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In Search of Predictors of Farmers' Knowledge about Proper Usage of Pesticides

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Abstract

Improper usage of pesticides for pest control has increased environmental and health hazards. This study was conducted to assess farmers' level of knowledge about proper usage of pesticides and their assistant sources of information. Results of the study revealed that farmer's average level of knowledge (41%) was very low. Farmers' highest perceived source of information was recorded to be landlords, followed by pesticide dealers, agriculture extension, neighboring farmers, representatives of pesticide companies, agricultural programs on radio, agricultural literature, and agricultural programs on TV. Using ANOVA, the perceived average scores for the above sources of information were recoded to be significantly different from each other ($p<0.01$). Estimates of the multiple linear regression model revealed that farmers' level of knowledge was significantly influenced by educational level, perceived scores for pesticide dealers, and cotton area. Since proposed ANOVA and regression models withstood the assumptions using log transformed and original data respectively, inferences drawn from the study were considered to be valid on sophisticated statistical footings.

Key words

Farmers, knowledge, regression, testing of assumptions

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1. Introduction

Consequent upon the institution of liberal policies in 1980s, aimed at transferring the import and sale of chemical pesticides to the private sector, numerous companies entered the country's pesticide market. Easy imports, low prices and availability of a variety of pesticides are distinct advantages of these liberal policies. On the other hand, over/misuse of pesticide by untrained farmers has increased the health and environmental risks especially in the prime cotton growing districts. Pesticide usage poses a threat to farmers, children, and women workers in fields who are at high risk of being poisoned (UNDP, 2001). The chronic poisoning due to pesticide causes adverse immune functions, peripheral neuropathies, and allergic sensitization reactions, particularly of skin. The acute poisoning may vary from skin irritation to complex systematic illness resulting in death. Accidental exposure in homes from inappropriate storage of pesticides, poisoning caused due to the use of empty container of pesticides for carrying water are quite common (Yasmin, 2003). Chemical-based pest control programs have disturbed the agro-ecosystem and killed the non-target and environment friendly organisms such as parasitoids, predators and birds. Besides, as many as 10,000 farmers are poisoned annually by indiscriminate use of pesticides in cotton growing areas of Pakistan (PARC, 1999). Inappropriate usage of pesticides has induced pest resistance and resurgence. Studies showed that the populations of natural enemies in cotton growing areas have declined as much as 90% during a decade (Husnain, 1999). Considering the health and environmental hazards due to over/misuse of pesticides, this study was conducted to assess farmers' level of knowledge about proper usage of pesticides and their assistant sources of information.

1.1 Objectives of the study

1. To assess farmers' level of knowledge of proper usage of pesticides.
2. To assess farmers' perceptions about various sources of information.
3. To explore predictors of farmers' knowledge of proper usage of pesticides.

2. Methodology

The target area of present study was limited to three cotton producing districts of Sindh, namely Sanghar, Nawabshah, and Naushahro Feroze. A representative sample of 90 farmers was proposed. The sample size was found appropriate at $\pm$10% error rate and 5% level of significance for very big populations, enumerated in thousands using Wunsch's table of determining sample size (Wunsch, 1986). Population of farmers in three districts was assumed to quite large (in thousands), however, the same could not be exactly enumerated through available documentation and resources. Multistage cluster sampling was applied to select representative sample of farmers.

Using multistage cluster sampling, one *taluka* was randomly selected from each district in the first stage. In second stage, three villages were selected from each randomly selected *taluka*; nine villages were selected from three *talukas*. Names of selected *taluka* and villages are given in Table 1. A sample of 10 cotton growers from each village was then randomly selected. Thus, 90 farmers were selected from three selected *talukas*.

Farmers' level of knowledge was estimated in the following three areas pertaining to proper usage of pesticides:

1. Selection of proper pesticides for the common insect pests/mites of cotton;
2. Selection of proper doses per acre of the selected pesticides; and,
3. Basic knowledge about proper usage and safe handling of pesticides.

Likert scale of 10 points (1 being little information, 5 being reasonable quantity of information and 10 being much information) was used to estimate the perceived contribution of various sources of information. R-code, Macanova, and Statistix computer packages were used to analyze the data. To compare perceived effectiveness of various sources of information, F-values and their corresponding p-values were calculated using analysis of variance (ANOVA) technique. When F-value was found to be significant at 0.05 level of significance, Duncan Multiple Range Test (DMRT) was applied to rank the means. For regression analysis, farmers' scores about proper usage of pesticides were taken as dependent variable while demographic characteristics and perceived scores for assistant sources of information were taken as independent variables. Significant variables were identified and reported. R-square was calculated to know the percent variation in dependent variables accounted for by the significant independent variables.

For the appropriateness of results, the assumptions of ANOVA and regression: (1) variances of the errors should be constant and (2) errors should be normally and independently distributed, were tested. For ANOVA, first assumption was tested by applying Bartlett's test of equal variances (Snedecor and Cochran, 1989) using Statistix package. To test the second assumption, using Macanova package, rankits plot was constructed (Fig. 1). When the errors are normally and independently distributed the plotted values roughly form a straight-line in rankits plot (SPSS, 1997). When the errors are not normally distributed, the line made of the plotted values has bumps and either of the tail is longer (Montgomery, 1997). Using Macanova computer package, appropriate transformation was explored when proposed model did not withstand the assumptions. Fig. 2 suggests transformation on the basis of minimum sum of squares of residuals. The suggested transformation is between 0 and 0.5, which reveals that either log or square transformation is appropriate for the data used for ANOVA results.

To test the assumption of regression, nonconstant variance plot and residual plot were constructed using R-code computer package. Besides, nonconstant variance test was applied to test assumption 1 at the probability level of 0.05. In nonconstant variance plots (Fig. 3) lowess was set at ± 1 standard deviation. When the lines of nonconstant variance plot do not go parallel, variances are assumed to be nonconstant. Besides, mean score are reported to be significant at 0.05, level of significance. To test the assumption that errors should be normally and independently distributed, residual plot was constructed (Fig. 4). When the errors are normally distributed, about half of the errors fall on either side; the errors mostly cluster on both sides of the origin. The number of errors gets fewer as the error values get farther from origin on both sides. Besides, when the model does not need any quadratic term, the lowess line (which is little curvy) converges with the

OLS line (which is straight). Besides, when p-value for the test of curvature is nonsignificant ($p>0.05$), errors are assumed to be normally distributed (Cook and Weisberg, 1998). In case, regression model did not withstand assumption, appropriate transformation of data was explored using Box-Cox method as shown in Fig. 5. The figure suggests square root transformation ($\lambda = 0.5$) of the dependent variable.

3.Results and Discussion

Table 2 presents the farmers' average scores regarding proper usage of pesticides. On an overall basis, farmers' average knowledge was 41%. The available literature indicated that none of the study was conducted on the estimation of farmers' average level of knowledge about proper usage of pesticides in Sindh, Pakistan. Very limited studies were conducted on the proportion of farmers who had know-how about proper usage of pesticides. In this regard, NFDC (2002) reported that 65% of the farmers had basic information about pesticide usage. Feenstra (2000) reported that 60% of the farmers were aware of health hazards of pesticides. It was concluded that the problem of pesticide poisoning was extensive in Sindh, while the awareness of farmers about pesticide related health problems was low.

Farmers' perceived scores about various sources of information

Table 3 showed that farmers' highest perceived score was recorded for landlords (5.77), followed by pesticide dealers (4.87), agriculture extension (4.40), neighboring farmers (3.66), representatives of pesticide companies (2.53), agricultural programs on radio (2.46), agricultural literature (2.27), and agricultural programs on TV (2.11). Scores were recorded to be highly significant ($p<0.01$). Log transformed values were used for analysis since the assumption equality of variances did not withstand the proposed model on actual values.

Farmers who purchased pesticide themselves relied mostly on pesticide dealers; therefore, the second highest perceived score was recorded for pesticide dealers. Low perceived scores for representatives of pesticides companies indicated that representatives of pesticide companies did not provide extension services to poor tenants, however, they focused on highly resourced landlords to achieve annual sale target. Similar findings are also reported by Davidson *et al.* (2001).

Least perceived sources of information were agricultural programs on radio, agricultural literature, and agricultural programs on TV. The same results were reported by Muhammad *et al.* (2002) who stated that fellow farmers were playing an important role in informing each other about proper selection, usage and handling of pesticides. Farm and home visits, discussion meetings, signboards, radio and TV were relatively less effective methods in disseminating information about safe handling and use of pesticide in Pakistan.

Similar findings regarding ineffectiveness of mass media was depicted by Madukwe *et al.* (2002) who reported that radio and television have high potential for contacts because of their suitability to reach a large number of farmers and to disseminate urgent farm programs. However, radio and television were the least used extension-farmer contact techniques. In this regard, Mahmood and Sheikh (2005) argued that agricultural programs on TV were not broadcasted at primetime; therefore, electronic media was reported to be ineffective in disseminating agricultural information to farming community.

3.1 Testing of assumptions of ANOVA

Table 4 revealed that chi-square value for Bartlett's test (61.72) was highly significant ($p<0.01$). This indicated assumption of equal variance might be rejected. Since the first assumption did not withstand the model, Box Cox plot was constructed (Fig. 6), which suggested log transformation. Using transformed values, the chi-square value for Bartlett's test of equal variance was nonsignificant ($p>0.05$) which revealed that assumption of equal variance was not rejected. Rankits plot given in Fig. 7 revealed that plotted values roughly formed a straight line, there appeared to be no serious problem with the normality assumption.

Significant factors enhancing farmers' knowledge

Stepwise regression results revealed that farmers' level of knowledge was significantly influenced by educational level, perceived scores for pesticide dealers, and cotton area (Table 5). Proposed regression model is given as under:

Farmer's scores = 23.916 + 5.661(Educational Level) + 1.876(Pesticide Dealers) + 0.381(Cotton Area)

Educational level and perceived scores for pesticide dealers were reported to be highly significant ($p<0.01$) while area (acres) was significant at 0.05, level of significance (Table 5). On an overall basis, an increment of 5.66% in farmers' scores was recorded as their educational level increased from illiterate to primary; primary to matriculation; matriculation to intermediate; intermediate to graduation; and from graduation to postgraduation. Linear positive relationship was observed among farmers' level of knowledge and perceptions for pesticide dealers as source of information and cotton area cultivated. Adjusted R-square was reported to be 0.54, which indicated that more than half (54%) of the variation in farmers' scores was explained by the significant variables.

3.2 Testing of assumptions of linear regression

Fig. 9 did not show any indication of nonconstant variances (three lines go parallel). Since p-value (0.897) of the mean scores for nonconstant variance test for the proposed regression model was nonsignificant, the variance of the model was assumed to be constant. Fig. 10 revealed that most of the errors were pretty close to the origin, both lines overlapped each other very well and the p-value (0.720) for the test of curvature was nonsignificant; therefore, the errors were assumed to the independently distributed and the proposed regression model was fit to the data.

4. Conclusions and Suggestions

Farmers had insufficient knowledge (41%) about proper usage of pesticides in Sindh province of Pakistan. Pesticide dealers were the significant source of information about proper usage of pesticides. Interpersonal communication methods, namely landlords and pesticide dealers were more effective than mass media (TV and radio). On the basis of conclusions drawn from primary data analysis, the following policy suggestions were developed:

- Coordinated (public and private) extension programs may be arranged for the capacity building of farmers in proper usage of pesticide to mitigate health and environmental risks associated with over/misuse of pesticides.

- Farmers' field schools on IPM may be fully supported so as to optimize pesticide import bills and to ensure quality of agriculture produce in the wake of trade globalization.

- Training programs for Pesticide Dealers may be arranged in the following areas: (1) service for the farmers; (2) product knowledge of pesticides; and, (3) method of safe handling and efficient use of pesticide.

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Table 1. **Sampling plan for the selection of farmers**

Districts	Selected Taluka/Tahseel	Selected villages for the selection of farmers
Sanghar	Shahdadpur	1. Din Muhammad Khoso 2. Masso Keerio 3. Mua Chhora
Nawabshah	Nawabshah	1. Sain Bux Brohi 2. Nawab Chandio 3. Qazi Noor Ahmed Ansari
Naushahro Feroze	Bhiria	1. Jalbani 2. Muhammad Urs Solangi 3. Ghulam Muhammad Lakho
Total		9 villages surveyed from 3 talukas

Table 2. **Average scores about proper usage of pesticides**

Areas of knowledge	Mean	SE.
Selection of proper pesticides for cotton insect pests	35.2	7.0
Selection of proper dose per acre to control cotton insect pests	33.3	6.2
Basic information about proper usage and safe handling of pesticide	53.5	5.0
Overall Score	40.7	3.8

Table 3. **Farmers' average perceived scores about selected sources of information**

Sources of information	Scores (out of 10)	Ranks	
		Ordinary	DMRT
Landlords	5.77	I	A
Pesticide dealers	4.87	II	B
Agriculture extension	4.40	III	B
Neighboring farmers	3.66	IV	C

Representatives of pesticide companies	2.53	V	D
Agricultural programs on radio	2.46	VI	D
Agricultural literature	2.27	VII	D
Agricultural programs on TV	2.11	VIII	D
ANOVA Results: F = 36.49** (log transformation)			

Table 4. **Summary of ANOVA and Bartlett's test of equal variance**

TEST STATISTIC		ESTIMATED VALUES
ANOVA Results using original values	F-value	39.45
	p-value	0.000
Bartlett's test using original values	Chi-square value	61.72
	p-value	0.000
ANOVA Results using log values	F-value	36.49
	p-value	0.000
Bartlett's test using log values	Chi-square value	7.84
	p-value	0.347

Table 5. **Significant variables enhancing farmers' level of knowledge**

	Unstandardized coefficients		Standardized coefficients	t	Sig.
Model	B	Std. Error	Beta		
(Constant)	23.916	4.505		5.309	.000
Education Level	5.661	1.467	.360	3.859	.000
Pesticide Dealers	1.876	.687	.255	2.731	.008
Cotton Area	.381	.170	.208	2.246	.027
Adjusted R-square = 0.54					

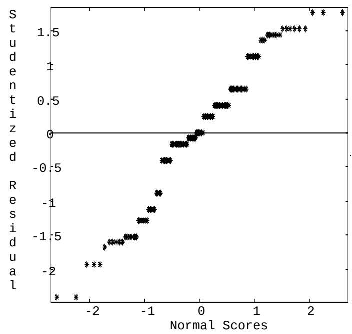

Fig. 1. Rankits plot

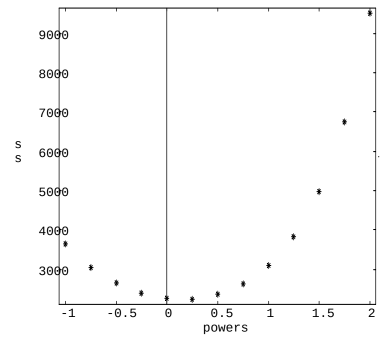

Fig. 2. Box-Cox power for ANOVA

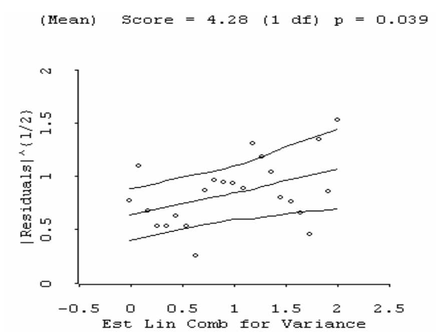

Fig. 3. Nonconstant variance plot

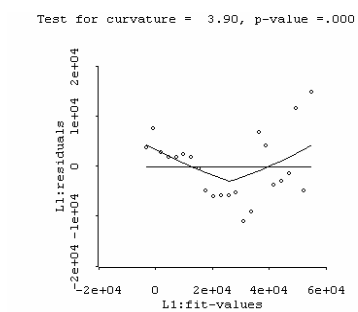

Fig. 4. Residual plot

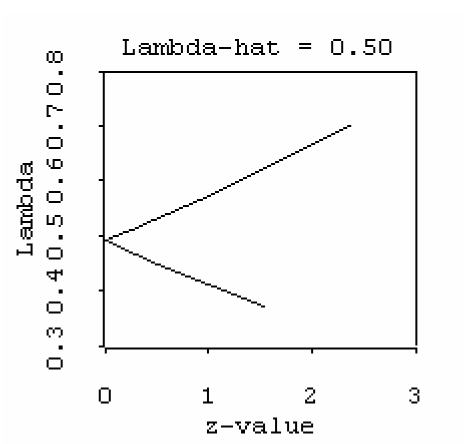

Fig. 5. Box-Cox power for Regress

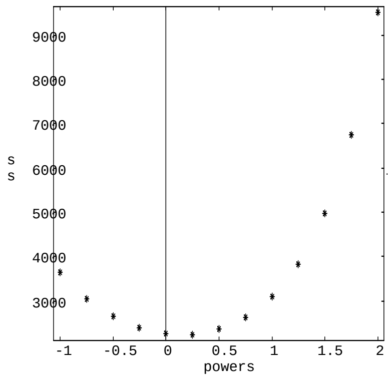

Fig. 6. Box-Cox power plot

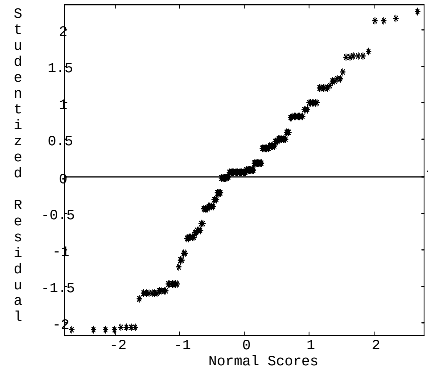

Fig. 7. Rankits plot

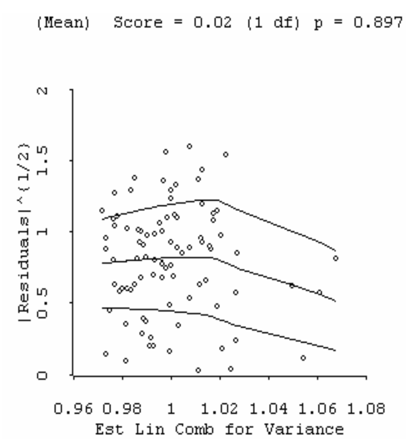

Fig. 9. Nonconstant variance plot

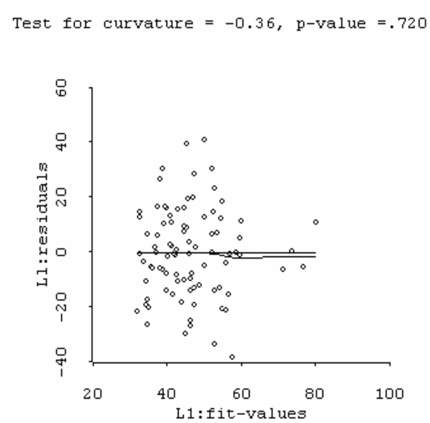

Fig. 10. Residual plot