

International Journal of Agriculture Extension and Social Development

Volume 9; Issue 9; September 2026; Page No. 565-569

Received: 11-06-2026
Accepted: 15-07-2026

Indexed Journal
Peer Reviewed Journal

Promoting biological pest management in organic farming: Farmers' awareness and adoption constraints under a NABARD-financed project in Kotabagh, Uttarakhand

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DOI: <https://www.doi.org/10.33545/26180723.2026.v9.i9h.4236>

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Abstract

Indiscriminate use of chemical pesticides in hill agriculture has raised concerns over rising input costs, pest resurgence and adverse effects on human health, soil biodiversity and water resources, prompting renewed interest in biological control-based pest management for organic farming. The present study was undertaken under a NABARD-financed project to assess farmers' awareness, existing pest management practices and the constraints limiting adoption of biological control technologies in five villages of Kotabagh block, Nainital district, Uttarakhand — Bhatlani, Ginati Gaon–Ramdatt, Devirampur–Dohnia, Naudha–Kalyanpur and Kaptanganj–Selsia. A structured, pre-tested questionnaire covering sixteen major indicators was administered to a purposively and randomly drawn sample of farm households across the five villages, followed by awareness campaigns and a participatory selection of 125 farmers (25 per village) for subsequent training. Results show that all respondents (100%) faced insect-pest problems and relied predominantly on visual pest identification, while awareness of Integrated Pest Management (IPM) ranged from 17.1% to 46.1% and awareness of Bio-Intensive Pest Management (BIPM) remained critically low, between 5.7% and 11.5% across villages. Despite universal awareness of the harmful effects of insecticides, 96–100% of farmers continued routine calendar-based spraying every 15–20 days. Although 7.4% to 76.9% of farmers reported some organic farming activity, the area under organic cultivation was small (3.12–25.83 acres per village), certification rates were low (11.4–69.2%), and over 90% of farmers in most villages lacked access to remunerative organic markets. Key constraints identified were technical (low BIPM/biopesticide awareness, weak pest-identification skills), economic (poor market access, low price realisation, perceived high cost of biological inputs) and institutional (low group membership, weak extension support, limited certification). Nonetheless, demand for training on biopesticide use was unanimous (100%) in every village. The study underscores the need for intensive, sustained extension efforts, farmer institution-building and market linkage support to translate awareness into adoption of biological control technologies for organic farming in the hill ecosystem of Uttarakhand.

Keywords: Biological control, Integrated Pest Management, Bio-Intensive Pest Management, organic farming, farmer awareness, Kotabagh, NABARD, Uttarakhand

1. Introduction

Hill agriculture in Uttarakhand is characterised by small, fragmented and family-owned landholdings, high dependence on vegetable and field crops, and increasing pest pressure that has driven farmers toward heavy and often indiscriminate use of chemical pesticides. While such practices offer short-term protection against crop losses, they are associated with rising input costs, pest resistance and resurgence, and well-documented adverse effects on human health, soil biodiversity, pollinators, natural enemies and water resources. At the same time, growing consumer demand for pesticide-residue-free and organically grown produce has opened new opportunities for smallholder farmers to shift toward ecologically sound pest management systems, provided they have access to appropriate knowledge, inputs and markets.

Biological control — the use of natural enemies such as

parasitoids, predators and entomopathogenic micro-organisms (e.g., Trichogramma, coccinellid beetles and entomopathogenic fungi) — together with the broader framework of Integrated Pest Management (IPM) and Bio-Intensive Pest Management (BIPM), offers a scientifically validated and environmentally sustainable alternative to calendar-based chemical spraying. Successful adoption of these technologies, however, depends critically on farmers' awareness, their existing pest management practices, and the technical, economic and institutional constraints they face at the field level.

Recognising this gap, a project titled 'Promotion of biological control-based pest management technology for organic farming in the Kotabagh block of Nainital district' was undertaken with financial support from the National Bank for Agriculture and Rural Development (NABARD). Kotabagh block was selected as the project site owing to significant pest

pressure in staple vegetable crops such as brinjal, tomato, cole crops and capsicum, heavy reliance of farmers on chemical pesticides, and the block's considerable untapped potential for organic farming among its predominantly small and marginal farm households. This paper reports the findings of the baseline survey conducted under the project, with the specific objectives of (i) assessing farmers' awareness of biological control, IPM and BIPM technologies; (ii) documenting prevailing pest management practices; (iii) identifying the technical, economic and institutional constraints to adoption of biological control-based organic farming; and (iv) determining the training needs of farmers to inform subsequent capacity-building interventions.

2. Materials and Methods

2.1 Study Area

The study was conducted in Kotabagh block of Nainital district, Uttarakhand. Five villages — Bhatlani, Ginati Gaon–Ramdatt, Devirampur–Dohnia, Naudha–Kalyanpur and Kaptanganj–Selsia — were selected through purposive sampling, based on the predominance of agriculture as the main occupation, significant insect-pest pressure on vegetable and field crops, and heavy dependence on chemical pesticides. The demographic profile of the selected villages is presented in Table 1.

Table 1: Demographic profile of the selected villages

Village	Population	No. of Families	Main Occupation
Bhatlani	455	90	Agriculture
Ginati Gaon–Ramdatt	1,161	218	Agriculture
Devirampur–Dohnia	554	123	Agriculture
Naudha–Kalyanpur	744	148	Agriculture
Kaptanganj–Selsia	257	55	Agriculture

2.2 Sampling and Data Collection

A structured questionnaire was developed in simple Hindi to facilitate ease of understanding among farmers. The instrument covered sixteen major indicators relating to socio-economic status, cropping pattern, membership in farmer institutions, major pest problems, pest identification methods, existing pest management practices, awareness of IPM and BIPM, awareness of and demand for training on biopesticides, extent and status of organic farming, organic

certification, access to organic markets, and price realisation for organic produce; it also captured constraints faced and training needs. From each of the five villages, a representative sample of farm households was drawn using random sampling to ensure adequate coverage of different farm sizes and cropping systems.

2.3 Data Analysis

Collected responses were compiled, coded and entered into a spreadsheet for tabulation. Descriptive statistics — principally frequencies and percentages — were computed for each indicator, separately for each village, to enable village-wise as well as block-level comparison and to identify patterns underlying farmers' awareness, practices and constraints.

2.4 Awareness Programme and Selection of Farmers for Training

Following the baseline survey, awareness programmes on biocontrol-based pest management were organised in each of the five villages in coordination with local leaders (gram pradhans and farmer groups) at common gathering points such as panchayat halls, schools and farmers' fields. Each programme covered four themes — pest incidence in crops, harmful effects of indiscriminate insecticide use, importance of organic farming, and promotion of biocontrol-based pest management — supported by pamphlets, booklets and PowerPoint presentations in Hindi, interactive lectures, question-answer sessions and success-story sharing to build farmer motivation. Subsequently, farmers for hands-on training were identified through preliminary village meetings, voluntary registration and brief interviews assessing interest, existing practices and willingness to adopt biocontrol technologies, applying selection criteria that ensured balanced representation of small and marginal farmers, women and unemployed rural youth alongside progressive farmers.

3. Results and Discussion

3.1 Consolidated Survey Findings

The village-wise responses on the sixteen survey indicators are consolidated in Table 2. The findings reveal broadly consistent patterns across the five villages, alongside notable village-level variation in organic farming activity and institutional membership.

Table 2: Village-wise summary of farmers' awareness, pest management practices and organic farming status (Kotabagh block)

Parameter	Bhatlani	Ginatigaon–Ramdatt	Devirampur–Dohnia	Naudha–Kalyanpur	Kaptanganj–Selsia
1. Member of farmers' group	FPO-65.3%, SHG-3.5%, No-31.0%	FPO-22.2%, SHG-3.7%, No-33.3%	FPO-34.3%, SHG-6.2%, No-12.5%	FPO-54.2%, SHG-5.7%, Coop-8.5%, No-25.7%	SHG-8.6%, Coop-17.3%, No-56.5%
2. Insect pest problem reported	100%	100%	100%	100%	100%
3. Method of insect identification	Visual-100%	Visual-92.5%, Expert-7.4%	Visual-93.7%, Expert-6.2%	Visual-82.8%, Traps-8.5%, Expert-14.2%	Visual-86.9%, Traps-4.3%, Expert-8.6%, Others-4.3%
4. Pest control method used	Chemical-57.6%, Biological-46.1%, Botanical-7.6%	Chemical-100%	Chemical-100%	Chemical-88.5%, Biological-22.8%, Botanical-5.7%	Chemical-100%
5. Awareness of IPM	Yes-46.1%, No-53.8%	Yes-25.9%, No-74.0%	Yes-21.8%, No-78.1%	Yes-17.1%, No-82.8%	Yes-43.4%, No-56.5%
6. Use of chemical	Yes-96.1%, No-3.8%	100%	100%	100%	100%

insecticide					
7. Frequency of insecticide spray	15–20 days	Need-based	15–20 days	15–20 days	15–20 days
8. Knowledge of ill effects of insecticides	100%	100%	100%	100%	100%
9. Awareness of biopesticides	Yes-65.3%, No-34.6%	Yes-18.5%, No-81.4%	Yes-56.2%, No-43.7%	Yes-28.5%, No-71.4%	Yes-28.5%, No-71.4%
10. Need training on biopesticides	Yes-100%	Yes-100%	Yes-100%	Yes-100%	Yes-100%
11. Awareness of BIPM	Yes-11.5%, No-88.4%	Yes-7.4%, No-92.5%	Yes-6.2%, No-93.7%	Yes-5.7%, No-94.2%	Yes-5.7%, No-94.2%
12. Practicing organic farming	Yes-76.9%, No-23.0%	Yes-7.4%, No-92.5%	Yes-25.0%, No-75.0%	Yes-28.5%, No-71.4%	Yes-28.5%, No-71.4%
13. Area under organic farming	25.83 acre	3.12 acre	7.75 acre	4.70 acre	4.70 acre
14. Organic certification obtained	Yes-69.2%, No-30.7%	Yes-14.8%, No-85.1%	Yes-25.0%, No-75.0%	Yes-11.4%, No-88.5%	Yes-11.4%, No-88.5%
15. Access to organic market	Yes-34.6%, No-65.3%	Yes-3.7%, No-96.2%	Yes-6.2%, No-93.7%	Yes-5.7%, No-94.2%	Yes-5.7%, No-94.2%
16. Receiving premium price for organic produce	Yes-7.6%, No-92.3%	Yes-3.7%, No-96.2%	Yes-3.1%, No-96.8%	Yes-5.7%, No-94.2%	Yes-5.7%, No-94.2%

3.2 Widespread Insect-Pest Pressure and Chemical Dependence

All surveyed farmers across the five villages reported facing problems due to insect pests, confirming that pest infestation is a pervasive and persistent challenge in the region. Despite this, the dominant response remained conventional. 96–100% of farmers across villages relied solely on chemical insecticides, with spraying typically carried out on a fixed 15–20 day cycle rather than being triggered by actual pest load, reflecting fear of crop loss rather than threshold-based decision-making. Notably, all respondents (100%) in every village were aware of the harmful effects of insecticides on human health, soil biodiversity, water sources and beneficial organisms, yet this awareness had not translated into reduced usage — indicating that knowledge of hazards alone is insufficient to change entrenched practice without viable, accessible alternatives and extension support.

3.3 Pest Identification Practices

Insect identification was overwhelmingly visual across all villages (82.8–100%), with only a small proportion of farmers using pheromone traps or seeking expert guidance (up to 14.2% in Naudha-Kalyanpur). While experienced farmers can identify common pests visually, reliance on this method alone increases the risk of misidentification and delayed response to outbreaks, underscoring the need for simple diagnostic aids and stronger technical support systems.

3.4 Awareness of IPM and BIPM

Awareness of Integrated Pest Management ranged from 17.1% (Naudha-Kalyanpur) to 46.1% (Bhatlani), remaining below 50% in every village. Awareness of Bio-Intensive Pest Management was markedly lower still, ranging from 5.7% to 11.5% across all five villages — below 12% everywhere. This wide gap between the availability of ecologically safer pest-management strategies and farmers' awareness of them represents the most fundamental barrier to adoption identified in this study, and points to an urgent need for targeted, sustained outreach and field demonstrations.

3.5 Demand for Biopesticide Training

Awareness of biopesticides varied considerably across villages, from as low as 18.5% in Ginati Gaon–Ramdatt to 65.3% in Bhatlani. Despite this variation, demand for training on biopesticide use was unanimous — 100% of farmers in every village expressed a wish to be trained — reflecting strong latent willingness among farmers to adopt new, environmentally friendly pest-control methods once these are made accessible and comprehensible.

3.6 Status of Organic Farming

The proportion of farmers reporting some organic farming activity ranged widely, from 7.4% in Ginati Gaon–Ramdatt to 76.9% in Bhatlani, but the actual area under organic cultivation remained modest in every village, ranging from 3.12 acres (Ginati Gaon–Ramdatt) to 25.83 acres (Bhatlani). Organic certification was similarly limited, achieved by only 11.4% to 69.2% of farmers across villages. Most critically, access to reliable organic markets was poor everywhere — as low as 3.7% of farmers in Ginati Gaon–Ramdatt and no higher than 34.6% in Bhatlani — and the great majority of farmers (over 90% in most villages) did not receive a price premium for organic produce. This absence of assured market access and price incentive appears to be a major disincentive to wider investment in organic and biological pest-management practices, irrespective of underlying awareness levels.

3.7 Farmer Institutional Membership

Membership in Farmer Producer Organizations (FPOs), Self-Help Groups (SHGs) and cooperatives varied considerably across villages, with a substantial share of farmers remaining unorganised — as high as 56.5% in Kaptanganj–Selsia. Weak institutional membership restricts farmers' access to technical support, collective bargaining, financial schemes and market linkages, and strengthening such institutions emerges as an important lever for improving both awareness and adoption of biological control-based organic farming.

3.8 Constraints to Adoption of Biological Control Technologies

Based on the survey findings and farmer interactions, the constraints to adoption were classified into three categories:

(A) Technical Constraints

- Low awareness of BIPM, ranging from 5.7% to 11.5% across the five villages.
- Limited knowledge of biopesticides, as low as 18.5% in Ginati Gaon–Ramdatt and 28.5% in Kaptanganj–Selsia and Naudha–Kalyanpur.
- Continued dependence on chemical pesticides, used by 96–100% of respondents in every village.
- Weak pest-identification skills, with most farmers relying solely on visual identification and minimal expert involvement.

(B) Economic Constraints

- Poor access to organic markets, with over 90% of farmers in most villages lacking reliable market outlets for organic produce.
- Low price realisation, with only 3.1–7.6% of farmers receiving premium pricing for organic produce.
- Perception among farmers that biological inputs are more expensive or less immediately effective than conventional pesticides.

(C) Institutional Constraints

- Limited organisational support, with up to 56.5% of farmers in Kaptanganj–Selsia unaffiliated with any farmer group.
- Low organic certification rates, below 25% of organic farmers in most villages.
- Weak extension services, with inadequate on-ground staff or trained personnel to guide farmers on IPM/BIPM practices.

3.9 Training Needs Identified

Based on the gaps identified through the survey and farmer feedback, four broad areas of training need were prioritised:

- Pest Management Training — identification and monitoring of major insect pests using visual aids and pheromone traps; formulation and use of biopesticides and botanical alternatives (e.g., neem-based formulations); and application techniques and timing to maximise the effectiveness of biological control agents.
- Awareness and Adoption of IPM/BIPM — comprehensive modules on Integrated Pest Management and Bio-Intensive Pest Management, supported by field demonstrations and exposure visits.
- Organic Farming and Marketing — support for organic certification and documentation, post-harvest handling and packaging, and linkage of farmers with niche organic markets and buyers.
- Institutional Capacity Building — mobilisation and strengthening of Farmer Producer Organizations and Self-Help Groups.

3.10 Awareness Programme Outcomes

Five awareness programmes were conducted, one in each village, covering the ill effects of indiscriminate insecticide use, the advantages of biological control over chemical

pesticides, identification of naturally occurring parasitoids and predators, and the role of microbial bioagents such as fungi, bacteria and viruses. Live demonstrations of bioagent application, discussion of BIPM technologies for major local crops (paddy, tomato, brinjal, soybean and cucumber), ecological farming practices such as crop rotation and intercropping, on-farm production of bioagents, and information on market avenues for organic produce were all incorporated, supported by distribution of pamphlets, posters and booklets for future reference.

Following the awareness programmes, farmers were identified and selected for hands-on training through preliminary village meetings, voluntary registration and brief interviews assessing motivation and willingness to adopt biocontrol technologies, applying selection criteria to ensure balanced representation of small and marginal farmers, women and unemployed rural youth. A total of 125 farmers — 25 from each of the five villages — were finally selected for training, as summarised in Table 3.

Table 3: Farmers selected for training in biocontrol-based pest management technology

Village	No. of Farmers Selected for Training
Bhatlani	25
Ginati Gaon–Ramdatt	25
Devirampur–Dohnia	25
Naudha–Kalyanpur	25
Kaptanganj–Selsia	25
Total	125

4. Conclusion

The baseline survey conducted under the NABARD-financed project in Kotabagh block reveals a clear paradox: farmers are universally aware of the hazards of chemical pesticides yet remain heavily dependent on them, while awareness of ecologically safer alternatives — particularly Bio-Intensive Pest Management and biological control agents — remains critically low, at well under 12% across all surveyed villages. At the same time, farmers displayed unanimous willingness to be trained in biopesticide use, indicating that the barrier to adoption is not one of attitude but of access to knowledge, inputs, technical support and remunerative markets. Organic farming activity, though present in varying degrees, remains constrained by small cultivated area, low certification rates and, most critically, poor market access and price realisation. Addressing the technical, economic and institutional constraints identified in this study through sustained extension, farmer institution-building and market linkage support is essential to translate the strong latent demand for training into durable adoption of biological control-based organic farming in the hill agro-ecosystem of Kotabagh.

5. Recommendations

- Scale up village-level awareness campaigns and field demonstrations on BIPM and biological control agents (e.g., Trichogramma, coccinellid predators, entomopathogenic fungi), given the very low baseline awareness (5.7–11.5%).
- Provide hands-on, farmer-participatory training on identification, mass production and field application of biopesticides and bioagents, in line with the unanimous training demand recorded in every village.

- Strengthen pest-monitoring capacity through simple diagnostic aids and pheromone traps to reduce over-reliance on visual identification alone.
- Facilitate organic certification and develop assured market linkages, given that over 90% of farmers in most villages lack access to remunerative organic markets despite practising some organic farming.
- Strengthen and mobilise Farmer Producer Organizations and Self-Help Groups, particularly in villages such as Kaptanganj–Selsia with high proportions of unorganised farmers, to improve collective access to inputs, credit, extension and markets.
- Institutionalise periodic follow-up and monitoring of the 125 trained farmers to assess adoption levels and course-correct extension strategy in subsequent project phases.

Acknowledgement

This study was carried out under a project financially supported by the National Bank for Agriculture and Rural Development (NABARD) for the promotion of biological control-based pest management technology for organic farming in Kotabagh block, Nainital district, Uttarakhand. The authors gratefully acknowledge the cooperation of the farmers of Bhatlani, Ginati Gaon–Ramdatt, Devirampur–Dohnia, Naudha–Kalyanpur and Kaptanganj–Selsia, and the support of local gram pradhans and farmer groups during the survey and awareness programmes.

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