NPRC Journal of Multidisciplinary Research
Volume 2, Issue 9, September, 2025 Pages: 130-142
ISSN: 3059-9148 (Online)
DOI: 10.3126/nprcjmr.v2i9.85177

From Field to Food: Assessing Health Risks from Pesticide Use and Residues in the Nepalese Agri-Food System

Mayanath Ghimire, PhD & PDF
Research Head
Gaurishankar Campus, Nijgadh, Bara, Nepal
mayanathghimire@gmail.com
https://orcid.org/0009-0007-1671-5069

Dasarath Neupane*, PhD & PDF
Research Export
Nepal Philosophical Research Center, Nepal
neupane.dasarath@gmail.com
https://orcid.org/0000-0001-9285-8984

Krishna Prasad Dhital, PhD & PDF
Research Export
Nepal Philosophical Research Center, Nepal
kpdhitalhtd@yahoo.com
https://orcid.org/0000-0001-5717-0156

Corresponding Author*
Received: August 01, 2025 Revised & Accepted: September 28, 2025

Abstract

Background: The widespread and often unsafe use of synthetic pesticides in Nepalese agriculture poses a significant threat to human health, despite its role in boosting crop yields. **Objective:** This review aims to assess the impacts of agricultural pesticide use on the health of rural populations in Nepal. **Methods:** A systematic literature review was conducted, analyzing scientific articles published between 2019 and 2025, sourced from databases like Google Scholar. **Findings:** The study found that Nepalese farmers frequently use highly hazardous pesticides with inadequate safety measures, leading to direct exposure and acute health symptoms (e.g., dizziness, skin irritation). Chronic exposure is linked to severe long-term health consequences, including cancer, neurological disorders, and respiratory illnesses. Pesticide residues in food further extend these risks to consumers. **Conclusion:** Unsafe pesticide practices in Nepal result in serious health repercussions for rural communities,

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underscoring an urgent need for intervention. **Implication:** There is a critical need for stricter pesticide regulations, comprehensive farmer education on Integrated Pest Management (IPM) and safe handling, and a promotion of sustainable agricultural alternatives.

Keywords: Pesticides; Human Health; Nepal; Agriculture; Food Safety; Integrated Pest Management

Introduction

The majority of pesticides are chemicals applied in agriculture to combat weeds, pests, or plant diseases. The chemicals can be "synthetic" or of botanical origin. Synthetic pesticides with a probable harm to human health are the focus of this study.

FAO (1986a) defines a pesticide as any substance or mixture of substances for the purpose of killing, repelling, or preventing any pest or the vectors of animal and human disease. animal disease unwanted species of plant or animal causing harm during, or otherwise interfering with, food, agricultural commodities, wood and wood products, or animal feedstuffs production, processing, storage, transportation, or marketing, or which can be fed to animals to destroy insects, arachnids, or other pests on or within their bodies. The term refers to those compounds which are to be used as a plant growth regulator, defoliant, desiccant, fruit-thinning chemical, or prevention chemical against early drop of fruit, and those chemicals used on the plants pre- or post-harvest to prevent rot during storage transit (WHO, 1990).

By prevention and eradication of harmful organisms on crops, the application of pesticides is essential to govern food production by improved agriculture yield. Pesticides, though, have vast negative impacts on the environment and human health (European commission, 2021).

Pesticides will continue to be utilized in the future since they are used for controlling pests and will continue to be used due to food security and vector control. The majority of the pesticides can injure humans and cause a considerable health impact. Additionally, there is evidence that exposure in childhood or adolescence and parental exposure occurs, which may produce negative effects, enhance the possibility of longer-term effects. Some human illnesses, including Alzheimer's, Parkinson's, amyotrophic lateral sclerosis, asthma, bronchitis, infertility, and birth defects, have been linked with pesticide exposure. Attention deficit hyperactivity disorder, autism, diabetes, obesity, respiratory disease, organ disease, and system failure are some of the diseases that are more likely to develop in individuals exposed to pesticides. a likelihood of the occurrence of a variety of malignancies, which include leukaemia, non-Hodgkin lymphoma (NHL), brain tumours, and malignancies of the breast, prostate, lung, stomach, colorectal, liver, and urinary system bladder. The cell culture is a good model for mimicking human pesticide exposure at the molecular level, which is crucial to the understanding of the threats. The users of pesticides need to be made aware of their risk and safe handling, and they also need to employ personal protective equipment that is effective in minimizing injury to human health (Riaz Shah, 2020).

The area continued to utilize the very dangerous and prohibited pesticides with unsafe methods, and associated health risks were seen. In order to enhance the farmers' Government should give

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first preference to alternative methods and train farmers in the utilization of them and enhance public awareness of chemical pesticide use through awareness and education programs and monitoring of pesticides. Regulations have to be put in place, as well as enhanced collaboration between the farmer and specialists, which can bring about clean production processes and a healthier environment and community (Sapkota, 2025).

Pesticides are a form of substance that is used to destroy or stop the reproduction of a pest. Pesticides are normally applied to suppress weeds and insect pests in cropland and numerous other pests and disease carriers (e.g., rodents, ticks, mosquitoes, mice) in residential, occupational, retail mall, and further, there exist roads. Because the modes of action of pesticides are not species-specific, concerns have been raised about the potential environmental risk due to their exposure in numerous ways such as persistence in food and drinking water. For many years, different forms of pesticides have been used in an effort to guard crops. Pesticides are helpful to the environment. But they also exert significant negative effects on the environment. Overuse of pesticides has the ability to lead to loss of biodiversity. Many aquatic animals, birds, in a bid to survive, they are exposed to dangerous pesticides. Pesticides are ingested into the body by mouth, inhalation, and exposure through skin, and well established to be the causative agent for a variety of diseases like endocrine disruption, reproductive failure, cancer, dermatological diseases, and respiratory disease. Pesticides gained some advantages over humanity in the agricultural, industrial sector, but their toxicity to animals and humans has always been an issue (Vinod Kumar, 2019).

Literature Review

IPM is a multi-layered, integrated approach that incorporates physical controls in combination with attitudinal and animal husbandry practices that between them can contribute to Integrated Pest Management (IPM) is a central component of future Government strategy for crop protection and is now featured in successful strategy important policy statements, such as the 25 Year Environmental Plan, and legislation derived from the European Union Sustainable Use Directive have been transposed. SRUC and ADAS were requested by Defra to carry out a research project to: I) Improve Defra's understanding of what works in IPM by conducting a wide-ranging review of extant data, II) Gather examples of best practice that may help when approaching growers (Adamson, 2020).

Pesticides are chemicals used to kill pests, such as insects, germs, fungi, viruses, and wild animals that present threats to human food and enjoyably living. The term pesticide is defined in the International Code of Conduct on Pesticides Management (ICCPM) as "any substance, or mixture of substances of chemical or biological origin, intended to destroy pests." biological constituents for repelling, killing, or controlling any pest, or regulating plant growth." To make it further clear, insecticides are used for killing different insects, herbicides destroy plants, fungicides and bactericides kill or control fungi, and plant growth regulators causing damage to crops and plant growth regulators are used to alter the stages of growth of crops. Pesticide is a general term for its different forms, e.g., insecticides, fungicides, herbicides/weedicides,

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and plant growth regulators. Due to their harmful impact on human beings and various forms of life, the widespread use of such harmful substances has been identified as a serious public health problem for a long time. (Kumar Dilip, 2024).

The degree and size of the environmental impacts of on-site and off-site pesticide application. Adverse effects on health due to direct or indirect exposure to harmful chemicals; groundwater and surface water contamination through seepage and runoff; spreading of pesticide residues up the food chain to the farm household and urban consumers; increased resistance level of pest populations, the decrease in beneficial insects such as parasites and predators that lower the effectiveness of pesticides and cause infestation by pests; decrease in beneficial insects such as parasites and predators that lower the effectiveness of pesticides and cause infestation by pests; decrease in the microbial population in the soil and water of paddy fields; and the adoption of integrated pest management practices with a goal of lowering pesticide use. which reduce the application of chemical fertilizers without affecting soil fertility. The severity and frequency of each of these effects vary with the types of chemicals, their frequency of application, the amount applied, as well as their persistence (Pingali, 1995).

Chemical agents used in a bid to defend plants against diseases, weeds, and are also extensively used to enhance productivity are known as pesticides. The quality of the cuisine. As would be anticipated, these kinds of pesticides are toxic by interacting with the environment and altering the host material's properties since most of them are farmers do not have any idea of how to handle such chemical substances. Pesticides are absorbed by soil particles, who also lay them in plants and animals. By causing acute process or chronic disease in individuals of all ages through the process of the food chain, which has a wide impact on the environment (Dad, 2022).

To minimize the risks imposed by pesticides on the environment and human health, European nations have established ambitious policy targets. European agriculture can take the initiative. Its contribution towards achieving a lower pesticide-risk future, with multiple advantages for society. There are also risks, expenses, and trade-offs, though, for farmers as well as society (Robert, 2023).

To find out the range of pesticides applied in the three districts of Barak valley (Cachar, Karimganj, and Hailakandi), a survey was conducted in Assam, India. are employed in farming, and the potential effects of the pesticides on farmers' health are discussed. The research revealed that the farmers frequently employ pesticides of different severity levels. ranging from highly dangerous to very dangerous classes such as Organochlorides, Organophosphates, and Carbamates. A variety of disease/physiological disorder signs and symptoms were noted, and the relative risk Further, it was noted that (RR) was high. Decline in the health of the farmers in the area was further worsened by the lack of appropriate safety precautions (Dey, 2013).

One Health strategy within the 2030 Agenda for Sustainable Development framework. They stressed the need to be in a position to be able to access effective antimicrobials as well as safe and appropriate usage. Abuse of use contributes to rising AMR levels, and this has adverse effects on sustainable and productive aquaculture and agriculture. Affects gains in veterinary

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medicine, human health, medicine, food and agricultural production systems and food safety (FAO, 2021).

The impact on the soil biota and the environment of the build-up and complex combination of pesticide residues in soil is poorly studied. Soil health. The sooner safety standards are enacted and incorporated into (soil) legislation, the better the level of living. Additionally, conversion to organic agriculture needs to take into account the mix of residues at the point of transition and for how long they persist in the soil (Violette, 2021).

In the modern world, the areas of agronomy and pesticides are extremely relevant. Pesticides have detrimental impacts on human health, both short-term and long-term. We have done an extensive review of the different types of pesticides, including a complete description of their mode of action, occurrence, and worldwide use. The health effects of cancer inducing by the use of agro-pesticides on human health have been the focus of extensive critique of existing research studies. The extensive application of parathion and malathion in controlling pests shows how a person's profession accounts largely for his/her exposure to these chemicals. Pesticides can cause neurological diseases. Aside from their cancerogenicity (breast cancer, lymphomas, multiple myeloma, etc.), sub lethal effects include reproductive disturbances, respiratory irritations, ecological disruption, and pest resistance development (leukaemia, bladder cancer, etc). Finally, there is a hope of an increasing move to reduce the use of toxic pesticides and the related effects of the risk involved in posing harm to nature and mankind (Oirdi, 2024).

The lowest and unsafe practices of chemical use are common among African farmers whose impact is bringing about serious health and environmental consequences. Three questions are linked to it, these are:

(1) What influences/drives the use of agrochemicals among smallholder farmers in Ghana?

(2) What are the safety or lowest uses of chemicals that can be recognized in the communities?

(3) What are the health consequences of using agrochemicals among smallholder farmers in Ghana? Environmental issues, government policy activities, lack of or costly labour, and inter-farm competition were most responsible for farmers applying agrochemicals. Contemporary agrochemical methods, pesticide use, economic rationale, food security regulation, and politics, the joint concentrations were accessed differently between the countries. The resulting health risk according to the EPA method for all the chemicals was found to be an HQ less than 1, meaning safe consumption. Despite the fact that from the results safe consumption is implied, considering the fact that cucumber is a regular product in diet, its regular consumption might actually impose health risk. The implementation of public education campaigns, and legal regulations (e.g., the EU's Farm to Fork strategy) might drastically reduce the health impacts associated with the application of pesticides. It would be feasible to counteract the human health consequences of agricultural pesticide use worldwide through the enforcement of national and global strategies for the sustainable management of pesticides that aim to phase out poisonous pesticides, provide low-risk alternatives to high-risk crops, and streamline periodic training to improve the performance of pesticide users (Karimi, 2025).

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The United States is facing an unprecedented health crisis. While heart disease, diabetes, and obesity overburden our healthcare system and shorten life spans, Americans boast some of the highest rates of chronic diseases of all developed nations. At the same time, ordinary Americans are regularly exposed to a score of toxic pesticides. There is compelling scientific evidence that our intake of highly chemicalized and ultra-processed food is largely responsible for this healthcare predicament.

As Secretary Kennedy reports, several of the most dangerous pesticides employed in agriculture are "extraordinarily toxic." He has provided testimony to their destruction by claiming that a few of the pesticides were "originally developed by Nazis during World War II for use as a nerve gas." These exceedingly hazardous pesticides justify instant and firm action is needed if we are to treat our healthcare problem. We cannot hope to make America healthy while these pesticides continue to infuse our everyday existence. Again, until we eliminate their presence in our everyday diet (Suckling, 2024).

Pesticides are man-made or naturally derived chemicals used to control a variety of pests. The chemical compounds find application in various activities. Some of the industries include food, forestry, agriculture, and aquaculture. Pesticides show their toxicity in bio systems. The possible applications of pesticides and how pesticides are categorized based on their toxicity and characters, and their adverse effects to natural ecosystems (aquatic and soil), water, and plants (growth, metabolism, genotypic and phenotypic alterations, and effects on plants). Food product preservation, human health (genetic engineering, cancer, allergy, and asthma), and defense mechanisms. Additionally, as one of the sustainable pesticide management measures, we have been at the mention of pesticide application. a green approach that employs microalgae-based bioremediation, phytoremediation, myco-remediation, and bacterial degradation (Pathak VM, 2022).

The public health issues resulting from pesticide contamination of food come to the forefront, but the gaps in pesticide regulations affecting consumer safety are also realized. The research directions and approaches are suggested which would avoid and/or mitigate the unwanted effect of pesticides on the environment and human health. Organophosphates are given special attention. Pesticides, used largely as insecticides in agriculture, veterinary science, and urban environments. Both biotic and abiotic processes of degradation of organophosphate pesticides are explained from the food point of view. From the safety point of view, highlighting inter-related issues and possible future development. As never before in the history of the world, food systems are threatened on an unprecedented scale, there is an urgent need for protecting human health, striving to harmonize pesticide regulation worldwide and enhance food safety practices (Leskovac, 2023).

The unscientific and indiscriminate use of pesticides has marred the present traditional agricultural system of Nepal and Nepalese agriculture is also influenced from its effect to a great extent. Pesticide use being less laborious, less expensive, and easy to use in one hand and excessive import of the pesticides through erstwhile border on the other hand has led to the farmers adopting pesticide based farming methods more and more. The chemical pesticides were introduced in the country in the 1950s. The countrywide average pesticide use is 396gm

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a.i/ha. Hotspot of excessive use of pesticide is the Terai part of the country (995 gm a.i/ha). Vegetables are the most prevalent among pesticides applied to agricultural products (90%). The maximum proportion share of the pesticide out of the total pesticide application is fungicide (49%). Observing the 20 years pesticide import situation from 1997/98 to 2017/18, the result looks outstripping unexpectedly. The rise of pesticide residue in farm produce such as fruits and vegetables is challenging human and animal health in addition to posing burdens to attaining the target to food security and sustainability. According to Parajuli around 50% farmers used fungicide in agricultural crop such as cereals, vegetable in Nepal to protect it from fungus (Parajuli, 2021).

Health risk caused by pesticide is headache (56%), skin irritation (9.38%), eye irritation (6.25%), dizziness (25%), and vomiting (3.12%). According to kafle report used agricultural pesticide impacted human health during the use of pesticide as well (Kafle, 2023).

Statement of Problem

The five percent male were hired to spray pesticides on commercialize vegetables Panchakhal Municipality which is vegetables pocket region of Nepal. Most of them among in Panchakhal Municipality, a vegetable pocket region of Nepal, the five percent male population were hired to spray pesticides on commercialized veggies. Young people were the majority of them engaged in this activity. The majority of the farmers were literate but did not know how to safely apply pesticides. Farming activities engaged almost everyone. Businesses within the study area. In order to increase production, the majority of farmers used chemical pesticides in their vegetable farms to kill the pests. The majority of the purchases agro vets and local shops were among the destinations. The agriculture office and the JTA gave no recommendations. Most farmers had already harvested vegetables the next day. Pesticide spraying. Nine out of every ten farmers received no training in safe handling of pesticides and used no form of personal protection. Farmers who received basic training on correct use of personal protective equipment (PPE). Most of them were unaware of how to dispose of empty pesticide packets or bottles. Few farmers made good personal hygiene a priority following their use of pesticides. Handling of pesticides was poor, and numerous health problems were experienced. In response to the question of what they did with empty pesticide bottles or packets following their use, 78.95% of farmers simply disposed of them. 7.90 percent of farmers buried them, but the remaining 13.15 percent dumped pesticides or rolls of it into trash. Pesticide was not applied by many farmers and through packing materials in open field, it is very dangerous to human and environment (Kafle, 2023).

The majority of farmers in the research area, it was found, are unaware of the health risks to human being presented by the above. Pesticides and consequences of their misuse. Farmers put cloth mask on faces and smoke tobacco to protect themselves. In addition, it It was observed that, subsequent to the application of pesticides, routine farming operations continued in the cultivation fields. Thus, it can be expected that these Women, children, and other farmers will be directly exposed to pesticides. Other diseases and physiological abnormalities with varied symptoms and signs existed. Additionally, there was a considerable relative risk (RR). The

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farmers in the research location were found to be sick, which was The lack of awareness and inability to embrace appropriate preventive measures as it relates to using pesticides only worsened issues (Chaudhari, 2023).

While the majority of the farmers were well aware of trade names, colour labels, prohibited pesticides, waiting time, and danger of misuse of pesticides, very few knew only the specific names of the prohibited pesticides. A very small minority knew about the mode of action of the pesticides. Approximately 40% of the farmers reported health problems with the use of pesticides, including severe symptoms. Dizziness and skin irritation were the effects felt. Only masks and gloves were worn by most farmers when they applied pesticides. Most, 52%, were discovered. Although it was discovered that pesticide application was a main determinant of income in vegetable farms, farmers were clearly spending less on pesticides. Some people are responsible for 40% have health problem to use excessive amount of pesticide application and for their health protection they have adopted safety practices (Baral, 2025).

Nature is harmed by excessive use and misuse of chemical pesticides. Pests develop resistance when at the beginning, broad-spectrum pesticides kill their natural enemies. Because of the resistance of these compounds, there is a pesticide treadmill that requires increasing and sustained use of more toxic and heavier pesticides. These chemicals have adverse effects as well. Impacts on non-target organisms such as humans, animals, plants, and microbes. The pesticide residue results in buildup of residues and pollutes food items. Possible long-term consequences of Cancer, birth defects, fertility issues, and liver, kidney, and nervous system damage are just some of the effects of pesticide applications on the health of human beings. (Dahal, 1994).

Terai region of Nepal is the place where bananas are cultivated commercially and in larger quantities. September to February is the season when there is a more reliable and greater benefit. During winter, in banana-cultivated region of Nepal, pesticides and insecticides are sprayed seven to twenty-four times a day, and Indian products are available at 60–70% lower rates compared to foreign ones. Nijgadh, Banana cultivation is twice as valuable as grain and sugarcane cultivation. Poison ruin soil and reduce yields once they decay. It should be proved after a long time of usage and destruction to human lives as well. The farmers of the Nijgadh area should be informed. Otherwise, time will prove that there are deep-seated issues. Shorty had to experiment with organic production and supply in Nepal's local, regional, and central markets (Ghimire M., 2024).

Objective

To research pesticide used food and its impact on Rural People of Nepal.

Methodology

Articles on the topic were read from Google scholar and considered from 2019 to 2025 published papers. Special referred publication 1990 and 1995 as well. The study used scientific review, and the outcome was combined to respond to the impact of poison use on human health.

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The use of pesticide has an effect on the health of Nepal's rural population. Farmers utilize poison in crops (grains, vegetables, fruits) to promote production. Technician told them not to apply poison. Excessive use of poison has a negative impact on human health. Rigorous archival analysis and strict scrutiny would form a part of the strategies that would be adopted in the scientific review. Subject to the data available, qualitative or quantitative research methods could be appropriate. The evaluation was done systematically by gathering data, research articles, and facts.

Results and Discussion

Findings

Pesticides are typically chemicals applied to agriculture for killing weeds, insects, and plant pathogens. These chemicals can be "synthetic" or they can be botanical. Anything that is a chemical or blend of chemicals that is intended to prevent, kill, or repel any pest, including disease vectors of human or animal disease that are not wanted, is a pesticide.

Apart from agriculture, pesticides are used in a broad variety of non-agricultural applications including construction, gardening and landscaping, and vector management in public health programs.

One of the primary aspects of food production management is to avoid and remove pathogenic organisms from crops, which increases agricultural yield. The promotion of the existence of pesticide residue on agricultural products like vegetables and fruits poses a threat to human health and prevents achieving food security and sustainability.

Pesticides increase the risk of various cancers including leukaemia, non-Hodgkin lymphoma (NHL), brain tumours, and lung, prostate, breast, stomach, and other organ cancers. The urinary bladder, the liver, and the colorectal tract. In addition to their carcinogenicity (breast cancer), pesticides can exert other sublethal effects including neurological disorders, reproductive disorders, respiratory irritations, ecological disturbance, and the induction of pest resistance. Agricultural practitioners habitually utilize pesticides that fall under the high to very dangerous class, e.g., Organochlorides, Organophosphates, and Carbamates. The relative risk indicators and signs and symptoms of ailments or physiological illnesses.

Effective antimicrobials and rational and effective use are essential to successful and sustainable agriculture and aquaculture in 2030 Sustainable Development. The misuse is a driving force behind increasing rates of AMR, which have detrimental effects on the successes that have been achieved in veterinary care, medicine, public health, food, and food safety, and agricultural production systems.

Their possible applications as pesticides, their taxonomy based on their nature and toxicity, and their harmful impact on the environment (soil and aquatic), water, plants (growth, etc.), and other organisms. Metabolism, genotypic and phenotypic alteration, impact on plant defense mechanism), human health (genetic alteration, cancer, allergy, asthma), and food storage.

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Conclusion

The evidence presented in this review leads to the inescapable conclusion that the current paradigm of pesticide use in Nepal is unsustainable and poses a severe threat to public health, particularly in rural communities. The widespread application of highly hazardous pesticides, coupled with a critical lack of safety awareness, proper protective equipment, and safe disposal practices, results in significant and preventable exposure among farmers. This exposure manifests in a dual burden of disease: immediate, acute poisonings with symptoms like dizziness and skin irritation, and long-term, chronic conditions including cancers, neurological disorders, and respiratory ailments. Furthermore, the persistence of pesticide residues in food commodities extends these health risks beyond the farm to the general consumer, directly challenging national goals for food security and safety. The situation is exacerbated by weak regulatory enforcement and a lack of accessible alternatives, trapping farmers in a cycle of chemical dependency that harms both their health and the environment upon which their livelihoods depend.

Recommendations

To address this critical public health and environmental issue, a multi-pronged and coordinated approach is urgently required. The following recommendations are proposed:

1. **Strengthen Policy and Regulatory Frameworks:**
    - **Phase Out Hazardous Pesticides:** Enforce a progressive ban on the import and use of WHO Class Ia and Ib (extremely and highly hazardous) pesticides, prioritizing their replacement with safer, low-risk alternatives.
    - **Harmonize and Enforce Regulations:** Align national pesticide regulations with international standards and significantly strengthen monitoring and enforcement mechanisms at local and national levels to prevent the illegal sale and use of prohibited substances.
2. **Enhance Farmer Education and Capacity Building:**
    - **Implement Large-Scale Training Programs:** Government and non-governmental organizations should collaborate to deliver widespread, practical training for farmers on Integrated Pest Management (IPM), the correct use of Personal Protective Equipment (PPE), safe mixing and application techniques, and proper methods for disposing of empty containers.
    - **Launch Public Awareness Campaigns:** Use mass media and local communication channels to raise awareness among both farmers and the general public about the health risks of pesticides and the benefits of safe practices and organic produce.
3. **Promote the Adoption of Sustainable Agricultural Practices:**
    - **Incentivize Integrated Pest Management (IPM):** Provide technical and financial support to farmers for adopting IPM strategies, which reduce reliance on chemicals by using biological control, crop rotation, and other ecological methods.

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- **Support the Transition to Organic Farming:** Establish and promote market linkages, certification support, and premium prices for organic products to encourage farmers to shift away from synthetic pesticide-dependent systems.

4. **Improve Health Surveillance and Research:**
   - **Establish a Pesticide Poisoning Surveillance System:** Integrate monitoring of pesticide-related illnesses into the national health management information system to better understand the scale of the problem and inform policy.
   - **Conduct Localized Research:** Fund further research to monitor pesticide residue levels in common food items in Nepalese markets and to assess the long-term health impacts on chronically exposed populations.

Funding Statement: No fund available from any institution
Transparency Statement: We confirm that this study has been conducted with honesty and in full adherence to ethical guidelines.
Data Availability Statement: Authors can provide data.
Conflict of Interest: The authors declare there is no conflicts of interest.
Authors' Contributions: The authors conducted all research activities i.e., concept, data collecting, drafting and final review of manuscript.

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Volume 2, Issue 9, September, 2025 Pages: 130-142
ISSN: 3059-9148 (Online)
DOI: 10.3126/nprcjmr.v2i9.85177

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