The Pharma Innovation Journal 2022; SP-11(8): 246-252

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(8): 246-252

www.thepharmajournal.com
Received: 13-05-2022
Accepted: 17-06-2022

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Awareness about the use of agrochemicals by the farmers in rural areas of Solan (H.P.) India

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Abstract
As per the World Bank, the current rural population of India accounts for 65% and agriculture is the predominant sector in the rural economy. Solan, one of the major vegetable growers, is situated in the South of Northern Hill state of Himachal Pradesh. People residing in rural areas cultivate tomatoes and other vegetables such as peas, capsicum, ginger, etc. In order to get a larger yield from the lesser agrarian land area, farmers use different types of fertilizers and/or manure and pesticides for increasing the yield as well as for the protection of crops. Pesticides are the toxic chemicals used against pests while fertilizers are the agrochemicals used to increase the fertility of soil and productivity. The study was undertaken in rural areas surrounding Solan town to know about common agricultural practices and the use of pesticides and fertilizers by the farmers. We selected 118 rural households at random to generate quantitative and qualitative data on selected parameters and indicators. A questionnaire was designed to gather information. Relevant information was collected from households to evaluate the impact of agrochemical use on the environment, whether chemical farming improved the farmer's economic status and awareness about health hazards caused by their use. We report here that tomato is the main cash crop in the area of study. During this study, 72.88% of the farmers were reported to be small landholders who used pesticides and chemical fertilizers in order to generate more income. Further, 33.89% of the farmers invested 5-10% of the money on pesticides and manure. Most of the agriculturists (94.9%) used pesticides to protect the crops while 63.56% used varied measures to increase soil fertility. Furthermore, 73.73% of the pesticide users used pesticides more than four times per season and 73% reported inorganic farming to be more profitable in comparison to organic farming. Many of the farmers were not aware about disposing of the bags or containers properly as per the manufacturer's instructions, thus affecting the environment. It was revealed that 42.53% of agrochemical users did not use any precautions while applying these chemicals. These results can be used to develop a policy for the safe and effective use of agrochemicals in order to address the low yield problem and to suggest ways and means to minimize adverse effects on human health and the environment.

Keywords: Agriculture, fertilizers, pesticides, health hazard, environment

Introduction
Agriculture plays an important role in the Indian economy. Agricultural land in India was reported about 60.43% in 2018, according to the World Bank [1]. Himachal Pradesh (H.P.) is a northern Hill state of India having a total geographical area of 55-67 lakh hectares with a gross cropped area of about 9.51 lakh hectares [2]. Furthermore, the average land holding size for Himachal Pradesh is 1.04 hectares. Distribution of land holdings in H.P. according to the 2005-06 Agricultural Census shows that 87.03% of the total holdings are of small and marginal farmers. Further, about 12.54% of holdings are owned by semi medium/medium farmers and only 0.43% by large farmers in H.P. Land sown area of Himachal Pradesh has decreased from 19.07% in 1971-72 to 11.81% in 2009-2010 as per the Directorate of Land records, Govt. Of H.P. (2) Solan is one of the twelve districts of Himachal Pradesh and is situated 45 km south of the state capital, Shimla. The district lies between north latitude 30°44'53" to 31°22'01" and east longitude 76°36'10" to 77°15'14". Geographically, Solan has mainly mountainous hilly terrain with sandy loam soils in most of the area. The climate of the district is sub-tropical in the valley and tends to be temperate on the hilltops [3].
India is the largest producer of spices, pulses, milk, tea, etc. while the 2nd largest producer of wheat, rice, fruits and vegetables, sugarcane, cotton, and oilseeds[4]. Further, fruits and vegetables account for nearly 90% of total horticulture production in the country. The livelihood of the rural households in Solan is agriculture. Although the main cereal crops are wheat and maize, however, majority of the farmers are vegetable growers who grow tomatoes, ginger, peas, capsicum, and other seasonal vegetables [5].

The farmers also grow off-seasonal vegetables in the greenhouses. The climatic condition of Solan district is very suitable for growing seasonal and off-season vegetables. In addition to that, the farmers are also into the growing pome and stone fruits. Furthermore, Dr. Y S Parmar University of Horticulture and Forestry, a State University based in Solan is an advantage to the farmers of Solan which organizes time to time orientations/training for the farmers as its extension activities and also makes available seeds/saplings of the varieties of fruits and vegetables.

Due to the small land holdings, the farmers practice the use of agrochemicals to get a better yield. India is the world's 4th largest producer of agrochemicals after the United States, Japan, and China and also is the 13th largest exporter of pesticides globally [4]. Agrochemicals are the chemicals used in the fields to protect the crop and to get a higher yield. Agrochemical is a broad term that includes insecticides, pesticides, weedicides/herbicides, and fungicides. Growth in horticulture and floriculture industries has resulted in increased demand for agrochemicals, especially fungicides. A pesticide has two ingredients: active and inert. The pesticidal action of a pesticide is due to an active part while the inert ingredient is some solvent or adjuvant. At the time of use, the active ingredient is mixed with the inert ingredient as per the instructions given. The use of pesticides also has shown a sharp rise, particularly in vegetable crops Agrochemicals also include the fertilizers that are used to increase agricultural yield. The term fertilizer means a commercial fertilizer known to have one or more known essential plant nutrients. The fertilizers are derived from natural or synthetic materials and sold in solid, liquid, or gaseous forms. All fertilizers are labeled with three numbers (N, P, K) which give the percentage by weight of total nitrogen (N), citrate-soluble phosphorus (expressed as P2O5), and water-soluble potassium (expressed as K2O), respectively [6]. The total fertilizer use, comprising nitrogenous (N), phosphatic (P), and potassic (K) fertilizers, in India increased from 2.65 million tonnes (mt) of NPK in 1971–72 to 28.12 mt in 2010–11 [7]. The optimal level of fertilizer use varies according to soil type, level of yield, crop, and water availability. The level of fertilizer consumption is continuously increasing in the state of H.P. since 1966 and has increased from around 30 kg/ha in1993-94 to around 51.3kg/ha in 2009-10 [2]. Cereals need larger doses of nitrogen per ton of output than the pulses, fruits, and vegetables. Injudicious use of pesticides as well as fertilizers can lead to many harmful effects on our health as well as on the environment. The first report of poisoning due to pesticides in India came from Kerala in 1958 where, over 100 people died after consuming wheat flour contaminated with parathion (PK Gupta,2004) [8]. These pesticides get into the food chain thereby causing a bio magnification effect, hence leading to untoward effects on the biodiversity. Similarly, overuse or disproportionate use of fertilizers leads to degradation of soil quality reducing the organic matter, soil acidification, and harming many useful species. These chemicals also cause water pollution when the farm run-off enters the nearby water bodies imbalancing the ecosystem. Overall, the farmer who is the primary user of these agrochemicals should have knowledge about the effects of agrochemicals on biodiversity, human health, and the environment. Therefore, a study was designed to analyze whether the farmers are using agrochemicals judiciously or they are aware of the harmful effects of these chemicals on health as well as the environment.

Methodology

The study was conducted in District Solan of Himachal Pradesh. About fourteen rural areas surrounding Solan town were selected randomly. The study was so designed to know about the agrochemical practices of the farmers, to find out whether chemical farming increased their economy, their attentiveness while handling the chemicals, and awareness about hazards caused to health and the ecosystem. A total of 118 rural households were selected to generate primary data on selective parameters and indicators. A questionnaire was designed to gather information. Methodology of data collection also included interview schedule as a tool. The respondents were asked about their main source of income, their annual income, cash crop, agrarian land area, monetary input, measures taken to protect/increase the produce, use of agrochemicals, frequency of chemical use, handling of agrochemicals, health hazards, etc. The study areas were Ashani Khad, Basal, Bakhor, Jabalti, Pab, Narag, Nandal, Neri, Wasni, Grani, Jakhet, Harath, Seoli, and Seri. The data was collected by the students (B.Sc. Zoology), PG Govt. Degree College, Solan as a part of their project work assigned by the author.

The data was procured on questionnaire forms which were filled up as per the responses obtained and the respondents were also interviewed personally. The interview schedule helped to gather correct information from the respondents in addition to the answers to the questionnaire. The data was compiled and analyzed statistically. The Chi-square test was applied wherever required.

Results and Discussion

Solan is one of the twelve districts of Himachal Pradesh which lies between north latitude 30°44'53" to 31°22'01" and east longitude 76°36'10" to 77°15'14". Solan is located 45 km south of the state capital, Shimla. District Solan is surrounded by three districts; Shimla, Sirmour, and Bilaspur. District Solan has seven tehsils; Arki, Kandaghat, Nalagarh, Solan, Baddi, Ramshahar, and Kasauli. The total number of villages in Solan tehsil is 478 as per the Census 2011[9-10]. The total of fourteen rural areas (villages) selected for study, fall under Solan Tehsil and lie in the surroundings of Solan town. The students who collected data either resided there or nearby, hence the respondents could be approached easily to conduct the survey. Solan has conducive climate conditions and people of rural areas are fruit and vegetable growers. The cash crop of Solan is tomatoes hence is crowned as the "city of red gold".

During this investigation, it was revealed that the sample of the study had three different income groups: Low-income group (44.19%), middle-income group (44.19%), and high-income group (10.17%) whose income was below one lakh, between one lakh to five lakhs and six lakhs and above per annum respectively (Fig 1a). Most of the farmers belonged to nuclear families. It reveals that the joint family system has degraded down the lane in rural areas also which is further supported by the study that the number of small agricultural landholders was highest that accounted for 77.82% having land holdings less than 10 bighas. Moderate agrarian landholders were reported to be 22.03% with land between 11-40 bighas whereas large landholders having land of 40-60 bighas were reported to be 05.08% (Fig.1b). This result is corroborated by the report of Agricultural Census 2005-2006 that 87.03% of the total holdings are of small and marginal farmers and medium landholder farmers are 0.43% ln H.P. [2].

It was further reported that very large agrarian land holdings (> 60 bighas) were negligible and only two farmers in the sample had very large agricultural land. The study reveals that tomato is the main crop of the area which requires the use of pesticides during different stages of its cultivation. Furthermore, it was recorded that these two variables were interdependent i.e. the agrarian land holdings and annual income were found to be interdependent (Fig1c).

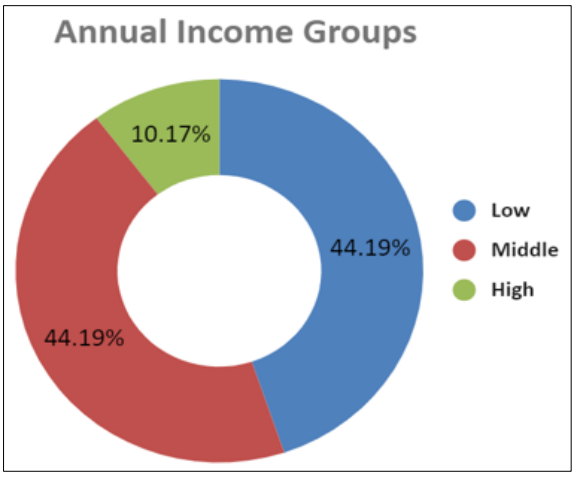

Fig 1a: Percentage of different Annual Income Groups

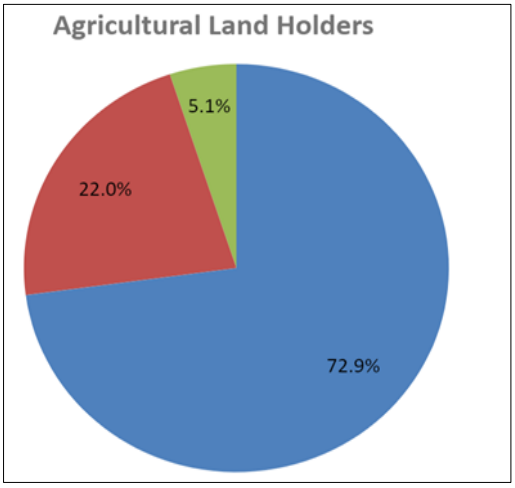

Fig 1b: Percentage of Land Holders

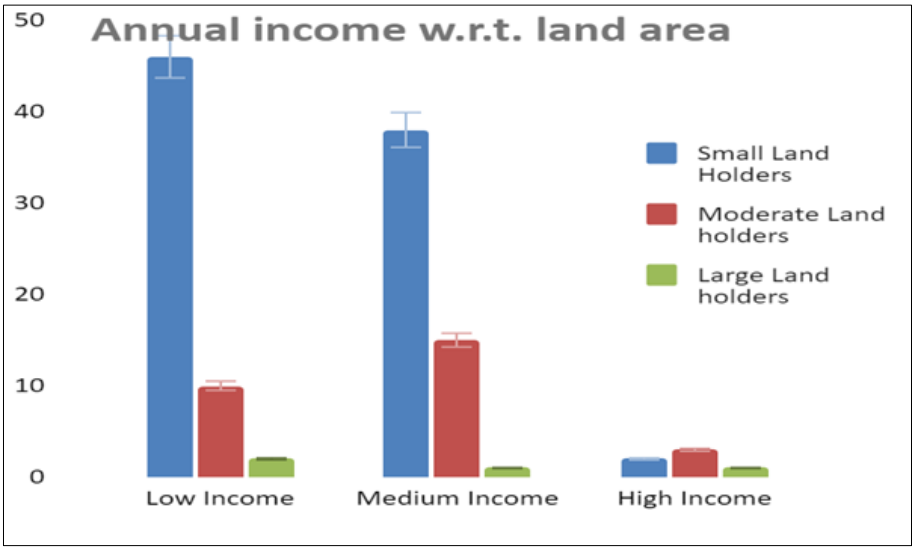

Fig 1c: Interdependence of Annual Income to Land Area (χ^2=8.308, P value=0. 08093 n=118)

The study revealed that less than 5% of the income was spent by 26.27% of farmers on agrochemicals. It was reported that 33.38% of farmers invested 5-10% of their income on pesticides, fertilizers/manure whereas 13.55% and 26.27% of the farmers spent 11-15% and 16-20% of their incomes on pesticides, manure/fertilizers respectively. Investment in

seeds was not reported to be higher. As such the monetary input on seeds by 53.38% of farmers was less than 5% of their income and approximately 11% spent 16-20% of their income on seeds. The Government of H.P. runs many schemes for the welfare of farmers and provides seeds, manure, hail nets, etc. at subsidized rates [11-12] which supports the finding. Similarly, monetary input for labor was also less where 38.28% of the farmers in the study area spent less than 5% of their income for hiring labor (Table 1) which suggests that due to low income, they worked in the fields themselves. Our study is further supported by EDA Pvt. Ltd, 2001[13] who reported that as tomato cultivation is more labor intensive, upper and middle economic categories hire labor but in low economy farmers the family members (men, women, and children) carry out all farm activities.

Table 1: Monetary Input of The Farmers on seeds, Labor and manure & agrochemicals

Monetary input	Below 5% of income		5-10% of income		11-15% of income		16-20% and above	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Seeds	63	53.38%	31	26.27%	11	9.32%	13	11.31%
Labour* *35 spend no money	44	37.28%	16	13.56%	23	19.49%	0	0
Manure, fertilizers, pesticides	31	26.27%	40	33.89%	16	13.55%	31	26.27%

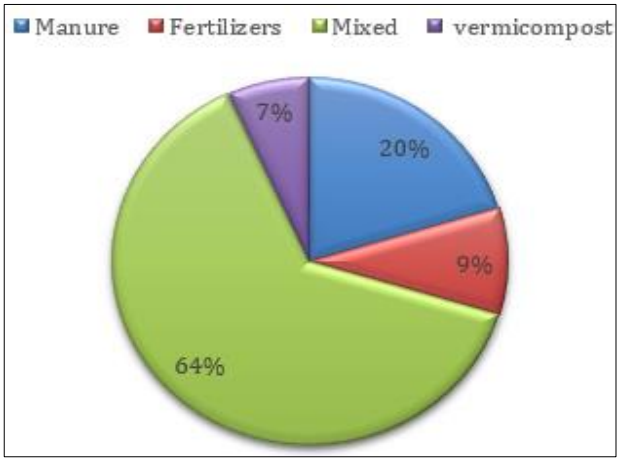

Fig 2a:%age of farmers using different measures to increase soil fertility

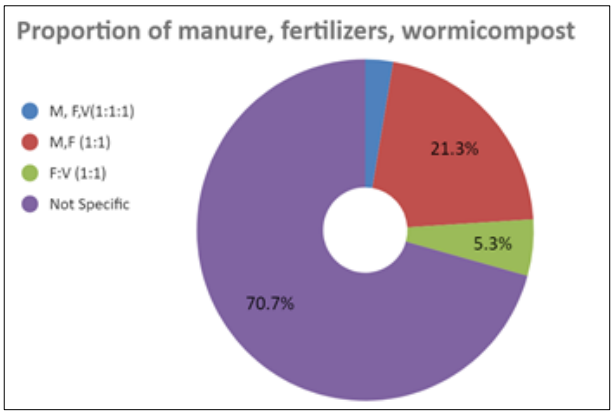

Fig 2b: Farmers using different proportions of manure, fertilizers and vermicompost

During this investigation, it was found out that most of the cultivators were dependent on rainwater for irrigation, however, few reported using surface or groundwater too. The farmers took measures to increase the fertility of the soil in order to get higher yields. The sample under the study area used vermicompost (6.8%), manure (20.3%), and fertilizers (9.3%) while 63.6% used mixed composition (Fig2a). Further, 71% of the farmers who used mixed composition were not putting a specific proportion of the same. However, 5% used fertilizer and vermicompost in the 1:1 ratio, 21% used manure and fertilizer in the 1:1 proportion while 3% used manure, fertilizers, and vermicompost in the 1:1:1 ratio (Fig 2b). Further, 97% of farmers from the study area used pesticides and 62.71% of the growers applied pesticides prior to harvesting (Fig 3a &3b). It was further reported that the frequency of pesticide application and annual income were also interdependent (Fig 3c). The growers falling under the low-income group applied pesticides more than four times per season while the frequency of pesticide application was least in higher-income groups (Fig 3c). This finding of the study is very important as reported here that small agrarian landholders used the pesticides more frequently per season in order to get higher yield yet this practice has not resulted in an increase in their income.

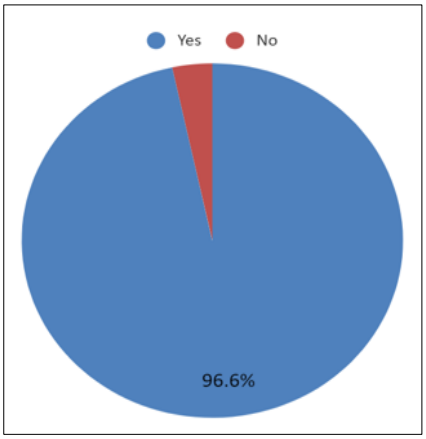

Fig 3a:%age of Farmers using pesticides

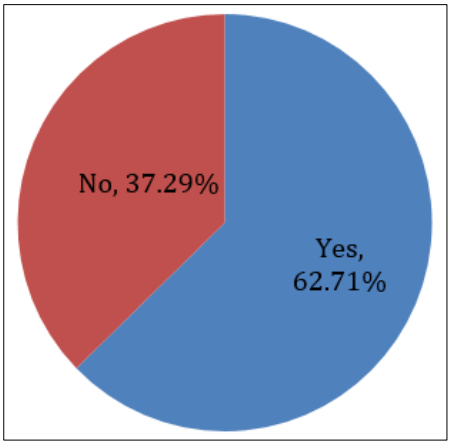

Fig 3b:%age of Farmers applying pesticides pre-harvest

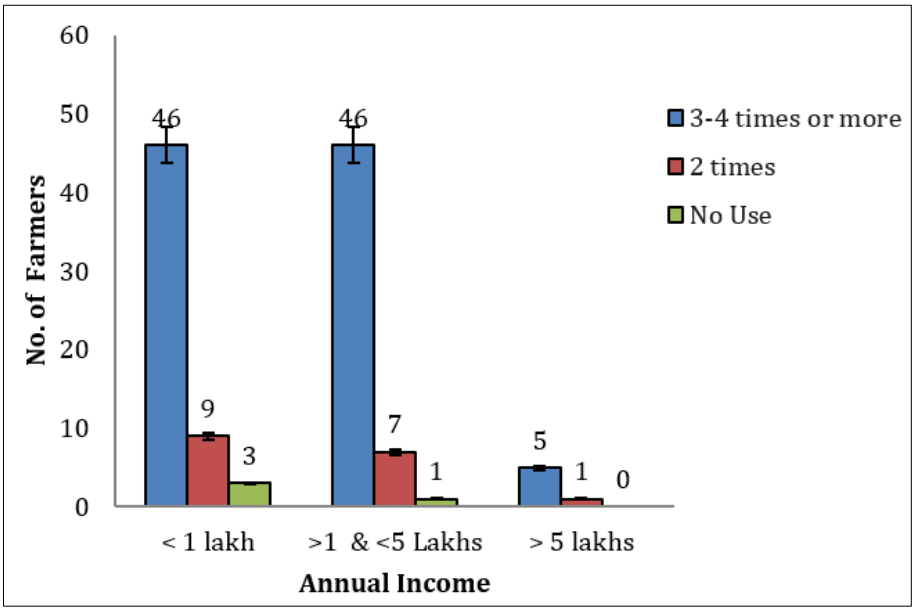

Fig 3c: Frequency of pesticide use w.r.t. annual income (χ^2=1.39, P=0.84576, n=118)

Further, 90% of the growers in the sample were aware of the hazards caused due to pesticide use and above 60% of the farmers applied pesticides before harvesting (Fig 4a & 4b). These results are also supported by the study of Nuegetti *et al.* (2018) who documented that 76.9% of the farmers sprayed pesticides on tomato produce and had seven days for the pre-harvest period [14]. The study is also corroborated by Shashi *et al.* (2016) where 86% of farmers in open fields wait for two days for harvesting capsicum after pesticide application [15]. Using pesticides at a pre-harvesting time can be hazardous for the health of communities at large as the produce after harvest is sold and reaches our kitchens. This kind of practice by the growers clearly indicates that they did not have any knowledge about pesticide residue.

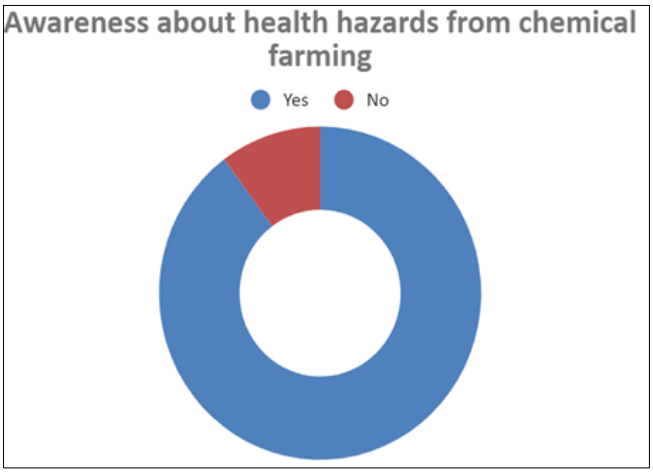

Fig 4a: Awareness about health hazards from chemical farming

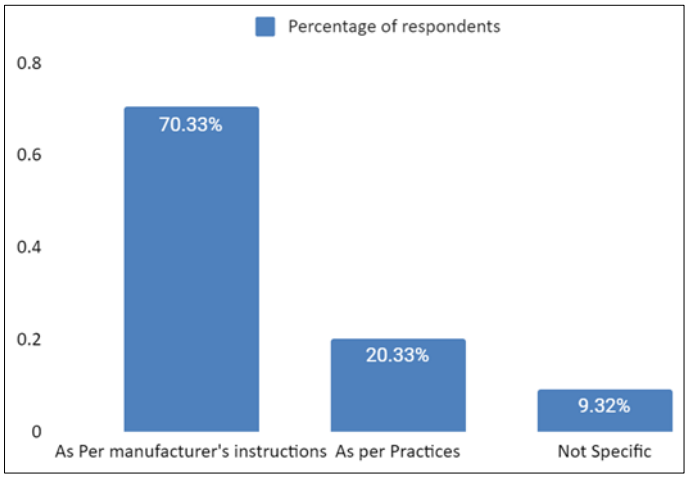

Fig 4b: Mode of use of pesticides

It was found during the investigation that the pesticide dosage used was as per the manufacturer's instructions by 70.33% of farmers, however, 20.33% were using it as per routine practices and 9.23% of the farmers were not specific with regard to the pesticide dose. The percentage of the farmers who did not take any precautions during pesticide application was 37.28% whereas 44.04% of farmers used masks and gloves, 10.16% used masks only, and 8.47% used only gloves (Fig 5a).

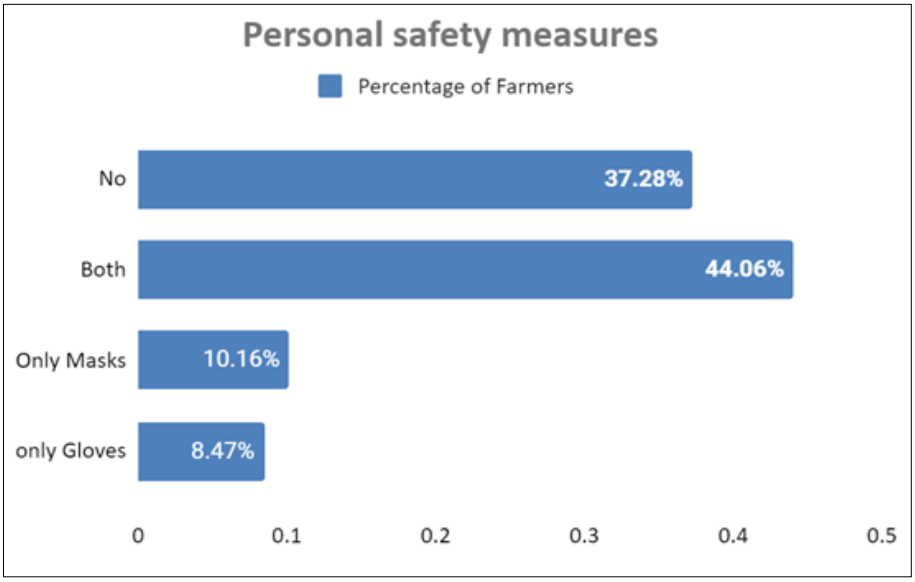

Fig 5a: Safety measures

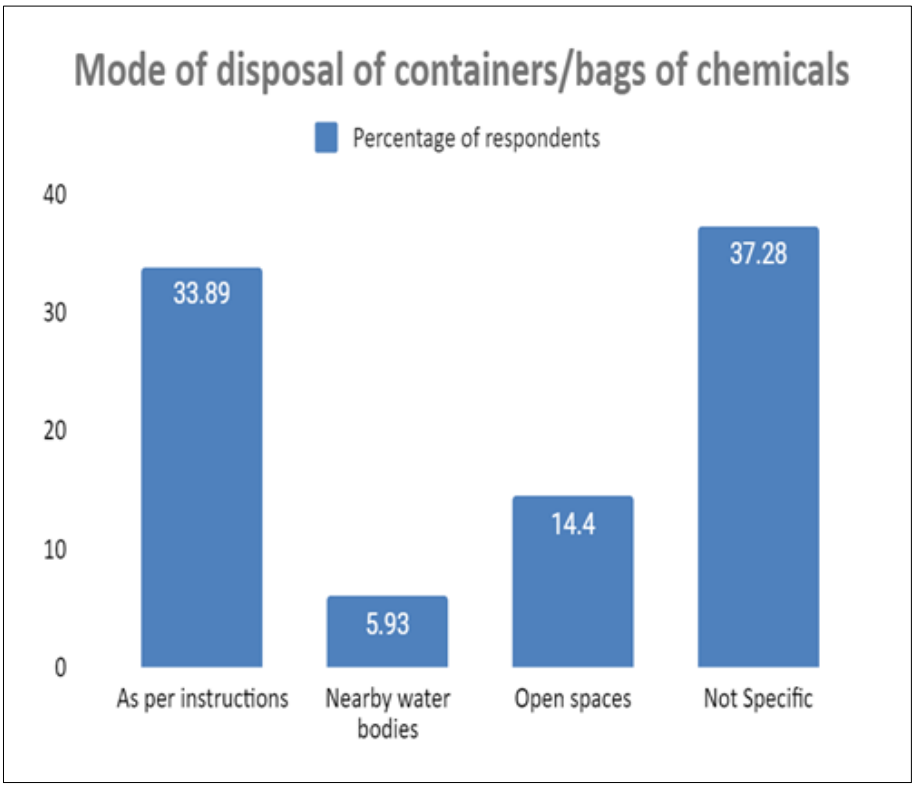

Fig 5b: Mode of disposal of chemical bags/containers

As revealed during the investigation that the maximum number of farmers (97%) were using pesticides in order to protect the crop and hence to earn better monetary benefits. More than 90% of the growers also knew about the harm caused due to the same. The study revealed that 33.89% of the farmers disposed of empty bags/containers as per the manufacturer's instructions whereas 37.28% were not specific about their disposal (Fig 5b). Although 5.13% and 14.4% of the growers disposed of the containers/bags after use in water bodies and open spaces respectively which is alarming. It is interpreted that in order to get more yield, they used the agrochemicals intensively and injudiciously. Lack of proper knowledge, ignorance, and carelessness seems to be the reason. Previously, it was reported by some researchers that the inability to understand the information displayed led to the adoption of practices that in reality increased exposure, risks to human health, and environmental contamination [16]. As such there is no guidance to the people or many may not be

literate enough to read the instructions on the chemical bottles. The usefulness of the agrochemicals goes from one person to another and is spread easily amongst the growers. The information thus passed may be incomplete or distorted leading to such malpractices. As seen in the study, farmers spent the least on the seeds. The Govt of India and the State Government runs a number of schemes that provide subsidies for seeds as well as for other agricultural commodities [11]. There are two types of subsidies for the farmers, direct and indirect. From the observations and results, it seems that the growers are either getting seeds at a cheaper rate from different Departments like Agriculture, Horticulture, Nabard, etc., or they are using their own raised seeds hence spending less on the same. Similarly, for fertilizers and pesticides, the indirect subsidy is made available to the farmers by the sellers, and sellers are paid by the Govt hence that explains their injudicious use.

Conclusion

From this study, it came out that maximum number of farmers belonged to low income group and had small land holdings. Further, main crop of the area was reported to be tomatoes which requires pesticide application many times during a season. Furthermore, the growers get many incentives from the Centre and State Government schemes in terms of subsidized rates for seeds, agrochemicals and many agriculture commodities. Having lesser area, low incomes, lesser knowledge and subsidies play key roles in extensive use of agrochemicals. As such, due to ignorance and lack of interest or careless attitude, the farmers do not follow the protocols of usage which are given in detail on the bottles and bags of the chemicals. It was reported previously that in spite of extensive efforts made by various development agencies including the health department, only 36.04 percent of farmers attended any training course, camp, or workshop pertaining to pesticide poisoning or its safe use in agriculture and allied fields [16]. One out of many amongst the farmers who is literate enough might be conveying the directions. When that information reaches the masses from one to another person, it gets distorted and is incomplete leading to improper use. Excessive use of the agrochemicals, improper handling, and improper disposal may have hazardous consequences on soil quality, water quality, biodiversity, human health, and the environment in the long run if not taken care of well in time.

Acknowledgement

The contribution of the students of Zoology VI SEM, (Govt PG College, Solan) in collecting data is duly acknowledged.

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