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Common Pests and Pesticides used in High Value Crops: A Case Study on Some Selected Districts of Nepal

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This study was carried out in eight districts of Nepal to explore the pests, pesticides and other agro-chemicals used in high value crops viz. tea, coffee, honey and vegetables (tomato and brinjal). The study carried out districts for tea were Jhapa and Illam, whereas for vegetables Bara and Kavre. Similarly, honey was studied in Chitwan and Nawalparasi, whereas coffee in Gulmi and Lalitpur. The results revealed that different type of pests were found to be problematic in high value crops production. Loopers were the major pests in tea, borers in coffee, fruit fly in vegetables and mites in beekeeping. Different pesticides and some other agro-chemicals have been found to be used for pest management. Additionally, pesticide residues analysis for selected pesticides was carried out using GC-MS technique. The result of analysis showed that non of pesticides was found at the detection level of 0.7 parts per million.

Key words: High value crops, Pests, Pesticides, Pesticide residue, GC-MS

Introduction

Pesticides pollution in the environment results disturbance of agri-environment system, residues in food and loss of biodiversity, develops pest resistance, secondary pest outbreak and economic loss to the users (Gupta 2004, Keshavchandran 2009).

Until the 1950s, the people of Nepal remained unaware of modern chemical pesticides and were dependent upon traditional organic techniques for killing pests. Chemical pesticides were first introduced to Nepal in 1952, when Paris green, Gammaxene, and Nicotine sulphates were imported from USA for malaria control. DDT made its first appearance in 1956. This was soon followed by a variety of other organochlorines (in 1950s), organophosphates (in 1960s), Carbamates (in 1970s), and Synthetic pyrethroids (in 1980s) (Koirala *et al.*, 2009b).

Pesticide residue analysis was started in 1978 in Department of Food Technology and Quality Control, Nepal with assistance of FAO. Monitoring results of 1995-2009 for the analysis of 1034 food products showed that 11.2 % food products are contaminated with pesticides (Koirala *et al*., 2008a). Study on pesticide residue in honey (2007) and in tea (2008) also showed that none pesticide residues were observed for 17 types of pesticides at the detection level of 0.5 parts per million. In 2009, a study on pesticide risk in 15 kinds of Nepalese diet was analyzed for 97 kinds of pesticides. Six pesticides were present (Endosulfan, Chlorpyrifos, Malathion, Fenvalarate, Cyhalothrin, Permithrin). Pesticide residues were detected in different food commodities like cereals, pulses and vegetables. Among all the food items, vegetables were the maximum contributor for pesticide residues consumption. Multiple pesticide residues were observed in studied foods. The synergistic effect of different types of pesticides may have unusual consequence to consumer health (DFTQC, 2011). The objective of this study is to identify the type of pests and pesticides or other agro-chemicals used in high value crops (Tea, coffee, honey and vegetables).

Materials and Methods

For four different types of high value crops, eight districts were selected for the study purpose (Table 1). In case of vegetables, tomato and brinjal were studied. These districts were selected from different agro-climatic zones because pests in the different agro-climatic zones are different and thus use of pesticides applied could be different. The Village Development Committee (VDC) from the selected districts were taken purposively based on the criteria of highest production statistics of high value crops. The 192 farmers involved in the production of the high value crops were selected for the study purpose. There were altogether 24 samples of high value crops were taken for pesticide residues analysis.

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Table 1. Sampling frame

SN	Samples	Study districts	Study unit at household level	No of households visited	Sample collection for laboratory analysis
1	Tea	Jhapa, Illam	3 VDCs, 4 wards	48	6
2	Coffee	Gulmi, Lalitpur	3 VDCs, 4 wards	48	6
3	Vegetables	Kavre, Bara	3 VDCs, 4 wards	48	6
4	Honey	Nawalparasi, Chitwan	3 VDCs, 4 wards	48	6
Total				192	24

***Sampling process*-** Sampling process including criteria for sampling has been shown as follows;

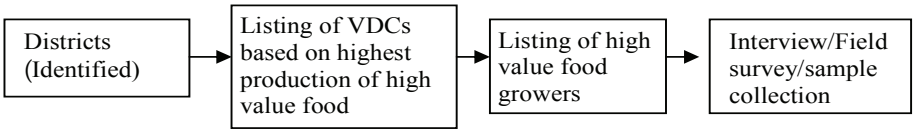

Table 2. Sample code of different food commodities

Commodities	Sample Code	Sample Code
Tea	J 1-Tea sample from Bhadrapur municipality Jhapa	IL 2- Tea sample from Jasbire VDC Ilam
	J 2- Tea sample from Bahudangi VDC Jhapa	IL 3- Tea sample from Fikkal VDC Ilam
	J 3- Tea sample from Haldabari VDC Jhapa	IL1- Tea sample from Mangalbare VDC Ilam
Vegetables (Tomato)	SN 1- Tomato sample from Nala, Kavre	SM 1- Tomato sample from Mahadevbeshi, Kavre
	SP 1- Tomato sample from Pachkhal, Kavre	
Brinjal	DU1- Brinjal sample from Bariyarpur, Bara	DU2- Brinjal sample from Inaruwa, Bara
	DU3- Brinjal sample from Banjaria; Bara	
Coffee	CGR - Coffee sample from Ruru VDC Gulmi	CGH- Coffee sample from Digam Gulmi
	CGT- Coffee sample from Thanapati VDC Gulmi	CLG - Coffee sample from Gimdi VDC Lalitpur
	CLT - Coffee sample from Thula Durlung VDCLalitpur	CLP Coffee sample from VDC Pyutar Lalitpur
Honey	HCC1- Honey sample from Chitwan, Chiuri	HNM 2- Honey sample from Nawalparasi,

***Pesticide residues analysis*-** Laboratory analysis was done using GCMS Model QP 2010+ Japan (Rissato 2003 and Anastassiades 2007) and sample extraction was done using a Mini-Multiresidue Method for the Analysis of Pesticide Residues. A mini-multiresidue method for the analysis of pesticide residues (QuEChERS) was used. The sample extraction process is as follows;

Weigh 10 g sample into 50 ml centrifuge tube (with screw cap)

↓

Add 10 ml of acetonitrile and then ISTD solution and shake vigorously for 1 min

↓

4 g magnesium sulfate 1 g sodium chloride 1 g trisodiumcitrate dihydrate and 0.5 g of sodium dihydrogencitrate sesquihydrate shake well add 600 micro liter of 5 N sodium hydroxide for acidic samples and shake vigorously

↓

Centrifuge for 5 min at 3000 RPM

↓

Take supernatant in a vial and freeze for fatty sample

↓

Add 1 ml supernatant in sorbent and shake well for 30 sec; centrifuge for 5 min at 3000 RPM

↓

Add 1 ml supernatant in sorbent

↓

Transfer and supernatant to vial after maintaining pH

***GCMS condition*-** EPA methods 508 Pesticide using Rtx -5 and modified methods: Oven 60°; 25°/min:150° (1min); 3°/min:200°(1min);8°/min:290°(8min); Ion source:250°; Detector:280°; Carrier gas: Helium; SIM.

Results and Discussion

Among the studied high value crop growers, majority (60 %) of respondents were in between the age group of 40 to 50 years.

Majority (60 %) of respondents were with other business along with high value crop production. 30 % were with qualification intermediate or more. Among the respondents, cash crop income (income for tea, coffee, vegetables and honey) contributes 20 to 25 depending on type of crops. It was observed that rise in agriculture income of farmers; there were more education level attainment among the family members. ($p < 0.05$).

The area covered by commercially cultivate crops were (for tea 25 % coffee 10 % and vegetables 20 %). The highest average income per farmer was found to be NRs 30,000 for tea farmers followed by NRs 15,000 in coffee, NRs 10,000 for vegetables and NRs 7,000 for honey. The average duration of stay time to farmers at the field were- beekeeping 8 hrs, vegetables 7 hrs, tea 5 hrs and coffee 4 hrs daily.

Table 3. Socio-economic aspects of high value crop growers

Particulars	Tea		Vegetable		Coffee		Honey	
	Total number	%	Total number	%	Total number	%	Total number	%
Type of family								
Joint	30	63	30	63	30	63	30	63
Nuclear	15	31	14	29	14	29	15	31
Extended	3	6	4	8	4	8	3	6
Total	**48**	**100**	**48**	**100**	**48**	**100**	**48**	**100**
Religion								
Hindu	35	73	40	83	45	94	43	90
Buddhist	8	17	5	10	2	4	1	2
Others	5	10	3	7	1	2	4	8
Total	**48**	**100**	**48**	**100**	**48**	**100**	**48**	**100**
Age of the respondents								
30 or less	5	10	5	10	5	10	12	25
30 to 40 years	5	10	15	31	15	31	21	44
40 to 50 years	30	63	25	52	25	52	10	21
Above 50 years	8	17	3	6	3	7	5	10
Total	**48**	**100**	**48**	**100**	**48**	**100**	**48**	**100**
Profession								
Agriculture solely	20	42	24	50	21	44	15	31
Agriculture with private business	10	21	9	19	12	25	21	44
Agriculture with government worker	8	17	7	15	5	10	3	7
Agriculture with self employed	10	21	8	16	10	21	9	18
Total	**48**	**100**	**48**	**100**	**48**	**100**	**48**	**100**
Education level								
SLC or below	20	42	35	73	20	42	15	31
SLC to intermediate	20	42	5	10	20	42	20	42
Bachelors or above	8	16	8	17	8	16	13	27
Total	**48**	**100**	**48**	**100**	**48**	**100**	**48**	**100**
Annual Agriculture income								
Up to Nrs 50,000	10	21	15	31	28	58	20	41
Nrs 50 000 to 1, 00,000	5	10	16	33	15	31	12	25
Nrs 1, 00,000 to 1,5 0,000	10	21	10	21	3	7	13	27
More than 1,5 0,000	23	48	7	15	2	4	3	7
Total	**48**	**100**	**48**	**100**	**48**	**100**	**48**	**100**

Analysis of pesticide residues- In total, 24 samples of high value crops were collected from eight different districts of Nepal. 6 samples of tea were collected from Jhapa and Illam districts, whereas 6 samples of vegetables (brinjal and tomato) were collected from Bara and Kavre. Similarly, six 6 samples were collected from Gumli and Lalitpur and 6 samples of honey were collected from Chitwan and Nawalparasi. These high value crops were analyzed for pesticides by using GC-

Table 4. Analytical result of pesticide residue level in Tea

Pesticide analyzed	Tea samples (J1, J2, J3 IL1, IL2, IL3)	Vegetables (SN 1 SM 1 SP 1, DU1 DU2 DU3)	Coffee (CGR, CGH, LGC, CGT, CLT, CLP)	Honey (HCC1, HNM 2, HCC 3, HNJ 1, HCR 2, HNM 3)
Aldrin	ND	ND	ND	ND
α-BHC	ND	ND	ND	ND
ß-BHC	ND	ND	ND	ND
γ-BHC (Lindane)	ND	ND	ND	ND
α-Chlordane (cis)	ND	ND	ND	ND
γ -Chlordane (trans)	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND
2,4'-DDT	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND
A-endosulfan I	ND	ND	ND	ND
B-endosulfan II	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND
Endrin	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND
Heptachlor epioxide	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND
Oxychlordane	ND	ND	ND	ND

Note: ND – At detection level of 0.7 mg/kg

MS. The results of pesticide residues analysis showed that none of the pesticides were found at the detection level of 0.7 parts per million. The list of pesticide analyzed is given in Table 4.

Pests problem were the highest in tea followed by vegetables, coffee and honey. The common pests in high value crops along with their management practices are given in table (Table 4). According to respondents, the damage of different crops by pests if not pesticides and agro-chemicals applied were 30% in tea, 25% in vegetables, coffee 15% and honey 20%. Majority of farmers were using pesticides and other agro-chemicals use once started farming. The average duration of pesticide and other agro-chemicals use in tea was 19 y/rs, vegetables 13 yrs and in coffee was 10 yrs and honey 7 yrs. Farmers were using twenty 7 types of pesticides in tea, for vegetables twenty 4 types of pesticides and agro-chemicals were found to be applied. In case of coffee no pesticides and agro-chemicals have been found to be applied but for honey 6 agro-chemicals were in practice. Since, farmers were found to be dissatisfied with IPM approach for pest control, IPM practice in controlling pests were less practiced. The current field pest management practice like Integrated Pest Management (IPM) has adopted in tea 10%, Coffee 30 %, honey 20 %, vegetables 10 %).

Farmers were aware of health hazard of pesticides/agro-chemicals (95% tea, 80% vegetables, 80 % coffee, 75% honey). Interestingly, only male were found to be handling of pesticides and agro-chemicals. No any new pests were reported in crops that could damage the high value crops significantly. Additionally, the training to decrease pesticide use in agriculture (such as IPM) and use of alternatives pesticide such as biopesticides and equipment handling for safety were found to be demanded by farmers.

The most common types of pests and diseases as well as pesticides used in in different high value crops are given in Table 5.

Conclusion

Different pests and diseases were creating problems for agro farmers, who were involved in high value crop production. Field survey results reveled that there were different pesticides used in tea and vegetables to control different types of pests. However, in coffee and honey no pesticides were reported to be applied. Banned pesticides were not observed in the field survey neither in the laboratory analysis result. In other hand, the results revealed that loopers in tea, borers in coffee, fruit fly in vegetables and mites in beekeeping were the major pests. Pesticides and some other agro-chemicals used was one of the most applied techniques for the management of pests. Pesticide residue analysis result in high value crops showed that it was below the detection level of 0.7 ppm in all analyzed samples.

Table 5. Common Pests in high value crops and their management practices

	Pests/ Diseases	Common Pesticides Applied /Management practices
Common pests/disease in Brinjal		
1.	Brinjal fruit and shoot borer	Methyl parathion, Rogor, Thiodan, Devicyper, Jackpot 10, Nurami, Ammo, Devikol
2	White fly	Nuvan
3	Aphid	Devikol, Dhanuka, Gajani,
4	Melon thrips	Dhanuka,
5	Army worm	Super lethal, Dolphin
6	Cut worm	Gajani
7	Spotted beetle	Anumida
Common Pests/Diseases in tomato		
1	Helicoverpa	Decis, Silcord, Dolphin, Superlethal, Ammo
2	Aphid	Devikol, Dhanuka, Gajani,
3	Leaf minor	Rogor, Thiodan, Devicyper, Record, Super D
4	White fly	Nuvan
5	Late blight	Diethan M 45, Krilaxyl
6	Leaf curl virus	Nuvan
7	Wilting	Anumida
8	White grub	Methyl parathion , Devimono
9	Brown rot	Diethan M 45
Common pests/diseases in Tea		
1	Green Fly, Looper, Red slugs, Thrips Aphids, Flushwormes etc.	Thiodane, Orthene
2	Tea Mosquito, Thrips	Farsa, Gem
3	Jassids, Aphids	Flash, Kinalaux
4	Catterpillar, thrips, Red spider, pink scarlet and purple mite	Omite, Ripcord
5	Green Fly, halopaltis, Thips, Looper, Jasids, Caterpillar	Monosil
6	Tea mosquito	Malathion
7	Thrips, Aphides, worms etc.	Propanophos
8	Mites and other insect	Emidagold, Josh
9	Tea mosquito, Jassids, Fly Iarvae	Nuvan
10	Mosquitos, fly larvae, Aphids other insect and termites	Durmet
11	Dicot/Broad leafs, of Dicot/Broad Leafs, Prevent Pre and post emergence of weeds, Broadleaf weeds	Gramoxone, Round up, 2 .4 D
12	Red Rust	Blitox
13	Fungus Infestation	Captaf
14	Wide range of Foliage disease	Dithane, PenncoZeb
15	Fungus disease and infestation	Unilux
16	Mite	Dicofoll, Devicol
17	Mites, spider	Omite, Sulphex
Common pests/disease in coffee		
1	White stem borer	Manual clearance
2	Red stem borer	Manual clearance
3	Coffee rust	Manual clearance
4	Goad weed (Ageratum conyzoids)	Manual clearance
5	Jungle rice (Echinoochloa spp)	Manual clearance
Common pests/disease in honey		
1	Tropilaelaps cleareae	Apistan, formic acid
2	Varroa jacobsonii	Formic acid and sulfur smoking
3	European foulbrood	Teramycin and tetracyclin
4	Acarapis woodi	Formic acid and sulfur
4	Nosema	Sulfur smoking, camphous
5	Wax moth and sornet	Prevention/management

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