae. albopictus*. Since *Ae. aegypti* is the principal vector of dengue in Sri Lanka, information on the distribution of this species is of immense importance. Entomological surveillance data provides information on the vector oviposition sites and dynamics of vector density over time. Regular monitoring of such data would help identify the fluctuations of vector density (Fig 5.2).

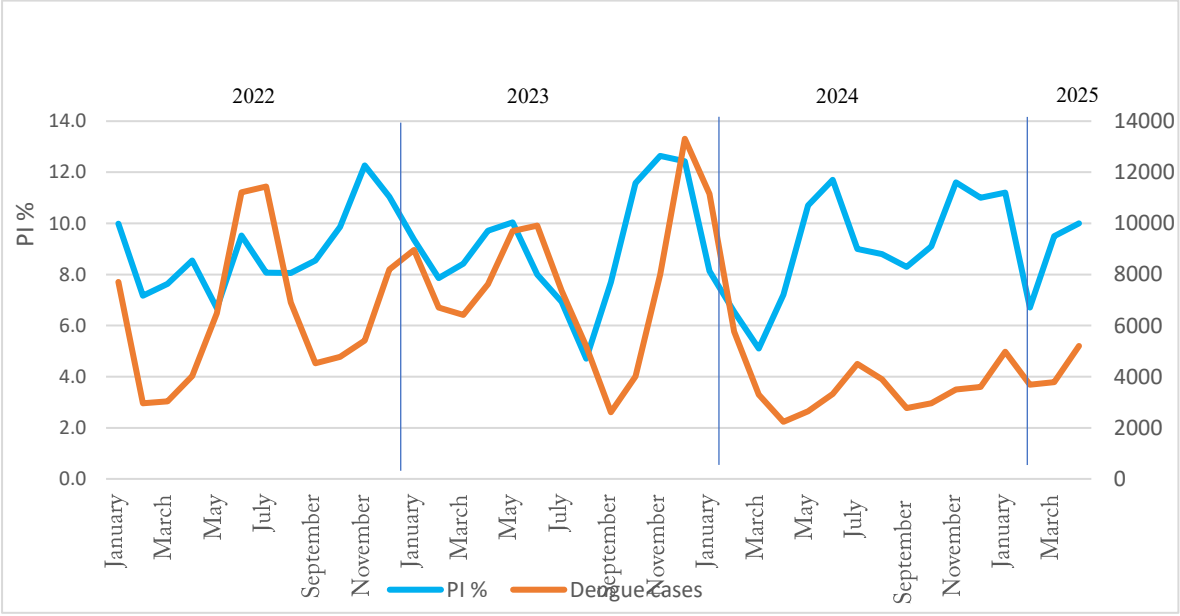


Figure 5.2: Relationship between PI and dengue cases in Sri Lanka in 2022, 2023, 2024 and 2025

It is observed that high larval indices precede an increase in the number of dengue patients reported with a lag period of 1-2 months (Fig. 5.2). Monitoring and mapping such data is

helpful in identifying outbreak prone areas, potential risk levels. Importance in adult and pupal surveys in identifying the high-risk areas need to be mention as we are planning to go with these indices in future.

Entomological surveillance provides information on vector oviposition sites and vector behaviour. Biting behaviour of *Ae. aegypti* are useful in performing space spraying during peak biting hours.

b. Utilization of a range of interventions, often in combination and synergistically – (integrated vector control)

Source reduction by cleaning campaigns is carried out routinely during inter epidemic periods and before the expected dengue transmission period in order to prevent outbreaks. Cleaning can be accompanied by space spraying of insecticide in high risk areas and application of temephos 1% SG for water storage tanks, and in combination. Single or multiple vector control interventions can be used to control *Aedes* vector borne diseases.

c. Collaboration within the health sector and with other agencies in the public and private sectors that have an impact on vector breeding – (intra and inter sectoral collaboration/ participation)

Intersectoral collaboration is of utmost importance for dengue vector control. All relevant sectors such as Ministries of Education, Provincial Councils and Local Government, Environment, Public Administration, Construction, NGOs, CBOs and other relevant sectors should engage for prevention and control of dengue vector breeding grounds with the technical guidance that is provided by the Ministry of Health.

d. Engagement with local communities and other stakeholders – (Community participation)

Active community participation and community mobilization are important activities for sustainable elimination of vector breeding grounds Communities can be involved in small scale and mass cleaning campaigns, for desirable behaviour change and larvivorous fish programmes etc.

e. Public health regulatory and legislative framework

The households and other property owners may be issued notices or prosecuted if breeding sites are identified on their premises and pose a threat to neighboring communities.

f. Rational use of insecticides

As the number of insecticides for vector control is limited and the indiscriminate use of insecticides results in vector resistance, extreme care should be taken when using insecticides ensuring the use of insecticides in areas where such interventions are extremely necessary.

5.2. Dengue vector control interventions in Sri Lanka

Dengue vector control programme should be planned on scientific evidence and implemented by trained personal including community groups. The programme should be well supervised, monitored and reviewed monthly in inter-epidemic periods and weekly in the epidemic periods.

Considering the socio economic, cultural and religious diversity of the human society, breeding grounds in different types of premises the vector control intervention methods described in this chapter can be integrated appropriately.

Environmental, biological and chemical methods are used for dengue vector control in Sri Lanka. However, source reduction through environmental management is the most cost-effective activity. Major approaches of dengue vector management and control are shown in Fig 5.3.

5.2.1. Environmental management methods

Environmental management seeks to change the environment in order to prevent or minimize vector propagation and human contact with the vector by destroying, altering, covering and removing or recycling of containers and potential water holding items that provide *Aedes* mosquito breeding habitats. Such actions should be the mainstay of dengue vector control. Three types of environmental management are defined:

a. Environmental modification: Environmental modification includes long-lasting physical transformation of vector breeding habitats to eliminate and/ or prevent mosquito breeding.

For example,

- Providing continuous water supply to minimize storage of water in cement tanks, barrels, and other containers in areas with irregular water supply.
- Mosquito-proofing of water storage cement tanks, domestic wells and overhead tanks/cisterns permanently.
- Construction of buildings without roof gutters.
- Removal of unserviceable roof gutters.
- Removal of unwanted cement tanks.
- Use of mosquito proof plastic overhead tanks instead of open tanks.

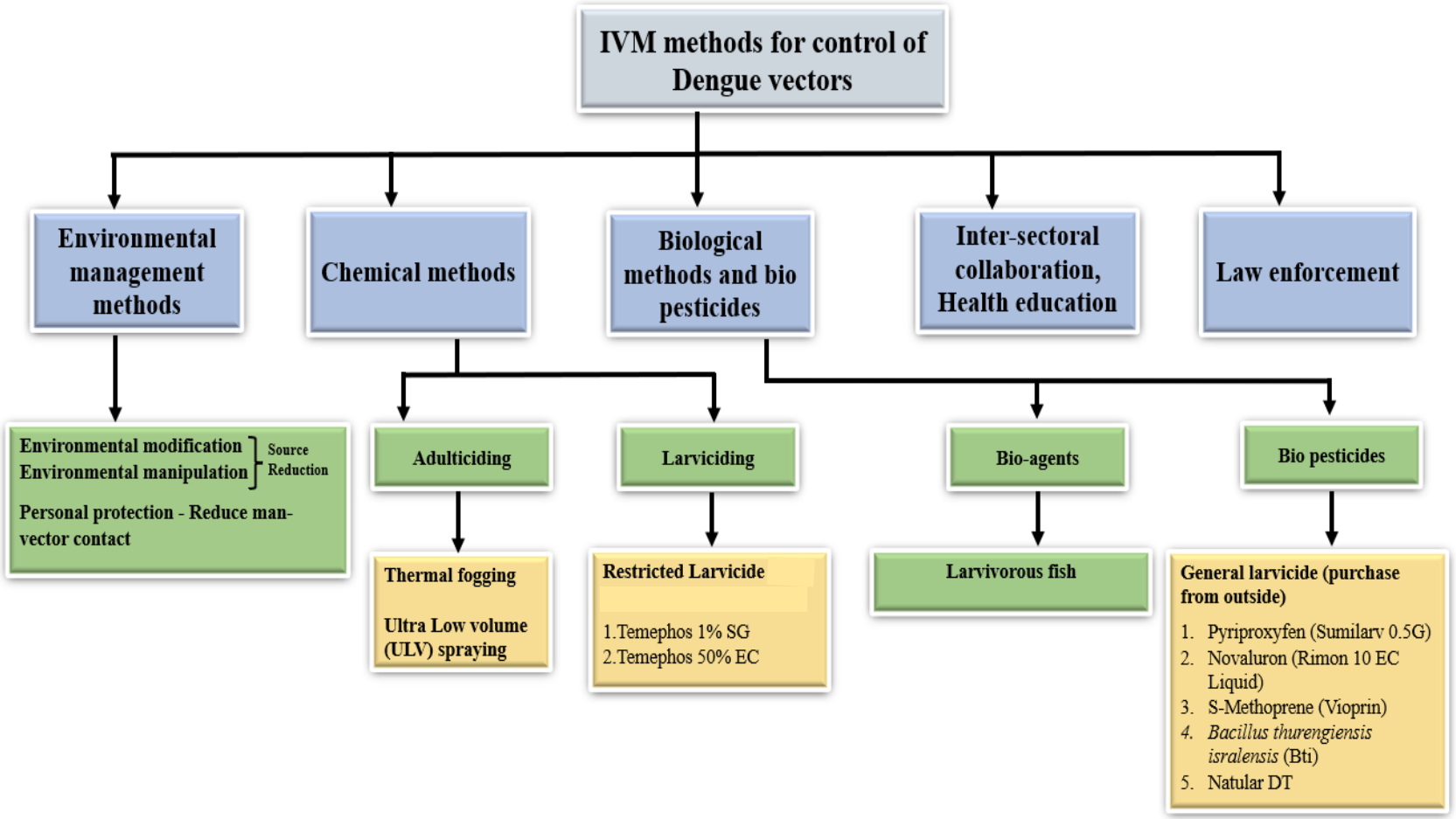


Figure 5.3: Integrated Vector Control methods for *Aedes* vectors

- Removal of unnecessary plants that hold water.

Fig.5.4 Removal of unserviceable roof gutters

b. Environmental manipulation: Environmental manipulation involves temporary changes in vector habitats to prevent or reduce mosquito breeding. The effects of environmental manipulation is short term, thus, such type of activities needs repeated application.

For example,

- Regular cleaning with scrubbing of water storage tanks, refrigerator trays, flower pots, flower vases, ant-traps, etc.
- Proper draining of cement lined drains, water collections on cement floors and concrete slabs.
- Periodic cleaning of roof gutters.
- Segregation of waste and proper disposal of solid waste and reducing, reusing and recycling of discarded receptacles.
- Proper storage of used tyres, household items and garden utensils, i.e., store under a shade.
- End capping or filling the cavities of iron/ galvanized poles using cement or soil.
- Cutting bamboo at the nodes or filling bamboo stumps and tree holes with sand or cement.

Different potential environmental measures can be applied for the control of *Ae. aegypti* and *Ae. albopictus* larvae in different types of oviposition sites and different localities.

C. **Changes to human habitation or behaviour (Personal Protection)** – actions to reduce human–vector contact, such as application of repellents, installing mosquito screening on windows, doors and other entry points, and using mosquito nets while sleeping during daytime.

Fig 5.5.a. Regular cleaning with scrubbing of flower pots, flower vases,

Source: https://blogs.extension.org/mastergardener/emg/plants-2/page/6/

Fig 5.5.b. Proper disposal of solid waste

Source: https://www.flickr.com/photos/janiquegoff/8309063703

For example,

- Personal Protection/ Physical barriers
- Screening doors and windows of houses/ premises using mosquito proof mesh
- Protective clothes to cover the body
- Mosquito proof curtains
- Use of repellents

Application of chemical repellents approved by the Registrar of Pesticides, such as repellents containing DEET (N, N-Diethyl-m-Toluamide), Ethyl butyl acetylamino propionate and Icaridin. There are some natural repellents, such as citronella oil, lemon grass oil, and neem oil, which are also used in Sri Lanka. However, repellents have short term effect (0.5 - 10 hours).

Different premises/ institutions can have different mechanisms for dengue vector prevention and control. Potential dengue vector control measures for different types of premises are shown in Table 5.2.

Table 5.2. Monitoring of vector control measures by different stakeholders

	Type of premise	Recommended activity	Responsibility
1	Residential houses	Regular examination and elimination of oviposition sites (eg. cleaning on every	Household owners/ residents

	Type of premise	Recommended activity	Responsibility
		Sunday) and ensure no vector oviposition sites	
2	Construction site	Regular (at least weekly) inspections to ensure mosquito free environment eg, Cleaning, application of larvicides Ensure no vector breeding grounds	Contractors (appointing inspection team), site Engineers, safety officers, etc.
3	Schools	Establishing committees for prevention and control of dengue Weekly cleaning (half an hour on every Friday or designated day) Ensure no vector breeding grounds	Education Ministry, Director National Schools, Director Health and Nutrition Provincial directors, Zonal directors, School principal/ Responsible teacher/ staff member, School Development Committees, Students
4	Condominium	Weekly cleaning (Half an hour cleaning on every Sunday) Ensure no vector breeding grounds	Condominium authorities, cleaning services/ Municipal councils/ Urban councils, all local governments
5	Institutions (Public and private) Eg. Bus depots Railway yards	Establish an active committee for prevention and control of dengue Weekly cleaning (half an hour on every Friday)	Head of the institutions, dengue committee members

	Type of premise	Recommended activity	Responsibility
	Courts (Products in court premises)	Ensure no vector breeding grounds	
6	Hospitals	Establish an active committee to look after the hospital environment Weekly cleaning (half an hour on every Friday) Ensure no vector breeding grounds	Director/ MS/ DMO/ MOIC/PH, PHI' and Dengue committees
7	Bare lands/ abandoned lands	To trace owner and issue notices and ensure no vector breeding grounds	Land owner, Local authority
8	Public places	Display notices and ensure no vector breeding grounds	Local authority, Relevant responsible authorities eg. Railway Department – GM, Station Masters
9	Religious places	Clean weekly (half an hour on every Sunday)	Chief priest, Dayaka sabha, Students Daham Pasal (Sunday schools)
10	Roads and highways	Develop proper drainage systems and avoid accumulation of garbage	Road Development Authority, Provincial Road Development Authority, All local governments
11	Harbors and coastal regions	Prevention of mosquito breeding in abandoned boats, anchorage barrels, jetty protecting tyres and coastal regions and establishing Dengue Control Committees	Ministry of Fisheries, Ceylon Fisheries Harbour Cooperation, Marine Environment Protection Agency, National Aquatic Resources, Research and Development Agency, Boat owners

	Type of premise	Recommended activity	Responsibility
12	Factories	Establishing committees for prevention and control of dengue Weekly cleaning (half an hour on every Friday or designated day) ensure no vector breeding grounds	Factory owners, Board of Investments of Sri Lanka
13	Military camps and establishments	Establishing committees for prevention and control of dengue Weekly cleaning (half an hour on every Friday or designated day) Ensure no vector breeding grounds	Ministry of Defence, Chief of Defence Staff, Commanding Officers
14	Plantation lands	Regular (at least weekly) inspections to ensure mosquito free environment If larvae present in leaf axils coordinate with the relevant MOH to apply suitable larvicide	Ministry of Plantations Industries, State owners/ companies, State superintendent

Monitoring of these activities according to the circular from the President Secretariat circular number: PS/EAD/Circular/10/2023 and dated 22.12.2022 (Annexure IX).

5.2.2. Law enforcement

Legal action could be taken against premises creating conditions favourable to the breeding of mosquitoes, which would be a threat to public health under different provisions of following acts, ordinances and statutes by the authorities as relevant.

- Quarantine and prevention of disease ordinance, No.3 of 1897
- Prevention of Mosquito Breeding Act, No. 11 of 2007
- The prevention of Public Health Nuisance statutes of the Western Province and North Western Provinces
- Section 262 and 261 of CHAPTER XIV of the penal code
- Nuisances Ordinance, No.15 of 1862

5.2. 3.Biological and bio-chemical methods for dengue vector control

Biological vector control agents prey upon, parasitize and/ or compete with the target vector species and bio-chemical methods interfere with the development process of the vector species, thus, eliminating/reducing vector populations. Use of biological and bio-chemical agents for vector control avoids chemical contamination of the environment and reduces/averts development of resistance of vectors against insecticides. Larvivorous fish (biological), *Bacillus thurengiensis isralensis* (Bti), Spinosad and insect growth regulators are used for dengue vector larval control in non-potable water-storage tanks and barrels, ornamental ponds and fountains.

a. Larvivorous fish

Poecilia reticulata (guppy), *Aplocheilus* spp (nalahandaya) *Rasbora daniconius* (dandi), juvenile stages of *Tilapia* spp (*Orechromis mossambicus* and *O. niloticus*) (Fig. 5.7) feed on mosquito larvae. These fish species can be used for dengue vector control in wells, water storage tanks, barrels, ornamental ponds, fountains, cement lined drains etc.

Poecilia reticulata

Rasbora daniconius

Tilapia species (juvenile stages)

Aplocheilus dayi (Nalahandaya)

Fig.5.6. Larvivorous fish species suitable for dengue vector control

Limitations of use of larvivorous fish

- The fish die in the absence of food in the breeding grounds and due to changes in the pH and salinity in the oviposition sites.
- The fish die when the domestic water storage containers are refilled with chlorinated water.
- Fish cannot tolerate high water temperatures.

Messages for the community in stocking larvivorous fish for dengue vector control

Remove fish when refilling the tanks and place the fish back after 6 hours of refilling. This allows for the dissipation of residual chlorine and ensures thermal stabilization, thereby preventing fish mortality due to chemical or temperature shock.

***Bacillus thurengiensis israelensis* (*Bti*)**

Bacillus thurengiensis israelensis (*Bti*) is a spore forming bacterium that produces highly specific insecticidal proteins, called ∂-endotoxins during sporulation (Fig. 5.8). When larvae ingest these spores, the toxins are activated by the **alkaline pH** and enzymes present in the midgut. This process destroys the midgut lining, effectively neutralizing the larvae. This mode of action is highly specific, making Bti an effective biological control agent for mosquito populations.

Bti has an extremely low-level of mammalian toxicity and does not affect non-target organisms.

In Sri Lanka, liquid and briquette (a slow-release formulation) formulations of Bti are used. Liquid formulation diluted product of Bt (Bactivec) is applied in the form of drops or using hand compression sprayers / and mist blowers.

Bti is recommended for *Ae. aegypti / Ae. albopictus breeding grounds* sites that cannot be eliminated by source reduction methods, e.g., water storage tanks, artificial and ornamental ponds, and fountains.

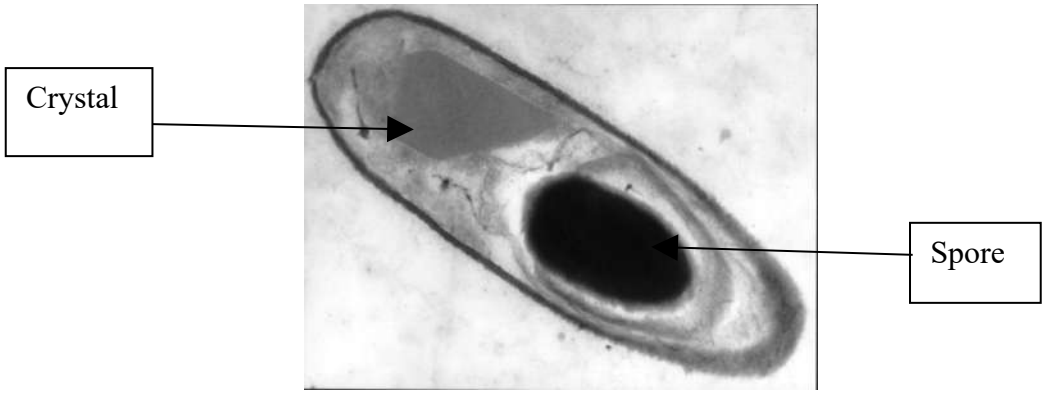


Fig. 5.7. *Bacillus thurengiensis* bacterium containing a spore and the crystal

Limitations of the use of *Bti* for dengue vector control

- *Bti* is not recommended for water containers where the water is likely to be used for human consumption (drinking) due to the possibility of the presence of other microbial contaminations in the product (ref. WHO Document WHO/HSE/WSH/09.01/8 Bti in drinking water).

  Bti formulations tend to rapidly settle at the bottom of water containers, thus, frequent applications or mixing are required.
- Liquid formulation of *Bt* H-14 is effective for 10-12 days and the briquette formulation is effective for 30 days or more in the treated water. Thus, fortnightly application of liquid *Bti* and monthly application of *Bti* briquette is required for effective dengue vector larval control

Dosages for application of *Bti* (liquid) and *Bti* (Briquette) formulations are shown in Table 5.3.

Table 5.3. Dosages for application of *Bti* (liquid) and *Bti* (Briquette) formulations

Product	Formulation	Application methods	Dosage	Dilution factor	Frequency of application
Bti(Bactivec)	Liquid	Drops	04 drops of Bactivec per 10 liters of water.	Not applicable	Fortnightly intervals
		Using hand compression sprayers,		540ml of Bactivec to 09 liters of water.	Fortnightly intervals
		Mist blowers	For urban area	3.5l of Bti to 6.5l of water	Fortnightly intervals

Product	Formulation	Application methods	Dosage	Dilution factor	*F*requency of application
		Mist blowers	For semi urban area	1.8 l of Bti to 8.2 l of water	Fortnightly intervals
Bti	Briquette	Briquette	01 dunk/100 sq ft of water.		Monthly intervals

These dosages give 100% mortality of 1st – 3rd instar larvae of both *Ae. aegypti* and *Ae. albopictus* larvae within 48 hours.

Figure 5.8: Field application of Bti using a mist blower

Insect growth regulators (IGRs) interfere with the development of the immature stages of the mosquito by:

- **Inhibition of Chitin Synthesis:** Disrupting the molting process in larvae, preventing the formation of a functional exoskeleton
- **Hormonal Disruption:** Interfering with the transformation from pupa to adult by acting as juvenile hormone analogues or anti-juvenile hormone agents, which prevents successful maturation.

IGR is recommended for dengue vector control in water storage tanks and containers. In waters that have been treated with recommended dosage (0.01 mg/litre) of IGR, the larvae do not become pupae, instead, the larval period is extended and causes death.

The disadvantage of application of IGR for dengue vector control is that larvae and pupae remain visible in the IGR treated water. This may impact on legislative actions. IGR is not recommended for application in drinking water sources.

5.2.4. Chemical methods for dengue vector control

Chemical methods of vector control include use of insecticides for larval and adult mosquito control. Classification and major groups of chemical insecticides that are used for adult and larval control are shown in Fig. 5.9.

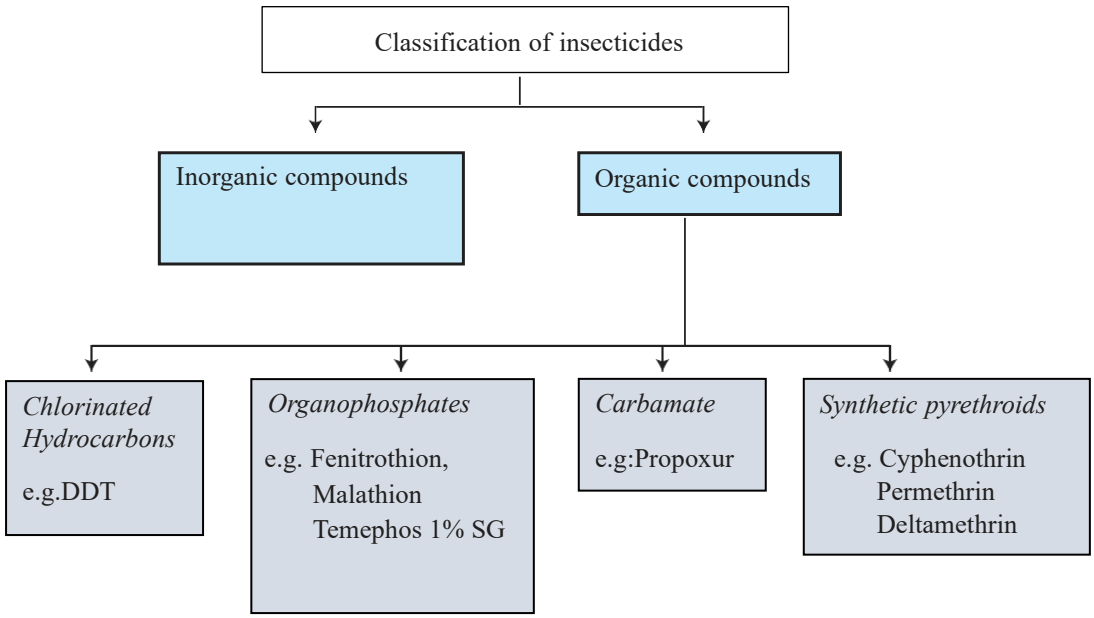


Fig. 5.9. Classification of major groups of insecticides that are used for adult mosquito and larval control

The NDCU currently uses Temephos 1% SG for dengue vector larval control. Technical Malathion, Cyphenothrin (Gokilaht) and Cyphenothrin+ tetramethrin (Pesguard) are used for space spraying.

5.2.4.1. Chemical larviciding

Use of Temephos 1% Sand Granules (SG)

Temephos 1% SG is a slow releasing formulation of larvicide that is recommended for *Ae. aegypti* and *Ae. albopictus* control in domestic water storage containers such as water storage tanks, barrels and other containers that cannot be destroyed, eliminated or otherwise managed. This insecticide is registered for restricted use in Sri Lanka and is not approved for treatment of drinking water.

Dosage, application methods and frequency of application of Temephos 1% SG are shown in Table 5.4.

Table 5.4. Dosage, application methods and frequency of application of Temephos 1%SG

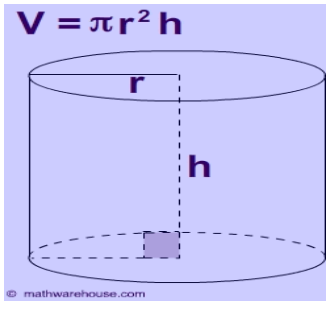
Product	Formulation	Application methods	Dosage (active ingredient) Container breeding (mg/l)	Frequency of application
Temephos	1% SG (GR)	In cotton cloth pouches (put the required amount of granules in the pouch and keep it suspended in the water)	1ppm dosage (1g of the product in 09liters of water)	03 month intervals

Indications for use of Temephos 1% SG

- **Epidemic Response:** For application in areas experiencing active dengue outbreaks or epidemics.
- **Proactive Prevention:** For use prior to peak transmission periods to avert potential epidemics. Application is prioritized when epidemiological indicators including disease incidence, entomological indices, and environmental factors signal a heightened risk of an outbreak.

Application of Temephos 1% SG should be applied precisely in accordance with the total volume of water contained within the storage tanks to ensure optimal efficacy and safety. Method of calculation of the volume of the container are shown in Table 5.5

Table 5.5. Method of calculation of the volume of the container

Shape of the container	Method of calculation of the volume	
Square (pictures)	Length x width x height of the tank	
Cylindrical	22/7x radius ^{2} x height of the container	

Quantities of Temephos 1% SG for containers of different sizes are given in Table 5.4.

Table 5.6. Quantities of temephos 1% SG required to treat water containers of different sizes to kill mosquito larvae

Capacity of the container in liters	Grams of Temephos 1% SG required	Number of teaspoons required (one teaspoon contains approximately 5 grams)
< 25	Less than 5	Pinch (small amount held between thumb and finger)
45	5	1
90	10	2
180	20	4
225	25	5
450	50	10
900	100	20

5.2.4.2. Adult Vector Control

5.2.4.2.1. Role of space spraying to control adult mosquitoes for dengue control in Sri Lanka

This method is used in emergency vector control to kill the adult vector population and thereby interrupt ongoing dengue outbreaks/epidemics or to prevent an impending dengue outbreak from occurring. In addition, this measure can be utilized proactively before an increase in disease incidence is recorded, particularly when current vector densities are observed to be higher than previous baseline levels. Space spraying can be done using 2 methods, namely: thermal fogging and ultra-low volume (ULV) spraying.

Thermal fogging

Generally, thermal fogging machine employs the resonant pulse principle to generate hot gas (over 200 °C) at high velocity to produce microdroplets.

Each of the micro droplets of the fog contains the appropriate dose of the active ingredient and has the ability to float long distances. These droplets can penetrate and access sites with dense vegetation and reach corners in open buildings and houses.

Upon contact with the target mosquito species at a lethal dosage, the insecticide droplets induce rapid 'knockdown' followed by mortality. As a space-spraying intervention, this application provides an immediate reduction in the adult mosquito population; however, it lacks residual efficacy, as the droplets remain suspended and active in the environment for only a limited duration.

Thermal fogging is carried out by hand-carried (portable) machine and it can be done as water or oil-based method.

Ultra-low volume (ULV) applications

Ultra-low volume (ULV) applications are executed using specialized ULV generators designed to mechanically atomize insecticide liquid concentrates. This technique involves the dispersal of a minimal volume of highly concentrated insecticide over an extensive area, ensuring maximum coverage with a low environmental volume load.

Effectiveness of space spraying heavily depends on the environmental conditions under which spraying is carried out.

Similarities and differences between thermal fogging and ULV are shown in Table 5.7

Table 5.7. Similarities and differences between ULV and Thermal fogging

ULV	**Thermal fogging**
Similarities	
Both create a fog where the user can determine the droplet size and amount of product being dispensed.	
Differences	
ULV machines use high pressure of air to convert the solution into tiny particles.	Thermal foggers use heat to produce fog
ULV machines apply more on surfaces and may not penetrate obstructed areas and dense foliage completely	Thermal Fogging reaches deep into obstructed areas
ULV sprayer generates fog droplets of a more precise size	Thermal fogger produces a range of droplet sizes including a large number of small droplets.
The absence of a large number of very small droplets will limit penetration of the fog into highly obstructed areas.	Presence of very small droplets enables the fog to reach spaces in areas highly

ULV	Thermal fogging
	obstructed by vegetation, or other physical obstructions in buildings.
Fog is comparatively less visible	Presence of a large number of small droplets in the fog makes the fog highly visible.
ULV sprayers can dispense formulations in a more concentrated form	Generally, less insecticide quantity required
Able to calibrate the machine to produce droplets of the optimum size for the type of chemical being used	Visibility of fog helps the operator to monitor the fog and ensure thoroughness of application.
ULV machines create comparatively less noise	Thermal foggers make more noise

5.2.4.2.1.a Insecticides that are used for space spraying

Organophosphate and synthetic pyrethroid insecticides are used for adult vector control. WHO recommended insecticides for space spraying against mosquitoes are shown in Annexure X.

5.2.4.2.1.b Technical details of space spraying

Following aspects are to be considered when application of space spraying as an adult *Aedes* mosquito control measure, especially since all insecticides used in space spraying are classified under chemicals for restricted use.

Ae. aegypti and *Ae. albopictus* rest and bite indoors as well as outdoors. Thus, indoor and peri domestic fogging is recommended in outbreaks/epidemics situations and in areas with current dengue transmission that could lead to outbreaks.

Important points to consider in fogging operations (Indoor and peri domestic)

- Fogging is most effective if conducted as indoor and peri-domestic (surrounding the premises) rather than outdoor fogging along the street. Therefore, considering all aspects indoor and peri-domestic fogging is recommended as a vector control strategy.
- The street maps of the area marked with the reported cases must be studied carefully before the fogging operation begins.

- Space spraying should be carried out in identified high-risk locations within a 100 m radius (figure 5.12) from the dengue case or cluster. The second round of spraying, repeated at intervals of 3-5 days is advised.
- It is crucial to maintain continuous monitoring of entomological and epidemiological data in the aforementioned targeted areas. If the data indicates a necessity, additional space spraying cycles can be implemented for an extra two weeks. However, in such instances it is important to scrutinize whether the fogging process is followed according to the technical guidance.
- However, space spraying is not a standalone strategy; it should be linked with effective and targeted source reduction campaign.

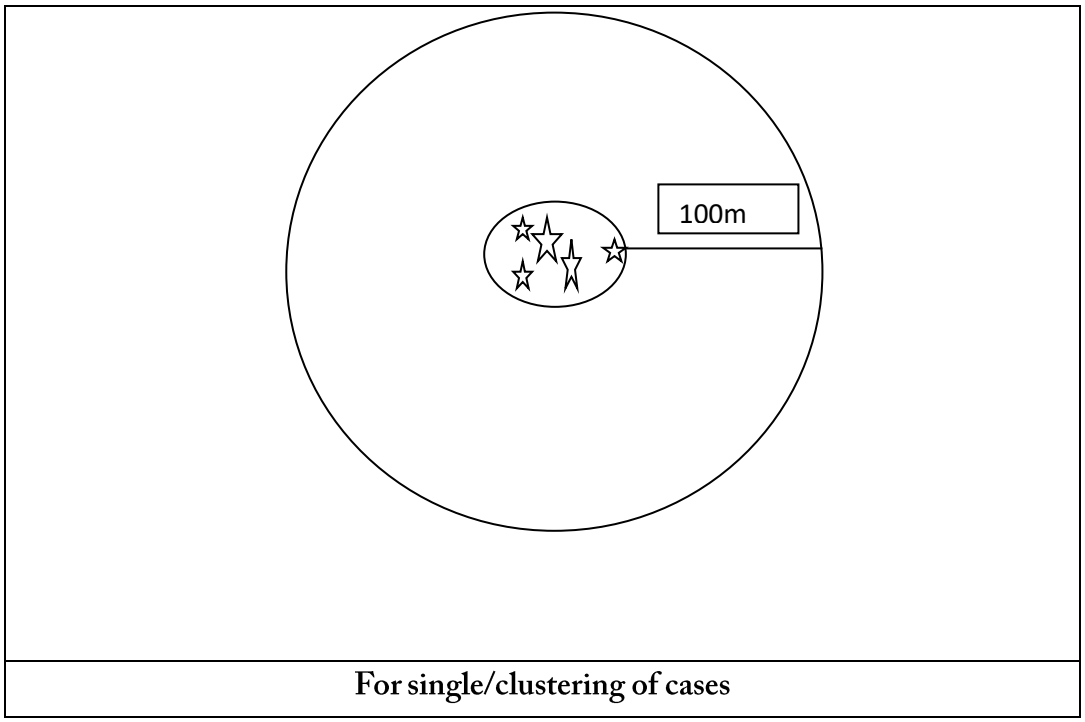


Fig 5.10. Area to be covered by space spraying for a single/cluster of cases

I. Activities to be followed prior to, during and after space spraying

- Demarcate the target area to be covered by space spraying by studying a sketch map of the area.

I.a.Steps to be followed prior to indoor space spraying

- Prior announcement (eg. public addressing system) to the community about the date and time of indoor fogging activity and important preparatory actions to be taken such as
    - Shut off electricity

- Turn off all heating and cooking equipment and allow some time to cool down before spraying.
- Cover all water containers and food items.
- Cover fish tanks
- Ensure all occupants and animals remain outside the house during spraying and stay outside for 30 minutes after spraying.
- All doors and windows in their houses should be closed at the time of indoor fogging and for half an hour after

- Ensure that the building is ventilated before reoccupation

I.b. Steps to be followed when conducting indoor space spraying

- Spray operator should move from house to house
- Spray operators should work backwards and away from the fog to minimize exposure.

  eg. In single room houses and small single-story houses, the spray can be delivered from the front door or through an open window without entering every room of the house, provided that adequate dispersal of the insecticide droplets can be achieved.

  In large single-story buildings, it may be necessary to apply the spray, room by room, beginning at the back of the building and working towards the front or vice versa (Fig 5.11 and Fig 5.12)

  In multi-story buildings, spraying is started from top floor to the ground floor and from the back of the building to the front. This ensures that the operator has good visibility at all times.
- A fog must be "dry" before being directed into a building (for thermal oil-based fogging). Test the fog by placing the machine on the ground and checking that the area immediately in front of the nozzle is not wet due to the fog. Water-based thermal fogging is preferred in indoor fogging as it minimize fire hazards and reduces contamination of household item by kerosene/diesel.

I.c. Steps to be followed prior to peri-domestic space spraying

- Peri-domestic space spraying is conducted along with indoor fogging as outdoor biting/resting is maximum surrounding the premises. In addition, if indoor fogging cannot be conducted in a premise due to practical issues the doors and windows of these houses could be kept open while conducting the peri-domestic fogging to ensure

the fogging will give an indoor effect as well. In these instances, the household should follow the same steps as indoor fogging (section III.a).

- Study wind direction and decide the path of spray man to ensure full coverage of the target area. The spray operator should move from downwind to upwind, i.e. against the wind direction.

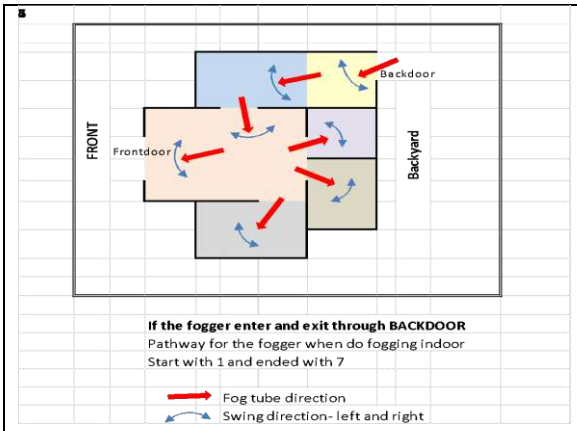


Fig 5.11 pathway for the fogger when doing fogging indoor – back door entry and exit

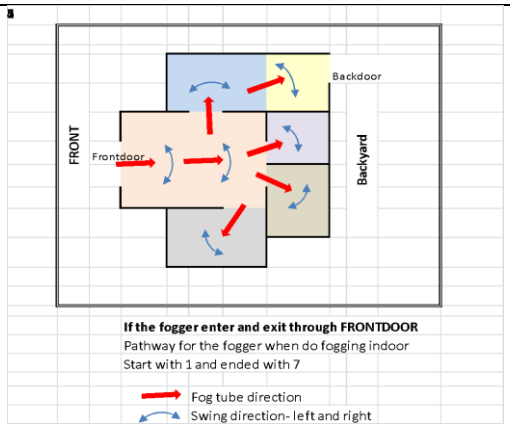


Fig 5 .12 pathway for the fogger when doing fogging indoor– front door entry and exit

I.d. Steps to be followed during peri-domestic space spraying

Steps to be followed when fogging is done using hand operated (Portable) thermal fogging machines

- Spray operator should move from house to house
- Fogging should essentially cover all possible mosquito resting sites including hedges, covered drains, bushes, and tree-shaded areas based on the evidence and depending on the local situations.
- Oil-based thermal fogging has a higher dispersion of the fog compare to the water based and therefore, may be more suitable in situation which warrants a wider dispersion area

II. Optimum conditions for space spraying for dengue vector control

Space spraying should be carried out during of peak biting period of *Ae. aegypti* and *Ae. albopictus* and when the right weather conditions are present for its optimum effectiveness. Time of the day, ambient temperature, wind speed and precipitation are important environmental conditions that affect the effectiveness of space spraying.

III.a. Timing

Ae. aegypti and *Ae. albopictus* are mostly active in the morning for a few hours after sun rise (0600 – 1000 hours) and for a few hours before sunset (from 1500 – 1800 hours). Thus, space spraying is carried out within these peak periods of activity.

III.b. Temperature

The most appropriate periods for fogging are the mornings and the afternoons when the ambient temperature is cooler and favours optimal dispersion of droplets targeting the vector. In the middle of the day, when temperature is high, convection currents from the ground will prevent concentration of the fog close to the ground where adult mosquitoes are flying or resting, thus rendering the space spraying ineffective

III.c. Wind speed and wind direction

Wind direction is the most important environment factor to reach fogging effectively to target area. Air movements of less than 3 km/hr may result in vertical mixing, while winds greater than 13km/hr disperse the spray too quickly. Thus, optimum wind speed for fogging is between 3 – 13 km/hour.

The spray man should be moving opposite the wind direction with the nozzle held backwards so that the spray would move with the wind in the same direction However, the spray man (with the hand carried machine) may move perpendicular to the wind direction.

III.d. Precipitation

In rain, the spray loses its consistency and does not disperse in the air to the target area. Therefore, fogging should not be done during rains.

Fogging is carried out only when the right weather conditions are present and usually only at the prescribed time. These conditions are summarized in table 5.11.

Table 5.6. Favourable and unfavorable weather conditions for space spraying

	Most favorable conditions	**Unfavorable conditions**
Time	Early morning (0630 -0900) or evening (1600-1800)	Mid-morning to mid afternoon
Wind	Steady, between 3-13 km/h	Medium to strong over 13km/h
Rain	No rain	Heavy rain
Temperature	Cool or mild	Hot

III.e. Droplet size

Space spraying is only effective while the droplets remain airborne. Droplets larger than 30µm in diameter are less effective as they do not remain airborne for a sufficient time. Droplets smaller than 5µm in diameter do not readily come in contact with flying insects, as the movement of the smallest droplets is affected by the air turbulence created by the insect's flight. The droplet size of a thermal fog is usually less than 15 microns in diameter and the optimum droplet size for ULV spray usually falls within the range of 10 – 25 microns in diameter

IV. Types of insecticides use for space spraying in Sri Lanka

Following are the insecticides available for space spraying in Sri Lanka

1. Cyphenothrin (Gokilaht) or Cyphenothrin + Tetramethrin (Pesguard)
2. Technical Malathion – only for outdoor use

Dilution factors of different insecticides that are used for dengue vector control in Sri Lanka by thermal fogging and ULV are shown in Annexure XI & XII. Furthermore, insecticide and diluents should be measured correctly and mixed inside a bucket. The machine should be filled with a properly mixed insecticide mixture by using a funnel.

5.2.4.2.1.c. Supply of insecticides and logistics for space spraying

Insecticides are issued by the NDCU to RDHS offices based on the local requirements. Insecticides should be requested from the NDCU monthly according to the Annexure XIII format. Kerosene oil/ Diesel and other logistics are to be obtained from the RDHS office or respective local government authorities on the request by the RDHS/MOH of the area.

When using insecticides for vector control, the safety of the spray personnel, public and their domestic pets and animals and the environment should be considered. The precautions that are to be taken to ensure safety are discussed in Chapter 6.

5.2.4.2.2 Use of targeted indoor residual spraying (TIRS) for dengue vector control

Targeted indoor residual spraying (TIRS) with an effective insecticide has emerged as a highly effective, evidence-based intervention for controlling *Ae. aegypti*, the primary vector of dengue. Unlike traditional IRS, which covers all indoor surfaces, TIRS focuses exclusively on low-level wall surfaces and dark, sheltered areas where *Aedes* mosquitoes prefer to rest, such as under furniture and inside closets.

By applying long-lasting residual insecticides to these specific "resting hotspots," TIRS achieves significant reductions in adult mosquito density and longevity while utilizing less

insecticide than conventional the method. This focused approach is not only more cost-effective, less time consuming and environmentally friendly but also increases community acceptance due to the reduced spray footprint within the houses. Recent field trials indicate that TIRS can significantly lower dengue transmission rates, making it a vital component of Integrated Vector Management (IVM) programmes, particularly in high-risk urban environments where indoor and outdoor space spraying/fogging makes no residual impact of insecticides.

Targeted Indoor Residual Spraying into the vector control program, several critical factors must be evaluated before its commencement. To ensure the operational effectiveness of TIRS for control of *Aedes* vectors, the following prerequisites are essential:

1. Entomological confirmation

Before deployment, local vector dynamics must be scientifically validated, and includes:

- Vector behaviour: Indoor resting (endophilic) behaviour of *Aedes* spp. must be confirmed through systematic indoor collections. TIRS is only effective when the target mosquitoes rest on treated surfaces before or after blood feeding.
- Insecticide susceptibility: Confirm through WHO susceptibility tests (tube test or bottle bioassays) that the target vector species is fully susceptible to the insecticide selected for TIRS. Resistance monitoring should be regularly performed, usually once a year, to prevent vector control programme failure.
- Residual efficacy of insecticide: The chosen insecticide formulation must demonstrate a residual effect of at least 4–6 months on local wall substrates, such as mud, bricks, cement plaster, wood.

2. Stratification and mapping

Resources should be directed where they will have the highest impact:

- Hotspot identification: Use historical dengue incidence data alongside entomological indices, specifically larval, ovitrap, and egg density indices to prioritize and map specific MOH areas by stratification for implementing the intended intervention.

3. Strategic timing

Correct timing is the linchpin of a successful TIRS campaign. Implementation must be finalized 4–8 weeks prior to the predicted monsoon peak vector density or the onset of the dengue transmission season. This proactive approach establishes a "protective shield" within the community before dengue viral circulation intensifies.

While TIRS appears to have potential for vector control, it is important to understand how the entomological efficacy of this approach translates into epidemiological impact on dengue.

However, the National Dengue Control Unit (NDCU) haven't integrated this into the integrated vector management activities for *Aedes* vector control in the country. Currently, assessments are being carried out in this regard.

5.3 Insecticide resistance management

When it comes to chemical vector control, adult female *Aedes* mosquitos must be susceptible to the insecticide used by the vector control sectors. As Pyrethroids and Organophosphates are the most often used insecticides for this purpose, the resistance in *Ae. aegypti* and *Ae. albopictus* towards these chemical class groups must be monitored timely.

When administered before resistance develops, insecticide resistance management (IRM) is most successful. Hence continuous monitoring for insecticide resistance is vital in *Aedes* vector control.

Options to prevent or limit the development of insecticide resistance are listed below (WHO 2012a):

3. **Insecticide rotation:** To preclude the emergence of resistance, insecticides of unrelated classes with different modes of action should be sprayed in rotation, ideally in a six-monthly cycle. This is good practice and should be implemented wherever possible, even before resistance has been reported. •
4. **Combining interventions**: As adult and larval control must be done simultaneously to have an impact on vector populations, insecticides with different modes of action should be used for each stage (e.g. using an organophosphate as an adulticide, combined with a Bti or Bti+Bs, or IGR as larvicide). •
5. **Mosaics:** One compound is used in one geographic area, and a compound of different insecticide class and mode of action (i.e. organophosphate and pyrethroid) used in neighbouring areas. This strategy, while theoretically robust, is logistically difficult to implement – especially in an epidemic setting where rapid response is key to contain a disease outbreak.

5.4 Safe use of adulticides to minimize health and environmental hazards

Safety measures in insecticide use are necessary to protect the health and lives of spray men, spray team supervisors, the public and their pets and domestic animals, and to minimize hazards to the environment. To minimize routine and accidental exposure to insecticides, safety precautions must be taken at all stages of insecticide use such as while storage, transport, and preparation of insecticide solutions, and during and after spraying of insecticides.

5.4.1. Safety precautions to be taken when storing insecticides

Store the insecticide in the container with the original label. The labels should identify the contents, nature of the material and precaution methods.

- Do not transfer insecticides to other containers, or to containers used for food or beverages.
- Keep all insecticide containers sealed or properly closed.
- Store/ keep insecticides in a properly designated place, away from direct sunlight, food, medicine, clothing, children and animals, and protected from rain and flooding.
- Store the insecticide in a locked room with posted warning signs such as "Dangerous insecticides, children and unauthorized persons are not allowed".
- Use the earliest expiring insecticides first to ensure optimum use

5.4.2. Safety precautions to be taken before use of insecticides

Read the label carefully and understand the directions for the preparation and application of the insecticide as well as the precautions listed. Follow the directions and precautions exactly as recommended. Know the first aid measures and antidotes for the insecticides being used.

5.4.3. Safety precautions to be taken during mixing and fogging

- Wear personal protective equipment (masks, cap/ helmet, overalls, gloves, boots, goggles), etc during mixing of insecticides and fogging.
- Wash clothes daily after working.
- Mix insecticides in a well-ventilated area, preferably outdoors.
- Stand with the wind blowing from behind when mixing insecticides.
- Make sure that the spray equipment does not leak.
- Keep all unnecessary people away from where insecticides are being mixed.
- Keep a fire extinguisher with the spray team.
- Do not blow with the mouth to clear blocked spray nozzles.
- Do not wear unwashed protective clothing.
- Do not drink, eat or smoke while fogging.
- Do not smell or inhale insecticides.

Figure 5.13 Machine operator with personal protective equipment

5.4.4. Safety precautions to be taken after fogging

- Wash all spray equipments thoroughly and keep in the storeroom.
- All workers must wash themselves thoroughly with soap and water to remove insecticide deposits on the skin.
- All protective clothing should be washed daily after use.
- Properly discard the empty insecticide containers. Do not store food or drinking water in these containers.
- Make records on the daily use of insecticides.
- Before consuming food, wash hands thoroughly with soap and water.
- Do not consume food while fogging.
- Do not fog too close to an object (<2m).
- Do not use the fogging machine if it is not working properly especially when leaking.

CHAPTER 6

OUTBREAK MANAGEMENT

A disease outbreak is the occurrence of cases of disease in excess of what would normally be expected in a defined community, geographical area or season.

Outbreak could occur at many different levels of intensity, duration, velocity driven by a range of factors. As such following factors could be considered to identify an outbreak.

- Current caseload of the locality
- Past epidemiological data
- Entomological data – mainly current entomological indices
- Climatic data – Rainfall, temperature and humidity
- Dengue viral factors

This section briefly outlines the measures that should be taken during the period of outbreak preparedness, during the outbreak and the post outbreak period based on risk level.

Objectives of controlling an outbreak are to reduce the patient numbers, case fatality rate and mosquito density.

As a Public Health technical staff, one should detect the early stage of outbreak by:

- Regularly monitoring of entomological data
- Regular monitoring of disease data
- Prompt reporting and communication with relevant stakeholders

6.1 Outbreak preparedness

Outbreak preparedness and control measures should be conducted according to the risk level. The risk categorization for a particular location or division is dynamic and will vary both temporally and spatially.

As a part of outbreak preparedness, following steps are to be taken:

6.1.1Establishing dengue action committees at different levels

Both national and sub-national level (Provincial, District and divisional) should have an outbreak response committee with multi-sectoral representation for emergency response. The committee must have sub committees at the sub national level that can take quick decisions, mobilize resources and respond quickly during the outbreaks.

The committee will have following responsibilities:

- Capacity building of curative and preventive health staff, and other relevant personnel
- Improve facilities and establish “fever corners” for screening suspected fever patients in

hospitals

- Ensure the supply of necessary logistics without interruption to all treatment facilities and makeavailable patient transport facilities at all treatment centres
- Prompt notification of suspected cases from the health care facilities to identify vulnerable areas
- Capacity building of all relevant staff on proper communication and health education
- Ensure availability of necessary facilities for communication and health education in all hospitals
- Ensure communication within Division (MOH), District, Provincial and National level units as well as with other stakeholders including media
- Conducting regular entomological surveys and analysis of entomological and disease data
- Establishing operation centres (or a communication channel) at different level depending on theextent of the outbreak

All Divisions/Districts/Provinces must have a contingency plan to increase the man power needed andequipment for immediate action when an outbreak detects.

Following measures should be initiated as early as possible once you detect an outbreak:

6.1.2 Adult and larval vector control

1. Plot reported cases on the area map to identify clusters.
2. Assessment of logistics and infrastructures
3. Commence larval control and adult space spray operations (thermal Fogging or ULV aerosols) in the outbreak locality. (Refer Chapter 5.2.4).
4. All houses within100 m radius of the 'dengue cluster' houses and 'dengue case contact points' must be inspected for mosquito breeding.
5. Special attention should be given to hospitals to prevent dengue transmission.
6. Intensify long term larval control measures in permanent water storage containers that are difficult to clean and empty. These measures should include using larvicides and deposition of fish.
7. Monitor larval and adult mosquito densities using relevant techniques.

6.1.3 Source reduction

1. Activate the Divisional and District Committees. Health authorities should communicate regularly with other stakeholders including Local Government, Government Agent, Assistant Government Agent, Zonal education offices, schools,

police, Grama Niladari, Government institutes, Religious leaders and Community Leaders

2. Intensify source reduction campaigns in high-risk localities involving the local community and other stakeholders
3. Encourage Local authorities to intensify solid waste collection and environmental clean-up.

6.1.4 Health Education

1. Encourage patients to seek medical attention if they have fever for more than 48 hours (pregnant mothers should seek medical advice immediately). However, patients who exhibit any warning signs (continued vomiting and diarrhoea, lethargy/restlessness, bleeding from any site, severe headache, severe abdominal pain) must seek medical advice immediately. Those diagnosed with dengue (including inward patients) are encouraged to use mosquito nets when sleeping and applying insect repellent to break the dengue transmission chain. Paracetamol is the only drug that should be used to control fever.
2. Enhance Public awareness through mass media, newspapers and local communication systems. Reinforce the importance of seeking medical attention if they have symptoms of dengue
3. Deploy a mobile health education team during fogging operations to obtain more cooperation from public.
4. Advise on source reduction
5. Advise the community to assist public health staff

Legal Actions – Can be taken as mentioned previously

6.1.5 Monitoring

During the outbreak, the relevant health authorities should;

- Monitor the situation daily and act accordingly. Aspects to monitoring include disease, vector trends, logistics and resources
- When needed solicit support of higher levels within health sector and other stakeholders.

6.1.6 Post outbreak activities

- A detailed report should be developed once the outbreak is curtailed, highlighting the lessons learnt for long term prevention of further outbreak.
- Larval and adult surveys should be continued according to the risk levels.

CHAPTER 7

NOVEL METHODS FOR DENGUE VECTOR CONTROL IN SRI LANKA

Novel vector control methods to disrupt different stages of the mosquito life cycle.

7.1. Egg and adult stages

Lethal and autocidal traps

The ovitrap (oviposition trap) was first recommended by WHO for surveillance of *Aedes* vectors, then modified to render it lethal to adults or larvae of *Aedes*-mosquitoes(Fig 7.1). Lethal ovitraps utilize insecticide-treated "ovistrips" or sticky surfaces to kill gravid females, often incorporating fine nylon netting to ensure any hatched larvae cannot escape. This technology has proven highly effective in real-world applications; Singapore successfully deployed these traps to eradicate vectors at its international airport, while field trials in Brazil using deltamethrin-treated strips achieved an 89% adult kill rate and 99% larval mortality within a month.

Fig.7.1. **Lethal and autocidal traps**

The Autocidal Gravid Ovitrap (AGO) offers an advanced, insecticide-free alternative for sustainable control. By using organic infusions to attract gravid mosquitoes into a capture chamber, the AGO physically traps them with adhesives or mesh, preventing egg-laying and further biting. These traps are particularly valuable in high-density urban areas with high dengue incidence, as they provide a low-maintenance, environmentally friendly solution. By specifically targeting the segment of the population responsible for virus transmission, these traps serve as both a potent control mechanism and a precise monitoring tool for managing mosquito density over time.

7.2.Adult stage

As the limitations of traditional chemical spraying become more apparent due to rising insecticide resistance, the focus of dengue prevention has shifted toward novel adult stage control methods. Unlike conventional methods that rely on broad spectrum toxins, these modern strategies utilize novel technology to disrupt the mosquito's life cycle or its ability to carry disease

A primary technique is the Sterile Insect Technique (SIT), which involves the mass release of sterile males that mate with wild females. Since these matings produce non viable offspring, the local mosquito population is systematically suppressed over time. Following this, biological interference specifically the introduction of *Wolbachia* bacteria into wild populations offers a long-term solution. This bacterium functions as a "virus blocker," significantly inhibiting the mosquito's capacity to transmit dengue while simultaneously causing reproductive interference.

Furthermore, targeted environmental tools now exploit the "indoor-resting" behavior of *Aedes* mosquitoes. Innovations like passive emanators release spatial repellents, such as transfluthrin, without requiring electricity or heat, providing durable and localized protection. Collectively, these approaches represent a fundamental shift toward Integrated Vector Management (IVM), prioritizing ecological sustainability over temporary chemical fixes. Sri Lanka is currently piloting these advanced techniques, with plans to integrate them into the national vector control strategy based on the outcomes of these local trials.

7.2.1 **Sterile Insect Technique (SIT)**

The Sterile Insect Technique (SIT) is an environmentally friendly and species-specific method of vector control that involves the mass rearing, sterilization, and release of male mosquitoes into the target population. The sterilization process is typically achieved through using gamma or X-ray irradiation of males after sex separation, which makes the male mosquitoes reproductively sterile without significantly affecting their ability to mate (i.e. they remain sex competitive). When sterile males are mass released in the target areas, they compete with fertile males to mate with wild mosquito females, resulting in no viable offspring and leading to a progressive reduction in the next generation of mosquito population.

SIT is a form of biological control that is most effective when integrated with other vector management strategies. It has been successfully implemented in the control and eradication of several insect pests, including *Cochliomyia hominivorax* (screwworm fly), *Glossina* spp. (tsetse fly), and *Ceratitis capitata* (Mediterranean fruit fly).

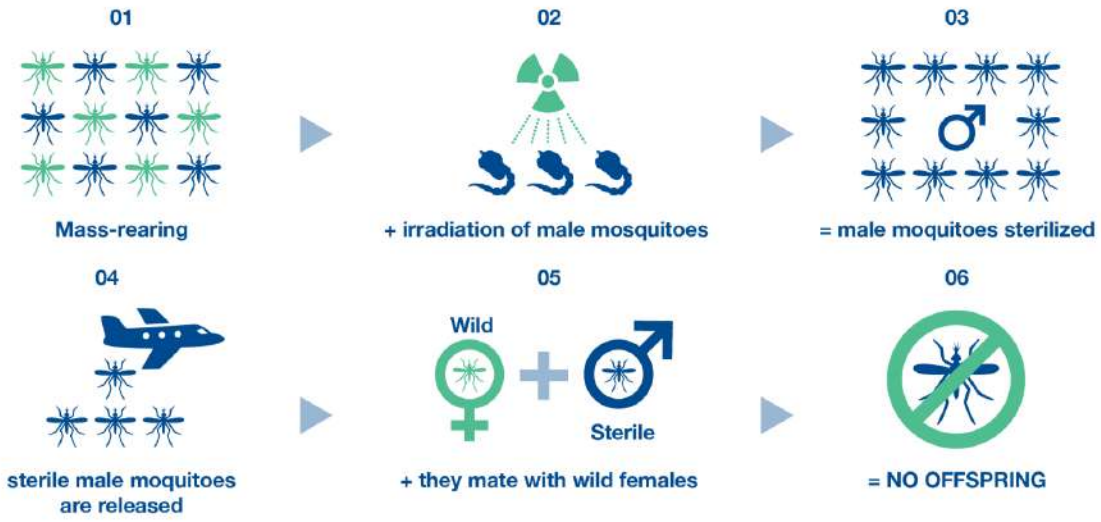


Fig.7.2. Steps of Sterile Insect Technique (SIT) method

(Source:https://tdr.who.int/newsroom/news/item/16-05-2023-scientists-in-tahiti-prepare-to-release-sterilized-mosquitoes-to-control-dengue)

More recently, effectiveness of SIT has been investigated for control of disease vectors, including *Aedes aegypti* and *Ae. albopictus*, which are responsible for transmitting arboviruses such as dengue, chikungunya, Zika, and yellow fever.

In Sri Lanka, a small-scale field trial conducted using *Ae. albopictus* in the Gampaha district demonstrated promising results, with an approximate 98% reduction in the fecundity rate (i.e. *Ae. albopictus* mosquito egg hatching rate) sustained over six months. Based on these outcomes, preparations are underway to launch a pre-operational trial across a larger geographic area to control *Ae. albopictus*, scheduled to commence in late 2025.

7.2.2 *Wolbachia*-carrying mosquitoes for dengue vector control

Wolbachia are bacteria (Fig 7.3) that live within reproductive tissues of the insect hosts, manipulate the reproduction in the hosts and are passed from one generation to the next through the insect's eggs. This bacterium is symbiotic rather than parasitic and present in up to 60% of all the different species of insects including some human biting mosquitoes, but, not the major mosquito species *(Aedes aegypti)* involved in the transmission of diseases such as dengue. Scientists are now studying *Wolbachia* to see its potential as a new tool for the control of dengue vectors.

Wolbachia bacterium

Insect egg containing *Wolbachia*

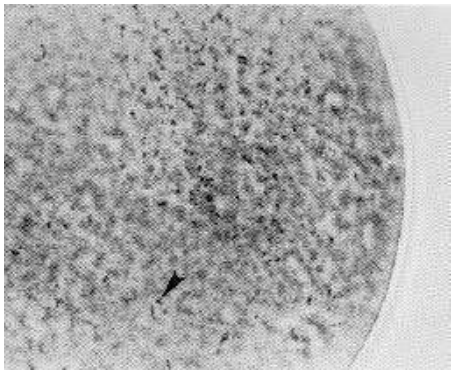


Fig. 7.3. *Wolbachia* bacterium and an insect egg containing *Wolbachia*

The bacterial obligatory endosymbionts are passed vertically into the cytoplasm of the eggs of their hosts. It causes male killing and sterility in males and also induces parthenogenesis (unfertilized eggs produce off springs). There is cytoplasmic incompatibility (conflict between cytoplasmic and nuclear components) that impacts on the off springs as follows (Fig 7.4).

a) When male mosquitoes with *Wolbachia* mate with female wild mosquitoes that don't have *Wolbachia*, those females will lay eggs but they won't hatch. –**Population suppression**

b) When male mosquitoes with *Wolbachia* mate with females that are already having *Wolbachia* all offspring will have *Wolbachia*. – **Population replacement**

c) When female mosquitoes with *Wolbachia* mate with males without *Wolbachia* all her offspring will have *Wolbachia* (Fig . 7.5).- **Population replacement**

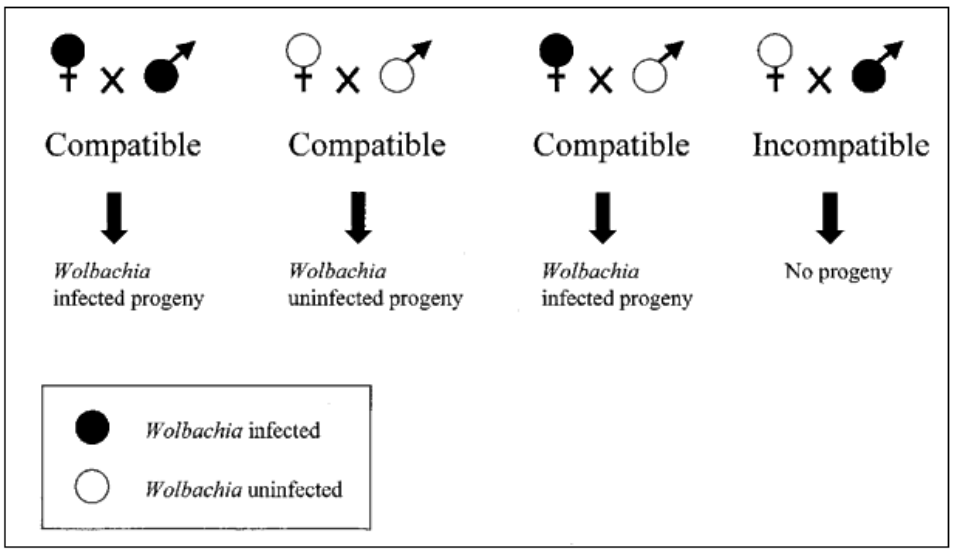


Fig 7.4. Cytoplasmic Incompatibility and vertical transmission

The "virus blocking" effect in *Wolbachia*-carrying *Aedes aegypti* is achieved through a combination of resource competition and immune system activation. Once established inside

the mosquito's cells, *Wolbachia* competes directly with viruses like dengue for essential nutrients, particularly lipids and cholesterol, which are vital for viral replication. By consuming these resources first, the bacteria effectively "starve" the virus, preventing it from multiplying. Additionally, because *Wolbachia* is not naturally present in *Aedes aegypti*, its presence keeps the mosquito's innate immune system in a permanent state of high alert. Consequently, the virus is unable to reach the mosquito's salivary glands in sufficient quantities, breaking the cycle of transmission to humans.

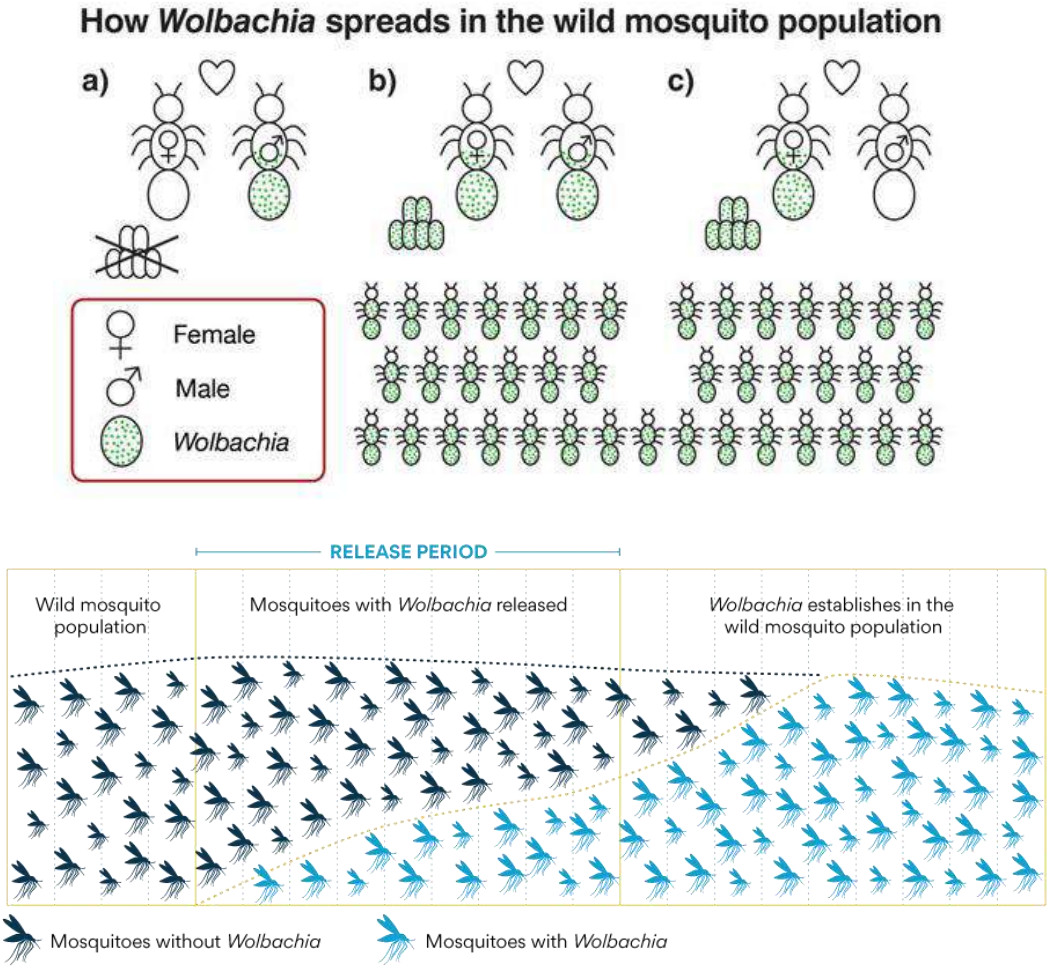


Fig. 7.5. Spread of *Wolbachia* in the wild mosquito population

Source: WMP

7.2.3 Spatial emanators (also known as spatial repellents)

Spatial emanators (spatial repellents) are innovative tools used in vector control that function by releasing volatile insecticidal or repellent compounds into the surrounding air to create a protective space against disease-transmitting mosquitoes.

Unlike contact-based interventions such as insecticide-treated nets (ITNs) or indoor residual spraying (IRS), spatial emanators provide area-wide protection by continuously emitting active ingredients into the air to kill mosquitoes, deter them from entering treated spaces, and prevent them from locating and biting human hosts within a defined radius.

In 2025, World Health Organization has issued a conditional recommendation for the indoor use of spatial emanators for personal protection, in addition to ITNs, to prevent and control malaria in both children and adults in areas with ongoing malaria transmission. WHO has not yet prequalified spatial repellent devices for community protection.

Spatial emanators have shown promise in controlling *Aedes* mosquitoes, the primary vectors of dengue, chikungunya, and Zika viruses, which typically exhibit daytime and outdoor biting behaviours. In a cluster-randomized controlled clinical trial in Iquitos, Peru, use of spatial emanator devices reduced *Aedes*-borne virus (ABV) infections by 34% compared to a placebo. This was the first study to demonstrate that spatial repellents can protect from *Aedes*-borne viruses like Zika and dengue in humans.

The advantages of use of the spatial repellent emanators include ease of deployment, user acceptability, and the ability to provide both personal and possibly community-level protection. However, their protective efficacy may be influenced by environmental factors such as wind, temperature, and humidity, and the potential for insecticide resistance development warrants careful consideration. When integrated into a comprehensive vector management framework, spatial emanators can play a valuable supplementary role in reducing human–vector contact and interrupting arboviral disease transmission.

A cluster-randomized, placebo-controlled trial to evaluate the protection provided by the spatial emanator device of SC Johnson – Mosquito Shield™ – against *Aedes*-borne dengue, transmission is being carried out in Gampaha district, Sri Lanka, which has active seasonal dengue transmission and well-established infrastructure for studying urban dengue fever. The effectiveness of the intervention will be assessed by standard household monitoring of *Aedes aegypti* densities, and surveillance of *Aedes*-borne virus transmission and sero-surveillance for dengue, chikungunya, and Zika.

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Dengue Entomological Survey - Immature Survey Daily Summary Report

NDCU/RMO/AFU/MOH …….. Entomology team

RDHS area: MOH area:

PHI area: GN area:

Locality: Type of survey Date:

	Type of the premises*																						Total	
	G		H		I 1		I 2		J		K		L 1		L 2		M		N		Ot			
	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O
Total number of premises inspected:																								
Number of positive premises:																								
** percentage(%) of premises positive																								
Number of wet containers:																								
Number of dry containers :																								
Number of positive containers:																								

Comments and suggestions:

Date | Name of the reporting Officer | Designation | Signature

* **G**-Houses **H**-Commercial Sites **I1**-Government Institutions **I2**-Private Institutions **J**-Construction Sites **K**-Open Areas **N**-Factories **Ot**-Other places
L1-Schools **L2**-Other Education centres **M**-Religious places **I**- Indoor **O**-Outdoor
Target: should expect to keep this <1%

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Dengue Entomological Survey - Immature Survey Report

RDHS area:		PHI area:		Period: from		to	Type of survey:
MOH area:		GN division:		Locality:			

No. of premises inspected												No. of containers inspected			No. of premises positive for			No. of containers positive for			Premise Index (%)			Container index (%)			Breteau Index		
G	H	I1	I2	J	K	L1	L2	M	N	Ot	Total	Wet	Dry	Total	A	B	AB	A	B	AB	A	B	C	A	B	C	A	B	C

A << No of premises positive for the breeding places of A

B << No of premises positive for the breeding places of B

AB << No of premises positive for the breeding places of AB

Identified other species with breeding places	
Total no.of containers positive for *An.stephensi*	

Summary of breeding places

No. of containers positive							No. of containers positive							No. of containers positive							No. of containers positive						
Wet	Dry	A	B	AB	S		Wet	Dry	A	B	AB	S		Wet	Dry	A	B	AB	S		Wet	Dry	A	B	AB	S	
						WSB							Ornam							TRI							Nuc/c
						WSCT							Natu							COV							.....
						WSO							Ponds							Dis(deg)							.....
						Con.sl							Wells							Dis(nd)							.....
						Gut							T.wells							Dis(r)							.....
						Tyres							A/C,ref							PFD							.....

Comments:

Date	Name of the reporting officer	Designation	Signature

Date	Name of the head of the institution /Designation	Signature

A- *Aedes aegypti* , B - *Aedes albopictus* , S - *Anopheles stephensi* , C - common

G-Houses, **H**-Commercial sites, **I1**-Government institutions, **I2**-Private Institutions, **J**-Construction sites, **K**-Open areas, **L1**-Schools, **L2**-Other Education Centers, **M**-Religious places, **N**-Factories, **Ot**-Other

WSB-Water storage barrels, **WSCT**-water sorage cement tanks, **WSO**-water storage other, **Con.sl**-concrete slab, **Gut**-Gutter, **Ornam**-Ornamental, **Natu**-Natural, **T.wells**-Tube wells, **A/C,Ref**-A/c,refrigerator, **TRI**-Temporary remove items, **Cov**-Covering items, **Dis(deg)** -discared degradable , **Dis(nd)**-discarded non degradable, **Dis(r)**-Discarded reuse, **PFC**-Pet feeding cups, **Nuc/c**-non use cisterns/commode

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Dengue Entomological Survey -Immature Survey (*Detail Summary Report*)

RDHS area: PHI area: Type of survey: Date:
MOH area: GN division: Locality:

Type of container		WSB		WSCT		WSO		Con. Sl		Gut		Tyres		Ornam.		Natu		Ponds		wells		T. wells		A/C ref.		TRI		Cov		Disc		PFD		NUC/C		Other		Total	
		I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O
Dry																														.							
Wet																																					
With Larvae	A																																				
	B																																				
	AB																																				
	Os																																				
Total																																					

Type of the inspected site		G		H		I1		I2		J		K		L1		L2		M		N		Ot		Total	
		I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O
Number of larvae positive	A																								
	B																								
	AB																								
	Os																								

Date | Name of the reporting officer | Designation | Signature

WSB-Water sorage barrels, **W.S.C.T**-water sorage cement tanks, **WSO**-water storage other, **Con.sl**-concrete slab, **Gut**-Gutter, **Ornam**-Ornamental,**Natu**-Natural, **T.wells**-Tube wells, **A/C,ref**-Air conditioner and refrigerators , **TRI**-Temporary remove items, **Cov**-Covering items, **Dis(deg)** -discared degradable , **Dis(nd)**-discarded non degradable, **Dis(r)**-Discarded reuse, **PFC**-Pet feeding cups, **Nuc/c**-Non use cisterns/commode

G-Houses, **H**-Commercial sites, **I1**-Government institutions, **I2**-Private institutions, **J**-Construction sites, **K**-Open areas, **L1**-Schools, **L2**-Other Education Centers, **M**-Religious places, **N**-Factories **Ot**-Other places

A-*Aedes aegypti* **B**-*Aedes albopictus* **Os** - Other species **I**-Indoor **O**-Outdoor

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Dengue Entomological Survey - Immature Survey Report on Institutions/construction sites/……*

NDCU/RMO/AFU/MOH…… Entomology Team

RDHS area: PHI area: Survey type: Date:

MOH area: GN area: Name of the premises /Site surveyed:

SN	Specify the locality surveyed within the premises/site	Type of breeding	Number of containers						Presence of *Aedes* spp.				Presence of other mosquito sp.		Type of identified *Aedes* sp.	Remarks	Action taken
			With water		Without water		Positive for mosquito larvae		No. of *Aedes* larvae		No. of *Aedes* pupae						
			I	O	I	O	I	O	I	O	I	O	I	O	A/B/AB		
Total																	

Date Name of the reporting officer Designation Signature

A-*Aedes aegypti* **B**-*Aedes albopictus* **AB** - A & B mix breeding **I**- In door **O** - Out door *Please use one format per premise/site inspected.

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Dengue Entomological Survey - Pupal survey Report

RDHS area:		PHI area:		Period: from		to	Type of survey:
MOH area:		GN division:		Locality:			

No. of premises inspected												No. of containers inspected			No. of premises positive for (Pupae)			No. of containers positive for (Pupae)			Pupal Premise Index (%)			Pupal Container index (%)		
G	H	I1	I2	J	K	L1	L2	M	N	Ot	Total	Wet	Dry	Total	A	B	AB	A	B	AB	A	B	C	A	B	C

A << No of premises positive for the breeding places of A-Pupae

B << No of premises positive for the breeding places of B-Pupae

AB << No of premises positive for the breeding places of AB-Pupae

Identified other species with breeding places

Total no.of containers positive for *An.stephensi*

Summary of breeding places (pupae)

	No. of containers positive							No. of containers positive							No. of containers positive							No. of containers positive						
Wet	Dry	A	B	AB	S		Wet	Dry	A	B	AB	S		Wet	Dry	A	B	AB	S		Wet	Dry	A	B	AB	S		
						WSB							Ornam							TRI							Nuc/c
						WSCT							Natu							COV							.....
						WSO							Ponds							Dis(deg)							.....
						Con.sl							Wells							Dis(nd)							.....
						Gut							T.wells							Dis(r)							.....
						Tyres							A/C,ref							PFC							.....

Comments:

Date	Name of the reporting officer	Designation	Signature

Date	Name of the head of the institution /Designation	Signature

A- *Aedes aegypti* , B - *Aedes albopictus* , S - *Anopheles stephensi* , C - common

G-Houses, **H**-Commercial sites, **I1**-Government institutions, **I2**-Private Institutions, **J**-Construction sites, **K**-Open areas, **L1**-Schools, **L2**-Other Education Centers, **M**-Religious places, **N**-Factories, **Ot**-Other

WSB-Water storage barrels, **WSCT**-water sorage cement tanks, **WSO**-water storage other, **Con.sl**-concrete slab, **Gut**-Gutter, **Ornam**-Ornamental, **Natu**-Natural, **T.wells**-Tube wells, **A/C,Ref**-A/c,refrigerator, **TRI**-Temporary remove items, **Cov**-Covering items, **Dis(deg)** -discared degradable , **Dis(nd)**-discarded non degradable, **Dis(r)**-Discarded reuse, **PFC**-Pet feeding cups, **Nuc/c**-non use cisterns/commode

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Dengue Entomological Survey - Pupal Survey Report (*For containers*)

RDHS area:		GN division:	
MOH area:		Locality:	
PHI area:		Date:	

Breeding place	No. of Wet Containers	No. of Containers Positive For Pupa	No. of Pupae		% contribution of breeding place	
			Ae. aegypti	*Ae.albopictus*	*Ae. aegypti*	*Ae.albopictus*
Water Storage Barrel						
Water Storage Cement Tank						
Water Storage Other						
Concrete Slab						
Roof Gutters						
Tyres						
Ornamentals						
Natural						
Ponds						
Wells						
Tube Wells						
A.C./ Refrigerator						
Temporary Removed Items						
Covering Items						
Discarded (degradable)						
Discarded (non degradable)						
Discarded (reusable)						
Pet Feeding Cups						
Non use commode/ cistern						
Other-						
Other-						
Other-						
Other-						
Other-						
Total						

No. of Premises Examined: No. of Pupae (*Ae. aegypti, Ae. albopictus*)

Pupal Index**

** $Pupal\ Index = \frac{No.of\ pupae}{No.of\ premises\ inspectes} \times 100$

Date	Name of the reporting officer	Designation	Signature

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Dengue Entomological Survey - Indoor and Outdoor Adult Mosquito Resting Collection Report

RDHS area: GN Division: Date: Type of survey
MOH area: Locality:
PHI area: Weather Condition: Start at: Finished at:

SN	Address	Start time	End time	Type of the roof*	Type of the wall**	Resting Site	I	O	No. of Mosquitoes Collected				Condition of the abdomen	Other Mosquito sp
									Ae.aegypti		*Ae.albopictus*			
									Male	Female	Male	Female		

No. of Premises Examined

No. of Premises Positive for Adult Dengue Vector Mosquitoes
Female: Male:

Total No. of Dengue Vector Mosquitoes Collected
Female: Male:

Date | Name of the reporting officer | Designation | Signature

National Dengue Control Unit

Public Health Complex , 555/5, Elvitigala Mawatha, Narahenpita, Colombo 05

Telephone: (+94) 11 2368416, 2368417 Fax: (+94) 11 2369893 Email: ndcu2010@yahoo.com

Dengue Entomological Survey - Ovitrap Survey Report

RDHS area:
MOH area:
PHI area:
GN Division:
Locality:

Ovitrp set date | Ovitrap collection date | Type of survey

Climatic Conditions: Bright sun shine | Gloomy | Raining heavily | Drizzling

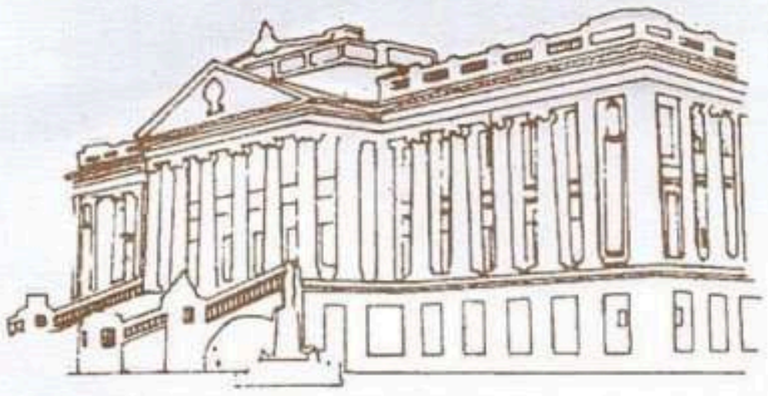
Nature of Locality: Residential | Public site | Town | Other

	Field works						Laboratory works								
							Indoor				Outdoor				
SN	Type of premises*	Name & address of the house holder/public site	Ovitrap placement area		Positive /Negative (On the collection day)		No. of eggs	No. of A** larvae	No. of B ** larvae	Mix	No. of eggs	No. of A** larvae	No. of B** larvae	Mix	Total
			I	O	I	O									

Date | Name of the reporting officer | Designation | Signature

**A-*Aedes aegypti* B-*Aedes albopictus* I-Indoor O-Outdoor

ජනාධිපති කාර්යාලය
சனாதிபதி அலுவலகம்
PRESIDENTIAL SECRETARIAT



වක්‍රලේඛ අංක : PS/EAD/Circular/10/2023

මගේ අංකය: PS/EAD/02/14

2023 දෙසැම්බර් මස 22 වන දින

සියලුම අමාත්‍යාංශ ලේකම්වරුන්
සියලුම පළාත් ප්‍රධාන ලේකම්වරුන්
සියලුම ආණ්ඩුකාර ලේකම්වරුන්
සියලුම දිසාපති/ දිස්ත්‍රික් ලේකම්වරුන්
සියලුම දෙපාර්තමේන්තු ප්‍රධානීන් සහ
රාජ්‍ය සංස්ථා/ ව්‍යවස්ථාපිත මණ්ඩලවල සභාපතිවරුන් වෙත,

ඩෙංගු රෝගය වැළැක්වීම සහ පාලනය

මගේ අංක PS/EAD/Circular/06/2023 හා 2023 අප්‍රේල් 20 දිනැතිව නිකුත් කරන ලද වක්‍රලේඛයට වැඩිමනත් වශයෙනි.

ශ්‍රී ලංකාව තුළ මේ වන විට ඇති වී තිබෙන අයහපත් කාලගුණ තත්ත්වයන් හමුවේ ඩෙංගු රෝගය සීඝ්‍රයෙන් ව්‍යාප්ත වීමේ උග්‍ර අවදානමක් උද්ගත වී ඇති බැවින් එය ව්‍යාප්ත වීම වළක්වාගැනීම සඳහා සියලු ආයතනවල සක්‍රීය දායකත්වයෙන් යුතුව කඩිනමින් ඩෙංගු මර්දන වැඩපිළිවෙළක් ක්‍රියාත්මක කළ යුතුය.

වර්තමාන සංඛ්‍යාලේඛන දත්ත අනුව, බස්නාහිර පළාත අධිඅවදානම් කලාපයක් ලෙස හඳුනාගෙන ඇති අතර, දිවයින පුරා රෝග ව්‍යාප්තිය සීඝ්‍රයෙන් වැඩිවීමේ ප්‍රවනතාවයක් පෙන්නුම් කරයි. මෙවැනි පසුබිමක් තුළ, ඩෙංගු රෝගය අධි වසංගත තත්ත්වයක් බවට පත්වීම වැළැක්වීම පිළිබඳව විශේෂ අවධානයක් යොමු කළ යුතු අතර, ඩෙංගු මර්දන කටයුතු ජාතික, පළාත්, දිස්ත්‍රික්, ආයතන, ග්‍රාමීය හා නිවාස මට්ටමින් සෞඛ්‍ය අංශවල සහයෝගය ද ඇතිව ක්‍රියාත්මක කිරීමට සියලු ආයතන ප්‍රධානීන් කැපවී කටයුතු කළ යුතු වේ.

මදුරුවන් බෝවීමේ අවදානම් සහිත ස්ථාන ලෙස හඳුනාගෙන ඇති රාජ්‍ය සහ පෞද්ගලික ආයතන, ඉදිකිරීම් පරිශ්‍ර, පාසල්, ආගමික ස්ථාන, ධීවර කටයුතු ආශ්‍රිත ප්‍රදේශ, නිවාස සහ නගර මධ්‍යයේ ඇති පොදු ස්ථාන පිළිබඳවද විශේෂ අවධානයක් යොමු කළ යුතුය.

ඒ සඳහා පහත පරිදි ක්‍රියාමාර්ග ගැනීමට කටයුතු කරන ලෙස අවධාරණය කරමි.

1. <u>ආයතන තුළ ඩෙංගු මර්දනය හා පාලන කටයුතු සම්බන්ධයෙන් ගත යුතු ක්‍රියාමාර්ග</u>

1.1 තම ආයතන පරිශ්‍රය තුළ ඩෙංගු මදුරුවන් බෝ නොවන පරිසරයක් පවත්වා ගැනීම අදාළ ආයතන ප්‍රධානියාගේ වගකීම වේ. එබැවින් ඩෙංගු වලින් තොර පරිසරයක් ඇති කිරීම පිණිස, සියලු රාජ්‍ය සහ අර්ධ රාජ්‍ය ආයතන, පෞද්ගලික ආයතන,ඉදිකිරීම් පරිශ්‍ර, වැඩබිම්, පාසල් සහ ආගමික ස්ථාන ඇතුළු පොදු පරිශ්‍රයන්වල ඩෙංගු ව්‍යාප්තිය වැළැක්වීමේ සහ පාලනය කිරීමේ ක්‍රියාකාරකම් ක්‍රියාත්මක කිරීම සඳහා ආයතන ප්‍රධානීන් විසින් අවශ්‍ය පියවර ගත යුතුය.

ගාලු මුවදොර, කොළඹ 01
காலி முகத்திடல், கொழும்பு 01
Galle Face, Colombo 01
දුරකථන தொலைபேசி Telephones ++ 94 (0) 11 2354418 ++ 94 (0) 11 2473873
ෆැක්ස් தொலைநகல் Fax ++ 94 11 2446657
ඉ-තැපෑල மின்-அஞ்சல் e-mail prsec@presidentsoffice.lk

1.2 ආයතනය තුළ ඩෙංගු මදුරුවන් බෝවීමට හැකි අවදානම් ස්ථාන හඳුනාගැනීම, ඒවා ඉවත් කිරීම හා පසුවිපරම් කිරීම සම්බන්ධයෙන් සක්‍රීයව දායක විය හැකි පුද්ගලයින්ගෙන් සමන්විත ආයතනික කමිටුවක් ස්ථාපිත කර, ඒ සඳහා නායකත්ව වගකීම් දැරීමට ක්‍රියාකාරී පුද්ගලයකු නම් කළ යුතුය.

1.3 අදාළ ආයතන තුළ ක්‍රියාත්මක කරනු ලබන කමිටු මඟින්, අනෙකුත් නිලධාරීන්ගේද සහාය ඇතිව ඩෙංගු මර්දන ක්‍රියාකාරකම් සෑම සතියකම සිකුරාදා දින පෙරවරු 9.00-9.30 කාලය තුළ ක්‍රියාත්මක කළ යුතු අතර අදාළ කාලය තුළ තම ආයතනයේ එම ක්‍රියාකාරකම් සිදු කරන බවට ආයතන ප්‍රධානීන් වගබලා ගත යුතුය.

1.4 තවද, එම ක්‍රියාකාරකම් සම්බන්ධයෙන් මෙම චක්‍රලේඛයේ ඇමුණුම 01 ලෙස ඇති ආකෘතිය ප්‍රකාරව වාර්තාවක් ආයතන ප්‍රධානීන් විසින් ප්‍රදේශයේ සෞඛ්‍ය වෛද්‍ය නිලධාරී වෙත මාසිකව ලබා දීමට කටයුතු කළ යුතුය. ඒ සඳහා ආයතනය තුල ඇමුණුම 02හි දක්වා ඇති ආකෘතිය ප්‍රකාරව වාර්තාවක් පවත්වාගෙන යා හැකිය.

1.5 ප්‍රාදේශීය සෞඛ්‍ය වෛද්‍ය නිලධාරී විසින් එම වාර්තා විශ්ලේෂණය කර නිරීක්ෂණය වන ප්‍රතිඵල අනුව අවශ්‍ය පරිදි තාක්ෂණික සහාය ලබා දෙනු ඇති අතර, අඛණ්ඩ නියාමනයක්ද ක්‍රියාත්මක කරනු ඇත.

1.6 තම ආයතනය සම්බන්ධයෙන් සෞඛ්‍ය වෛද්‍ය නිලධාරී විසින් ලබාදෙන උපදෙස් අනුව අවශ්‍ය ක්‍රියාමාර්ග ගැනීමට ආයතන ප්‍රධානීන් පෞද්ගලික අවධානය යොමු කළ යුතුය.

2. <u>ඩෙංගු මර්දන හා පාලන කටයුතු මෙහෙයවීම, අධීක්ෂණය හා සම්බන්ධීකරණය</u>

2.1 ඩෙංගු මර්දන ක්‍රියාකාරකම් දීප ව්‍යාප්ත මට්ටමින් කාර්යක්ෂමව ඉටු කිරීමට අවශ්‍ය සියලු සම්බන්ධීකරණ කටයුතු ජාතික ඩෙංගු මර්දන ඒකකය මඟින් සිදු කළ යුතු අතර, සෞඛ්‍ය සේවා අධ්‍යක්ෂ ජනරාල් යටතේ ජාතික ඩෙංගු මර්දන ඒකකය ශක්තිමත් කරමින් ඩෙංගු මර්දන ක්‍රියාකාරකම් බල ගැන්වීමේ ක්‍රියාන්විතයක් දියත් කළ යුතුය.

2.2 ඩෙංගු මර්දනය සඳහා පළාත්, දිස්ත්‍රික්, ප්‍රාදේශීය සහ ග්‍රාමීය මට්ටමේ පාර්ශව විසින් සෞඛ්‍ය අංශ වෙත සහයෝගය ලබා දිය යුතු අතර, ඒ පිළිබඳ තහවුරු කිරීම හා අදාළ පාර්ශවයන් සම්බන්ධීකරණය කිරීමේ වගකීම පළාත් ආණ්ඩුකාරවරුන් වෙත හා ඩෙංගු ව්‍යාප්තිය පාලනය කිරීම සඳහා පත්කරන ලද පළාත් අනුකමිටු වෙත පැවරේ.

2.3 පළාත් අනුකමිටු මසකට දෙවරක් රැස්විය යුතු අතර, එම සාකච්ඡාවලට තම පළාත තුළ ඩෙංගු වසංගත රෝග ව්‍යාප්තිය වැළැක්වීම හා පාලනය සඳහා වන සැලසුම් ඇතුළත් කරමින් ඒවායේ ප්‍රගතිය සමාලෝචනය කර අවශ්‍ය ක්‍රියාමාර්ග ගැනීම සිදුකළ යුතුය. තවද, ප්‍රාදේශීය වශයෙන් ක්‍රියාත්මක කරනු ලබන වැඩසටහන් හා කාර්යයන් සඳහා අවශ්‍ය මහපෙන්වීම ලබාදෙමින් අදාළ ප්‍රදේශයේ මහනගර සභා, නගර සභා, ප්‍රාදේශීය සභා ඇතුළු පළාත් පාලන ආයතනවල සක්‍රීය දායකත්වය මත එම කටයුතු සිදු කළ යුතුය.

2.4 ඩෙංගු අධිඅවදානම් ස්ථාන ලෙස සැලකිය හැකි ඉදිකිරීම් පරිශ්‍ර, පාසැල්, ආගමික ස්ථාන ඇතුළු පොදු ස්ථාන සහ සෞඛ්‍ය අංශ විසින් ඩෙංගු අධිඅවදානම් ස්ථාන ලෙස නම් කරනු ලබන වෙනත් ඕනෑම ස්ථානයක් සම්බන්ධයෙන් පළාත් අනුකමිටුවේ විශේෂ අවධානය යොමු විය යුතුය. ජාතික ඩෙංගු මර්දන ඒකකය හා පළාත් අනුකමිටු විසින් ලබාදෙන මාර්ගෝපදේශ අනුව මෙම ස්ථානයන්හි ඩෙංගු ව්‍යාප්ත වීම වැළැක්වීමට අවශ්‍ය කටයුතු කඩිනමින් ක්‍රියාත්මක කළ යුතුය.

2.5 පළාත් සෞඛ්‍ය අධ්‍යක්ෂකවරුන් විසින් පාසැල්, අනෙකුත් අධ්‍යාපන ආයතන, ආගමික ස්ථාන ආදී පොදු ස්ථානවල ඩෙංගු මර්දන කටයුතු සංවිධානය කළ යුතු අතර සෞඛ්‍ය අමාත්‍යාංශයේ ජාතික ඩෙංගු මර්දන ඒකකය මඟින් අදාළ කටයුතු අධීක්ෂණය කළ යුතුය.

2.6 දිස්ත්‍රික් සම්බන්ධීකරණ කමිටු, ප්‍රාදේශීය සම්බන්ධීකරණ කමිටු හා ග්‍රාමීය කමිටුවලද විශේෂ අවධානය ඩෙංගු රෝග ව්‍යාප්තිය පාලනය සඳහා යොමු කළ යුතු අතර, ඒ සම්බන්ධයෙන් වන කරුණු සමාලෝචනය කිරීමට ඉහත රැස්වීම්වලදී අදාළ දිස්ත්‍රික් හා ප්‍රාදේශීය සෞඛ්‍ය නිලධාරීන් වෙත නිශ්චිත කාලයක් වෙන් කර දිය යුතුය.

2.7 ඩෙංගු මර්දනය අරමුණු කොටගෙන, ඉදිකිරීම් ගිවිසුම්වලට ඉදිකිරීම් පරිශ්‍ර සඳහා වන නීති රීති සහ සෞඛ්‍ය මාර්ගෝපදේශ ඇතුළත් කිරීමත්, හිස් ඉඩම්, අත්වැසිකිලි දේපල සහ ධීවර වරායන් ආශ්‍රිතව ඇති භාවිතා නොවන/අත්හැර දැමූ හෝ හිමිකරුවකු නොමැති බෝට්ටු යනාදිය තුළ ඩෙංගු මදුරුවන් බෝවීම වැළැක්වීම සඳහා නීතිමය ප්‍රතිපාදන ක්‍රියාත්මක කළ යුතු අතර, එවැනි ප්‍රතිපාදන නොමැති නම් ඒවා සම්පාදනය සඳහා නාගරික සංවර්ධන හා නිවාස, මහාමාර්ග, රාජ්‍ය සේවා, පළාත් සභා හා පළාත් පාලන, ධීවර හා සෞඛ්‍ය යන විෂය භාර අමාත්‍යාංශවල ලේකම්වරුන් කටයුතු කළ යුතුය.

2.8 ඩෙංගු රෝගය වසංගත තත්ත්වයක අවදානම පිළිබඳව ජාතික, පළාත් හෝ දිස්ත්‍රික් සෞඛ්‍ය අංශ විසින් දන්වා සිටින අවස්ථාවන් හි දී, අදාළ පාර්ශ්වයන්ගේ ක්‍රියාකාරී සහයෝගය සෞඛ්‍ය අංශ වෙත ලබාදීම ප්‍රමුඛ කර්තව්‍යයක් ලෙස සලකා කටයුතු කළ යුතුය. තවද, අවස්ථානුකූලව ඩෙංගු මර්දන හා පාලන කටයුතු සඳහා අවශ්‍ය මානව හා භෞතික සම්පත් ලබාදීමට අවශ්‍ය පියවර ගැනීම ආයතන ප්‍රධානීන්ගේ වගකීමක් ලෙස සලකා කටයුතු කළ යුතුය.

ඉහත සඳහන් ක්‍රියාකාරකම් සඳහා පමණක් සීමා නොවී ඩෙංගු රෝගය වසංගත තත්ත්වයෙන් පැතිර යාම වැළැක්වීමට ගත හැකි සියලු ක්‍රියාමාර්ග සඳහා ප්‍රමුඛත්වය දී කටයුතු කළ යුතු අතර, ඉහත උපදෙස් ඔබ යටතේ පවතින සියලු ආයතන වෙත නොපමාව දැනුම් දීමට අවශ්‍ය පියවර ගත යුතු වේ.

මේ සඳහා ඔබ සහ ඔබගේ කාර්ය මණ්ඩලය දක්වන සක්‍රිය දායකත්වය බෙහෙවින් අගය කරමි.

ස්තුතියි
මෙයට - විශ්වාසී

ඊ එම් එස් බී ඒකනායක
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අමාත්‍ය මණ්ඩලයේ ලේකම්
විගණකාධිපති
ලේකම්, සෞඛ්‍ය අමාත්‍යාංශය
ලේකම්, කොවිඩ්-19 සහ ඩෙංගු රෝගය රට තුළ ව්‍යාප්තිය පාලනය කිරීම සඳහා වන කමිටුව
සෞඛ්‍ය සේවා අධ්‍යක්ෂ ජනරාල්
අධ්‍යක්ෂ, ජාතික ඩෙංගු මර්දන ඒකකය

ඇමුණුම 01

ඩෙංගු මදුරුවන් බෝවන ස්ථාන පරීක්ෂා කිරීම පිළිබඳ මාසික වාර්තාව

රජයේ ආයතන/ පෞද්ගලික ආයතන/පාසල් සහ අධ්‍යාපන ආයතන/ ඉදිකිරීම් පරිශ්‍ර/ ආගමික ස්ථාන/ ධීවර හා ධීවර වරායන් ආශ්‍රිතව

සාමාන්‍ය තොරතුරු

ආයතනයේ නම		
මාසය		
සෞඛ්‍ය වෛද්‍ය නිලධාරී කොට්ඨාශය		
ආයතන තුළ ඩෙංගු මර්දන කමිටුවක්		ඇත/නැත
ආයතනය තුළ පවතින ඩෙංගු මර්දන කමිටුවේ සම්බන්ධීකාරකගේ තොරතුරු	නම	
	තනතුර	
	දුරකථන අංකය	
	විද්‍යුත් ලිපිනය	

ස්ථාන පරීක්ෂාව, දැනුවත් කිරීමේ වැඩසටහන් සහ ඩෙංගු රෝගීන් පිළිබඳ තොරතුරු

➢ ආයතන ප්‍රධානියාගේ හා ඩෙංගු මර්දන කමිටුවේ අධීක්ෂණයෙන් සෑම සතියකම සිකුරාදා දින පෙ.ව.9.00-9.30 කාලය තුළ මදුරු මර්දන කටයුතු සිදුකරන ලදී	සති 1	සති 2	සති 3	සති 4	සති 5
➢ අදාළ සතිය තුළ හඳුනා ගත් මදුරුවන් බෝවිය හැකි ස්ථාන ගණන					
➢ අදාළ සතිය තුළ හඳුනා ගත් මදුරුවන් බෝවූ ස්ථාන ගණන					
➢ අදාළ සතිය තුළ නිවැරදි කළ ස්ථාන ගණන					
➢ නිවැරදි කිරීමට නොහැකි ස්ථාන පිළිබඳව සෞ. වෛ. නි. කාර්යාලයට දැනුම් දෙන ලදී	ඔව්/නැත				
➢ සෞ. වෛ. නි. කාර්යාලයෙන් අනතුරු ඇඟවීම් දිම / රතු නිවේදන නිකුත් කිරීම	ඇත/නැත				
➢ අදාළ මාසය තුළ ඩෙංගු හෝ ඩෙංගු යැයි සැක සහිත රෝගීන් වාර්තා වුයේද	ඔව්/නැත				

වෙනත් කරුණු

මෙම වාර්තාව සහතික කරන නිලධාරියාගේ නම තනතුර සහ අත්සන: .....

මෙම වාර්තාව ඊළඟ මාසයේ 10 වන දිනට පෙර ප්‍රදේශයේ සෞඛ්‍ය වෛද්‍ය නිලධාරි වෙත යොමු කරන්න. ඉදිකිරීම් පරිශ්‍ර සඳහා පමණක් මෙම වාර්තාව පළාත් පාලන ආයතන හා ඉදිකිරීම් කර්මාන්ත සංවර්ධන අධිකාරිය (CIDA) වෙතද යැවීමට කටයුතු කරන්න

මෙම ඩෙංගු මර්දන ජාතික වැඩසටහන සඳහා ඔබ ආයතනය ලබා දෙන සහය ඉතා අගය කොට සලකමු

ඩෙංගු මදුරුවන් බෝවන ස්ථාන පරීක්ෂා කිරීම පිළිබඳ මාසික වාර්තාව

ඇමුණුම 02

රජයේ ආයතන/ පෞද්ගලික ආයතන/පාසල් සහ අධ්‍යාපන ආයතන/ ඉදිකිරීම් පරිශ්‍ර/ ආගමික ස්ථාන/ ධිවර හා ධිවර වරයන්

ආයතනයේ නම සහ ලිපිනය-	මාසය-	සෞඛ්‍ය වෛද්‍ය නිලධාරී කොට්ඨාශය-

මදුරු කීටයන් සහිත හෝ මදුරුවන් බෝවිය හැකි ස්ථාන	1 සතිය		2 සතිය		3 සතිය		4 සතිය		5 සතිය	
	හමු වූ ගණන	නිවැරදි කළ ගණන	හමු වූ ගණන	නිවැරදි කළ ගණන	හමු වූ ගණන	නිවැරදි කළ ගණන	හමු වූ ගණන	නිවැරදි කළ ගණන	හමු වූ ගණන	නිවැරදි කළ ගණන
ඉවතලන භාජන **(A 1)** සහ අයිතමයන්										
ජල ටැංකි සහ ජලය රැස් කරන බඳුන්										
ජලය නොබසින කාණු සහ ගලි වලවල්										
වැහි පිහිලි										
පොකුණු සහ පක්ෂි තටාක										
ජලය බැසීම අවහිර වූ මල් බඳුන් සහ තැටි										
කොන්ක්‍රීට් ස්ලැබ්										
ටයර්										
ගස්බෙන/ ඕරෝමිලියා ශාඛ										
භාවිතා නොකරන වැසිකිලි උපාංග සහ ටැංකි										
ශීතකරණ/ වායු සමීකරණ තැටි										
මල් බඳුන්										
වෙනත් **(A 2)**										
මුළු ගණන										
පරීක්ෂා කළ දිනය හා පරීක්ෂාව මෙහෙයවූ නිලධාරියාගේ නම										

- ඉවතලන භාජන හා අයිතමයන් ලෙස - **(A 1)**
  ප්ලාස්ටික් කෝප්ප,යෝගට් කෝප්ප,පොල් කටු, කිරි හට්ටි, බෝතල්, සෙල්ලම් බඩු කොටස්,පිඟන් කැබලි,ටින්, ලී පෙට්ටි, ඉවතලන පොලිතීන් සිට්, ප්ලාස්ටික් දවටන, පොලිස්ටයිරින් ද්‍රව්‍ය, බියර් කැන් ආදිය සලකන්න.
- වෙනත් ස්ථාන ලෙස **(A 2)**
  පරිශ්‍ර ඇතුලත - ජලය එක් රැස් විය හැකි සඳලු තලල තාවකාලිකව ජලය රැස්වන ස්ථාන-වතුර කාන්දු වන ස්ථාන සඳහා යෙදූ බකට්ය
  පරිශ්‍රවලින් පිටත - ඉවත්කල උළුකැට්ල කැඩුණු ගොඩනැගිලි අයිතමල අබිලි ද්‍රව්‍යඃහුගත බටඃඇන්ටෙනා බටල කැඩුණු වැසිකිළි වලවල්ඃ වැසි ආවරණ සඳහා යොදා ඇති පොලිතීන් දවටනල මුනින් නමා ඇති බකට් වල දාර.
- ආයතන පරිශ්‍රය නිරීක්ෂණයේදී මල්බදුන්,ශීතකරණ/ වායු සමීකරණ තැටි,භාවිතා නොකරන වැසිකිලි උපාංග සහ ටැංකි නිරීක්ෂණය කරන්න. එහිදී සිස්ටන පියන ඔසවා නිරීක්ෂණය කරන්න. එමෙන්ම එතුල පවතින ගලි වලද නිරීක්ෂණය කල යුතුවේ. උඩු මහල් පරීක්ෂා කිරීමේදි ජලය රැස්

Annexure X: WHO recommended insecticides for space spraying against mosquitoes

WHO recommended insecticides for space spraying against mosquitoes

Compound and formulation	**Indoor**		**Outdoor**	
	(g Al/1000 m^3)		**(g/Al/ha)**	
	Cold	**Thermal**	**Cold**	**Thermal**
	fog	**fog**	**fog**	**fog**
Deltamethrin UL	0.5	0.05	0.5	0.5-1.0
Delatamethrin EW	-	0.05	1	-
Lambda-cyhalothrin EC	-	-	1-2	2
Malathion EW and UL	-	-	112-600	112-600
Permathrin(25 cis: 75 trans;10.35%w/w)+s-bioallethrin(0.14w/w)+ piperonyl butoxide(9.85% w/w)EW	0.55 Permethrin	0.73 permethrin	-	-
d-d, trans-cyphenothrin EC	0.1-0.2	0.2	3.5-4.00	3.5-4.0

ANNEXURE XI – Dilution factors of different insecticides that are used for dengue vector control

Dilution factors of different insecticides that are used for dengue vector control in Sri Lanka by thermal fogging and ULV are shown in Table 1.1 and 1.2.

Table 1.1 Dilution factors of different insecticides that are used for dengue vector control in Sri Lanka by thermal fogging (oil base and water base)

Insecticide	Mixing proportion		Required insecticide amount for 5 litre capacity hand held fogging machine
	Insecticide	Kerosine oil/ Diesel /Water*	
Technical malathion (Peri-domestic fogging only)	1	19	250 ml
Cyphenothrin + Tetramethrin (Pesguard) (Indoor+ peri domestic fogging)	1	160	31ml
Cyphenothrin (Gokilaht) (Indoor+ peri domestic fogging)	1	99	50 ml

Annexure XII: Interim guideline to conduct water-based thermal fogging

Insecticides that can be used for water-based thermal fogging that are currently used in Sri Lanka are as follows.

1. Pesguard® FG 161
2. Gokilahts® 5 EC

The mixing proportions of Insecticide and water is given in Table 1

Table 1: Insecticides and their relevant concentration used in water-based thermal fogging

Insecticide	Mixing proportion		Required amounts for 5 L liter capacity hand-held fogging machine	
	Insecticide	water	insecticide	water
Pesguard® FG 161 (Indoor+peridomestic)	1	160	31ml	4969ml
Gokilahts® 5 EC (Indoor+Peridomestic)	1	99	50ml	4950ml

a. **The type of machines and other requirements used to conduct cage bioassays are as follows:**

Type of machine	**Nozzle**
Airo fog*	1.2
IGEBA EVO 35	1.2

*When using the Airo fog machine, the fog tube must be relocated to the appropriate position(water) before initiating water-based thermal fogging.

- The implementation of water-based thermal fogging is possible to conduct in any MOH office that has the machines stated above. If there are any alternative fogging machines in addition to the ones mentioned, it is necessary to follow the manufacturer's instructions in order to make sure these machines are capable of conducting water-based thermal fogging.
- **Insecticide mixing is important for any fogging activities.** Therefore, the measured (by using a measuring cylinder) insecticide should be mixed well with the appropriate amount of water using a 5/10-liter bucket, and the mixture should be poured into the chemical tank of the machine using a funnel.

NOTE: Fogging machines should be cleaned properly each day after the fogging sessions.

Table 2Dilution factors of different insecticides that are used for dengue vector control in Sri Lanka by ULV application

Insecticide	Mixing proportion		Required insecticide amount for 4 litre capacity hand held fogging machine
	Insecticide	Water	
Pesguard	1	16	235ml (total volume of the mixture 3765ml)

Gokilaht	1	49	80ml (total with water 3920ml)

ANNEXURE – XIII-Monthly stock Return of Insecticide

MONTHLY STOCK RETURN OF INSECTICIDE

RDHS Area: **Month:** **Year:**

Insecticide	Larvicides			Adulticides			
	Vactor1% SG (kg)	Sumilarv 0.5G (kg)	Aquatain (L)	Technical Malathion (L)	Pesguard (L)	Gokilaht (L)	Other (Specify)
Stocks on hand at the beginning of the month							
Stocks received during the month							
Amount distributed during the month							
Balance at the end of month							
Monthly average distribution (Include current and past 2 months)							
Amount requested from NDCU for the next month							
For official use only Amount issued by the NDCU							

Prepared and checked by (Name and designation):

.....
Signature of the Entomologist
Date:

.....
Signature of Regional Epidemiologist
Date:

.....
Signature of the Regional Director of Health Services
Date: