Chapter IV

MOSQUITO CONTROL: A SEARCH FOR ALTERNATIVE PARADIGM
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IV.1. Introduction

Mosquitoes are a group of haematophagus insects and which have been tormentors of human beings from time immemorial and continue to jeopardize the existence of man. Since mosquitoes possess great survival potentiality due to high fecundity, short gestation period, high dispersal potentiality, high degree of resilience in recovering from population reduction, their control is more strenuous on one hand and these blood suckers are responsible for transmitting many diseases like Malaria, Dengue fever (DF), Japanese Encephalitis (JE), Yellow Fever (YF), West Nile (WN), Chikungunya (CHIKF), Lymphatic Filariosis, etc. on the other hand. So it is highly necessary to control them for the betterment of human race on the earth.

This chapter aims to evaluate the effectiveness of various methods of mosquito control and tries to suggest an alternate paradigm for the same by giving genus and species based and habitat based approaches rather than suggesting a panacea for mosquito control which remains as a Herculean task even now. An attempt is also made to highlight the traditional practices of mosquito control by going through lifestyle oriented and agricultural oriented practices which were in practice, which are still in use and will be measures to control mosquitoes. Finally habitat based suggestion for control measures are dealt with.

VI.2. Traditional Practices Of Mosquito Control

To achieve progress and stability in the field of human health, mosquito borne diseases have to be controlled effectively. In olden days people practiced various tips to control mosquitoes. They are grouped into two main headings:

A. Lifestyle oriented practices
B. Agriculture oriented practices

A) Lifestyle oriented practices

Human beings used to have various measures to control the menace of mosquitoes

1. Fogging techniques

As part of traditional practices in order to avoid mosquitoes and other harmful insects people used fogging techniques since early times. For fogging people used various materials.
i. Ayurvedic combinations from branded companies.
ii. Special combinations by indigenous experts (Nattuvaidyanmar).
iii. By burning dried leaves and plant parts.
iv. Incensing by using cidor, neemleaves, chaff, Coconut fibres etc.
v. Mosquito repellent coils such us Aamathiri, Sandal thiri, Spike of Artocarpus spp, dried cow dung and paddy husk.
vi. Dried elephant dung.

Burning of these materials give some sort of fragrance to the surroundings on one hand and getting relief from mosquito biting. These practices have religious and social importance.

2. **Use of Domestic plants of penetrating aromatic smell**

Every house rears plants which produce aromatic penetrating smell eg. *Coleus aromaticus, Leucus aspera, Ocimum sanctum, Ocimum basilicum, Vitex negundo, Glyricidia glabra* etc which repel mosquitoes.

3. **Oil bathing**

To avoid mosquito bites people usually practice oil bathing. It not only helps mosquito avoidance but also has health significance.

4. **Periodic Decanting of Arencnut soaking water**

People used soaked arecnut for chewing. Inorder to soak arecnut, water in vessels was used in almost all houses. In such vessels mosquitoes used to lay eggs. To avoid mosquito breeding people often decant water from the vessels within 3 to 4 days. This practice found to be a precautionary measure to control mosquitoes.

B) **Agriculture oriented practices**

Agricultural oriented practices also helped human beings to control mosquitoes. Such practices include,

i. **Biological control by using oil cakes**

Deep and penetrating smell from cakes likes neem, caster, hydnocarpus etc drive away mosquitoes and other harmful insects from human surroundings.
ii. Burning of agricultural wastes
For achieving soil fertility farmers often burn agricultural waste materials and its ash makes soil fertile on one hand and its fog repel mosquitoes from human beings on the other hand.

iii. Agricultural practices itself
Agricultural practices itself become a measure to avoid or reduce mosquito menace. Farmers used to plant different varieties of plants in their agricultural fields in them spiders used to make webs in which mosquitoes held up and eaten up by predators. It helped to reduce mosquitoes considerably but today that practice become ineffect because rubber plantation monopolies the olden agricultural tradition.

iv. Periodical cleaning for agriculture
For agriculture, farmers used periodic cleaning of bushy areas, where mosquitoes breed and rear. It is followed by filling up of ditches containing water, making water. All these measures avoid mosquito breeding surroundings.

Today the indigenous or traditional practices are getting much importance which were ignored or lost due to the influence of modern technological approaches. In the last century farmers thought that chemical methods could be used to solve the problem of mosquitoes as well as harmful insects but in this century the main challenge of people in agricultural field is to develop insect control measure which are scientific and eco friendly.

VI.3. Mosquito Control Methods an Appraisal
To control mosquitoes and other harmful insects human beings adopt many measures such as

- Physical measures,
- Chemical measures
- Biological measures
- Integrated measures

Each measure has its own merits and demerits.

In this context let us briefly evaluate the effectiveness of the said measures.
A) Physical measures

Physical measures include common methods for controlling mosquitoes. It includes,

i. The uses of traps
Traps are used to capture adult mosquitoes. Zoophagous mosquitoes are attracted by making use of attractants like CO\textsubscript{2} and dim lights. The effectiveness of traps are determined by the factors such as correct operation, proper setup and maintenance of the devices etc. A number of other flying insects such as moths, flies, beetles will be captured by the traps are the demerits of using traps.

ii. Use of sonic energy
Sonic energy is being used at a range of 18 to 36 kilo hertz could be used to kill larvae of mosquitoes. But further studies are essential in this regard.

iii. Use of mosquito bats
These are battery operated devices to kill mosquitoes and it is not a permanent solution to control mosquitoes.

iv. Use of mosquito nets
Mosquito nets protect us from mosquito biting.

v. Use of mosquito repellents
Mosquito coils, electric mosquito machines, mosquito aerosol sprays, mosquito repellent creams or lotions etc. can be used against mosquito biting.

B) Chemical Measures

These are measures against mosquitoes by using suitable chemical substances such as light mineral oils, insect growth regulators, organophosphates temephos malathion, phyrethrin etc. This control measure could be aimed at different stages of the insects in its life cycle. Larvicides are used to control larvae of mosquitoes while adulticides are used to kill adult mosquitoes.
1) **Use of larvicides**

Larvicides are applied on the larval habitats at an average of seven days because the larval states prolong a period of seven days approximately. If we used mineral oils it can form a film over water surface which prevents oxygen to larvae and hence they suffocate and die. Use of mineral oil kill both the larvae and pupae of mosquito.

2) **Use of adulticides**

Adulticide like pyrethrin applied on the water surface they kill adult mosquito but are not efficient in killing eggs and pupae of mosquitoes.

i) Getting rid of adult mosquitoes in an effective way to bring down the mosquito pest problem the following techniques are commonly used.

ii) Fogging - It is done in outdoors by using chemical pesticides like pyrethrin.

iii) Spraying- It is used in indoor sides by spraying suitable chemicals.

Chemical measure has its own merits and demerits. It brings speedy effect on one hand and is costly and may cause for environmental pollution, it kills other aquatic organisms like fishes and other life forms.

C) **Biological Measures**

Biological control or bio control is the use of natural enemies to manage mosquito populations. There are several types of biological control including the direct introduction of parasites, pathogens and predators to target mosquitoes (http://en.wikipedia.org/wiki/vectorcontrol).

Effective bio control agents include

i. **Use of predator fishes**

Predator fishes feed on mosquito larvae eg. *Gambusia affinis, Tilapia cyprinids* etc. Direct introduction of tilapia fish in the eco system have disastrous consequences (Service 1993).

ii. **Use of other predators**

Other predators like dragon fly naiads, lizards and geckos, Toxorhynchites mosquitoes, crustaceans like mesocyclops copepods, nematodes and fungi are used to control mosquitoes.
iii. Use of biological control agents

Biological control agents like soil bacterium Bacillus thuringiensis especially Btisraelensis (BTI) to infect mosquito larvae. Fungi like Metarhiziumanisopliae and Beauberia bassiana etc. can be used to control mosquitoes.

iv. Use of bio repellents

Bio repellents like Lemon, Eucalyptus oil, Citronella, Soyvean oil, Neem oil etc. can be used as natural mosquito repellents (http://etips.sulekha.com)

Biological measures are comparatively safer than the physical and chemical measures a more sustainable approach is to identify agronomical methods that combine economic benefit to the farmer with the vector control, and to involve the farming community in their large scale application method such as intermittent irrigation, rice cum fish culture and the use of Neem cake powder are being tested.

D) Integrated Measures (IPM)

In agriculture, integrated pest management (IPM) is a pest control strategy that uses a variety of complementary strategies including mechanical physical genetic, biological cultural chemical managements these methods are done in three stages; prevention, observation and intervention. It is an ecological approach with a main goal of significantly reducing or eliminating the use of pesticides while at the same time managing pest populations at acceptable levels (http://www.epa.gov/pesticides/food/ipm.htm) Integrated measure select appropriate technique to control mosquitoes depending on the type of habitat and environment

VI.4. A Search for Alternate Paradigm

Inspite of the remarkable advancement of science and technology, the control of mosquitoes remains to a large extent one of man’s most difficult tasks. This is mainly due to the fact that the collective wisdom of man has not matched the scientific advancement of modern world in such a situation a more suitable approach could be identified and which must be agronomical and ecofriendly. Here genus and species based approach and habitat based approaches are to be dealt with
A) Genus and species based approach.

Depletion of mosquito breeding places by using environmentally safe and suitable mosquito control method such as biological control agents and keeping our surroundings clean are most important steps towards mosquito reduction everywhere. Here genus and species based approaches are significant.

Mosquito management approach should be adopted for getting an effective and efficient control in mosquito with minimal impact on the ecological system. It starts from identification of the species of mosquito causing problem. Control measures could be aimed at different stages of the insects in its life cycle.

Aedes larvae are container breeders which thrive in both clean and organically rich water in both natural and artificial containers. Hence container management to reduce the sources of breeding habitats is one of the best approaches for controlling *Ae.aegypti* and *Ae.albopictus* to reduce DF/DHS.

Surveillance of vector is an important step in the planning of control measures and their periodic evaluation and their studies to determine the risk of outbreak of epidemics. Surveys are necessary for studying ecology and distribution of vectors. The indices like a house index (HI),container index (CI), and Breateau index (BI) are commonly used to record vectors such us *Ae.aegypti* and *Ae.albopictus Anophelene, Culex* and *Mansonia* species of mosquitoes generally breed in irrigated rice fields, shallow ditches and pools. These mosquitoes are zoophilic, feeding primarily on vertebrate hosts. Thermal fogging with insecticides such as pyrethrin or Malathion is recommended to prevent the vector born epidemics. Chemical larviciding of rice fields is not cost effective.

JE virus has been isolated in nature from 13 species of mosquito of which 3 belonging to the genus *Anopheles*, 8 to *Culex* and 2 to *Mansonia*. Among them *Culex vishnui* group (*C.x.vi, Cx.ps, Cx.tr*).Mosquitoes plays a significant role in the transmission of JE these mosquitoes generally breed in irrigated rice fields, shallow ditches and pools.
The main vectors of Bancroftian filariasis in India are *Cx.qu*, the polluted water breeding mosquitoes and *Mansonina* mosquitoes-Ma uniformis, *Ma annularis* and *Ma indiana* for brugian filariasis. The breeding of *mansonia* mosquitoes is associated with certain aquatic plants such as Pistia, Stratioles, Eichornia crassipes etc.

B) Habitat based approach

Habitats are very important as far as the bionomics of mosquitoes are concerned. Habitat only determines the strategy for control measure of mosquito. Mosquito breeding habits identified where drains canals, septic tanks, cement tanks, pools, ponds, pit latrines, marshy lands, wells, overhead tanks, Miscellaneous house hold domestic containers emergence of mosquitoes from various habitats varied with season and locality (Dhanda et al 1991 and 1996). Septic tanks supporting prolific breeding of mosquitoes (ICMR 2000).

The use of adulticide is not advisable due to environmental hazards and prohibitive cost. Personal protection measures such as using mosquito nets or repellents are not a practical solution in view of social economic background of the community and poor sustainability are concerned. The approach to eradicate immatures of mosquitoes or to make the habitats unsuitable for mosquito breeding, through environmental modification is not admissible. The personal protection measures may be considered as an environment friendly approach but cannot be applicable to all the habitats in all seasons. Though such source reduction is a permanent solution for the prevention of mosquito breeding it needs an engineering solution which involves huge expenditure therefore larvicidal operation could be an alternative measure of choice has received adequate attention in recent time.

Intersectorial coordination is an important component for successful implementation of mosquito control programme (ICMR 2000).
C) **Suggestion to control mosquitoes**

Since the study is mainly habitat oriented one let us have a few suggestions to control mosquitoes in habitat wise.

1. **House premises**

   In house premises artificial containers like discarded tins, bottles, motor vehicle tyres tubes barrels, earthen wares of varying sizes etc. and rain water collection depressions, fallen leaves, plant axils, leaf axils, cesspits and cesspools containing domestic effluents are very common which form breeding habitats of mosquitoes (ICMR 2000). Some of the measures taken in and around house premises to control mosquitoes are:

   i. The best preventive measure for residential areas infested with mosquitoes is to eliminate the places where the mosquitoes lay eggs, basically in containers that hold water.

   ii. Items that collect rain water or to store water or used automobile tyres etc. should be covered properly discarded.

   iii. Pet and animal watering containers and vases with fresh flowers should be emptied and cleaned at least once a week. This will eliminate the mosquito eggs and larvae and reduce the number of mosquitoes present in these areas.

   iv. Use of air conditioning, ventilation net reduce the risk of mosquitoes coming indoors.

   v. Proper usage of mosquito repellents.

   vi. Adequate clothing decreases the risk of being bitten by mosquitoes.

   vii. Above all, residents are responsible for keeping their yards and patios free of stagnant water where mosquitoes can be bred.

2. **Plantation**

   Rubber plantations are much in all terrains studied and their latex collection cups are the breeding sites of mosquitoes, especially for *Ae.albopictus* (Sumodan 2003). While studying the breeding potential of *Ae.albopictus* (Skuse, 1895) in Chikungunya effected areas of Kerala India Eappen *et al* reported that Aedes especially *Ae.albopictus* and *Ae. vittatus* had predominance in Pathanamthitta and Kottayam districts.
Eapen et al 2010. *Ae.albopictus* breeding water encountered in the leaf axils of many plants viz: Pineapple (*Ananas comosus*), Bromeliads (*Guzmania spp*), Banana (*Musca spp*), Screw pine (*Pandanus adoratissimus*) and in the primary rachis of coconut (*Cocos nucifera*). In Pathanamthitta District is having fairly good Rubber plantation. Pineapple being cultivated as an inter crop in rubber plantations. During south western monsoon period rubber tapping being suspended temporarily and during that time the latex collecting cup being filled with water and it can serve as the breeding site of many mosquitoes. Leaf axils of pineapple containing water also act as breeding site of mosquitoes. Moreover bushy wet soil act as the rearing place of mosquitoes the important measures to be taken in the plantations for mosquito control are,

i. Decant water from the latex cup and keep upside down during rainy season.

ii. Elimination of water filled small and big ditches, artificial containers found in plantations.

iii. Keep the environment neat and clean.

iv. Fill the bamboo cuts and plant bases with mud where water can be stored.

v. Clean the bushes to avoid unusual mosquito adherence.

3. **Cattle shed**

   In the present study cattle shed was the most important site where recorded 37011 (60.58%) mosquitoes. Cattle are very helpful for human existence in many ways such as food requirements, agricultural purposes, economic environment etc. Mosquitoes directly or indirectly use their habitat for breeding and rearing.

   Some of the measures taken in and around cattle shed to control mosquitoes are:

   1. Eliminate the places where mosquitoes can lay eggs i.e., the containers holding water.
2. Use disinfectants like dettol, lizol etc., as insect repellant occasionally.

3. Adopt indeginous methods to drive away mosquitoes by hanging plants like Leucas.

4. Use mosquito repellent oils on the body of cattles.

5. Regular use of mosquito repellent oils in the cowdung pits.

6. Keep the envirionment neat and clean.

7. Dispose the left over cattle feed regularly.

8. Keep the cattle in a hygienic manner by providing medical assistance.

4. Marshy lands

Water logged marshy lands are common in many parts of the districts which supports profuse breeding of various vector mosquitoes. Since these areas are too vast, spraying of insecticides are not feasible or economical. These water logged areas are infested with aquatic floating weeds which supports the breeding of Mansonioides mosquitoes.

The important measures to control mosquitoes in marshy land are

i. Filling of low lying waterlogged areas, which are not suitable for agriculture will prevent water accumulation (ICMR 2000). But it may distract the habitats of many other aquatic organisms.

ii. Periodical removal of weeds from ponds canals etc., make the habitat unsuitable for breeding mosquitoes of Mansonioides.

iii. Make the stream flowing, remove obstacles from canals, ponds so that water may flow and hence mosquito breeding does not happen.
IV.5. Conclusion

A proper approach to control mosquitoes involves imparting awareness to the people. Proper water and environment management are also highly necessary. Environmentally safe and sustainable mosquito control method especially biological control measures, continuous uninterrupted monitoring and implementation of control programme would help us to control mosquitoes. A constant vigil against the creation of mosquito breeding places involving participation of the general public and civic authorities are required for proper control of mosquitoes. Mosquito control problem has to be approached in its entirety with wisdom and foresight. Successful mosquito control programmes should ensure sustainability, environmental safety and economic benefits. The co-operation and participation of the community are vital for the control of vector borne diseases.