



Research Article

Assessment of Pesticide Application Pattern in Major Vegetables of Palpa District, Nepal

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Abstract

This study was conducted to determine the cost contribution of pesticide to total cost of vegetable production along with criteria for the choice of pesticides, its handling and application pattern. It also includes the amount of pesticides imported in 2020 in Palpa district. Fifty farmers and 15 agro-vets were selected for a pretested questionnaire schedule. Microsoft-Excel and Statistical Package for Social Sciences were used to analyze the data. Mean and standard deviation was used to categorize the age of respondents. Contribution of pesticides was 3% to the total cost of vegetable production. Farmers were rarely aware of safe application procedures, 64% used different pesticides based on their efficacy alone and 54% didn't adopt any safe disposal mechanism. Among different chemical classes of pesticide used for vegetable production, organophosphates constitute the highest i.e. 80%. Highest annual consumption of organophosphate pesticide was malathion dust (2287 kg) and carbamate was mancozeb (196 kg).

Introduction

Nepal is an agro based country where agriculture is the major source of earning and livelihood for majority of the people. Farming is integrated and subsistent in nature. Although the economy is dominated by agriculture, its full potential remains unexploited. Out of 41,21,000 hectares of cultivable land in our country, only 30,91,000 hectares are

under cultivation and the remaining 10,30,000 hectares is fallow (Krishi Diary, 2076). Agriculture contributes 27.10% to the country's GDP of which horticulture contributes 15% to AGDP (MOALD, 2019). Extreme variation in physiographic locations and agro-climatic conditions of the country is boon for various crops at

different seasons. Vegetable farming has been widely adopted across the country. Vegetable gardens to meet the requirements of the family is adopted by almost all Nepalese people. Vegetable production has great influence on the improvement of farm economy and enrichment of the diet. So it's healthier production is today's need.

Above 30% of losses in crop have been reported without the use of crop protection measures (Damalas, 2016). Global potential loss due to pests varies among crops i.e. from 50 to 80% (Oerke, 2006). In one side, increasing population has resulted in increased use of agricultural products whereas in the other side losses incurred due to pest infestation have threatened food security. Excess use of pesticide results in accumulation of pesticide residue in leaf/plant (through spray/dust), underground water (through percolation), surface water (through run-off) and environment (through aerosols). To address the growing need of individuals and control the ever-increasing pest population, use of pesticide has been realized in modern agriculture. In such a situation its wise and judicious use is of utmost importance for sustainable agriculture with less damage on non-target species, human health and environment.

There is an increasing trend of pesticide use in developing countries, especially in Southeast Asia. The global market for agrochemicals reached \$243.1 billion in 2019 and should reach \$299.8 billion by 2024, at a compound annual growth rate (CAGR) of 4.3% for the period of 2019-2024 (Global Markets for Agrochemicals, 2020). Major producer, user and exporter of the pesticides in the world is China (Yang, 2007). The Nepal Government's show nine major pesticides groups with seven subgroups of insecticides were imported from the year 1997 to 2003. Pesticides quantity imported and quantity consumed from the 2056/57 (1999) to 2060/061(2003) was highest for fungicides followed by bactericides, acaricides and seed treatment group (Diwakar *et al.*, 2008). According to (Diary, 2019) 21 pesticides were banned in Nepal. They are chlordane, DDT, dieldrin, endrin, aldrin, heptachlor, mirex, toxaphene, BHC, lindane, phosphamidon, organomercuric compound, methylparathion, monocrotophos, endosulphan, phorate, carbofuran, carbaryl, dichlorovus, triaziphus, and benomyl.

Palpa is one of the major vegetables producing districts in mid hill region of Nepal. Agro-climatic conditions favor year-round production of vegetables. Globally, use of pesticide is found higher among vegetable growers. When compared to different countries of Asia pacific regions pesticide use was found to be lowest in Nepal (142a.i. g/ha) (Sharma, 2015). On different ecological belts, quantity consumption is lower in the hills (0.34 a.i. kg /ha) than in the terai and valleys. Potential power of pesticides in controlling pests has led to its tremendous use. Cocktails of

various chemicals are used in order to control pests for increasing yield. Effectiveness is preferred over appropriateness for the choice of pesticides. Little or no attention is paid to the amount used, frequency applied and their hazardous level.

Materials and Methods

Study Area and Sampling Design

Palpa is one of the districts of Lumbini province located in the mid-hill region of Nepal. The head-quarter of Palpa district is Tansen and the district covers an area of 1373 km². It is located in between 27°49'36.48" north latitudes and 83°38'16.44" east longitudes. Its altitude ranges from 157m to 1936m height from the mean sea level. The district has a warm and temperate climate with much less rainfall in winter than in summer. Total cultivated land is 36567 ha. It is linked by Siddhartha Highway to the industrial cities Butwal on the south and Pokhara on the north. Ethnic diversity prevails in the study area. Purposeful selection of the site was done based on area coverage of vegetable production, number of vegetables growing farmers and number of agro-vets. The study was conducted in different wards of Tansen Municipality. Random sampling technique was used to select the samples based on the data obtained from the vegetable zone profile. Fifty vegetables producers were surveyed for collecting the information. In addition to this, 15 traders were also selected to study the import of different types of pesticides and its amount in the study area.

Data Collection and Analysis

Primary data of both farmers and agrochemical dealers was collected through semi-structured interview schedules through face-to-face interview, Focus Group Discussion (FGD) and Key Informants Interview (KII). The questionnaire was translated into Nepali language but care is taken to retain their original meaning. Secondary data was collected by reviewing relevant literature on the subject matter including AKC profiles, annual reports, newsletters, bulletin, different journals, Central Bureau of Statistics, Nepal Agricultural Research Council, proceedings of various NGOs and INGOs etc. Internet browsing was done for additional information. Interview schedule was pre-tested by interviewing 10 vegetable growers outside the study area for checking the reliability and validity of the interview schedule. Final amelioration in the interview schedule was done to make it final to collect information. The data collected from the socio-economic survey were coded, tabulated and analyzed using SPSS and Microsoft Excel. Descriptive statistical tools such as mean, standard deviation, percent and frequency were used to analyze data on socio demography and status of pesticide use. Results from the interview schedule were presented via graphical means like bar diagrams, and pie charts.

Results and Discussions

Household and Farm Characteristics

Majority of respondent farmers were male (66%) while 34% were female. The age of the respondents was categorized into three groups by using mean and standard deviation. Majority of the respondents (70%) were between the age group 38-59 years followed by below 38 years (16%) and above 59 years (14%). Education level was categorized into six groups. Illiterate are those who cannot read and write. SEE refers to 10 years of schooling. Intermediate refers to education level up to twelve and graduation and post-graduation refers to university level education. It was found that the highest number of farmers (34%) had SEE level followed by below SEE (28%) and intermediate (22%). Graduated were 8%, post-graduate 6% and illiterate or those who had no formal schooling were 2%. In the study area, Brahmin/Chhetri were found to be (80%) followed by Janajati (18%) and Dalit (2%). Half of the sampled respondents i.e. 50% had agriculture as their primary occupation followed by both private jobs and foreign employment (14%). Similarly, 12% were involved in government jobs and 10% were involved in business. The average landholding size in the study area was found to be 17.09 ropani with average total cultivated land of 12.33 ropani and average area under vegetable cultivation was found to be 6.69 ropani. Average annual household income was found to be NRs. 6,57,300.00. The average annual income from agriculture was NRs. 3,95,400.00 of which vegetable farming contributes the highest i.e. 87% (NRs. 3,44,000.00).

Cost Aspect of Vegetable Cultivation

Fig.1 shows the average percentage of contribution of different cost items to the total cost of vegetable production. Among cost components, labor cost was highest (24%) followed by fertilizer (14%) and land preparation (13%). Pesticide cost was found to be 3%. Among different costs incurred, there was not much contribution of pesticide to the total cost of vegetable production.

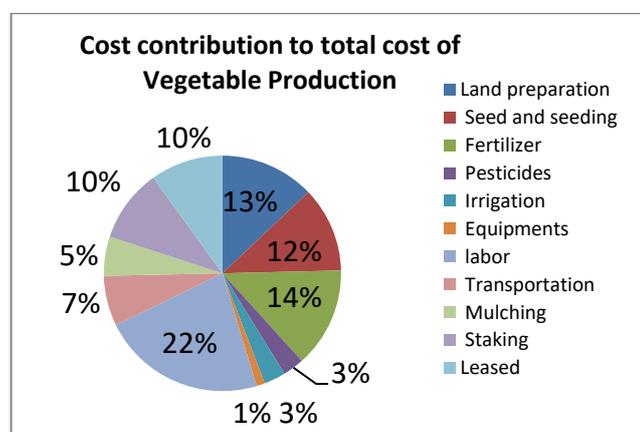


Fig. 1: Contribution of different cost items to total cost of vegetable production Palpa, Nepal.

Pesticide Use and Management Practices

Type of pesticide and its choice:

All the farmers in the study area were reported to use various kinds of chemical pesticides. That includes mainly insecticides and fungicides. Also, Neem based biological pesticides were found to be used as insecticides in combination with chemical pesticides. Majority of the farmers generally tend to use a combination of one or more pesticides as per agro vet recommendation.

Majority of the respondents (64%) said efficacy (pest control) is the crucial factor behind the selection of pesticides while 28% farmers pointed out that they follow agro-vet's recommendation. Only 8% responded that choice of pesticide also depends on the cost of pesticide (Table 1). If the cost is too high, they go for cheaper ones. The finding appears to be in line with (Sharifzadeh *et al.*, 2018) in which the criteria related to efficacy had the highest rank among the factors in the pesticides selection in the process of pest control. Since farmers' main objectives for using pesticides as a quick and easy solution to pest control, effectiveness are the main determinants of farmers' decisions in selecting pesticides.

Table 1: Factors affecting choice of pesticide Palpa, Nepal.

Factors	Frequency
Efficiency of pest control	32(64%)
Agro vet recommendation	14(28%)
Cost of pesticide	4(8%)
Ease of availability	0

Note: Figures in parentheses indicate percentage

Buying Place and Information Source

All the farmers were found to buy pesticide from nearby agro-vets and agreed that the source of information about pesticide application and its dose is the same. Agro vets as the major source of advice regarding use of pesticides was also observed by (Sharma *et al.*, 2013).

Application Pattern and Disposal

Maximum number of farmers (96%) revealed they apply pesticide as a response to heavy damage by pests and only 4% apply just before the pest occurrence period. No farmers were found to use pesticide on a regular basis. All the farmers confirmed morning or evening as the time for applying the pesticides. Further, it was found that 44% farmers apply the pesticide to a crop at least more than four times in a season and 32% farmers apply more than six times. Spraying intervals usually depend upon spread of pest and its severity. Regarding the disposal of pesticides and their containers (54%) of the respondents do not follow safer procedures of disposal. They just throw at dumping a site or at a water source or leave as it is around the field area. A good thing revealed was that no one re-used the empty containers for household purpose (Table 2) which

contradicted the finding of (Sharma, Thapa, Manandhar, Shrestha, & Pradhan, 2013) where empty containers were used to put oil or for food storage.

Table 2: Application pattern and disposal Palpa, Nepal.

S.N.	Actions/Practices	Percentages
1	Time of pesticide application	
	I. Before the pest appearance	4
	II. After the damage by pest	96
2	Time of the day when application takes place	
	I. Morning/evening	100
3	Frequency of spraying	
	I. 1-3 times	24
	II. 4-6 times	44
4	Spraying intervals	
	I. weekly or at certain interval	0
5	Disposal	
	I. Bury	46
	II. Random	54
	III. Re-use	0

Awareness Among Vegetable Growers

No farmer has received training on safe use of pesticide. All the farmers in the study area were dimly aware (have heard but failed to make a note) of the waiting period of different pesticides and its harmful effect on soil, water bodies and

human health. They are also found to consider wind direction during application of pesticides. Most used pesticides were of yellow label and red label was found to be used least.

Protective Measures and Health Issues

Safety precautions:

It was found that 16% of the farmers did not adopt any kind of safety measures and precautions while applying the pesticides except covering their mouth and nose with cloth and 78% adopted partial safety measures and precautions. Partial safety measures refer to the use of fully covered clothing and shoes along with covering of mouth and nose with cloth. Taking complete protective measures like wearing protective clothing, hand-gloves, goggles, nose-masks and taking bath immediately after application etc. was reported by only 6% (Fig 2). Furthermore, it was found that people adopting complete protective measures were those who were offered protective measures while buying the sprayer.

Health issues:

As a result of continuous exposure of the farm workers to chemical pesticides in various ways many health effects were confirmed by the respondents (Fig 3). Most common problems reported by the surveyed farmers was allergy (34%) which refers especially to itchy hands and other exposed parts of the body, followed by eye problems like itching and redness (16%). Other widespread problems were vomiting and nausea (16%) and (34%) were not able to distinguish that their health related issues were either of pesticide use or of any other factors/cause. Similar symptoms such as eye irritation, nausea and vomiting was observed by (Sharma et al., 2013).

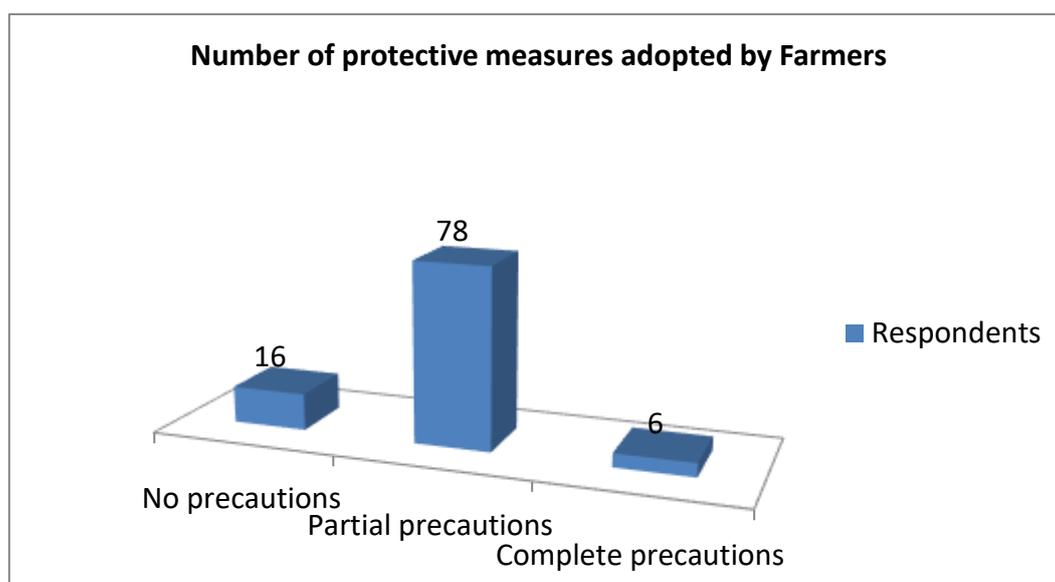


Fig. 2: Adoption of protective measures by farmers Palpa, Nepal.

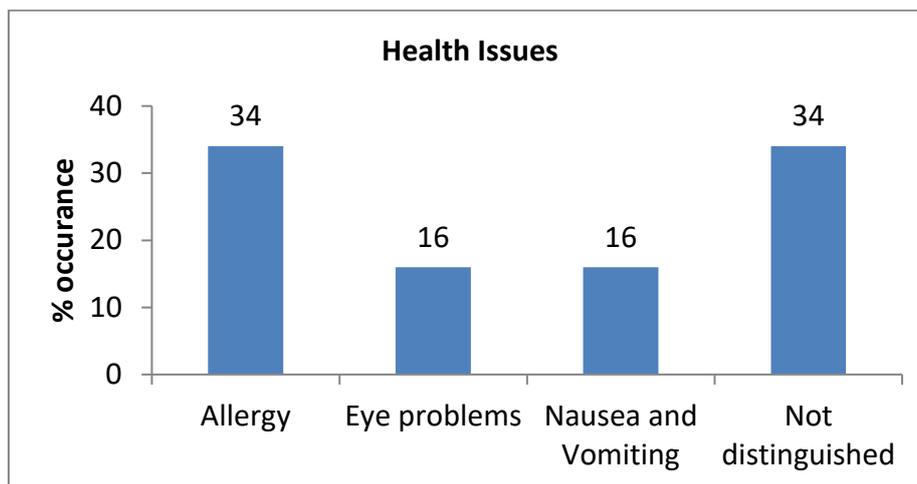


Fig. 3: Health issues reported Palpa, Nepal.

Table 3: Type of pesticides sold Palpa, Nepal.

S.N.	Type of pesticide	Common Name	Chemical class	Toxicity Class*
1	Insecticides	Malathion (Dust)	Organophosphates	III
2	Insecticides	Malathion (Liquid)	Organophosphate	III
3	Insecticides	Chlorpyrifos	Organophosphate	II
4	Insecticides	Celphos		
5	Insecticides	ZnP		IB
6	Insecticides	Dichlorvos	Organophosphate	IB
7	Fungicides	Mancozeb	Carbamate	U/NH
8	Insecticides	Copperoxychloride	Copper compound	III
9	Insecticides	Cypermethrin	Pyrethroid	II
10	Insecticides	Carbofuran	Carbamate	IB

(Source: WHO)

Agro Vet's Characteristics

General information

Men, who had gained a minimum of 10 years of schooling and age between 26-59, were found to be involved in retailing of pesticides in the study area. As per the Pesticide Act, 2048 every pesticide dealer has to own a license for selling pesticide from an authorized committee. All the pesticides sellers were trained on safe handling of pesticides. Also agro vets were involved in providing information related to pesticides proper use, safe handling, waiting period, and restricted pesticides.

Place of buying

Most of the pesticides used in the study area were bought from Birgunj (66%) followed by Bhairahawa (30%) and very few of them also bought from Kathmandu (4%).

Disposal of pesticides

The practice of burying the expired pesticides has been adopted by all the agro-vets. There was no such hazardous waste collection site. Also no one was found to dispose of

it in dumping sites. Safe returning to the supplier or company has not been reported.

Type of Pesticide

Table 3 shows the pesticides the agro-vets are selling in the study area. Most of them are insecticides.

Toxicity class* IB-Highly Hazardous, II-Moderately Hazardous, III-Slightly Hazardous, U/NH-Unlikely to present acute hazard/Non-hazard

Amount of Pesticides imported/sold

Among insecticides malathion(dust) was found to be sold in the highest amount in the study area followed by dichlorvos. In fungicides mancozeb was imported in the highest amount (Fig 4). The amount imported was less as compared to previous year data according to statistical year book 2076/77 AKC, Palpa.

Percentage of Different Chemical Class Pesticides Sold

80% of the sold pesticides were of the Organophosphate group, Carbamates represent 13% and others 7% (Fig 5). Here others refer to different chemical classes except the above two.

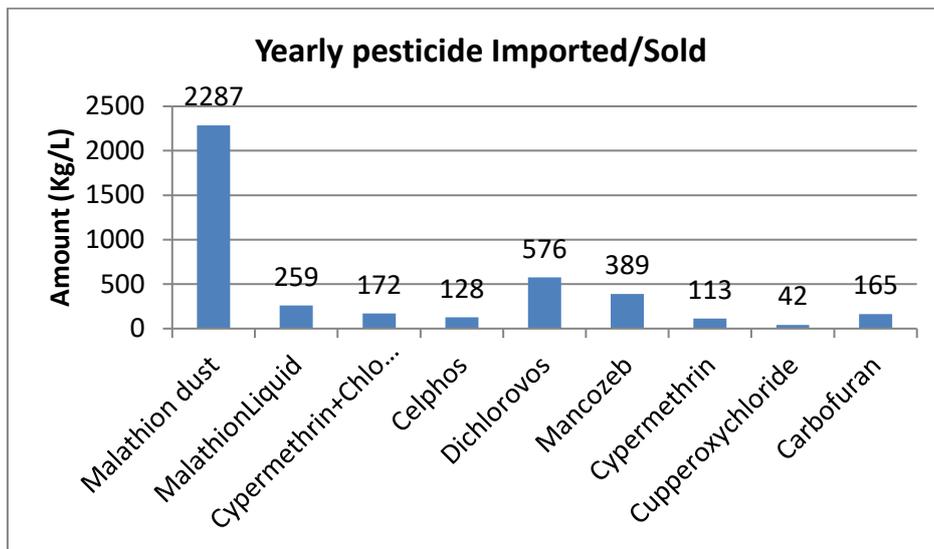


Fig. 4: Yearly pesticide imported/sold Palpa, Nepal 2020.

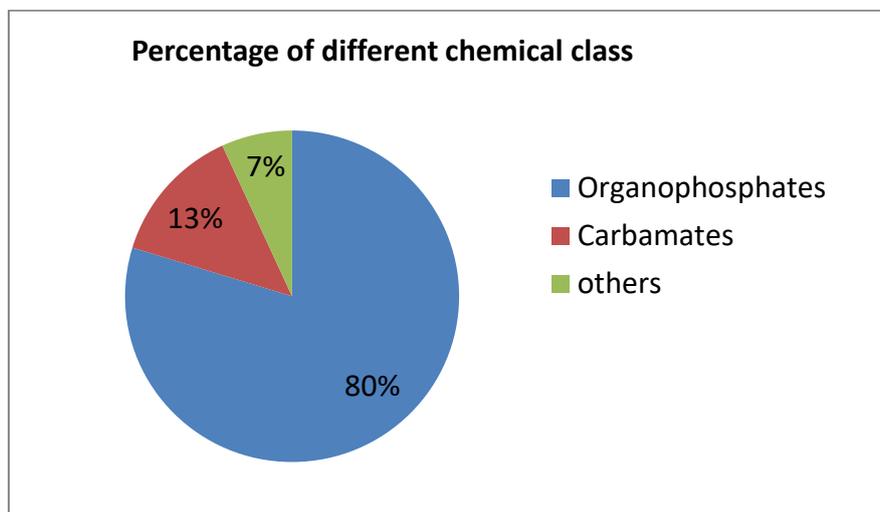


Fig. 5: Percentage of different chemical class pesticides sold Palpa, Nepal 2020.

Conclusion

Palpa district is one of the prominent areas for vegetable cultivation. Vegetable crops have great influence in the economy of the farming community in Palpa. Production of vegetables is in increasing trend in Palpa district due to production potential having climatic suitability as well as increasing market access. The present study found that the contribution of pesticides was minimum to the total cost of vegetable production. The study revealed heavy application of pesticides after pest infestation in terms of time and frequency. They were dimly aware of the waiting period, restricted pesticide, negative effect on health and environment but failed to make a note on it. No one has got training on pesticide use and they rely completely on agro-vets for necessary information. Considerable number of farmers have no safer procedures of disposal. Agro-vets reported that they have no choice other than to bury the

expired pesticides. Very few respondents were found to adopt complete precautions. There were farmers not able to distinguish problems due to pesticides. This concludes that there was no technology and awareness among farmers for safe application and disposal. It was found that farmers adopting complete precautions were affected by a free PPE scheme provided with some of the Chinese sprayer. This implies different schemes were found effective in adoption of safety measures and precautions. This research suggests local or state government or agriculture related organizations to provide educational packages that include complete package on safe handling and use of pesticide and joint effort of municipality waste management body and government to establish effective medium for pesticide disposal.

Authors' Contributions

B. Sharma performed the survey, analyzed the data, and wrote the paper. B.R. Ojha supervised the entire research and manuscript preparation. A. Ojha was responsible for the edition and revision of the paper. B. Sapkota, G. Adhikari and S. Gautam was involved in the literature review, pretesting of interview schedule, preparation of questionnaires, and the publication process.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding publication of this Manuscript.

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