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Using the Health Belief Model to Understand Pesticide Use Decisions

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1. INTRODUCTION

Farmers use pesticide to protect their crops from pests which in-turn help them maximise agricultural output on limited acres of land. However, the extensive use of such pesticide results in substantial health and environmental threats. According to WHO (1990) pesticide use causes 3.5 to 5 million acute poisonings a year. Rough estimates show that 20,000 workers dying from exposure every year and most of them from developing countries.

The literature shows that health and environmental hazards of pesticide use occur due to lack of information, awareness and knowledge which are chief contributing factors of extensive overuse or misuse of hazardous pesticide and dangerous practices [Forget (1991); Dasgupta, *et al*. (2005a); Ibitayo (2006)]. Research has also shown that health and environmental hazards of pesticides can be avoided by awareness, education and changing farmer's attitude and behaviour regarding pesticide use [Dasgupta, *et al*. (2005a)]. Therefore, the first step in developing pesticide's health and environmental hazard reduction policy is to set up the extent of the problem by investigating farmer's attitudes and behaviours regarding pesticide use [Koh and Jeyaratnam (1996); Dasgupta (2005a, 2005b)]. Such information is critical to identify the 'prospects and constraints to the adoption of alternative crop protection policy' [Ajayi (2000)].

According to classical microeconomic consumer theory, individuals make choices following their preferences. However, classical microeconomic models of consumer behaviour are poor in explaining and predicting consumer behaviour and do not focus on the processes of individual's reasoning behind choices. An obvious shortcoming of the microeconomic models is that they do not consider psychological, sociological, and other (noneconomic) factors that guide consumer behaviour [Huang (1993)].

Theories of cognitive psychology show that at personal level, people develop risk understandings through two interacting systems: a cognitive analytic system and an intuitive experiential system. Experiential information is more meaningful to change behaviour than abstract information [Severtson (2006)]. According to Leventhal (1983), experiences drive most of the risk perceptions and outcomes. One of the factors that affect whether or not farmers adopt environmentally sound behaviour of pesticide use is,

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'whether or not they have experienced a personal health effect' [Lichtenberg, *et al.* (1999)]. As health psychology literature says that most of our knowledge in our lives comes from actual personally relevant experiences rather than from intellectual exercises. Williamson (2003), in the context of farmers field schools says that it has been found that adults learn best from experience; firsthand knowledge is superior to information received from others. Communication researchers recommend applying behavioural theory to understand psychological processes that explain the relationship between experience and behaviour [Severtson (2006)]. The health belief model provides a framework for understanding the effect of experience on perception and outcomes. This study therefore combines an approach from social psychology with new classical theory to illustrate individual reasoning behind their decisions [Pouta (2003)].

Objective of the Study

The purpose of present study is to apply the health belief model to explore how farmers respond to information about and perceived experience with the threat of pesticide. It also attempts to analyse the implications for the adoption of alternative crop protection strategies at the farm level.

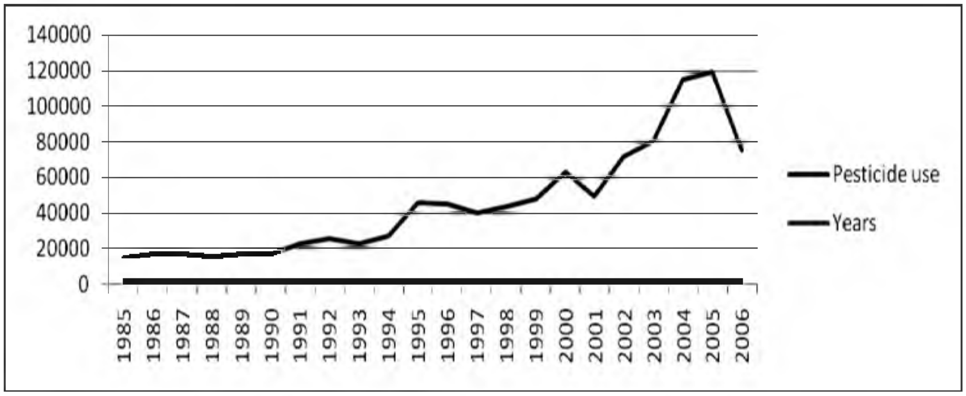
The specific objectives of the study are:

(a) To identify pesticide associated health effects experienced by farmers.
(b) To assess the relationship between health effects, risk perceptions and adoption of alternative pest management which is environmentally sound.
(c) To identify prospects and constraints in adoption of Integrated Pest Management (IPM) in the area.

2. REVIEW OF LITERATURE

The use of pesticide begun in 1952 in Pakistan. Government of Pakistan, like other developing countries, provided full support for the use of pesticide to save crops from pests and diseases [Rasheed (2007)]. Pesticide use grew at the rate of 11.6 percent on average over the last twenty years or so, reaching 117513 metric tonnes in 2005 which was 12530 metric tonnes in 1985. This massive increase in pesticide consumption contributed very little to improve the yield of crops, however, the rapid increase in pesticide use has caused a huge cost in terms of human health and environment. Azeem, *et al.* (2002) estimated that the environmental and social cost of pesticide use in nine major cotton growing districts in Punjab is 11941 million Pak-rupees per year. While estimating health and environmental cost, they reported that about 1.08 million persons were subjected to pesticide associated sickness, among those 24000 persons were hospitalised because of serious illness and about 271 fatalities were happened in these districts. In another study, Hassan (1994) reported that 22 out of 25 blood samples of farmers were found contaminated with pesticide residues in Multan Division. Similarly, Jabbar, *et al.* (1992) reported the result of blood samples of 88 female cotton pickers in cotton growing areas of Punjab which shows that nearly 74 percent female cotton pickers had blood (AChE) inhibition between 12.5 to 40 percent, while 25 percent of them were in dangerous condition where blood AChE inhibition was between 50-87.5 percent.

In addition to health effects, many studies [e.g. Iqbal, *et al.* (1997); Hasnain (1999); Azeem, *et al.* (2002)] have noted that indiscriminate use of pesticide has resulted in development of resistance in pests against the pesticide which ultimately leads to increase in their population. Due to extensive use of pesticide, the flora and fauna have been destroyed causing imbalance in agro-ecosystem and biodiversity [Iqbal, *et al.* (1997)]. Studies have also noted that in cotton growing areas of the country, the population of natural enemy pests has declined substantially [Hasnain (1999)].



Source: Agricultural Statistics of Pakistan, 2008.

Fig. 1. Pesticide Consumption in Pakistan (mt)

Pesticides are intensively used on cotton in Pakistan which accounts for about 80 percent of the total consumption of active ingredient of pesticide [NFDC (2002)]. Most of the pesticides used are insecticide including organophosphates, which are in the WHO hazardous categories I and II. The field evidence [Poswal, *et al.* (1998); Iqbal, *et al.* (1997); Hasnain (1999); Azeem, *et al.* (2002)] shows that farmers have moved to high levels of dependence on the use of pesticide. This reliance on pesticides has led to increased future costs of pest's control since such frequency of pesticide use leads to disturb or even breakdown in the ecological balance between the pests and their predators. The evidences from cotton growing areas have revealed that dependency on pesticide use has already led to the development of pest resistance for cotton pests, further reinforcing farmer's reliance on chemical pesticide. For example Poswal, *et al.* (1998) and Husnain (1999) have reported that the rapid increase in pesticide consumption has destroyed the bio-control agents in the agro-ecosystems and the populations of natural predators in cotton growing areas of Pakistan without contributing any productivity improvements. The best examples are the experiences with the major outbreaks of the Cotton Leaf Curl Virus (CLCV) in early 1990s, Burewala Strain of Cotton Virus and Mealy Bug in the beginning of 2000s which have done colossal damage to cotton crop.

Given Pakistan's agriculture settings and cash crops security situation, it can be expected that current crop protection practices will likely continue to be the main system in the country. There will be a growing use of agricultural pesticide because farmers recognise pesticide to have larger impacts on crop yields. The trust on pesticide for plant protection is expected to lead to more dependence on and to rising use of pesticide due to rapid development of resistance among pests. Therefore, there is an urgent need to address pesticide issues, so that rural communities can be secured from pesticide associated health and environmental damage which also put huge toll to the economy.

3. DATA METHODOLOGY AND RESEARCH DESIGN

Cotton has been identified as the major crop which accounts more than 80 percent of total pesticide use in Pakistan [NFDC (2002)], whereas more than 80 percent of cotton is produced in Punjab province and being the center of cotton crop the cotton zone of the Punjab has been recognised as the most intensive with respect to pesticide use. Overall two districts Lodhran and Vehari in Punjab province are selected for study area which are historically famous for cotton production and have a long history of pesticide use, an approximately 50 years [Khan (2009)]. Both districts represent more than 17 percent area under cotton cultivation in Punjab [Agriculture Census (2000)]. In addition, the selection of these districts is also based on the understanding that a reasonable data of farmers currently using IPM could be available and that the farmers of these districts are very much aware of IPM since the government has undertaken the activities of Farmers Field School (FFS) and Training of Facilitators (TOF) under the umbrella of National Integrated Pest Management (IPM) programme in these districts.

The technique of multi stage cluster sampling was used to obtain cross-sectional data. As a sampling strategy, after selection of study districts, all three tehsils were chosen for survey as the representative area. At least three villages (clusters), from every tehsil were selected purposively in each district to get the pesticide-related information from a sample of pesticide applicators. Overall, 915 farmers from both the districts, 412 from district Vehari and 503 from district Lodhran were enlisted [Khan (2009)]. Respondents for the interview were selected randomly from the numbers drawn until 318 interviews were successfully completed.

4. SURVEY RESULTS

Household Information: The average number of members per household[1] is 6.52. The average household size differs in districts, (6 in Lodhran and 6.8 in Vehari). Age of the surveyed farmers' ranges from 18 to 66 years, with an average age of 33.3 years approximately. Most of the farmers 113 were in age groups 21-30 (35.5 percent) and 101 were in age group of 31-40 (31.8 percent).

Over 73 percent of respondents had received education of different levels. About 6 percent of them also obtained graduation degree, whereas 26.5 percent of respondents had never in the school and could not read or write. In terms of higher education categories (matric and above) the farmers up to age 40 years are better educated than their older counterparts, this is probably due to changing attitude towards schooling and more opportunities available than the past. However, overall distribution is more or less same for all age categories.

[1]A household is defined to comprise all usual residents, where they sleep and share common facilities and share mutual reciprocal responsibility.

Table 1

Distribution of Education Attainment by Age Groups

	Education attainment					
Age Categories	Illiterate	Up to Primary	Middle	Matric	Higher Secondary and above	Total
Up to 20	5 (27.8%)	6 (33.3%)	2 (11.1%)	3 (16.7%)	2 (11.1%)	100.0
21-30	32 (28.3%)	25 (22.1%)	14 (24.8%)	29 (13.3%)	13 (11.5%)	100.0
31-40	27 (26.7%)	33 (32.7%)	15 (24.8%)	17 (6.9%)	9 (8.9%)	100.0
41-50	10 (20.0%)	13 (26.0%)	3 (36.0%)	19 (8.0%)	5 (10.0%)	100.0
51-60	9 (25.7%)	11 (31.4%)	5 (14.3%)	8 (22.9%)	2 (5.8%)	100.0
61+	1 (100.0 %)	0.0	0.0	0.0	0.0	100.0

Land Ownership and Farm Characteristics: The land tenure system in the study area is similar to other parts of Pakistan where land is commonly owned. The majority of farmers 75.5 percent owned land. More than 10 percent have rental arrangements and 6 percent of the respondents are sharecropper. About 8 percent of them have mixed arrangements. A large number of the farmers surveyed 99 (31 percent) hold either 5 or less than 5 acre of land. In terms of large land holding, only few of them had 50 acres or over, and most of them in district Lodhran, while a large percentage of respondent farmers (more than half) can be said small farmers in terms of land holding. The respondents average land area was 13.5 acres in district Vehari, and 14.5 acres in Lodhran district.

Risk Perception of Pesticide's Health Effects: According to the study results, the majority (88 percent) of farmers believed that they are at risk while using pesticide. Farmers were also asked to rank the risk. Five categories were presented and scaled as shown in the Figure 2. More than half 52 percent reported some small risk, 23 percent a medium amount of risk, 10 percent believed that the risk is large and significant, 3 percent said that the risk is very toxic, however 12 percent believed that there is no risk at all.

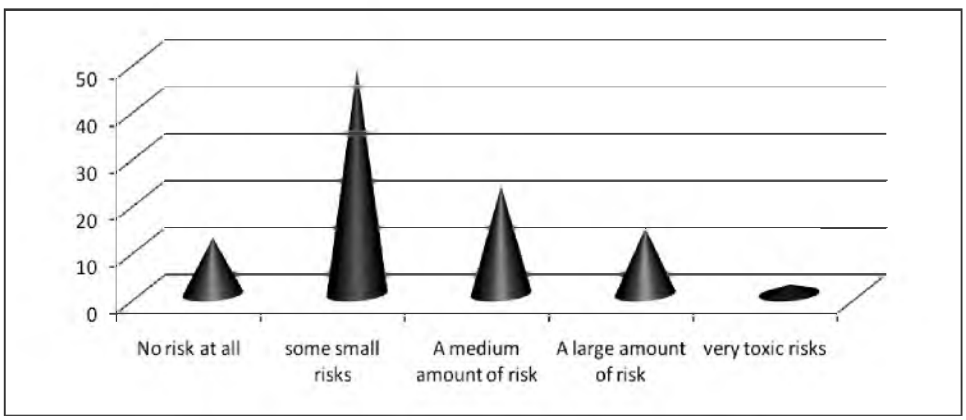


Fig. 2. Farmer's Perception of Pesticide Risk (%)

Health Effects of Pesticide Use: Farmers were asked if they experienced any health impairment after mixing and spraying pesticide. Almost 82 percent of them said they experienced health impairment after mixing and spraying pesticide. The most common signs[2] and symptom[3] experienced were eye (irritation: 33 percent), neurological (headaches: 26 percent, dizziness: 13 percent), gastrointestinal (vomiting: 9 percent), respiratory (shortness of breath: 10 percent), dermal (skin irritation: 33 percent) and (fever: 2 percent).

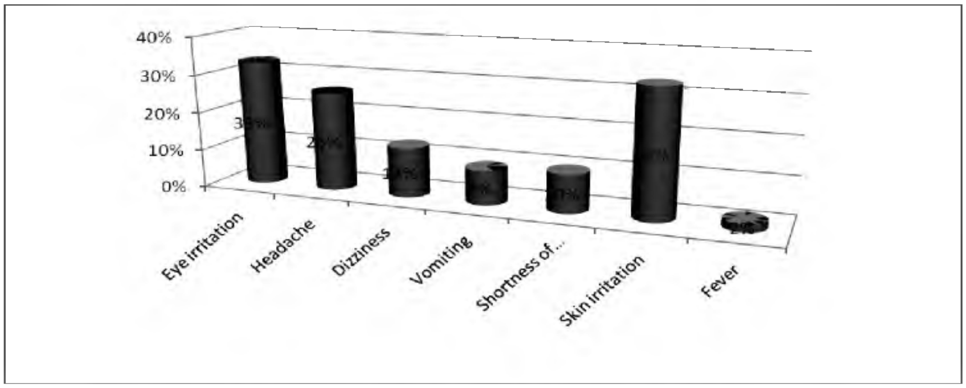


Fig. 3. Distribution of Health Effects Experienced by Farmers (%)

5. CONCEPTUAL FRAMEWORK

This study seeks theoretical support from Health Belief Model[4] to understand farmer's environmentally safe behaviour of pesticide use. The Health Belief Model was developed (originally) as a research tool to predict and explain preventive health behaviour [Green (2010); Stretcher (1997)]. Within the framework of health belief model, an individual's motivation to undertake a health behaviour can be divided into three main categories:

(i) Individual perceptions.
(ii) Modifying behaviours.
(iii) Likelihood of action.

Individual perceptions are factors that deal with the importance of health to the individual. These factors affect the perception of disease or illness; these are perceived

[2]*Sign: something you can observe or see that requires an examination.

[3]*Symptom: something a person feels but you cannot see.

[4]The Health Belief Model has been chosen for the present study because of several reasons; (1) the Health Belief Model considers individual as active information processor and independent decision maker. Since pesticide use is largely governed by voluntary behaviour, hence health belief model best suits in present circumstances; (2) another advantage of HBM is its simplicity that makes it a promising model to understand health behaviour. HBM is different from other models of health psychology in that there are no strict guidelines as to how the different variables predict behaviour. Instead it proposes that independent variables are likely to contribute to the prediction of health behaviour [Nejad, *et al.* (2005)]; (3) the model comprises a series of broadly defined constructs that might explain the variance in health behaviour but there are no clear operational guidelines regarding relationships between them. Although this lake of structure is often a source of criticism, but at the same time, the flexibility of the model makes it attractive[4] among researchers. This is the reason that it is the most frequently used model in health psychology; (4) though, HBM is a health-specific model, it allows socio-economic variables to be included in the model which affect health motivation. Because of the features, discussed above, the HBM has received much practitioner and research support over the years [Munro, *et al.* (2007)].

susceptibility and perceived severity. The modifying factors include individual characteristics, demographic variables and cues to action. The likelihood of action includes factors in probability of taking suggested health action to prevent disease [Green (2010)]. The combined effect of these factors leads to an individual to undertake the recommended preventive health action.

One of the problems that emerged out of the HBM framework is that different questions have been used in different studies to determine the same perception or beliefs. Consequently, it is difficult both to design appropriate scales or tests of the HBM and to compare results across studies [Green (2010)]. The present study has adopted more direct approach to apply HBM in the context of farmer's health behaviour which avoids many of such problems. Instead of using an individual's perceived susceptibility to the cause of harm, following Lichtenberg and Zimmerman (1999) this study uses self-reported experience of a health problem from pesticide,—a relatively more direct measure of threat to health than perceived threat. The susceptibility component of health belief model is the one most closely analogous to the health experiences that farmers have reported in connection with pesticide. The actual experience of health problem heightens individual's perception regarding health threat which in turn, may or may not encourage them to change their own behaviour with respect to pesticide use and safety [Lichtenberg, *et al.* (1999)].

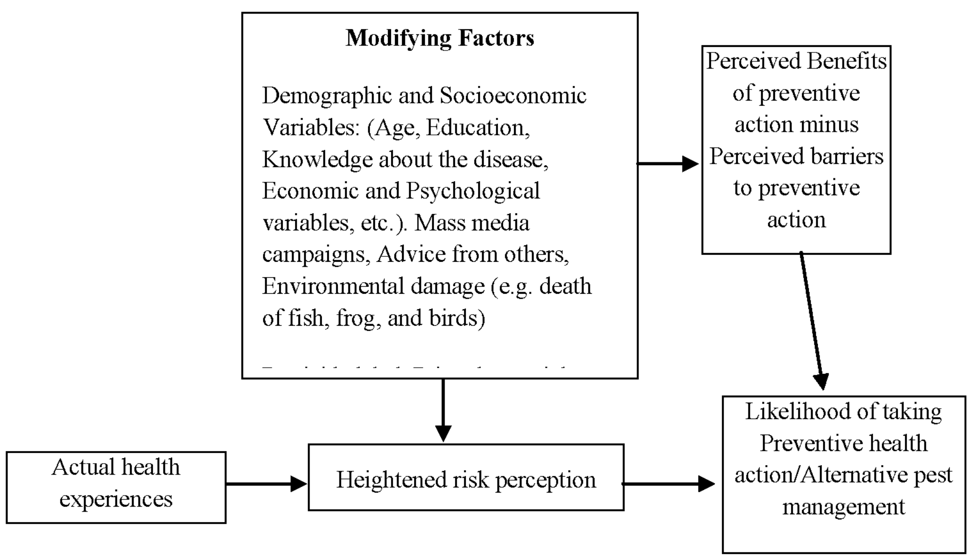


Fig. 4. Relationship Between Health Experiences, Risk Perception and Pesticide Use Behaviour

Health Experience, Farmers' Attitudes and Environmentally Sound Behaviour of Pesticide Use

One basic premise in new classic welfare (utility) economics is that individuals are best judges of their welfare and that inferences can be drawn about welfare (utility) for each individual by observing the individual's choice of bundles of goods and services

[Gunatilake (2003)]. Suppose a consumer (farmer) who consumes a product (pesticide) approaches the same product but in a safer form. A consumer who moves from consuming a usual product to the one which is assumed potentially safe to the health, presumably does so because choice of the safe product (pesticide) increases (or at least does not decrease) the utility of the consumption set, all other things being equal. If utility does not change, then a consumer will not rationally be willing to change with safe alternative, as an increase in price or efforts result in a lower level of utility compared to the base level of utility. If utility does increase, then a consumer may be willing to choose IPM product, provided the present choice does not lower utility beyond the base level. Specifically, an individual's preference for safe alternative is a function of the change in utility:

Environmentally Sound Alternative = $f(\Delta U)$

Where ΔU *is* the change in utility and $f' > 0$ ... ... (1)

An individual's consumption choice of safe alternative is a function of the change in utility in terms of improved health arising from the consumption of IPM. Since the choice of one product over another is a discrete one, it is convenient to cast choice in a random utility[5] setting. In this setting, an individual's utility function, and hence utility arising from the choice of alternative, is composed of a deterministic component and a random component. The deterministic component reflects observable alternative specific factors (i.e., attributes) that influence the level of utility realised by choosing the i^{th} product. The random component represents unobservable factors, such as unobservable variations in preferences, random individual behaviour and measurement error.[6] Alternative i is chosen if and only if the utility arising from its choice exceeds the utility arising from the currently consumer product.[7] Put another way, the ith alternative is chosen if and only if the change in utility (arising from a switch in products consumed) is positive.

Based on the conceptual framework, a model is formulated to analyse the relationship that links health experience and risk perception in a farmer's decision-making process for alternative pest management. The framework is specified as follows:

$$ESB = h(RP, HE, Z) + €i$$

Where *RP* represents farmer's perception of pesticide associated health risk, *HE* represent health effects a farmers observed while using pesticide, *Z* represent other variables included in the equation, *ESB* defines the environmentally sound behaviour of pesticide use and *€i* represents random error.

[5]Random utility theory is characteristically identified with preferences that are associated with the design of discrete choice experiments.

[6]In the random utility model, the utility function is expressed as $U_i = X'ß + \varepsilon_t$, where U_i is the utility arising from the choice of the *i*th alternative, $X_i'ß$ is the deterministic component of the utility function, X_i is a vector of observable alternative specific factors that influence utility, ß is a parameter vector and ε_t is the random component.

[7]Alternative i is chosen if and only if $U_i > U_j$ for all $j \neq$ i (or that $\Delta U = U_i \doteq U_j > \tilde{0}$). Willingness to adopt IPM can be re-written, without loss of generality, as IPM $= X'ß + \varepsilon_t$, where $X = X_i - X_j$ and $\varepsilon = \varepsilon_i - \varepsilon_t$.

The equation is restated as:

ENVIRONMENTALLY SOUND BEHAVIOUR OF PESTICIDE USE = f (RISK PERCEPTION, HEALTH EFFECTS, AGE, FARM SIZE, INCOME, EDUCATION, TRAINING, DISTRICT DUMMY) + ξ_2

Thus in the equation, farmers' behaviour of pesticide use is specified as a function of risk perception, health effect, age, education, income, farm size and training. The region dummy is also included in the equation to see possible differences in farmer's decision with respect to location. To test the stated hypotheses, the environmentally sound behaviour (ESB) variable is constructed based on data collected from the survey, where respondents were asked that thinking about adverse health effects of pesticide use, whether they adopted any alternative pest management technique such as integrated pest management which is supposed to be environmentally sound. A positive answer is taken as environmentally sound. Environmentally sound behaviour is hypothesised positive with health effects, education, training, income and age.

The dependent variable takes the form of binary response variable, hence binary response (probit or logit) models are available. The probit model will be used here. The latent variable *yi** as follows:

$$Y_t^* = X_i\theta + e_i$$

Where e_i is independent of X_i, θ is a K _ 1 vector of parameters, and $e \mid x \sim$ Normal (0, 1). Instead of observing Y_t^*, we observe only a binary variable indicating the sign of Y_t^*:

$$Y_i = 1 \qquad if\, Y_i^* > 0$$

$$Y_i = 0 \qquad if\, Y_i^* \geq 0$$

6. EMPIRICAL ANALYSIS OF HEALTH EXPERIENCE, RISK PERCEPTION AND ENVIRONMENTALLY SOUND BEHAVIOUR OF PESTICIDE USE

This section examines to what extent farmers engage in pest management practices that are considered environmentally sound in relation to health effects. A probit model was used to examine the relationship between health experience and alternative pest management practices. The probability of alternative pest management practices used was also assumed to be a function of farm size, farmer's characteristics and farmer's attitudes toward pesticide-related health experiences. The incorporation of the additional variables controls for factors that may be associated with health experience as well as decisions about using alternative pest management practices and thus allows isolation of the effects of health experience.

Table 2

Maximum Likelihood Estimates of Probit for the Use of Alternative Pest Management Practices

	Dependent Variable = IPM	
Independent Variable	Estimated Coefficients	Z-scores (P)
Perception	.4762618	2.97 (0.003)
Health effects	–.1566526	–0.41 (0.687)
Training	2.012281	6.87 (0.000)
Farm size	–.006086	–0.85 (0.396)
Income	.0074283	0.32 (0.749)
Age	.0071272	0.50 (0.616)
Education	.0809879	2.43 (0.015)
District dummy	–1.155681	–3.21 (0.001)
Constant	–2.400256	–3.53 (0.000)

–Values in parenthesis are P values.

The probit results did not support the hypothesis that farmers who have had an adverse health experience related to pesticide use are more likely to adopt sound behaviour of pest management than farmers who have not had such experiences. The lack of information or access to these methods is likely a contributing factor which did not allow many farmers to have proper awareness about alternative pest management practices. The non-existent or the absence of information on other methods of pest control and pro-pesticide extension made farmers biased in favour of pesticide use. As a result, alternative methods are locked out and pest control/management technology became almost synonymous with the use of pesticide. Therefore, farmers consider pesticide as the only crop protection method in this part of Pakistan. Hence, improving farmers' awareness and access to other methods will be necessary for their adoption of alternative crop protection practices.

Neither farm size nor income of the farmer had any effect on alternative pesticide use. Age is also not significant to alternative pesticide use. Training in safe-handling of pesticide had positive effect on alternative pesticide use and this effect is very strong also. Similarly, risk perception and education significantly affects alternative pest management practices. Among districts, alternative pest management practices are more likely prevalent in district Lodhran.

Predicted probabilities and marginal effects from the estimated probit model are presented in Table 3. Result shows that the farmers with heightened risk perception are more likely to adopt alternative pest management practices than farmers with less heightened perception. Similarly, controlling for other variables, the probability of alternative pesticide use among more educated farmers is higher than less educated farmers.

Table 3

Predicted Probabilities and Marginal Effects from the Estimated Probit Model

	Dependent variable = IPM Predicted probability=.0311968	
Variables	Marginal effects	Z-scores (P)
Perception	.0306913	2.77 (0.006)
Health Effects	–.0130484	–0.44 (0.657)
Training	.4323269	6.87 (0.000)
Farm Size	–.0026829	–0.22 (0.826)
Income	.006383	0.47 (0.640)
Age	–.0017495	–0.17 (0.866)
Education	.0137491	2.41 (0.016)
District Dummy	–.0750914	–3.21 (0.001)

The data did not appear to confirm that farmers who experienced health problems while using pesticide are more likely to adopt alternative pest management than farmers who have not had such experiences. Multiple reasons as reported by farmers may explain this comportment.

- The most important reason of not using alternative pest management techniques is that farmers in study area either haven't information about the availability of alternatives techniques to pesticide or haven't access to these alternatives. So they are forced to use pesticide despite their reservations.
- Generally, farmers are over cautious about economic losses. Since pesticides are easily available even at door-steps, they tend to use pesticide frequently to avoid crop damage. They do not want to use any alternative pest management technique that is not well tested or that is not believed as effective as chemical pesticide. Further IMP is not practiced on a large scale; therefore most of the farmers are unaware of its utility.
- Practically, most of the farmers are uneducated coupled with non-existent agriculture extension services let pesticide companies succeed to convince farmers through powerful advertising that without pesticide use crops cannot be protected from pests; hence pesticide are considered an integral part of present day agriculture in the study area. Furthermore, these companies/pesticide dealers also succeeded to speeding up the use of chemicals in agriculture by providing different services and offering lucrative incentives involving distribution of pesticides, sprayers and fertilisers on advance or in many cases free distribution of these items, and lotteries/prizes which ultimately leads to encourage the use of pesticide over other natural alternatives available to farmers.
- Agriculture extension is pro-pesticide in the study area. Further, it is also not oriented to the shift of information related to the dangers inherent in the use of pesticide. Due to cultural believes regarding health effects or farmers inability to distinguish health effects related to pesticide use, it is likely that health effects arising from pesticide use are grossly-underestimated. Farmers take many of health effects a routine matter and are not very serious to take steps to avoid these problems.

Controlling for other variables, the probability of alternative pesticide use among farmers who received training of alternative pesticide use/safe handling is significantly higher than the farmers who did not receive such training. Hence training appears to discourage pesticide use in the study area. However, evidence indicates that there is lack of formal training on safe handling and IPM use. Only 10 percent of the farmers reported receiving formal training on safe handling and better management of pesticide. The result is very much similar to that found by Dasgupta (2005a) in Bangladesh where farmers reported similar trend. Therefore, speeding up the formal training in IPM may be a workable solution to reduce health and environmental damages. However, strong institutional support is required to extend the scale of IPM training.

Coming to insignificant relationship between age and alternative pesticide use. The age of the farmers appeared in the negligence of pesticide related health impairments. As reported by Ajayi (2000) that with the increase of age (experience of pesticide spraying), farmers are likely to think less of the health problems that are associated with pesticide use. They are ready to accept a certain level of pesticide associated illness that in turn reflects their hesitation to adopt alternative pesticide use. Above explanation seems applicable in case of present study, since age appears negative but non-significant to risk perception.

Finally, the insignificant results of farm size and income indicate that in addition to farmer's health characteristics, wealth characteristics are also less likely to motivate farmers to adopt more sustainable practices. The analysis underscores the fact that human capital characteristics (e.g. education, training and awareness) of farmers appear to influence their decision for more sustainable practices than land characteristics (e.g. farm size).

7. CONCLUSION AND POLICY IMPLICATION

The present study analysed the current crop protection practices with the view to identifying the prospects and the constraints to improve crop protection methods. The study reveals that pest management is pro-pesticide in Pakistan. Government policies (pro-pesticide extension system, soft rules for import of pesticide and other support measures) either directly or indirectly encourage farmers to use pesticide to achieve higher crop yields. Over the years pesticide encouragement policies have led to erosion of alternative pest management practices among farmers in cotton growing areas. Farmers are not well conversant to integrated pest management (IPM) practices and they have no choice except to use pesticide, even their health concern.

The study concludes that cultural believes (ignorance) regarding pesticide related health effects, lack of information regarding and/or non-existent alternative pest management and fear of economic losses remains the main barrier in adoption of more sustainable pest management practices. In addition, the powerful consumer services network by pesticide companies perpetuating the vicious circle of pesticide use and serving as the chief barriers to switching to alternative pest management strategies. Therefore in seeking for a better solution to pest management problems and negative externalities of pesticide use, the priority issues are not just how to set up regulations and policies that would ban pesticide use in crop production, but how to use pesticide correctly and safely and avoid its misuse and overuse, so that farmers could internalise the negative health and environmental externalities of pesticide use and find better pest management solution. There is also a strong need to convince farmers that pesticide use is not the only way of controlling pests. Hence, improving farmer's knowledge of pest management and pesticide safety issues are critical. The availability of alternative pest management techniques is also an issue which should be resolved. Although some farmers decide to adopt alternative pest control strategies but such services are largely not available to farmers in study area. The study stresses that increasing use of farm pesticide cannot be effectively checked if there is no practical alternative pest management technology available.

The results of the study bear some implications for policy formulation.

(1) Government should commit further resources to research and training in integrated crop management with an orientation towards the reduction of pesticide use and safe use of pesticide. The results which indicate that heightened risk perception and IPM training are the main determinants of safe behaviour of pesticide use offer opportunities to integrate IPM technology into current crop protection methods. The feasibility of the IPM technology has been highlighted by many studies [e.g., Azeem, *et al.* (2002, 2004)] which were conducted in the cotton growing area of Punjab. In addition, the common belief among farmers that pesticide are getting less and less effective than before makes this claim stronger that the farming community in study area will warmly welcome IPM methods of crop protection.

(2) An important implication is that the investment of public resources in providing information can be effective even when resources for a more detailed intervention, such as provision of alternative pest management or enforcement of pesticide related laws are lacking. The government should strengthen information and services[8] provided by the agriculture extension for plant protection. The interventions can take many forms, including media events, NGOs and community programs undertaken to promote awareness and understanding of the risk issues. Intervention should also include social institutions (e.g., community leaders) that can help making farmers become aware of the risk and subsequently leads to some sort of change in knowledge, attitudes and behaviours.

APPENDIX

Risk Perception: This variable measures whether or not farmers perceive pesticide a potential danger to their health, particularly when mixing and applying pesticide. It is very important in the course of behaviour change since it motivates individuals to adopt measures to protect themselves from negative environmental conditions. Risk perception is specified as no risk at all=1 to very high risk=5. In defining the variable, the study follows a similar method used by Lichtenberg and Zimmerman (1999).

Health Effects: As farmers mix and spray pesticide, they are naturally exposed to the toxicity of the chemicals. Exposure to pesticide can lead to number of health effects, depending on the pesticide's toxicity and the dose absorbed by the body [Dasgupta (2005a)].

[8]There is a need to overhaul current extension services by improving their knowledge on the changing trends of pest populations.

Health effects variable is very important in the course of behaviour change. It heightens risk perception which ultimately motivates individuals to take protective measures to minimise health risk. Health effect is specified as whether or not farmers experienced negative health effects during or short after mixing or spraying operations. The health effects of pesticide exposure are manifested as specific symptoms or a combination of multiple symptoms. Building on WHO information as well as earlier studies, 10 types of symptoms were first identified. The question was also left open to include others if reported (any). The study focuses on acute health effects, as a detailed medical examination of sample farmers was beyond the scope of this study. Study relied on self-reported health effects, where farmers were questioned if they experienced any health impairment after mixing and spraying pesticide. Following Dasgupta (2005a), the health effects variable is defined as whether a farmer experienced at least one symptom (=1) or not (=0). Given the results of previous studies and theoretical background health effects is expected to have a positive relationship with alternative pest management practices.

IPM: The IPM variable is very important in the present context since this study makes an explicit link between illness experiences and coping strategies. It measures whether or not farmers adopt alternative pest management technique such as integrated pest management which is supposed to environmentally sound. It is worth knowing that IPM focuses on the adoption of various pest management practices regarded as environmentally sound/beneficial and either substituting for or supplementing pesticide use while not necessarily eliminating pesticide use.

Education: Education is expected to have positive impact on coping behaviour. The more educated people are expected to rank higher risk perception and subsequently adopting IPM practices owing to better awareness. For the purpose of analysis, the respondents were grouped into seven groups based on the education level—from 1= illiterate, 2= 1 year of schooling up to 4 years, 3=from 5 years up to the 7 years, 4= 8 years up to 9 years of schooling, 5= 10 years up to 11 years, 6=12 years up to 13 years and 7= 14 years and above.

Income: Income is the total monetary equivalence of all expenditures made by the household in the farm of cash plus total value of household grown agriculture products kept for household's consumption during a month. The household grown products also includes livestock's produced dairy products. Household were also asked about variations in income during different seasons.[9] The income is defined in rupees and is expected to impact risk perception, protective behaviour and IPM positively. It is based on the reasoning that high income individuals are more likely better aware and better informed and can afford protective measures.

Age: This variable represents farmers' age and is used as a proxy for farmer's experience and management capacity of pesticide operations. Compared to youth, adult are also assumed to be more caring. Given that farming is the major vocation in the study area and most of the individuals are introduced to farming as early as their youth, it is assumed that their age will better reflect pesticide hazard [Ajayi (2000)]. As prior expectation age is positively related to risk perception, protective behaviour and IPM.

Training: Training is also a variable of interest. An individual usually undertake training with the ultimate goal to avoid pesticide exposure. A trained farmer being better informed is expected to perceive more risk and engage in better management practices.

[9]Based on the understanding that livestock generates products like milk, eggs and the like items are not always same throughout the year. Similar reasoning holds for agricultural products like fruits and vegetables.

The training variable is defined as whether a farmer got training of safe handling of pesticide (=1) or not (=0)?

Farm Size: Based on the prior evidences [NFDC (2002); Jeyaratnam (1990); Forget (1991)] which states that agriculture extension services often limited to big landholders, farm size is assumed to be positive to risk perception and alternative pest management practices. Additionally, farm size is taken as the proxy of duration of pesticide exposure, since larger the farm size, higher the likelihood that farmers spend additional hours in spraying/farming activities. Therefore, carrying higher probability of being exposed to pesticide.

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