



Promotion of Low-Cost Integrated Pest Management (IPM) Practices in Chilli Cultivation at Village Level

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Abstract

Chilli (*Capsicum annuum* L.) is an important commercial spice crop that contributes significantly to farmers' income and rural livelihoods in India. However, its productivity is severely affected by insect pests such as *Thrips parvispinus*, *Scirtothrips dorsalis*, aphids, whiteflies, mites and fruit borers. Excessive reliance on chemical pesticides has led to insecticide resistance, pest resurgence, environmental pollution and increased cultivation costs. Low-Cost Integrated Pest Management (IPM) offers an eco-friendly and economically sustainable alternative for effective pest management. The present study assessed farmers' awareness, adoption and constraints regarding low-cost IPM practices through a survey of 150 chilli growers from three villages of Raipur district, Chhattisgarh, during 2025-26. The findings revealed that while awareness of major insect pests and routine crop monitoring was high, adoption of biological control, microbial biopesticides and Economic Threshold Level (ETL) based pest management remained comparatively low. The major constraints included inadequate technical knowledge, limited availability of biological inputs and insufficient extension support. Strengthening farmer training, field demonstrations and village-level extension services can significantly improve the adoption of low-cost IPM practices, thereby reducing pesticide dependence and promoting sustainable, profitable and environmentally friendly chilli cultivation.

Keywords: Chilli, Integrated Pest Management (IPM), Farmer awareness, Adoption, Extension education, Sustainable agriculture, Chhattisgarh.

Introduction

Agriculture is the backbone of rural India, providing livelihoods to millions of farming families. Among horticultural crops, chilli (*Capsicum annuum* L.) is one of the most important



spice crops due to its high economic value, nutritional significance and industrial uses.

India is the world's largest producer, consumer and exporter of chilli, with Chhattisgarh emerging as an important chilli-growing state under diverse agro-climatic conditions.

Despite its importance, chilli cultivation is severely constrained by insect pests such as invasive black thrips (*Thrips parvispinus*), chilli thrips (*Scirtothrips dorsalis*), aphids, whiteflies, yellow mites and fruit borers. Farmers often rely on repeated chemical pesticide applications, which have led to insecticide resistance, pest resurgence, destruction of beneficial insects, environmental pollution and increased production costs.

Low-Cost Integrated Pest Management (IPM) offers a sustainable and eco-friendly alternative by integrating cultural, mechanical, biological, botanical and need-based chemical methods to manage pests below the Economic Threshold Level (ETL). These technologies are particularly suitable for small and marginal farmers as they reduce production costs, conserve natural enemies and promote environmentally safe chilli cultivation.

Recognising the need to promote sustainable pest management, National Service Scheme volunteers implemented a village-level extension programme entitled "Promotion of Low-Cost Integrated Pest Management (IPM) Practices in Chilli Cultivation at Village Level." The programme aimed to create awareness, encourage the adoption of economical and eco-friendly IPM technologies, identify farmers' constraints and strengthen the link between agricultural research and rural communities through extension education and community participation. This study has been conducted based on these objectives:

1. To assess the level of awareness of farmers regarding low-cost IPM practices in chilli cultivation.
2. To promote the adoption of low-cost IPM practices among chilli growers.
3. To identify the major constraints faced by farmers in adopting low-cost IPM practices and obtain their suggestions for improving adoption

Study Area and Methodology

The programme was conducted during 2025–2026 in three villages of Raipur district, Chhattisgarh- Pirda, Dharampura and Serikhedi. A total of 150 chilli growers (50 farmers from each village) were selected randomly. Information was collected through personal interviews using a structured questionnaire and visited to farmers' fields and households to understand their existing pest management practices, create awareness about low-cost IPM technologies and demonstrate practical pest management methods. Various extension approaches were employed, including:



- Farmer interaction meetings
- Field visits
- Practical demonstrations
- Awareness campaigns
- Distribution of educational materials
- One-to-one technical guidance

Major Low-Cost IPM Practices Promoted: The extension programme focused on simple, economical and environmentally friendly pest management technologies, including:

Cultural Practices: Timely field sanitation, removal of pest infested plant parts, crop rotation, balanced fertilizer application, weed management.

Mechanical Methods: Installation of blue sticky traps for thrips, yellow sticky traps for aphids and whiteflies, pheromone traps for fruit borer monitoring, bird perches to encourage insectivorous birds.

Biological Control: Conservation of ladybird beetles, lacewings and spiders, Release of *Trichogramma chilonis*, Use of entomopathogenic fungi such as *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium lecanii*

Botanical and Microbial Control: Neem Seed Kernel Extract (NSKE 5%), Neem oil spray, *Bacillus thuringiensis* (Bt), *Helicoverpa armigera* Nuclear Polyhedrosis Virus (HaNPV)

Need-Based Chemical Control: Chemical insecticides were recommended only after pest populations reached the Economic Threshold Level (ETL), ensuring judicious and safe pesticide use.

Major Findings

The survey revealed a moderate level of awareness and adoption of low-cost IPM practices among chilli growers. Farmers showed high awareness and adoption of regular crop monitoring, neem-based insecticides, sticky traps and field sanitation. In contrast, awareness and adoption of biological control agents, microbial biopesticides, natural enemy conservation and ETL-based pest management remained comparatively low. The findings indicate that farmers readily adopt simple, affordable and easily accessible technologies, whereas knowledge-intensive IPM components require greater extension support and practical training.

Major Constraints

The adoption of low-cost IPM practices was primarily constrained by lack of technical knowledge, limited availability of biological control agents, inadequate extension support, high



cost of quality bio-inputs, lack of practical demonstrations, poor understanding of the Economic Threshold Level (ETL) and limited confidence in biological pest management. These constraints emphasize the need for continuous farmer education, timely access to quality IPM inputs and strengthened extension services to improve the adoption of sustainable pest management practices.

Impact of the Programme

The village-level extension programme positively influenced farmers' knowledge and attitudes towards sustainable pest management. It enhanced awareness of eco-friendly IPM practices, increased the use of neem-based products, sticky traps and regular crop monitoring, strengthened confidence in biological control, reduced reliance on indiscriminate pesticide use, and improved linkages between farmers and agricultural extension agencies. These findings demonstrate that community-based extension programmes can effectively promote the adoption of sustainable pest management technologies and improve village-level agricultural practices.

From Chemical Dependence to Sustainable Pest Management

Insect pests such as thrips, aphids, whiteflies, mites and fruit borers pose serious constraints to chilli production, often prompting farmers to rely heavily on chemical insecticides. However, indiscriminate pesticide use has resulted in insecticide resistance, destruction of natural enemies, environmental pollution and increased production costs. Low-cost Integrated Pest Management (IPM), which integrates cultural, mechanical, biological, botanical and need-based chemical measures, offers an economical and environmentally sustainable alternative for managing pests below the Economic Threshold Level (ETL). Accordingly, the present study was undertaken in Raipur district, Chhattisgarh, to assess farmers' awareness and adoption of low-cost IPM practices and identify the major constraints limiting their wider implementation.

Why Low-Cost IPM Matters More Than Ever

India is the world's leading producer, consumer and exporter of chilli; however, insect pests can cause 80–100% yield losses under severe infestations. Excessive dependence on chemical insecticides has resulted in resistance, pest resurgence, environmental contamination and increased production costs. Low-cost Integrated Pest Management (IPM) offers an affordable and sustainable alternative by integrating cultural, mechanical, biological and need-based chemical approaches, particularly benefiting small and marginal farmers.

Table. Importance of Low-Cost IPM in Chilli Cultivation



Aspect	Key Points
Major insect pests	<i>Thrips parvispinus</i> , <i>Scirtothrips dorsalis</i> , aphids, whiteflies, yellow mites, tobacco caterpillar and gram pod borer
Major challenges of chemical control	Insecticide resistance, pest resurgence, loss of natural enemies, pesticide residues, environmental pollution and increased production costs
Role of low-cost IPM	Integrates cultural, mechanical, biological and need-based chemical methods for sustainable pest management
Key benefits	Affordable, eco-friendly, reduces pesticide dependence and suitable for small and marginal farmers

Who Are the Farmers Behind the Study?

The socio-economic profile showed that most respondents were:

Table 1. Socio-economic profile of surveyed chilli growers (n = 150)

Indicator	Predominant Category	Percentage
Age	Middle (36–55 years)	54.67
Education	Secondary education	30.67
Landholding	Marginal + Small	60.00
Annual income	Medium	45.33
Farming experience	Medium	50.67
Extension contact	Medium	47.33

Farmers' Awareness of Low-Cost IPM Practices

Table 2. Farmers' awareness regarding low-cost IPM technologies

Awareness Component	Farmers Aware (%)
Major insect pests	94.67
Economic losses	90.67
Neem-based insecticides	84.00
Sticky traps	78.67
ETL concept	64.00
Natural enemy conservation	60.00
Biological control	58.67
Microbial biopesticides	54.67

Awareness Does Not Always Translate into Adoption

Although awareness was relatively high, adoption remained moderate. Regular crop monitoring (84.00%), neem-based insecticides (76.00%), sticky traps (72.00%), and field



sanitation (69.33%) were the most widely adopted practices. In contrast, adoption of ETL-based spraying (58.67%), pheromone traps (54.67%), natural enemy conservation (49.33%), and biological control agents (45.33%) was comparatively low. Overall, 45.33% of farmers showed medium adoption, while 29.34% and 25.33% exhibited high and low adoption levels, respectively, indicating the need for continued technical support and practical demonstrations.

Table 3. Adoption of low-cost IPM practices

Practice	Adoption (%)
Regular field monitoring	84.00
Neem-based insecticides	76.00
Sticky traps	72.00
Field sanitation	69.33
ETL-based spraying	58.67
Pheromone traps	54.67
Natural enemy conservation	49.33
Biological control	45.33

Low-Cost IPM Practices Farmers Can Easily Adopt

The survey identified several affordable technologies suitable for village-level promotion.

- ✓ **Intercropping** with onion, coriander, garlic and legumes increases biodiversity and naturally suppresses pest populations.
- ✓ Marigold serves as an excellent trap crop against *Helicoverpa armigera* when planted at a 10:1 chilli to marigold ratio.
- ✓ **Bird perches** encourage insectivorous birds that naturally reduce caterpillar populations.
- ✓ **Blue sticky traps** effectively monitor thrips, whereas yellow traps help detect aphids and whiteflies. Pheromone traps enable timely management of fruit borers before economic damage occurs.
- ✓ **Botanical pesticides** such as Neem Seed Kernel Extract (5%) and neem oil remain economical and environmentally safe options for controlling sucking pests.
- ✓ **Biological control** agents-including *Chrysoperla*, ladybird beetles, *Trichogramma chilonis* and entomopathogenic fungi provide sustainable pest suppression while conserving ecological balance.

Table 4. Major constraints in adopting low-cost IPM

Constraint	Percentage
Lack of technical knowledge	74.67
Non-availability of biological inputs	70.00



Constraint	Percentage
Inadequate extension support	65.33
High cost of bio-inputs	64.00
Lack of practical training	62.67
Limited ETL knowledge	58.67
Lack of confidence in biological control	56.00

Strategies to Enhance IPM Adoption

Enhancing farmer training, on-farm demonstrations and extension programmes is essential to improve IPM adoption. Timely availability of quality biological control agents, microbial biopesticides and sticky traps, supported by mobile-based advisories, WhatsApp groups and seasonal pest alerts, can facilitate informed decision-making. Recognizing progressive IPM farmers through village-level demonstrations and awards may further encourage community-wide adoption.

Why This Matters Beyond Chilli Fields

The benefits of low-cost IPM extend beyond pest management by reducing pesticide dependence, improving food safety and farmers' health, conserving natural enemies and biodiversity, delaying insecticide resistance, lowering production costs and enhancing farm profitability. Consequently, wider adoption of IPM contributes to food security, environmental conservation and sustainable rural livelihoods.

Conclusion

The study demonstrated that village-level promotion of low-cost Integrated Pest Management (IPM) effectively enhances sustainable chilli cultivation. Most farmers exhibited a moderate level of awareness (56.00%) and adoption (45.33%) of IPM practices, with greater adoption of regular crop monitoring, neem-based pesticides, sticky traps and field sanitation than biological control, microbial biopesticides and ETL-based pest management. Inadequate technical knowledge, limited availability of biological inputs, insufficient extension support and lack of practical training were the major barriers to adoption. Strengthening farmer training, field demonstrations and extension services can significantly improve the uptake of eco-friendly IPM technologies. The findings demonstrate that community-based NSS extension programmes can effectively reduce pesticide dependence, conserve beneficial organisms, lower production costs and promote sustainable, profitable and environmentally sound chilli production.