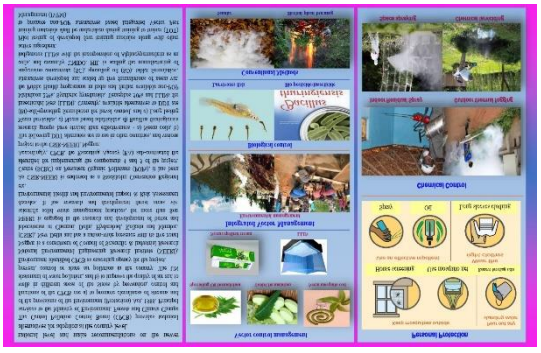
CSIR – National Environmental Engineering Research Institute
Nehru Marg, Nagpur – 440020.

5th Training Programme Report

On

Ten days online Training Programme for Pilot testing of Modules and ToT (SPOs, VBD Consultants & Entomologists from Karnataka State) to promote non-POPs alternatives based Integrated Vector Pest Management

Date: 16/11/2021 to 30/11/2021
Time: 02:30 PM to 05:30PM



Ministry of Environment, Forest and Climate Change

Table of Content

List of Abbreviations

BCC	Behaviour Change Communication
Bti	*Bacillus thuringiensis var. israelensis*
CCHF	Crimean-Congo Haemorrhagic Fever
CPCB	Central Pollution Control Board
CSIR	Council of Scientific & Industrial Research
DDT	Dichlorodiphenyltrichloroethane
EC	Emulsifiable Concentrate
FFS	Farmer Field School
GEF	Global Environment Facility
GoI	Government of India
HIL	Hindustan Insecticide Limited
ICMR	Indian Council of Medical Research
IEC	Information Education and Communication
IGRs	Insect Growth Regulators
IRS	Indoor Residual Spraying
IVM	Integrated Vector Management
IVPM	Integrated Vector and Pest Management
JE	Japanese Encephalitis
KFD	Kyasanur Forest Disease
LLINs	Long Lasting Insecticidal Nets
MoCF	Ministry of Chemicals and Fertilizers
MoEFCC	Ministry of Environment Forests and Climate Change
MoEFCC	Ministry of Environment, Forest and Climate Change
NEERI	National Environmental Engineering Research Institute
NIP	National Implementation Plan
NVBDCP	National Vector Borne Disease Control Programme
POPs	Persistent Organic Pollutants
RMRIMS	Rajendra Memorial Research Institute of Medical Sciences
RNA	Ribonucleic Acid
RPU	Rational Pesticide Use
SC POPs	Stockholm Convention on Persistent Organic Pollutants
SIT	Sterile Insect Techniques
UNEP	United Nations Environment Programme
VBD	Vector-Borne Disease
WDP	Water Dispersible Powder
WHO	World Health Organization
WP	Wettable Powder
ZIKV	Zika Virus

1. Introduction

Stockholm Convention (SC) is an international treaty works for the protection of human health and environment from harmful Persistent Organic Pollutants (POPs). The Government of India (GoI) signed the Stockholm Convention on POPs and the Ministry of Environment, Forests and Climate Change (MoEFCC) was assigned as the National Focal Point. India has committed to fulfilling its obligations under the Convention, prepared its National Implementation Plan (NIP) and submitted it to the Secretariat of the Stockholm Convention on 21st April 2011. India assured in the NIP, that the development and promotion of non-POPs alternatives to DDT is one of the top priorities that require immediate action. Accordingly, the project entitled "**Development and promotion of non-POPs alternatives to DDT**" was jointly developed by United Nations Environment Programme (UNEP) and United Nations Industrial Development Organization (UNIDO). The project was approved by Global Environmental Facility (GEF) in April 2015 with two GEF implementing agencies *i.e.,* United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP), which are responsible for supporting delivery of specific project components. Following are the major project components to be implemented under the project:

I. Legislation, policy framework and institutional capacity (UNEP)
II. Alternatives to vector control (UNIDO)
III. Promotion and propagation of new cultivars of Neem (UNIDO)
IV. Development and Promotion of Integrated Vector Pest Management (IVPM)
V. Monitoring and evaluation of results (UNIDO / UNEP)

For components I and IV, MoEFCC has nominated Central Pollution Control Board (CPCB) as a national Executing Agency to look after a partial execution of the project. As per the project document, the other part will be executed by the UNEP Law Division. The components of UNEP prescribe broadly Legislative framework and development, and pilot application of a set of Guidelines for Integrated Vector and Pest Management. UNIDO is working on the development of non-POPs alternatives to DDT viz. Long-Lasting Insecticidal Nets (LLIN), Neem based insecticides, *Bti* based pesticides under its two components.

The Global Environment Facility (GEF) was established to tackle our planet's most pressing environmental problems. The GEF supports countries to build capacity for the implementation of the Stockholm Convention through introduction and demonstration of viable, cost-effective and sustainable alternatives to eliminate dependency on DDT and other POPs chemicals.

The United Nations Environment Programme (UNEP) is the voice for the environment and the primary driving force for international activities related to the sound management of chemicals in the United Nations system. The UNEP promotes chemical safety by providing policy advice, technical guidance and capacity building to the developing countries. UNEP Chemicals Branch has the leadership of the Global Alliance for the Development and Deployment of Alternatives to DDT. As such, UNEP is a well-placed partner with other organizations to phase out current use and avoid future practices of DDT use in India.

The Directorate of NVBDCP, central agency responsible for guidelines, policy for prevention and control of vector-borne diseases in India has been implementing the Integrated Vector Pest Management (IVPM) strategy for effective management of vectors. It recommends Indoor

Residual Spray (IRS) and Insecticide Treated Bed Nets (ITNs)/Long lasting Insecticide Net (LLIN) for vector control in rural areas and anti-larval measures in urban areas.

IVPM is a tool for managing vector population to reduce or interrupt transmission of disease. IVPM is a way forward to improve cost-effectiveness, ecological soundness and sustainability of disease vector control. It emphasizes that the insecticides used in the programme must have negligible adverse human health effects, must be effective against the target species, must have minimal effect on non-target species and natural environment and their use must take into account the need to prevent the development of resistance. Key stakeholders involved in the project are the three Ministries viz. Ministry of Environment, Forests and Climate Change (MoEFCC), Ministry of Chemicals and Fertilizers (MoCF), and Ministry of Health and Family Welfare (MoHF&W) whose mandates and roles are given below:

The Ministry of Environment, Forests and Climate Change (MoEFCC) is the nodal ministry for planning, promoting and coordinating environmental programmes including the management of chemical disasters in India. The Ministry is mandated to protect the land, air and water systems and is responsible for the prevention and control of pollution including hazardous substances. MoEFCC is the GEF and Stockholm Convention focal point in the country, which coordinates activities and cooperation between relevant stakeholders of the NIP.

The Ministry of Chemicals and Fertilizers (MoCF) is mandated to control the production and scaling up of alternatives to chemical pesticides. The Department of Chemicals and Petrochemicals of MoCF is entrusted with the responsibility of policy, planning, development and regulations of chemicals and petrochemicals. The public sector named HIL under the MoCF is involved in the production, scaling up and setting up of the facility for industrial production of the alternatives, viz. production of synthetic pyrethroids, production of Long-Lasting Insecticidal Nets (LLINs), neem-based botanical pesticides and *Bti*-based biopesticides.

The MoHF&W mainly performs advisory role for matters related to public health including vector control programme in the country. The Ministry is responsible for the application, assessment and adoption of alternatives in public health activities; the State Health Departments coordinate and implement the project activities at the respective state level for the evaluation and assessment of newer alternatives to DDT in the field on the target pest; the National Vector Borne Disease Control Programme (NVBDCP), National Institute of Malaria Research (NIMR) and the National Centre for Disease Control (NCDC) undertake activities at the national level and make recommendations on the newer alternatives for adoption at the country level.

The Central Pollution Control Board (CPCB) provides technical services to the Ministry of Environment, Forests and Climate Change of the provisions of the Environment (Protection) Act, 1986. Principal functions of the CPCB are a) to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution and b) to improve the quality of air and to prevent, control or abate air pollution in the country. The United Nations Environment programme (UNEP) identified CPCB as executing agency for the project.

National Environmental Engineering Research Institute (NEERI), Nagpur is a constituent of Council of Scientific & Industrial Research (CSIR), New Delhi and has a nationwide presence with its five zonal laboratories at Chennai, Delhi, Hyderabad, Kolkata and Mumbai. NEERI is engaged in the research and development of better and scientific solid waste management practices, for more than four decades. It has research and development thrust areas viz. Environmental Health and Environmental Impact & Risk Assessment, etc. As CSIR-NEERI is endorsed as a Stockholm Convention Regional Centre (SCRC) on Persistent Organic Pollutants (POPs), it has been identified for implementing the components IV and V of the project. Accordingly, CPCB, the executing agency (EA) sub-contracted the project to the CSIR-NEERI, Nagpur.

2. Training Objectives

At the end of the training programme, the participants should be trained to:

- Define the vector, describe the morphological characteristics of adult and immature stages of mosquitoes and about the biology and ecology of vectors.
- Describe the vectors and their role in Vector-Borne Diseases, the basic information about vector-borne diseases, how vector-borne diseases are transmitted, transmission cycle for respective vector-borne diseases and global distribution as well as the burden of the diseases in India.
- Promotions and development of locally safe, effective, affordable and environmentally sound alternatives to DDT, Environment management methods for vector control: Biological control methods, Genetic control methods, Control of vectors by chemical, non-chemical methods, Natural and conventional vector control management strategies.
- Learn the role of Integrated Vector and Pest Management (IVPM), describe different control measures used to control vectors and pests, learn organization and management of IVM in different sectors including FFS and how IVM improves the awareness in the community through BCC.

3. Training Programme

This online training programme was conducted for 10 days for a period from 16/11/2021 to 30/11/2021, the total number of the training sessions were 10 and each session has 3 or 6 training parts. 33 participants from Karnataka states were selected including SPOs, DMOs, Zonal Entomologists, entomologist IDSP and DVBDC participated in the training programme. Dr. L. J. Kanhekar coordinated all the training sessions and Dr. Gujju Gandhi welcomed all the speakers/training experts. The training content covered from Training module-1: DDT and Vector-borne disease, Training module-2: Vector morphology and bionomics, Training module-3: Alternatives to DDT in vector control management and Training module-4: Integrated vector and pest management developed by CSIR-NEERI under the project "Development and promotion of non-POPs alternatives to DDT".

4. Training programme - Inaugural Function

Welcome Address

Inaugural function of the 5th online training for Pilot testing of Modules and ToT (SPOs, VBD Consultants & Entomologists from Karnataka State) to promote non-POPs alternatives based Integrated Vector Pest Management was held on 16th of November 2021, in an online mode via MS Teams, between 14:30 to 17:30; by CSIR-NEERI, Nagpur, Chemical and Hazardous Waste Management Division (CHWMD). **Dr. A. Ramesh Kumar** (Project Leader and Senior Scientist, CHWMD) welcomed **Dr. Ved Prakash Mishra** (Chief Guest), Director, HSMD, MoEF & CC, and other dignitaries and team members as well as all the participants on behalf of CSIR-NEERI. He explained about this GEF-UNEP funded project and 10 days online training programme which is organised for State Entomologists, State Programme Officer's & District Malaria Officer's as well as all those who are involved in the vector control activities. He also informed that CSIR-NEERI have organised 4 training programmes, so far and this 5th online training Programme especially for Karnataka state. The dignitaries/ experts present were **Dr. Ved Prakash Mishra**, Director, HSMD, MoEF&CC, Delhi; **Dr. Jitendra Sharma**, Programme Management Officer, UNEP; **Dr. Ramesh K. Kaulgud,** SPO I/c, Directorate of Health & FW Services, Karnataka, **Dr. M. Sharif,** Director, NVBDCP, Karnataka, **Smt. Bhavana**, State Entomologist, Karnataka.

Welcome address was given by **Dr. Atul N. Vaidya**, Co-ordinator (Stockholm Convention Regional Centre, CSIR-NEERI) and Chief Scientist & Head (CHWMD) on behalf of **Dr. S. Chandrasekhar**, Director CSIR-NEERI. He welcomed **Dr. Ved Prakash Mishra**, Director, HSMD, MoEF&CC, Delhi; **Dr. Jitendra Sharma**, Programme Management Officer, UNEP, all the team members as well as all the participants from Karnataka state. He briefly introduced about the programme & its components and also introduced about the establishment of NEERI in 1958 at Central Public Health Research Engineering Institute (CPHREI) primarily concerned with health sector. Later, CPHREI was renamed as National Environmental Engineering Research Institute (NEERI) concerned with environmental impacts of Persistent Organic Pollutants (POP's), chemical, hazardous waste management issues and therefore, NEERI was recognized as Stockholm Convention Regional Centre in 2011. He briefly introduced about development of training Modules (1-4): Introduction of Non-POPs alternatives to DDT and Vector Borne Diseases; Vector Morphology and Bionomics; Alternative for DDT in Vector Control Management; and Integrated Vector and Pest Management for ToT's, SPO's, DMO's, entomologists etc. in different states across the country, under the guidance of National Vector Borne Disease Control Programme (NVBDCP).

Dr. Jitendra Sharma, Programme Management Officer, UNEP (implementing agency) has given brief overview of the project and its objectives. He explained the four components of this project: 1) Legislation, policy framework and institutional capacity (UNEP); 2) Alternatives to vector control (UNIDO); 3) Promotion and propagation of new cultivars of Neem (UNIDO); 4) Development and Promotion of Integrated Vector Pest Management (IVPM) (UNEP); 5) Monitoring and evaluation of results (UNIDO / UNEP). UNIDO is the leading agency for this project. He informed that the Ministry has nominated CPCB as executing agency and work closely with CSIR-NEERI on technical aspects of the project. He suggested that outcomes of

the project should not only be project specific but must have long lasting effects for many years and support the country in controlling vectors and helps other countries to completely phase out DDT in vector control. He also praises decline of DDT consumption from 10,000 Tonnes to 1100 tonnes by the country, which is remarkable achievement. He congratulated the CSIR-NEERI and its expert team work in revising of training modules (1-4), as well as conducting training programme.

Dr. Ved Prakash Mishra, Director, HSMD, MoEF & CC, Delhi inaugurated the 5th online training for Pilot testing of Modules and ToT from Karnataka State and briefly explained about the overview of the project and role of MoEF & CC in this project. The Ministry has nominated CPCB as executing agency for this project and explained its function to evaluate the work progress regularly. He explained the importance of CSIR-NEERI for his work in Development & promotion of non-POP's alternatives to DDT for environment as well as for the people. He suggested to develop new technology for sustainable alternatives to POP's/ DDT and reduction or elimination dependence of DDT. He also praises CSIR-NEERI work based on Integrated Vector and Pest Management (IVPM) for the development of Bio-based, Neem-based pesticides, long lasting Insecticidal nets (LLIN's) and other alternatives. **Dr. A. Ramesh Kumar** proposed the vote of thanks at the end of the day 1 training session.

5. Training sessions

The total training sessions were 10, each session covered several parts and each part was conducted for approximately 30-40 minutes, the time was managed depending on a questionary discussion in end of the session. Every session was conducted in the afternoon from 2.30 pm to 5.30 pm.

5.1 Training session-1 (Day – 1 (Tuesday) 16/11/2021)

Training part - 1: Introduction to Modules 1 to 4

Dr. L. J. Kanhekar briefly introduced about the training modules 1-4 and its content. He informed that training modules were made available to all the participants in form of training module booklets, PPT on each module & its content, IEC materials, awareness brochures and FAQ's. He deliberated the focus of CSIR-NEERI on successful implementation of pilot testing of these training modules (1-4). He suggested to all the participants to provide suggestion/ comments as far as to make these training modules more usable/ effective.

Training Modules 1 to 4

Training part - 2: Introduction to DDT and its use in vector control

Dr. A. Ramesh Kumar briefly explained regarding this GEF funded project & its five component and role of CSIR-NEERI in implementing two of the five components. During his training session the contents covered were introduction regarding Stockholm convention on POPs., what is DDT, its structure (Ortho-Ortho, Ortho-Para & Para-Para isomers); physicochemical and its current production status (drastic change in DDT production from more than 10000 MT/year to 2000 MT/year; currently, Hindustan Insecticides Ltd., Maharashtra is the sole manufacturer of DDT (IRS) in India) and usage in vector control management (Technical grade DDT 50 % for use in India and DDT 75% for export purposes mostly African countries). State-wise (North-East states, Jharkhand, Chhattisgarh, Punjab, Rajasthan, UP, West Bengal) supply of DDT in the year 2019-2020 in India was discussed. He also discussed the overall objective of UNIDO/UNEP in this project is to introduced bio & botanical pesticides and other locally appropriate, cost-effective alternatives to DDT by ensuring reduction/ elimination of dependence on DDT, ensuring food safety, enhancing livelihood & protecting human environment. UNIDO has developed alternatives to DDT such

as Neem coils, neem larvicides, LLIN's, Bti based pesticides etc. He also discussed about Integrated Vector and Pest Management adapted by several countries to minimize/ reduce the use of POP's and present legal status of POPs and their use in pesticides and insecticides in India. He requested to all the participants to get maximum benefit of this training, it is not just a training programme but a capacity building programme and also requested to attend the lectures carefully & raise questions/ queries/ comments/ suggestions.

Training part - 3: Introduction to vector borne diseases: Malaria

Dr. R. S. Sharma has appreciated CSIR-NEERI for teaching material provided on this training programme. He deliberated this training session, a brief introduction about the vector borne diseases (Malaria: Global public health problem) and its impact. Causative agents of Malaria: *Plasmodium* Parasite (*P. Falciparum, P. vivax, P. ovale, P. malariae*) & its life cycle: Asexual & Sexual cycle; Vectors: Female Anopheles Mosquitoes (globally more than 70 vectors recorded out of which 9 in India (6- primary & 3- secondary vectors); Host: Human; Current status according to National Strategic Plan: Malaria elimination mode supported by organisation like NVBDCP, NCDC, NIMR etc., as per National framework for malaria elimination cases has been gradually decreasing from 2006 to 2020 approx. 70% decline, Global disease burden and burden in India: India has contributed 70% of cases in the South Asian region which is 3-4 % of total contribution globally, signs & symptoms and transmission of Malaria (Extra domestic and Urban); Malaria ecosystem: Malaria system & Malaria sub system (Abiotic factor: Temperature, rainfall, Humidity & Biotic factors: Parasite & Mosquitoes & their interaction); He deliberated regarding WHO documentation on Malaria elimination framework for Urban area; He conducted an interactive session with the participants where he asked various topic related questions.

Training part-4: Introduction to vector borne diseases: Japanese Encephalitis

This training part was covered by **Dr. P.T. Joshi** and content covered was learning objectives of training module-1, brief explanation about the introduction of Japanese Encephalitis (it's a vector borne disease occur in wider area of Russia, Korea, Japan, China, Indonesia (south) & India (West), in last two decades epidemiological pattern/ distribution has changed from Japan, Korea, China and increased towards Bangladesh, Burma, India, Nepal, Thailand & Vietnam), Causative agents: a virus (Flavivirus); Vectors: *Culex tritaeniorhyncus, Cx. gelidus, Cx. vishnui* etc.); signs & symptoms (According to WHO, a headache, high fever, tremors, nausea, vomiting); Host: primarily animal, birds & human incidentally and transmission of vector borne diseases (Natural transmission, horizontal & vertical transmission); Indian and global disease burden.

5.2 Training session - 2 (Day - 2 (Wednesday) 17/11/2021)

Training part - 1: Introduction to vector borne disease: Lymphatic Filariasis

Dr. P. K. Srivastava covered this training part, contents covered were introduction of VBDs (Lymphatic Filariasis), introduction to Lymphatic Filariasis, its causative agent (Filarial worm: Wuchereria bancrofti, Brugia Malayi), Microfilaria periodicity (Nocturnal Periodicity, Diurnal Periodicity), human filarial parasites, transmission cycle (in human and mosquito body),

external morphology of the vector (egg, larva, pupa and adult), Vector: *Culex quinquefasciatus, Mansonia annulifera, Mn. uniformis*. He also discussed national and global burden of Filariasis, its history in India, salient features of the vector life cycle, elimination of Lymphatic Filariasis, Species of filarial infections prevalent in India, current status of Lymphatic Filariasis in India, difference in *W. bancrofti* and *B. malayi* species, Filariasis disease manifestation (acute & chronic), Paradigm shift in LF control (Fig.-1), Elimination strategy: 1997 and guidelines about elimination of Lymphatic Filariasis in India (Fig.-2) and Endemic urban & Rural area- 2019 Triple Drug Therapy with IDA.

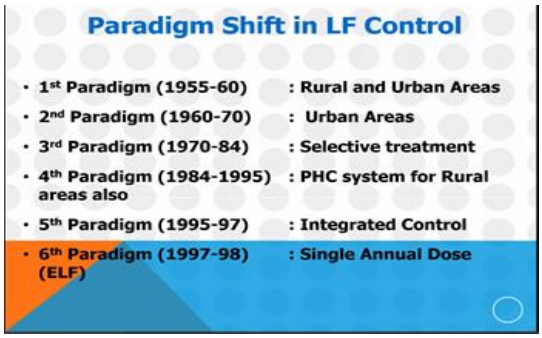


Fig.-1 Paradigm shift in LF control

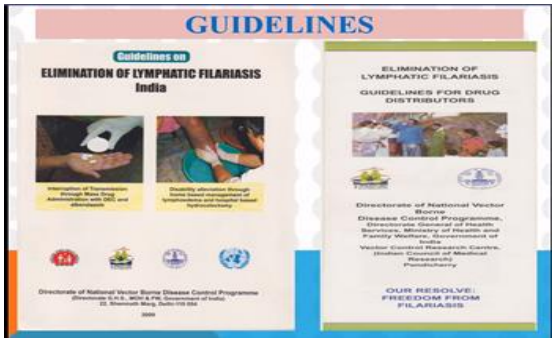


Fig.- 2 guidelines elimination of Lymphatic Filariasis

Training part – 2: Introduction to vector borne disease: Dengue, Chikungunya & Zika

This training part was introduced by **Dr Kalpana Baruah** and content covered was learning objectives of training module-1, brief explanation about the introduction of VBD's like Dengue, Chikungunya and Zika; What is Dengue? It's form (Dengue fever and severe dengue), Dengue fever symptoms: abrupt onset of high fever, severe frontal headache, muscle & joint pain, rashes over chest and upper limbs; Causative agent: Flavivirus (Four strain- DEN-1, DEN-2, DEN-3 & DEN-4); Vector: *Aedes* Mosquitoes (Primary- *aegypti* & Secondary- *albopictus*); Transmission cycle of Dengue: Forest/Enzootic, Rural/Epidemic & Urban/Endemic/Epidemic; Burden in India and global burden (Fig.-3).

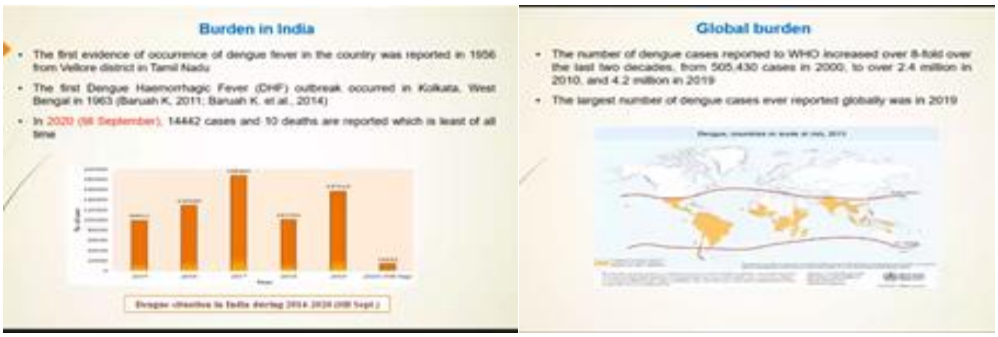


Fig.-3 Dengue: Burden in India and global burden

Introduction to Chikungunya & its symptoms: fever, chills, headache, nausea, vomiting, severe joint pain, rashes; Causative agent: Alphavirus; Vectors: *Aedes* Mosquitoes (a*egypti*, *albopictus, furcifer* & *africanus*); Transmission cycle of Chikungunya: Sylvatic CHIKV transmission and Urban CHIKV transmission; Burden in India and global burden (Fig.-4)

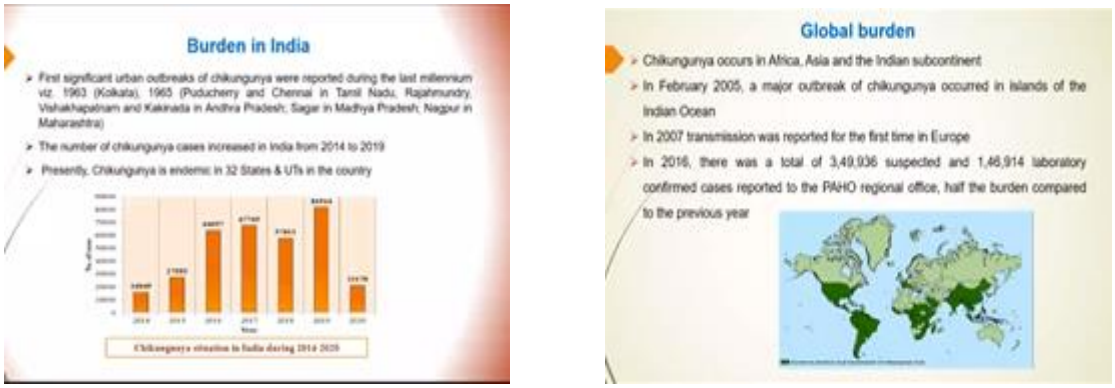


Fig.-4 Chikungunya: Burden in India and global burden

Introduction to Zika, History: 1st isolated in 1947 from a rhesus monkey in Kampala, Uganda from Aedes Africanus mosquitoes and its sign & symptoms: high fever, Malaise, stomach ache, Diarrhoea, conjunctivitis, Dizziness, Anorexia; Causative agent: Flavivirus; Vectors: *Aedes* Mosquitoes (*aegypti, albopictus, vitattus, furcifer, africanus*); Birth complications: Microcephaly, Gulllain-Barre syndrome; Incubation and Viremia- incubation period of zika virus 3 to 14 days; Transmission of Zika virus: Vector transmission and Non vector transmission; Burden in India and global burden (Fig.-5).

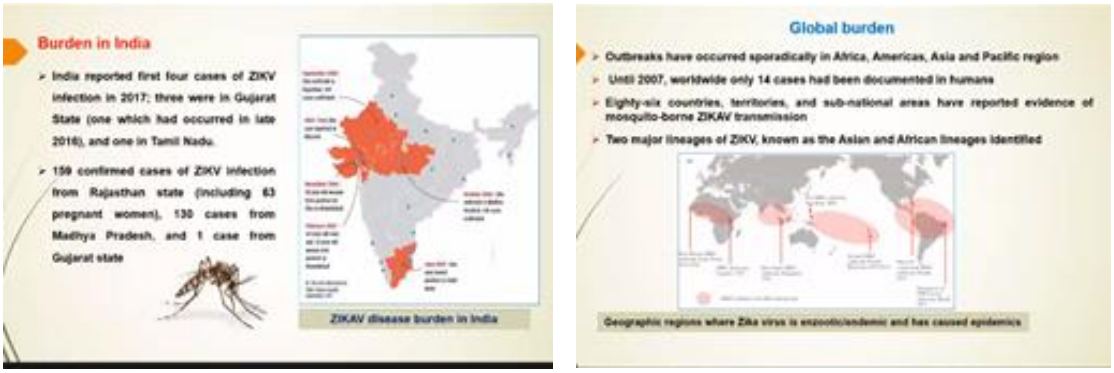


Fig.-5 Zika: Burden in India and global burden

Training part - 3: Introduction to vector borne disease: Scrub Typhus

Dr. T Ratna Joseph gave lecture on Section-9 (Scrub Typhus) of Chapter-2 of Training module-1. Brief introduction of Scrub typhus: History- First observed in 1899 in Japan as Tsutsugamushi fever; Causative agent: a gram-negative, obligate intracellular bacterium Orientia; Vector: Mites genus- *Leptotrombidium diliense*; Transmission: Trans-stadial and trans-ovarial transmission; Life cycle of mites: Egg→Larva→Nymph→Adult; Sign & symptoms: high fever with chills, enlarged lymph node, rash, necrosis, Eschar; Diagnosis & treatment: diagnosis bases on bacterial culture, serology, molecular methods-rapid ICT, ELISA, PCR test, Antibiotics such as Azithromycin, Doxycycline are prescribed drugs & other effective drugs: chloramphenicol and tetracycline; it is a zoonotic disease and humans are accidental hosts; Epidemiology & control: scrub typhus originally found in scrub jungles, also present in sandy beaches, mountain deserts & equatorial forests; prevention & control by avoiding such places, wear protecting clothing/PPE, controlling rodent population, topical application of DMP, DEET etc. Burden in India and global burden (Fig.-6).

Fig.-6 Scrub Typhus: Burden in India and global burden

Training part - 4: Introduction to vector borne disease: Leishmaniasis (Kala-azar)

Dr. Vijay Kumar (consultant ICMR) gave brief introduction of Leishmaniasis (Kala-azar): is wide spread tropical disease caused by protozoan parasite, which is spread by bite of phlebotomine sand fly vector, it causes: Cutaneous Leishmaniasis, Muccocutaneous Leishmaniasis and Visceral Leishmaniasis & post kala azar dermal leishmaniasis (PKDL); Causative agent: Protozoa Leishmaniasis (*L. donovani*- in India only, *L. infantum* and *L. chagasi*); Vector: only sand fly vector of kala-azar in India Phlebotomus argentipes; Life cycle within human (Amastigote) and Sand fly (Promastigate/ flagellate), Environment factors: altitude, season, rural areas, development projects; Burden in India and global burden (Fig.-7).

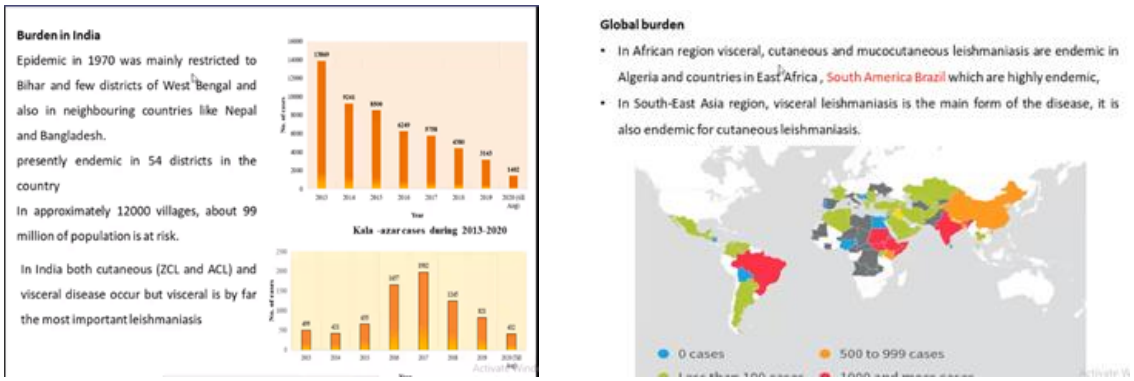


Fig.-7 Leishmaniasis: Burden in India and global burden

Training part - 5: Introduction to vector borne disease: Crimean Congo Hemorrhagic Fever

The training part of introduction to Crimean Congo Haemorrhagic Fever (CCHF), was covered by **Dr. K. Regu**, the contents covered were introduction about CCHF (an acute, highly contagious and life threatening), history of CCHF (1st outbreak in India was reported in 2011 in Gujarat other states were Rajasthan, U.P.), causative agent (Nairovirus of the family Bunyaviridae and vector- *Hyalomma* ticks), transmission (Transovarial and transstadial transmission), epidemiology and risk factor: occupation associated with animal husbandry, agricultural & agropastoral activities, tick exposures and health care workers; Tick life cycle: Egg→Larva→Nymph→Adult; *H. anatolicum, H. asiaticum, H. dromedarii, H. impeltatum, H.*

marginatum, *H. rufipes*, *H. truncatum*, *H. turanicum* recognised as potential vectors for acquiring, maintenance and transmission of CCHFV; Clinical manifestation: Incubation period 3 to 12 days, headache, fever, joint pain, stomach pain & vomiting. Control: wearing protecting clothes, use appropriate acaricides and approved repellent.

Training part - 6: Introduction to vector borne disease: Kyasanur Forest Disease

Dr. N. Balakrishnan (Joint Director retd., NCDC) gave a lecture on Kyasanur Forest Disease (KFD). He deliberated about history of KFD (1st outbreak recorded in 1957 in Shimoga District of Karnataka). He discussed about agent of the disease (Group Toga virus/ flavivirus), its natural host (Rodent/ small mammals) and Vector (*Haemophysalis spinigera & H. turturis*), amplifying host *(Presbytis entellus/ Macaca radiata*), reservoirs: cattle, dogs & other domestic animals; Life cycle of ticks: Egg→Larva→Nymph→Adult; Transmission: transstadial mode (nymphal stage ticks), incubation period- 3 to 8 days; Environmental factors: Tropical evergreen, deciduous forest, disease in man occur in dry months and disease & death in monkey similar case; Symptoms and Detection: Headache, red eyes, fever, bloody nose, joint pain, muscle aches and detection of virus in blood serology; National burden (Fig.-8); preventive measures: advise not to go to the forest where monkey death reported, Hot spot spray- Malathion powder, use of tick repellent- DMP (dimethyl phthlate) oil, KFD vaccine. Early diagnosis and prompt treatment- help to reduce the human mortality.

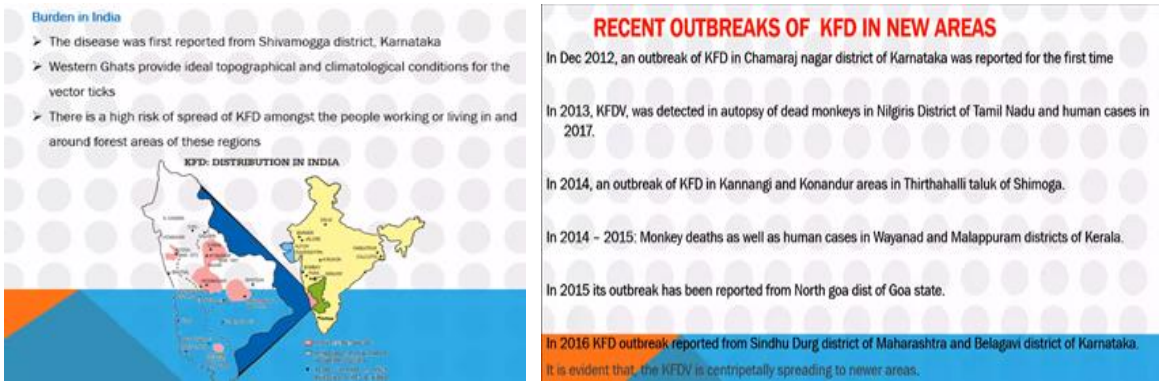


Fig.-8 KFD: Burden in India

5.3 Training session-3 Day 3 (Thursday) 18/11/2021

Training part - 1: Introduction to vector borne disease: Plague

On the third day, **Dr. N. Balakrishnan** covered Introduction to vector borne diseases. The content covered was introduction about plague. He covered various topics like its introduction (Zoonotic disease primarily of rodent, causative agent: Yersinia Pestis- Gram -ve bacteria); Vectors: *Xenopsylla cheopis, X. brasiliensis*; Reservoirs: Tatera Indica, Bandicota bengalensis; Susceptible hosts: *Rattus rattus, Mus musculus, Bandicota indica*; historical background (1st plague pandemic was in 542 B.C., final & most recent pandemic occur in 1984- China Yunan province), re-emerging plague, its current global status and types of plague (Bubonic plague, Pneumonic plague, Septicemic plague). He also deliberated on current status of plague in India, cases and deaths occurred due to it, plague surveillance network (Rodent, Blood, Organ, Dog sera, Human blood, fleas; surveillance methodology (bacteriology, Serology, molecular &

entomological), surveillance-investigation of seas and airports and endemic plague foci in India (1951), treatment, vector control, etc.

Training part - 2: Morphology of vector mosquitoes

Dr. L. J. Kanhekar deliberated in this training part, before starting the lecture he discussed the learning objectives of training module-2, Introduction to mosquito vectors: *Anopheles, Culex, Aedes and Mansonia* spp.; classification of mosquitos (arthropods, class-insecta, order-diptera & family- culicidae), morphological characters of mosquitos (head, mouthparts, thorax, abdomen, wings etc.). Then he deliberated the lecture about vectors of malaria: *Anopheles* mosquito (*Anopheles culicifacies, An. stephensi, An. fluviatilis, An. minimus, An. dirus, An. epiroticus, An. varuna, An. annularis, An. philippinesis*), morphological characters, classification (egg, larva, pupa and adult), vector biology and ecology (life cycle of *Anopheles*); vectors of lymphatic filariasis / Japanese Encephalitis: *Culex* spp. Most important vector of LF and arboviral disease such as JE, *Culex* vector: Cu. Quinquefasciatus, Cu. Tritaeniorhynchus, Cu. Pseudovishnui, Cu. Vishnui; External morphology- Adult, egg, larvae, pupa; Vector of Brugian filariasis transmitted by Mansonia Mosquito (*Mn. annulifera, Mn. uniformis and Mn. indiana*) & its external morphology (egg, larva, pupa, adult); Vectors of Dengue, Chikungunya, and Zika: Two medically important species viz *Aedes aegypti* & *Ae. albopictus*. *Aedes* generally found in tropical & sub-tropical zones; external morphology of vector: Adult (Head, Thorax- black, white; Abdomen- 8 segment, legs have a dark & white ring spot)

Training part - 3: Bionomics of vector mosquitoes

Dr. R. S. Sharma has deliberated this training session and covered topics - an introduction to bionomics: study of mosquito biology in relation to their distribution, habits- feeding habits, habitats, susceptibility towards insecticides and pathogens, complexity in sub species, site of transmission (intra, peri, extra, domiciliary sites), gonotropic cycle, flight range; information can be used in planning of vector control measures (Insecticides based interventions mainly LLIN's & IRS, which are core vector control interventions for malaria prevention- Endophagic & Endophilic); Eco-Epidemiological aspects: Interaction of various factors in transmission of malaria- Entomological factors (Vector density, frequency of biting man, longevity) & Environmental factors (Temperature, Relative humidity, Rainfall); variation of these factors produced variable endemicity (hypo, meso, hyper, halo) in different terrain system. He also discussed about malaria transmission: basic factors- Malaria parasite←→Vector←→Human Host; Concept of ecosystem: Terrestrial & aquatic ecosystem (adaptation, interdependence, carrying capacity & Interaction); Morphological adaptation: adapted to hot & dry climate- thermophilic species and adapted to wet climate- Hydrophilic species/ humidity loving; Epidemiological & Ecological consequences; morphology of eggs, life cycle of mosquitos, feeding behaviour; climate zones and natural distribution of malaria vectors in India; Epidemiology of diseases, vector composition, susceptibility, target population and environment; Vector Succession and Vector Disappearance (Fig.-9).

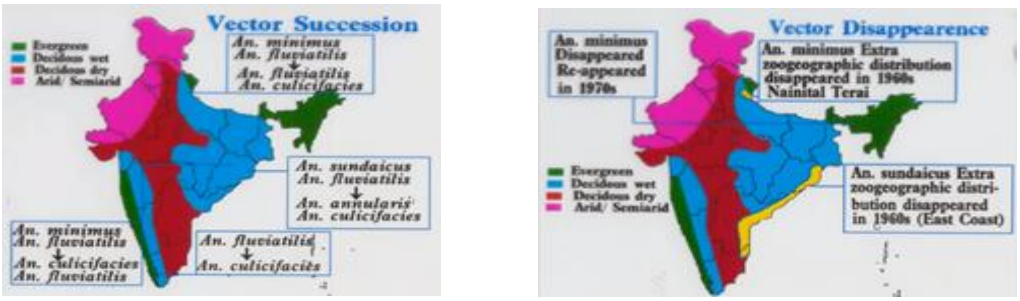


Fig.-9 Vector Succession and Vector Disappearance

Training part-4: Morphology and bionomics of Sand flies

Dr. Vijay Kumar, has deliberated this training session with a brief introduction of vector of kala-azar/Leishmaniasis disease: disease caused by protozoan parasite; *Phlebotomus argentipes* only known vector of visceral leishmaniasis or kala-azar in India and *Phlebotomus papatasi*- vector of cutaneous leishmaniasis for human. He also discussed about Classification of Sand Fly; external morphology- Adult (Head, Thorax, Abdomen & wings are densely covered with long hairs); vector biology: complete life cycle – eggs to adult (1 to 2 months); Vector ecology: Distribution South East Asia, Bangladesh, Nepal, Bhutan, Sri Lanka and in India- East Bihar, West Bengal to Kanyakumari; Breeding places, resting habits, feeding habit, biting habit, flight range; Types of parasite development: Suprapylarian development, Peripylarian development & Hypopylarian development.

Training part-5: Morphology and bionomics of Flies, Fleas

In the last training session of the day, **Dr. Amit Katewa** deliberated lecture about the morphology and bionomics of vectors of the enteric diseases. He briefly explained about fleas (small wingless insect with a characteristic jumping movement), about 2500 species in about 220 genera, 37 species known to occur in India; *Xenopsylla spp.* Medically important flea (vector of plague and murine typhus); Plague: an infectious disease caused by *Yersinia pestis*; classification and external morphology (size 1-6 mm, body divided by Head, Thorax-wing absent & 3 pair of powerful legs and abdomen). He made us understand the difference between male & female vector, Life cycle of Flea: Egg→Larva→Pupa→Adult; adult live in their cocoon for 4-12 months, ideal temperature for *X. cheopis* 65^{o} F to 80^{o} F. He also deliberated introduction on House Fly (Musca), can be a vector of Helminths, faecal bacteria, protozoan & viruses resulting in the spread of enteric diseases- gastrointestinal tract; classification of House fly: 4200 species, 190 genera, almost 70 species of house flies belonging to genus Musca. He also discussed on morphology of the house fly and its life cycle: Egg→Larva (Maggot)→Pupa→Adult.

5.4 Training session-4 (Day – 4 (Monday) 22/11/2021)

Training part - 1: Morphology and Bionomics of Ticks and Mites

Dr. T Ratna Joseph (Medical Entomologist) deliberated about the training modules-II: Vector morphology and bionomics of Ticks and Mites. He introduced about Ticks (obligate,

ectoparasites belong to class: Arachnida with more than 900 spp.) and its classification (3 families: Ixodidae-hard ticks, Argasidae-soft ticks and Nuttalliellide- limited to Tanzania & South Africa); capable of transmitting diseases: Lyme disease, tick borne encephalitis, Tularaemia Crimean-Congo Hemorrhagic Fever (CCHF), Kyasanur Forest disease (KFD); Type of ticks: Soft ticks and Hard ticks (Fig.-10), life span (soft ticks- 15 yrs & hard ticks- about 3 yrs.), their external morphology (soft ticks: flattened dorso-ventrally, 8-13 mm long, mouthparts(capitulum), 4 segmented Palps, Genital aperture opens b/w the base of 1st & 2nd pair of legs); Biology & Ecology- Life cycle of soft ticks: Eggs→Larvae (6 legged)→Nymph (8 legged)– 4 instar→Adult (complete life cycle takes about 6-12 months), population depends on various factors: climate, hosts, predators & competitors; Hard ticks (Ixodid): worldwide distribution (14 genera & more than 702 species among them *Amblyoma, Dermacentar, Haemaphysalis, Hyalomma, Ixodes, Rhipicephalus* having medical importance); External Morphology: adults are dorso-ventrally, Oval in shape, 2-23 mm long, capitulum/ false head projects from the body, females are usually bigger than males, Club shaped Palps, Scutum (larger in males), Life cycle of hard ticks: Eggs→Larvae (6 legged)→Nymph (8 legged)→Adult (complete life cycle takes about 2-4 years depending on species & availability of hosts), Adult shelters under stones and surface vegetation- plant roots & life span- about 3 years; key difference between soft ticks and hard ticks; tick-borne diseases in India. He also covered topic about Introduction of Mites (Class- Arachnids, Family- Trombiculidae, species: *Deliense, Pallidum, Fletcheri, Scutellare*), 6 Genera, more than 2000 species of trombiculid mites- only 20 spp. attack people, Life span is about 6 months, transmit Rickettsial Pox, Scrub Typhus, Dermatoses, chiggers and scabies; External morphology: adults are small (1-2 mm), segmented body into 2 tagmata: a prosoma (cephalothorax) and opisthosoma (Abdomen); Carapace, Capitulum, Palps & Thorax; *Leptotrombidium* is medically important species which is the vector of Scrub Typhus. Biology and Ecology: They found in fresh water and salt water, in the soil, in forests, agricultural crop, springs etc., they occupy wide range of ecological niche, eat wide variety of material: living and dead plant and fungal material, lichens; Life cycle: Egg→Larva (Prelarva)→Nymph- 3 instar→Adult (Life cycle takes 40-75 days but may differ due to environment); Larva also called ‘chiggers’ do not suck blood, feed on the lymph, other fluids & semi digestive tissues; they inject digestive enzymes through its ‘stylostome’, they remain attached to their hosts but *Leptotrombidium*- 3-10 days; females lay 1-5 spherical eggs on the grasses, leaves or bushes.

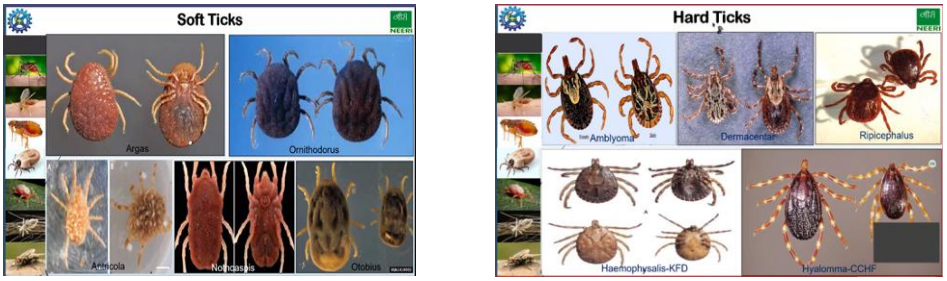


Fig.-10 Soft Ticks and Hard Ticks

Training part - 2: Entomological surveillance of VBDs

Dr. Himmat Singh, ICMR- National Institute of Malaria Research (NIMR) has deliberated on Entomological Surveillance of VBD's & its key elements: Introduction to Entomological Surveillance: Surveillance for vector is important in determining the distribution, population density, larval habitats and susceptibility to insecticides in order to prioritize vector control in time; Methods: detection & monitoring of larval and adult population- Collection of Adult mosquito: 1) Hand collection: suction tube (Aspirator)(indoor & outdoor), bait collection, Spray sheet collection, Trap collection- light trap, gravid trap, window, magoon & biogent mosquito trap, 2) Collection of adult Sand fly: Hand, Trap collection- sticky trap, light trap, funnel trap and Bait collection; 3)Larval collection method: Dipping, Netting, Collection Mansonia aquatic stage, Collection of inactive stage of Sand fly; Purpose of Collection: to collect information on – Presence & Distribution of mosquito species, Determination of breeding location, Seasonality of different mosquito, Ecology & Behaviour, Vector status, Biting Behaviour- Endophagic & Exophagic, Resting Behaviour (endophilly & exophilly) etc.; Types of collection: Adult collection (Hand, Total, Landing, Trap & catches outdoor), Larval collection (Dippers, well nets & using droppers) & Eggs (Surface of water & containers); Collection is based on Habitat, Behaviour, Response & Time; Methods- Qualitative (distribution data based on observations) and Quantitative (Numerical data: two types- Discrete & Continuous, Survey Research, Cross-sectional survey); Hand Collection- collection of resting mosquitoes on different surfaces & objective- to study resting habits & indoor density, Devices- Aspirators/ battery operated aspirators, paper cups, torch; Process: Selection of houses-10-20 houses normally be examined; Spray Sheet Collection: Collection of indoor resting mosquitoes after knock down by space spray (fine mist), Landing Collection: Collection while landing on the host to bite, Methods: Human- Ethical consent & Animal- Ethical consent; Trap Collections: collection of mosquitoes which are flying in search of food, shelter or egg laying sites, Objective- to study relative prevalence, Mosquito Behaviour, effect of residual insecticide or anti vector measures, Types of Traps: Fixed traps- Entry & Exit trap (Window, door, wall, eaves & veranda), Portable traps: mechanical devices, Funnel Traps- A Berlese or Tullgren funnel used to extract living organism, particularly arthropods, from samples of soil; Fixed-Exit traps: exit traps fixed on outside of windows, mosquito can enter inside trap while going outside; Magoon Trap (modified baited trap) and Veranda Trap; Tent Trap: baited with CO_2, Sugar baiting; Light Traps: source UV light; Vector Traps for disease surveillance: An Ovitrap is a device that mimic the preferred breeding site for container breeding mosquitoes, including *Aedes albopictus* and *Aedes aegypti*. To evaluate the impact of antiviral measures, to evaluate the impact of adulticide on larvae, collection of samples for taxonomic studies, Bio-assay test, Susceptibility test etc. Methods: Quantitative estimation, Netting method (surface collection), Dipping method; Larval collection method: Siphoning method (Tree hole), well net collection, Larva collection by dropper/ pipettes.

Training part - 3: Environment modification and manipulation (EMM)

Dr. R. S. Sharma, has deliberated this training session, the content covered was learning objectives of environmental management; Genesis of EMM in India; Malaria control: Pre DDT-era- after Ross discovery of mosquito transmission of malaria in 1897, then Govt. started malaria control activities by Environmental and Engineering methods. EEM (Fig. 10) is the management of aquatic habitats (water bodies) that are potential larval habitats for mosquitoes,

in order to prevent the completion of development of the immature stages; Some important vectors amenable to EMM approach: *Ae. aegypti*, in domestic containers, *An. stephensi* in urban wells and reservoirs, *An. culicifacies* in irrigation canals and pools; EEM technology Irrigation malaria; Environmental Management & it's component: change of the environment in order to prevent and reduce the vector productiveness and human contact with the vector-pathogen.

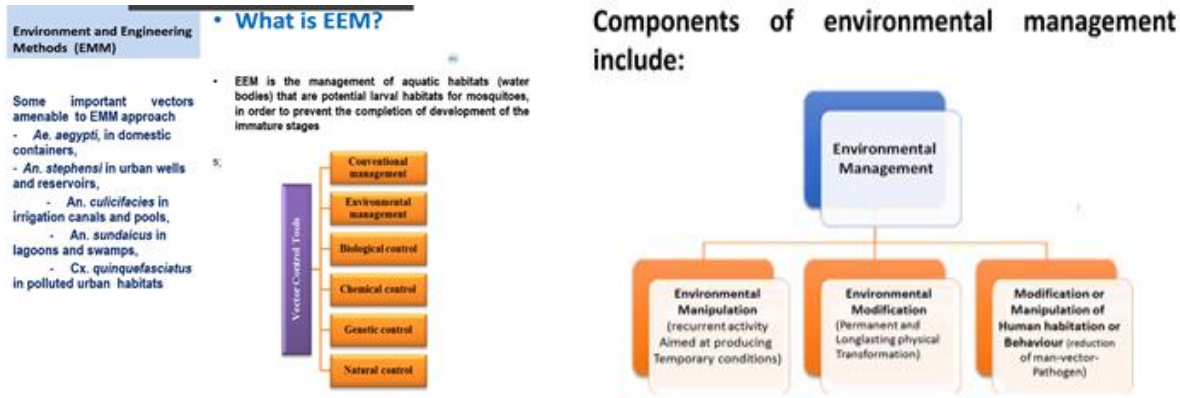


Fig.-11 EEM and its components

Environmental Manipulation and its types: Temporary changes to the vector habitats, such as Irrigation system, wet rice cultivation, controlled vegetation stream flushing, coastal flooding and impounding chemical and physical alteration and man-made lakes; Environmental modification and its types: any physical transformation that is permanent or long lasting, aimed at preventing, eliminating or reducing the vector habitats, such as Impundments, Irrigation, Natural stream, Drainage for agriculture, Landfilling and grading; EEM- Source reduction; Community based vector management: Environmental modification- control of immature stages of vectors- Improved water supply, Mosquito proofing of overhead tanks, cisterns or underground reservoirs; Environmental manipulation: management of essential & non-essential containers, Management/ removal of natural breeding sites; Environmental approach to vector control pre DDT; EEM for *Anopheles*- clear ground water; EEM for *Culex*: polluted ground water and rice fields; EEM was the primary method of malaria control: example vector control in Tea Garden- Assam (vector *An. minimus*)- Drainage as major tool/ shading of drains to eliminate breeding of *An. minimus*; Vector control in Delhi 1936-1940, EEM- Malaria reduction ranged from 76 to 98 percent and Delhi became a model city for demonstration of EEM Technology; Urban Malaria Control with EEM Technology and legislative vector control in 1928, EMM in Mumbai- Malaria control; Environmental control Sabarmati River's changing scenirio, Environmental modification Urban Malaria in Delhi 1961-2011 (50 yrs.) (Fig.-12), WHO-GVCR priority activities for Vector Control: NVBDCP/NMCP, Regional and international partners; Risk factor Urbanization, Construction activities, without HIA, Outbreak of Malaria (1996, 2005) Mangalore city; Petroleum project, IT & BT projects, Konkan Railway project; Impact of environmental change on distribution of the principal malaria vector *An. stephensi, An. culcifacies* and *An fluviatilis*. Farming and introducing model civic bye-laws and building bye-laws for prevention and control of vector breeding.

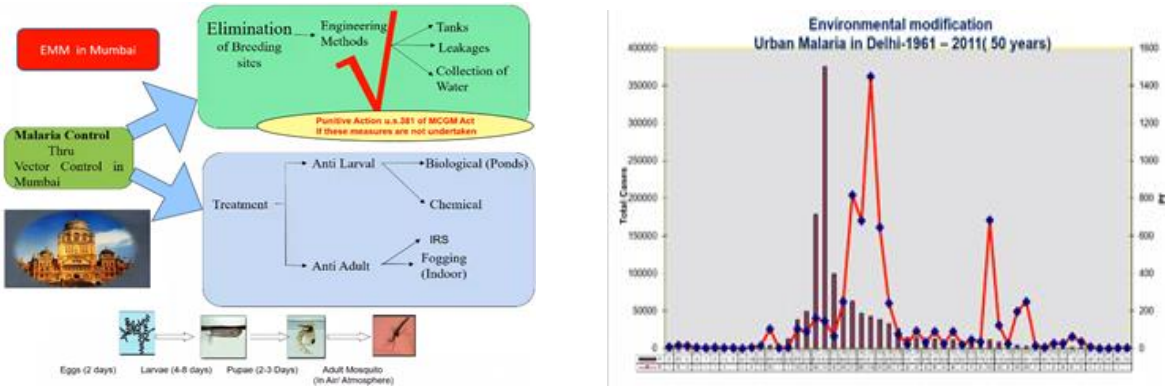


Fig.-12 Environmental Modification

5.5 Training session-5 (Day – 5) (Tuesday) 23/11/2021)

Training part - 1: Alternative to DDT vector control: Biological and Genetic Control

This training part was covered by **Dr. Ratna Joseph,** the topics covered in this lecture were Introduction: The control of Pests, including the vectors of human by direct/indirect use of

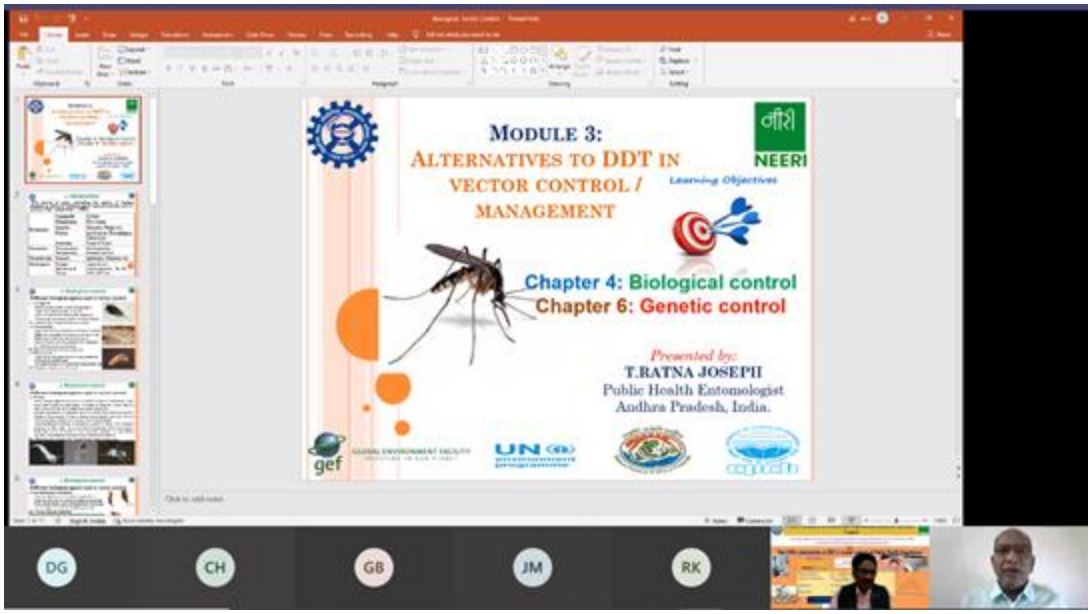


Fig. - 13: Screenshot of Training session - 5

natural enemies with or without their metabolites- WHO; Different Biological agents used in vector control: 1) Copepods, 2) Nematode, 3) Flatworms, 4) Fungi, 5) Invertebrates Predators, 6) Anuran Predators, 7) Bacteria (Bt) & Protozoans (Mirosporidians), 8) Larvivorous Fishes - 1. Gambusia Affinis (Gambusia), 2. Poecilia reticulata (Guppy), 3. Oreochromis Mossambicus (Tilapia), 4. Danio rerio (Carp); NIMR- suitable fish species used in different mosquitoes breeding habitats; Desirable attributes of Bio-control agents: Possible to collect or produce in sufficient numbers, Able to persist in Pest environment, Able to limit pest number, Should not destroy other bio-control agents, Must provide predictable level of control and Acceptable to the communities; Advantages of Biological Control: Minimum environment pollution, Safe to non-target organism, Ease of production & maintenance at local level, Reduction in operational cost, less likely hood of resistance development & Ease of construct an agent with local

environment features; use of Larvivorous fish, use of biocides. He also deliberated the topic Introduction to Genetic Control: Genetic control involves manipulation of genetic material of a pest species so as to confer lethality on the species- self-sustaining, self-limiting, population suppression & replacement: Sterile Insect Techniques: 1. Conventional SIT 2. Translocation of Heterozygotes; 3. Genetic sexing; 4. Cytoplasmic Incompatibility; 5. Hybrid Sterility; Refractoriness to disease transmission: it means production of insects refractory to the development of parasite and thus incapable of transmitting disease; Population replacement using Wolbachia: Population replacement strategy: using Wolbachia-infected female mosquito; Population Suppression- using Wolbachia infected male mosquitoes; Release of insects carrying dominant lethal gene; Gene Silencing using RNA interference; Other Genetic approaches: Gene drive- clustered randomly interspaced short palindromic repeats are family of DNA sequences.

Training part - 2: Integrated Vector Pest Management (IVPM)

Dr. R. S. Sharma deliberated this training session, a brief introduction about IVPM: contribution of Integrated Vector Management (IVM) & Integrated Pest Management (IPM). IVM: practised for Vector Control, IPM: practised mostly in agricultural sector for pest control; IVM- is a rational decision-making process for optimal use of resources for vector control, The

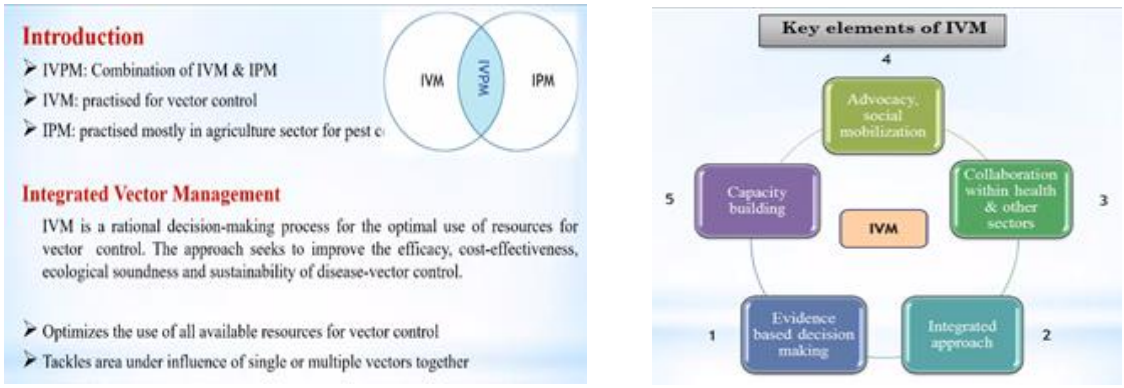


Fig.-14 Integrated Vector Management and its Key element

approach seeks to improve the efficacy, cost-effectiveness, ecological soundness and sustainability of disease-vector control; Optimizes the use of all available resources for vector control, Tackle area under influence of single/ multiple vectors together. Key elements of IVM (Fig.-14): Evidence based decision making, Integrated approach, Collaboration within health & other sectors, Advocacy Social mobilization and Capacity Building; IVC methods: improves the efficacy, cost effectiveness, ecological soundness and establish sustainable disease-vector management- Environment Management→ Personal Protection, Environment Modification→ Chemical Control, Environment Manipulation→ Biological Control, Changes to human habitat/ behaviour→ Genetic Control. IVM in different situation: Epidemic and Endemic; Organization & Management→ People & Institution, Technology and Process; Collaboration of Health Sector- at central level & at local level; Intersectoral Collaboration: An IVM strategy requires collaboration between health, other sectors and civil societies; The role of partnership: to conduct joint planning, evaluation and mapping, to collaborate in the implementation where needed and to comply with the agreed actions and time tables. Classical example- Sri Lanka.

Training part - 3: IVPM- Behavioural Change Communication (BCC)

Dr. P T Joshi deliberated this training session, a brief introduction about Behavioural Change Communication: It is a proved component for Vector Borne Disease control by community through its participation, BCC strategy is to focus target on specific individual households and communities to optimize health interventions outcomes. BCC efficiency can be used to develop better methods for Vector control & reduce transmission of the disease. Objective: To improve access to information, services, and change the behaviour in the community; BCC changes human behaviour- to reduce vector population & disease transmission, increasing compliance with interventions. Motivation for vector control activities and removing incorrect and wrong guided methods of vector control. It is important to provide access to information and services on VBDs & ensure mutual interaction and communication; Outcomes of interventions (Fig.-15): Tools of BCC: Four tools- Media Information (Radio/ TV Broadcast), Education &

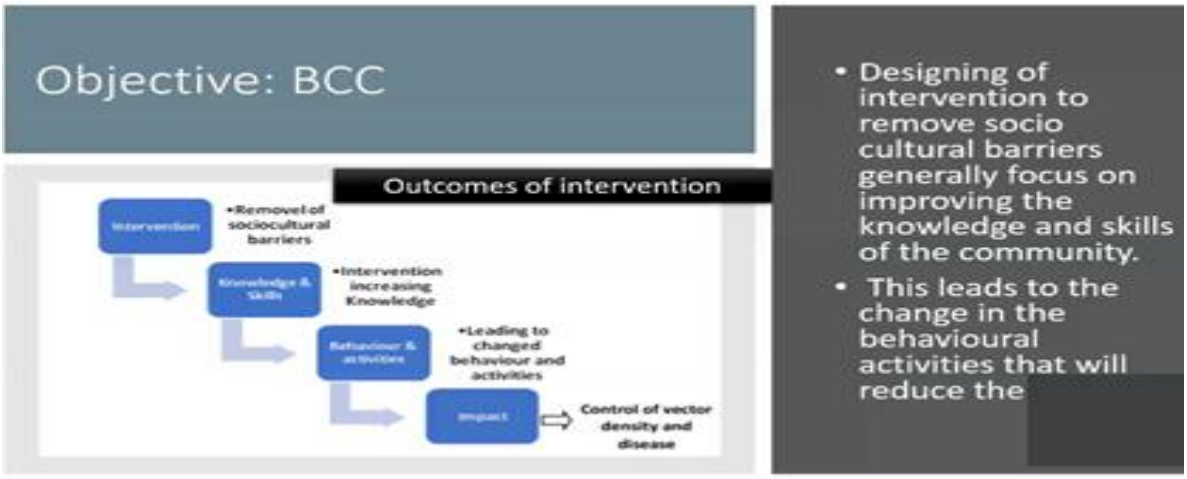


Fig.-15 BCC: Outcome of Intervention

Communication, Communication for behavioural impact, and Farmer Field schools; Accredited Social Health Activist (ASHA); Multipurpose Health Workers (MPHW).

Training part - 4: Entomological Parameters and their Importance

Dr. Himmat Singh deliberated this training part and the main content were entomological parameters and their importance. He gave brief introduction about Entomological Surveillance: is used to determine change in geographical distribution, density of vector, evaluate control programme, obtain relative measurements vector population over time and facilitate appropriate and timely decisions or period of population increase; Parameters are very important part of surveillance, they should be measurable & comparable; Importance of Surveillance programme: Density/ unit house, room, village etc., Sporozoite rates, Age; Adult parameters used in India: 1. Resting Collection (Aspirator/ handheld net), 2. Indoor Resting Density, 3. Human-biting rate (ethical clearance required); 4. Human blood Index, 5. Sporozoite rate, 6. Insecticide Susceptibility; Topics such as Entomological Indices: 1. Malaria Vector Density, 2. Abdominal Condition: Unfed, Full Fed, Semi-Gravid & Gravid, 3. Vector Incrimination- Whole night vector landing collection: Landing/night/bait/landing time; 4.

Space spray collection and 5. Entry/ Exit trap collection- Delayed Mortality & Excito-repellency. Mosquito Life Expectancy (Longevity); Parity Rates: reflects the proportion of parous from the total number of ovaries dissected; Vectoral Capacity; *Cu. quinquefasciatus* for Filaria: Ten Man- hour Vector density; Parameters of flea (total flea index, percentage of hosts infested, burrow index), larval survey (larval density, pupal density) and Dengue larval survey (House index, Container index, Breteau index, Pupa index); Entomological Survey of Lymphatic Filariasis: Ten Man- hour Vector density, infectivity rate, infection rate, mean number of L3/infective mosquito) were also discussed.

Fig.-16 Screenshot of training session- 5

5.6 Training session-6 (Day – 6 (Wednesday) 24/11/2021)

Training part - 1: IVPM: Vector Management through Farmer Field School (FFS)

Dr. R. S. Sharma, deliberated this training session, a brief introduction about IVPM Background: it builds upon the successful experience in Integrated Pest Management, which is based on the practical field-based education of groups of rice farmers in weekly sessions of the farmer field school (FFS). IVPM project- Sri Lanka- 2002, with support of FAO & UNEP thus involving rural communities in reducing the health risks of VBDs. Rational of IVPM: Malaria and other VBDs like LF, Leishmaniasis/ JE, Dengue is a major health problem in the South East Asia region; Objective of IVPM: Enhancing the role of local communities in sound ecosystem management. Goals- 1. Raise agricultural productivity & 2. Reduce risks of VBDs; Concept of IVPM: VBDs occur where there is a close interaction between host, parasite & vector; Agricultural Environment; Alternative approaches that help reduce reliance on pesticides have been developed and tested in recent decades, IPM & IVM are increasingly introduce and promoted in agricultural and as part of vector- borne disease control, respectively; Integration aims at the optimal, cost-effective combination of measures for a local situation UNEP, FAO & WHO are committed to promote integrated strategies for more sustainable Pest & Vector management; Pyrethroid Resistance in Malaria Endemic states-

Chhattisgarh, Madhya Pradesh, Odisha & Andhra Pradesh (*An. culicifacias* vector resistant to deltamethrin-SP); He also discussed topic Farmer Field School (FFS): is a group based learning process that has been used by number of Government, NGO's and International agencies to promote IPM- the 1st FFS, were designed and managed by the UN FAO in 1989; Evolution of the FFS approach: Asia (1989)→ 2016 (90+ Countries), The term "FFS" came from Indonesia 'Sekolah Lapangan' just the Field School to reflect the educational goals; Farmer Approach towards VBD's; Vector Management through the FFS approach: it provides practical filed-based education to farmers at weekly meeting, time bound activity. The method emphasizes group observation, discussion, analysis, presentation, collective decision making and actions. IPM Farmer Field School has been implemented by the agricultural sector without direct linkages with the health sector; The extended outcomes are reduced vector breeding, increased ecosystem integrity, reduced risk of insecticide resistance, increased personal protection, better living condition & social empowerment; Indicative numbers from Member Countries of the FAO community IPM Programme in Asia implementing IPM field schools (Fig.-17); Health risks associated with agriculture: irrigated agricultural eminents provide breeding habitats for vectors of Malaria, LF, JE, Dengue etc., Use of insecticides in agriculture can cause resistance

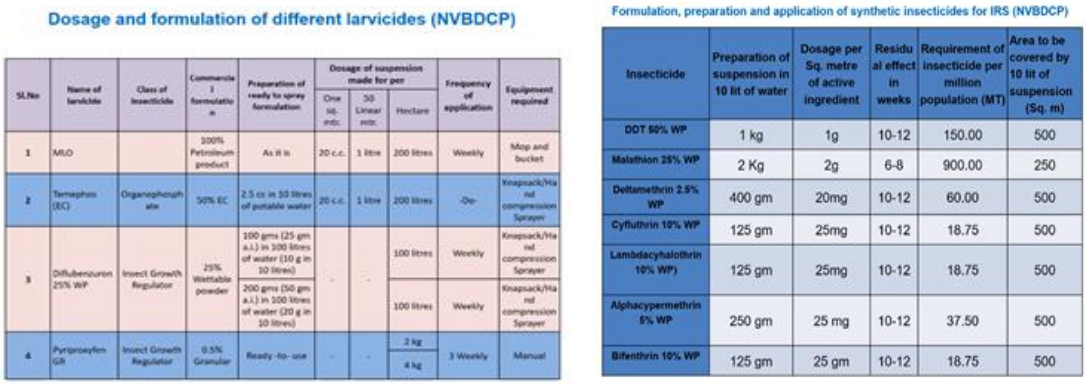
Fig.-17 FAO community IPM programme in Asia and success story

in disease-transmitting vectors breeding in agricultural environment there by reducing the effectiveness of insecticide- based vector control methods; Eg. Outbreak of Malaria due to Indira Gandhi Canal for Irrigation- Jaisalmer District, Rajasthan, 2001; Spraying of Insecticides causes occupational poisoning; Role of FFS at the Field Level: Strengthening knowledge & understanding of the impacts of current farmer practices in a cropping system, Development of training curricula on IPM including field studies on ecology to fine-tune management and using training approaches, suitable for adult training, Exchanges with other IPM programme field worker to become familiar with ecological and training approaches and use these as a source of further local development, Pilot testing for trainees & farmers, Well planned scaling up of training activities, with a focus on building capacity at local levels, Continued monitoring and evaluation to improve activities for new topics Zika, Dengue, Chikungunya; Rice Field and Japanese Encephalitis- Outbreak of JE in Assam State in 2018: the rice field while providing food and fodder supports pest and vector mosquitoes breeding; Mosquito breeding and rice field: a study of breeding of mosquito in the rice field agro-ecosystem was carried out in Madhya Pradesh, during 1987-88; Effect of irrigated rice

agricultural on JE; Success Story: Malaria Mosquito control in rice paddy farms using bio-larvicides mixed with fertilizer in Tanzania.

Training part - 2: NVBDCP Recommended Insecticides: Larval Source Management and Adult Vector Control

This training part was introduced by **Dr Kalpana Baruah** content covered were Larval Source Management: it is only preferred where- the vector breeds only during a short period; Measure to control adult mosquitoes are ineffective or culturally unacceptable; Permanent source reduction measures; In Urban areas, where breeding places are easily accessible and recognizable; Management of aquatic habitats potential larval habitats for mosquitoes, To prevent completion of development of immature stage; Environment Management for Source reduction: 1. Habitat Modification (Long lasting): Physical transformation of Land, Water & Vegetation - An estimated method of effective long-term mosquitoes management, particularly in salt-marsh environment and Successfully reduce mosquitoes number and minimize the risk of mosquito-borne disease, 2. Habitat Manipulation (Temporary changes in vector habitats)- Drainage water supply installation, covering domestic water-storage containers, Cleaning flowerpots, Vases, incidental water collection, Managing of Construction sites & Building exteriors, Mandatory water storage for fire-fighting. She also deliberated on topics such as Chemical, Biological and Adult vector control. Chemical Control (Larviciding): Chemical Larvicides in areas where disease and vector surveillance indicate the existence of certain periods of high risks and in localities where outbreaks might occur; Dosage and formulation of different larvicides (NVBDCP) and Formulation, Preparation & application of Synthetic Insecticides (NVBDCP). (Fig.-18); Mosquitos Larvicidal Oil (MLO)- classical larvicide,



Dosage and formulation of different larvicides (NVBDCP)

Sl.No	Name of larvicide	Class of insecticide	Commercial formulation	Preparation of ready to spray formulation	Dosage of suspension made for per			Frequency of application	Equipment required
					One sq. mtr.	50 Linear mtr.	Hectare		
1	MLO		100% Petroleum product	As it is	20 c.c.	1 litre	200 litres	Weekly	Mop and bucket
2	Temephos (EC)	Organophosphate	50% EC	2.5 cc in 10 litres of potable water	20 c.c.	1 litre	200 litres	-Do-	Knapsack/Hand compression Sprayer
3	Diflubenzuron 25% WP	Insect Growth Regulator	25% Wettable powder	100 gms (25 gm a.i.) in 100 litres of water (10 g in 10 litres)	-	-	100 litres	Weekly	Knapsack/Hand compression Sprayer
				200 gms (50 gm a.i.) in 100 litres of water (20 g in 10 litres)			100 litres	Weekly	Knapsack/Hand compression Sprayer
4	Pyriproxyfen GR	Insect Growth Regulator	0.5% Granular	Ready-to-use	-	-	2 kg	3 Weekly	Manual
							4 kg		

Formulation, preparation and application of synthetic insecticides for IRS (NVBDCP)

Insecticide	Preparation of suspension in 10 lit of water	Dosage per Sq. metre of active ingredient	Residual effect in weeks	Requirement of insecticide per million population (MT)	Area to be covered by 10 lit of suspension (Sq. m)
DDT 50% WP	1 kg	1g	10-12	150.00	500
Malathion 25% WP	2 Kg	2g	6-8	900.00	250
Deltamethrin 2.5% WP	400 gm	20mg	10-12	60.00	500
Cyfluthrin 10% WP	125 gm	25mg	10-12	18.75	500
Lambdacyhalothrin 10% WP)	125 gm	25mg	10-12	18.75	500
Alphacypermethrin 5% WP	250 gm	25 mg	10-12	37.50	500
Bifenthrin 10% WP	125 gm	25 gm	10-12	18.75	500

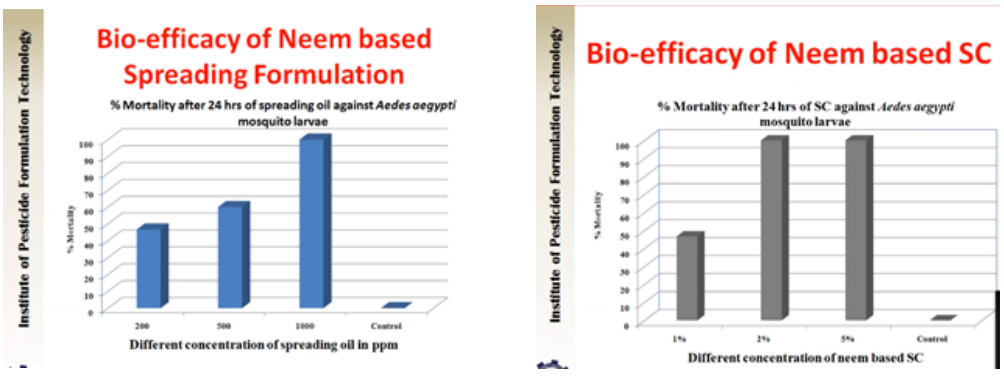
Fig.-18 Dosage and formulation of different larvicides (NVBDCP)

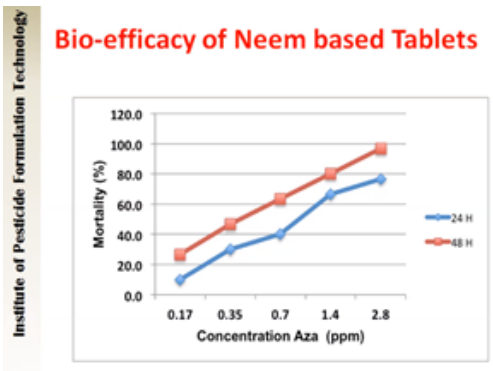
causes suffocation by producing a surface film on water & reduction of surface tension, making difficult to larvae to remain at surface; Temephos: An Organophosphorous compound with very low mammalian toxicity, used as 50 % emulsion concentration; Insect Growth Regulators (IGRs): Interfere with the development of the immature stages of the mosquitoes by interference of chitin synthesis e.g. Pyriproxyfen 0.5 % GR, Diflubenzuron 25 % WP; Biological Control: *Bacillus thuringiensis* var *israelensis* (Bti), Bacteria used as 'Biocontrol agent', target specific: used in both clean and polluted water, 5 % wettable powder & Aqueous suspension; Bio-control agents for mosquito larvae: Copepods, Nematods, Flatworms, Fungi, Invertebrates Predators: mosquitoes, aquatic beetles, dragon flies etc., Anuran Predators:

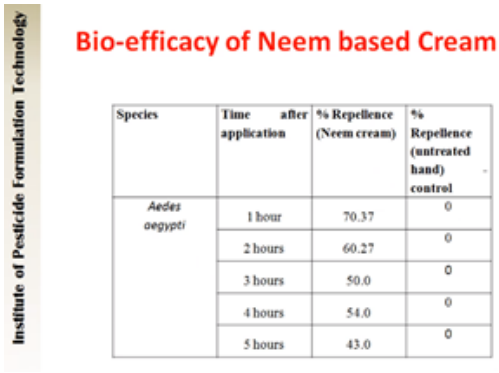
tadpoles of frogs & toads, Larvivorous fishes: *Esomus danricus, Badis badis, Chanda nama* etc.; Adult Vector Control: Adulticides are used to kill adult mosquito; For Indoor Residual Spray (IRS), Insecticides used are- DDT 50 % WP, Malathion 25 % WP and synthetic pyrethroid (SP); Indoor Space Spray: Recommended only in emergency situations to supress an on-going epidemic & is the massive, rapid destruction of the adult vector population; Outdoor fogging- fog is liquid insecticide, dispersed into the air in the form of hundreds & millions of tiny droplets; Thermal fogs or cold fogs; Long Lasting Insecticidal Nets (LLINs): Bed nets treated by a process that binds or incorporates insecticides into the fibres, LLINs provide better effective protection by keeping away mosquitoes as well as killing them;

Training part - 3: Alternatives to DDT: Neem derived products for Vector Control

Dr. Amrish Agrawal, has deliberated this training session with brief introduction about non-POPs alternative to DDT: Problem associated with use of Synthetic Pesticide- Synthetic chemical pesticides are not only toxic to the target insects but hazardous to non-target organisms like human, animal & environment; Promote effective alternatives to DDT and synthetic pesticides: Bio-botanical pesticides are gaining popularity as safe alternative to Chemical pesticides, are safe to humans, non-target organisms & environment; Neem (*Azadirachta* spp.) & *Bacillus thuringiensis* (Bt) are potential bio-botanical insecticides for controlling mosquitoes and agricultural insects; Objective of the Project: Development of Bio-Botanical based formulation technologies for mosquito control application as safe, user & environment friendly alternative to DDT, To develop and scale up the technologies of neem and Bt based bio-botanical pesticides formulation using locally raw material as cost effective and sustainable alternative, To reduce and eventual elimination of the dependency on DDT, ensuring food safety and protecting human health & environment; He also discussed about progress made in project: Neem based formulations developed and process standardized for pilot plant production: 1. Process for coil formulation: Grinding of raw material→ Blending→ Dough preparation→ Extrusion→ Drying; 2. Process for Cream formulation: Preparation of oil phase→ preparation of aqueous phase→ emulsification→ Addition of thickness; 3. Process for SC formulation: Preparation of oil phase→ preparation of aqueous phase→ Addition of oil phase into aqueous phase→ addition of solid inert ingredient & thickness; 4. Process for spreading oil formulation: Oil phase preparation→addition of surfactants and co-surfactants to oil phase→addition of active ingredient under high shear mixing; 5. Process for Tablet production: Absorption→ Blending→ Granulation→Tablet preparation; Bio-efficacy of neem based Spreading formulation/ SC/Tablets/Cream (Fig.- 19):







Species	Time after application	% Repellence (Neem cream)	% Repellence (untreated hand) control
Aedes aegypti	1 hour	70.37	0
	2 hours	60.27	0
	3 hours	50.0	0
	4 hours	54.0	0
	5 hours	43.0	0

Fig. 19 Bio-efficacy of neem based Spreading formulation/ SC/Tablets/Cream

Technology, Transfer & Training: Pilot plant scale technology of Neem based SC, coil, cream, SO and tablet transferred to HIL in September 2020; Process demonstrated in IPFT pilot plant; Bt-based formulation: *Bti* based WP, SC, and spreading formulations developed; Formulation provides good bio-efficacy against mosquito larvae; process optimized with standardized technical grade bacillus thuringiensis israelensis (Bti); and Technology transferred to HIL.

5.7 Training session-7 (Day – 7 (Thursday) 25/11/2021)

Training part - 1: Integrated Pest Management (IPM)

Dr. V.J. Tambe was covered this training session; discussed about IPM Pyramid: Control, Surveillance & Avoidance, History of IPM. He deliberated this training session, a brief introduction about Integrated Pest Management: "IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health and environmental risks". Principles and Strategies of IPM: 1. Monitoring of insect, pests and natural enemies; 2. Concepts of injury levels; 3. Integration of pest control: a) Preventive practices- can be used irrespective of low level of pest incidence, it can be followed as routine, even if the pest is at low level; b) Curative practices: have to followed only when the pest attains economic threshold level (ETL). Integration of different components of IPM: Selection of appropriate method; Integration of Pest Control Method. Major components of IPM: **1**. Cultural Practices- Cultural methods of pest control consists of regular farm operations in such a way which either destroy the pests or prevent them from causing economic loss. The various cultural practices: Planting time, Seed rate, Plant spacing, Plant Diversity (Intercropping, Trap cropping, Crop location & Presence of weeds), Crop rotation, Nutrient Management, Water Management, Harvesting Practices, and Sanitation. **2**. Physical Methods: These methods aim to reduce pest population by using devices which affect them physically or alter their physical environment; Methods: Hot or cold treatment, Moisture & Light traps. **3.** Mechanical Methods: the reduction or suppression of insect population by means of manual devices is referred to as Mechanical control; Methods: Hand picking, Screen & Barriers, Trapping & Suction devices, Clipping, Printing & Crushing; **4.** Biological Control: is most important component of IPM to control insect, pest & disease; Bio-control is use of living organism to control unwanted living organism (pests); Biological Control: Predators, Parasite (Parasitoid, Super, Multiple & Hyper Parasitism), Pathogen, Microbes (Bacterial, Viral,

Fungal, Protozoan & Nematodes Pathogen); Integrated Biological Control; **5.** Chemical Control: use of chemical pesticides is the last resort when all other methods fail to keep the pest population below economic loss, Methods: Insecticides, Chemosterilant, Antifeedents, Attractants, Repellents, Semiochemical, IGRs; **6.** Legal Methods: is the lawful regulation of the spread of pests from one state to another or from one country to another; this involves the observance of animal & plant quarantine and their terminal inspection during import and certification during export; **7.** Genetic Control: is a recent application wherein genetically manipulated (changed) insects are released among wild populations to male their mating infructuous (sterile) or to introduce lethal genes into the eggs of the female so that they do not develop beyond a certain state, Methods: Sterilization, Hybrid sterility, Cytoplasmic incompatibility, Translocation, Lethal factor, Sex ratio distortion by meiotic drive, Species replacement & Genetic Engineering.

Fig.-20 Screenshot of Pest Control

Training part – 2: Vector Control: Measures/ Management: Chemical Control Methods

This training part was introduced by **Dr Pradeep Kumar Srivastava** content covered were vector control methods; Plant Products: many plants contain compounds which prevent attack from phytophagous (plant eating) insects; it includes: Pyrethrum, Neem derived products; Synthetic chemicals: effective tools of insect control, Penetrates the insect body readily, Toxic to a wide range of mosquito species, Main component of all malaria/VBDs control strategies, Malaria Elimination based on 2 core VC interventions: LLINs and IRS (for adult mosquitoes), LSM in urban settings and works as supplementary tool in many urbanized rural areas. Organic Chemicals used for vector control include: Organochlorines, Organophosphates, Carbamates & Synthetic pyrethroids. Larval source Management (LSM): Management of aquatic habitats that are potential larval habitats- alternatives used: Mosquito Larvicidal Oil (MLO), Temephos 50 % EC, Insect Growth Regulators (IGRs)- They include Pyriproxyfen 0.5% and Diflubenzuron 25% WP; Adult Vector Control: Indoor Residual Spray- Application of long acting chemical insecticides on the walls and roofs of the houses and domestic animal shelters (mixed dwellings), Adulticides are used to kill adult mosquitoes, Wettable Powder (WP) formulations, IRS insecticide in use: DDT 50% WP, Malathion 25% WP, and Synthetic Pyrethroid (SP)- SP includes deltamethrin 2.5% WP, Cyfluthrin 10% WP, Lambda Cyhalothrin

10% WP, Alphacypermethrin 5% WP, Etofenprox 10% WP and Bifenthrin 10% WP; Long Lasting Insecticidal Nets (LLINs): Nets treated by a process that binds or incorporates insecticides into the fibres before manufacturing LLINs; Adult Vector Control (Outbreak Situation): Indoor Space Spray, Outdoor fogging- Thermal of Cold fogs and Larvicides for

Dosage and formulation of different Chemical larvicides (NVBDCP)

Sl.No	Name of larvicide	Class of insecticide	Commercial formulation	Preparation of ready to spray formulation	Dosage of suspension made for per			Frequency of application	Equipment required
					One sq. mtr.	50 Linear mtr.	Hectare		
1	MLO		100% Petroleum product	As it is	20 c.c.	1 litre	200 litres	Weekly	Mop and bucket
2	Temephos (EC)	OP	50% EC	2.5 cc in 10 litres of potable water	20 c.c.	1 litre	200 litres	-Do-	Knapsack/Hand compression Sprayer
3	Diflu benzuron 25% WP	IGR	25% Wettable powder	100 gms (25 gm a.i.) in 100 litres of water (10 g in 10 litres)	-	-	100 litres	Weekly	Knapsack/Hand compression Sprayer
				200 gms (50 gm a.i.) in 100 litres of water (20 g in 10 litres)			100 litres	Weekly	Knapsack/Hand compression Sprayer
4	Pyri proxyfen GR	IGR	0.5% Granular	Ready -to- use	-	-	2 kg 4 kg	3 Weekly	Manual

Preparation of ready-to-use suspension & application of insecticides for IRS (NVBDCP)

Insecticide	Preparation of suspension in 10 lit of water	Dosage per Sq. metre of active ingredient	Residual effect in weeks	Requirement of insecticide per million population (MT)	Area to be covered by 10 lit of suspension (Sq. m)
DDT 50% WP	1 kg	1g	10-12	150.00	500
Malathion 25% WP	2 Kg	2g	6-8	900.00	250
Deltamethrin 2.5% WP	400 gm	20mg	10-12	60.00	500
Cyfluthrin 10% WP	125 gm	25mg	10-12	18.75	500
Lambdacyhalothrin 10% WP)	125 gm	25mg	10-12	18.75	500
Alphacypermethrin 5% WP	250 gm	25 mg	10-12	37.50	500
Bifenthrin 10% WP	125 gm	25 gm	10-12	18.75	500

Fig. 21 Chemical larvicides and ready-to-use suspension

agricultural; Dosage and formulation of different chemical Larvicides (NVBDCP); Preparation of ready-to-use suspension & application of insecticides for IRS (NVBDCP) (Figure-21).

Training part - 3: Equipment for Larviciding and Adulticiding:

This training part was introduced by **Dr P. K. Srivastava** content covered were equipment/ tools for vector control (Fig. 22); Various tools have been currently in practices: 1. Knapsack Sprayer- can be used to spray breeding sites with larvicides, the application rate is 500 Litres/ha. The coverage of 0.5-1.0 ha/day; 2. Hand Compression pump- Standard equipment for residual spray; 3. Stirrup Pump: Mounted on a foot rest or stirrup, inserted in the spray liquid in a bucket.

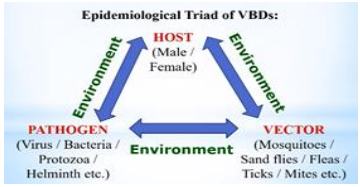
Fig.-22 Various tools for vector control

4. Fogging Machines: Insecticides is dissolved in oil of reasonably high flashpoint, vaporised into a high velocity stream of hot gas, At the point of discharge into atmosphere, the mixture containing insecticide condenses into form of fog. a) Portable thermal fogging machine: PFTM has a thermal energy nozzle into which the insecticide liquid (both oil & water miscible formulation) is metered, b) Ultra Low Volume (ULV): small quantity of concentrated Liquid

(less than 4.6 litres/ha); 5. Vehicle Mounted Fogging Machines: used in urban or sub-urban areas with a good road system, one machine covers up to 1500-2000 houses (or 80 ha.) per day and application time preferred early morning (6:00-8:30 a.m.) or in early evening (5:00-7:30 p.m.); 6. Vehicle Mounted Cold Fogging Machines; Control Flow Valves.

Training part - 4: IVPM-Monitoring & Evaluation- Epidemiological Surveillance:

Dr. T Ratna Joseph has deliberated this training session with brief introduction about Monitoring & Evaluation under IVPM, Epidemiological Surveillance and its importance: Epidemiology- 'The study of distribution and determinants of health-related states or events in specified population and the application of this study to the control of health problems'.



Epidemiological triad of VBDs; He also covered topics include Malaria Classification: Indigenous, Imported and Induced; Malaria Paradigms: Demography, Topography & Ecology based Urban Malaria, Rural Malaria, Hill Tract Malaria, Plains Malaria, Irrigation Malaria, Island Malaria, Coastal Malaria, Industrial Malaria, Project Malaria- To identify high risk, medium risk & low risk- To intensify measures needed for medium & low risks areas to prevent emergence/ re-emergence/ resurgence. IDSP-Integrated Health Information Platform (IHIP): Surveillance units have been established in all States/Districts (SSU/DSU), Central Surveillance Unit (CSU) established and integrated in NCDC, Delhi; Presumptive (P) form consists of 22 diseases including Malaria, Dengue, Chikungunya, AES, PUO etc.; Laboratory (L) form consists of 12 diseases including Dengue, Chikungunya, JE, Malaria etc.; NVBDCP: Blood Smear, Rapid Diagnostic Test (Antigen/ Antibody) Source: Active case detection will be carried out by trained community; Incidence and Prevalence- Point prevalence & Period prevalence; Parameters of Malaria: Malariametric Indices used for the measurement of Malaria were mostly Parasitological and commonly used parameters were: Annual Blood Examination Rate (ABER), Annual Parasite Index (API), Annual *falciparum* Incidence (AFI), Slide positivity rate, Slide *falciparum* rate; Other parameters- Pf%- P. *falciparum* cases among total malaria cases; Infant Parasite: Children below 1 year of age positive for Malaria; Case Fatality: Deaths confirmed due to Malaria; Drug Resistance: The ability of a parasite strain to survive/ multiply despite the absorption of a medicine given in the doses; Severe & complicated; Economic injury; Source of Infection: Primary, Secondary, Migration/Immigration, Relapse/recrudescence and Induced; Parameters of Lymphatic Filariasis: Filarial Endemicity Rate, Microfilaria Rate and Microfilaria density-Frequency: Weekly interval for Viral disease (DEN/CHK/JE), Fortnightly interval for Malaria, Quarterly interval for Filariasis; Parameter for other VBDs: 1. Dengue, 2. Chikungunya, 3. JE, 4. KFD, 5. Zika, 6. Plague. He conducted an interactive session with the participants.

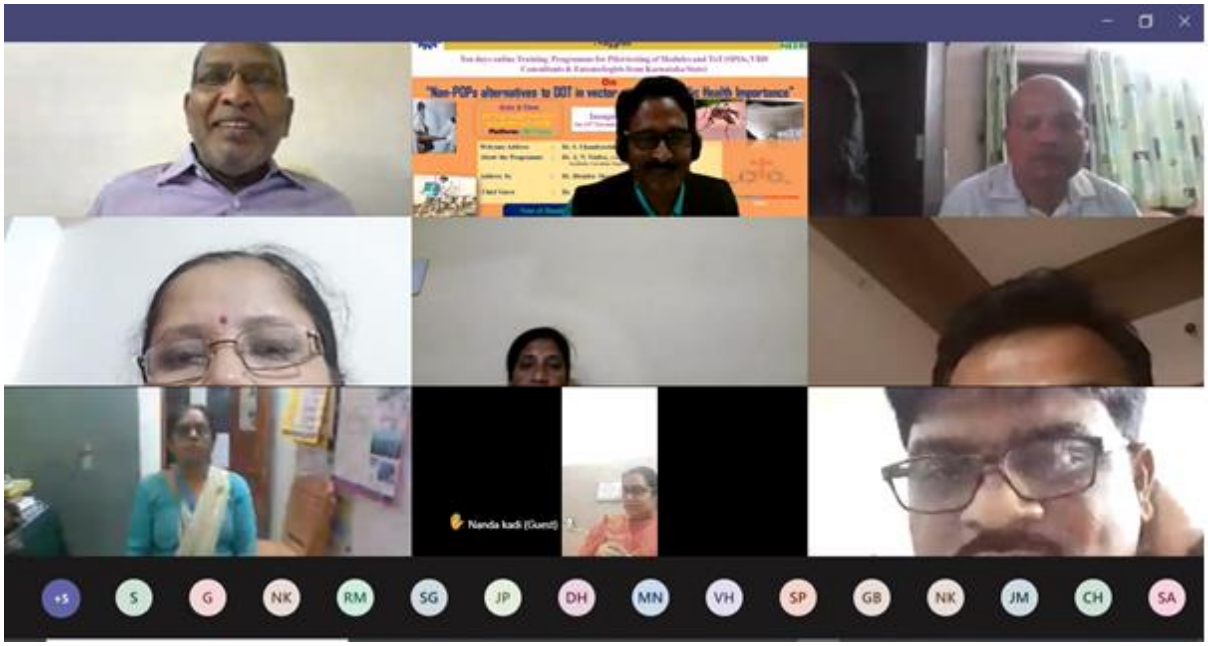


Fig.-23 Screenshot of training session- 7

5.8 Training session-8 (Day – 8 (Friday) 26/11/2021)

Training part - 1: Integrated Vector and Pest Management: Planning & Implementation

Dr. R.S. Sharma covered this training session; discussed about Planning & Implementation under IVPM: Learning objectives- Planning of IVM on the basis of Epidemiological and Entomological parameters, Different vector control tools in IVM, Implementation of vector control methods with involvement of Public Health sectors, Concept & Implementation of IVPM in district level and coordination with Farmer Field School (FFS); Introduction: Planning & Implementation- depends on intervention, management, resources & stakeholders Participation; Epidemiological Assessment: It is a process to determine actual burden of disease- 1. Measures of disease occurrence- a) Prevalence: Point & Period Prevalence, b) Incidence: Risk & Incidence; 2) Estimation of disease occurrence: a) Case Study, b) Primary survey, c) Cohort Study, d) Sampling; Entomological Assessment: it is one of the tools used in monitoring and controlling vector borne diseases- The selection of appropriate sampling methods depends on Surveillance objectives, levels of infestation & availability of resources; Collection of Adult mosquitoes is made for a) Qualitative studies & b) Quantitative studies; Determinants of Local diseases: the epidemiology of VBDs is complex and depends on a variety of local factors which determine of disease can be of 4 categories related to the: i) Parasite, ii) Vector, iii) Human activities & iv) Environment; Selection of vector control methods: can be Environmental, Mechanical, Biological and Chemical to reduce vector population or to reduce human vector contact. Selection criteria of vector control method (WHO)- MLO only insecticide kill mosquito larvae (mechanical barrier); IVM implementation Strategy: Entomological Surveillance in sentinel and random sites at monthly/ quarterly/ annual intervals; Promote source reduction; Scaling-up use of LLINs; Appropriate use of insecticide for supervised IRS; Treatment community owned bed-nets; Intensified anti-larval operations in Urban & peri-urban areas within the states/ districts; Supportive interventions including IEC and BCC activities through village health & sanitation committee meetings on

monthly basis; He also discussed roles of various sectors in IVPM implementation: Agriculture, Water resources development, Water supply, Road & building sector, Urban development, Industry/ mining, Railways, Environment/ Forest, Fisheries Institutional, Remote sensing; Private Pest control Agencies, Planning departments, Sea/ air ports, Education, Mass media, Village councils, Local Governments; Role of Health trainers coordinating IVM & IPM: SIMA- System-wide, Initiative on Malaria and Agriculture was started by the consultative group of international agencies; Evaluation of IVPM project in Sri Lanka: Success story in 1995 and Average seasonal catches on Adult *anopheles* spp. in a cattle baited net traps in each of one IVPM intervention village and one comparison village in Udawalawe during four recorded season of the IVPM project (Fig. 24).

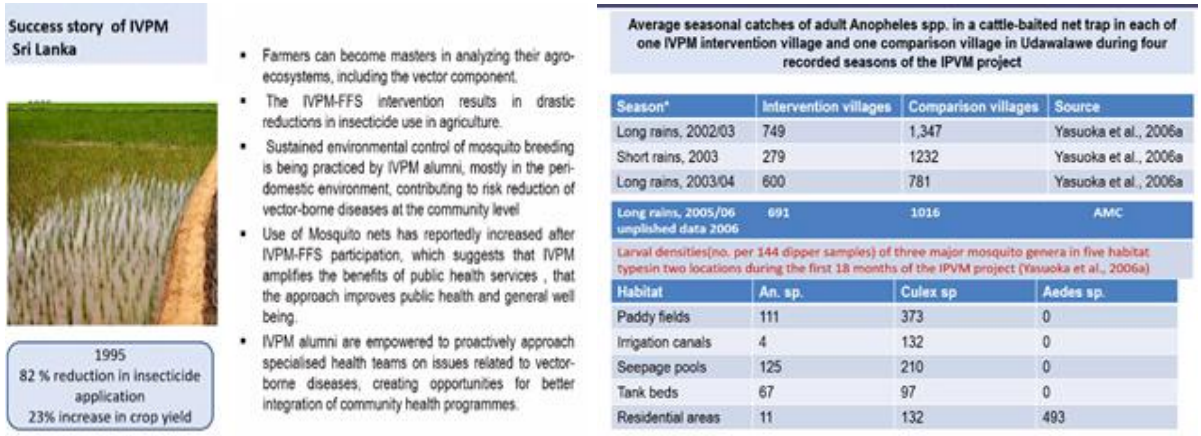


Fig.-24 Success story of IVPM and Average seasonal catches on Adult *anopheles* spp.

Training part - 2: Integrated Vector and Pest Management: Monitoring & Evaluation

Dr. L. J. Kanhekar briefly introduced about the IVPM: Monitoring & Evaluation and its methods: A functioning system for monitoring and evaluation is vital success of an IVPM strategy. Purposes: To guide the planning and implementation of the strategy to assess its effectiveness, to identify how the strategy should be improved and to account for the resources used; Methods of Monitoring and Evaluation: are important implication designed to improve existing system of vector control & prevention of VBDs. There are different methods used to determine the outcomes & impact: Design, Data collection, use of result, Roles; Outcome Indicators: There are 3 types of indicators used i.e. Process, Outcomes & impacts; Outcomes indicators followed though- Planning and implementation, Organization and Management, Behavioural Changing Communication; Organization and Management: Structure of Monitoring & Evaluation within health sector- At Central level, At Local Level, Inter-Sectoral collaboration; Behaviour Change Communication (BCC): campaigns are important for communicating information on behaviour for vector control. Number of sites (e.g. villages) at which such campaigns conducted indicates extent to communication at community level; Indicators to monitor and evaluate progress in Planning & Implementation of IVPM: Process indicators and Outcome indicators; Indicators to monitor and evaluate progress in Organization and Management of IVM: Process indicators and Outcome indicators; Indicators to monitor and evaluate progress in advocacy and communication of IVM: Process indicators and Outcome indicators; Entomological Surveillance: surveillance for vector is important in

determining:- The distribution, Population density, Larval Habitats & Susceptibility to insecticides in order to prioritize vector control in terms of time and adult populations: Adult Surveillance, Collection of Adult Mosquitoes: 1) Hand collection: suction tube (Aspirator)(indoor & outdoor), bait collection, Spray sheet collection, Trap collection- light trap, gravid trap, window, magoon & biogent mosquito trap, 2) Collection of adult Sand fly: Hand, Trap collection- sticky trap, light trap, funnel trap and Bait collection; 3)Larval collection method: Dipping, Netting, Collection Mansonia aquatic stage, Collection of inactive stage of Sand fly; Insecticide Resistance monitoring through susceptibility test: i) Adult Susceptibility & ii) Larval Susceptibility; Adult Aedes Survey: Landing/biting Collection; Resting Collection; Oviposition traps; Aedes Larval Indices & Significance; Surveillance of

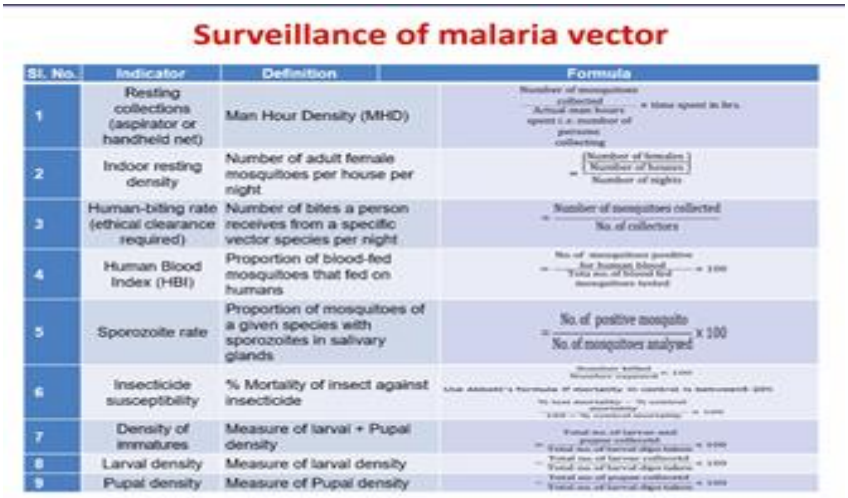


Fig.- 25 Surveillance of Malaria Vector

Malaria Vector (Fig. 25); Entomological Surveillance of Lymphatic Filariasis: Ten Man- hour Vector density, infectivity rate, infection rate, mean number of L3/infective mosquito) were also discussed.

Training Part 3: Input from participant trainees on Pilot testing Module – 1 and Module- 2

The training session on Day-8 came to an end with the feedback of the participants. **Dr. L. J. Kanhekar** asked the participants to give their valuable responses and inputs on the training modules – 1 and 2. Participants has raised queries, suggestions, and also healthy discussion with **Dr. R.S. Sharma** on various topics of module 1 and 2. **Dr. L.J. Kanhekar** asked all the participants to provide feedback via e-mail, if any.

5.9 Training session-9 (Day – 9 (Monday) 29/11/2021)

Training part - 1: Pilot testing Module – 3 inputs from participant trainees

Dr. T Ratna Joseph/ Dr. L J Kanhekar deliberated this training session, a brief introduction about Module-3: DDT alternatives to Vector Control Management and all the contents included in the training module and asked the participant trainees (entomologists) from Karnataka state to provide inputs, which are noted for editing.

Training part - 2: Pilot testing Module – 4 inputs from participant trainees

Dr. R S Sharma/ Dr. L J Kanhekar deliberated this training session, a brief introduction about Module-4: Integrated Vector & Pest Management and all the contents included in the training module and asked the participant trainees (entomologists) from Karnataka state to provide inputs, which are noted.

At the end, **Dr. L J Kanhekar** thanked all the participants trainees to share their views on this training module. Some suggestion, observations or success stories will be helpful to update/ modify this module. He also thanked **Dr. T Ratna Joseph** and **Dr. R S Sharma** for their participation.

5.10 Training Session on Day-10 of 5th online ToTs

Training part - 1: Lecture/Discussion on FAQs Materials

Dr. T Ratna Joseph deliberated this training session, a brief introduction about FAQs material on Vector Borne Diseases and Modules: 1-4 and its content and asked the participant trainees (entomologists) from Karnataka state to provide inputs on FAQs material which are noted for revising.

Training part - 2: Lecture/ Discussion on IEC Materials

Dr. P T Joshi deliberated this training session, a brief introduction about Information, Education & Communication (IEC) materials and its importance for IVPM: IEC campaign/ IEC Operation/ Programme, it should be in a local language/ terminology so that people can cooperate, participate and perform various activities to be done at their home particularly concerned to vector borne diseases (VBDs); He also appreciated the CSIR-NEERI work on IEC material prepared and provided to the participants, without IEC programme we can't get complete elimination or eradication of VBDs. IEC materials provided in the form of posters, pamphlets, stickers etc. are of great importance for awareness programme. IEC material included following topics: *Aedes* mosquito life cycle; *Anopheles* mosquito life cycle; *Culex* mosquito life cycle; Mosquito transmitted diseases; How to use insecticide treated nets (ITNs); Awareness on insecticide treated nets (ITNs), Malaria (No Mosquitoes- No Malaria) ; ways to prevent mosquito bite; Diseases caused by mosquito bite; Awareness poster (Let's prevent breeding of mosquitoes and protect public health diseases); Disease caused by mosquito bite: Malaria, Chikungunya, Dengue, Filaria, Japanese Encephalitis and Zika (Introduction, Vectors and its life cycle, Sign & Symptoms, breeding sites, Transmission, Transmission cycle, and preventative measures); Kyasanur Forest Disease: Introduction, Vectors and its life cycle, Sign & Symptoms, Transmission, Transmission cycle, and prevention. At the end of this session, he discussed how these IEC material impact on literate population providing awareness particularly VBDs.

Training Part-3: Feedback from participants/trainees on modules

The 5th online training programme came to an end on 30th of November with the feedback of the participants. **Dr. L. J. Kanhekar** asked the participants to give their valuable responses and inputs on the training modules, booklets, PPTs and the IEC material provided to them via

filling the Feedback forms (Part-A Pilot Testing feedback and Part-B Training feedback) sent to them via e-mail and asked them to submit feedback forms through ordinary post.

Training Part-4: Virtual valedictory session

Dr. A. Ramesh Kumar conducted a virtual valedictory session and proposed the vote of thanks to all the participants and experts, thus summing-up the training programme. He also asked the participants for their opinions on the training programme by filling the feedback form provided to them (figure –26)

Figure - 26: Photograph of virtual valedictory session

6. Annexures

6.1. List of organizing members

1. **Dr. A. N. Vaidya,**
   Coordinator, Stockholm Convention Regional Centre,
   HOD, Chemical and Hazardous Waste Management Division,
   CSIR – National Environmental Engineering Research Institute
   Nagpur

2. **Dr. A. Ramesh Kumar,**
   Sr. Scientist, (Project Leader),
   Chemical and Hazardous Waste Management Division,
   CSIR – National Environmental Engineering Research Institute
   Nagpur

3. **Dr. L. J. Kanhekar,**
   Project Consultant & Training Coordinator,
   CSIR – National Environmental Engineering Research Institute
   Nagpur

4. **Dr. Gujju Gandhi,**
   Project Research Associate-II,
   CSIR – National Environmental Engineering Research Institute
   Nagpur

5. **Mr. Irrusapann. H,**
   Project Associate-II (Entomology),
   CSIR – National Environmental Engineering Research Institute
   Nagpur

6.2. List of faculties

1. **Dr. R. S. Sharma,**
   Ex. Additional Director,
   National Centre for Disease Control

2. **Dr. P. K. Srivastava,**
   Ex-Joint Director,
   Directorate of National Vector Borne Disease Control Programme

3. **Dr. Kalpana Baruah,**
   Ex. Additional Director,
   Directorate of National Vector Borne Disease Control Programme

4. **Dr. Amit Katewa,**
   National Consultant,
   Directorate of National Vector Borne Disease Control Programme.

5. **Dr. Himmat Singh,**
   Scientist – D,
   ICMR - National Institute of Malaria Research.

6. **Dr. Vijay Kumar,**
   ICMR- Consultant, (Ex- Scientist E),
   ICMR-Rajendra Memorial Research Institute of Medical Sciences.

7. **Dr. N. Balakrishnan,**
   Ex-Joint Director,
   National Centre for Disease Control.

8. **Dr. P. T. Joshi,**
   Ex-State Entomologist, Gujarat state.

9. **Dr. T. Ratna Joseph,**
   Ex-Deputy Director,
   Government of Andhra Pradesh.

10. **Dr. Y.P. Ram dev,**
    National Technical Adviser,
    United National Industrial Development Organization.

11. **Dr. Regu,**
    Additional Director,
    National Centre for Disease Control Branch, Kozikode

12. **Dr Vilas Tambe**
    Prof. & Head, Dept. of Entomology, Agriculture College, Nagpur

6.3. List of Participants – Karnataka

S. No	Names	Designation
1	Dr. Mahamood Shariff	Deputy Director
2	Smt. Bhavana. R	Entomologist
3	Mrs. Usha. A	Assistant Entomologist
4	Smt. Manjushree R	Assistant Entomologist
5	Smt. Rekha M	Assistant Entomologist
6	Ms. Gangotri Ishwar Chimanchod	Entomologist-NAMP
7	Sri. Ganapati A Barki	Assistant Entomologist
8	Smt. Janet Menejis	Assistant Entomologist
9	Sri. Manjunath J N	District Entomologist
10	Sri. T. P. Manjunath	Assistant Entomologist
11	Sri. Rajesh Kulkarni	Assistant Entomologist
12	Smt. Annapurna K Shettar	Consultant Entomology
13	Shri. Jeetulal Pawar	Assistant Entomologist
14	Smt. Mukta Acharya	Assistant Entomologist
15	Sri. Satish Malagi	Assistant Entomologist
16	Smt. Jyothsna Kairanna	Assistant Entomologist
17	Sri. Shrikant Patil	Consultant Entomologist
18	Smt. Indira Patil	Assistant Entomologist
19	Smt. Nadini Kadi	Assistant Entomologist
20	Mr. Siddappa swamy	Entomologist
21	Smt. Rathna kumari K	Assistant Entomologist
22	Smt. Nanda Kadi	Zonal Consultant Entomologist
23	Sri. Ullas B Ganganahalli	Assistant Entomologist
24	Sri. Sowmya N	Assistant Entomologist
25	Smt. Manjula B	Entomologist
26	Smt. Gowthami. A	Entomologist
27	Sri. H M Venugopal	Assistant Entomologist
28	Mr. Chamaraj Dodamani	Assistant Entomologist
29	Smt. Latha B	Assistant Entomologist
30	Mr. Shivaraj. C. Ganachari	Assistant Entomologist
31	Sri. Parashuram Nayak	Assistant Entomologist
32	Dr. Lingaraj Hiregoudar	Assistant Entomologist
33	Sri. Mahadev L Hasaraddi	District Entomologist

6.4 Training Schedule

CSIR-National Environmental Engineering Research Institute, Nagpur

Training of Trainers (TOT) and pilot testing of modules to promote non-POPs alternatives based Integrated Vector and Pest Management

10 days online Training Programme to SPO/Entomologists, VBD Consultants from Karnataka State (33)

Time	Topic (Lecture discussion)	Faculty
All Participant Trainees are requested to join daily by 02.20 PM **Day 1 (Tuesday) 16/11/2021**		
1430-1500	**Inaugural Function** **Welcome Address** : **Dr. S. Chandrasekhar**, Director, CSIR-NEERI **About the program** : **Dr. A. N. Vaidya**, Coordinator, Stockholm Convention Regional Centre, CSIR-NEERI **Address by** : **Dr. Jitendra Sharma**, Programme Management Officer, UNEP, Geneva **Chief Guest** : **Dr. Ved Prakash Mishra,** Director, HSM Division, MoEF&CC **Vote of Thanks** : **Dr. A. Ramesh Kumar**, Sr. Scientist, CSIR-NEERI	
1500-1525	Introduction to Modules 1 to 4	Dr L J Kanhekar
1525-1600	Introduction to DDT and its use in Vector Control	Dr A Ramesh Kumar/ All participant
1600-1645	Introduction to vector borne diseases: Malaria	Dr R S Sharma / All participant
1645-1730	Introduction to vector borne disease: Japanese Encephalitis	Dr P T Joshi/ All participant
Day 2 (Wednesday) 17/11/2021		
1430-1500	Introduction to vector borne diseases: Lymphatic Filariasis	Dr. P K Srivastava / All participant
1500-1530	Introduction to vector borne diseases: Dengue, Chikungunya and Zika	Dr Kalpana Baruah / All participant
1530-1600	Introduction to vector borne diseases: Leishmaniasis (Kala-azar)	Dr Vijay Kumar/ All participant
1600-1630	Introduction to vector borne disease: Scrub Typhus	Dr T Ratna Joseph / All participant
1630-1700	Introduction to Crimean Congo Hemorrhagic Fever	Dr. K. Regu / All participant

1700-1730	Introduction to Kyasanur Forest Disease	Dr N Balakrishnan / All participant
Day 3 (Thursday) 18/11/2021		
1430-1500	Introduction to vector borne diseases: Plague	Dr N Balakrishnan/ All participant
1500-1530	Morphology of vector mosquito	Dr L J Kanhekar/ All participant
1530-1600	Bionomics of vector mosquitoes	Dr R S Sharma / All participant
1600-1630	Morphology and Bionomics of sandflies	Dr Vijay Kumar / All participant
1630-1720	Morphology and bionomics of flies and fleas	Dr Amit Katewa / All participant
1720-1730	Feedback on Modules 1	Dr L J Kanhekar/ All Participants
Day 4 (Monday) 22/11/2021		
1430-1520	Morphology and bionomics of Ticks and mites	Dr T Ratna Joseph / All participant
1520-1620	Entomological surveillance of VBDs	Dr Himmat Singh/ All participant
1620-1710	Alternatives to DDT in Vector Control Management – Conventional Methods & Environmental Management	Dr R S Sharma / All participant
1710-1730	Feedback on Modules 2	Dr L J Kanhekar/ Dr G Gandhi/ All participant
Day 5 (Tuesday) 23/11/2021		
1430-1515	Vector control measures/ management: Biological and Genetic	Dr T Ratna Joseph / All participant
1515-1600	Integrated Vector Pest Management: IVM	Dr R S Sharma / All participant
1600-1645	IVPM: Behavior Change Communication	Dr P T Joshi/ All participant
1645-1730	Entomological parameters and its importance	Dr Himmat Singh/ All participant
Day 6 (Wednesday) 24/11/2021		
1430-1540	IVPM: Vector management through Farmer Field School approach	Dr R S Sharma/ All participant
1540-1640	NVBDCP Recommended Insecticide: Larval Source Management and Adult Vector Control	Dr Kalpana Baruah / All participant
1640-1730	Neem derived products for vector control	Dr Y P Ramdev/ All participant
Day 7 (Thursday) 25/11/2021		
1430-1550	Integrated Vector Pest Management: IPM	Dr Vilas Tambe/ All participant

1550-1650	1.Vector control measures/ management: Chemical Methods 2.Equipment for larviciding and adulticiding	Dr P. K. Srivastava /All participant
1650-1750	Epidemiological surveillance and parameters	Dr T Ratna Joseph / All participant
Day 8 (Friday) 26/11/2021		
1430-1500	Planning and implementation of IVPM	Dr R S Sharma/ All participant
1500-1615	Monitoring and evaluation of IVPM	Dr L J Kanhekar / All participant
1615-1730	Pilot testing Module – 1 & 2 input from participant trainees	Dr R S Sharma / Dr L J Kanhekar/Participants
Day 9 (Monday) 29/11/2021		
1430-1600	Pilot testing Module – 3 inputs from participant trainees	Dr T Ratna Joseph / Dr L J Kanhekar/All Participants
1600-1730	Pilot testing Module – 4 inputs from participant trainees	Dr R S Sharma/ Dr L J Kanhekar/All Participants
Day 10 (Tuesday) 30/11/2021		
1430-1530	Lecture/Discussion on FAQs materials	Dr T Ratna Joseph / All Participant
1530-1630	Lecture/Discussion on IEC materials	Dr P T Joshi /All Participant
1630-1715	Feedback from Participant trainees & instructions	Dr L J Kanhekar/ Dr Gujju Gandhi
1715-1730	**Virtual Valedictory session**	Dr Ramesh Kumar/ Dr L J Kanhekar /

(Dr L J Kanhekar)
Project Consultant & Training Coordinator
CSIR-NEERI, Nagpur

Copy to: 1. **All Participant Trainees**

2. **State Programme Officers** I/c,
Directorate of Health & Family Welfare Service
Anand Rao Circle, BANGALURU-560009 (Karnataka)