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Environmental Impact of Pesticide Usage in Cotton

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ABSTRACT

Present days' use of pesticides has decreased the crop production & post-harvest losses which has contributed remarkably to the food security of the nation, but its adverse effects on human, animals, environment and the eco-system has been a major issue. The pesticide with the highest Field Environmental Impact Quotient (EIQ) value used by sample farmers was Profenophos i.e., 75.19, and the least Field EIQ value pesticide used by sample farmers was Acetamiprid i.e., 0.19. Average Field use EIQ was calculated for the different types of farmers. It was highest in the case of small farmers i.e., 39.56, followed by large farmers i.e., 38.23. The comparably less Field use EIQ was of medium farmers i.e., 36.83. About Willingness To Pay, 35.83 percent of farmers were willing to pay 6-10 percent more price for eco-friendly pesticides than that of chemical pesticides,whereas 24.16 percent farmers were ready to pay 1-5 percent more price.

Key words *: Field Use EIQ, Impact, Pesticides, Willingness To Pay*

Introduction

Presently, throughout the globe approximately 2 million tonnes of pesticides are utilized annually and China is the major contributing country followed by USA and Argentina (Sharma *et al*., 2019). About 64 percent of the world's arable land is at risk of pesticide pollution by more than one active ingredient and 31 percent is at high risk. Among the high risk areas, about 34 percent are in high-biodiversity regions, 19 percent in low-and lower-middle-income nations and five percent in water-scarce areas,The widespread use of pesticides in agriculture while enhancing productivity would have potential repercussions on environment, human and animal health (Tang *et al.,* 2021). Pesticides have played an important role in agriculture, by providing foodgrains at affordable prices to customers, quality improvement, and assuring good revenue to farmers. Although pesticides are manufactured based on less risk to human, animal and the environment, many studies have reported about health risks to farmers and exposure to other-side of the population from the residues found in food and drinking water. Pesticides have potentially adverse effects on human health and on the environment. In particular, misuse of pesticides is linked with: (1) adverse effects on beneficial organisms, (2) contamination of water (3) air pollution (4) Damage on non-target plants, (5) Damage to rotational crops from pesticide residues; (6) crop damage due to high doses etc. (Damalas and Eleftherohorinos, 2011; Eleftherohorinos, 2008).

India is among the largest producers of pesticides in the world. According to a report by database Research and Markets, the Indian pesticides market was worth Rs 197 billion in 2018. The market is further projected to reach a value of Rs 316 billion by 2024, growing at a Compound Annual Growth Rate of 8.1 per cent during 2019-2024. Total pesticide consumption is the highest in Maharashtra, followed by Uttar Pradesh, Punjab and Haryana. On the other hand, per hectare consumption of pesticides was the highest in Punjab (0.74 kg), followed by Haryana (0.62 kg) and Maharashtra (0.57 kg) during 2016-17 (Vineet Kumar, 2020). India stands 12th in pesticide use globally and 3rd in Asia after China and Turkey. The commonly used pesticides comprise insecticides, fungicides and herbicides for management of uncontrolled weeds and pests on agricultural sites. However in total pesticide consumption, insecticides occupies highest share in India. However, India applies fewer amounts of pesticides in per hectare of cropland area, but uncontrolled and haphazard pesticide usage is responsible for the presence of high pesticide residues in both natural and physical environment.

Cotton is one of the most important fibre and cash crop and plays a dominant role in industrial and agricultural economy of the country. China, United States and India are the top three exporters of cotton worldwide. However, India has the largest area under cultivation which is about 41 percent of the world area under cotton cultivation but yield is low i.e., below 500 kg per hectare. Cotton farmers every year face heavy losses due to pests attacking their crops hence using more pesticides than what is used for other crops, sometimes using hazardous, banned or counterfeit pesticides. As a result, over 55 percent of pesticide is used in cotton farming in India. Cotton accounts for about 16 percent of global insecticide usage. Almost one kilogram of hazardous pesticides is applied for every hectare under cotton. Each year, three percent of agricultural workers suffer from acute pesticide poisoning,and it is estimated that onemillion hospitalization is required worldwide. Cotton undoubtedly represents India's most important economic, nutritive and cultural commodities, but its conventional cultivation has become deeply problematic, because of the external costs of its impact on health and the environment (EJF, 2007). The few existing farm level studies (Shetty *et al.*, 2011) focused on side effects on health after handling pesticides. There is a need to review the application of pesticides and recommend rational use of pesticides and minimize the problems related to health and environment. Keeping this in view, the present study was conducted to assess the environmental impact of pesticides used by sample farmers and their willingness to pay for eco-friendly pesticides.

Materials and Methods

Karnataka was selected purposively, as it has an area of 5.10 lakh ha under cotton with 1288 M.T of pesticide consumption (2016-17). Dharwad district has an area of 70,272 ha under cotton which is one of the largest in the State, so Dharwad was purposively selected for the present study. Three taluks i.e., Navalgund, Kundagol, and Hubli, were selected based on the maximum area under cotton cultivation. Two villages from each taluk were selected based on the highest cotton farmers and the maximum area under cotton. Twenty cotton farmers were selected randomly from each village, making a total sample of 120 with 40 small, medium, and large farmers. Primary data on various aspects of sample farmers for the 2016-17 agricultural year was collected through field survey by the interview and recall memory method with a pre-tested and well-structured schedule in November and December 2016.

Environmental Impact Quotient (EIQ) was developed to measure the environmental impact of different pesticides (insecticides, acaricides, fungicides, and herbicides) used in commercial agriculture. The original paper of the EIQ was written by members of the New York System Integrated Pest Management Program (NYSIPM) (Kovach *et al.*(1992). The Environmental Impact Quotient (EIQ) is a formula with data regarding the health and the environmental impacts of pesticides which helps farmers to make good decisions regarding their pesticide selection. NYSIPM calculates EIQ values for new pesticides and reviews old EIQ values periodically. The EIQ values obtained are used to compare different pesticides and pest management programs to decide which pesticide or programhas higher or lower environmental impact. Environmental Impact Quotient value of an individual pesticide refers to its effect on farmworker, consumer, and ecology. In this study, Environmental Impact Quotient values were adopted from New York State Integrated Pest Management (https://nysipm.cornell.edu/eiq).

$$EIQ=\{C[(DT*5)+(DT*P)]+[(C*((S+P)/2)*SY)+(L)]+[(F*R)+(D*((S+P)/2)*3)+(Z*P*3)+(B*P*5)]\}/3$$

DT = dermal toxicity, C = chronic toxicity, SY =

systemicity, F = fish toxicity, L = leaching potential, R = surface loss potential, D = bird toxicity, S = soil half-life, Z = bee toxicity, B = beneficial arthropod toxicity, P = plant surface half-life

In addition to the standard EIQ, we derived a Field Use EIQ that accounts for different formulations of the same active ingredients. While the EIQ is specific to the individual active ingredients, the Field Use EIQ is specific to the individual pesticide formulation, which may have multiple active ingredients. Additionally, the Field Use EIQ is weighted by the pesticide's application rate. As with the standard EIQ, higher values of the Field Use EIQ indicate greater relative risk (Doris *et al.,* 2011). EIQ Field Use Rating is used to account different formulations of the same active ingredient and different use patterns.

EIQ Field Use Rating = EIQ x percent of active ingredient x Rate of application

From the data collected, individual EIQ was assigned to each pesticide, the active ingredient, and rate of application combined with EIQ to arrive at field use EIQ for each pesticide. Field use EIQ was then calculated separately for each farmer. The difference between them represents the amount of risk avoided during pesticide application. The present analysis covers only a single year, and pesticide use may vary considerably depending on weather conditions, which holds for all sample farmers.

To study the farmers' preference for the use of eco-friendly pesticides, the values of Willingness To Pay (WTP) were obtained through the Contingent Valuation method based on survey data in which people were directly asked how much they would be WTP for eco-friendly pesticides after knowing the ill effects of chemical pesticides to human and environment. For the present study, WTP scaling was taken as none (i.e WTP is zero), <5% WTP, 5-10% WTP, 11-15% WTP, 16-20% WTP and 20% WTP. Further, the analysis was done by running the Ordered Probit model using STATA software, which is a generalization of the widely used probit analysis in case of more than two outcomes of an ordinal dependent variable: here, in the study, we had six categories of WTP. The estimation result from the ordered probit model has several goodness-of-fit measures like log-likelihood ratio, pseudo R^2, and estimated probabilities. These measures indicate that the model has adequate explanatory power and fitted the data reasonably well. The equation used for the contingent valuation method was

$$WTP = \beta_0+\beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4+ \beta_5X_5+ \beta_6X_6+ \beta_7X_7+e$$

Where,

WTP= latent (or unobserved) willingness-to-pay

β = is a vector of parameters showing relationship between willingness-to-pay and variables in X

X_1.......X_7 = the vector of variables thought to influence willingness-to-pay

e = independently and identically distributed error term with mean zero and variance one.

The probability of a WTP in one of "I" finite categories written as:

$$Pr\ (WTP= i-1) = \phi\ (\alpha i-X\beta) - \phi\ (\alpha i_{-1}-X\beta)\ \ i\phi I$$

Where $\phi(.)$ is a cumulative density function (CDF), measuring the probability of WTP less than threshold level, an ordered probit model allows for calculating predicted probabilities for each WTP category and marginal effects. The chance of the averageis indicated by predicted probabilities i.e., farmer's willing-to-pay a price falling within each of the category of WTP. These provide valuable insight into farmers' preferences, as they can gauge the level of farmer's WTP for eco-friendly pesticides. These predicted probabilities indicate a strong likelihood that the average farmer is willing-to-pay some price for eco-friendly pesticides. Parameter estimates can also be used to calculate the marginal effects of explanatory variables on the predicted probabilities. The marginal probability is used to measure the change in probability of each choice concerning a change in each explanatory variable. A change in an explanatory variable affects the predicted probability is indicated by marginal effects, i.e., that explains farmers willing-to-pay for each of the WTP categories. Interpretation of the marginal effects for continuous variables is straightforward; all other things equal, a one-unit change in the explanatory variable will result in an increase or decrease in the predicted probability of selecting alternative j by the marginal effect expressed as equal to the size of the marginal effect expressed as a percent. In the case of a binary variable, the marginal effect is the change in predicted probability based on whether a respondent falls into that category or not. Several different explanatory variables are included in the WTP model. Among the variables, socio-economic characteristics, health effects, perception towards health risk were expected to be the most important variables determining WTP.

In Table 1, the dependent variable WTP has six categories, and the independent variables are education (X_1), family type (X_2), perception (X_3), area (X_4), income (X_5), age (X_6) and total health effects (X_7). Area, income and age are quantitative variables.

Results and Discussion

Descriptive estimation of health and environmental effects of pesticide usage

Pesticide risk to the environment is often related to the amount of active ingredient applied and expenditure incurred on pesticides. However, both these measures are not the best indicators of risk because pesticides differ to their toxicity, mobility, and persistence and thus pose different risk levels to other components of the environment. The environmental benefits of reduced pesticide use must examine the toxicity, mobility, and persistence characteristics of the pesticides being used. If farmers reduce the quantity of pesticide applied, replacing it with dangerous, mobile, and persistent chemicals, it is difficult to argue that environment has benefitted (Mullen *et al.*, 1997).

Different formulas of pesticides are used at various stages of crop growth in cotton, which cause damage to the environment and its components. The objective is to identify the least-toxic pesticide and estimate Field use EIQ for different size groups of farmers. The Environment Impact Quotient is a measure to know the damage caused by pesticide use. A higher EIQ value indicates higher damage to the ecosystem.

The highest Field Use EIQ value pesticide used by sample farmers was Profenophos i.e., 75.19 from Table 2, followed by Mancozeb with a Field Use EIQ value of 43.36. The least Field Use EIQ value pesticide used by sample farmers was Acetamiprid i.e., 0.19, followed by Emamectin.

Benzoate with a Field Use EIQ value of 0.63. Other common pesticides used by sample farmers were Imidachloropid Thiamethoxam, Acephate, Dimethoate, Carbendazim, Paraquat Dichloride, Pendimethalin, which had Field EIQ values of 1.13, 1.31, 14.74, 11.16, 13.13, 14.85, 27.72, respectively. Higher values indicate that there is a increased risk associated with the respective pesticides. Among the used pesticides, only two pesticides had higher EIQ values. The difference between Field Use EIQ for actual dosage; and recommended dosage; was highest in Mancozeb i.e., 20.23, followed by Profenophos and Dimethoate i.e., 8.25 and 3.87, respectively. Hence, there is a scope for better and comprehensive adoption of eco-friendly pesticides. Similar results have been found with Kavitha (2008), Quinolphos was least toxic, and Rogar was highly toxic in the

Table 1. Particulars of variables used in the ordered probit model to assess Willingness To Pay

S. No.	Variable	Units	Type of variable
1	Willingness To Pay (WTP)	WTP 0 = 1 WTP <5% = 2 WTP 5-10% = 3 WTP 11-15% = 4 WTP 16-20% = 5 WTP >20% = 6	Qualitative
2	Education (X_1)	Illiterate = 1 primary school= 2 high school = 3 college = 4 graduate = 5	Qualitative
3	Family type (X_2)	nuclear family = 1 joint family = 2	Qualitative
4	Perception (X_3)	low = 1 medium = 2 high = 3	Qualitative
5	Area (X_4)	ha	Quantitative
6	Income (X_5)	Rs.	Quantitative
7	Age (X_6)	years	Quantitative
8	Total health effects (X_7)	health effects = 1, otherwise 0	Qualitative

Table 2. Field use EIQ values of common pesticides used by sample farmers.

Pesticide	EIQ	Active ingredient percent	Recommended dosage in kg per ha	Actual dosage by farmers in kg per ha	Field use EIQ for Recommended dosage(a)	Field use EIQ for Actual Dosage(b)	Difference between (a-b) field use EIQ
Imidachloropid	36.7	0.28	0.10	0.11	1.03	1.13	0.10
Thiamethoxam	33.3	0.25	0.10	0.158	0.83	1.31	0.48
Acetamiprid	28.73	0.10	0.05	0.067	0.14	0.19	0.05
Emamectin benzoate	26.28	0.11	0.22	0.22	0.63	0.63	0.00
Profenofos	59.5	0.75	1.50	1.685	66.94	75.19	8.25
Acephate	24.9	0.74	0.78	0.80	14.37	14.74	0.37
Dimethoate	33.49	0.33	0.66	1.01	7.29	11.16	3.87
Mancozeb	25.7	0.45	2.00	3.75	23.13	43.36	20.23
Carbendazim	50.5	0.50	0.42	0.52	10.61	13.13	2.53
Paraquat dichloride	24.7	0.47	1.25	1.28	14.51	14.85	0.34
Pendimethalin	30.2	0.36	2.50	2.55	27.18	27.72	0.54

Source: Field survey data

case of both IPM and non IPM farmers

Table 3 presents the average Field Use EIQ for the different size groups of farmers. It was highest in the case of small farmers i.e., 39.56, followed by large farmers i.e., 38.23. A comparably less Field Use EIQ was observed in the case of medium farmers i.e., 36.83. The total average Field Use EIQ of sample farmers was 38.20. Small farmers were using higher EIQ value pesticides compared to medium and large farmers. Small farmers believedthat, use of more pesticides helps them to get a good yield and quick returns. These differences in Field Use EIQ between the different farm size groups of farmers represent the percent pesticide risk avoided, due to reduced pesticide application and a judicious selection of environment-friendly pesticides on farms in cotton cultivation in the study area.

Similar results were found with Sudha (2014), where EIQ values on IPM-cotton farm were 36.93 compared to non-IPM cotton (46.93) indicating, that the hazardous chemicals increased the cost of farmers but also had negative environmental impacts within these farms. Thus, from the results, EIQ values were the highest for Profenophos and lowest for Acetamipirid. A higher value of Field Use EIQ and double the quantity of optimum pesticide usage was observed in the case of small farmers.

Willingness to Pay more price for eco-friendly pesticides - Contingent Valuation Method

Willingness to Pay

Table 4 reports farmers' Willingness To Pay more price for eco-friendly pesticides after being aware of the ill effects of pesticides on humans and the environment. From the total sample of 120, only 6.66 percent were not willing to pay any extra price for eco-friendly pesticides. This might be due to their illiteracy, poor financial conditions, and fewer returns obtained from the crop. About 35.83 percent of farmers (mostly large farmers) were willing to pay 6-10 per cent more price than chemical pesticides, this may be because large farmers are financially stable, followed by 24.16 percent ready to pay 1-5 percent more price than chemical pesticides, and they are mostly small farmers because of fewer savings. About 22.50, 8.33 and 2.50 percent were willing to pay more price i.e., 11- 15, 16 -20 and more than 20 percent respectively. Based on their income, education level, awareness about ill-effects, and concern

Table 3. Average Field Use EIQ values of sample farmers

	Small farmers n=40	Medium farmers n=40	Large farmers n=40	Total farmers N=120
Field Use EIQ	39.56	36.83	38.23	38.20

Source: Field survey data

Table 4. Farmers Willingness to Pay (WTP) more for eco-friendly pesticides after knowing the ill effects of chemical pesticides on human and environment

S. No.	Willingness To Pay	Frequency			
		Small farmers n=40	Medium farmers n=40	Large farmers n=40	Total farmers N=120
1	None	1(0.83)	4(3.33)	3(2.50)	8(6.66)
2	1-5 percent	15(12.50)	11(9.16)	3(2.50)	29(24.16)
3	6-10 percent	12(10.00)	12(10.00)	19 (15.83)	43(35.83)
4	11-15 percent	9(7.50)	8(6.66)	10(8.33)	27(22.50)
5	16-20 percent	3(2.50)	4(3.33)	3(2.50)	10(8.33)
6	>20 percent	—	1(0.83)	2(1.66)	3(2.50)

Source: Field survey data
Note: Figures in parentheses indicate percentage to the total

towards the environment, farmers were ready to pay more for eco-friendly pesticides.

Ordered Probit Model

The ordered probit model is non-linear, and it has a dependent variable with ordered outcomes and estimated coefficients are not marginal effects hence reported separately. The ordered probit model estimated co-efficientsand their corresponding Z scores with p-values are shown in Table 5. Out of the seven explanatory variables, six are significant at 1 percent, 5 percent and 10 percent levels.

The pseudo R^2 of 0.1049 and likelihood ratio test statistic value of 38.46 imply that the null hypothesis that the estimated coefficients are jointly equal to zero is rejected at one percent level.

Total health effects and age were positive and significant at 5 percent level with coefficients 0.64695 and 0.01342, respectively. Results showed that the association between total health effects and WTP is powerful. The perception and education were consistently highly significant at 1 percent level with positive WTP i.e., 0.5229 and 0.2533. The area of sample farmers had no significant impact on WTP (-0.0480). The purchasing power i.e., income of the farmers is aconsiderable determinant of WTP where low-income farmers cannot decide freely on environmentally friendly or quality pesticides for higher prices. Thus education, perception, and total health effects were the most important determinants for positive WTP.

The predicted probabilities for the six categories of Willingness To Pay are reported in Table 6. The reported probabilities indicate average likelihood means that farmers are willing-to-pay more for eco-friendly pesticides to improve their health conditions. The table has two panels: the upper panel reports predicted probabilities, and the lower indicates the marginal effects for all explanatory variables. The predicted probability of WTP=0 and WTP=1-5 percent, given that the rest of the variables are at their average 4 percent and 27 percent, respectively. The predicted probability for other categories of WTP (6-10 %, 11-15 %, 16-20 %, and > 20 %) are

Table 5. Estimated coefficients of ordered probit model for positive WTP

S.No	Variables	Estimated coefficients	P values	Z-scores
1	Education	0.2533***	0.009	2.59
2	Family Type	-0.3719*	0.094	-1.67
3	Perception	0.5229***	0.001	3.33
4	Area	-0.0480	0.254	-1.14
5	Income	1.39e-06*	0.056	1.91
6	Age	0.01342**	0.031	2.15
7	Total Health Effects	0.64695**	0.030	2.17

Log likelihood = -164.01684, Pseudo R^2 = 0.1049, LR chi^2 (12) = 38.46***
*-Significant at 10percent level. ** - Significant at 5percent level. ***- Significant at 1percent level

43 percent, 17.56 percent, 6 percent, and 0.8 percent respectively given the rest of the variables are at their means.

The marginal effect of total health effects was negative for the first two WTP categories (i.e., WTP which is zero and another 1-5 percent) but a positive marginal effect for the other willingness to pay categories. This suggests that holding other things the same, there is a higher probability of being in lower WTP categories when total health effects are low relative to when total health effects are high. In case of total health effects, ill health experiences from the pesticides are more likely to influence farmer's attitudes to pay a huge price for eco-friendly pesticides.

The marginal effect of perception was negative for the first two WTP categories (i.e., WTP having zero and another 1-5 percent) but a positive marginal effect for the other willingness to pay categories. This suggests that holding other things the same, there is a higher probability of being in lower WTP categories when perception is low relative to when perception is high. Higher the perception, higher will be the WTP for eco-friendly pesticides.

The marginal effect of education was negative for the first two WTP categories (i.e., WTP having zero and in 1-5 percent range but a positive marginal effect for the other willingness to pay categories. This suggests that holding other things the same, there is a higher probability of being in lower WTP categories when education is low relative to when education is high. Educated farmers are more likely to pay a higher price for safe pesticide relative to less educated farmers.

The marginal effect of age was negative for the first two WTP categories (i.e., WTP having zero and another 1-5 percent) but a positive marginal effect for the other willingness to pay categories. This suggests that holding other things the same, there is a higher probability of being in lower WTP categories when age is low relative to when age is high. Age being significant variable, farmers are likely to pay some price for eco-friendly pesticides, which suggests that farmers who have been using pesticide fora long time are more likely to perceive higher risk and therefore willing to pay a premium for eco-friendly pesticides.

The marginal effect of income was negative for the first two WTP categories (i.e., WTP having zero and another 1-5 percent) but a positive marginal effect for the other willingness to pay categories. This suggests that holding other things the same, there is a higher probability of being in lower WTP categories when income is low relative to when income is high. In the case of income, old farmers are more likely to have higher income and more empowered. For perception, the farmers who perceive pesticides as a health risk are willing to pay a premium price relative to those who do not perceive pesticides as a health hazard.

Family type and area variables had positive marginal effects for the first two WTP categories but negative for the other WTP categories. This implies that holding other things same, large farmers belonging to nuclear families are less likely to pay more for eco-friendly pesticides.

Similar results were found by Khan and Damalas (2015) where the Ordered probit model was used i.e., contingent valuation method, using nine explanatory variables (i.e., education, perception, training, IPM, farm size, age, health effects, income, and district dummy Vehari), five are significant and have expected signs i.e., education, perception, farm

Table 6. Predicted probabilities and marginal effects from the estimated model

S. No.		WTP (=0)	WTP (1-5 percent)	WTP (6-10 percent)	WTP (11-15 percent)	WTP (16-20 percent)	WTP (>20 percent)
Predicted probabilities		0.04468	0.2712	0.4339	0.1756	0.0661	0.0084
Marginal Effects							
1	Education	-0.02388	-0.0662	0.0095	0.0448	0.0298	0.0058
2	Family Type	0.0351	0.0972	-0.0140	-0.0658	-0.0438	-0.0085
3	Perception	-0.0492	-0.1366	0.0197	0.0925	0.0616	0.0120
4	Area	0.0045	.01255	-0.0018	-0.0084	-0.0056	-0.0011
5	Income	-1.31e-07	-3.62e-07	5.23e-08	2.45e-07	1.63e-07	3.19e-08
6	Age	-0.0012	-0.0035	0.0005	0.0023	0.0015	0.0003
7	Total Health Effects	-0.0911	-0.1557	0.0778	0.1047	0.0554	0.0089

size, health effects and income. Age, perception, health, farm size, education, and income variables had negative marginal effects for the first two WTP categories and positive to the rest of the WTP categories indicating that the higher of these variables, the higher will be willingness to pay. A similar analysis was also done by Sukant *et al.* (1991) and Cranfield and Magnusson (2003) on consumers' willingness to pay for pesticide-free products.

From the above results, we can conclude that farmers are Willing to Pay 6-10 percent more for eco-friendly pesticides, and its predicted probability was 43 percent. Factors influencing WTP were education, family type, perception, income, age and total health effects. Farmers with high levels of education, high level of perception, high income, increase in age, and farmer's concerned about health were showing high WTP for safer pesticides.

Conclusion

The study utilized household-level survey data collected from 120 sample farmers of Dharwad district, Karnataka to measure the environmental impact of different pesticides and analyze the farmers willingness to pay more price for eco-friendly pesticides after being aware of the ill effects of pesticides on humans and the environment. While substantial literature exists on the environmental impact of pesticide usage in cotton, the empirical literature on farmers willingness to pay more price for eco-friendly pesticides, especially in Karnataka, India is limited. The environmental impact quotient (EIQ) model is used to quantify the health and environmental effect of pesticide usage in cotton. Field Use EIQ for the different size groups of farmers was highest in small farmersfollowed by large farmers. A comparably less Field use EIQ was observed in case of medium farmers i.e., 36.83. The highest Field EIQ value pesticide used by sample farmers was Profenophos and the least Field EIQ value pesticide was Acetamiprid. Further, the farmers willingness to pay more for eco-friendly pesticides analyzed through contingent valuation method wherein ordered probit model was used. Willingness to pay was higher incase of educated and higher-income farmers. Farmers who were aware of health effects and had higher perceptions were also willing to pay more. The ill-effects of pesticides were not understood and experienced by the majority of the farmers. The cotton farmers are not aware of the toxic residues of pesticides. The findings recommend policy efforts that focus on highlighting pesticide toxicity and its residual effects by conducting trainings and meetings with farmers. The farmers may be encouraged to use eco-friendly pesticides which not only helps farmers to increase their income but also reduces the health and environmental effects due to pesticides use.

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