Research Article

Pesticides Use in Jammu and Kashmir: Invisible Costs & Willingness to Pay for Available Alternative Measures

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Abstract

Excessive pesticide posed severe negative impacts to health of human beings, ecology and ecosystem services. Available research and studies on ecological valuation and sustainability have undertaken and analysed individually ill-effects of human health or ecological degradation and degeneration, but they fail to present a cost analysis of indirect/hidden/invisible costs associated with the use of pesticides to the health of human beings and to environmental services as well. Therefore, present study attempts to present a scenario of invisible costs associated with pesticide usage in Jammu and Kashmir region of Indian union and it was worked out that invisible costs of pesticide use was found out significant. Defensive expenditure method was used to estimate costs incurred on the health issue and items purchased for curing such ailments and also time lost due to illness caused owing to pesticide usage in apple orchards of the region. Furthermore, contingent valuation method through Willingness to Pay Model was employed to know willingness of apple growers to use biodegradable packaging to replace existing plastic and metal coated packaging material for reducing waste in canals, streams orchards and other open spaces. The results reveal that number of sprays are positively affecting the defensive expenses and there a 7.63 per cent decrease in defensive expenses with the reduction in number of pesticides. Similarly, with one stage increase in education level (illiterate to primary, primary to secondary, secondary to college level and college level to university level) leads to 1.35 per cent decline in defensive expenses and 2.5 per cent more willing to buy biodegradable packaged pesticides than the earlier ones. Likewise male are willing to pay 3.69 per cent more to buy a pesticide in the biodegradable bags than the female.

Keywords: Risk, health, hazards, invisible-costs, production, replacement

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Introduction

From past few decades, pesticides use has increased in agriculture to either improve yield or to secure yields from different pests and insects. Excessive use of pesticides has posed tremendous threat to environment and ecosystem and played a catastrophic role to contaminate every component of our ecosystem; be it water bodies or even soil and also increased threat to human health. Globally, there are approximately twenty six million poisoning case every year due to the use of excessive pesticides among them only three million gets a chance to be hospitalised, two million cases are reported as death cases and about seven million cases report chronic illnesses [1]. During 2015-16 in India, over 20,000 people died due to pesticide self-poisoning. There was a steady rise in suicide deaths from 1981, which has reduced by a small fraction in 2001 due to overall pesticide suicide rates in the country [2]. Excessive pesticide use has reached a mark when human well-being and loss of productivity has remained stagnant and it has increased medical expenses heavily. Ignorant and less qualified farmers apply pesticides indiscriminately without following any scientific recommendation. Pesticides they use are highly risk prone because of their sub-standard nature and it was found that about one-third of pesticides they use are spurious/sub-standard in nature. Using such kind of pesticides possess numerous environmental externalities. The invisible costs of pesticide are usually omitted from the economic analyses of any product that is either beneficial or harmful for agricultural sector. Evidences from research and

scientific investigations showed pesticide's pose extreme negative effects on human health in crop production [3], [4], [5], [6], [7], [8], [9], [10] and [11]. There are studies that valued menace of pesticides to human health. Studies across countries like India, Nepal and Africa [10], [8], [9] and [11] have analysed and valued the ill-effects of pesticides and presented that a small fraction of costs are involved in health aspect of the farmers. [8] pointed out that less health costs can prove sub-optimal on pesticides decision making, [12] when a farmer is given choice for choosing one among increase in health costs or increases in yield, the farmer will straightaway go with pesticide use. [13] analysed in Sahel that increase in health costs with time lost in curing such ailments, due to pesticide use per farmer for each year were estimated to $0.46, similarly, loses to livestock due to intoxication of pesticides were estimated at 0.5 per cent per year for small ruminants and 0.2 per cent for cattle, which accounts for US$0.33 per animal and costs incurred on obsolete pesticides accounts for $0.06 per ha. [14], were of the opinion that health costs incurred by the farmers are inseparable from production cost and are directly responsible for their less production and production activities and therefore should be treated as part of the production costs instead of considering as externalities. The available literature and studies on economic valuations of ecology and environment have either accounted health costs or environmental restoration, but hardly any study is there which takes into consideration the both aspects and has highlighted the hidden or invisible costs associated with the use of pesticides in the horticulture/agriculture. Present study, therefore, takes a lead to address the issues and invisible costs associated with the excessive pesticide use and also take steps and measure to reduce/combat the problems by pay some extra charges to restore the existing deteriorated situation of the environment.

Research Methodology

A multi-stage sample pattern was followed for collection of data from the sampled area. In first stage, two blocks from each of the three zones was identified and selected for collection of data on apple crop. Selected blocks include; blocks Shadimarg and Zainpora from South Kashmir, blocks Nagam and Harwan from the Central Kashmir and blocks Zainageer and Rafiabad from North Kashmir of valley. The selection of these blocks was done, owing to more inclination of the farming community towards diversification of agriculture through apple cultivation and represent an aggregation of Kashmir valley that form extensive territorial zones characterized by dominance of common physical, economic and social peculiarities. In second stage, a cluster of 2 to 3 villages was outlined from the selected blocks that fall within a radius of 5 to 10 kilometres from the tehsil/block headquarters were randomly selected. In third and last stage of sampling, a complete list of respondents in selected villages was compiled along with their land holdings. Thereafter, 100 respondents was selected randomly from each sampled zones. Hence a total of 600 apple growers was selected randomly for the data collection.

Econometric Models

Defensive Expenses Method

The method was used to assess negative impact and externalities there off due to heavy and excessive pesticide use. [15], [16], [17], [9], [18] used defensive expenditure model to assess the impact of pesticides on health of human beings. This method includes all costs pertaining to safety measures taken before going for spraying a pesticide. The expenditure incurred on items; covered in this method include face-masks, handkerchiefs, long-sleeved shirts/pants, hats, gloves and boots. The model specifications are as;

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

Where, DE = Defensive expenses (Expenditure on masks, handkerchiefs, long-sleeved shirts/pants, and sprayers), 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 Method

The willingness-to-pay (WTP) approach was adopted for assessing the impact of pesticide use on local environment. During the last round of survey, an open-ended WTP questionnaire for "new brands" hypothetical pesticides was also separately served to the respondents. The new pesticides were assumed to be similar to those of currently in use in terms of their killing effect; only different thing assumed was that new pesticides were less harmful to human health and ecological degradation. The algebraic expression for the items of willingness to pay were of the form as;

$$WTP = \alpha+\beta_1Ge+ \beta_2Ag+ \beta_3Ed+ \beta_4TRF+ \beta_5FM+u_i$$

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

Results and Discussions

Table 1 presents the details of family size in sampled area. The majority (32.67%) of respondents belong to households having 0-5 members followed (31.17 %) by 5-7 members in the sampled area. Similarly, only 0.67 per cent and 1.00 per cent of households were found where the family size ranges from 25-30 and 30 & above in the sampled area.

Table 1 Range of family members in the sampled area

S. No.	Family Members	Male	Female	Total	(%)
1	0-5	94	102	196	32.67
2	5-7	90	97	187	31.17
3	7-10	43	40	83	13.83
4	10-12	32	29	61	10.17
5	12-15	19	18	37	6.17
6	15-20	10	8	18	3.00
7	20-25	4	5	8	1.33
8	25-30	2	2	4	0.67
9	30 & above	4	2	6	1.00

Source: Field survey

Losses or post-harvest losses is one of the main concerns confronting the farmers nowadays. The losses can be associated with many reasons, but the major bottleneck for losses is due to the use of spurious or sub-standard chemical or pesticides. **Table 2** shows losses accrued to respondents in the sampled area. From the analysis of data presented in Table 2, it is very much evident that 89.5 per cent of respondent face almost three per cent loss during grading and packaging of the apple produce, and 95.5 per cent respondents are of the opinion that they face approximately 2 per cent losses at field while plucking or transporting the apple produce. Similarly, 98.33 per cent of respondents are of the opinion that they face almost 1 per cent loss of their produce at harvesting stage and 90.5 per cent of respondents face 1 per cent loss of their total produce due to damaged fruits.

Table 2 Losses/consumption pattern of different respondents in the sampled area

S. No.	Losses	In percentage terms	Responses (%)
1	At field	2.0	573 (95.5)
2	Damaged fruit	1.0	543 (90.5)
3	At harvesting	1.0	593 (98.33)
4	At grading/packaging	3.0	537 (89.5)
5	Others	-	-
6	Family consumption	0.02	595 (99.16)
7	Given as gift	0.01	597 (99.5)

Source: Field survey

Marketing of apple produce is one of the crucial determinants of fetching a remunerative price by a farmer. In Kashmir many marketing channels are operational for selling of apple produce. Farmers opt for many channels and sell their produce through the channel which is very fruitful and remunerative to them. **Table 3** presents marketing of apple produce by respondents in the sampled area. From the table it can be observed that 94.5 of respondents sell 18 per cent of their produce at Rs. 30/kg to pre-harvest contractors, 81.5 per cent of the respondents sell approximately 20 per cent of their produce at Rs. 35/kg through commissioning agent, 98.17 per cent respondents sell out 16 per cent of their apple produce at Rs. 35/kg through forwarding agents, 96.17 per cent of respondents in the sampled area sell out 33 per cent of their apple produce to post-harvest contractors at Rs.40/kg. Similarly, 98. 5 per cent, 80.0 per cent, 98.83 per cent and 81.17 per cent of respondents in the sampled area sold out their 6 per cent, 0.5 per cent, 0.1 per cent and 0.1 per cent of apple produce to Horticulture Production Marketing Corporation, processing industries, wholesalers and retailers at Rs. 42/kg, Rs. 40/kg respectively.

Apple industry being one of the main and dominant industries in the region of Jammu and Kashmir. Majority of the famers are directly or indirectly dependent of horticulture for their livelihood and sustenance. But in the recent past due to climate change issues and spurious and sub-standard pesticides and chemicals, farmers are suffering

heavily and their situation has become miserable. **Table 4** shows that 87.0 perc cent of farmers are satisfied with the apple cultivation in sampled area, only 1.0 per cent of respondents are highly satisfied with the apple cultivation. Similarly, 2 per cent of respondents are depressed with apple cultivation due to huge cost involvement in apple.

Table 3 Marketing of the produce of respondents in the sampled area

S. No.	Sold/Marketed to	Cost Rs./Kg	Percentage of produce sold	Responses (%)
1	Pre-harvest contractor	Rs. 30/-	18	567 (94.5)
2	Commissioning agent	Rs. 35/-	20	489 (81.5)
3	Forwarding agent	Rs. 35/-	16	589 (98.17)
4	Post-harvest contractor	Rs. 40/-	33	577 (96.17)
5	Horticulture Production marketing Corporation (HPMC)	Rs. 42/-	6	591 (98.5)
6	Processing industries	Rs. 40/-	0.5	498 (83.0)
7	Wholesalers	Rs. 40/-	0.1	593 (98.83)
8	Retailers	Rs. 40/-	0.1	487 (81.17)
9	Others	-	-	-

Source: Field survey

Table 4 Response of the respondents regarding the apple business in the sampled area

S. No.	Responses	Percentage
1	Depressed	588 (2.0)
2	Satisfactory	522 (87.0)
3	Good	60 (10.0)
4	High	06 (1.0)

Source: Field survey

Though pesticide use is very helpful for the farmers to increase productivity, quality of fruits and in turn economic welfare. Judicious use of pesticides and fertilisers is good for health of both biotic and abiotic components of the ecosystem, but over dose of pesticides and fertilisers can harm food web and food chain of this ecosystem. **Table 5** presents perception of respondents regarding over dose of pesticides on many beneficial species of insects in sampled area. From the table it is clear that, 95.5 of respondents in sampled area are aware about heavy utilisation of fertilisers and they know it is very harmful for many types of insects, compared to 3.67 per cent respondents who are of opinion that there is no harm to any kind insects beneficial for the farmers. There is a very less percentage of respondents (0.5%) in sampled area who do not know anything about such an issue.

Pesticides and fertiliser application is very risky and it poses huge economic costs to respondents in the form cost on defensive expenditure and cost on purchasing precautionary items. **Table 6** shows the responses of respondents regarding precautionary measures taken by them while applying pesticides and other chemicals to apple in sampled are. Table shows that 60.17 per cent of respondents follow precautionary measures while applying pesticides and fertilisers to apple crop compared to 39.83 per cent respondents do not follow precautionary measures while applying fertilisers or pesticides to the apple crop. It was found that during sparing of pesticides the frames even eat and drink with the contaminated hands.

Table 5 Responses of heavy utilisation of pesticides can cause harm to many beneficial species of insects in the sampled area

S. No.	Awareness about heavy utilisation of pesticides	Responses (%)
1	Yes	573 (95.5)
2	No	24 (3.67)
3	Don’t know	03 (0.5)

Source: Field survey

Judicious pesticide usage in agriculture has revolutionised production and productivity. But over utilisation or improper utilisation has at the same deteriorated health of soil as well as other living components of ecosystem. The contamination has reached up to that level that it has now negative impacts on the life on earth. **Table 7** presents awareness of respondents regarding contamination of soil and water due to pesticide and chemical utilisation. From the table it is evident that, 82.67 per cent of respondents are aware about contamination due to usage of pesticides in

the sampled area and 16.83 per cent respondents are not aware about contamination done due to pesticide usage and 0.5 per cent respondents even do not know the ill effects of pesticide usage in sampled area.

Table 8 Shows recommended spray, their quantity, market price and cost/ha of different pesticides and insectides by the SKUAST-K (Agricultural University of the Union Territory). From the table it can be concluded that the University has fixed a calendar schedule of all sprays and is making suitable adjustments and requisite change in the schedule as per situation and climatic condition prevailing in the valley. The sprays are done as per the growth stage of apple fruit and almost 7-9 sprays are recommended by the Agricultural University.

Table 6 Precautionary measures followed by the respondents in the sampled area

S. No.	Precautionary measures followed	Reponses (%)
1	Yes	361 (60.17)
2	No	239 (39.83)
3	Don't know	----
Source: Field survey		

Table 7 Responses regarding contamination of soil and water due to improper utilisation in the sampled area

S. No.	Awareness about contamination of soil & water	Reponses (%)
1	Yes	496 (82.67)
2	No	101 (16.83)
3	Don't know	03 (0.5)
Source: Field survey		

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 Lt	Rs.4460/Lt	Rs. 8920/-
7	Fruit Development-II	Governor + Coroban	1.20 Lt	Rs. 6420/Lt	Rs. 7740/-
			2.50 Lt	308/Lt	Rs. 770/-
8	Fruit Development-III	(Dithane M-45 + Roger)	16.50 Kg + 2.50 Lt	Rs. 350/Kg	Rs. 5775/-
				Rs. 410/Lt	Rs. 1025/-
		Maiden	2.00 Lt	Rs.1825/Lt	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 shows that defensive expenditure is highly related with age of the respondent and there is an increase of 0.43 per cent with increase in age, because immunity of a person decreases with the increase in age, gender also plays a significant role in the defensive expenditure and is having a value of 5.98 per cent, meaning thereby, if the respondent who applies pesticides is a male has to spent less on illness caused due to pesticide exposure and if the applicant is a female, she has to spent more on illness expenses. Similarly, frequency of pesticide application is having a significant effect on the defensive expenses in sampled area and value of cost incurred by respondents comes out to 2.25 per cent and exposure to fungicides is also significantly contributing to defensive expenses incurred on health of respondents in the sampled area and the value comes to 2.36 per cent. Farming experience a significant attribute in pesticide application, it was observed, with increase in farming experience there is reduction of 0.95 per cent in defensive expenses of respondent's. While number of sprays are positively affecting defensive expenses and there is a 7.63 per cent decrease in defensive expenses with the reduction in number of pesticides in sampled area. Similarly, education a significant factor in awaring people regarding ill effects of excessive pesticide use is highly contributing in reducing defensive expenses, with one stage (illiterate to primary, primary to secondary, secondary to college level and college level to university level) increase in education leads to 1.35 per cent decline in defensive

expenses. The standard error of all these statistical coefficients is less than half of the values of the coefficients and all statistical coefficients except age and number of sprays are statistically insignificant.

The R^2 value of this model is 0.59, which implies that there is about 59 per cent impact of all these variables on the dependent variable as is shown in **Table 10**.

Table 9 Regressants on Defensive expenses incurred on the pesticide application in apple cultivation in the sampled area

Coefficients [a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	554.530	72.167		7.684	.000
	Gender	5.986	13.915	.018	.430	.667
	Age	-.433	.530	-.041	-.817	.414
	Frequency of pesticide application	2.259	.869	.106	2.601	.010
	Exposure to fungicides	2.363	6.292	.015	.375	.707
	Farming experience	.952	.603	.080	1.578	.115
	Number of sprays	-7.633	5.613	-.056	-1.360	.174
	Education level	1.351	14.025	.004	.096	.923
a. Dependent Variable: Defensive expenditure						

Table 10 R^2 value of the model estimates of defensive expenses of apple in the sampled area

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.139[a]	.59	.008	168.343032

Table 11 Willingness to pay for biodegradable packaging of pesticides to replace the earlier ones

Coefficients [a]					
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
(Constant)	98.600	12.529		7.869	.000
Gender	3.693	5.701	.027	.648	.517
Age	-.108	.175	-.025	-.621	.535
Education level	-2.506	5.709	-.018	-.439	.661
Total rupees fetched/ha	-1.067E-005	.000	-.102	-2.497	.013
Family members	.435	.561	.032	.776	.438
a. Dependent Variable: Biodegradable packaging material					

From the model specifications as represented in **Table 11**, it can be understood that gender of respondent is playing an important role for reducing the environment pollution because of higher education, exposure and well acquaintance regarding ill effects of polythene bags and bottles either thrown in the orchards or thrown in to the rivers and open fields. From the table it can be seen that male respondents are willing to pay 3.69 per cent more to buy a pesticide in biodegradable bags than the earlier ones. Age of respondent, one more determining factor for biodegradable packaging and in sampled area the young respondents are willing to pay 0.10 per cent more, though being very little amount but it suggests that the young ones are concerned about the damage caused due to polythene bags and other bottles. Education of respondents a very significant and highly determining factor to reduce pollution and save the resources for future generations and therefore, highly educated respondents are willing to pay 2.5 per cent more to buy biodegradable packaged pesticides than the earlier ones. Income of respondent plays a dominant role in purchasing quality pesticide for apple orchards, therefore, a high income family can pay extra amount to reduce the environmental pollution, apple orchardists are earning handsomely from apple fruit and thus growers are highly conscious about environment conservation and they are willing to 1.06 per cent more amount to purchase pesticides in biodegradable packets than earlier ones, so that they can reduce a little bit of waste and can provide a better and secure environment to their future generation. Family size also plays a significant role to purchase of biodegradable packaged pesticides, as households with less number of family members are willing to pay 0.43 per cent extra to buy a biodegradable packaged packet of pesticide than earlier one.

Conclusion

To conclude, the study shows that apple growers spend on an average Rs. 69164/- on pesticide expenditure yearly and due this huge pesticide expenditure, considerable health and environmental issue arise which intern drive considerable costs in apple farming and it was estimated that 6-8 per cent of expenditure is incurred on the health issues caused due to excessive pesticide application. The results revealed that educated apple growers are highly conscious about environmental degradation and degeneration and are therefore willing to pay 7 to 9 per cent more prices to purchase pesticides in biodegradable packages which are environmental friendly and can pose less risk to human health as well. The study further revealed that, exposures to the chemicals and frequent contact are responsible for these costs.

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