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Research Article

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Knowledge, Skills, and Behavior Towards Chemical Pesticide Among Vegetable Growers, Vegetable Sellers, and Consumers of Rupandehi District, Nepal

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Abstract

Pesticides applied on food crops and vegetables not only reduce the pest population but also leave the residue of chemicals that may result in serious health consequences. The study aims to access the knowledge, skill, and behavior towards chemical pesticides among vegetable producers, vegetable sellers, and vegetable consumers of the Rupandehi district. A survey was carried out from November 2018 to January 2019 to know the knowledge, skill, and behaviors towards chemical pesticides among vegetable growers, sellers, and consumers. The household survey was carried out with a well-designed questionnaire among 180 respondents, 60 each of vegetable producers, vegetable sellers, and vegetable consumers using the purposive sampling technique. The present study revealed that knowledge of chemical pesticides and their residue in vegetables, chemical pesticide handling skill, and behavior towards chemical pesticides among vegetable growers, sellers, and consumers was inadequate. The concerned authorities should stretch the extension services regarding pesticide use and post-use precautions to the nook and corners of Nepal as 60% of farmers seek the help of Agrovet for such information and rest either from neighbors or from manual. Sound policy formulation and implementation are necessary for judicious and rational use of chemical pesticides in vegetable crops and promoting non-chemical pest control measures. Such activities might solve pesticide-residue-related issues on the vegetable crop that makes vegetable growers, sellers, and consumers safe. Coordination among concerned organizations/agencies viz farmers group, consumers' association and Government Organization, Non-Government Organization and International Non-Government Organization is necessary to address the issues of chemical pesticide in the vegetable supply chain.

Keywords: Health-hazard, Pre-harvest-interval, Residue, Survey, Waiting period

Introduction:

In recent days the use of pesticides has become necessary for vegetable crop production as it exhibits very quick results, ease in application, and availability. Pesticides are chemicals used for the control or management of insects, rodents, nematodes, etc., and are widely used to represent insecticides, rodenticides, herbicides, fungicides, biocides, and similar chemicals (Hamilton, 2010). Pesticides belong to diverse chemical families, with hundreds of active ingredients, thousands of different formulations, and many other harmful substances which cause adverse health effects. In addition to the active ingredients, other chemicals in pesticides known as 'inerts' could be solvents, surfactants, preservatives, etc. which may contain toxic nature distinct from the active ingredients (Cox & Surgan, 2006).

All the authors declares that there is no any conflict of interest.

There is an increasing trend of pesticide consumption for agricultural purposes. The import status of pesticides recently in Nepal was 169.13 metric tons in the fiscal year 2016 which increased to 216.13 metric tons and 246.14 metric tons in the fiscal year 2017/18 and 2018/19 respectively and in the fiscal year 2019/20 it was 163.38 metric tons (PQPMC, 2077). The majority of the farmers are unaware of the pesticide they are using, their hazard category, basic safety measures, and negative impacts on human health and their environment around (Yassin et al., 2002). Chronic exposure to chemicals leads to extreme notorious causes effects on the immunity, nervous system, respiratory system, endocrine glands, and even reproductive system(Blair et al., 2015). Farmers usually do not follow the pre-harvest interval (phi) i.e., waiting period of pesticides. They simply focus on the level of pest in the field and quite often apply pesticides in the matured vegetables and harvest soon harvesting time, and some even dip vegetables in pesticidal solution before sale to extend the postharvest life of the vegetables (Dahal, 1995). Farmers mostly have incomplete knowledge about pesticide handling and so do the distributors, wholesalers, or importers, who do not regard the concern of the negative impact of these poisons to either humans or the environment (Sharma et al., 2012). Most of the farmers simply are very careless and handle pesticides haphazardly. Some of the studies show that more than 50% of farmers do not use gloves and mix pesticides with their bare hands (Shrestha et al., 2010).

Considering the impacts of pesticide residue on human health and our environment, Nepal Government has banned twenty-four pesticides to date (Khanal et al, 2021). They include Chlordane, DDT, Dieldrin, Endrin, Endosulfan, Phorate, Benomyl, Aldrin, Heptachlor, Mirex, Organo Mercuric Fungicide, Toxaphene, Lindane, BHC, Phosphamidon, Methyl Parathion, Monocrotophos, Carbofuran, Triozophos, Dichlorovus, Carbaryl, Carbosulfan, Dicofol, and Aluminium phosphide (PQPMC, 2077). Even though pesticides impart negative impacts to human health, many farmers do not show concern about it while using pesticides (Sharma et al., 2012).

However, the studies regarding the knowledge and concern of producers, sellers as well as consumers about the hazardous effects of pesticides, are not adequate. Farmers in developing countries use pesticides haphazardly due to ignorance, lack of alternatives, and poor enforcement of laws and policies(Wilson & Wilson, 2000). Farmers possess inadequate knowledge about pesticides and their application and other necessary precautionary measures are also lacking and the enforcement of pesticide regulation is very poor (Shrestha & Neupane, 2002). Therefore, it is necessary to understand knowledge, skill, and behavior towards chemical pesticides among vegetable farmers, vegetable sellers, and consumers. The study was carried out to assess the farmers' practices and awareness of pesticide use, its hazards, and safety measures adopted by various actors of the supply chain.

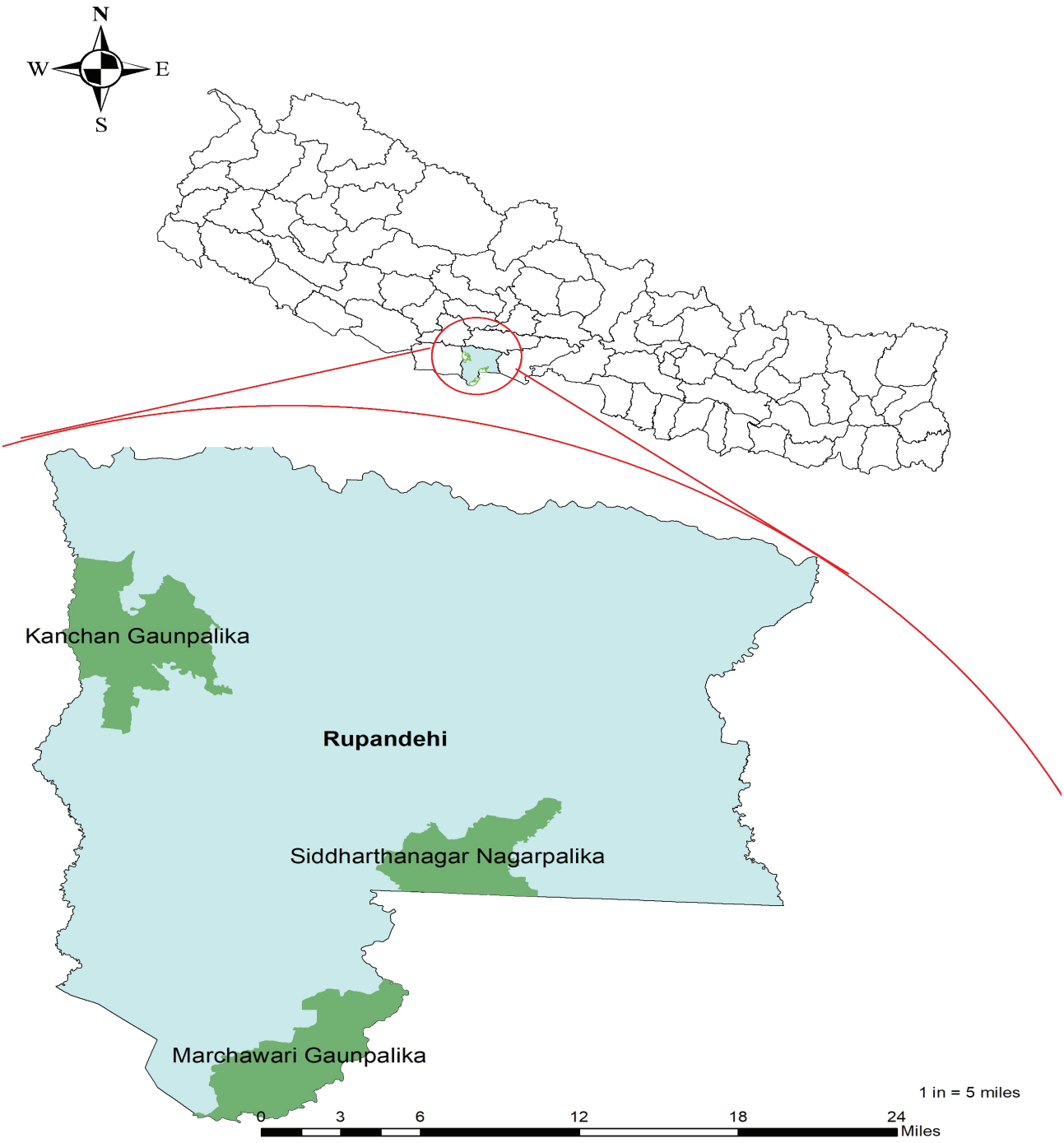
Methodology:

Site selection

The survey was conducted from November 2018 to January 2019 at Siddharthanagar Municipality, Kanchan Rural Municipality, and Marchawar Rural Municipality of Rupandehi district. Rupandehi (latitudes: $27^0$20' 00'' N to $28^0$47'25'' N, longitudes: $83^0$12'16'' E to $83^0$38'16'' E) is one of the high pesticides using district in agriculture (G.C., 2012). Rupandehi is considered as one of the important districts from an agricultural point of view as more than 70% of the population are involved in farming and 58% of the total area is used for agriculture purposes (CBS, 2011).

Sampling procedure

The methodological approach for attaining our objectives was mainly "empirical research" as a considerable amount of information was acquired from the respondents, whereas the supplementary study for cross-validation was required for the study have been collected from the selected respondents, with supplementary information by secondary data, accumulated from e-sources. Primary data were collected from vegetable producers, wholesalers, and consumers using the purposive sampling technique. During the study, 60 producers and 60 consumers were randomly selected and a total of 60 wholesalers were surveyed from the overall district. For the survey, a well-structured questionnaire was developed and pretested on 15 randomly selected respondents and modified accordingly. The respondents used in the pre-testing were not included in the final data.



GIS map representing the study area

Data Processing and analysis

Both qualitative and quantitative data were obtained from the survey. The information obtained was tabulated and analyzed using Ms. Excel 2013. The collected data were mostly subjected to descriptive analysis using graphical representation tools. For measuring qualitative data like concern on pesticide residue, a three-point scale with varying degrees of concern is used.

Results:

Source of information regarding pesticide use

Results exhibited that 60% of respondents reported that they receive information on pesticide use and dose from Agrovet (pesticides retailers), 23.3% from neighbors/ friends, and 16.7% follow manual/brochure (guidelines provided with pesticides). Figure 1 shows the source of pesticide use information among farmers. Agrovets play a significant role in disseminating information regarding pesticides. Farmer to farmer flow of information was

found to be significantly more regarding pesticides use as the stats suggest.

The practice of farmers to a waiting period of pesticides

The results revealed that 81% of farmers/producers harvested their vegetables before seven days of pesticide application while 19% harvested after seven days of application (figure 2). Most of the farmers were found to wait for the pre-harvest interval (PHI) to harvest their vegetables which are particularly important for workers' safety and consumers to get safe food. Most of the farmers were simply found to harvest vegetables during their maturity without considering the waiting period of the pesticides.

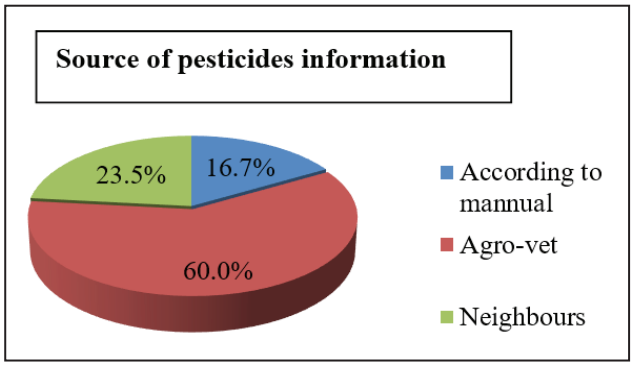


Fig1: Source of pesticides information among vegetable farmers in Rupandehi district, (2018/2019)

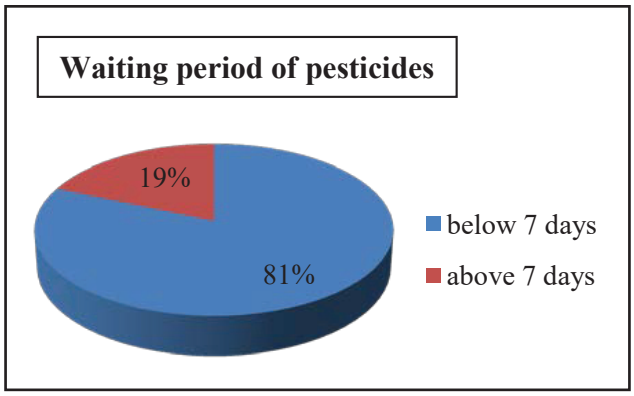


Fig 2: Pre-harvest interval (waiting period) followed by vegetable farmers in Rupandehi district, (2018/2019)

Response of farmers towards the use of safety measures, time of pesticide application, and health risks

Figure 3 shows the time of using pesticides in their vegetable farm in response to plant protection from pests. The pie chart shows that 63.3 percent of farmers sprayed pesticides at evening time whereas 30% of them sprayed at morning time. Only a small percentage of farmers (6.7%) sprayed pesticides during the daytime. Majority of them either spray in the morning or evening.

Most of the farmers (60%) responded that they do not consider safety measures while handling and spraying pesticides. 40% of farmers were found using some safety measures such as covering their face with clothes and masks, wearing boots. Few of them used gloves and some used Personal Protective Equipment (PPE) set while spraying pesticides (figure 4). Amongst those using safety measures, 21.67% were found to use face masks or cloth to cover their face, 10% were found to use masks and gloves both and 5 % used all masks, gloves, and boots. About 3.33% of the total vegetable farmers were found to use PPE set during pesticide use.

Consequently, most farmers (66.7%) stated going through health issues due to pesticides used during application (figure 5). Headache, eye irritation, skin itching, dizziness, restlessness, etc. were observed as common acute problems because of pesticides use. They also stated that they have observed respiratory problems like COPD (Chronic Obstructive Pulmonary Disease), nervous problems, etc. after long-term use of pesticides. Organophosphate insecticide which is commonly used in Nepal inhibits the neurotransmitter acetyl cholinesterase and affects the central and peripheral nervous system in the long run (Nepal Health Research Council, 2016).

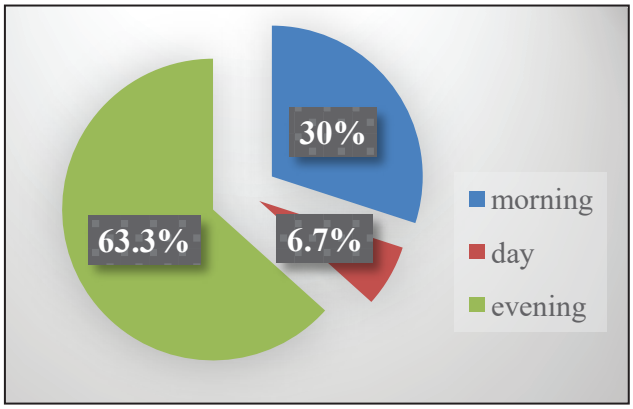


Figure 3: Time of application of pesticides in the field by vegetable growers of Rupandehi district, 2019

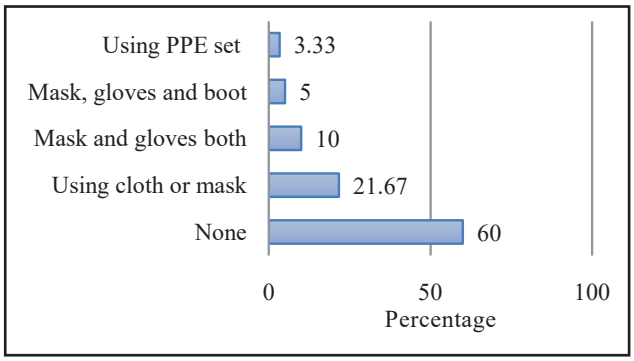


Figure 4: Consideration of safe measures during pesticide application by vegetable farmers of Rupandehi district, 2019

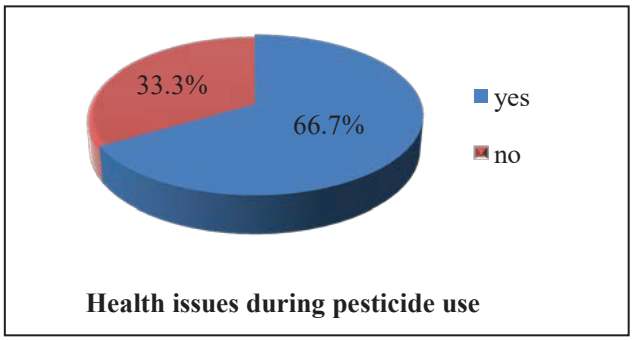


Fig 5: Response of vegetable producers towards health issues due to pesticide application in Rupandehi district, 2019

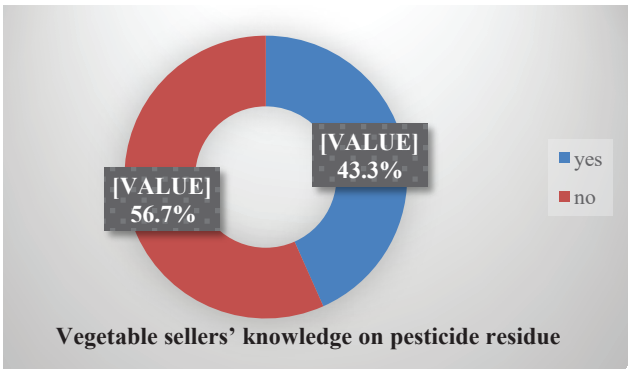


Fig 6: Awareness of vegetable sellers towards pesticides residue in Rupandehi district, 2019

Knowledge and behavior of vegetable sellers and consumers towards pesticide residue

More than half of the sellers (56.7%) reported that they were not concerned about pesticides residue in the vegetable crops they purchase. They didn't even bother asking the farmers about the nature of pesticide used and the time after pesticide application in the vegetables while purchasing vegetables. It indicates the lack of concern among most sellers regarding the safety of consumers (figure 6). Similarly, 35% of the consumers responded they didn't have any idea about pesticides residue and its impact on human health. About 40% of consumers said that they had little concern about chemical pesticides residue, but the farmers were not reluctant on providing such information to them.

Also, most of the consumers (40%) didn't have much concern about the pesticide residue in the vegetables they consume. They believed that it's difficult to differentiate such vegetables from external appearance. Amongst them, 25% of consumers stated higher concern towards the residue of chemical pesticides in vegetable crops during purchase (figure 7). They also stated that they tend to inquire with the sellers and tend to differentiate from the appearance. They rather prefer vegetables with some live pests, that could be removed easily, over those with very neat and bright due to pesticide application. However, 35% of them have no idea about the pesticide residue after application and its hazards to their health.

Figure 8 shows that only 40% of consumers tried some of their knowhow to reduce the potential residue in vegetables at their home before consumption while others (60% respondents) consumed vegetables without doing any intervention specifically to reduce the potential pesticide residue. Mostly they were found to wash vegetables with hot water, dip vegetables in saltwater for 10 - 15 minutes, and overcook fresh vegetables. Most of the respondents reported that they did not have proper ideas about safe methods to avoid pesticide residues in vegetable-related food.

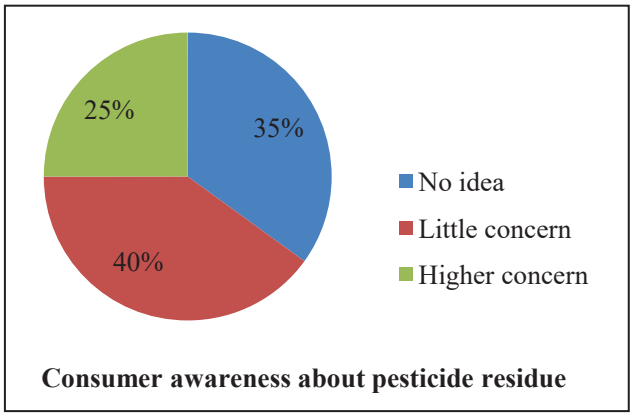


Fig 7: Percentage of consumers aware of pesticide residue in vegetables in Rupandehi district, 2019

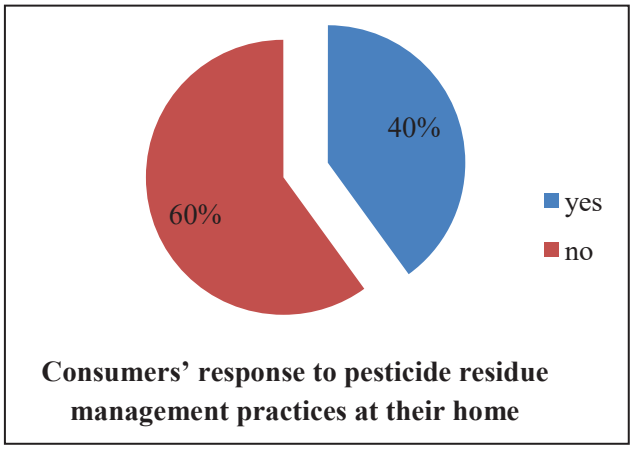


Fig 8: Proportion of consumers following safety measures to reduce pesticide residue in Rupandehi district, 2019

Discussion:

Pesticides are chemicals that are deliberately used to suppress the pest population (Adhikari, 2017). The application of chemical pesticides, on one hand, suppresses pest population, however, on another hand,

creates an unfavorable environment for non-target organisms including natural enemies (Aktar et al., 2009). Knowledge, skill, and behavior towards chemical pesticides among concerned stakeholders are necessary to minimize their unsafe use. Over and underdose, mishandling of chemical pesticides might produce unpredicted results(Abang et al., 2013). The awareness level in the farmer is still not adequate and the efficiency of concerned authorities still needs to be increased. The information on the pesticide use received by the farmer from agrovet cannot be adequate and yet most (60%) of them seem to have acquired information from Agrovet, peer-farmers, and some from the manual which seems to be irrelevant for the uneducated farmers. A study by Rijal et al. (2018) in Chitwan also exhibited that majority (90%) of farmers completely get their technical knowledge regarding pesticide selection, use, and handling from local pesticide sellers (i.e., Agrovets. As the number of technical service providers, government's concern and efforts are increasing on agriculture every year (Adhikari, 2017), the efficiency yet needs to magnify to reach nook and corners where the poor and uneducated farmers exist who rely on sources which are not very authentic and reliable. The farmers deny having received the pesticide use-related information from technical persons/bodies of agriculture.

As farmers are slowly gaining the idea of the effects of pesticides on environment but most of the farmers seemed to have no clear clue on the need to wait after pesticide application and how long it takes to reach a safe level (Atreya, 2007). Some of them tend to wait for as long as they can to let the residue fall within safe limits. However, they were found not to have clear idea that the waiting period of pesticides may vary greatly based on the nature of the pesticides. Even though some knowledge regarding the need to wait, they simply do not hesitate to harvest and sell whenever the demand for vegetable arises. Similarly, Budhathoki et al. (2019) revealed that almost 50% of farmers in Bhaktapur did not follow the rule of waiting period for vegetables they sell. An analogous situation prevails with the vegetable wholesalers, where a majority of them do not have any clue on pesticide residue and a waiting period of the pesticides. Some of them do know need to wait but claim that they have no control over the safe vegetable distribution. The knowledge they have seems to be incomplete as they do not have a clear-cut idea that pesticides have a varying waiting period. Even the consumers have no idea about the pesticide residue as they are quite unaware of the dynamics of pesticides. The only knowledge they have is pesticides pose a potential threat to human health and our ecosystem. Very few of them seem to be genuinely concerned and make a thorough inquiry before purchasing the vegetables(Sharma & Pudasaini, 2021). Some of them regularly purchase with the same trustable sellers to keep themselves on safer side. Those who have an idea on the pesticide residue and vegetables in the market pose potential risk to human health practice some home-based interventions based on their know-how. They practice washing vegetables with hot water, salt solution (Bajwa & Sandhu, 2014)and some belief over cooking may result in a reduction of pesticide residue from vegetables(Clostre et al., 2014).

Most farmers did not handle pesticides considering their safety. This might be due to a lack of awareness on the safe handling of pesticides. Many farmers are risking their lives due to exposure to pesticides. Even though the level of awareness is raising many farmers still do not use any protective measures while handling pesticides. However, some farmers are using masks considering that to be an adequate safety measure to prevent direct pesticide hazards on them. Very few farmers have started covering themselves from top to bottom to keep themselves safe. They have incomplete knowledge on doses of pesticides and are found to less for safety while using pesticides (Bhandari et al., 2019). Mishandling of pesticides such as using the pesticide bottles for alternative uses, transferring pesticide in their owe container for use, and not being able to read the label in the pesticide's bottle can also be a source of exposure (Damalas & Eleftherohorinos, 2011).

Most farmers have observed acute short-term effects of the pesticide application with mild to severe headache, skin problems, irritation in eye and restlessness(Lu et al., 2010) and some complained of having nervous and respiratory problems after long term use(Lee & Choi, 2020). This shows the result of haphazard use of pesticides even though farmers are gaining adequate knowledge that pesticide application can directly wreck their health. If the trend of pesticide use keeps increasing like this more cases of acute and chronic diseases may arise (El-Nahhal et al., 2013). This demands alternative means of pest controls and limiting the growth of the use of pesticides. Organic means of pest control (Crowder et al., 2010) using locally available botanicals(Guleria & Tiku, 2009), Jholmal(Acharya et al., 2020), and other means like using pheromone traps, crop rotation,

introduction and conservation of natural enemies (Dainese et al., 2017).

Regarding the application time, most of the farmers applied either in the morning or in the evening. The best time being either in the evening or morning after the dew dries, farmers' practices were similar. Only a few farmers were applying in the daytime, having no idea about the suitable time for pesticide application. A study by Kafle et al. (2021) at Chitwan showed that more than 71% of the farmers knew on the right time to apply pesticides.

Conclusion:

This study reveals that the farmers are not having access to good extension services regarding pesticide use and about 60% of them receive information on pesticides from Agrovets and the rest from either, neighbors or directly from the manual. As the use of pesticides is increasing at a rapid speed the awareness of the pesticide application and waiting period seem to be on the lagging side. Farmers are getting more and more exposed to the risk of health impairment and to cope that minority (3.33% using PPE) seem to be prepared, 36.67% of are changing their behavior practicing some measures but most of them are still fully in the edge of safety. The result from this most of them is experiencing either acute or chronic side effects. Neither the vegetable sellers nor the consumers seem to have adequate concern over the potential remains of poison in their vegetable diet. Some have them are having clue on what is entering their kitchen and thus are practicing some home remedies to make it safe applying their knowhow. Basic knowledge regarding pesticide residue among vegetable producers, sellers, and consumers seemed extremely poor. The result suggests good policy formulation and their effective implementation to minimize the misuse, improper handling of pesticides which ultimately focuses on the safe use of chemical pesticides among stakeholders including growers, sellers, and consumers. Proper coordination among government and non-governmental organizations, consumers' associations, and farmers' groups are necessary to address the issues of chemical pesticides in the food supply chain. The use of locally available botanical control and organic pest management strategies should be encouraged and promoted to keep the health of every being safe from the notorious effects of pesticides.

Declaration of conflict of interest and ethical approval:

The authors declare no conflict of interest.

ETHICAL APPROVAL/ DECLARATION

Not applicable

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