AN OVERVIEW OF CHEMICAL PESTICIDE IMPORT IN NEPAL

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AN OVERVIEW OF CHEMICAL PESTICIDE IMPORT IN NEPAL

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ABSTRACT

In 2021, this study has attempted to analyze the trend of pesticide importover two decades in Nepal. Secondary data obtained from Plant Quarantine and Pesticide Management Center were analyzed to know the pesticide import trend. The result showed that the import of pesticides was in increasing trend and the average annual increase in import was 30.48 tons (a.i.) over the last twenty-two years. Fungicide had the highest import followed by insecticide, herbicide and these three groups comprised more than 90% of the pesticide import. The importof insecticide, fungicide, herbicide, organophosphate, mix group pesticide was in increasing trend while that of rodenticide, bactericide was in decreasing trend. The import of synthetic pyrethroid, carbamates, and some new groups like nicotinoids had been increasing in recent years. Although the import of chemical pesticides was increasing in huge amount; import of biopesticide also seems to be in increasing trend. The use of pesticide is still low in Nepal as compared to the global average or other countries however, the effects of its use are greater and hazardous which indicates the need for strong policy implementation for the safe import and use of pesticides.

Keywords: Banned-pesticides, hazardous, import, pesticide, trend

INTRODUCTION

Pesticides are substances used by human beings to kill or deter the organisms that threaten our health and wellbeing of pets and livestock or cause damage to crops (Giliomee, 2009). These are any substance or mixture of substances that prevents, destroys or controls any pests, including disease vectors, unwanted plant or animal species, causing harm during production, processing, storage, transport or marketing of food, agricultural commodities, animal feedstuffs or substances that may be administered to animals for the control of insects, arachnids or other pests in or on their bodies (FAO, 1990).

Up until the 1940s inorganic substances such as sodium chlorate, Paris green, lead arsenate, calcium arsenate, ethylene dibromide, or organic chemicals derived from natural sources were widely used in pest control worldwide (EPD, 2004; Sanchez, 2019). The growth in synthetic pesticides accelerated in

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the 1940s with the discovery of the effects of DDT, BHC, aldrin, dieldrin, endrin, chlordane, parathion, captan, and 2,4-D. In the 1950s organophosphates and carbamates were introduced followed by synthetic pyrethroids in the 1970s (Arora, 2018). Throughout most of the 1950s, consumers and most policymakers were not overly concerned about the potential health risks of using pesticides. About two million tons of pesticides were used globally among which 45 % was consumed in Europe followed by 24 % in the USA and the remaining 25 % in the rest of the world (Abhilash and Singh, 2009). In Nepal, during the 1950s DDT was introduced for the malaria eradication program. Later on, other pesticides like Paris green, gramoxone, and nicotine sulfates were imported for the same purposes from the USA (Dahal, 1995). Gradually after some year's organophosphates, organochlorines and carbamates were introduced. To make use of pesticides, various acts were taken into enforcement that includes Pesticide Act 1991, Pesticide Regulation 1994, and enforced from 1994 July 16 (Adhikari, 2008). The Pesticide Management Act 2019 has been enacted to regulate the production, formulation, export, import, storage, sale and purchase, transportation, use and disposal of pesticides to minimize the negative effects to human, animal health and the environment (NPPO, 2020). At present, there are 253 licensed owned pesticide importers, 5 formulators, and 14,849 sellers through agro-vets in Nepal. 3,037 and 172 types of pesticide by trade name and common name respectively have been registered for use while 24 pesticides have been banned under the Pesticide Management Act 2019 till now (AITC, 2021).

METHODOLOGY

The study was based on time series secondary data for twenty-two years that were obtained from Plant Quarantine and Pesticide Management Centre, Lalitpur. It also includes reviews of different journal articles and other kinds of literature. Data were assembled and different line graphs and column graphs were generated.

RESULTS AND DISCUSSION

TOTAL PESTICIDE IMPORTIN NEPAL

Most pesticides used in Nepal are imported from India, some from China and other countries (Winrock International, cited in Kalauni and Joshi, 2019). In comparison to other countries in Asia Pacific Region, the use of chemical pesticides in Nepal is one of the lowest i.e., 0.396 kg (a.i)/ha (PPD, 2014). Pesticide use, however, is higher in vegetable and fruit production and areas having greater access to markets (Jasmine *et al.*, 2008; Sharma, 2014). Also, the survey conducted by the Department of Food Technology and Quality Control indicated that Nepalese people are at alarming threat of pesticides in their diets (Koirala *et al.*, 2009). Pesticide is imported in two forms

formulated or non-formulated. The import quantity in this article indicates total import. The trend line shows an increasing trend of pesticide import with an average annual increase of 30.48 tons (a.i.) over the last twenty-two years as shown in Figure 1. According to the latest estimate in the fiscal year 2018/19, the annual import of pesticide is 809092.9 kg (a.i.) worth of NRs. 95,89,71,910 (US$ 8093956.03) which is increased from 56172 kg (a.i.) in 1997/98, i.e., 14 folds increase in 22 years. One of the reasons behind this may be an increase in vegetable cultivated area by more than 100000 ha in the last eighteen years (AITC, 2021; Gurung *et al*., 2016) as 90% of pesticides [1.6 kg (a.i.)/ha] have been applied on vegetable crops and 0.18 kg (a.i.)/ha on cash crops (PPD, 2014). Also, 27 vegetable zones developed under Prime Minister Agriculture Modernization Project might have amplified the use of pesticides. Chemical pesticides are readily available in the local markets nowadays due to the increase in the number of agrovets. Pesticide resistance, elimination of natural enemies and pest resurgence are also increasing the amount of pesticide applied on crops (Palikhe, 2002). Pesticide import is increasing over decades however, there is fluctuation in import every year. The highest increase in the pesticide import is in the fiscal year 2007/08 by about 165% and the highest decrease is in the year 2009/10 by about 41% as shown in Figure 2. The significant increase in pesticide import is probably due to an increased application because of an increase in area for the cultivation of high-value vegetable crop replacing low-earning cereal crops in a hilly region. Also, it might be related to the increased use in the health sector because of Kalazar, Malaria control program running in 11 districts of Nepal (MOF, 2008). The slow rise or decrease from 2001 for few years is perhaps due to IPM-FFS program running intensively in Nepal.

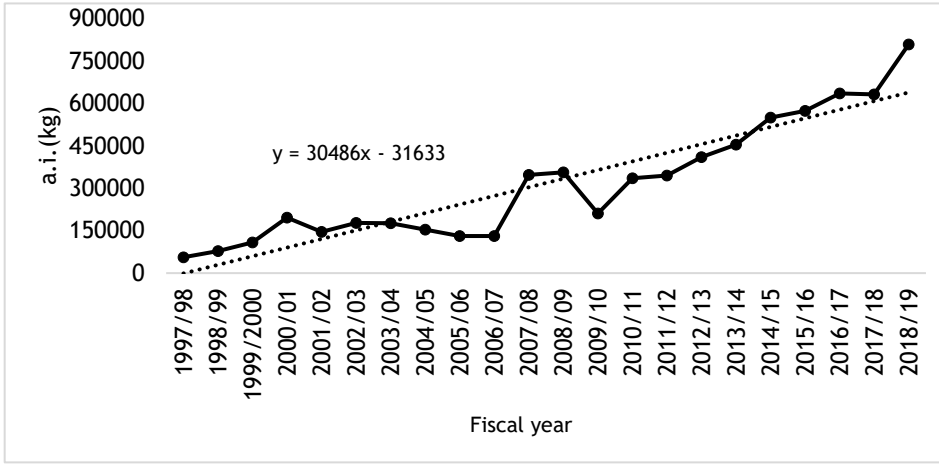

Figure1: Import trend of pesticides over twenty-two years in Nepal.

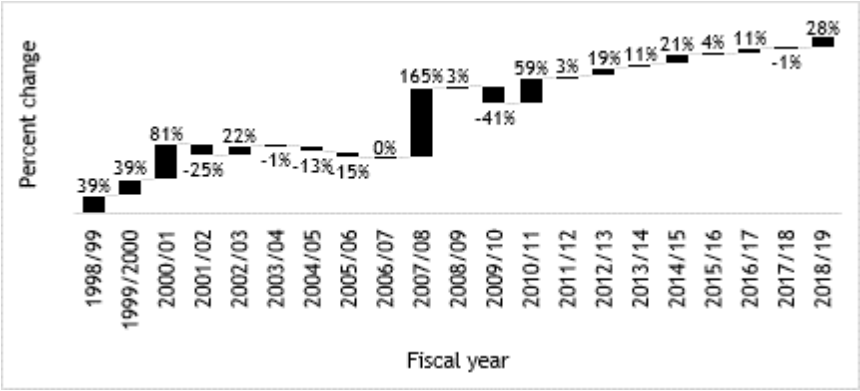

Figure 2: Percent change in pesticide import in Nepal.

IMPORT OF DIFFERENT CATEGORY OF PESTICIDES

The import of insecticides, fungicides and herbicides is in increasing trend with an average annual increase of 13.61 tons (a.i.), 17.95 tons (a.i.), 12.40 tons (a.i.) respectively while that of rodenticide is in decreasing trend with an average annual decrease of 98.51 kg (a.i.) for the last fifteen years as shown in Figure 3. Among different types of pesticides, fungicide has the highest import followed by insecticide, herbicide and rodenticide. In the latest year 2018/19, out of total pesticides imported, insecticide, fungicide, herbicide account for about 30%, 48%, 20% respectively as in Figure 4. According to the latest estimate in the fiscal year 2018/19, the annual import of fungicide, insecticide, herbicide and rodenticide is 390509.81 kg (a.i.), 246025.67 kg (a.i.), 164370.04 kg (a.i.) and 7959.06 kg (a.i.) respectively (PQPMC, 2019). The incidence of fungal disease recorded is higher than that of other disease or insect pest among samples diagnosed in the Plant Pathology Division from the year 2009 to 2018 (NARC, 2018). The import trend of bactericide and pesticides used for public health are in decreasing trend with an average annual decrease of 8.60 kg (a.i.) and 241.47 kg (a.i.) over the last fifteen years. Since 2012/13, the import of pesticides used for public health purposes had been stopped which can be seen in Figure 4. The import of bio-pesticide is in increasing trend over the last fifteen years with the highest increase in the year 2016/17 but with an abrupt decrease in the year 2018/19. The import is 4.29 kg (a.i.) in the year 2004/05 and 19.81 kg (a.i.) in 2018/19. However, the trendline in Figure 5 shows that an average annual increase in bio-pesticide importis 37.86 kg (a.i.).This is due to an increase in farmers' involvement in organic farming (Nandwani *et al.*, 2021). Prioritization of organic agriculture in the national plan since Tenth Five Years Plan and promotion by providing subsidies on organic product certification might have attracted people towards organic farming (NPC, 2002; MOALD, 2018). Also, the establishment of RBPR labs in Nepal and the

test of fresh vegetables for pesticide residue before sale might have encouraged growers to use biopesticides (CAL, 2017). Rise in demand for organic vegetables in urban settlements due to increased knowledge and understanding about the safety of organic produce, awareness about hazardous effects of chemical pesticides, increased buying power, and customers' desire to eat chemical-free foods may have contributed to the increased use of biopesticides on crops (Nandwani *et al.*, 2021). Also, IPM-FFS of the Government and FAO over the years has some role in raising awareness among vegetable growers; pesticide application reduced up to 40% in FFS implemented areas as compared with non-FFS areas (GC, 2011, cited in Kafle *et al.*, 2014). However, higher production cost, existence of market competition and a difficult certification process are some constraints in the adoption of organic farming (Nandwani *et al.*, 2021).

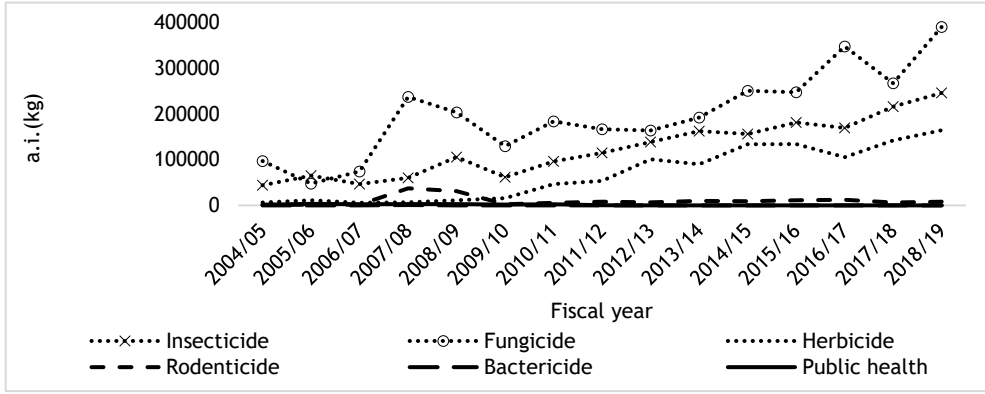

Figure 3: Import trend of different pesticide groups in Nepal.

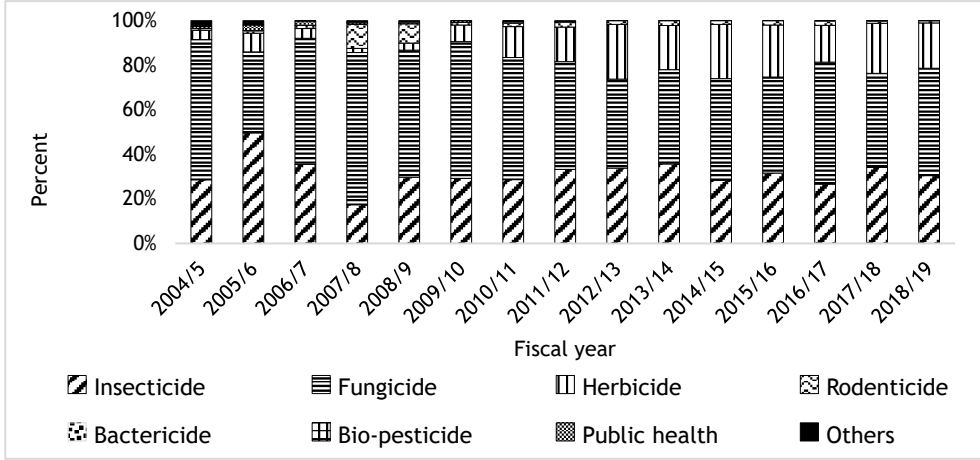

Figure 4: Percent share of different pesticides imported in Nepal

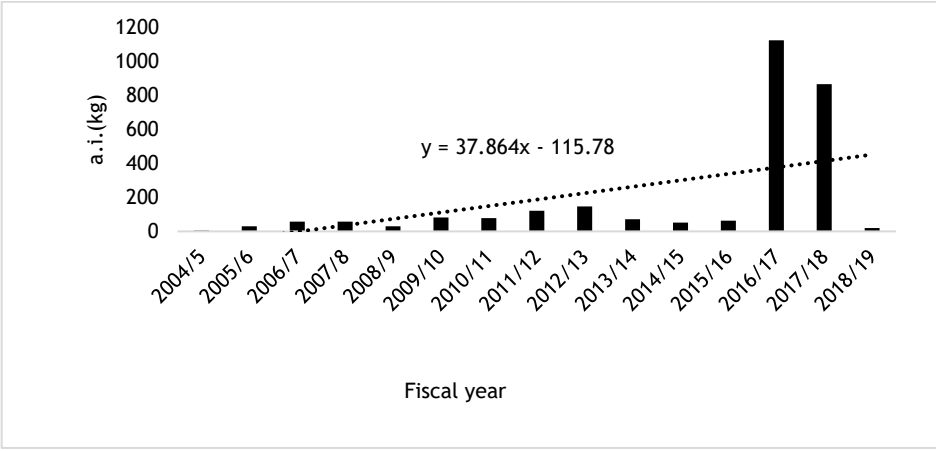

Figure 5: Import trend of bio-pesticides in Nepal.

The import of organophosphate, carbamate and synthetic pyrethroid is in increasing trend with an average annual increase of 2.19 tons (a.i.), 0.23 ton (a.i.) and 0.32 ton (a.i.) respectively whereas the import of organochlorine is in decreasing trend that has been completely stopped since 2012 as most of them are now banned in Nepal. The increase in the import of carbamate and synthetic pyrethroids might be due to their chemical nature. Carbamates can be easily degraded under a natural environment with less environmental pollution. Similarly, synthetic pyrethroids are highly toxic to insects but slightly toxic to mammals and birds. They are considered to be amongst the safest insecticides for use in food crops (Yadav and Devi, 2017). The import of organophosphate was relatively higher in past years but in recent years organophosphate and mix group are major constituents of total pesticide imported in Nepal due to their higher effectiveness which is shown in Figure 6. The import of organophosphate in 2018/19 is 79548.49 kg (a.i.). Mix pesticide group includes pesticide made by mixing two or more active ingredients. For example, a pesticide with the trade name dragon includes a mixture of chlorpyrifos 50% and cypermethrin 5%. Figure 7 shows the increasing trend of pesticide import with an average annual increase of 6.14 tons (a.i.) over the last fifteen years. According to the latest estimate in the year 2018/19, the import of mixed pesticide is 81,799 kg (a.i.). The first abrupt increase is in the year 2010/11 with an annual rise of 9.18 tons (a.i.) while the highest annual increase is in the year 2015/16 i.e., 36.02 tons (a.i.).

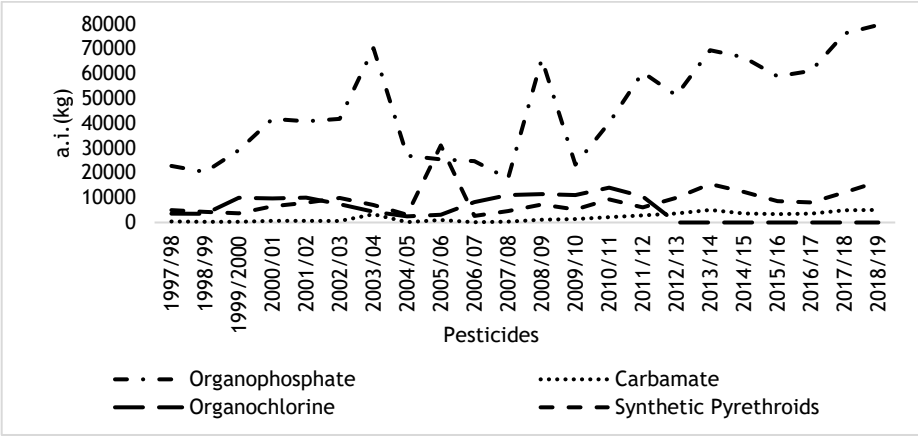

Figure 6: Import trend of different category of pesticides in Nepal.

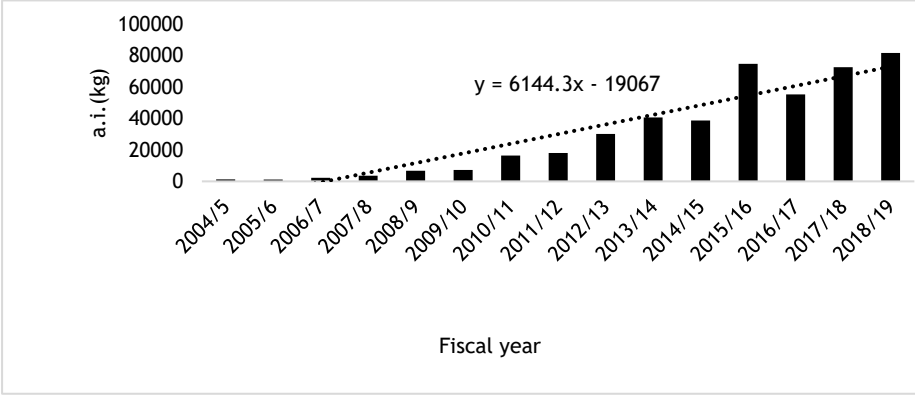

Figure 7: Import trend of mix group of pesticides in Nepal.

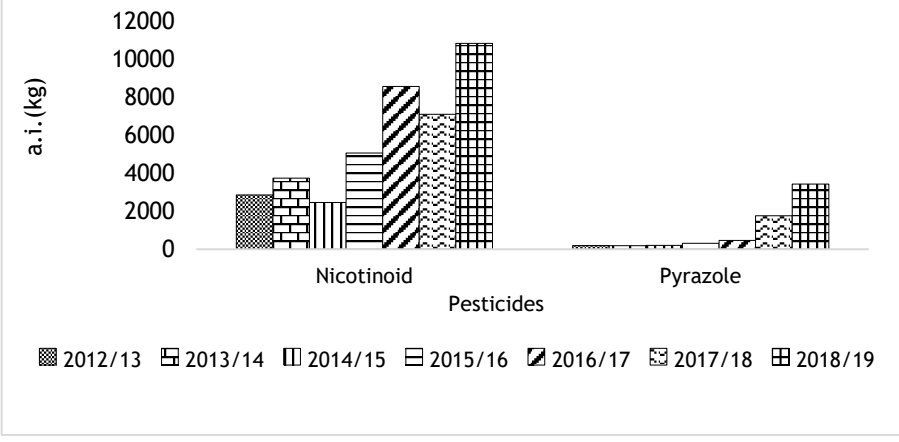

Figure 8: Import trend of some new pesticide groups imported in Nepal.

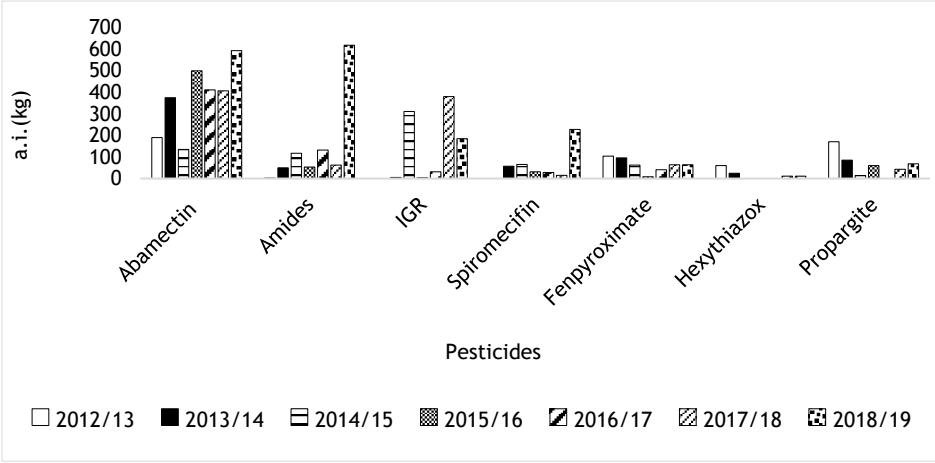

Figure 9: Importtrend of some new pesticide groups imported in Nepal.

Figure 8 shows the increasing trend in the import of nicotinoids and pyrazole in the last seven years. The annual import of nicotinoid and pyrazole in 2018/19 are 10841.21 kg (a.i.) and 3431.5 kg (a.i.) respectively. The importof abamectin, amides, IGR and spiromecifin are in increasing trend while that of fenpyroximate, hexythiazox and propargite is in decreasing trend over the last seven years as shown in Figure 9. The graph shows a higher import of abamectin on average. The annual import in the year 2018/19 of amides, abamectin, spiromecifin, and IGR are 619.32 kg (a.i.), 593.76 kg (a.i.), 227.86 kg (a.i.) and 184.65 kg (a.i) respectively. The import of propargite, fenpyroximate, and hexythiazox decrease from 171 to 68.4 kg (a.i.), 103.75 to 63.5kg (a.i.), and 60.17 to 10.9 kg (a.i) respectively from 2012/13 to 2018/19. These new pesticides are considered relatively safe for most non-target organisms, so their use and import are slowly increasing in recent years. Abamectin neither persists nor accumulates in the environment. It rapidly photolyzes in water, on soil, and both inert and biological surfaces. Its instability, strong binding to the soil, and low water solubility limit its bioavailability and prevent it from entering the aquatic environment (Wislocki *et al.*, 1989). Also, soil microorganisms degrade abamectin (Lasota and Dybas, 1990). Likewise, pyrazole does not accumulate in the abiotic environment, is relatively immobile in soil and has low potential to leach into groundwater (Tingle *et al.*, 2003).

REGISTERED AND BANNED PESTICIDES IN NEPAL

Plant Quarantine and Pesticide Management Centre (PQPMC) implements Pesticide Act/ Regulation for pesticide management in the country. It performs the role of registration, management and regulation of pesticides to minimize haphazard use of pesticides and solve pesticide problems. At

present 3037 pesticides by trade name and 172 pesticides by common name are registered in Nepal which is listed in Table 1.

Table 4: List of registered pesticides in Nepal.

S.N.	Pesticides	Trade Name	Common Name
1	Insecticide	1636	61
2	Fungicide	747	43
3	Herbicide	436	30
4	Biopesticide	113	14
5	Rodenticide	38	2
6	Acaricide	28	6
7	Bactericide	17	1
8	Molluscicide	2	1
9	Nematicide	1	1
10	Herbal	19	13
	Total	3037	172

Source: (AITC, 2021)

After the realization of the impacts of hazardous pesticides on human and the environment, the Government of Nepal first banned twelve pesticides [including 8 Persistent Organic Pollutants (POPs)], mostly organochlorines in 2001 (2057 B.S). These chemicals have low aqueous solubility, low polarity, high lipid solubility, and are volatile and stable, thus increasing their high persistence and bioaccumulation potential (Jayaraj *et al.*, 2016). Exposure to organochlorine pesticide residue is reported as a potential risk factor for type-2 diabetes (Airaksinen *et al.*, 2011), thyroid system (Freire *et al.*, 2011), gallstone disease (Su *et al.*, 2012), hormone-related cancers including breast, prostate, stomach and lung cancer (Wolff *et al.*, 1993) and neurological disorder (Forns *et al.*, 2012). Later in the year 2007, 2012, 2015, 2018 number of pesticides banned were 2, 1, 1, 5 respectively. Recently in August 2019 three pesticides were banned which can be used till 2021/8/4 and have yet to be notified in the Nepal Gazette. At present 24 pesticides are banned in Nepal which is listed below in Table 2.

Table 5: List of banned pesticides in Nepal.

S.N.	Pesticides	Banned Year	S.N.	Pesticides	Banned Year
1	Aldrin*	2001	13	Methyl parathion	2007
2	BHC	2001	14	Monocrotophos	2007
3	Chlordane*	2001	15	Endosulfan*	2012
4	DDT*	2001	16	Phorate	2015
5	Dieldrin*	2001	17	Benomyl	2018
6	Endrin*	2001	18	Carbaryl	2018
7	Heptachlor*	2001	19	Carbofuran	2018
8	Lindane*	2001	20	Dichlorvos	2018
9	Mirex*	2001	21	Triazophos	2018

10	Organo-mercury	2001	22	Aluminium phosphide 3gm tablet	2019 (can be used
11	Phosphamidon	2001	23	Carbosulfan	till
12	Toxaphene*	2001	24	Dicofol*	2021/08/04)

*= *Persistent Organic Pollutants, Source: (PQPMC, 2020)* (Secretariat of the Stockholm Convention Clearing House, 2008), (Stockholm Convention, 2004 with 2013 update)

PESTICIDE CONSUMPTION AND SAFE HANDLING OF PESTICIDE

Approximately 4.11 million tons [2.63 kg (a.i.)/ha] of pesticides was utilized annually worldwide in 2017, where China was a major contributing country, followed by the USA, Brazil, Argentina, and Canada, which is increasing rapidly (Roser, 2019). The use of chemical pesticides per area of cropland in Nepal is low as compared to other countries in the world like France [3.63 kg (a.i.)/ha], New Zealand [7.89 kg (a.i.)/ha], Japan [11.76 kg (a.i.)/ha], Israel [12.61 kg (a.i.)/ha], China [13.07 kg (a.i.]/ha) and Saint Lucia [19.6kg (a.i.)/ha] as shown in Figure 10. Among different types of pesticides consumed (kg/ha) in Nepal, fungicides shared a major part of 60%, followed by insecticide 37% (PPD, 2014). Among the pesticides used across the globe, herbicides had the highest consumption followed by insecticides, fungicides, and others (Roser, 2019). However, in Nepal fungicides are highly consumed by total active ingredient but by total quantity (kg) insecticides share a higher percentage of total consumption (PQPMC, 2019). However, Nepalese farmers are more exposed to pesticides and are at greater risk. Many farmers are still unaware of pesticide handling, pesticide label and hazard level (Atreya *et al.*, 2012). On the basis of ecological domains of Nepal, the pesticide consumption is highest in terai [0.995kg (a.i.)/ha] followed by valley [0.47 kg (a.i.)/ha], mid-hill [0.314kg (a.i.)/ha] and high hill [0.085 kg (a.i.)/ha] (PPD, 2014).Reportshows that the residue analysis of 75 samples (of 13 vegetables), 4% of samples exceed the maximum residue limit (Sharma, 2015). Overdose and frequent application of pesticides on crops have been reported. Many vegetable growers, nearly 50%, apply pesticide5-6 times in a single cropping period (Shrestha *et al.*, 2010). Most of the farmers spray pesticide up to 4 times a month (Khanal and Singh, 2016). A certain category of farmers apply pesticides without proper advice from trained personnel/agrovets and harvest their crops without considering the pre-harvest interval (PHI) or waiting period. They apply pesticides on vegetables near harvesting time and even a day before selling (PPD, 2014). Farmers do not follow safety measures during the handling and application of pesticides. Only 10% of farmers used face mask while handling or spraying pesticides (Atreya *et al.*, 2012). Half of the vegetable growers use their bare hands while mixing pesticides (Shrestha *et al.*, 2010). Farmers have been practicing unsafe disposal of pesticide containers near a water source (Khanal and Singh,

2016). Misuse of pesticides such as sales of expired, banned and counterfeit products have been reported in Nepal (Sharma *et al.*, 2012).

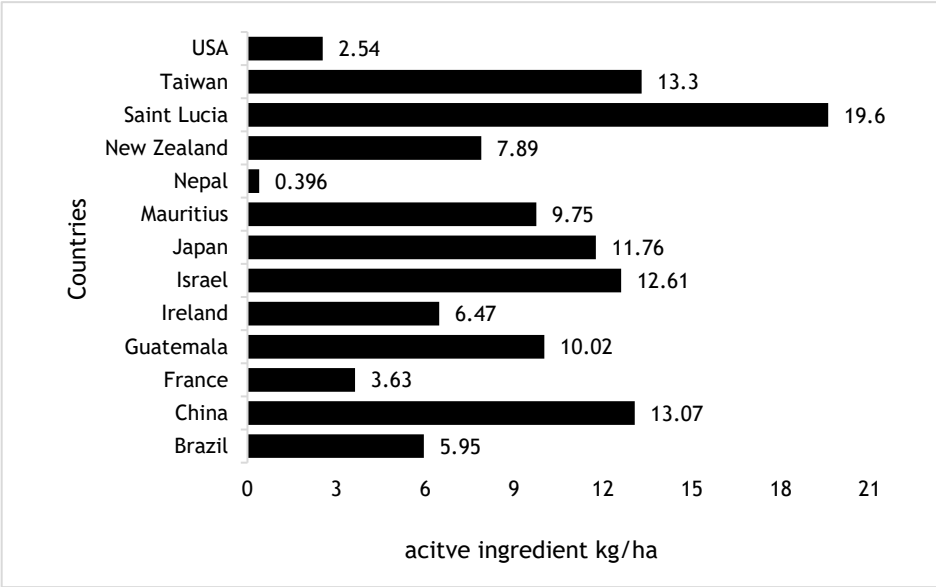

Figure 30: Pesticide consumption pattern.

Source: Roser (2019); PPD (2014)

CONCLUSION

The import of pesticides has been increasing over the decades. Organophosphate and mix group has a major share followed by synthetic pyrethroids and carbamates. Although among 172 registered pesticides, insecticides are the highest in number i.e., 61, fungicide occupies a larger quantity (a.i.) of total import among pesticide groups. In Nepal, pesticide consumption is increasing [396 gm (a.i.)/ha], though it has a low national average as compared to other countries in the world. However, the risks of chemical pesticide are higher in Nepal because of the absence of proper knowledge on their safe handling and application. Awareness campaign on harmful effects of chemical pesticides, training on safe handling of pesticides targeting agrovets, extension workers,farmers and consumers, emphasis on research and extension activity related to IPM techniques, proper implementation of Pesticide Management Act could help minimize injudicious use of pesticides and its hazard on non-targeted organism.

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