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Health cost and economic loss due to excessive pesticide use in apple growing region of Jammu and Kashmir

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Abstract

Jammu and Kashmir, the northern most state is one of the most important apple producing states of India. The pesticide trade has increased tremendously in the region which affects both environment and human health. This paper presents and estimated the cost of illness resulting from pesticide-related acute health symptoms in the apple growing region of Jammu and Kashmir. Apple growers reported as many as 15 serious issues and symptoms associated with the use of pesticides in the region. The study employs Cobb-Douglas linear production function, Cost of Illness method and Contingent valuation method through Willingness to Pay for analysing the requisite data. The study reveals that pesticide sprays and chemical fertilisers contribute 17.25 and 24.23 per cent to the overall apple production in the region. There is a decrease of 7.72 per cent cost of illness if the respondent who applies pesticides is a male and similarly, age of the respondent is having 0.35 per cent impact and incurs huge cost for the illness due to exposure. Similarly, household willingness to pay (WTP) for safer pesticides states that highly qualified respondents in the area are ready to pay 63.59 percent more than the less qualified/illiterate respondents.

Key words: Pesticide use, disposal, empty container, willingness to pay, cost of illness, production, apple

Introduction

Food industry is under severe threat due to pest infestation in the world, and it was found that more than 45 per cent of food production is lost due to pest infestation annually (Abhilash and Singh, 2009). Role of pesticides is increasing in agricultural/horticulture, because, it has enhanced agricultural productivity, reduced insect-borne and endemic diseases, and is protecting plants and animals from severe damages (Ecobichon, 2001). But due to increased use and overdose of pesticides, threats to agricultural workers and food consumers, and environment are increasing day by day. Inappropriate use of pesticides can have negative effects on human health and agro-ecosystems, damage wildlife habitats, create pesticide resistance in insects and to diseases, and pollute ground and surface water resources as well (Recena *et al.*, 2006; Polidoro *et al.*, 2008; Pimental and Paoletti, 2009; Shormar *et al.*, 2014). In third world countries, the application of a wide variety of pesticides to crop plants is necessary due to high temperature and humidity as these climatic conditions lead to rapid multiplication of insects and diseases (Kannan *et al.*, 1992; Abhilash and Singh, 2009). In addition, the prevalence of multiple cropping systems (two or three crops each year) leads to increased pesticide use compared with agricultural practices in temperate regions. For economic reasons, in tropical agricultural systems of developing countries, many older, non-patented, inexpensive chemicals are used extensively. These compounds are often highly toxic, environmentally persistent, and capable of causing acute health problems and environmental contamination (Ecobichon, 2001). The World Health Organization (WHO) reported that 20 per cent of pesticide use in the world is concentrated in developing countries and that misuse poses a significant threat to the human health and environment (Hurtig *et al.*, 2003).

Apple is an economically important fruit in India and the World as whole. Globally, apple is produced on an area of 4.7 million ha with 75.4 million tonnes of production. The leading producers of apple in the world are China (47.7 %), USA (5.7 %), India (3.8 %) and Turkey (3.6 %), respectively. Inspite of India's third rank in terms of production (FAO, 2014) its exports are still not at a satisfactory level, corresponding to its status in the world. The reasons can be many, such as cultivation of traditional varieties, quality of apple in terms of colour and shelf life, characteristics of apple farms, excessive use of pesticides and infrastructural facilities.

Excessive use of the pesticides in agriculture has enormous ill-effects on human health and other agro-ecosystems. The use of pesticides in agricultural farms frequently leads to acute health symptoms like headaches, skin irritation, eye irritation, respiratory and throat discomfort, *etc.* Mancini *et al.* (2005) found 16.4 per cent asymptomatic, 39 per cent mild poisoning, 38 per cent moderate poisoning, and 6 per cent severe poisoning among the household due to excessive pesticide use in India. Exposure to high-dose pesticides have reported health problems such as immune-suppression, hormone disruption, diminished intelligence, reproductive abnormalities, and cancer (Gupta, 2004). Excessive use of pesticides is a sound reason for carcinogenic threat related to human health (Pimentel, 2005). According to the EPA, 1999 report, there are probable linkages between long-term pesticide exposure and human health problems like neurological effects, endocrine disruption, reproductive health and cancer.

In addition to the negative implications and effects on human ecosystem, the excessive use of pesticides have posed immense negative effects on the interacting factors like soil, surface and ground water, crop productivity, micro and macro flora and fauna in the environment (Pimentel, 2005). Traditionally, economic analysis weighs the conventional costs-benefits of pesticide in to consideration. In this approach, only the visible benefits are taken care of and it ignores the negative effects of pesticides on ecosystems and human health. In addition, possible linkages among pesticide use, international transport, and arctic degradation are emerging issues (Cone, 2006). Likewise, human health impacts and social implications (like suicide attempts by consuming pesticides, unintentional poisoning by contaminated foods, *etc.*) of pesticides are also not adequately considered. Moreover, the cost does not capture the physical and psychological pain and discomfort experienced as a result of acute and long-term illnesses (Pimentel, 2005).

In India; Jammu and Kashmir, Himachal Pradesh, Uttrakhand and Arunachal Pradesh are the major apple producing states. The two important states namely Jammu and Kashmir and Himachal Pradesh accounts for 96.57 per cent of the total production and about 89.16 per cent of the total area under apple in India. As far as productivity of apple is concerned Jammu and Kashmir has the highest productivity (12.25 tonnes/ha) followed by Himachal Pradesh (4.45 tonnes/ha) and Uttrakhand (2.70 tonnes/ha) (NHB, 2017) (Table 1).

State scenario of apple: Apple is the principal fruit crop of Jammu and Kashmir and accounts for 1.64 lakh hectares of area in the state. The annual apple production in the state was 20.03 lakh MT (2019-20). Average yield of commercially important apple cultivars per unit area was highest in the country ranging between 11-13 tonnes/ha, but it compares poorly to the yields of 20-40 tonnes/ha in horticulturally advanced countries of the world.

Table 1. State-wise area, production and yield of apple (2019-20)

State	Area (000, ha)	Production (000,MT)	Yield (tonnes/ha)
Jammu and Kashmir	136.54 (49.24)	1672.72 (74.62)	12.25
Himachal Pradesh	110.68 (39.92)	492.10 (21.95)	4.45
Uttrakhand	25 (9.02)	67.48 (3.01)	2.70
Arunachal Pradesh	4.73 (1.71)	7.35 (0.33)	1.55
Others	0.32 (0.12)	2.05 (0.09)	6.41
Total	311.5 (100.00)	1914 (100.00)	8.08

Figures within parentheses indicate percentages
Source: National Horticulture Board (NHB)

In Jammu and Kashmir region, for enriching the quality and quality of apple, both organic and inorganic inputs like chemical fertilizers, fungicides, acaricides, and pesticides are utilised on a large scale and pesticide usage is playing a significant role in this domain. Thus, pesticides applied on apple together constituted about 83 per cent of all the agro-chemicals utilized in the state. On the one hand, there is very significant impact of pesticides on crop industry especially apple, but on the other hand these pesticides have increased the cost of illness and have reduced the environmental quality *viz.*, reduced the water quality, polluted the water bodies and have increased air pollution, soil pollution levels in the region and even some beneficial species have reached to the state of extinction in the region of Jammu and Kashmir. It is in this backdrop the present study was carried out to observe and estimate the role of pesticides in production of apple, the cost of illness necessitated due to excessive use of pesticides and the negative externalities owing to overutilization of pesticides and the willingness to substitute the existing dreadful pesticides with the environment friendly pesticides.

Methodology

Study area: The study was conducted in three zones of Jammu and Kashmir by a multistage random sampling. In the first stage, two blocks from each of the three zones were selected and data on apple crop was collected. The blocks were: Shadimarg and Zainpora from South Kashmir, Nagam and Harwan from the Central Kashmir and Zainageer and Rafiabad from the North Kashmir of valley. In the second stage, 2 to 3 villages were selected and in the third stage 100 respondents were selected randomly from each of the sampled zones forming a sample of 600 in totality.

Econometric models: The factors affecting pesticide use at farm level was examined by fitting Cobb-Douglas linear production function. In the model, explanatory variables was regressed upon the dependent variable. Various independent variables were considered in the model.

The production function fitted is of the form.

$$Y = a + b_1P + b_2L + b_3F + b_4FYM + b_5Ar$$

Where,

Y = Total number of apple boxes produced
a = efficiency parameter
P = Pesticides used (No.)
L = Labour utilised (No. of days)
F = Fertilizer used (quantity in quintals)
FYM = Farm yard manure (quantity in quintals)
Ar = Area under apple

Cost of illness model: In order to conduct the present study "health effect" or "being sick" were defined as the incidence of any one or more than one short-term acute health symptoms during or within 48 hours of pesticide application. The method was estimated by adding up the days lost through pesticide-induced sickness and the costs of medical care treatment-such as consultation fees, medication costs, travel costs to and from health care facilities, time spent in travelling, and dietary expenses resulting from such illness (Atreya *et al.*, 2013). The model utilised for calculating cost of illness was as:

$$COI = \alpha+\beta_1x_1+ \beta_2x_2+ \beta_3x_3+ \beta_4x_4+ \beta_5x_5+ \beta_6x_6+ \beta_7x_7+u_i$$

Where, COI = Cost of illness, α = intercept, x_1 = Gender of respondent, x_2 = Age of respondent, x_3 = Frequency of pesticides application, x_4 = Exposure to fungicides, x_5 = Farm experience of the respondent, x_6 = Number of sprays done, x_7 = Education of the respondent

Willingness to pay model: The contingent valuation methods like willingness-to-pay (WTP) approach was adopted for assessing the impact of pesticide use on the local environment. It is likely that when a person is asked how much he/she would be willing to pay for safe environment, he/she may consider much of the environmental impacts incurred in revealing his/her true willingness to pay along with other costs such as medical treatment and defensive costs, pain and discomfort. An open-ended WTP questionnaire for "new brands" hypothetical pesticides "degradable packaging" was also separately administered. It was assumed that the new pesticides were similar to the ones currently in use in terms of their efficacy at killing pests; the only difference was that the new pesticides were harmless in terms of human and environmental health. The algebraic expression for the items of willingness to pay was as:

$$WTP = \alpha+\beta_1 Ag+ \beta_2 Ed+ \beta_3 Ge+ \beta_4 TRF+ \beta_5 FM+ u_i$$

Where, WTP = willingness to pay (for bio-degradable packaging), α = intercept, Ag = Age of the respondent, Ed = Education of the respondent, TRF = Total Rupees fetched, FM = Family members

Results and discussion

Possession of land and property is positive sign of having a decent standard of living for a household. Table 2 presents the land inventory of the respondents in the sampled area. It is very evident from the table that 82.16 per cent of respondents in the sampled area possessed 4-8 kanals of land and rest 17.84 per cent of respondents possessed land greater than 8 kanals. Similarly, operational holdings of the respondents in the sample ranged between 4-5 kanals. Likewise, 95.66 per cent of respondents in the sampled area cultivated rice on 2-3 kanals of land in comparison to 79.83 per cent and 86.67 per cent cultivated maize and vegetables on 0.001 and 0.02 kanals of land, respectively in the sampled area. The oil seeds and vegetables as Rabi crops were cultivated by 95.16 and 86.67 per cent respondents on 1-2 kanals and 0.02 kanals of land, respectively. Among fruit crops apple was cultivated by 99.5 % of respondents on 4-5 kanals of land followed by pear (97.0 %) on 1 kanals of land and peach (95.5 %) on 0.01 kanals and cherry (82.16 %) on 0.01 kanals of land by the respondents in the sampled area. It is clear from the table that the cropping pattern in the sampled area is dominated by fruit crops especially apple.

Table 2. Average land inventory of the respondents in the sampled area

S. No.	Land use class	Area (kanals)	Responses (%)
1	Total holding size	4-8	493 (82.16)
2	Fallow land	0.02	573 (95.5)
3	Pasture land	0.04	594 (99.0)
4	Operational holding	4-5	493 (82.16)
A	Kharif		
	Rice	2-3	574 (95.66)
	Maize	0.01	479 (79.83)
	Vegetables	0.02	520 (86.67)
	Legumes	-	-
B	Rabi		
	Wheat	-	-
	Oilseeds	1-2	571 (95.16)
	Vegetables	0.02	520 (86.67)
C	Fruits		
	Apple (Owned/leased)	4-5	597 (99.5)
	Pear	01	582 (97.0)
	Peach	0.01	573 (95.5)
	Cherry	0.01	493 (82.16)
	Others	-	-

Source: Field Survey

From the data collected from field, it becomes evident from table 3, majority of the respondents (96.33 %) possessed 6-8 kanals of land and 84.0 per cent respondents leased out 2-3 kanals of their land to others. Similarly, 95.66 per cent of respondents were having availability of irrigation facility to 5-6 kanals of land in the sampled area.

Table 3. Average acreage of land cultivated by the respondents in the sampled area

S. No.	Land type	Unit (kanal)	Responses (%)
1	Owned	6-8	578 (96.33)
2	Leased in	2-3	504 (84.0)
3	Total cultivated area	5-6	594 (99.0)
4	Irrigation status- irrigated/ unirrigated/partly irrigated	5-6	574 (95.66)

Source: Field survey

Table 4 presents the educational attainment of the respondents in the sampled area. From the table it is evident that 40.17 per cent of the respondents were having primary or middle level of education, means that they were having less knowledge about the negative impacts and externalities of the pesticides followed by 29.97 per cent who were totally illiterate in the sampled area. Similarly, only 20.50 and 9.67 per cent of respondents were having high school and graduation and above attainment of education in the sampled area.

Table 4. Educational status of respondents in the sampled area

Educational status	Average	Percentage
Illiterate	178	29.67
Primary/Middle	241	40.17
High school	123	20.50
Graduate and above	58	9.67

Source: Field survey

During the apple harvest there is a residual of apple produce everywhere in the orchards. There are numerous ways to dispose of the residual apples so that the trees and environment can be saved from the ill-effects or negative externalities of this residue. If this residual produce is not disposed off at proper time, lot of inconveniences may occur to the apple producers or even to other living creatures in the ecosystem. Table 5 shows the ways and means that the respondents use to manage the apple residue in the sampled area. From the table, it can be observed that majority (35.5 %) of respondent's used this residual for livestock feeding. Similarly, 12.17 per cent, 8.83 per cent, 17.17 per cent of the respondents disposed the residue through burning, making manure, for pollination purpose for the next season, respectively.

Table 5. Methods utilised for manging the apple residue by the respondents in the sampled area

S. No.	Methods used	Responses (%)
1	Burning	73 (12.17)
2	Making manure	53 (8.83)
3	Livestock feeding	213 (35.5)
4	For pollination	103 (17.17)
5	Other	158 (26.34)

Source: Field survey

After green revolution, pesticides usage has revolutionised the whole scenario of agricultural production and productivity and same is the case with horticulture sector as well. The turnover of the pesticide industry is in millions of crores and is increasing each passing day. This is because the conversion of agricultural land to horticulture is at increasing pace not only in India but throughout the world, because of later being highly remunerative.

The horticulture sector is mainly dependent on pesticides a for its growth and it has played a great role in enhancing the living pattern, lifestyle and livelihood of the people all over the globe. Though having played a positive role, it has its negative side as well; it has deteriorated the soil salinity, texture, quality *etc.* and has at the same time polluted the air, water which in turn has destroyed many beneficial species on earth. Last but not least, the pesticide usage has highly negative impact of human health. Table 6 shows the impact of pesticide usage on human health in the sampled area. From the table it is very evident that 34.67, 34.0, 17.16, 50.17, 18.17, 53.5, 52.0, 18.33, 14.83, 17.33, 40.83, 13.0, 5.33, 3.16 and 8.17 per cent of respondents suffered from headache, skin-irritation, chest-pain, eye-irritation/burn, throat-discomfort, weakness, hand-crack, excessive-sweating, muscle-pain, nausea, dizziness, vomiting, unconsciousness, stomach-pain and itching, respectively.

Table 6. Incidence of acute illness of individuals due to spraying of pesticides/insecticides in the sampled area

S. No.	Acute illness	Responses	(%)
1	Headache	208	34.67
2	Skin irritation	204	34.0
3	Chest pain	103	17.16
4	Eye irritation/burn	301	50.17
5	Throat discomfort	109	18.17
6	Weakness	321	53.5
7	Hand crack	312	52.0
8	Excessive sweating	110	18.33
9	Muscle pain	89	14.83
10	Nausea	104	17.33
11	Dizziness	245	40.83
12	Vomiting	78	13.0
13	Unconsciousness	32	5.33
14	Stomach pain	19	3.16
15	Itching	49	8.17

Source: Field survey

The pesticides are packed in bottles, cartoon packs and silver polythene bags. After using pesticides, pakaging materials need proper disposal, but due to ignorance and irresponsibility of the growers, these are not properly disposed off. Table 7 shows the ways of disposing of these wrappers/bottles in the sampled area. From the table it can been seen that majority (52.16 %) of the respondents threw away these on the farm followed by17.17 % respondents piled and sold these bottles to the street vendors in the sampled area. Similarly, 5 and 16.83 % of respondents due to their ignorance threw away in the town or village or into the waterbody passing by in the sampled area. Only 2.33 per cent of the respondent burried these wrapper or bottles in the farm in the sampled area, which is the proper method and is praiseworthy.

Table 7. Responses regarding disposal of empty insecticide bottles or wrappers in the sampled area

S. No.	Disposal	Responses	Percentage
1	Throw away on farm	313	52.16
2	Throw away in town or village	30.0	5.0
3	Pile and sell	103	17.17
4	Bury in ground in farm	14	2.33
5	Bury on farm	39	6.5
6	Throw into the waterbody passing nearby	101	16.83

Source: Field survey

Table 8 shows the recommended spray, their quantity, market price and the cost/ha of different pesticides by the SKUAST-K (Agricultural University of the state). From the table it can be concluded that the University has fixed a calendar schedule of all the sprays and is making suitable adjustments and requisite change in the schedule as per the situation and climatic condition prevailing in the valley. The sprays are done as per the growth stage of the apple fruit and almost 11-13 sprays are recommended by the state agricultural university.

From the analysis of Table 9, the coefficients reveal that the contribution of fertiliser/ ha to the cultivation apple in the sampled area is 24.2 % and the contribution of area under apple was estimated 25.27 %. Farm yard manure/ha contribution was not found so significantly high and its contribution in apple production was found out to be 0.03 per cent in the sampled area, the reason being the decline in the livestock population in the Kashmir valley in general and the sampled area in particular. Likewise the contribution of labour days/ha was found out to be very less and from the model estimates, the contribution was calculated at 0.001 % and the contribution of pesticides sprays was calculated from the model estimates of Cobb-Douglas production function at 17.25 %, which has proved the hypothesis that pesticides are playing a significant and positive role in enhancing the apple productivity in the sampled area.

Table 10 shows that cost of illness was highly related with the gender of the respondent and there was a decrease of 7.72 % cost of illness if the respondent who applied pesticides was a male. Age of the respondent had 0.35 % role meaning that old people are very sensitive to the exposure of pesticides and it incurs huge cost for the illness due to this exposure. Similarly, frequency of pesticide application had a significant effect on the cost incurred on the illness and the value of the cost incurred by the respondents was 4.91 % and exposure to pesticides significantly contributed (4.27 %) to the cost incurred on health of the respondents in the sampled area. Farming experience is a significant attribute in the pesticide application, with the increase in farming experience there was reduction of 0.83 % in the cost of illness of the respondents. While number of sprays were positively affecting the cost of illness and there was 10.93 % increase in annual cost of illness with the increase in number of sprays in the sampled area. Similarly, with one stage (illiterate to primary, primary to secondary, secondary to college level and college level to university level) increase in education leads to 18.25 % decline in cost of illness. The standard error of all these statistical coefficients was less than the half of the values of the coefficients and all the statistical coefficients except gender of the respondent, farming experience and education level were statistically insignificant.

The R^2 value of this model is 0.52, which implies that that there is about 52 per cent impact of all these variables on the dependent variable as is shown in Table 11.

Table 12 shows the respondents willingness to pay for alternate and least harmful pesticides in the sampled area. From the table it is very clear that younger respondents were willing to pay 8.78 per cent more to buy the new and safe brands, because of their awareness and knowledge about the ill-effects and negative externalities of the hazardous pesticide application in the area, educational attainment a positive and highly relevant factor to reduce the morbidity and negative effects of the pesticides has its significant role in the sampled area too as the highly qualified respondents in the area ready pay 63.59 percent more than the less/illiterate respondents. Income is a dominant and

Table 8. Cost of sprays at the farmer's field (Rs./ha)

S. No.	Stage	Name of the Spray	Quantity	Rate	Cost
1	Dormant	HP Spray oil	63.0 Lt	Rs.135/Lt	Rs. 8505/-
2	Green Tip	Superstar + Roger	2.50 kg	Rs.1780/kg	Rs. 4450/-
			2.50 kg	Rs. 410/kg	Rs. 1025/-
3	Pink Bud	Superstar	2.50 kg	Rs.1780/kg	Rs. 4450/-
4	Petal Fall	Score	1.75 kg	Rs. 3622/kg	Rs. 6339/-
5	Fruit Let	Dithane M-45	16.50 kg	Rs. 350/kg	Rs. 5775/-
6	Fruit Development-I	Tata Ergon	2.00 L	Rs.4460/L	Rs. 8920/-
7	Fruit Development-II	Governor + Coroban	1.20 L	Rs. 6420/L	Rs. 7740/-
			2.50 L	Rs. 308/L	Rs. 770/-
8	Fruit Development-III	(Dithane M-45 + Roger)	16.50 kg +	Rs. 350/kg	Rs. 5775/-
		Maiden	2.50 L+2.00 L	Rs. 410/L	Rs. 1025/-
9				Rs.1825/L	Rs. 3650/-
10	Fruit Development-IV	Wave	2.50 kg	Rs. 1050/kg	Rs. 2625/-
11	Pre-Harvest	Z-78	16.50 kg	Rs. 494/kg	Rs. 8151/-
	Total				Rs. 69164/-

Table 9. Composition/contribution of different variables to apple production in the sampled area

Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	R^2
	B	SE	Beta			
(Constant)	-177.278	127.842		-1.387	0.166	0.871
Total area under apple	25.341	17.405	0.023	1.456	0.146	
Fertilizer/ha	24.231	16.304	0.013	-1.132	0.129	
FYM/ha	0.033	0.001	0.954	45.036	0.000	
Labour day/ha	-0.001	0.001	-0.043	-2.063	0.040	
Number of sprays	17.252	11.054	0.023	1.561	0.119	

Table 10. Regressants on cost of illness in apple cultivation in the sampled area

Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	SE	Beta		
Constant	853.838	186.882		4.569	0.000
Gender	-7.742	36.034	-0.009	-0.215	0.830
Age	0.357	1.373	0.013	0.260	0.795
Frequency of pesticide application	4.912	2.249	0.090	2.184	0.029
Exposure to fungicides	4.272	16.293	0.011	0.262	0.793
Farming experience	-0.839	1.562	-0.027	-0.537	0.591
Number of sprays	10.932	14.536	0.031	0.752	0.452
Education level	-18.252	36.319	-0.021	-0.503	0.615

a. Dependent Variable: Cost of illness

Table 11. R^2 value of the model

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.100[a]	0.520	-0.002	435.93618

Table 12. Willingness to pay for new brands of pesticides to replace the earlier ones

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	SE	Beta		
(Constant)	2023.679	256.376		7.893	0.000
Age	-8.781	3.574	-0.100	-2.457	0.014
Education level	-63.593	116.821	-0.022	-.544	0.586
Total rupees fetched/ha	1.685E-006	0.000	0.001	0.019	0.985
Family members	-1.664	11.471	-0.006	-0.145	0.885

a. Dependent Variable: New-brands

highly significant factor to purchase the pesticides and in the sampled area, the respondents were willing to pay 1.68 per cent extra for purchasing a new brand which is environment friendly and less harmful to the biotic component of the ecosystem. Family size is a determining factor in deciding the purchase of the groceries and other daily machinery and equipment's for the horticulture purpose. Purchase of pesticides is also dependent on the family members of the household, therefore, a household with less number of members were willing to pay 1.66 percent more to buy new brands of the pesticides those are less harmful for environment than the households with large family size because, there always remains diversity and differences of opinion which affect any household decision.

Pesticides are very important input in agricultural/horticultural sector and is playing a pivotal role in enhancing the quality and productivity of the fruit crops or agricultural crops everywhere. The study, though supports the judicious use of pesticides and chemicals in the region but due to illiteracy, ignorance, lack of knowledge, lack of exposure to scientific techniques and procedures; there is huge mismatch and huge demand-supply gaps prevalent in the application of these chemicals and pesticide, due to which the respondents themselves observe and recorded huge negative externalities associated with the improper use of these pesticides. Another reason that can be attributed to the pollution of environment and intern to health effects of the human beings is fragmented and scattered land holdings prevalent in the sampled area. The study also supports that 35.5 per cent of the respondents were those who provide the apple residue to the livestock as feeding and 26.34 per cent left it uncovered in the orchards and other places which ultimately becomes a cause for health issue and environmental issues in the region. By using Cobb-Douglas production function, the results supported that pesticide sprays and chemical fertilizers contribute 17.25 and 24.23 per cent to the overall apple quality and quantity in the region. Cost of illness method revealed that there was a decrease of 7.72 per cent cost of illness if the respondent who applied pesticides was a male and similarly, age of the respondent was having 0.35 per cent impact and incurred huge cost for the illness due to the exposure. Similarly, household willingness to pay (WTP) for safer pesticides states that highly qualified respondents in the area were ready to pay 63.59 % more than the less/illiterate respondents.

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