Pesticide use practices and awareness among potato growers in Nepal

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Abstract

Pests are serious problems in many major food and industrial crops grown in the Asia Pacific region, causing annual yield losses estimated at 30 to 60 %. Consequently, many developing countries in the region are heavily depending on the use of pesticides. Increased use of pesticides, however, has caused considerable concern about their effects on health, the natural environment and the quality of agricultural products. Many older, non-patented, more toxic, environmentally persistent and inexpensive chemicals are being used intensively in Nepal. Usage of pesticides in Nepalese agriculture is regulated by Act and Law; however, law enforcement is almost absent in major vegetable growing areas. Given the limited or poor literacy skills of Nepalese farmers and widespread use of pesticides, it is expected that occupational exposure to pesticides is likely to be high. This study was carried out to assess farmers' understanding of pesticide safety labels, pesticide handling and spraying practices that might potentially expose them to chemical hazards. Data was based on random sample of 471 pesticide practitioners (mainly potato farmers, but also field workers, extension officers, and pesticide dealers) across Nepal's' major potato production zones using structured interviews. This paper presents social characteristics, understanding of labels and pictograms on pesticide packages, source, preparation, and storage of pesticides, disposal of pesticide containers, practitioners' preventative measures, and understanding of WHO classes of pesticides among farmers, technicians, pesticide dealers and cooperatives.

Keywords: pesticides, pictograms, FAO class, cultivation, preventive measures, Nepal.

Introduction

Pesticides play a major role in pest management in agriculture and, pesticide sales have soared since the 1970s globally. Many older, non-patented, more toxic, environmentally persistent and inexpensive chemicals are used intensively in developing nations (Ecobichon, 2001). The Food and Agriculture Organization (FAO), estimates that up to 50% of the annual crop production in developing countries may be lost due to pests and diseases. Consequently, many of these countries depend heavily on the use of pesticides to increase agricultural production. Although developing countries currently account for about 20% only of the global pesticide market, pesticide use is expected to increase more drastically in the coming years then in industrialized countries, where minimal market growth is expected. While developing countries have benefited from pesticide use, increasing dependence on these substances and adverse effects on human health and the environment has caused considerable concerns; especially since more persistent and hazardous pesticides are commonly used, often with little or no education, monitoring or regulatory control.

Pesticide use in Nepal started in the early 1950s especially with the use of DDT for malaria eradication (Manandhar, 2005). This was subsequently followed by use of other organochlorines (BHC, dieldrin, and chlordane), organophosphates (Ethyl parathion, methyl parathion, malathion, and oxydemeton methyl), carbamates and synthetic pyrethroids. In Nepal, insecticide use increased rapidly over the last 10 years from 29.8 mt in 1998 to 102.8 mt in 2003 (PPD, 2003, PRMS, 2006). Since the 1960s, Nepal's government had given major emphasis to import and supply chemical pesticides to increase agricultural production and as a result, pesticides started to be used indiscriminately and widely throughout the country. Total amount of pesticides used annually in Nepal is 128.697 mt (active ingredient) that includes 46.553 mt of insecticides, 74.368 mt of fungicides, 5.701 mt of herbicides, 1.808 of roddenticides, 0.057mt of bio-pesticides, and 0.238 mt of acaricides for agriculture as well as 2.556 mt of pesticides for the public health sector (PPD, 2008). The national mean pesticide consumption of Nepal was 142g /ha in recent past, which seems low compared to pesticide consumption of other Asian countries; however, use of pesticides is not uniform in Nepal. Most pesticides are used in rice (40-50%), pulses (14-20%), cotton (13-15%) and vegetables and fruits (10-15%) (Manandhar, 2005). Moreover, pesticides are used

by vegetable farmers in the periphery of urban and sub-urban areas where they have access to vegetable markets (NARC, 2005).

A number of 306 commercial products grouped under 71 common names of pesticides have been registered in Nepal: insecticides (40); fungicides (18); herbicides (5); rodenticides (3); acaricides (1) and others (4) (NARC, 2005). Illegal trade and use of pesticide has been an issue for journalists and highlighted by media now and then. Till now, 14 pesticides (POPs) have been banned in Nepal, including DDT, BHC, aldrine, dialdrin, endrin, chlordane, lindane, heptachlor, toxaphene, mirex, phosphamidon, organomercury compounds, monocrotophos and methyl parathion (PPD, 2008). At present, commonly found pesticides in markets are organophosphates, synthetic pyrethroids and one organochlorine i.e. Thiodan (Manandhar, 2005).

Nepal government has passed Plant protection Act 1972; Plant protection Rules 1975; Pesticide Act in 1991; Pesticide rules 1993; Environmental Protection Act 1996; Environmental protection Rules in order to mange the discriminate use of pesticides (Palikhe, 1998). However, there is no comprehensive record indicating the volumes of pesticides used.

Due to lack of training and education programs for safe use from industries or government, Nepalese farmers are not much aware about the risks and rarely follow proper safety methods when using pesticides. Pesticides are applied at higher doses than needed (Manandhar, 2005), causing waste of pesticides and reduced farmers' profits. Generally, farmers make decision for applying pesticides once they notice pests in the field, irrespectively of damage level. Pesticide use is not static due to many factors such as availability of alternatives, market prices, effectiveness and pesticide availability in markets (Manandhar, 2005). Earlier studies have not explored sufficiently the recent use pattern of pesticides and its market system in totality. Available information does not provide information about the real status of pesticide use in Nepal. Regular monitoring on different issues of pesticide could be helpful to update the changing situation of pesticide use. Besides, Nepal is a member of World Trade Organization that requires authentic data of pesticide use for the export of agricultural products.

The objective of this study was to determine the potential health risks for farmers and the environment due to increasing pesticide use. The study focused on farmers' understanding of pesticide labels, farmers' awareness about the risks arising from pesticide use, and in how far appropriate safety measure are taken up by farmers. The results are used to quantify the environmental and health impacts of pesticides in agricultural production in Nepal.

Materials and methods

A standardized questionnaire was used to gather the information about the chemical pesticides used and farmers' awareness about its risk. The questions focused on pesticide handling, including pesticide application practice, storage, and disposal of pesticide containers, and farmer's understanding of pesticide labels and safety measures adopted. Farmers were also asked if they read pesticide labels and which other sources of information they used for appropriate handling of pesticides. Pictograms generally included in pesticide labels were shown on one sheet where farmers noted their understanding of the pictorial warnings. Personal figures, like farmers' sex, age, educational level, land tenure situation, years of farming and pesticide use experience were included.

The field survey was carried out during September 2008 to May 2009 in twenty vegetable (especially potato) growing districts of all development regions of Nepal. The districts covered high hills (3), mid-hill (11), and plain (6) agro-ecological zones (Fig). The potato growing areas of Chitwan, Dang, Banke, Bardiya, Kailali and Nawalparasi represent plains, the districts Arghakhanchi Dadeldhura, Kaski, Kavrepalanchowk, Kathmandu, Lalitpur, Bhaktapur, Parvat, Salyan, Dahding and Makawanpur represent mid-hills, and the districts Solukhambu, Jumla, and Sindhupalchowk represent high hills of Nepal. In total, more than 500 farmers were interviewed. The sample size varied between 5 and 58 potato growers in each districts.

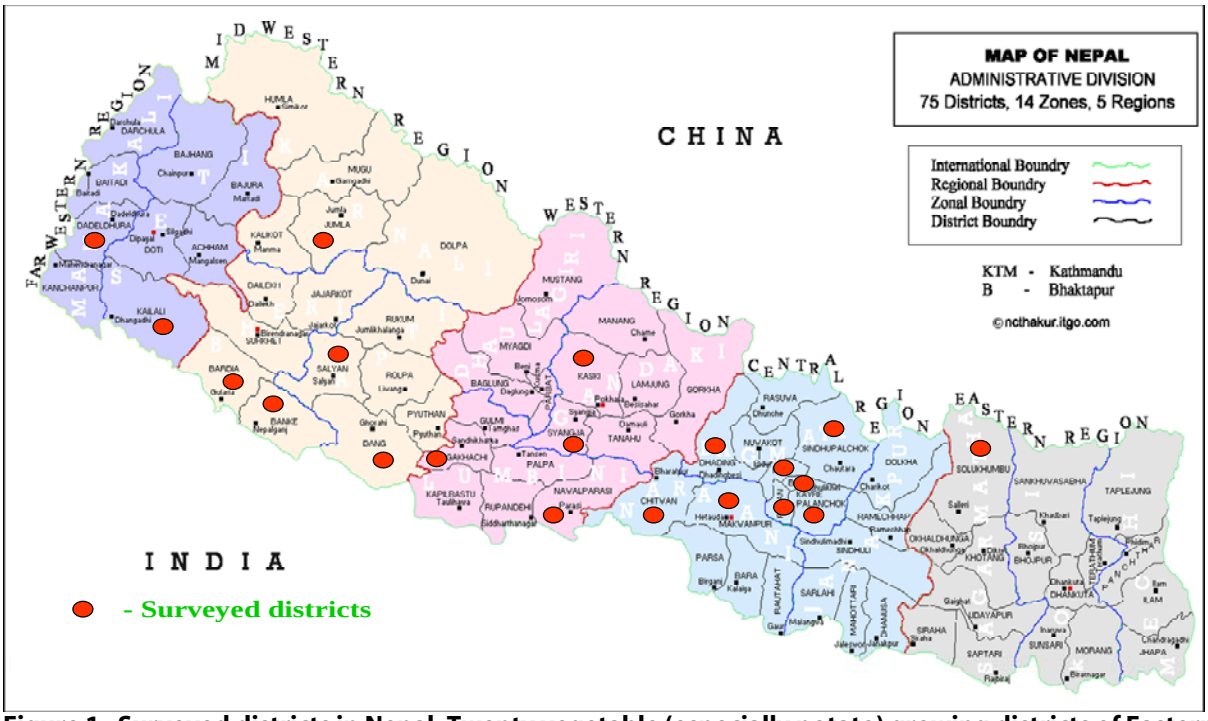

Figure 1. Surveyed districts in Nepal. Twenty vegetable (especially potato) growing districts of Eastern, Central, Mid-western and Far-western development region of Nepal were selected for survey covering high hill, mid-hill, and plain agro-ecological zones

The study was conducted by personal interviews using a (semi-)structured questionnaire. The questionnaire was pre-tested with farmers in Bhaktapur. Interviews were carried out by entomologists of NARC assisted by Plant Protection Officers of the Department of Agriculture (DOA) in each district and in some cases additionally by research assistants and junior technicians. Orientation meetings were organized for the survey team members before interviews. For verifying farmers understanding of pictograms and their knowledge about color codes and WHO classes on pesticide labels, respondents were asked to note their explications on a questionnaire sheet that presented the warning symbols. In case that the farmer was illiterate the interviewer noted the farmer's answers on the sheet. The team members also conducted observational studies on farmers' attitudes and practices for verifying the outcome of the questionnaire during field visits. Altogether a total of 504 pesticide practitioners, categorized as farmers that are non members of co-operatives (464), extension officers (15, from Kabre only), pesticide dealers (9, Kabre only) and members of co-operatives (15, Arghakhanchi) were interviewed.

All farmers in Solukhambu (5) and Sindhupalchowk (28) (high hills) had never used pesticides and were not included in the analysis. The 15 famer organized in co-operatives came all from the district Arghakhanchi and were also excluded from the category of farmers for the analysis. Comparison between the groups of pesticide practitioners is limited by the fact that subjects in the groups of 'extension officers', 'pesticide dealers' and 'farmers organized in co-operatives' is low and all subjects within each of these groups were derived from one district only. This paper therefore focuses more on the attitudes of farmers which are not organized in co-operatives. For verifying differences in response between categories of pesticide practitioners and differences within the group of farmers which are not organized in co-operatives (simple random sample) due to personal variables, i.e. sex, age, education level, farming experience, etc., data were submitted to ANOVA (ordinal data) or evaluated by Chi^2-test (dichotomous data). For analysis the software package SPSS-10 was used.

Results

Demography and social characterization of respondents

Majority of farmers (62.4%) interviewed were of the middle-age class, i.e. between 25 and 50 years old. The proportion of women (28%) interviewed was lower, which might reflect the involvement of women in pesticide applications since women were interviewed only when they apply pesticides. Educational levels of respondent were variable (Table 1). About 1.7% of farmers were illiterate, and another 21% did not complete more than 5 years of formal education, while over 50% had obtained 12 years of formal education with about 30% holding a B.A to M.A. level. Education levels were generally higher in Nepal's mid-hill regions then in high hills or plains and were also higher in the Western and Central Development region then in the Mid and Far Western region. Most farmers were land owners but some farmers rent additional land (13%) while 3.4% only have been using solely land in rent. Most farmers have been involved in agricultures for more than 10 years (>68%) but pesticides are used since fewer years. Only 32.7% of the farmers have been using pesticides for more than 10 years. Most farmers interviewed apply pesticides both in their own family land as well as in other's taken in rent; or apply pesticides as a hired labor for others.

Table 1. Social characterization of respondents

Types and characteristics	Number	Percentage
Occupational Categories		
Farmer	461	91.7
Agriculture Technician	15	3.2
Pesticide dealer	9	1.9
Representatives of farmer's co-operatives	15	3.2
Sex		
Female	134	28.5
Male	337	71.5
Age (years)		
Up to 25	87	18.5
25-50	294	62.4
More than 50	89	18.9
Education level		
Illiterate	8	1.7
Literate (below 5 class)	101	21.4
5-10 class	104	22.1
SLC-IA level	119	25.3
BA-MA level	139	29.5

Types and characteristics	Number	Percentage
Land tenure		
Own land	393	83.4
Land in rent	16	3.4
Both type of land ownership	62	13.2
Farming experience		
1-5 years	67	14.2
6-10 years	88	18.7
11-15 years	83	17.6
16-20 years	60	12.7
>20 years	173	36.7
Experience of pesticide use (years)		
1-5 years	190	40.3
6-10 years	120	25.5
>10 years	153	32.5
Work force		
Household labour	137	29.1
Wage labour	25	5.3
Both	307	65.2

Knowledge on pesticide categories and labels

Approximately 50% of the farmers do read pesticide labels before using them. The reading practice was significantly more frequent with increasing level of education (strong correlation), and significantly different between farmers' age groups (younger farmer read more frequently label than older farmers), farmers' farming experience (less experienced farmers read more frequently then farmers with longer farming experience) as well as between farmers in the three agroecological zones of Nepal (farmers in high hills and mid-hills read more frequently the label than in the plains (

). Most frequent answers why farmers do not read the labels were "because they are illiterate" (16%), that "they trust pesticide dealers" and follow their advice rather than to read and follow written instruction (18%), "trust in

pesticides without reading the label" (3.3%), "rely on neighbors" (9.4%), or simply "don't see the need to read the label" (8.2%); however, about 44% of farmer did not reply to this question at all.

Table 2. Percentages of farmers who do not read labels by personal and regional categories

Variables	Total number of respondents	Do not read (%)		Chi square
Education				
Illiterate	8	0.63	$p < 0.001$	113.5
literate (below 5 class)	96	0.92		
5-10 class	100	0.7		
SLC - IA Level	103	0.43		
BA - MA level	117	0.24		
Sex				
male	308	0.54	$p = 0.211$	1.57
Female	116	0.6		
Age (years)				
upto 25 years	85	0.44	$p < 0.001$	17.49
25 - 50 years	250	0.53		
> 50 years	88	0.74		
Farming experience				
1 - 5 years	64	0.41	$p < 0.001$	24.25
6 - 10 years	85	0.41		
11 - 15 years	80	0.55		
16 - 20 years	57	0.6		
> 20 years	138	0.7		
Pesticide use experience				
1 - 5 years	173	0.49	$p = 0.066$	5.6
6 - 10 years	114	0.6		
> 10 years	137	0.61		
Ecological zone				
Plains	144	0.66	$p = 0.005$	10.24
mid hills	270	0.5		
high hills	10	0.4		
Development region				
Far Western	32	0.69	$p = 0.233$	4.28
Mid Western	77	0.61		
Western	114	0.54		
Central	201	0.52		
Total (farmers)	424	0.55	$p < 0.001$	36.8
Extension officers	15	0.13		
Pesticide dealers	9	0		
Farmers in co-operatives	15	0		

All farmers organized in co-operatives (only from one district) and all pesticide dealers said that they always read the labels. From a total of 15 extension officers interviewed two responded that they do not read pesticide labels. As a major source for information about pesticide use and the risks, farmers rely on pesticide dealers (60.6%), extension officers (42%), neighbors (20%) and others (2%).

Among the farmers (all non-members of co-operatives) 82.4% indicated that they are not familiar with the FAO color-coding scheme; however, 8.6% only were able to correctly understand the meaning of all color classes

(16.4 and 10.6% understood correctly the meaning of two red color codes for extremely hazardous (Ia) and highly toxic (Ib) pesticides). All farmers which were organized in co-operatives (from one district only) were familiar with the color codes and interpreted them correctly. Three pesticide dealers (33%) and one extension officer (6.7%) were unfamiliar with the codes and not able to interpret them.

Similarly, the majority of farmers did not have a clear understanding of the pictograms' meanings (

).

Table 3. Frequencies for correct understanding of pictograms on pesticide labels

Pictograms	Meaning	*N*		%	
		Yes	*No*	*Yes*	*No*
Activity pictograms					
	Handle carefully - liquid product	42	429	8.9	91.1
	Handle carefully - powder or granulated product	29	442	6.2	93.8
	Application - use a hydraulic spray atomizer	265	206	56.3	43.7
Advisory pictograms					
	Use protective gloves	375	96	79.6	20.4
	Wash after use	352	119	74.7	25.3
	Wear a mask	367	104	77.9	22.1
	Wear a water proof apron	197	275	41.8	58.4
	Use a face shield	40	431	8.5	91.5
	Wear spactacles	342	129	72.6	27.4
	Wear boots	312	159	66.2	33.8
	Wear a pesticide respirator	50	421	10.6	89.4
	Wear protective clothing	18	453	3.8	96.2
Environmental hazard					
	Dangerous/harmful for livestock and poultry	154	317	32.7	67.3
	Dangerous/harmful for wild animals and birds	96	375	20.4	79.6
	Dangerous/harmful for fish/Do not contaminate water	153	318	32.5	67.5
Children hazard warning					
	Keep locked away and out of reach of children	192	279	40.8	59.2

All 15 farmers organized in co-operatives interpreted all 16 pictograms correctly; however, among other farmers 14.8% did not understand the meaning of any pictogram, 48% understood the meaning of at least 6 pictograms, while more then 10 were identified correctly by 13.9% of the farmers. Few farmers were able to understand the handling pictograms for liquid (8.9%) and granulated (6.2%) products, while frequently more farmers understood the pictogram for using a hydraulic sprayer (56.3%).

Likewise, understanding of advisory and warning pictograms was low; relatively frequently the signs for using protective gloves, washing after use, wear mask, wear spectacles were understood (all >72%), while understanding of the need for wearing boots (66%) and a waterproof apron (42%) was moderate, for wearing a respirator (10.6%) and a face shields (8.5%) extremely low, and for wearing protective clothes almost nil (3.8%). Pictograms for environmental hazard were also poorly understood; while the danger sign for livestock and poultry intoxication and danger of water and fish contamination was understood by about 33%, lower numbers of farmers were able to identify correctly the hazard sign related to wildlife (20%). Less than 41% of farmers identified correctly the hazard warning related to children.

None of respondents perfectly followed the recommended safety measures. However, majority of farmers (62.6%) used to wear a piece of cloths or cover mouth and nose, which is considered an important and easy to use protection measure, during applying pesticides and take a bath afterwards (41%). Some farmers only wear gloves (29.5%), an apron (27.8%), or a hat (22%). Wearing shoes during pesticide application was reported from 16.3% only (most farmers spray pesticides barefooted or wearing sandals). Spraying according to the wind for avoiding direct contact with pesticides consider 26% of the farmers only. Very few farmer (1.5%) use other than above mentioned protective measures

Farmers' pesticide handling practices

Nepalese farmers are using various types and wide range of chemical insecticides (organochlorines, organophosphates and synthetic pyrethroids). Among them, Endosulfan (Thiodan) is an insecticide that is still being used by a big group of farmers (52.2%). In addition, Malathion and Mancozeb (DM-45) have been found widely (36.7%). More than 28% of the farmers still use highly hazardous pesticides of the WHO class Ia and Ib (**Error! Not a valid bookmark self-reference.**). One farmer mentioned that he is still using DDT, but which could not be verified.

Table 4. Types of pesticides used

Trade name	Pesticide group	WHO classification	Numbers of respondents	Percentage
Insecticides				
Malathion	Organophosphates	III	182	38.6
Dimethoate	Organophosphates	II	51	10.8
Endosulfan	Organochlorine	II	246	52.2
Nuvan	Organophosphates	Ib	88	18.7
Methyle parathion	Organophosphates	Ia	47	10.0
DDT	Organochlorine	Ia	1	0.2
Chloripyriphos	Organophosphates		1	0.2
Cypermethrin	Synthetic pyrathroid	II	14	3.0
Fenfen	Organophosphates	II	1	0.2
Current	Organophosphates	Ib	1	0.2
Metasystox	Organophosphates	Ia	4	0.8
Super D			1	0.2

Trade name	Pesticide group	WHO classification	Numbers of respondents	Percentage
Fungicides				
Keronoxyl			20	4.2
Copperoxychloride	Copperoxychloride		1	0.2
Bavistin	Carbendazim	NH	8	1.7
Blitox	Copperoxychloride		3	0.6
DM-45	Mencozeb	U	173	36.7
Copperoxide	Copperoxychloride		27	5.7
Hinosan	Carbendazim		1	0.2
Benomyl		U	15	3.2
Endofil-45	Mencozeb		1	0.2
Dhanucup			1	0.2
Curex			1	0.2
Sixer			1	0.2
Carbedigm	Carbendazim		1	0.2
Indofil	Mencozeb		1	0.2

Most farmers (57.7%) prepare pesticides in the field just before its application. Pesticides are stored mostly in a separate store within the house along with agricultural tools (40.6%), which is followed by storing them outside the house (37.8%); however, 2.1% store pesticides in the bedroom and 1.5% in the kitchen. Farmers have different practices for disposing the empty pesticide containers. Disposing of empty containers in a pit has been most frequently reported (46.9%) followed by leaving them in the crop field (22.3%), burning (16.8%). 5% of the

farmer reported that they use empty pesticide container for home purpose rather than wasting or burning them (Table 5).

Table 5. Pesticide preparation place, storage and disposal practice

	Number	Percentage
Pesticide preparation place		
In home	88	18.7
In the field	272	57.7
Nearby water source	101	21.4
Pesticides storage place		
In bed room	10	2.1
In kitchen	7	1.5
Normal store room	75	15.9
Separate store room	191	40.6
Store out side house	178	37.8
Disposal of empty pesticide containers		
Home use	24	5.1
Disposing in pit	221	46.9
Throwing in sewage canal	37	7.9
Throwing in stream or canal	56	11.9
Burning	79	16.8
Throwing in crop field	105	22.3
Throwing in forest	41	8.7

Discussion

Similar studies have been carried out by various researchers (Giri *et al*., 2006; Giri, 1995; Ghimire and Katiwada, 2001; Maharjan *et al*., 2004) in Nepal. Giri *et al.* (2006) carried out a study in eastern and central mid hills and eastern, central, mid- and far western plains of Nepal and found that most vegetable growers were rarely using any safety measure during spraying of pesticide as found in the present study. Giri *et al.* (2006) reported that farmers avoid spraying pesticides in bright sunshine or under windy conditions (Maharjan *et al*., 2004) as a common measure preventing hazardous effect of pesticide. A second adopted safety practice by farmers was covering the face with cloth during spraying as it was reported by most farmers in the present study. Even if farmers are aware that the use of pesticides is unsafe, they are not conscious about all the risks (e.g., many farmers mentioned that they did not know that skin contact with pesticides might be hazardous (see also Giri, 1995)) and that farmers in Nepal have not adopted adequate safety measures for applying pesticides (Baker and Gyawali, 1994; Klarman, 1987; Dahal, 1995; Giri *et al*., 2006, this study). Chemical pesticides are commonly known as *"Kit Nasak Aushadi"* (insect destroying medicine), and they are handled carelessly. Farmers even use the broom to apply pesticides (Dahal, 1995).

Given the increasing trend of pesticide use in Nepal there is an urgent need for awareness and training activities which could enhance the adoption of safety measures. Today, little is known about the health impacts of chemical pesticides on farmers; however, some studies (Atreya, 2008) showed that increasing pesticide use affects farmers' health in Nepal. Nepal's authorities have realized that the use of pesticides has huge detrimental

effects within the country. For sustainable agricultural production it is important to reduce farmers' dependency on chemical pesticides and shift to integrated pest management practices and use of safer alternatives.

Giri et al. (2006) and Maharjan *et al.* (2004) have reported that vegetable growers of different districts and development regions have been using a long range of pesticides, using them with minimum protective measures. This study shows that the situation has not been changed yet; it seems that pesticide use by vegetable growers of Nepal is increasing while still some hazardous pesticides (WHO class IA and IB) are in use. Potato growers of high hills generally do not use chemical pesticides except in Jumla but where the use of chemical pesticides is also still low. The chemical pesticides commonly used are insecticides (organophosphates, pyrethroids, and organochlorins) and fungicides (mancozeb, carbendazim and copperoxychlroride).

Pesticide label reading practice of Nepalese farmers is very poor due to use of foreign language, unclear instruction of the label as well as carelessness of the users. This study revealed no differences in reading practices between man and women; however, Atreya (2007) showed that gender-specific difference on pesticide use knowledge and adoption of safety measures exist that need to be addressed in any awareness and training program. Most farmers are also unfamiliar with the color signs, which are specifically included in pesticide labels for users who are illiterate or unfamiliar with the language used on labels. Studies carried out by Eve (1995) have shown that reading and writing ability is high considering the geographical and resource constraints encountered by those providing education. It seems that technical language used for instructions discourages farmers to read pesticide labels. Giri et al. (2006) have also reported that a big segment of vegetable growers of Nepal were not aware about pesticide labels and it's expiring date. Similar trends were seen in this study too. Ghimire and Katiwada (2001) reported that farmers of Chitwan (Tandi) have very little or no knowledge of safe use of chemical pesticides in vegetable production. They are not aware of waiting period, environmental and health hazards. Pesticide use in commercial farming and fresh vegetables is excessively uncontrolled and without consideration of health of consumers.

Conclusions

Awareness on the correct use of pesticides by vegetable growers of Nepal is low and should be improved through adequate training programs and the provision of safer alternatives to chemical pesticides. Farmers from co-operatives showed a relatively good knowledge about pesticide use and safer pesticide application practices compared to farmer who are not organized in farmers groups. Other studies showed that farmers are worried about negative health impacts of pesticides and are willing to pay for safer alternatives (Atreya, 2008). Although integrated pest management has been developed for rice production in Nepal alternative control measures for other crops have been rarely developed and provided to farmers. It is recommended to strengthen research efforts for developing integrated pest management strategies especially for vegetable crops, including potato.

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