Chapter

Use of Insecticides in Nepal, Its Impact and Alternatives of Insecticides for Nepalese Farmers

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Abstract

Nepal is an agrarian country whose population is primarily dependent on agriculture but the contribution to national Gross Domestic Product (GDP) is low as expected. There are many constraints to agricultural crop production and the farmers are facing those problems in their day-to-day lives. Deployment of insecticides and others to mitigate various insects and pests is one of them. Although abundant with locally available plant resources for pest management, farmers, especially in commercial pocket areas, are primarily dependent on conventional pesticides and those chemicals have detrimental effects on human health, including various flora, fauna, and environment. Although the Nepal government has formulated an act and worked on that basis, there is plenty of room to work on. Since farmer knowledge and behavior have a positive impact on reducing the use of conventional insecticides and work on alternative measures for pest management, these sorts of programs should be prioritized by the Government of Nepal and its allied agricultural organizations.

Keywords: agrarian, GDP, insecticides, health, act, farmer

1. Introduction

Nepal is an agrarian country and 60.4% of its population is dependent on agriculture and it contributes to 26.8% of national GDP [1, 2]. Commercialization of agriculture is needed to accelerate the economic growth in the country, which is largely subsistence type. Since Nepal has entered World Trade Organization (WTO) as a member country in 2004, it is necessary to exploit the globalized trade for the nation [3]. Most of the people who are engaged in agriculture are rural dwellings and they are the prime driver of the agriculture of the country, Nepal. However, the commercialization of agriculture demands high-value inputs, which are often associated with higher use of improved, and hybrid cultivars, machinery, fertilizers, pesticides, etc.

Pesticides are those chemical substances that are used to control pests of an agricultural and urban setting. These substances include fungicides, insecticides, rodenticides, herbicides, molluscicides, nematicides, miticides, avicides, etc. Insecticides are used for a very long time to deter, minimize, and manage insect pests in an agricultural field, forest land, and in human settlements. In agricultural crop production only, insects and other pests cause around 35% yield decline [4].

The role of insecticides to reduce the insect pests attack on various crops, damage to the health of humans and livestock is crucial. Due to the advantage of the rapid

action of these chemicals over target organisms, these are widely being used all over the world. Nepal could not be an exception regarding the use of chemical insecticides. Insecticides encompass a broad range of chemicals that are toxic not only to insects but also to other organisms. These chemicals often lead to pesticide resistance, the resurgence of insect pests, and the decline of beneficial organisms, along with the detrimental impact on human health and the environment [5]. Unscientific use of pesticides is of major concern to the farmers of the developing countries and Nepal could not be the exception, which further exacerbates the situation.

Phytophagous insects only do the damage to grown crops, on average of 35–40%. Sometimes, it exceeds more than that based on the severity of the pest [6]. Commercial growers mainly depend on various insecticides to get rid of the various insect pests. But, the exact amount of import of these insecticides, their use, and the effect on human health and the environment is of major concern to Nepalese agriculture [7].

2. Material and methods

A rigorous and thorough study was done to collect and synthesize information on the topic of the review. Different research papers, review articles, reports, governmental websites, and their publications were studied and screened for data compilations. Gathered data were coded in the MS-Excel and subsequent tabulation and column graphs were generated.

3. Results and discussion

3.1 History of pesticide use in Nepal

The use of insecticides started in Nepal in early 1950s with intention of control of malaria, especially to eradicate the disease transmitted by mosquitoes for the Gandaki Hydropower Project [8]. First introduced chemicals to Nepal were Paris green, gramaxone, nicotine sulfates, Dichloro-diphenyl –trichloroethane (DDT), and these all were brought from the USA. These chemicals were followed by other organochlorines, organophosphates, carbamates, and synthetic pyrethroids [8, 9]. In the agricultural field, pesticides were started to use in the early sixties. This is the era of the green revolution where farmers were instructed to get maximum yield from a crop by using higher inputs such as improved seeds, chemical fertilizers, pesticides, etc. Until that period, farmers were unaware of the chemicals and insecticides to manage the various insect pests of agricultural crops. At the time, farmers have a preference over broad-spectrum pesticides due to the effective work to knock down the pests [10]. Nepal does not produce any insecticides till now but imported primarily from six countries, that is, India, China, Malaysia, Singapore, Italy, and Japan [3]. Till now, 54 types of insecticides were introduced to Nepal with 14 bio-pesticides, which are depicted in **Tables 1** and **2**. Organochlorines and some other highly toxic chemical pesticides were banned in Nepal, which are shown in **Table 3**. Insecticides were registered in 1787 commercial names by Plant Quarantine and Pesticide Management Center (PQPMC) under the Department of Agriculture, Nepal. In Nepal, there are altogether 16,110 retailers, 5 pesticide formulators, 37 pesticide applicators, and 286 pesticide importers [11]. Traders of pesticides are mainly concentrated in the commercial agricultural areas such as in plain regions, in the valley, and in and around the major cities of the country. Still, pesticide business has not penetrated the mid-hills, hills, and larger rural areas of the country.

S. No.	Insecticide chemical group (in use)	Common names
1	Organophosphate	Acephate, Azamethiphos, Chlorantraniliprole, Chlorpyrifos, Dimethoate, Ethion, Malathion, Phenthoate, Profenofos, Quinalphos, Temephos
2	Carbamates	Propoxur, Thiodicarb
3	Synthetic pyrethroids	Cypermethrin, Permthrin, Alphacypermethrin, Alphamethrin, Bifenthrin, Beta-cyfluthrin, Cyfluthrin, Etofenprox, Fenvalerate, Flumethrin, Lambda Cyhalothrin
4	Nicotinoid	Acetamiprid, Dinotefuran, Imidacloprid, Nitenpyram, Thiacloprid, Thiamethoxam
5	Avermectin	Abamectin, Emamectin benzoate
6	Methyl	Amitrazz
7	Organic thiophosphate	Azamethiphos
8	Nereistoxin analogue	Cartap hydrochloride
9	Halogenated pyrroles	Chlorfenapyr
10	Thioureas	Diafenthiuron
11	Benzoylurea	Diflubenzuron
12	Pyrazole	Fipronil
13	Pyridine compound	Flonicamid, Pymetrozin
14	Diamide	Flubendiamide
15	Isoxazoline	Fluralaner
16	Oxadiazine	Indoxacarb
17	Spinosyns	Spinosad
18	Tetronic acid	Spriomesifen
19	Tetramic acid	Spriotetreamat
20	Insect growth regulator	Novaluron, Lufenuron, Cyromazine, Chlorfluazuron, Buprofezin
21	Dazomet	—

Table 1.
Registered pesticides in Nepal till 14 July, 2020.

In average, consumption of pesticide inactive ingredient is very low, that is, 0.396 kg/ha compared to other countries such as India (0. 481 kg/ha), China (2.0–2.5 kg/ha), Japan (10.8 kg/ha), Europe (1.9 kg/ha) and USA (1.5 kg/ha) [12]. But, in highly commercial agricultural areas have much higher use of pesticides than the national average.

3.2 Trend of insecticide use in Nepal

Since insecticides are imported highly from foreign countries based on higher demand, farmers are using those chemicals in their fields injudiciously. Comparatively use of insecticides and other pesticides used in Nepal are lower than in developed countries, but the real problem is in the commercial pocket areas where growers are using exceedingly higher than they needed. There is a wider perception to the farmers that they have got the only chemical measures to control insect pests. Lack of awareness and knowledge of farmers, lack of alternatives of insect pests' management other than chemicals, lack of governmental regulation

S. No.	Common name	Origin
1	*Azadirachtin*	Neem based
2	*Bacillus amyloliquefaciens D 203*	Bacteria
3	*Bacillus subtilis*	Bacteria
4	*Bacillus thuringiensis*	Bacteria
5	*Pseudomonas fluroscens*	Bacteria
6	*Beauveria bassiana*	Fungus
7	*Metarhizium anisopliae*	Fungus
8	*Verticillium lecanii*	Fungus
9	*Trichoderma viridae*	Fungus
10	*Trichoderma harzianum*	Fungus
11	*Paecilomyces lilacinus*	Fungus
12	*Paecilomyces Spp* (Nematicide)	Fungus
13	*Heterohabditis indica*	Nematode
14	Nuclear polyhedrosis virus	Virus

Table 2.
List of bio-pesticides registered in Nepal.

S. No.	Banned pesticides	Decision year	S. No.	Banned pesticides	Decision year
1	DDT	2001	13	Monocrotophus	2006
2	BHC	2001	14	Methyl Parathion	2006
3	Aldrin	2001	15	Endosulphan	2012
4	Dieldrin	2001	16	Phorate	2015
5	Endrin	2001	17	Carbofuran	2019
6	Heptachlor	2001	18	Dichlorvos	2019
7	Chlordane	2001	19	Triazophos	2019
8	Mirex	2001	20	Carbaryl	2019
9	Phosphamidon	2001	21	Benomyl	2019
10	Organo Murcuric Fungicides	2001	22	Carbosulphan	2019
11	Lindane	2001	23	Dicofol	2019
12	Toxapheone	2001	24	Aluminium Phosphide 56%	2019

Table 3.
Banned pesticides in Nepal.

and monitoring policies and actions for pesticide use are some of the reasons for improper and excessive use of insecticides in Nepal [13]. Insecticide use is reported much higher in vegetables compared to cereal crops and others. Since the vegetable growers are commercial, they tend to use insecticides more often. One study reported that more than 85% of insecticides imported were used in vegetable crops to deter various insect pests and oftentimes farmers are using insecticides even the insects are not at a damaging level. It is reported that a higher concentration of insecticides residues, that is, Cypermethrin than the permissible limit was

detected in tomato and brinjal. The same study also showed that the concentration of Deltamethrin was higher in cowpea and was followed by cauliflower, tomato, and brinjal [14]. The residues of carbamate and organophosphate group of insecticides were observed in the vegetables sampled from the leading vegetable market of Nepal located in the heart of the capital city, Kathmandu. Tomato and cowpea were having higher residues of insecticides and these were grown in the commercial pocket of vegetables of Nepal, that is, Sarlahi and Kavre districts. The same study has revealed that 21.38% of tomato samples and 18.75% of cowpea samples were of sub-standard quality among the samples which were tested positive in pesticide residue analysis using the reagent kit method were [15]. The trend of insecticide use is increasing in Nepal by 10–20% per year and this signifies the prevailing crisis of Nepalese agriculture not only in terms of economic losses but also of associated detrimental effects [16].

It is reported that 25% of farmers of plain regions, 9% of mid-hills, and 7% of mountains use pesticides in their fields, and their usage in these ecological zones of Nepal is depicted in **Figure 1** [17]. It is also reported that insecticides application is significantly higher in cotton and tea plantation in Nepal and it is worthwhile to mention that, compared to the cereal crops, use of insecticides and other pesticides is significantly higher in vegetables and other commercial/cash crops, as shown in **Figure 2** [11]. In Kavrepalanchok district, near to the capital city, farmers were using insecticides 1–3 times whereas the same farmers were using 2–15 times in vegetables such as cabbage, potato, tomato, bitter gourd, cucumber, etc. It is even comparable to the share of pesticides in the production of various crops. Wheat has no pesticide application whereas, pesticide application in bitter gourd accounts for an 8.41% share in crop production [18]. Farmers have reported the use of a cocktail spray of insecticides. Some farmers have also malpractice of dipping green vegetables in insecticide solutions such as malathion, mancozeb, etc. for a shiny and fresh look to fetch a good price in the market [12]. Farmers are very unaware and they hardly care for the waiting period to pick their harvest before they take it to the market. And, these products are purchased by the consumer and immediately taken for their food requirement and this makes the case more worsen [15].

Farmers of Nepal are very unaware of pesticide risk and it is the case of the area where people are engaged in conventional agriculture. In one survey conducted in Gaidahawa Rural Municipality of Rupandehi district, about 73% of the vegetable farmers have the practice of reusing the leftover pesticides. In the farmers' field, researchers have reported that farmers have left the pesticide containers and packets in the open field, without thinking about the risk those containers possess [19]. Among the various pesticides reported in the area, chlorpyrifos was with higher concentration, that is, 177 μg/kg from the soil samples collected from three different depths of soil, that is, 0–5 cm, 15–20 cm, and 35–40 cm. DDT although banned in Nepal from 2001, its residues were found at all depths of the soil, which shows its persistent nature in the environment [19, 20]. The DDT mean concentration at 35–40 cm soil depth from the above-mentioned research area was found higher than 10 μg/kg, which is more than the threshold value for the safety of various soil organisms. Other insecticides such as Profenofos and imidacloprid were also found in the soil samples abundantly at different soil samples and found to be toxic to different soil organisms [19].

3.3 Impact of insecticide use

Insecticides can be used in a variety of forms, including liquid, concentrated, powder, dust, particle, aerosol, and fog, to control various insect pests of various crops. Those chemicals sprayed in a crop's field will move and transfer to the

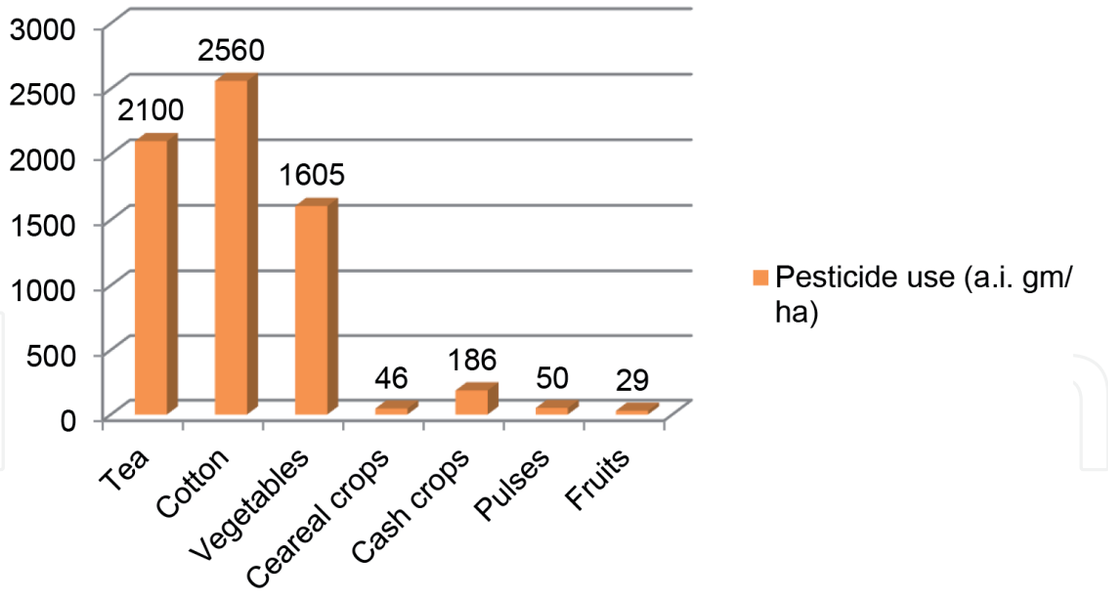

Figure 1.
Crop wise pesticide use (a. i. gm/ha) in Nepal (Source: PQPMC, 2021).

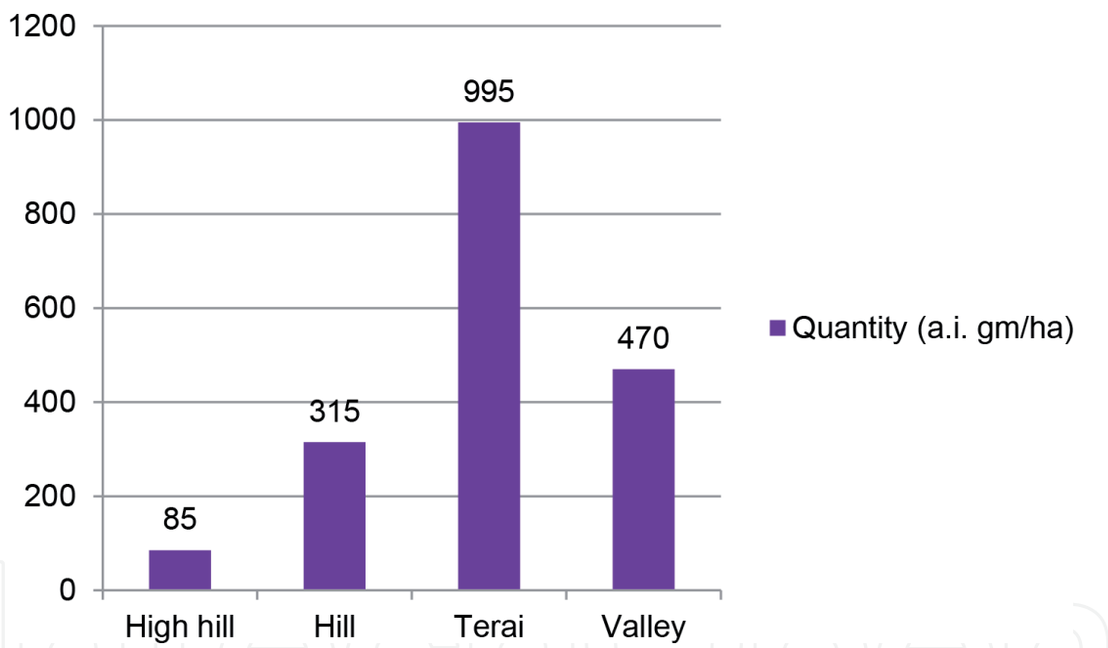

Figure 2.
Ecological scenario of pesticide use in Nepal (Source: PQPMC, 2021).

environment via water, wind, and absorption. It can be transferred to long distances and in various forms. A large part of the most commonly used insecticides do not reach their target insect and may be affecting non-target organisms or polluting the environment. Non-target organisms include not only other insects, but also vertebrates such as wildlife, humans, and domestic animals. Insecticides can enter non-target habitats or ecosystems and affect non-target organisms [20]. Since food is a basic need and the practices of insecticide use do have a greater impact on human health. The most contaminated insecticides group, that is, carbamate and organophosphates are neurotoxic and are acetylcholinesterase inhibitors. These insecticides belong to the toxicity categories I and II. These are categorized under the most dangerous insecticides to the non-target organisms including humans and the environment [21]. These chemical insecticides may have contaminate on the environment such as soil, water (surface and ground), various flora and fauna, etc.

Since the import of pesticides including insecticides is increasing every year. The import of pesticides in the year 2013/14 was 454 tons but now, in the year 2019/20, import has been increased to 681 tons as shown in **Figure 3** [11]. The residues of those chemicals on the soil and water are accumulating every year. One research has highlighted the moderate risk of cancer to the public where the soil is contaminated with organochlorine residues such as DDT and endosulfan [22]. This signifies not only the impending to the human health but also to the rich flora and fauna of the country itself. This sort of unsustainable practices in agriculture could be the cause of the loss of rich fauna which includes 17,097 species [23]. Various biotas inhabiting the soil such as bacteria, fungi, nematodes, earthworms, soil-inhabiting insects, and other arthropods with the presence of other organisms help to maintain the quality of soil and provide major ecosystem services for maintaining soil health and ultimately the quality of food production. The malpractices of insecticides along with other hazardous pesticides could have a detrimental effect on those organisms and ultimately deteriorate the quality and quantity of food production [19]. Another research conducted at Biratnagar of Nepal reported the presence of DDT and endosulfan in soil. The research also suggested that the use of DDT is still ongoing in the region but endosulfan residues were of past use [22].

These insecticides exposure to humans causes detrimental health defects such as hormonal imbalance, immune suppression, lower intelligence, reproductive anomaly, damage on kidney, liver, neural regions, and cancer. Farmworkers who have also exposure to insecticides get the symptoms of headache, drowsiness, dizziness, skin irritation, muscular twitching, respiratory discomfort, etc. [24, 25].

It is reported that the estimated health cost of the pesticide user individual who has got exposure to pesticides is Nepalese Rupee (NPR) 287. Of the total household expenditure, pesticide-induced health costs take 0.2% of annual household expenditure and 10.32% of annual health care expenditure [26].

More than the optimal concentration of insecticides also has unprecedented results human health and their expenditure on health care. One unit increase in insecticide concentration, that is, by 1 ml/L of water, would cause increased

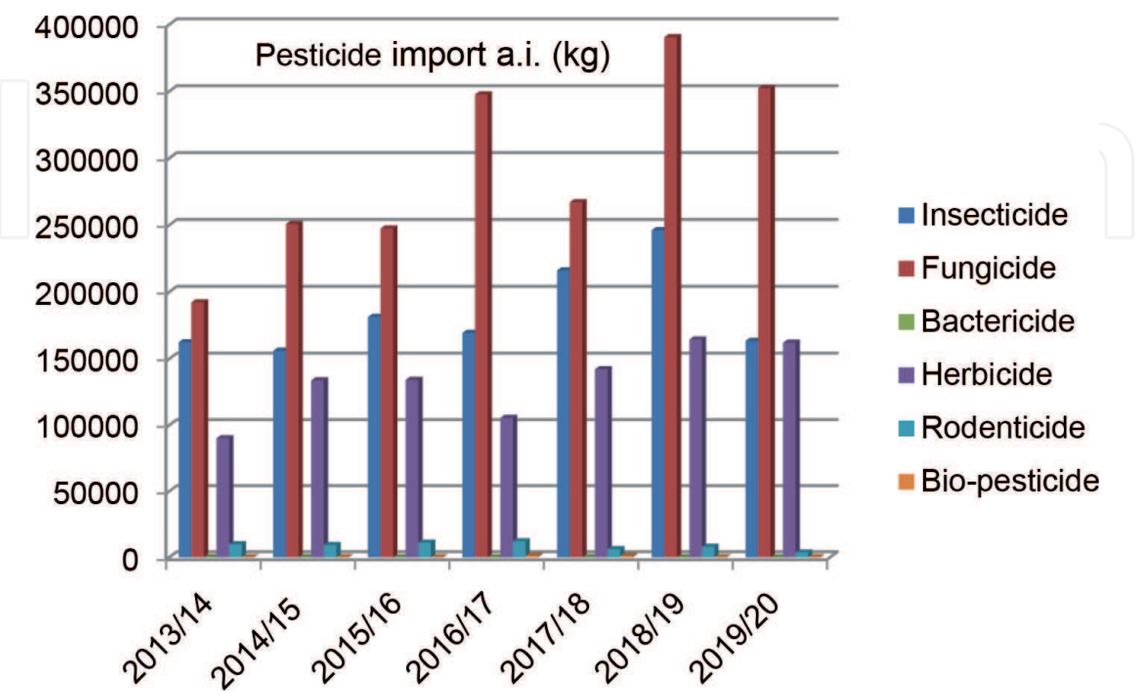

Figure 3.
Scenario of yearly pesticide import into Nepal (Source: PQPMC, 2021).

sickness cases by 6.8% and health costs by nearly NPR 30. Similarly, more hours of insecticide or any other pesticides application would bring unintended results to the health of the farmers and their expenditure [26].

It is also upsetting to mention the intentional or suicidal attempts of pesticide poisoning are common in Nepal. Most of the time, insecticides; mainly organophosphate are used by suicidal attempters. The most commonly used insecticides for self-pesticide poisoning were methyl parathion, dichlorvos, aluminum phosphide, and zinc phosphide [27].

3.4 Lesson learned from other countries

It is speculated that the insecticide reduction will cause a decline in the yield of the crops. But, it is not the case of the countries which are following a reduction in pesticide use because of their focus on the ecology of pests and agro-ecosystem. In that scenario, their production has been affected as speculated. Sweden has reduced pesticide use by 68% and public health poisonings by 77%. Their cutoff to the pesticides did not cause increased crop losses by the various pest species including insects. Indonesia also has reduced pesticide use by 65% and on the contrary, their production of rice has increased by 12%. India is also practicing the same and reducing the use significantly over the past years. But, Nepal is doing the opposite [25]. We are quite increasing the pesticide use for the sake of higher production, but, we are not aware of the fact that we are using unwarranted pesticides. Farmers, the ones who are not trained with the Integrated Pest Management (IPM) practices, are spraying the chemical pesticides more often than the ones who are trained. It is found that the trained farmers are spraying the pesticides 2.7 more times than the optimal whereas; the ones who are not trained are spraying 4.4 times of control [27]. This suggests the need of organizing community-based IPM training and environmental awareness programs about harmful effects of pesticides and sharing the know-how of insect pest management other than chemicals. It is also reported that Nepalese farmers are willing to pay higher prices (53–79%) than the current pesticide costs to mitigate the detrimental effect on their health and environment, and this clearly shows that they are willing to adopt alternative measures of pest management. But, the IPM programs of Nepal do have a contribution to the reduction of pesticide use but do not have a significant contribution to the reduction of health damages associated with the pesticides [25].

3.5 Regulation policy of pesticides in Nepal

For the first time in Nepal's history, the pesticide act was enacted in 1991, regulations were approved in 1993, and pesticide board was formulated in 1994 [18, 28]. Currently, Pesticides Management Act, 2019 was enacted which provisioned registration of bio-pesticides and also included the provision of facilitating warehouses for storing the date expire, band, and obsoleted pesticides in seven provinces of Nepal. It also included the provision of bringing back the pesticides which are spoiled, banned, or obsolete pesticides. It also included the provincial pesticide committee. Punishment was also provisioned in the act and upon defiance of these laws minimum of 25 thousand Nepalese Rupee (NPR) penalty, one-month prison, and maximum 200 thousand NRS penalty, and one-year prison was provisioned. Overall, the pesticide act regulates the manufacture, import, sale, transport, distribution, and use of pesticides in the country. This enabled the registration of pesticides, monitoring and inspection of pesticides, registration of importers and traders, and banning of highly toxic pesticides to minimize the exposure to humans, livestock, and other associated environmental components [29]. But, there is a great scope for proper inaction of law so that the widespread misuse of chemical pesticides in the country either by the importers, traders, and

applicators could be minimized greatly. Since Nepal shares an open border with India, there are unintended pesticide imports to the country and many of them are more toxic, banned, and unregistered. Tracking the trade with India is oftentimes difficult since a porous border gives the opportunity to the persons who are involved in illegal trades.

Nepal is also a signatory country for WHO and follows the rules, regulations, and treaties proposed by them. Recently as directed by WHO, the country has banned 1a and 1b types of extremely hazardous pesticides. As a responsible member, Nepal has signed international treaties like the Basal convention, Stockholm convention, and Rotterdam convention, which have aimed to minimize the use of persistent and toxic pesticides [3].

3.6 Alternatives of conventional insecticides to Nepalese farmers

Since Nepali farmers do not have much more information and knowledge about the methods of pest management other than chemicals. But, the Nepal Government and Department of Agriculture have started to prioritize the IPM program. Integrated Pest Management (IPM) is a pest control strategy that aims to combine various techniques of pest management such as mechanical, physical, cultural, biological, and chemical to minimize the risks possessed by the pest in a given ecosystem [30]. IPM always considers the use of chemicals as a last resort and before using chemicals, it seeks out all the possible alternatives for insect pest management.

Since 1999, the Nepalese government has used the Farmer Field School approach to strengthen farmers for cultivating healthy crops with decisions based on an understanding of the field agroecosystem with having eyes on beneficial organisms such as predators and parasites of insect pests. A Farmer Field School, also known as a school without walls, is a school that teaches basic agroecology and crop management skills. A group of farmers gathers in one of their own fields to observe, discuss, record, and analyze real-world field problems from crop planting to harvest. This field school is based on the concept of "learning by doing" rather than "seeing is believing". The FFS was specially designed for farmers to learn and adopt IPM practices to their diverse and ever-changing ecological conditions [31]. Several crop season-long FFS have been organized in Nepal in recent years to provide knowledge and know-how on IPM to vegetable farmers in the hope of reducing their use of pesticides [32].

IPM farmer's field schools in the country have positive impacts on the farmers for using a lesser amount of pesticides. This was evident in the Bhaktapur district of the country, which is also well known for commercial vegetable production, and seasonal and off-seasonal vegetables are produced here. As reported, farmers were using a significantly higher amount of pesticides where mean active ingredient (a.i.) of fungicides and insecticides were 2373 and 1963 g respectively and on average use of pesticide use was 2011 g a.i./ha. Among the used pesticides to cruciferous vegetables, the share of insecticides was more, that is, 76% which was followed by fungicides (19%) and unknown were 5%. The participants of IPM farmer's field school had reduced significantly lower amounts of pesticides compared to non-participants. It was reported the 36% lesser amount of pesticides due to the effect of participation of IPM farmer's field school [32]. In another report, pesticide application by the farmers was decreased by 40% upon participation in farmer's field school [33]. This obviously shows the importance of these programs organized by governmental institutions.

Bio-pesticide could be a viable alternatives for Nepalese farmers since it will not be toxic to humans, other organisms, and the environment at large. There are altogether 14 registered bio-pesticides in Nepal which are effective to manage various

insect pests and in some instances, other pests too of various crops. In Nepal, the use of bio-pesticides started commercially roughly after 2000. The share of bio-pesticides in the year 2019/20 is 0.005% of the total quantity of pesticides imported and used. This shows the predominantly higher use of conventional pesticides compared to commercial bio-pesticides. But, the use of locally available plant resources for pest control is a long practiced tradition of the farmers of Nepal. Many plants possess pesticide properties and these are all available all around the country. Three hundred and twenty four species of botanicals are found in Nepal only and among them, 23 species have special importance to the farming community of Nepal. The most common plants used as pesticides are as follows: Neem (*Azadirachta indica*), Garlic (*Allium sativum*), Bojho (*Acorus calamus*), Mint (*Mentha arvensis*), Turmeric (*Curcuma domestica*), Ginger (*Zingiber officinalis*), Marigold (*Tagetus patula*), Tobacco (*Nicotiana tabacum*), Drum-stick (*Moringa oleifera*), Basil (*Ocimum sanctum*), Onion (*Allium sepa*), Sugar apple (*Annonaa squamosa*), Sweet flag (*Acorus calamus*), *Artemesia vulgaris*, Winged prickly ash (*Zanthoxylum armatum*), China berry (*Melia azedarach*), *Urtica dioica*, Malabar nut (*Justicia adhatoda*), Marsh pepper (*Polygonum hydropiper)*, *Euphorbia royaleana*, *Jatropha curcus*, Lantana (*Lantana camara*) and *Vitex nigundo* [34]. Botanical pesticides are easily made with these plant materials with pungency, bitterness, sourness, and repellent and antifeedant properties that make insects unhappy or cause death due to toxicity [3]. These botanicals are being used as a pesticide for a very long time. But, commercial production of these botanicals is missing in Nepal and it offers great scope for Nepalese entrepreneurs. Nepal possesses tremendous scope of developing these plants parts as botanical pesticides.

Although Nepal shares larger scope of isolation of different micro-organisms from the soil of Nepal, it offers only the formulation of two funguses, that is, *Metarhizium anisopliae* and *Trichoderma viridae,* only two isolated till now [3]. In the new pesticide act, the government of Nepal has made it easier to register the bio-pesticides compared to conventional pesticides, and obviously that would have positive impacts in the days to come. Nepal Government also have prioritized and started to give emphasis on organic agriculture since the 10th five-year plan [35], the scope of commercializing the bio-pesticides is certainly the need of the country.

4. Conclusion

Nepal, an agrarian country located in Southeast Asia is going to face unprecedented changes in human health, environment, and ecosystems due to more use of insecticides to deter insect pests in the farmer's field. Large amounts of insecticides are imported from foreign countries. These chemicals certainly have negative impacts on the farming community and the environment at large. The situation seems even worse because of a lack of knowledge and skills related to the safety aspects of the farming community about the use of insecticides and its negative effects not only to the consumers but on them too. Many researches have confirmed the presence of undesirable residues of insecticides in vegetables, fruits, and other agricultural commodities. Incidences of human diseases such as immune dysfunction, kidney failure, cancer, etc. are also increasing in the country which somehow has a direct or indirect relation to the more use of insecticides in the field. Because farmer knowledge and behavior can reduce the ecological risk of pesticides, programs such as IPM training and farmer's field school (FFS), etc. could be determined to change the status quo. Prioritizing the botanicals by the Nepal government and its respective agricultural agencies to the area where there is

no practice of using conventional pesticides has special significance to protect the health of humans, various flora and fauna, and the environment.

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