International Journal of Science, Strategic Management and Technology
Volume **02** Issue **05** May-**2026** | ISSN: **3108-1762 (Online)** | Impact Factor: 3.8
An International, Peer-Reviewed, Open Access Scholarly Journal Indexed in recognized academic databases

Survey on Types of Pesticides and Insecticide use in Villages of Nagaur District

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https://doi.org/10.55041/ijsmt.v2i6.028

Cite this Article: Lamror, S., Vaishnav, M. & Joshi, M. (2026). Survey on Types of Pesticides and Insecticide use in Villages of Nagaur District. International Journal of Science, Strategic Management and Technology, *02*(6). https://doi.org/10.55041/ijsmt.v2i6.028

Abstract

As the global population is projected to reach 9 billion by 2050, the demand for food continues to escalate, leading to increased reliance on chemical pesticides to ensure crop yields. This research presents a survey of 11 villages in the Nagaur district to document the current status of pesticide use, the knowledge level of farmers, and the associated health and environmental impacts. The study reveals a heavy dependence on synthetic chemical pesticides such as Trifloxystrobin, Imidacloprid, and Dimethoate, with very limited adoption of biopesticides. Furthermore, a significant lack of formal training and protective measures among farmers was observed, highlighting urgent needs for government-led awareness programs.

Introduction:

The global population is projected to reach 9 billion by 2050, rising from approximately 6.8 billion in recent years (Lam,2025). This rapid demographic expansion which has seen the human population more than double since 1960 presents a critical challenge for global food security. The vulnerability of the current system was highlighted by the food price spikes of 2022, where the costs of staples like wheat, sorghum, and rice surged by 230%, 107%, and 74% respectively, triggering civil unrest in 36 countries (Mlambo et al.,2024). With hunger and malnutrition already claiming more lives annually than AIDS, tuberculosis, and malaria combined, the World Bank estimates that cereal and meat production must increase by 50% and 85% respectively to meet impending demand (Sanchez.,2005).

To meet these production targets, agriculture relies heavily on pesticides: chemical or biological mixtures designed to protect crops, stored grains, and households from pests such as insects, rodents, weeds, and fungi (Khan et al.,2023). Far from a modern invention, pest control dates back to ancient civilizations. The Sumerians utilized elemental sulfur, while medieval farmers employed arsenic and lead. Early Chinese civilizations developed arsenic and mercury compounds to control lice and utilized natural remedies like oil, ash, and neem leaves. A significant turning point occurred in 1939 with Paul Hermann Muller's discovery of DDT, the first synthetic chemical used to combat insect-borne diseases like malaria before its eventual ban in 1972 (Hassan.,2019).

Classification and Chemical Diversity of pesticides (Abubakar et al.,2020):

Modern pesticides are classified based on the specific pests they target or their chemical properties:

- Target-Based Classification: Includes insecticides (insects), herbicides (plants), rodenticides (rodents), bactericides (bacteria), fungicides (fungi), and larvicides (larvae).
- Environmental Persistence: Pesticides are categorized as biodegradable (broken down quickly by microbes) or non-biodegradable/persistent, such as DDT and chlordane, which can remain in the soil for over 15 years.
- Chemical Groups:
  - Organophosphates and Carbamates: Both impact the nervous system by affecting enzymes that regulate neurotransmitters.
  - Organochlorines: Persistent legacy chemicals like toxaphene.
  - Pyrethroids: Synthetic versions of natural pesticides found in chrysanthemums.
  - Biopesticides: Natural alternatives derived from animals, plants, bacteria, and minerals.

Despite the necessity for crop yields, pesticides pose severe risks to human health and the environment through biomagnification. In India, exposure has been linked to respiratory issues (sore throat, dizziness, shortness of breath), gastrointestinal distress, and skin or eye irritation. These risks are often exacerbated by a lack of personal protective equipment (PPE) during application. Environmentally, improper disposal of packaging and chemical runoff contaminate surface water and drinking supplies, potentially decimating local bird populations, wildlife, and essential soil organisms like worms, which are vital for vermicompost activity (Yeswanth and Vinitha.,2026).

Methodology

The study targeted a scale of 11 villages in the Nagaur district: Khajwna, Roon, Indokali, Gawaloo, Janana, Mundwa, Paldi Jodha, Chheelara, Dhadhariya Khurd, Dhadhariya Kalan, and Deswal (Doran et al.,2026).

- Survey Instrument: A structured questionnaire was developed to collect data from agricultural households.
- Data Collection: Information was gathered regarding farmer age, education, years of experience, crop types, specific pesticides used, and knowledge of application methods.
- Field Observation: Direct interactions with farmers in Khajwna village provided insights into the practical methods of pesticide spraying.
- Geographical Mapping: Google Earth images were utilized to document the geographical distribution and boundaries of the surveyed villages.

Result:

The survey documented data from 99 participants. Participants ranged from illiterate to post-graduates, with farming experience spanning from 3 to over 30 years.Cumin was predominantly treated with Mancozeb 75% WP, Imidacloprid 17.8% SL, and occasionally neem-based insecticides. Wheat, common treatments include Metsulfuron-methyl 20% WP and Chlorpyrifos. Fenugreekis often treated with Pyriproxyfen, Dinotefuran, and Diafenthiuron. Isabgol (Psyllium) heavily used Dimethoate 30% EC and Thiamethoxam. While nearly all farmers claimed knowledge of spraying methods, most relied on "classical" or traditional knowledge rather than formal technical training.

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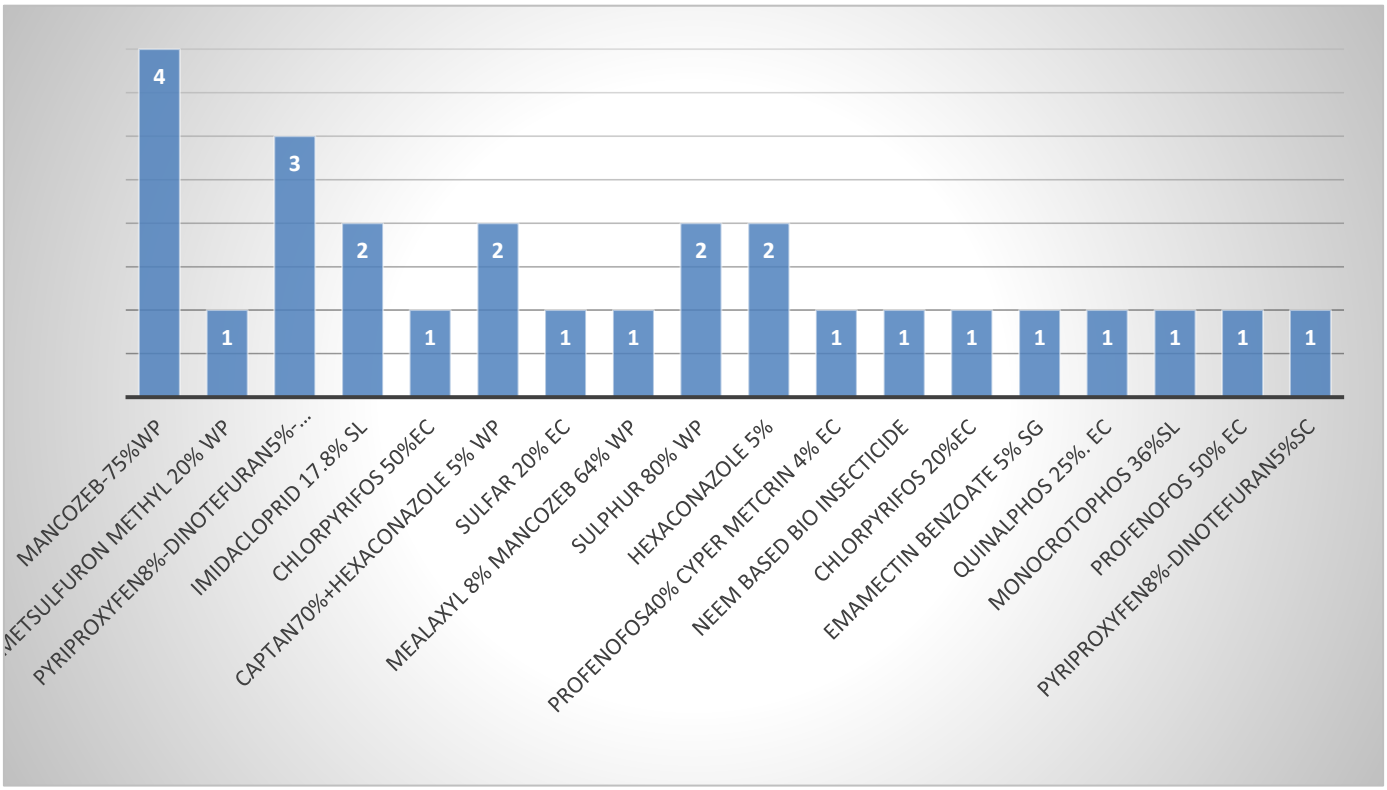

Figure 1: Comparative Usage Frequency of Pesticide and Insecticide Formulations in Khajwana and Mundwa.

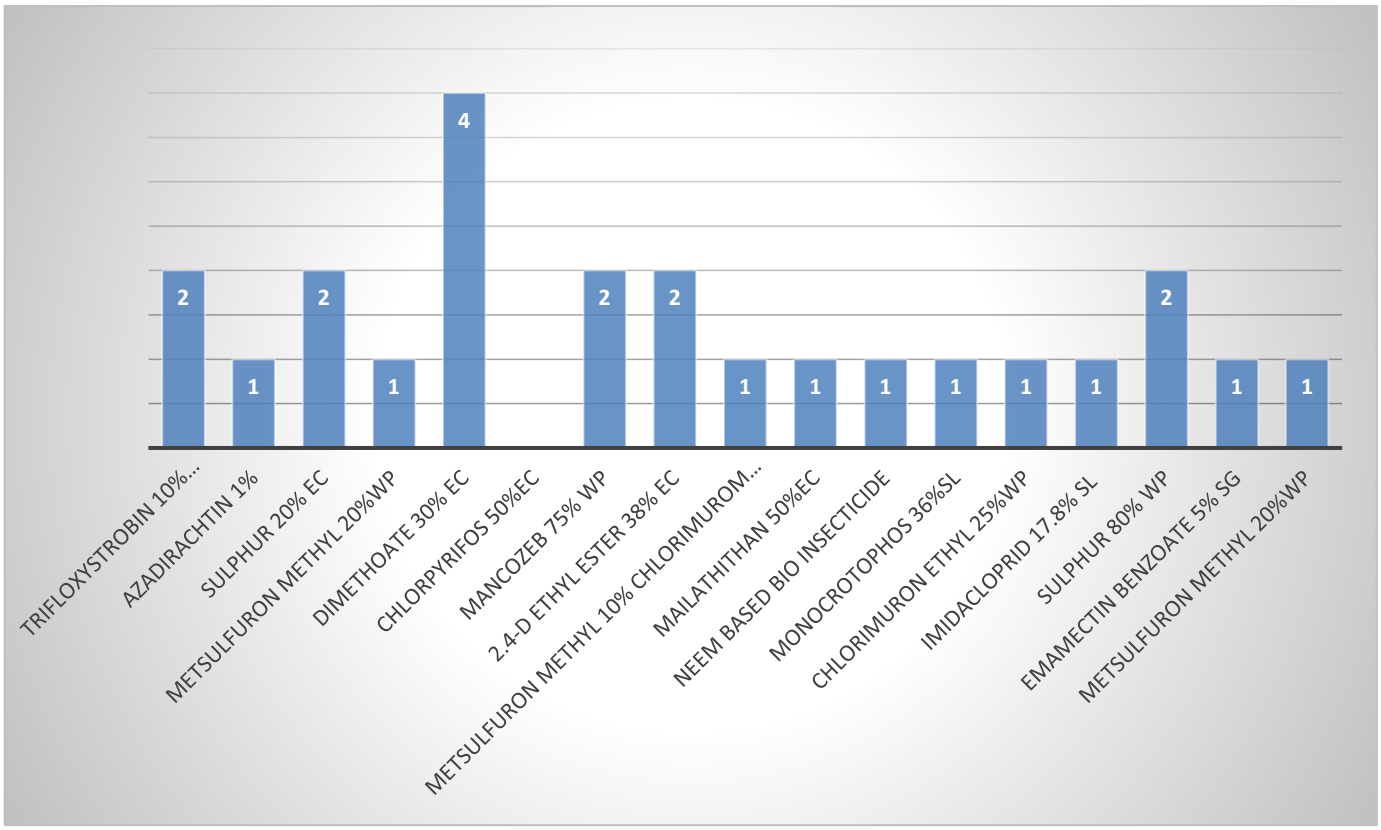

Figure 2: Pesticide use in Dhadhriyakhurd, Chheelara, Paldi and Jodhain

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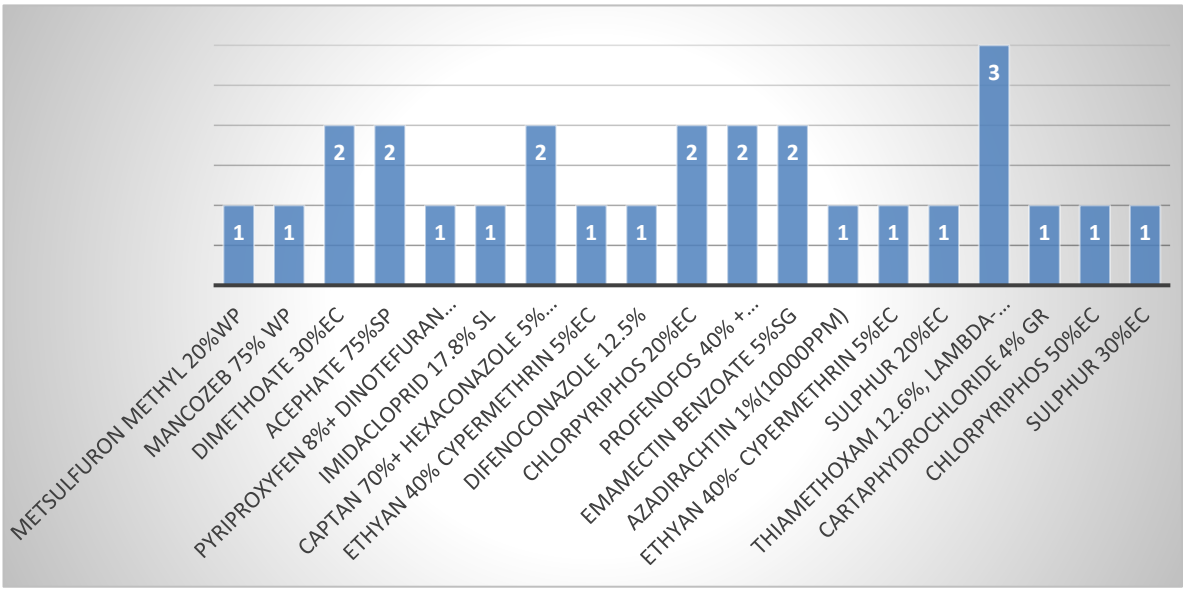

Figure 3: Pesticide use in Janana and gawaloo

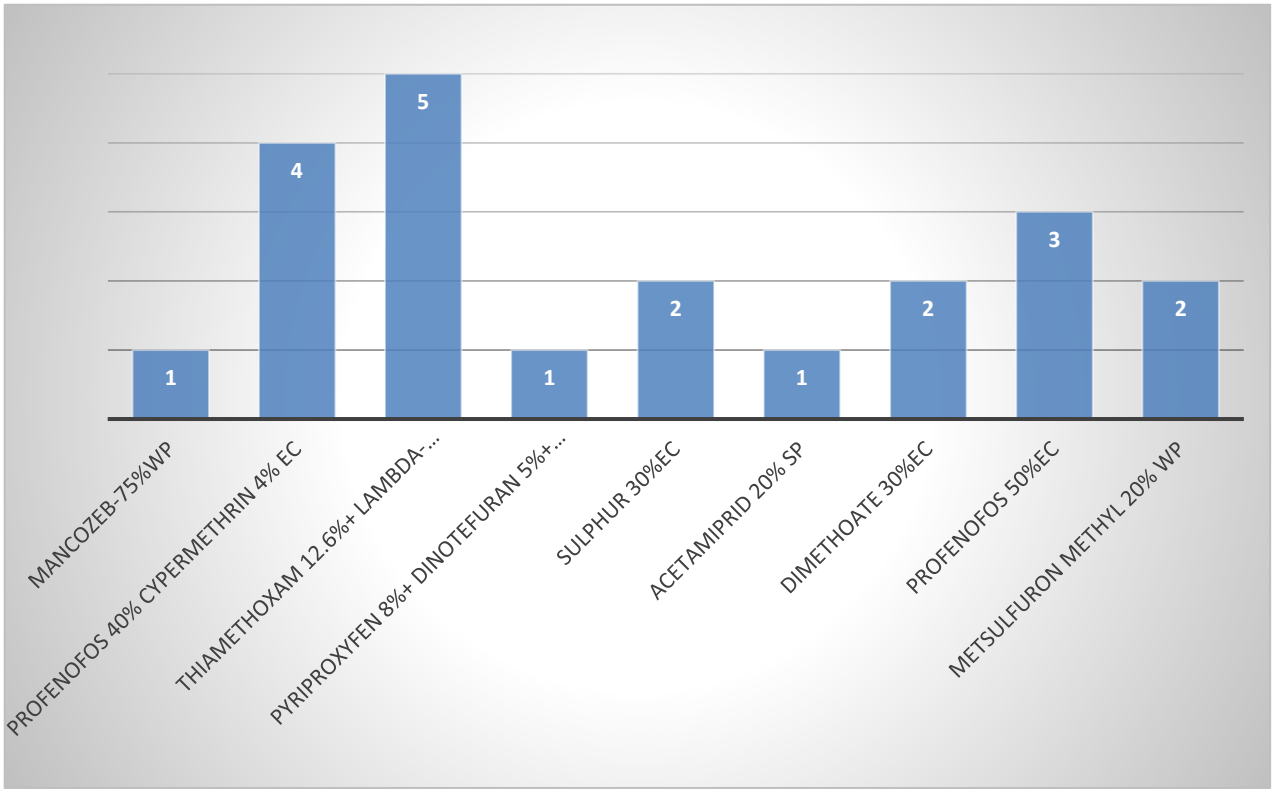

Figure 4: Pesticide use in Roon, and Indokaliin

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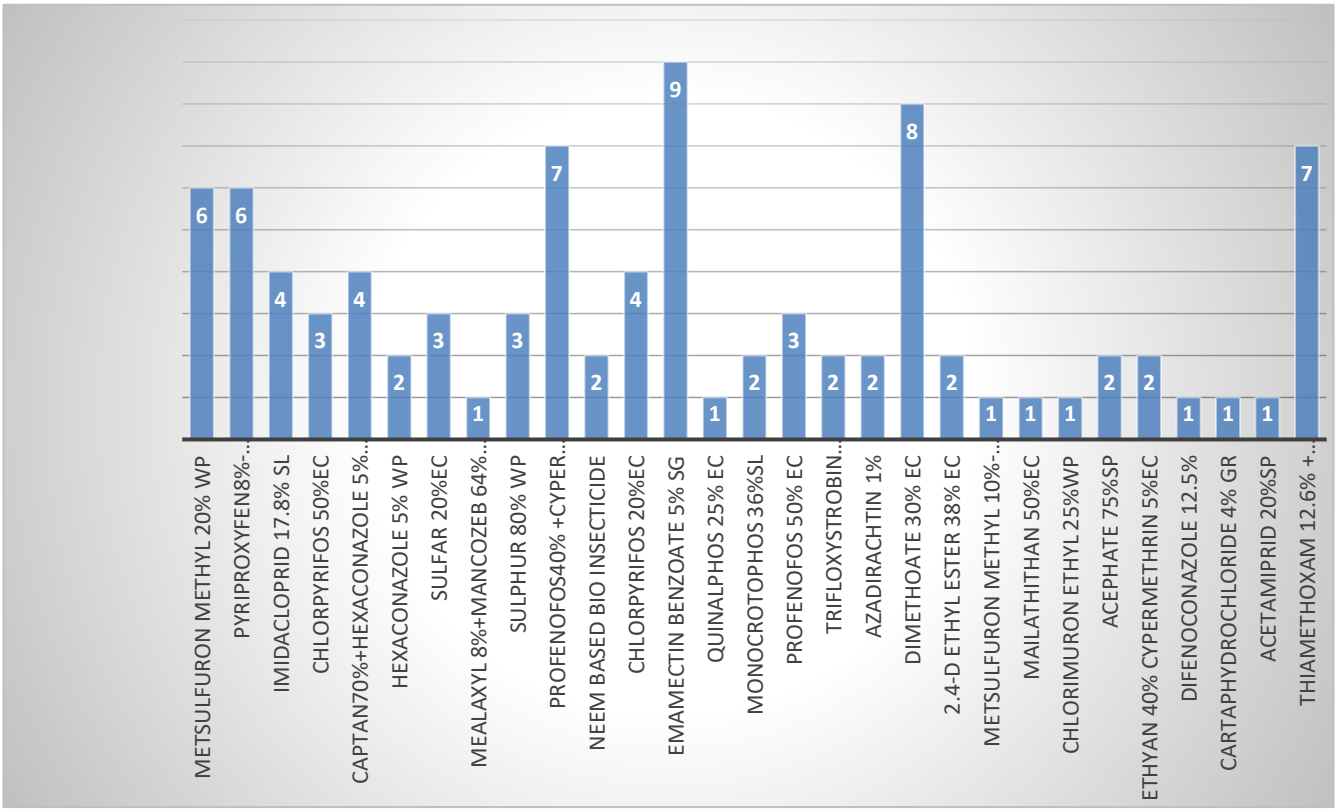

Figure 5: Total pesticides used in Nagaur district

The survey illustrates a significant reliance on synthetic chemical pesticides across the surveyed villages in Nagaur district, with Emamectin Benzoate 5% SG emerging as the most frequently used formulation with a count of 9. This is closely followed by Dimethoate 30% EC at 8 and both Profenofos 40% + Cypermethrin 4% EC and Thiamethoxam 12.6% + Lambda-Cyhalothrin 9.5% ZC at 7. While herbicides like Metsulfuron Methyl 20% WP and insecticides like Pyriproxyfen 8% + Diafenthiuron 18% SC show moderate usage levels of 6, the overall data reveals a diverse but chemically intensive approach to pest management. Notably, the adoption of biological alternatives remains low, with Azadirachtin 1% (a neem-based biopesticide) used only twice, underscoring a critical need for increased awareness regarding sustainable agricultural practices and the potential health and environmental hazards associated with these persistent synthetic chemicals.

Conclusion

The survey conducted across various villages in the Nagaur district reveals a dominant and significant reliance on synthetic chemical pesticides (Nayi and Bharodia.,2025). The data highlights a chemically intensive approach to pest management (Teng and Savary.,1992), with Emamectin Benzoate 5% SG emerging as the most frequently used formulation (count of 9), followed closely by Dimethoate 30% EC (count of 8). Furthermore, Profenofos 40% + Cypermethrin 4% EC and Thiamethoxam 12.6% + Lambda-Cyhalothrin 9.5% ZC both showed high usage levels (count of 7). In contrast, the adoption of biological alternatives remains strikingly low; for instance, Azadirachtin 1% (a neem-based biopesticide) was utilized only twice. The study identified specific chemical-crop associations and their subsequent biological and environmental impacts:

- Fenugreek (Khajwna, Mundwa): Trifloxystrobin is used to prevent fungal infections by interfering with the fungal respiratory system. However, it is found to inhibit soil nitrification, denitrification, and the carbon fixation ability of microorganisms (Kumari et al.,2025).
- Fennel: Azadirachtin, an extract from the Neem tree, acts as a commercial insect growth regulator by disrupting the metamorphosis process from larva to pupa (Almaiy.,2025).
- Wheat: Metsulfuron-methyl, a post-emergence herbicide used for broad-leaf weed control, has been observed to cause temporary reductions in microbial biomass and nitrogen mineralization (Sondhia.,2008).
- Cumin: Imidacloprid is utilized to mimic natural nicotine, serving as a toxin for sucking insects, termites, and soil pests (Mishra .,2020).
- Gram: Emamectin benzoate, a derivative of abamectin, is widely utilized for its chloride channel activation properties (Ahmad et al.,2025) .
- Mustard: Farmers utilize Quinalphos, a synthetic organophosphate acetylcholinesterase inhibitor. Additionally, Sulphur 80% WP is used as a broad-spectrum fungicide and miticide, though its high toxicity to aquatic organisms makes it hazardous near water bodies (Faruk.,2021).
- Isabgol (Psyllium) (Dhadhriyakhurd, Chheelara, Paldi Jodha): Dimethoate is used extensively. As an acetylcholinesterase inhibitor, it affects the central and peripheral nervous systems of pests but also poses risks to human health (Varghese et al.,2018).

In villages such as Janana and Gawaloo, a wide array of chemicals including Mancozeb 75% and Chlorpyrifos are used for diverse crops like mustard and cumin. In Roon and Indokali, Acetamiprid and Profenofos are frequently applied. While a minority of farmers use neem-based biopesticides in cumin cultivation for ecosystem benefits despite moderate yields, the majority prioritize immediate yield increases via synthetic means. The survey uncovered critical concerns regarding the health and safety of the farming community.Most farmers apply pesticides based on "classical knowledge" rather than formal training. This lack of professional guidance has led to hazardous results, including instances of fever, illness, and even death during application. Farmers continue to utilize various pesticides that are officially banned in India.

There is a critical and urgent need for government-led awareness programs and timely surveys. Documenting the status of pesticide use and its adverse side effects is essential to transition toward sustainable agricultural practices and mitigate the potential health and environmental hazards associated with persistent synthetic chemicals.

Funding Declaration:

No funding was received for above work.

Conflict of Interest:

Authors hold no conflict of interest.

Acknowledgement:

The authors would like to express their sincere gratitude to the farmers of the 11 surveyed villages in the Nagaur district—Khajwna, Roon, Indokali, Gawaloo, Janana, Mundwa, Paldi Jodha, Chheelara, Dhadhariya Khurd, Dhadhariya Kalan, and Deswal—for their cooperation and support during the data collection process. We are particularly grateful for the valuable time and practical insights provided by the agricultural households during field observations and interviews, which were essential for the completion of this study.

Author Contributions

- **C.S.** wrote the main manuscript text.
- **S.L.** conducted the field surveys across the 11 villages in the Nagaur district.
- **M.J.** performed the data analysis, provided geographical mapping using Google Earth, and guided the complete research work.
- All authors reviewed and approved the final manuscript.

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