

Full Length Article

Operational And Behavioural Gaps In Mosquito Vector Control In A Forest-Rural Block Of Central India: A Household And Breeding-Habitat Assessment From Devbhog, Chhattisgarh

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Abstract

Background: Mosquito-borne diseases remain a persistent public-health concern in forest-rural landscapes where ecological suitability for vectors overlaps with operational constraints and household-level behavioural gaps. Devbhog Block of Gariyaband district, Chhattisgarh, represents such a setting, with scattered rural settlements, agricultural fields, domestic water-storage practices and forest-fringe habitats. This study assessed vector-control coverage, environmental risk, breeding-habitat distribution, simple larval observations and community knowledge, attitude and practices (KAP) in selected villages of Devbhog Block.

Methods: A descriptive cross-sectional field assessment was conducted in 10 selected villages. Data were collected from 100 households using a structured survey, transect walks, environmental observations, simple larval assessment and key-informant interactions with local health personnel. The analysis used frequencies and percentages to describe household risk factors, intervention coverage, breeding habitats, seasonal variation and KAP indicators.

Results: Household-level environmental risk was prominent: poor drainage was recorded around 78% of households, uncovered water storage around 69% and stagnant water around 64%. Indoor residual spraying (IRS) coverage was 46%, while complete spraying acceptance was 32%. Mosquito-net ownership was 66%, but regular use was only 37%, suggesting a large ownership-use gap. Larval source management was weak; only 22% of households reported removing stagnant water and 16% participated in cleanliness drives. Eighty-seven potential breeding sites were recorded, dominated by stagnant ponds/ditches, forest pools, domestic containers and paddy fields. Simple larval observations identified *Anopheles* spp. (41.9%), *Aedes* spp. (33.8%) and *Culex* spp. (24.3%). KAP indicators were low, particularly for dengue transmission, breeding-site awareness and community source reduction.

Conclusion: Devbhog Block requires locally adapted integrated vector management that combines improved IRS planning, consistent mosquito-net use, household-level source reduction, seasonal surveillance, Panchayat-supported sanitation and ASHA/Mitanin-led communication. The findings highlight that vector-control effectiveness in forest-rural settings depends as much on community behaviour and environmental management as on the availability of formal control measures.

Keywords: Devbhog Block; vector control; malaria; dengue; mosquito breeding; KAP; larval source management; Integrated Vector Management; Chhattisgarh.

1 Introduction

Mosquito-borne diseases remain an important public-health challenge in tropical and subtropical regions, particularly where ecological conditions favour mosquito survival and where control

programmes face implementation constraints. Vector control is therefore not only a technical public-health operation but also a community-level and environmental-management issue. The World Health Organization (WHO) has emphasized integrated, locally adapted vector control under the

Global Vector Control Response 2017-2030 (World Health Organization [WHO], 2017).

India has committed to malaria elimination by 2030, with district-level surveillance, vector control, early diagnosis, complete treatment and community participation forming core elements of the national strategy (National Center for Vector Borne Diseases Control [NCVBDC], 2023). However, forested and forest-fringe areas remain difficult settings because ecological receptivity, scattered settlements, access barriers and behavioural factors may reduce the effectiveness of standard interventions. Forest malaria has been described as a persistent obstacle to malaria control and elimination in India (Ranjha & Sharma, 2021). Devbhog Block in Gariyaband district, Chhattisgarh, represents a forest-rural context where malaria- and dengue-related risk cannot be understood through disease records alone. Household surroundings, domestic water storage, paddy fields, stagnant water, open drains and forest pools can simultaneously support different mosquito genera. The present paper converts field-based dissertation data into a focused research manuscript to examine vector-control challenges in Devbhog Block, with emphasis on household risk, intervention coverage, breeding ecology and low KAP status.

The specific objectives were to assess household-level environmental risk factors; estimate coverage and acceptance of IRS and mosquito-net use; identify common mosquito breeding habitats; document simple larval observations by genus; assess KAP indicators; and suggest locally feasible integrated vector-management priorities.

2 Materials and methods

2.1 Study design and setting

A descriptive, field-based cross-sectional assessment was conducted in Devbhog Block of Gariyaband district, Chhattisgarh, India. Devbhog is one of the administrative blocks of Gariyaband district and includes rural settlements with agricultural, forest-fringe and seasonal water-body characteristics. The study was designed as a practical public-health and entomological field assessment suitable for identifying local vector-control gaps.

2.2 Study population and sampling

The study included 100 households from 10 selected villages of Devbhog Block. Ten households were surveyed from each selected village. Adult respondents who had lived in the village for at least one year and were willing to participate were included. Local health staff and community representatives were also consulted through informal/key-informant interactions to understand field-level implementation issues.

2.3 Data-collection tools

Data were collected using a structured household questionnaire, KAP questions, environmental observation sheets, transect-walk records, breeding-site formats and simple larval observation notes. Field photographs were used to document the study setting and interactions with health staff. The household questionnaire covered socio-demographic information, housing conditions, water-storage practices, IRS coverage and acceptance, mosquito-net ownership and use, larval source management, fever reporting and community participation.

2.4 Environmental and larval observations

Transect walks were conducted to identify potential breeding habitats such as ponds, ditches, paddy fields, forest pools, domestic containers, drains and discarded water-holding objects. Larvae observed during field visits were recorded at genus level as *Anopheles* spp., *Aedes* spp. or *Culex* spp. based on basic morphological and habitat characteristics. Advanced molecular identification and insecticide-resistance testing were not included.

2.5 Data analysis

Data were entered and summarized using descriptive statistics. Frequencies and percentages were used for household risk factors, intervention coverage, breeding habitats, KAP indicators and larval observations. Because the study was exploratory and block-specific, the emphasis was on practical interpretation rather than inferential modelling.

2.6 Ethical considerations

The purpose of the study was explained to respondents before data collection. Participation was voluntary, and personal identity was not disclosed in the analysis. Field photographs used in the manuscript are presented as contextual documentation; identifiable photographs should be

submitted to journals only after appropriate permission and institutional approval.

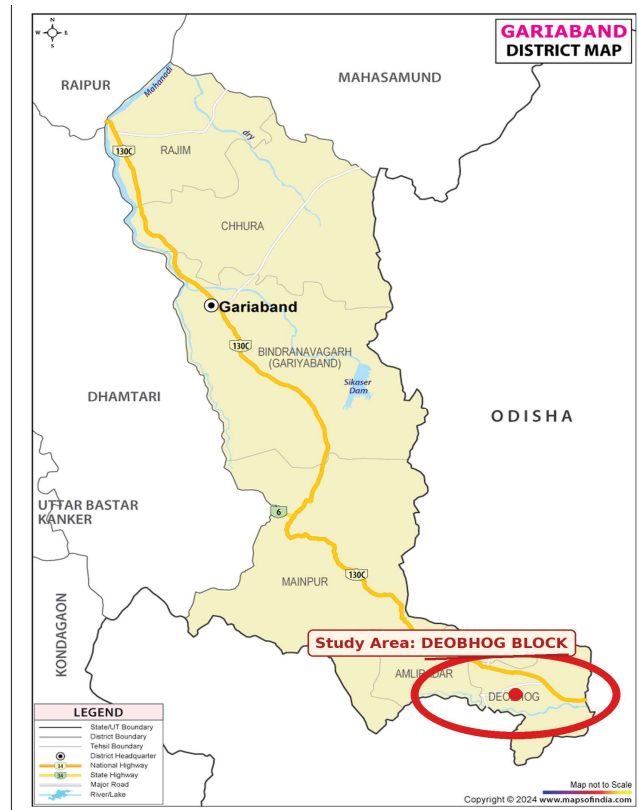


Fig. 1 Location map showing Deobhog Block as the selected study area in Gariaband District, Chhattisgarh. Source: Prepared using Gariaband district map with administrative verification from District Administration Gariaband, Government of Chhattisgarh..

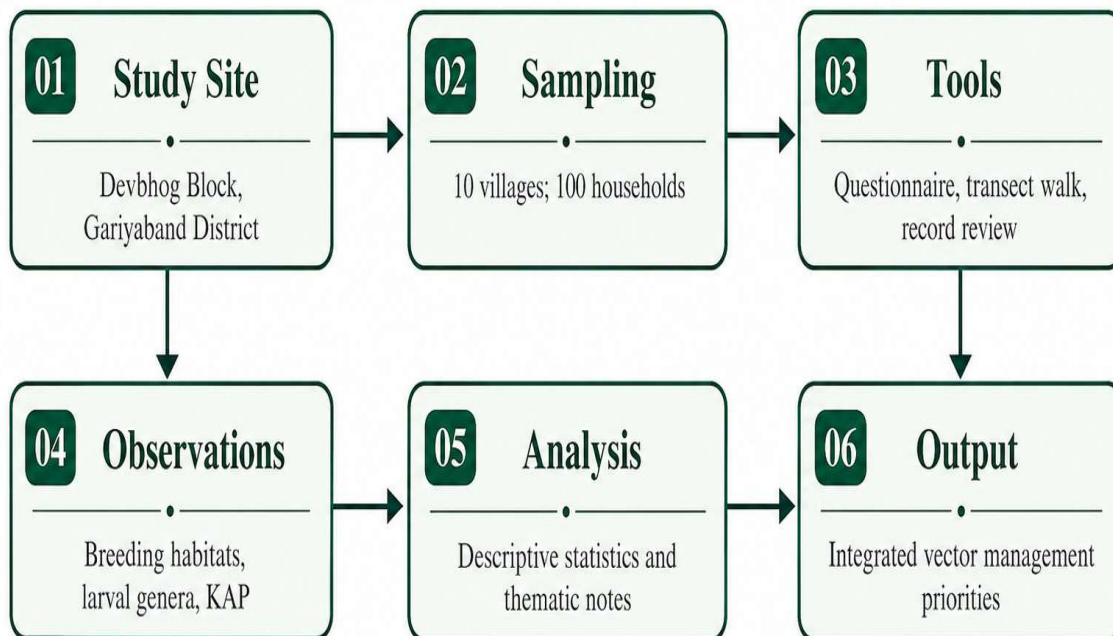


Fig. 2 Methodological workflow followed for the household survey, transect walk, larval observation, KAP assessment and descriptive analysis.

Representative field photographs used for contextual validation



Front view of CHC Devbhog



Review of local records



Discussion with health staff



Household/field survey documentation

Fig. 3 Representative field photographs from Devbhog Block used for contextual validation of local health-system interaction and survey documentation.

3 Results

3.1 Household profile and environmental risk

The surveyed households represented a forest-rural population with a high dependence on agriculture, labour and forest-associated livelihood activities. Environmental risk factors were common. Poor

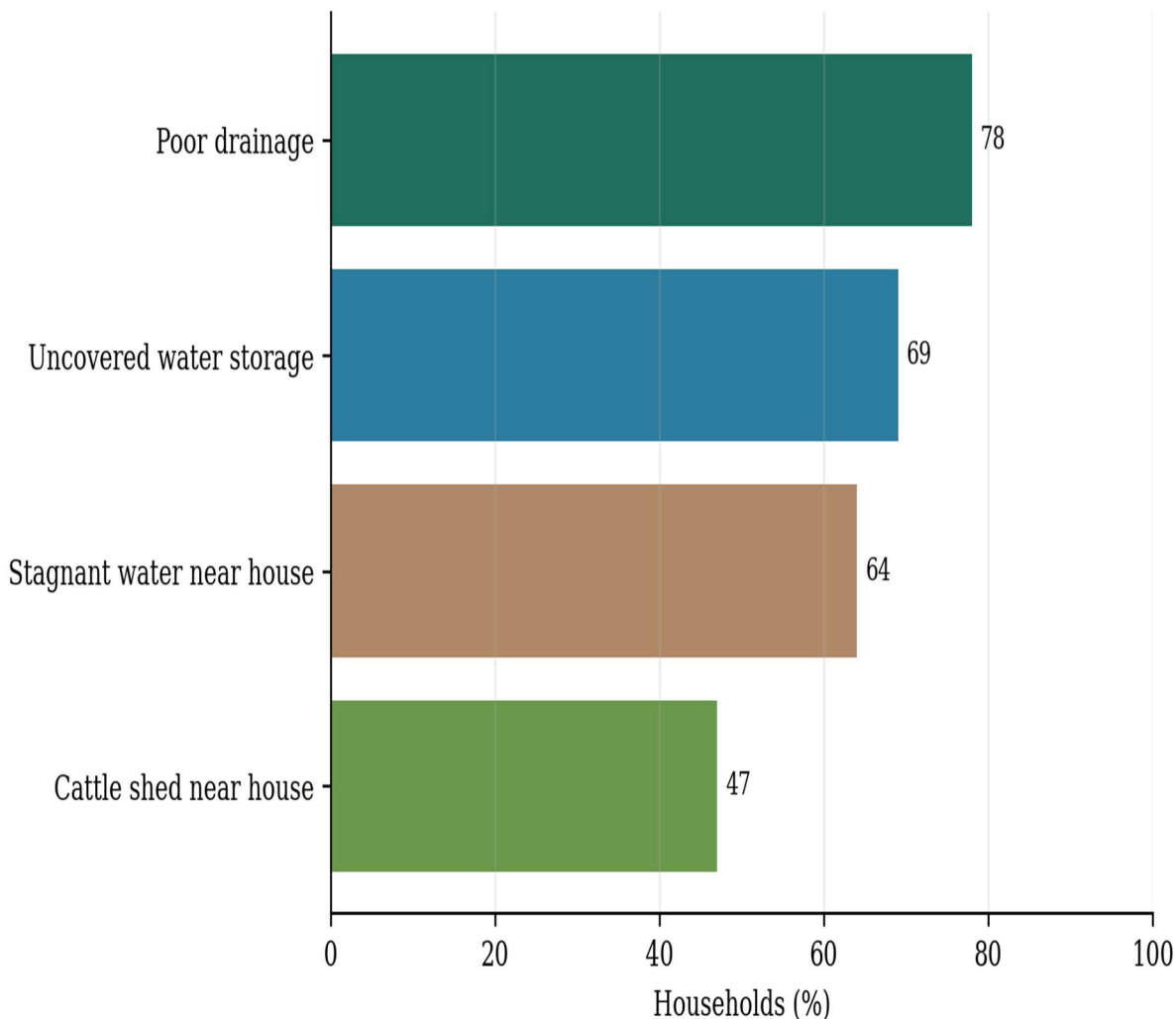
drainage was observed around 78% of households, uncovered water storage around 69% and stagnant water around 64%. Cattle sheds near households were recorded in 47% of households. These conditions can support multiple vector genera through domestic, peri-domestic and environmental breeding sites.

Table 1 Household-level environmental risk factors in Devbhog Block

Indicator	Frequency (n = 100)	Percentage (%)
Poor drainage near household	78	78.0
Uncovered water storage	69	69.0

Stagnant water near household	64	64.0
Cattle shed near household	47	47.0

Environmental risk factors around households



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Fig. 4 Household-level environmental risk factors recorded in the surveyed villages of Devbhog Block.

3.2 Vector-control coverage and behavioural indicators

IRS coverage was 46%, and complete household acceptance of spraying was only 32%. Mosquito-net ownership was 66%, but regular use was only 37%, indicating a substantial ownership-use gap.

Larval source management participation was only 22%, and the overall awareness score was approximately 35%. The indicators show that formal intervention availability did not translate into consistent household-level practice.

Table 2 Vector-control coverage and behavioural indicators in Devbhog Block

Vector-control indicator	Value (%)	Interpretation
IRS coverage	46.0	Low to moderate
Complete IRS acceptance	32.0	Low
Mosquito-net ownership	66.0	Moderate
Regular mosquito-net use	37.0	Low
Larval source-management participation	22.0	Very low
Overall awareness score	35.0	Low

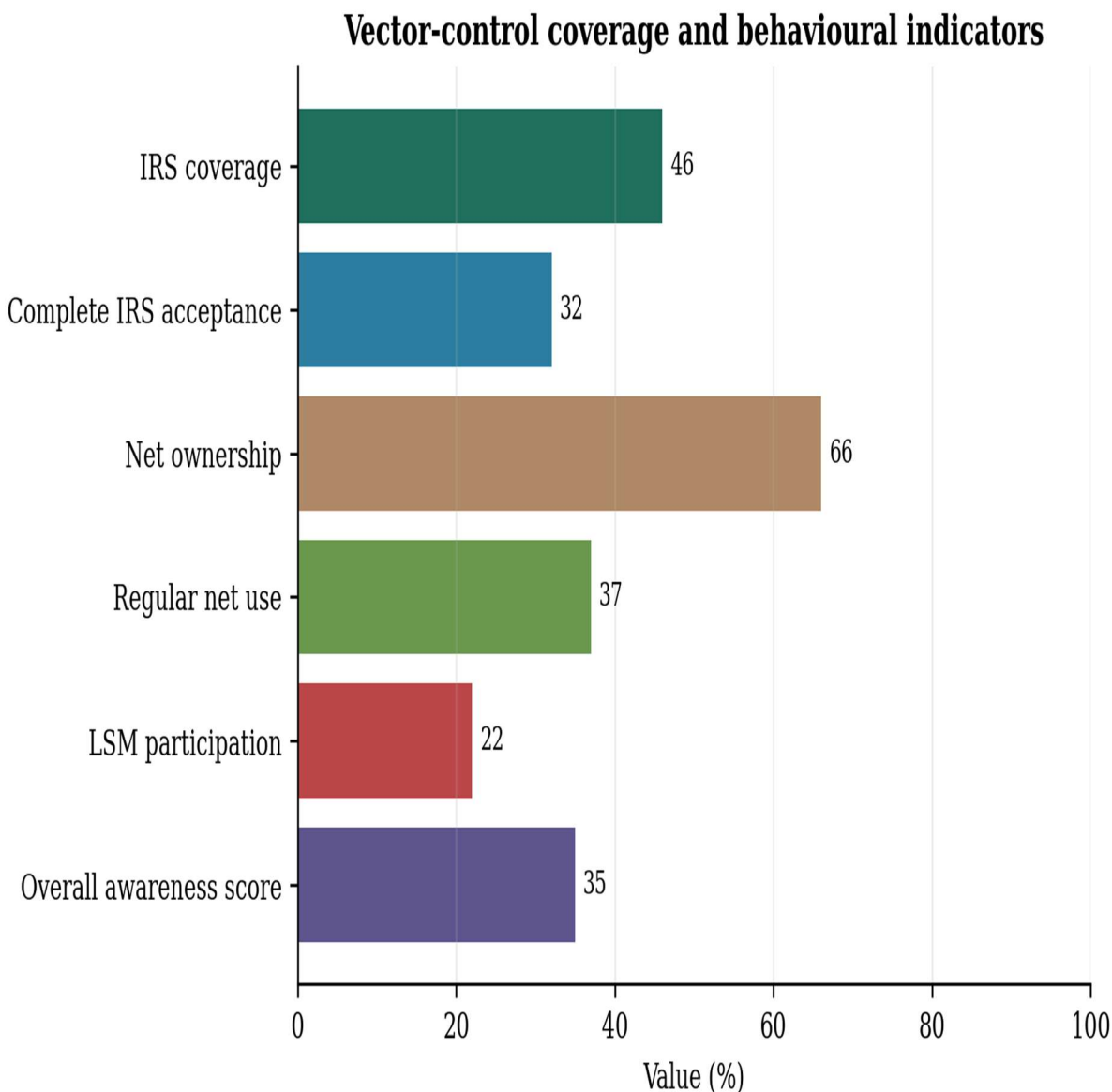


Fig. 5 Vector-control coverage and behavioural indicators showing gaps between intervention availability and regular household practice.

3.3 Breeding habitats and seasonal pattern

Eighty-seven potential breeding sites were recorded. Stagnant ponds and ditches formed the largest category (24.1%), followed by forest streams/small pools (23.0%), domestic containers

(18.4%) and paddy fields (17.2%). The seasonal pattern showed the highest breeding-site burden during monsoon (49.4%), followed by post-monsoon (29.9%) and pre-monsoon (20.7%).

Table 3 Potential mosquito breeding habitats recorded during field observations

Breeding habitat type	Sites recorded	Percentage (%)
Stagnant ponds/ditches	21	24.1
Paddy fields	15	17.2
Forest streams/small pools	20	23.0
Domestic water containers	16	18.4
Open drains/wastewater pools	10	11.5
Discarded tyres/plastic containers	5	5.8

Total	87	100.0
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Potential mosquito breeding habitats (n = 87)

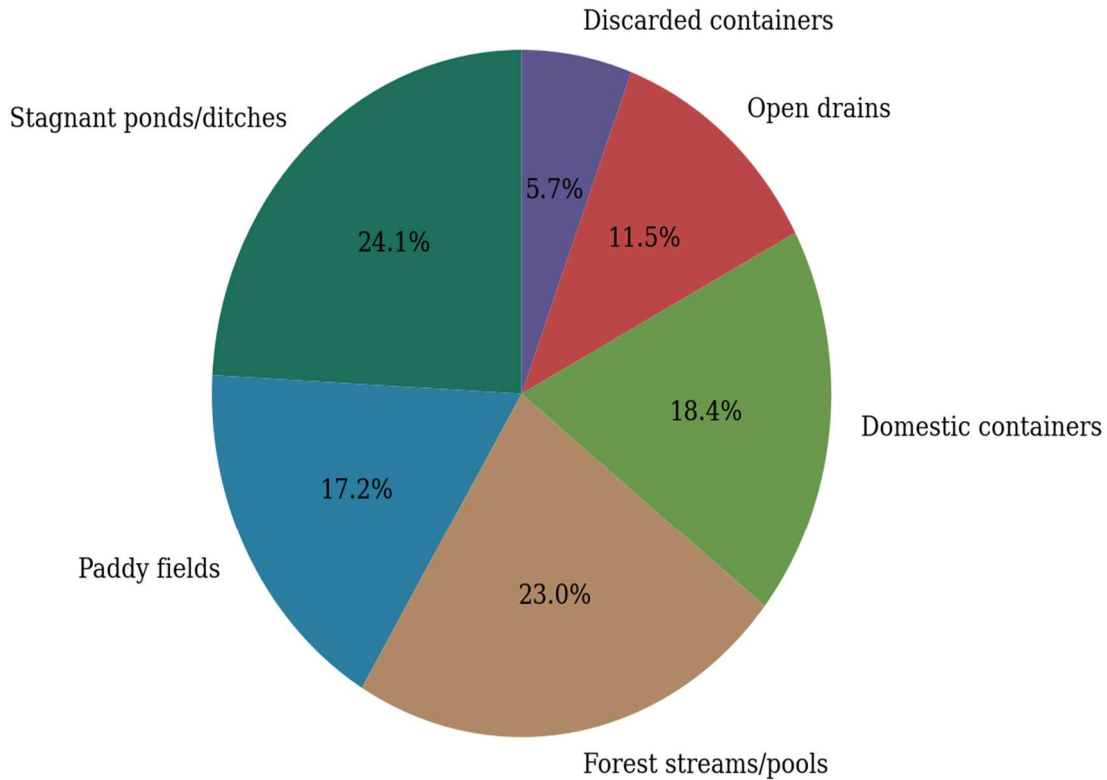


Fig. 6 Distribution of potential mosquito breeding habitats recorded in selected villages of Devbhog Block.



Fig. 7 Seasonal variation in mosquito breeding sites, with monsoon and post-monsoon periods showing higher risk.

3.4 Larval observations by mosquito genus

A total of 74 positive larval observations were summarized by genus. Anopheles spp. accounted for 41.9%, Aedes spp. for 33.8% and Culex spp. for 24.3%. Habitat-wise analysis showed Anopheles

larvae mainly in ponds, paddy fields and forest pools, Aedes larvae mainly in domestic and discarded containers and Culex larvae mainly in open drains and wastewater pools.

Table 4 Mosquito genera observed during simple larval survey

Mosquito genus	Positive observations	Percentage (%)
Anopheles spp.	31	41.9
Aedes spp.	25	33.8
Culex spp.	18	24.3
Total	74	100.0

Mosquito genera observed during larval survey (n = 74)

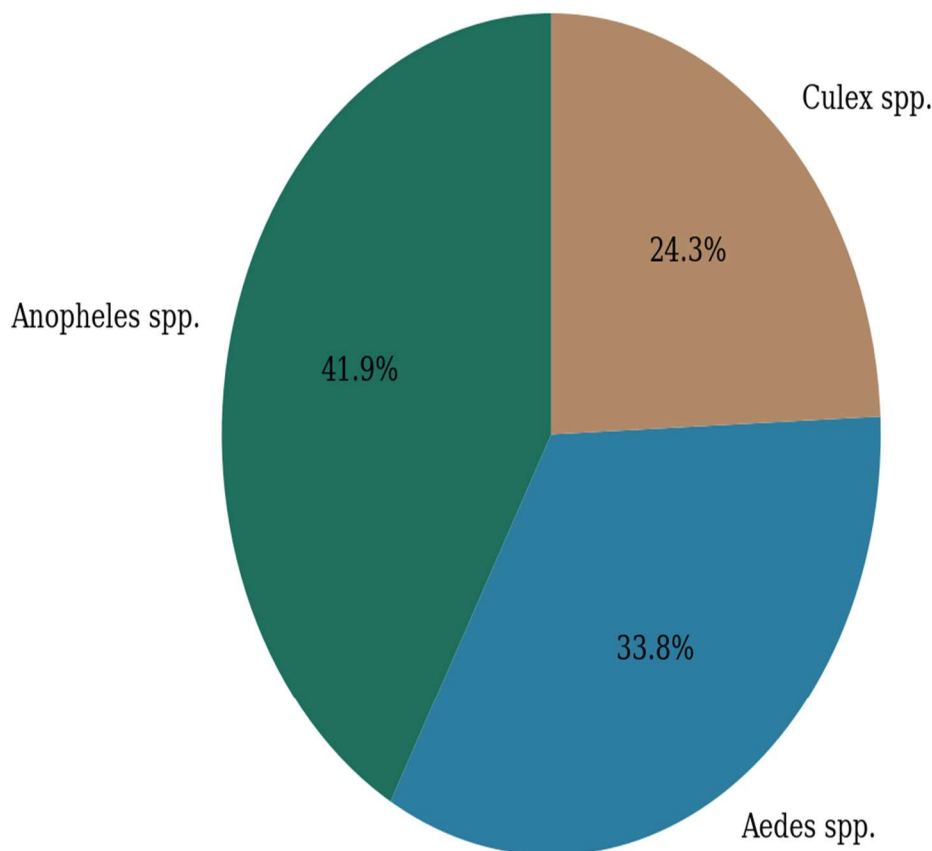


Fig. 8 Proportion of mosquito genera observed during simple larval survey in Devbhog Block.

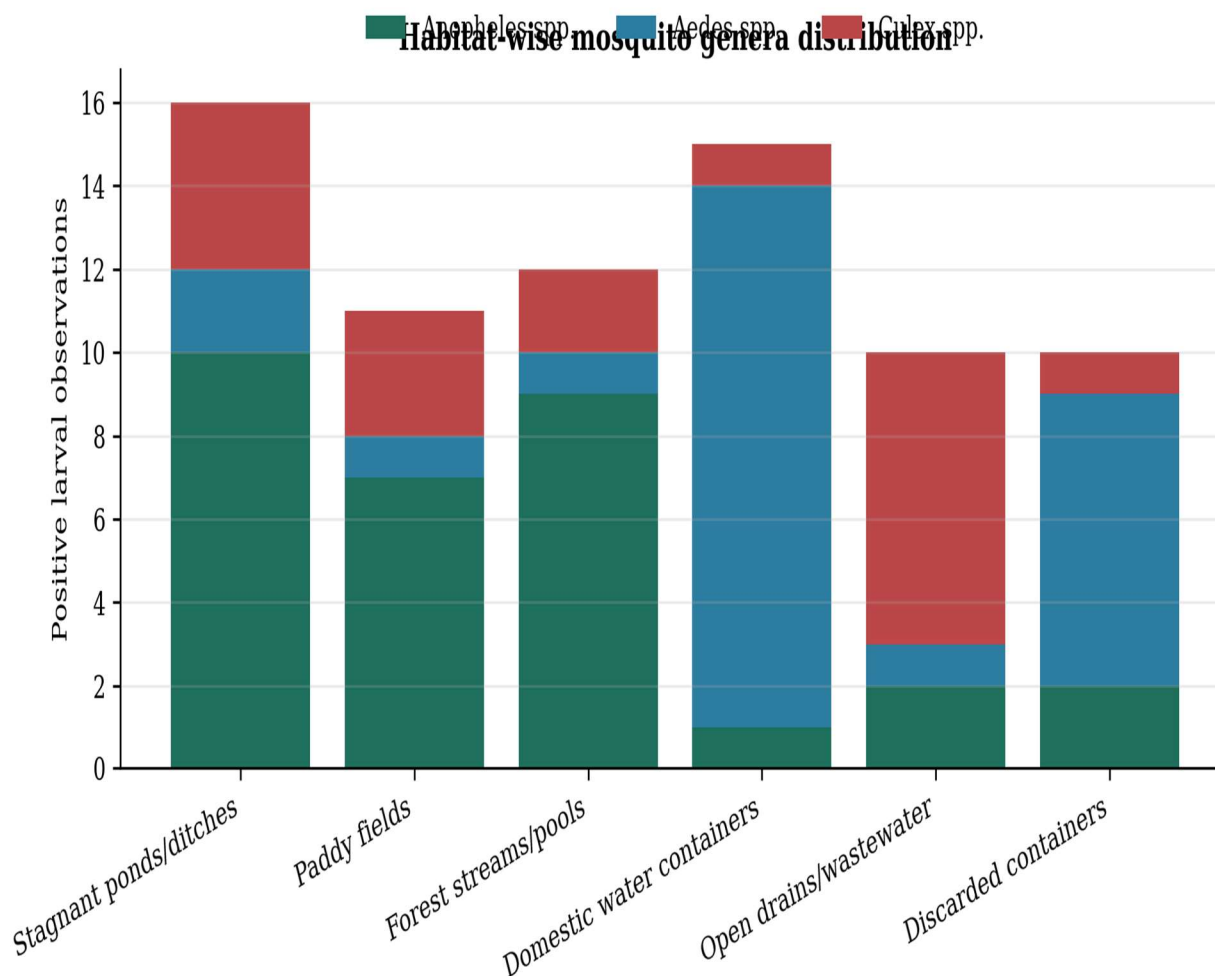


Fig. 9 Habitat-wise distribution of *Anopheles*, *Aedes* and *Culex* larval observations.

3.5 KAP indicators

KAP indicators were low. Awareness that mosquitoes transmit malaria was 45%, while awareness of dengue transmission was only 28%. Only 26% of respondents recognized stagnant water as a mosquito-breeding source, and only 24% knew

the importance of covering water containers for mosquito prevention. Preventive practices were also poor: regular net use was 37%, covering water containers 31%, removing stagnant water 22% and participation in cleanliness drives only 16%.

Table 5 Selected KAP indicators among surveyed households

KAP domain	Indicator	Respondents (%)
Knowledge	Aware that mosquitoes transmit malaria	45.0
Knowledge	Aware that mosquitoes transmit dengue	28.0
Knowledge	Aware that stagnant water supports breeding	26.0
Attitude	Mosquito-borne diseases considered serious	49.0
Attitude	Willing to participate in source reduction	26.0
Practice	Regular mosquito-net use	37.0
Practice	Removal of stagnant water	22.0
Practice	Participation in cleanliness drives	16.0

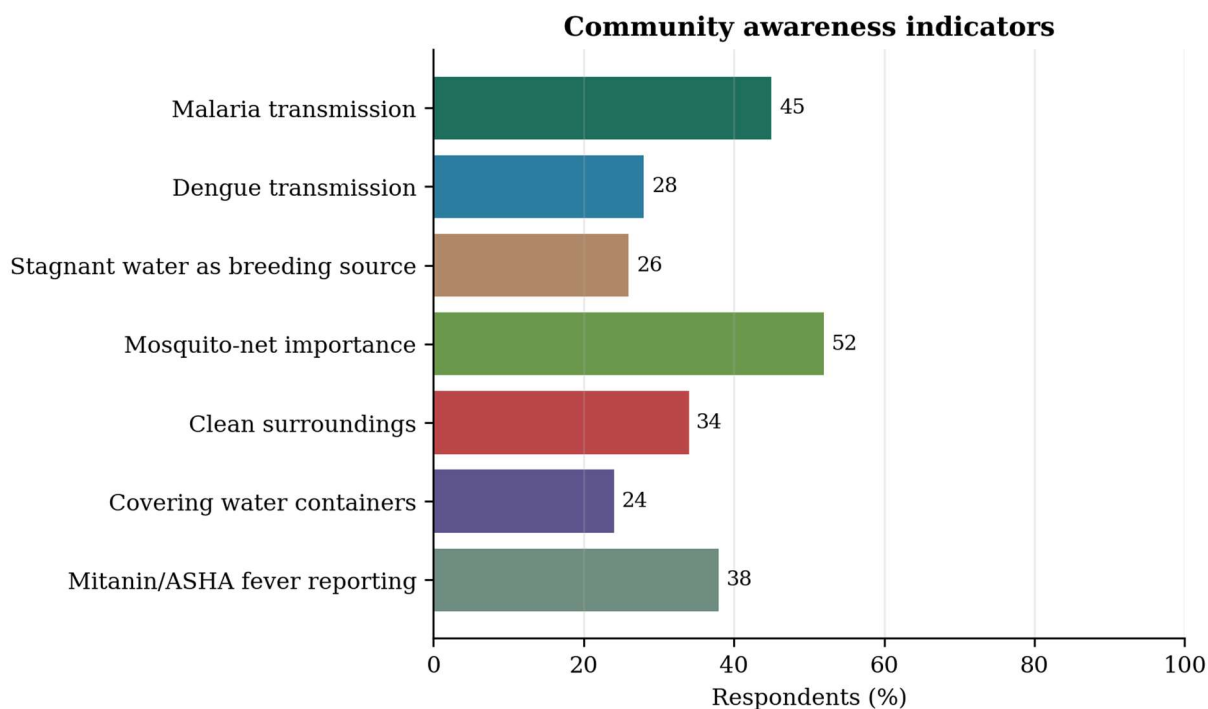


Fig. 10 Awareness indicators related to mosquito-borne diseases and preventive practices.

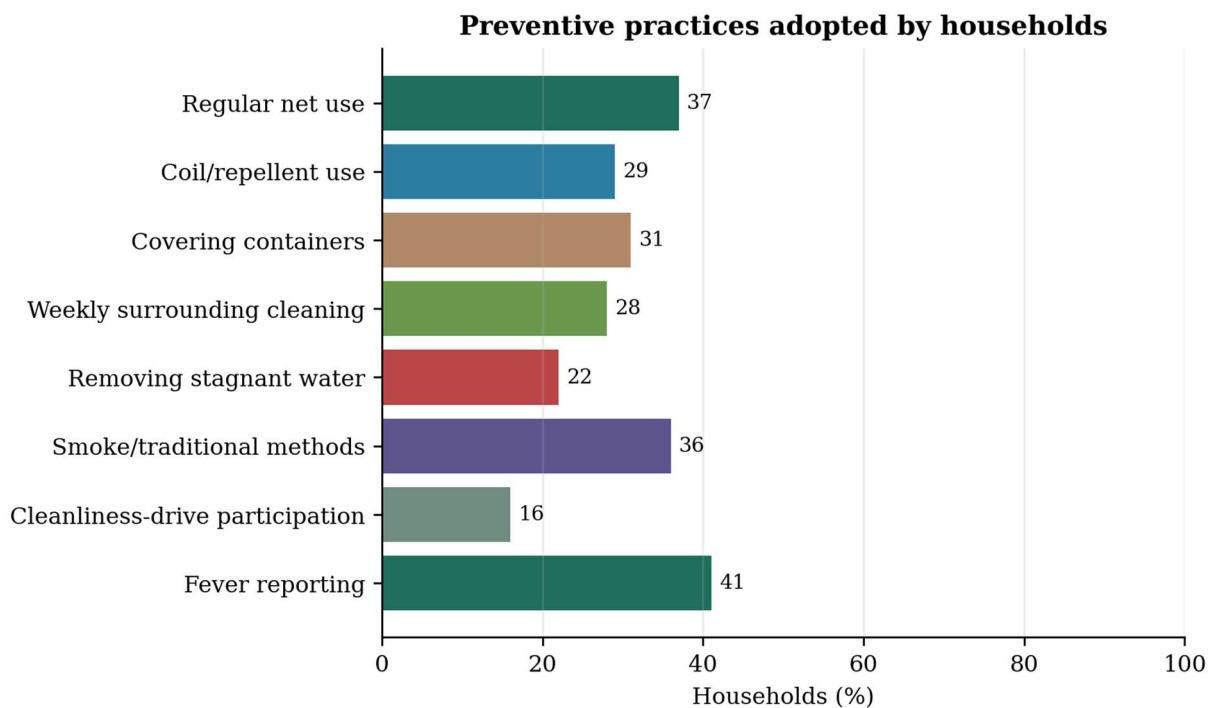


Fig. 11 Preventive practices adopted by households in Devbhog Block.

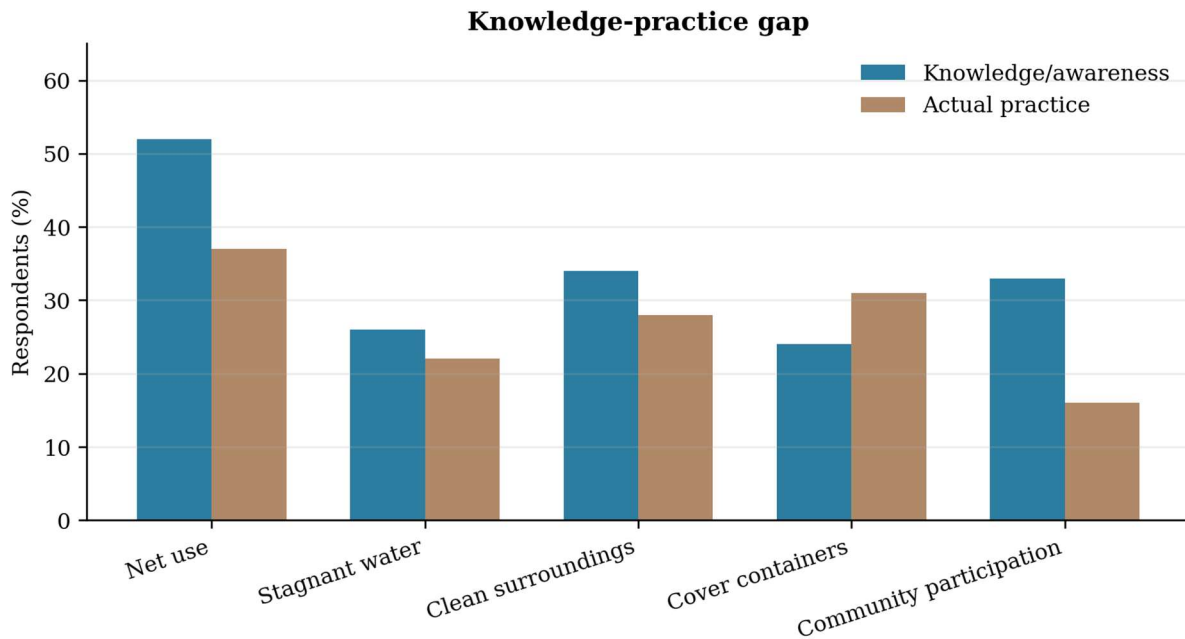


Fig. 12 Knowledge-practice gap showing that awareness did not consistently translate into preventive action.

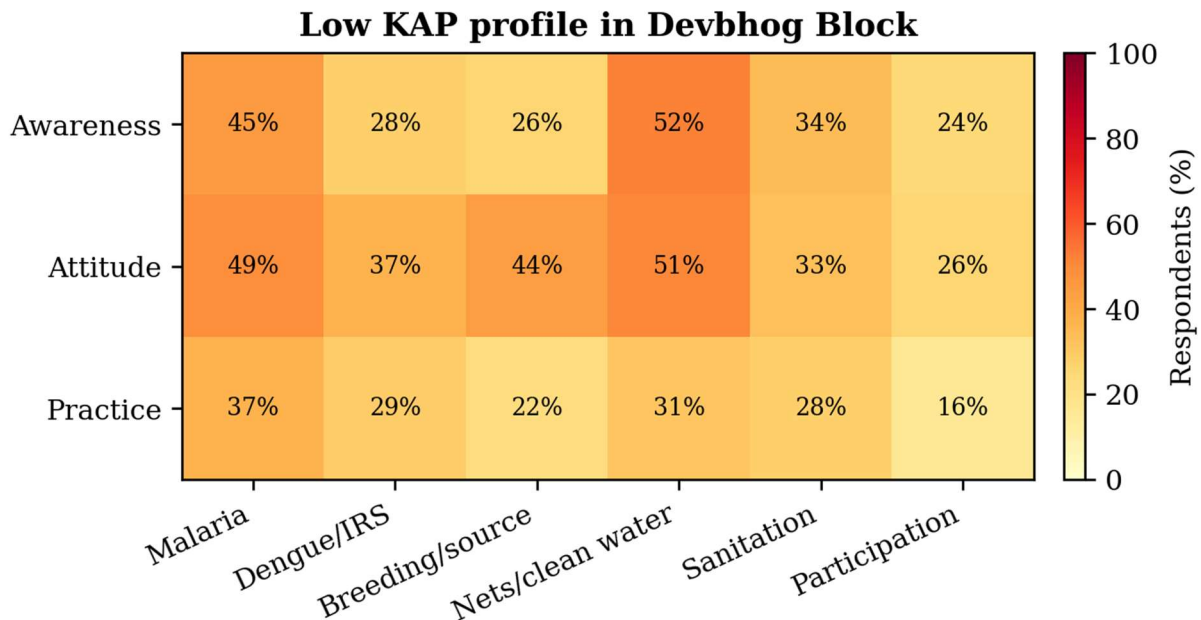


Fig. 13 Low KAP profile across selected knowledge, attitude and practice indicators.

4 Discussion

This field assessment shows that vector-control challenges in Devbhog Block are driven by the combined influence of environmental risk, modest intervention coverage, low community participation and weak KAP status. The pattern is typical of forest-rural settings where vector breeding is not restricted to one habitat type and where household practices strongly influence the success of formal vector-control programmes.

The high proportion of households with poor drainage, uncovered water storage and stagnant water indicates that local environmental conditions are favourable for breeding of multiple mosquito genera. Stagnant ponds, forest pools and paddy fields are relevant to Anopheles ecology, domestic containers and discarded objects are relevant to Aedes breeding and drains and wastewater pools are relevant to Culex occurrence. This habitat diversity explains why an integrated approach is

needed rather than a single intervention focused only on IRS or bed nets (Becker et al., 2020; Service, 2012).

IRS coverage and acceptance were below satisfactory levels. Household barriers such as lack of prior information, fear of chemical odour or side effects and practical difficulty in shifting household materials can reduce the reach of spraying. The national malaria-elimination strategy highlights the need for effective vector control and local planning (NCVBDC, 2023). The Devbhog findings suggest that IRS micro-planning should include advance household information, Mitanin/ASHA participation, revisit of missed houses and community-level counselling.

The mosquito-net findings show a clear gap between ownership and regular use. Although two-thirds of households owned nets, only a little more than one-third reported regular use. This gap is epidemiologically important because vector-control commodities protect households only when used consistently and correctly. Heat, damaged nets, insufficient nets and lack of routine were common barriers. These findings support the need for repeated behaviour-change communication and household follow-up rather than one-time distribution.

Low KAP was one of the strongest findings. Awareness regarding dengue transmission, breeding

sites and source reduction was particularly poor. This matters because *Aedes* larvae were observed in domestic containers and discarded objects. A household may therefore have dengue-related risk even when it does not perceive dengue as a local threat. Earlier work from Chhattisgarh has also emphasized the importance of community health workers and locally adapted communication in malaria-elimination settings (Ranjha et al., 2022).

The seasonal pattern indicates that vector control must begin before the monsoon. Nearly half of all recorded breeding sites were observed during the monsoon period, and post-monsoon water retention continued to support breeding. A pre-monsoon action plan involving drain cleaning, container management, awareness, IRS scheduling and Panchayat-supported source reduction would be more useful than reactive control after mosquito density increases.

The presence of *Anopheles*, *Aedes* and *Culex* larvae in the same block suggests mixed mosquito risk. Forest malaria remains a recognized barrier in India, but Devbhog also shows domestic container habitats relevant to dengue and chikungunya risk (Ranjha & Sharma, 2021). Therefore, local vector control should be framed as integrated vector management, with malaria- and dengue-sensitive communication delivered together.

Proposed Devbhog-focused Integrated Vector Management model

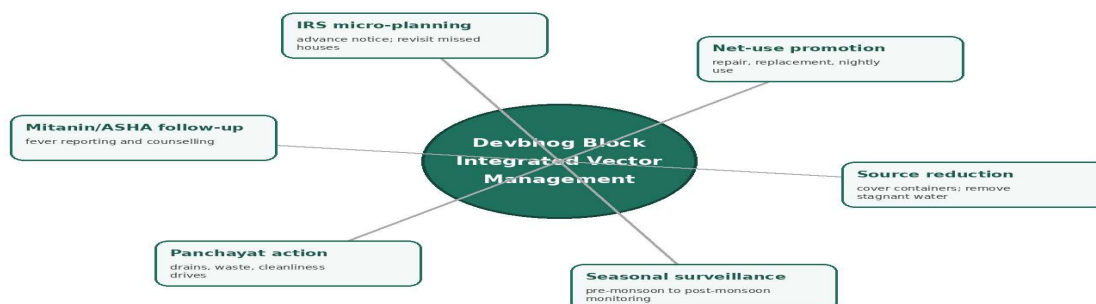


Fig. 14 Proposed integrated vector-management model for Devbhog Block based on the study findings.

5 Conclusion

The study concludes that Devbhog Block has important vector-control gaps shaped by forest-rural ecology, weak environmental sanitation and low household-level KAP. IRS coverage and complete acceptance were limited, mosquito-net ownership did not translate into regular use and larval source-management participation was poor. The study also

documented 87 potential breeding sites and the presence of *Anopheles* spp., *Aedes* spp. and *Culex* spp., indicating mixed vector risk.

The findings suggest that vector-control strengthening in Devbhog Block should focus on pre-monsoon planning, better IRS communication, consistent mosquito-net use, household container management, removal of stagnant water,

Panchayat-led cleanliness drives, school-based awareness and ASHA/Mitanin-led follow-up. A locally adapted integrated vector-management model is more suitable than isolated intervention delivery.

6 Practical recommendations

- Conduct village-level pre-monsoon vector-control planning before the first rains.
- Inform households in advance about IRS dates, purpose and safety to improve acceptance.
- Revisit missed households after spray rounds, especially in scattered settlements.
- Replace or repair damaged mosquito nets and promote nightly use through household counselling.
- Introduce weekly source-reduction days for container cleaning and removal of stagnant water.
- Use Panchayats, schools, self-help groups and youth groups for cleanliness drives and local monitoring.
- Strengthen dengue-focused messages because awareness of dengue and container breeding was low.
- Train ASHA/Mitanin workers to identify common breeding habitats and reinforce fever reporting.
- Monitor paddy fields, forest pools, ponds and drains during monsoon and post-monsoon periods.
- Develop village-wise risk maps for high-risk habitats and missed intervention areas.

7 Limitations

The study was restricted to 100 households in 10 selected villages of Devbhog Block and therefore should be interpreted as a local field assessment rather than a district-wide estimate. Mosquito identification was done only at genus level, and species-level taxonomy, molecular confirmation and insecticide-resistance testing were not performed. Some household responses may be affected by recall and reporting bias. Despite these limitations, the study provides practical evidence for improving local vector-control planning in forest-rural settings.

Declarations

Ethics approval and consent to participate: The study was conducted as a field-based academic

assessment. Verbal consent was obtained from respondents before household interaction. Identifiable photographs should be used in journal submission only after obtaining appropriate permission from the individuals and institution concerned.

Consent for publication: Not applicable for anonymized survey data. For photographs containing identifiable persons, consent for publication should be obtained before final journal submission.

Availability of data and materials: The summarized data used in the manuscript are included in the article. Raw survey sheets may be made available by the author on reasonable request, subject to confidentiality.

Competing interests: The author declares no competing interests.

Funding: No external funding was received for this study.

Author contributions: The author conceptualized the study, conducted field data collection, analysed the data and prepared the manuscript.

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