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1947 TO 2047

CASE STUDY

on

Regulatory Barriers to the Acceptance of Bio-pesticides among Farmers for Sustainable Agriculture in Gurgaon and Nuh Districts of Haryana

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Introduction

Despite enhancing the crop yields, the green revolution (GR) has proven unsuccessful in assuring long term agricultural sustainability. The methods used for productivity enhancement during GR have not only proven to be problematic but have also resulted in deterioration of soil quality and several other issues related to ecosystems and health issues. The damage was mainly caused by the indiscriminate use of chemical fertilizers and insecticides. Various types of pesticides, are now known to be causing huge problems in the agro-ecosystems. In such a situation, where chemicals have caused or are causing irreversible impacts on agroecosystems, the use of bio-pesticides has emerged as a sustainable alternative leading to safe organic farming. At the global level, environmentally benign nature and target-specificity of bio-pesticides are gaining wide popularity. However, in developing countries like India usage of bio-pesticides is still minuscule in comparison to conventional chemical pesticides. Although the Indian government has encouraged the use of bio-pesticides by placing them into many of the agricultural schemes, at the grassroots level, bio-pesticides are facing many challenges. The lower adaptability and declining interest of farmers towards bio-pesticides have become a matter of concern. However, technological challenges related to production, manufacture and application in agroecosystems have also raised a question on their long-term sustainability.

Haryana is one of the prominent agricultural state in India, has been facing significant challenges related to the overuse of chemical pesticides, leading to environmental degradation and health issues. Gurgaon and Nuh districts, in particular, have diverse agricultural practices but lag in the adoption of sustainable methods like Integrated Pest Management practices including bio-pesticides. IPM module was

implemented by NCIPM, New Delhi in 15623 ha of Basmati rice (Pusa Basmati-1) in Jind, Kaithal, Kurukshetra, Yamunanagar and Panipat districts of Haryana and Fateh Garh Sahib and Patiala districts of Punjab, by participation of 2462 farmers in 396 villages during Kharif 2019. IPM in Cotton was synthesized & validated during Kharif 2022 in 100 acre area in Behnichanderpal village of Rohtak, Haryana in farmers'-participatory mode. Boll rot was found as major biotic stress. Need based spray of streptocycline @1 g + copper oxychloride 50% WP @ 25 g in 10 liter of water was done to successfully manage the disease. For pink bollworm management SPLAT technique was introduced and validated. IPM implementation resulted in 27.6 % reduction in chemical pesticide sprays and 30.6 % increase in benefit-cost ratio as compared to FP. The adoption of IPM in the cluster of villages resulted in higher yield in IPM field (18.50 q/ha) as compared to FP (14.5 q/ha).

Bio-pesticides are an integral part of sustainable agriculture, offering an environment friendly alternative to conventional chemical pesticides. However Gurgaon and Nuh Districts remain untouched in this context. However, the adoption of bio-pesticides among farmers can be hindered by various regulatory barriers. Therefore, survey was undertaken by the students in villages of Gurgaon (Berka, Lakhuwas, and Shikohpur villages) and Nuh (Kherla and Pinangwan villages) districts to generate baseline information on the current plant protection practices through questionnaires. This report explores the regulatory challenges faced by farmers in Gurgaon and Nuh districts of Haryana, India, in accepting bio-pesticides. It also outlines extension activities conducted to promote bio-pesticides and provides a case study analysis. The main objective of this study is to investigate the trend in the acceptability of biocontrol products. Apart from this, the study also focuses on the consumption of technological

perspectives that are required for the long-term sustainability of biological control products in Indian agriculture and market.

Objectives:

1. Identify the regulatory barriers to the acceptance of bio-pesticides among farmers.
2. Assess the awareness and knowledge level of farmers regarding bio-pesticides and non-chemical methods.
3. Implement extension activities to educate farmers about the benefits and usage of bio-pesticides and non-chemical methods.
4. Assess the impact of these activities on bio-pesticide adoption.

Methodology

1. **Survey**: Conducted with farmers to gather data on regulatory challenges and awareness levels.
2. **Extension Activities**: Field demonstrations, distribution of informational materials and expert consultations to educate farmers.
3. Detailed analysis of selected farmers before and after the intervention to measure the impact of the extension activities.

Map of district Gurgaon (Gurugram)

Map of district Nuh

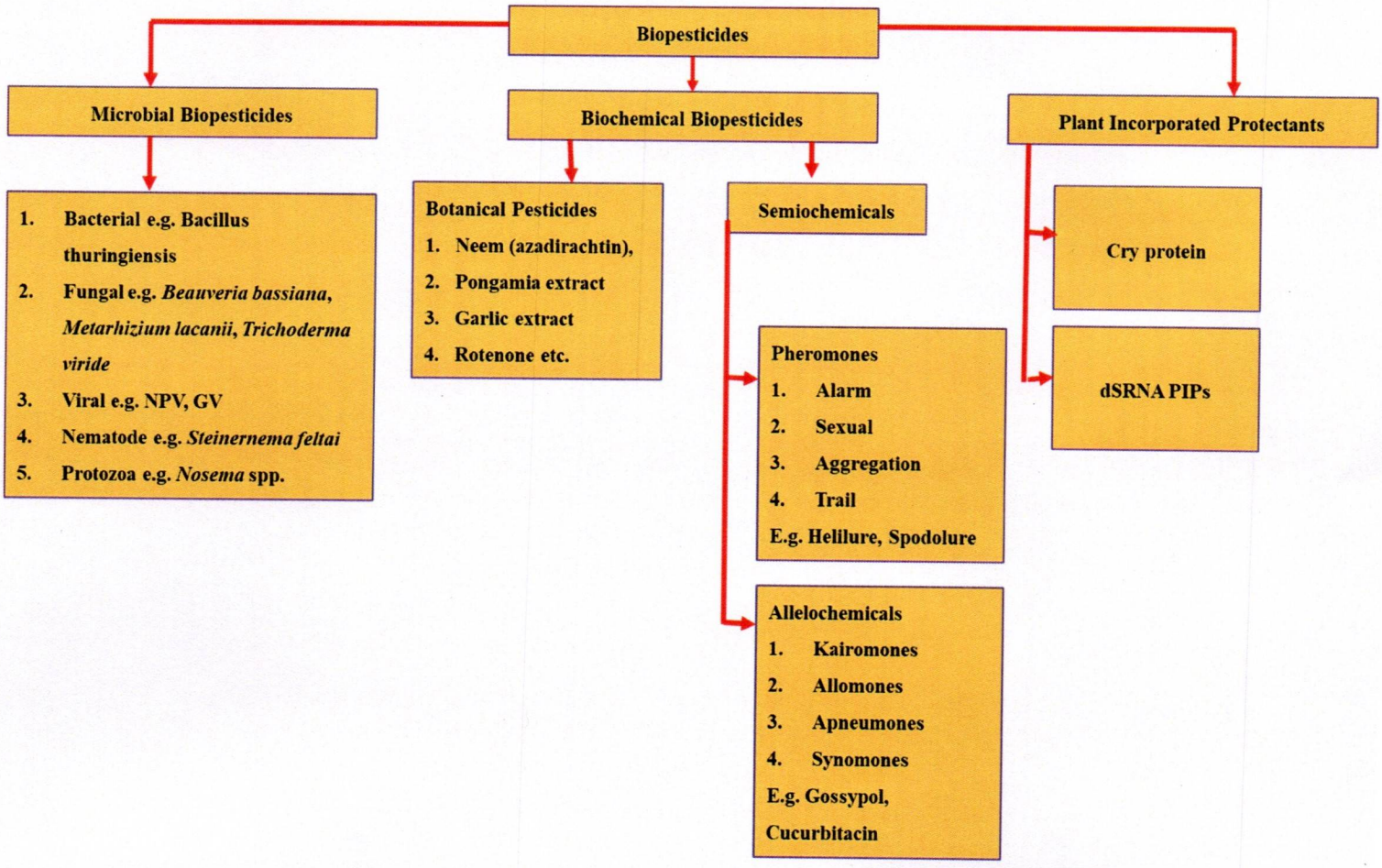


Fig A. Flow chart illustrating the classification of Bio-pesticides on the basis of their nature of origin.

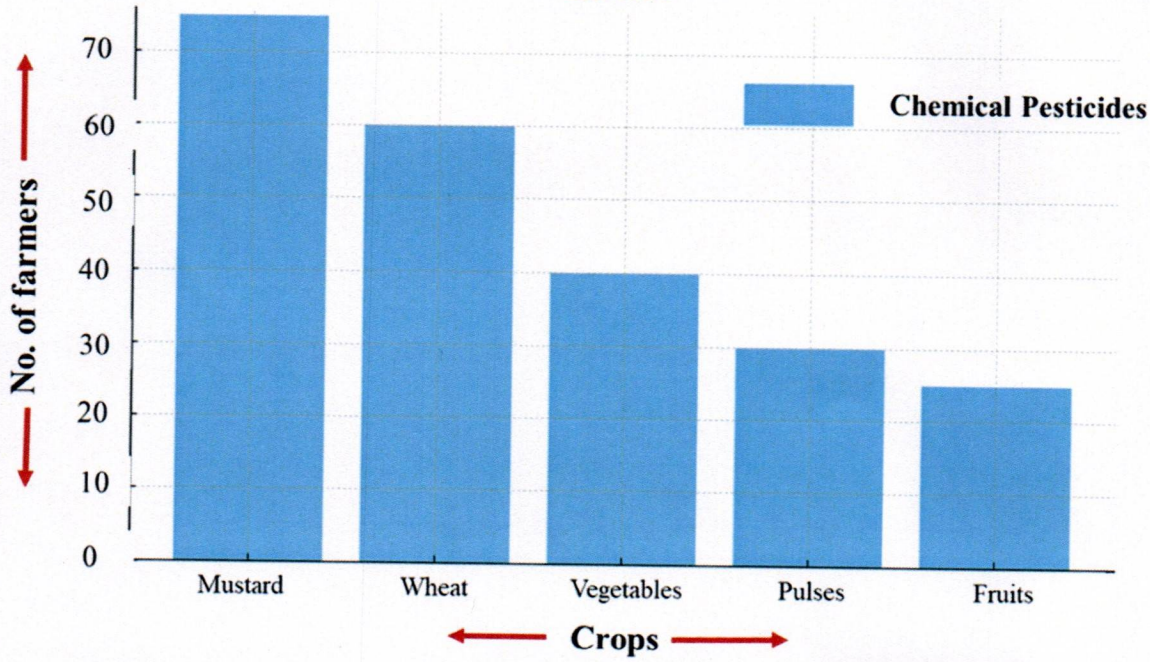
Result and Discussion:

Survey

1. Pre-intervention:

- **Gurgaon District**: The survey was conducted in the rabi season. Farmers were primarily using chemical pesticides to manage pests and diseases in the crops. They were found unaware of bio-pesticides available in the market. Farmers were reported using highest amount of chemical pesticides in mustard followed by wheat, vegetables, pulses and fruits. The problem identified in mustard was due to late sowing of the crop. Following is the graph showing application of chemical pesticides by the number of farmers in different crops (Fig. 1).

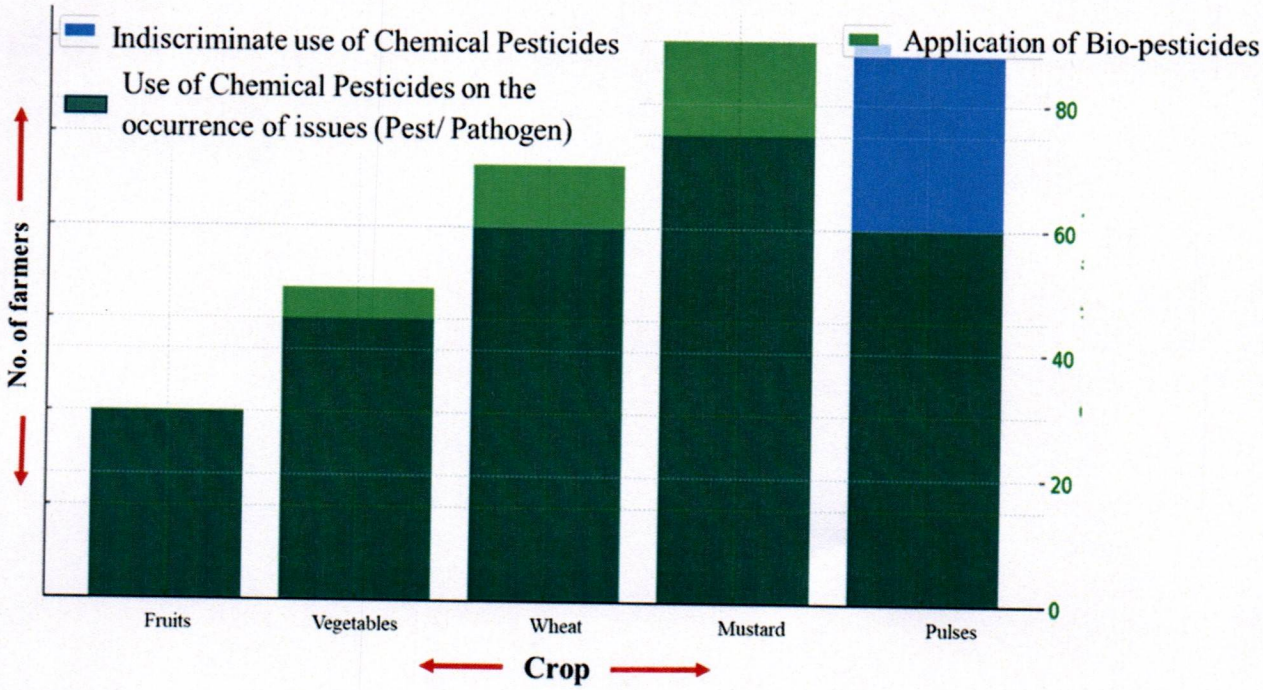
Fig 1. Application of pesticides by the farmers on different crops in Gurgaon district



A] Students collecting data from the farmers and recorded with the help of questionnaire

- **Nuh District:** The result was different in Nuh district compared to Gurgaon district. Here, the farmers were aware and in practice with bio-pesticides. Some farmers were religiously practicing ecofriendly approaches such as bio-pesticides to manage pests and diseases. Following graph is showing the data of number of farmers involved in usage of bio –pesticides, chemical pesticides on the occurrence of pests and appearance of disease symptom and indiscriminate usage of chemical pesticides with the commencement of crop vegetative growth without any monitoring (Fig. 2).

Fig 2. Application of pesticides by the farmers on different crops in Nuh district



On the other hand, there were farmers found with the indiscriminate use of chemical pesticides. Farmers involved with the utilization of biopesticides for managing pasts and diseases

were also practicing monitoring and following the economic threshold level based application. Farmers faced severe pest issues and was skeptical about the effectiveness of bio-pesticides. However, farmers found with the indiscriminate and unjudicious use of chemical pesticides.

Fig 3. Percentage change in the practices followed by the farmers to manage the pest and diseases

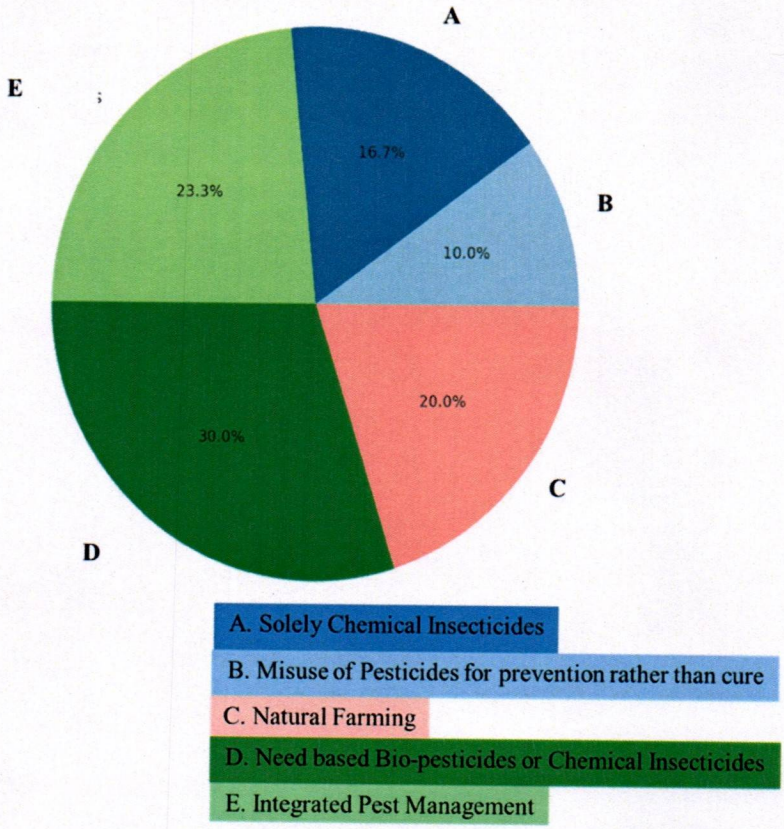
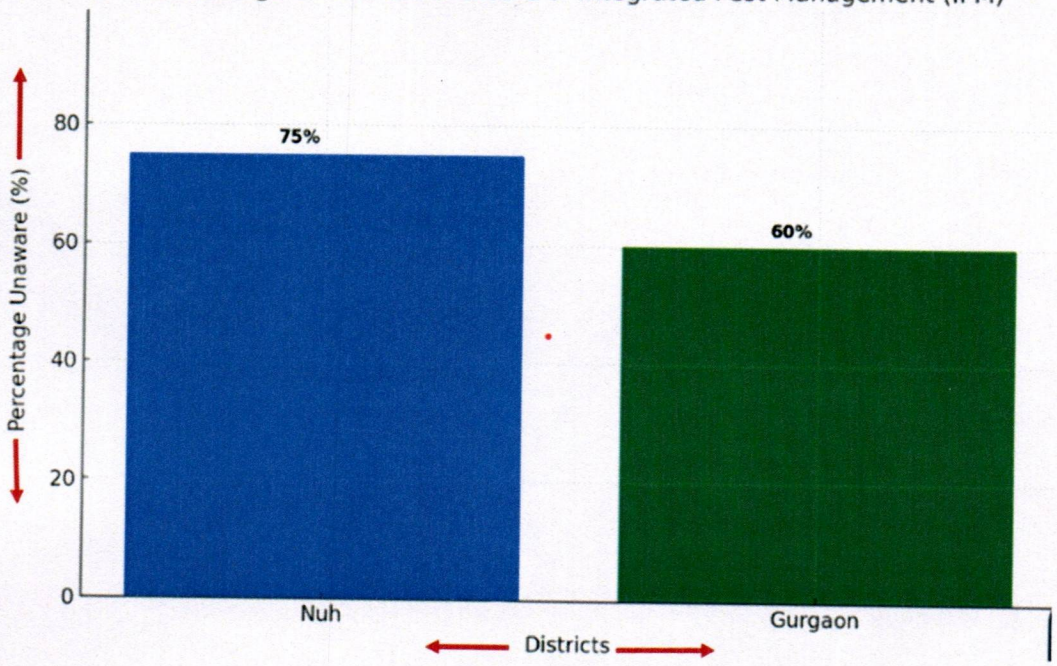


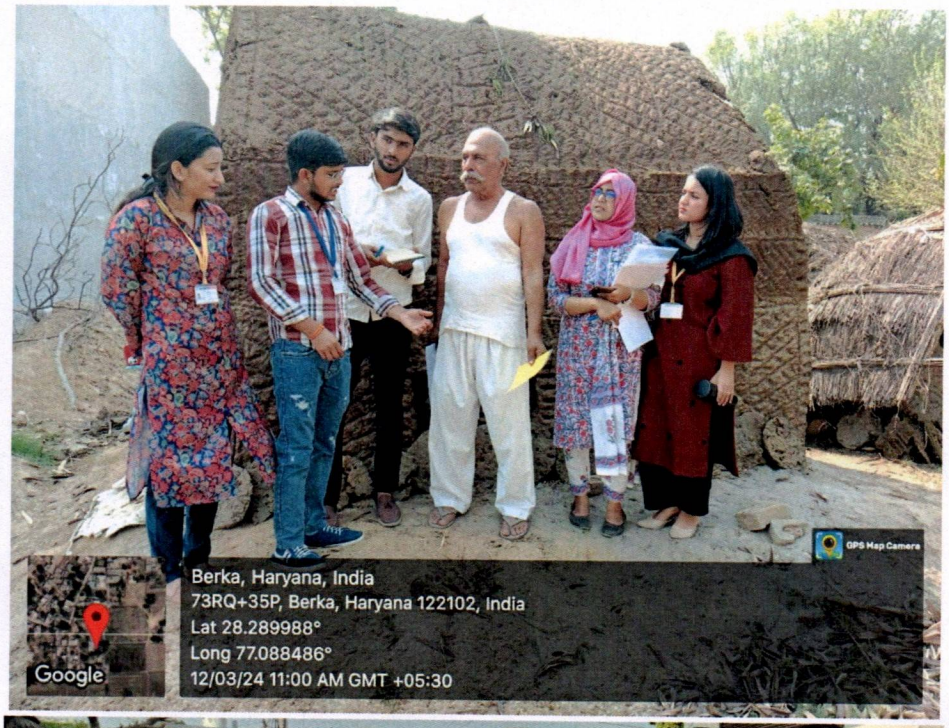
Fig 4. Percentage of Farmers Unaware of Integrated Pest Management (IPM)



Extension activities: Extension activities were conducted to help the farmers in to identify the pest and diseases. Moreover, to apply need based application of bio-pesticides or chemical pesticides. Farmers were also made aware related to other bio-rational approaches for instance different types of traps.

Extension Activities:

1. **Informational Materials**: Distributed pamphlets in local languages detailing the benefits and usage of bio-pesticides.
2. **Expert Consultations**: Organized sessions for farmers and bio-pesticide to address farmers' queries and concerns. Dr. J. S. Yadav, Dr. Neha, Dr. Ambika, Dr. Parita, Dr. Dinesh Kumar and Dr. Deepak Kumar have served as expertise for providing the consultation to the farmers.



B] Expert consultations and demonstrations provided to the farmers (Berka)

3. **Field Demonstrations**: Demonstrated the application of bio-pesticides (neem oil, Datura and Calotropis extract) on various crops to showcase their effectiveness.

Farmers were made aware about the following bio-pesticides and their applications:

Microbial Bio-pesticides

Bacillus thuringiensis (Bt)

- A bacterium that produces toxins harmful to insects but safe for plants and humans. Recommended dose is 1.0-1.5 gram/liter of water.

Trichoderma viride

- Fungi used to control plant pathogenic fungi by parasitizing them.
- Seed treatment: Mix 8-10 gm formulation in 50 ml of water and apply on 1 kg of seed uniformly. Shade dry the seeds for 20-30 minutes before sowing.
- Seedlings treatment: Dissolve 500 gm formulation in 50 lit of water Dip seedling roots for about half an hour in the suspension and transplant immediately.
- Nursery seedbed Treatment: Mix 500 gm formulation in 10 kg of well decomposed Farm Yard Manure /Compost/Vermicompost and broadcast in an acre.
- Soil drenching: Mix 1-2 kg formulation in 200 liters of water and drench the soil in 1 acre.
- Horticulture crops: Mix 50 – 100 gm formulation per plant in sufficient quantity of well-decomposed farm yard manure/vermi-compost/field soil and apply the mixture in effective root zone of fruit tree. The dosage will change depending upon the age of the crop.

A] Application *Trichoderma* sp. and benefits were introduced to the farmers

E] Distribution of bio-pesticides and sticky traps to the farmers to integrate in management practices against aphids in mustard crop Pinangwa.

2. Botanical bio-pesticides

Neem Oil

- Oil extracted from neem seeds, used to disrupt the growth and reproduction of insects. Recommended concentration is 5% for horticultural crops.
- Neem-based products are generally non-toxic to mammals, birds, and beneficial insects like pollinators and predators. They break down quickly in the environment, reducing long-term ecological impact compared to synthetic chemicals because of their biodegradable nature.

Effectiveness against different Insect Pests

1. **Broad-Spectrum Activity**: Neem extracts and neem oil is effective against a broad spectrum of insect pests, including:
    - **Lepidopteran pests**: Such as caterpillars and moths.
    - **Coleopteran pests**: Including beetles and weevils.
    - **Homopteran pests**: Such as aphids and leafhoppers.
    - **Dipteran pests**: Including flies and mosquitoes.
2. **Modes of Action**:
    - **Anti-feedant**: Neem compounds deter feeding by making the plant tissues less palatable to insects.
    - **Growth regulation**: Disrupting insect growth and development stages, such as molting and reproduction.

- **Repellent**: Acting as a repellent against insects, reducing their settlement and feeding on crops.

Pyrethrin

- Natural insecticide derived from Chrysanthemum flowers, effective against a variety of insects.

Rotenone

- Extracted from the roots of certain plants like Derris, used as an insecticide.

*Calotropis and datura extract can also be used at the diluted levels.

3. Biochemical Pesticides

Insect Growth Regulators (IGRs)

- Chemicals that disrupt the growth and reproduction of insects by mimicking hormones.

Benefits of Bio-pesticides:

- **Enhanced Root Growth**: Stimulated plant defense mechanism by enhancing the production of secondary metabolites and nutrient uptake.
- **Environmental Safety**: Non-toxic to humans, animals, and beneficial organisms, making it environmentally friendly.

4. Biological Control Agents

Coccinellid beetles, syrphid fly

- Predatory insects used to control aphid populations in gardens and farms.

Diaretiella rapae is a parasitoid of aphids and its parasitization results into mummified aphids.

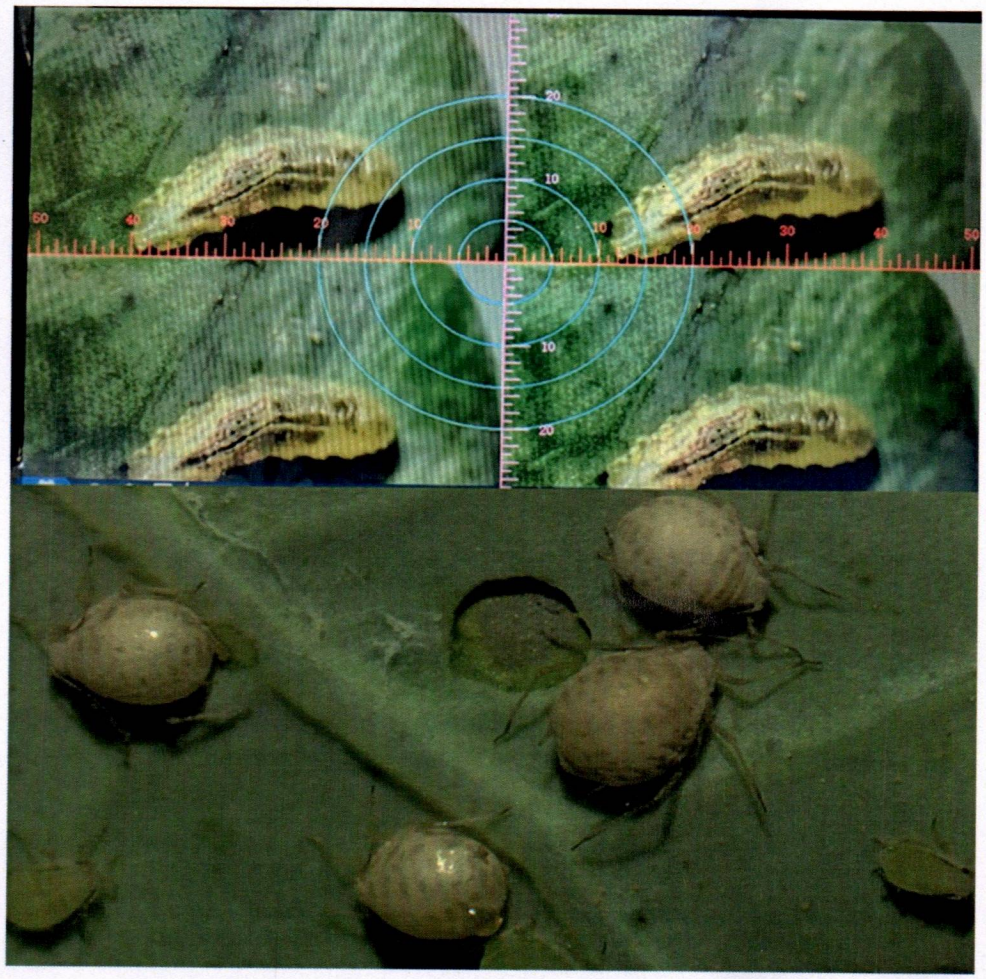
Nematodes

- Parasitic worms that target and kill specific insect pests that comes in contact with moist soil.

These organisms act as a biological control agent by parasitizing and antagonizing pest and pathogens. These biocontrol agents augmented in the field to multiply. This control population of insect pests and intensity of pathogen by various mode of actions like predation, release of toxins, coiling etc. After release or application of these biological control agent, they must be conserve by protecting their habitat. Conservation of biological control agents (BCAs) is crucial in maintaining sustainable pest management strategies across diverse agroecosystems. Farmers were explained to the importance of conservation of natural enemies.

Importance of Conservation

1. **Natural Pest Control**: BCAs play a vital role in controlling pests through predation, parasitism, or competition, reducing reliance on synthetic pesticides.
2. **Sustainability**: Promoting natural enemies helps maintain ecological balance and reduces environmental impacts associated with chemical inputs.



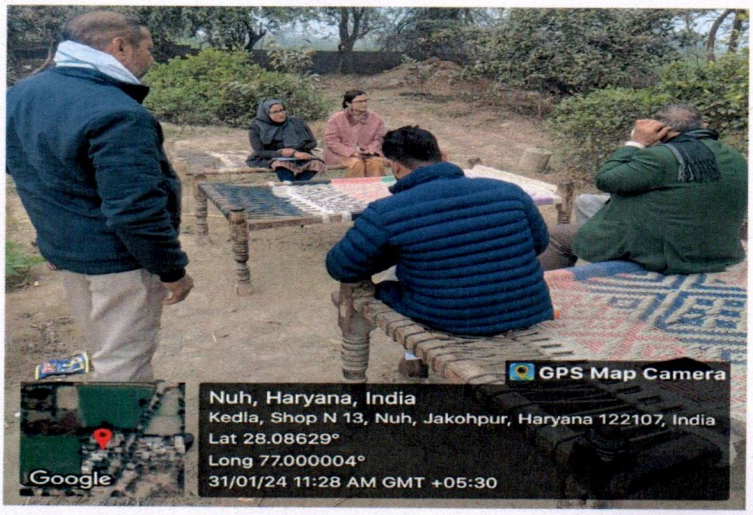
B] Predator of aphid, maggots of syrphid fly (above), parasitized aphid known as mummified aphid (below)

Strategies for Conservation

1. **Habitat Management**:
    - **Natural Habitats**: Preserving natural habitats like hedgerows, forests, and wetlands that harbor BCAs.

- **Diversity**: Enhancing biodiversity within and around agroecosystems to support a variety of natural enemies.
- **Cover Crops**: Planting cover crops that provide alternative hosts and shelter for BCAs.

2. **Reduced Pesticide Use**:
   - **Selective Application**: Using selective pesticides that are less harmful to BCAs or timing applications to minimize impact on beneficial.
   - **Integrated Pest Management (IPM)**: Implementing IPM strategies that prioritize biological control over chemical control.
3. **Cultural Practices**:
   - **Crop Rotation**: Rotating crops to disrupt pest cycles and maintain populations of BCAs.
   - **Conservation Tillage**: Minimizing soil disturbance to preserve beneficial soil organisms.
   - **Trap Cropping**: Planting specific crops to attract pests away from main crops, allowing BCAs to control them.
4. **Augmentation and Introduction**:
   - **Release of bio-control agents**: Introducing or augmenting populations of BCAs through controlled releases when natural populations are insufficient. E.g.: *Trichogramma* sp. in the form of tricho-cards to manage lepidopteran pests in vegetable crops.
   - Developing and promoting native BCAs adapted to local conditions and pests.
5. **Monitoring**:



C] Expert consultations and demonstrations provided to the farmers (Kherla)

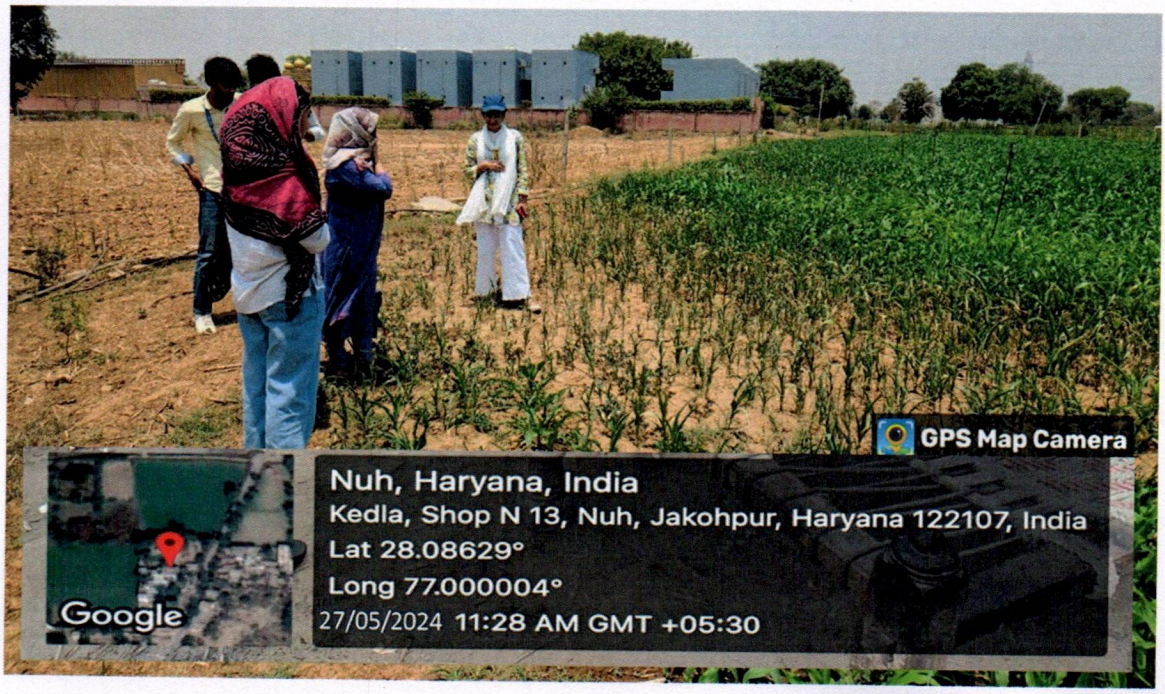
D] Expert consultations and demonstrations provided to the farmers (Lakhuwas)

- **Surveillance**: Regularly monitoring pest and beneficial populations to apply management strategies accordingly including cultural, mechanical, biological, behavioural and chemical practices.
- Understanding the complex interactions between BCAs, pests, and their environment to effectively conserve natural enemies is very significant for agroecosystem of the farms.

6. **Economic Viability**: Balancing conservation efforts with economic considerations and farmer livelihoods.

Following factors needs to know by the farmers to improve the efficacy of bio-pesticides:

1. **Application Method**: Proper application techniques ensure that bio-pesticides reach the target area effectively. E.g. use of dispersants, stickers, spreaders etc.
2. **Environmental Conditions**: Temperature, humidity, and soil pH affect the growth and survival of every bio-pesticides. Application of bio-pesticides must be done in evening to protect it from the UV rays or overhead sun. Application should be made when wind speed <5 Km/hr. Application of bio-pesticides must be done in the humid weather conditions.
3. Bio-pesticides vary in their effectiveness against the different habit and habitat of pests and pathogens and more target specific.
4. **Crop Compatibility**: Different crops may have varying levels of susceptibility to pests and diseases which may interact differently with bio-pesticides.
5. **Integrated Pest Management (IPM)**: Combining other control methods along with the judicious and need based application of chemical pesticides can enhance overall pest management strategies.



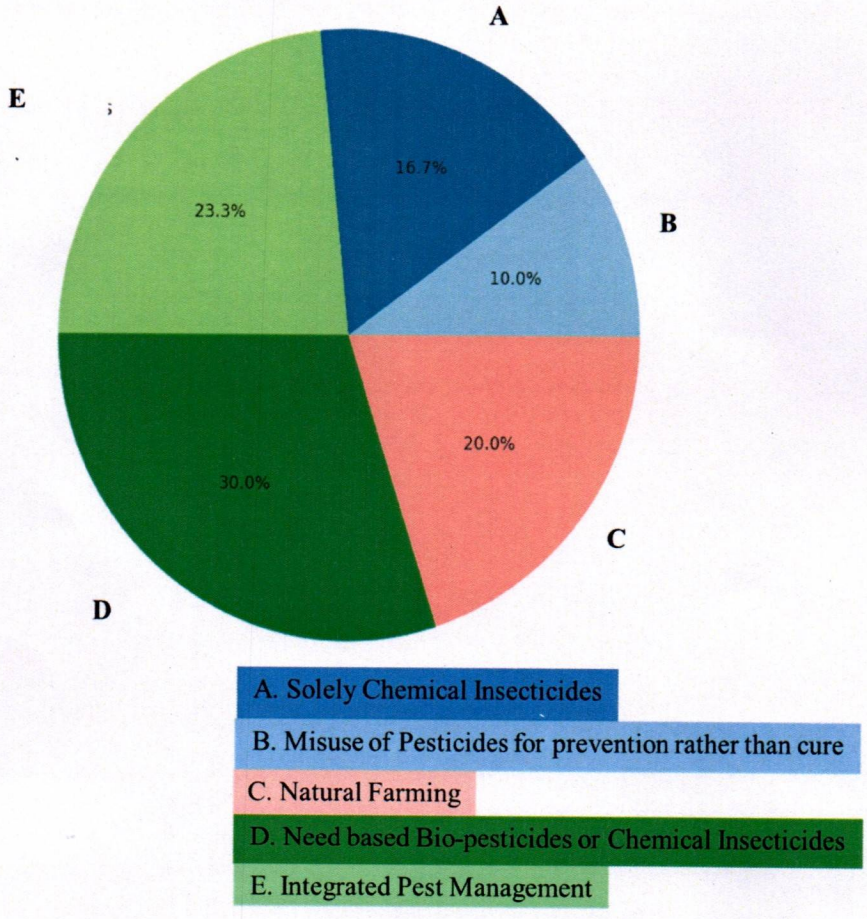
F] Issues related to pest management were discussed with farmers

Traps could be installed, it can be light trap, sticky trap, pheromone trap according to the nature of pest.

2. Post-intervention:

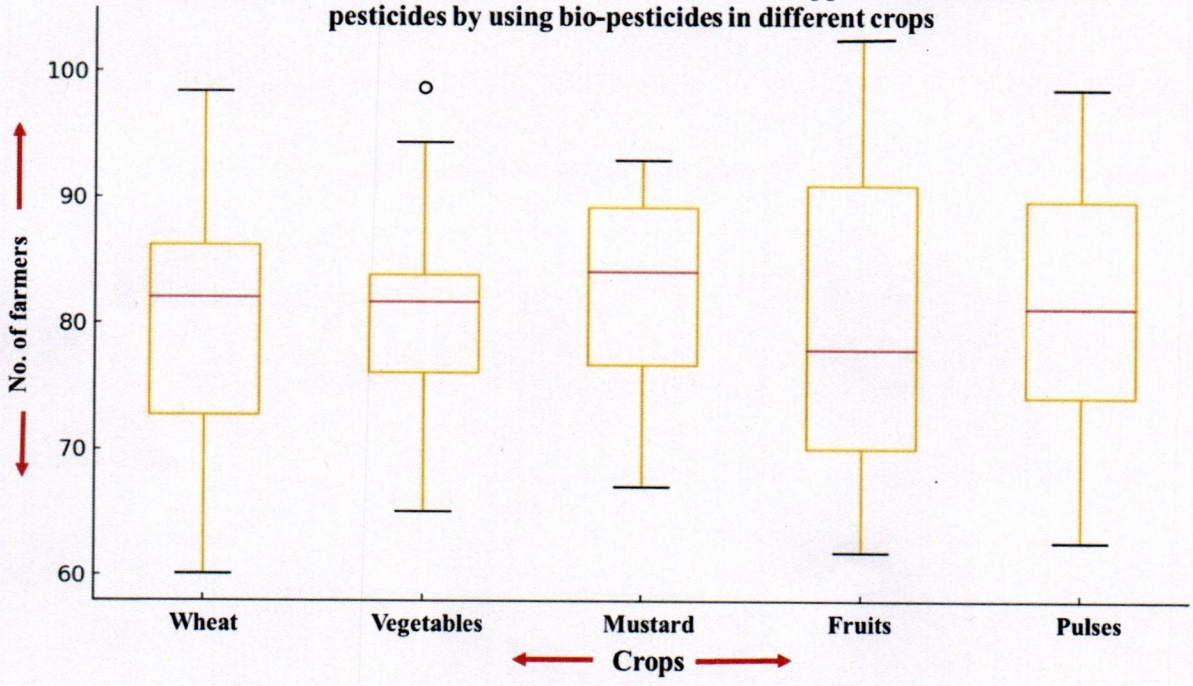
On succession of the extension activities, farmers decided to try bio-pesticides on a portion of the farm. The results were promising, with a 15% increase in the usage of bio-pesticides. Farmers need to be proponent of bio-pesticides and integrated pest management in the local farming community.

Fig 5. Percentage change in the practices followed by the farmers to manage the pest and diseases



After attending the expert session and field demonstrations, farmers have adopted bio-pesticides for pest control. Within a season, there was a noticeable improvement in pesticide application and bio-rational approaches towards the management of pest and diseases. This study showed the neem-based insecticides have been successfully used to protect a variety of crops including vegetables, fruits, and grains from insect pests. This study has revealed that neem-based products can be as effective as synthetic chemical insecticides in controlling certain insect pests at the early stage of pest occurrence with proper monitoring.

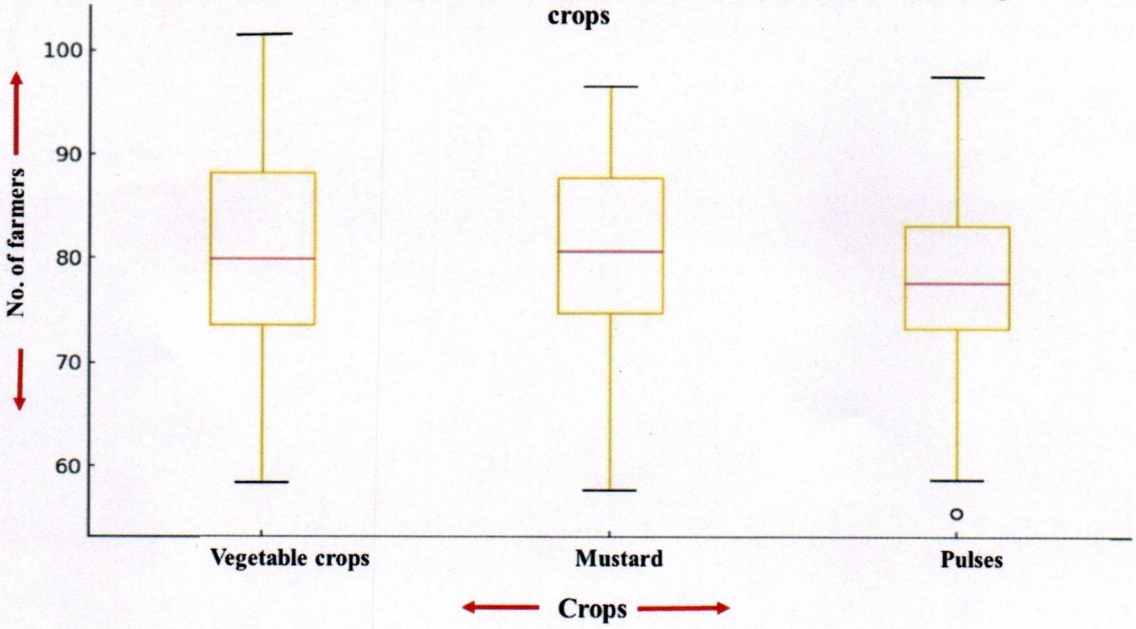
Fig 6. Number of farmers agreed to reduce the no. of application with chemical pesticides by using bio-pesticides in different crops



Investigation carried out through appendixes of questionnaire revealed that farmers get their plant protection advice from pesticide dealers or majority of the farmers make their plant protection decisions through their adjacent farmers or large scale farmers of their area. A majority of the farmers initiate the

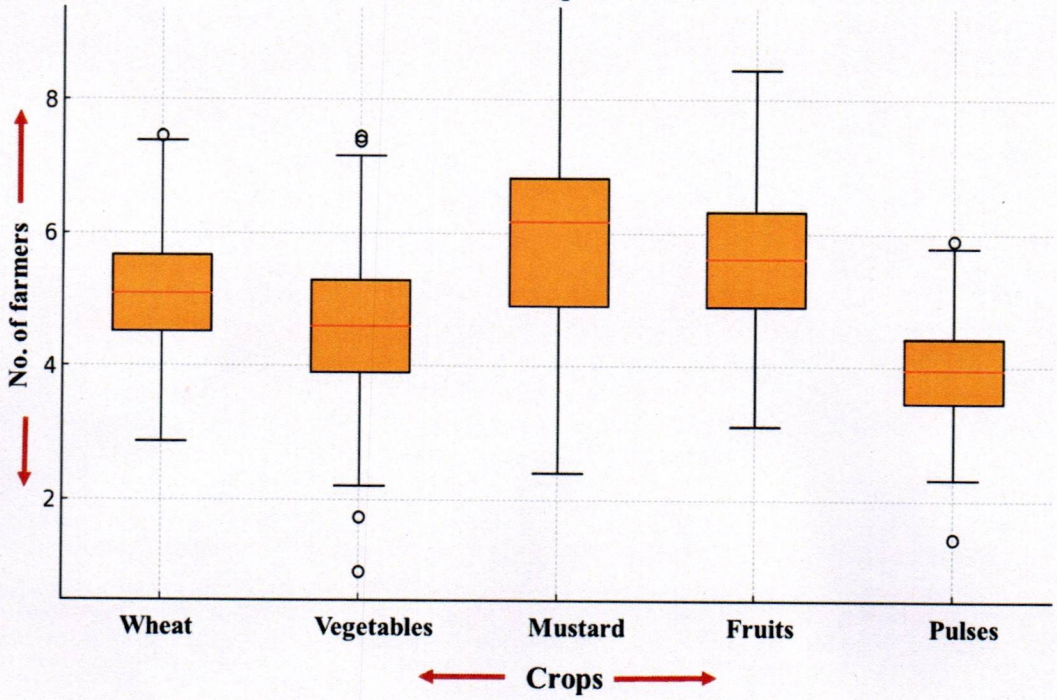
plant protection based on the first appearance of the pest, irrespective of their population, crop stage and their damage relationships. Farmers were also found not using any protective clothing while spraying. Health problems associated with the application of plant protection chemicals were reported by farmers. Many of them were not aware of IPM practices. Awareness regarding IPM implementation in selected villages was spread in different crops. Neem-based insecticides offer a valuable alternative to synthetic chemicals for pest management in agriculture, providing effective control while minimizing environmental and health risks. Therefore, this was the reason for adoption of neem based pesticide by the farmers.

Fig 7. Number of farmers adopted application of bio-pesticides in following crops



This study helped the number of farmers, who has adopted methods other than chemical control for the management of various insect pests in different crops; however, less farmers expressed confidence on practicing integrated pest management.

Fig 8. Number of farmers adopted Integrated Pest Management in different crops



Outcome:

The usage of bio-pesticides was found increased by 15%. Farmers already using bio-pesticide were found proponent of bio-pesticides in the local farming community. Natural farming was found more convenient for the small farmers and increased in adoption by 10%. Implementation of integrated pest management was enhanced by 3%. Dependency of farmers solely on chemical insecticide was reduced from 25% to 16.7%. Misuse of chemical pesticides was significantly reduced from 30% to 10%.

Less number of farmers among the surveyed were convinced by Integrated Management Practices in the investigated crops. Continuous research and field application are key to optimizing their efficacy and promoting sustainable agricultural practices. By integrating these strategies, agricultural systems can enhance the resilience and sustainability of pest management while conserving valuable biological control agents. By addressing different management strategies, farmers better understood the efficacy of bio-pesticide in agricultural settings. Neem-based insecticides have shown significant effectiveness against a wide range of insect pests but still some challenges need to be addressed mentioned below:

Challenges and Considerations

1. **Persistence**: Neem-based insecticides may require more frequent application compared to synthetic chemicals due to their biodegradable nature.
2. **Target Specificity**: While generally broad-spectrum, efficacy can vary depending on the pest species and life stage.
3. **Application Techniques**: Proper application techniques are crucial to maximize effectiveness, including coverage and timing.

- **Application Challenges**: Ensuring uniform distribution of bio-pesticides in the field.
- **Pest and Pathogen Specificity**: Effectiveness can vary against different pests and pathogens.
- **Environmental Sensitivity**: Susceptibility to environmental conditions like sun rays, temperature and moisture.

Conclusion

The summary of the study signifies that the use of unsustainable levels of plant protection chemicals has resulted in a steady decline in soil quality and crop productivity as informed by the farmers. To combat this decline, agricultural practices must evolve to meet the growing global demand for food without irreversibly damaging the natural resources. Bio-pesticides have tremendous potential to bring sustainability to agriculture and environmental safety. Study also revealed that farmers, manufacturers or suppliers of bio-pesticides, and R&D scientists can play an important role in adaptation of bio-pesticides by the farmers by demonstrating the advantages of applying microbial bio-pesticides and other alternatives to chemical pesticides to field crops. Yet, despite their positive impact on the health of humans, soil, ecosystems, and friendly invertebrates, bio-pesticides face significant challenges and competition vis-à-vis synthetic pesticides due to various reasons. Therefore, these factors hindered the results of bio-pestoicides if not applied in a scientifically suggested manner. The development of bio-pesticides and its adaptation by the farmers must overcome the problems of improper formulations, short shelf life, delayed action, and high market costs.

It is concluded from the present study that the adoption of bio-pesticides in Gurgaon and Nuh districts is hindered by several regulatory barriers, primarily lack of awareness, and cost issues. Also unavailability of few of microbial pesticides in nearby market has affected the timely application to manage at the earliest possible under proper guidance. However, targeted extension activities have shown that with proper education and support, farmers are willing to adopt bio-pesticides, leading to sustainable

agricultural practices and improved crop yields. Continued efforts in simplifying regulations and enhancing farmer education are crucial for broader acceptance of bio-pesticides.

Regulatory Barriers Identified

1. **Limited Awareness**: Many farmers are unaware of bio-pesticides and their benefits due to inadequate information dissemination. Also they are unaware of serious issues caused by the indiscriminate use of chemical pesticides.
2. **Cost and Subsidy Issues**: Higher initial costs of bio-pesticides compared to chemical pesticides and insufficient subsidies deter farmers.
3. **Market Availability**: Limited availability of bio-pesticides in local markets restricts access for farmers.

Recommendations

1. **Increase Awareness**: Expand extension activities and use mass media to educate farmers about bio-pesticides.
2. **Provide Subsidies**: Offer financial incentives and subsidies to make bio-pesticides more affordable for farmers.
3. **Improve Market Availability**: Ensure that bio-pesticides are readily available in local markets to enhance accessibility.

By addressing these regulatory barriers and continuing with robust extension activities, the adoption of bio-pesticides can be significantly increased, leading to more sustainable agricultural practices in Gurgaon and Nuh districts of Haryana.

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11. Static data source: NCIPM, IARI, *NIPHM* and *Directorate of Plant Protection, Quarantine & Storage*

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