Poverty-Environment Nexus: Use of Pesticide in Cotton Zone of Punjab, Pakistan

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Abstract

The use of pesticide in agriculture is on the rise in Pakistan. The studies have identified that due to hazardous use of pesticides, health and environmental effects are mounting. This study answers three questions relating to pesticide use in Pakistan, 1) Whether small and poor farmers use more amounts of pesticides?, 2) Whether poor farmers use more toxic pesticides than non poor farmers?, 3) Is pesticide use and its associated health effects, impacting the poor farmers to a greater extent than the non-poor farmers? Using structured questionnaire, 318 farmers were interviewed in the cotton belt in Punjab, an area known for extremely intensive cotton production and pesticide use. Results show that although the poor are currently using smaller amounts of pesticides, they are using relatively more toxic pesticides. Resultantly, poor farmers reported experiencing relatively higher number of pesticide associated illness. The study recommends that policy measures addressing health and environmental issues of pesticide use should focus on poor farmers.

Keywords: Pesticide use, Poverty, Poor, Health effects

1. Background

The agricultural crops are subject to pests attacks. Particularly, the cotton is the most vulnerable to pest attacks. The use of pesticides as crop protection technology begun in 1952 in Pakistan and the Government provided full support for the use of pesticide to save crops from pests and diseases (Rasheed, 2007). Pesticide consumption has increased tremendously over the last two decades reaching 117513 metric tonnes in 2005-06 which was only 12530 metric tonnes in 1985. In terms of crops, 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 insecticides. The colossal increase in pesticide use from 1980 when the pesticide trade was liberalized and transferred to the private sector raised serious concern about sustainability of pesticide use.

The field evidences (Poswal et al, 1998; Iqbal et al, 1997; Hasnain, 1999; Azeem et al 2002) indicate that farmers have moved to high levels of dependence on the use of pesticide. This reliance on pesticide has led to increased future costs of pest's control since indiscriminate use of pesticides leads to disturb the agro-ecological balance between pests and predators. The evidences from cotton growing areas have revealed that dependency on pesticide use has already led to create resistance among 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 delicate balance between pests and 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.

In addition to the alarming increase in pesticide use, the evidence also suggests that the extensive increase in pesticide use results in substantial health threats. Azeem et al (2002) estimated health and environmental cost of pesticide use in nine districts of cotton belt in the Punjab province. The result shows that cost of pesticide use is worth 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 hospitalized because of serious illness and about 271 fatalities happened in these districts. A study in Multan division reported that 22 out of 25 blood samples of farmers were found contaminated with pesticide residues (Hassan, 1994). Similarly, another study reported the result of blood samples obtained from female cotton pickers in cotton growing areas of Punjab which shows that nearly 74% 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 (Jabbar et al, 1992).

Given the dismal picture of pesticide use in the country, this paper attempts to provide evidence on poverty-environment inter-linkages from cotton growing area by segregating poor from non-poor. Three Main questions that this paper aims to answer are:

1) Whether poor farmers use more amounts of pesticides?

2) Whether poor farmers use more toxic pesticides than non poor farmers?

3) Is pesticide use and its associated health effects, impacting the poor farmers to a greater extent than the non-poor farmers?

To answer above mentioned questions, a detailed pesticide use survey was constructed to interview sample of poor and non-poor farmers in Lodhran and Vehari districts regarding pesticide use. The description of the survey and sampling strategy is given in next section.

2. Survey design and research methodology

According to Government estimates, 70 to 80% pesticides are being used on cotton in Pakistan (NFDC, 2002; Rasheed, 2007), whereas more than 80% of cotton is produced in Punjab province. Two districts of cotton growing area of Punjab (Lodhran and Vehari) which are famous for cotton production are selected for the study. The study area is also known for intensive use of pesticides. It represents 17.5 % of total area under cotton crop in Punjab. The questionnaire used for the study is modified version of similar World Bank studies in Bangladesh and Vietnam. Detailed information was collected from the sample farmers on pesticide use and practices, applicator precautions/ averting behavior and health/ environmental effects.

To collect representative data for both the districts, multi stage cluster sampling was used. In first stage study districts were selected purposively, in second stage each Tehsil of both districts was chosen for survey. In third stage, a cluster of at least three villages from every Tehsil in each district was selected to collect pesticide-related information from a sample of farmers who use pesticides. Out of total 915 households, 318 randomly selected farmers provided information.

2.1 Definition of the poor

As the main objective of this study is to investigate the possible inter-linkages of pesticide use and the poor. The most important part of this analysis is the determination of the limit beyond which people are to be considered as poor, called as poverty line. On the basis of Pakistan Integrated Household Survey (PIHS) 1998-99 data, Federal Bauru of Statistics (FBS) Pakistan estimated the poverty line as Rs. 673.54 per adult per month on calories 2,350 per adult per day, on the calorie based approach (note 1). For each and every year this line is updated on the basis of inflation. Accordingly, as reported in Pakistan Economic Survey 2009-10, for Pakistan Social and Living Standard Measurement Survey (PSLM) 2005-06 this line stands at Rs. 948.47. The survey of the present study was conducted in the year 2008, so we have incorporated the inflation of the successive years, resultantly; the poverty line that is used in the study is Rs. 1144.82 per month. Applying this criterion to our sample of farmers, table 1 presents the number of respondents who fall in the category henceforth known as the 'poor'.

2.2 Measurement of income

Another important step in the analysis is the measurement of income. Total expenditure in a month was used as the proxy of income. Total expenditures were divided into two component; all expenditures made by the household in the form of cash and total value of household grown agriculture products including products received from others, kept for household's consumption during a month. The household grown products also includes livestock's produced dairy products. Households were also asked about variations in income during different seasons (note 2).

3. Survey results and analysis

3.1 Age and education of the sample farmers

Age of the sample farmers ranges between 18 to 66 years. The mean age of the farmers is 33.3 years approximately. Age is almost evenly distributed among poor and non poor. Over 35 percent farmers fall in age groups 21-30, and about 32 percent are in age group of 31-40.

In terms of education, the survey indicates that more than 73 percent farmers are educated i.e. they have attained education of different levels from primary to graduation. The survey also reveals that most of them are non poor. About 6 percent of them received graduation degree; again most of them are non poor. Whereas about 27% respondents had never been in the school and could not read or write. Here poor farmers dominated which may clearly indicate the lack of sufficient resources at their part. In terms of higher education categories (e.g. matric and above) the farmers up to age 40 years are better educated than their older counterparts, this is probably due to more awareness towards schooling and more opportunities available than the past (Khan, 2009).

3.2 Land ownership and farm characteristics

The land ownership data indicate that the majority of farmers 75.5 percent owned land. More than 10 percent have rented from land owning families and 6 percent of the respondents are sharecropper. About 8 percent of them have mixed arrangements. Most of the fields cultivated in the area were inherited from parents. A large number of the farmers surveyed 99 (31%) hold either 5 or less than 5 acre of land. In terms of large land holding, only few of them had 50 acres or more 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.

3.3 Use of pesticide

Pesticide use can be measured by many ways. The well established measurement indicators include; by number of pesticide applications on a crop in a season, by absolute quantity of pesticides used, and a "measure of the relative risk or toxicity" of the pesticide. The first two types of measurements i.e. absolute quantity of pesticides used and number of pesticide applications are easy to handle and interpret, "however, factoring in the relative risk of each pesticide requires the adoption of a methodology that can rank one pesticide as more toxic than another" (Meisner, 2005). The methodology adopted for this study is described below.

By simply summing all pesticides measured as kg of active ingredient used in crop protection. "To gauge the relative toxicity of each active ingredient, a measure called the LD50 (or lethal dose 50%) is used. LD50 is a statistical estimate of the number of milligrams (mg) of toxicant per kilogram (kg) of bodyweight required to kill 50% of a large population of test animals (note 3). Pesticides with a lower LD50 value are more toxic" (Meisner, 2005). To better understand the extent of risk exposure, the study used widely-known categorical method developed by the World Health Organization (WHO) which is also based on the LD50 measure (note 4). Pesticides are divided into 4 major hazard groups: Category Ia & Ib (extremely hazardous& highly hazardous), Category II (moderately hazardous), Category III (slightly hazardous), and Category U (unlikely to present acute hazard if used safely).

Note that extremely hazardous (category 1a) is non-existent in the study area but highly hazardous (category 1b) is still being used by a large fraction of farmers. The more concerning is the use of this class of pesticide on vegetables in large quantity, posing a possibly serious health hazard to consumers. In absolute terms, irrespective of pesticide class, non-poor in this study are using more amounts (mean application amount) than poor on selected crops. Yet another important and more appropriate method of pesticide use measurement is the classification of pesticides by their chemical class. Returning to the pesticide use hazard classification indicators and accounting for the relative risk of the pesticides used, the poor are using more toxic/hazardous class of pesticides (highly hazardous). Figure 3 indicates that average application amounts on *per acre* basis are almost twice for the poor than for the non-poor.

Category 1a &1b chemical class has been recognized as being extremely and highly toxic and persistent in the environment. Epidemiological studies have linked highly hazardous pesticides which also include organophosphates, pyrethroids and carbamates with fatalities, preterm birth, pregnancy loss and infertility, hormonal changes, DNA damage, cancer (note 5), congenital anomalies and fetal growth retardation (Potashnik, 1987; Pimentel et al, 1996; Garcia, 1999; Sanborn, 2004).

3.4 Pesticide spray frequency

The survey found that farmers often apply pesticide very frequently. It was quite common for farmers (73 percent) to use pesticide more than 10 times on cotton in a season. The spray frequency is as high as 16 on cotton crop in one season. Almost all the farmers found mixing several different brands together and the common reason of this practice was better control over different type of insects at a time.

Mean application on different crops by poor and non poor farmers is shown in figure 4. On average, the non-poor farmers (12.0 sprays) were found spraying frequently than the poor farmers (11.6 spray) in a season on cotton crop. The comparison also shows that non poor registered higher spray frequencies on wheat and vegetables.

3.5 Misuse and overuse of pesticides

From health and environmental perspectives, the overuse of pesticides is a safety concern. In the survey respondents were asked about pesticide application amounts which were then compared to the prescribed amounts on the label or recommended by the extension officer. The analysis of pesticide overuse revealed that overuse is slightly more prevalent among non-poor. Another concern is the misuse of pesticides. The misuse of pesticide is defined as using pesticides on a crop for which it is not recommended. It was found that it is not a very common practice among farmers in the survey area; only 5.6% of non-poor and 6% poor farmers mentioned misuse of pesticides.

3.6 Risk perception

Perception of a pesticide' risk influences the dose decision by farmers (Dasgupta, 2005a). It is important to know that whether farmers perceive pesticide a risk to their health (Meisner, 2005). Identification of their perception is very important in the design of any safety program. Farmers were asked to rank the risk. Five categories were presented and scaled as shown in the figure 6. The figure shows that although poor use more toxic pesticides but they perceive less risk than non-poor. The lack of education and awareness are the possible reasons, since it is well established that pesticide extension services are skewed towards progressive and rich farmers (Khan, 2009& 2010; National Fertilizer Development Center, 2002). Thus result shows that when setting priorities, policy makers must first select a policy benchmark. For example, if they are concerned with banning highly hazardous pesticides or intending to launch awareness programs, then focusing on poor farmers may better address these issues than focusing on farmers in general.

3.7 Pesticide practices and use of protective measures

When farmers undertake spraying operations, they are naturally face direct toxic exposure. This toxic exposure cause number of negative health effects (note 6). However, the health effects of pesticide use can be avoided by taking safety measures (Dasgupta, 2005a). In our survey only 8% farmers reported receiving basic training on the safe handling of pesticides, while 89% said that neither had they any access to nor did they know who provides this training. Upon asking does the liquid come into contact with any part of your body when you mix/use pesticides, 47 percent poor and 42 percent non-poor farmer said that usually liquid touch their hands, 3 percent reported same incident with their feet. Another fact describing unsafe practices is the re-entry time in the field after application, 72 percent and 75 percent (poor and non-poor respectively) re-enter in the sprayed field within 24 hours after pesticide application. This shows that farmer's re-entry time in the area is very short which raise serious concerns because many of pesticides used by the farmers consist of organophosphate and pyrethroid mixture and they have essentially acute effects.

Upon asking about precautions, most of the respondents said that they cover their body with protective clothing. The use of masks and glasses were almost nonexistent, but they usually use cloth to cover their faces instead mask which could be said a substitute of mask in present circumstances. Also the use of gloves and boots were limited. The main reasons for not using protective clothing was; already high cost of inputs (poor=14%, non-poor=2) non availability of these materials (poor=25%, non-poor=11), uncomfortable to wear due to hot weather (poor=61%, non-poor=87).

3.8 Health effects of pesticide use

A medical examination of sample farmers was beyond the scope of this study. Instead study relied solely on self-assessed/reported (note 7) health effects. Farmers were asked if they experienced any health impairment after mixing and spraying pesticide. Almost 82 percent of farmers said they experienced health impairment after mixing and spraying pesticide. The most common signs and symptom experienced were eye irritation (poor=41%, non-poor=27), headaches (poor=21%, non-poor=26%), dizziness (poor=17%, non-poor=10%), vomiting (poor=11%, non-poor=8%), shortness of breath (poor=11%, non-poor=10%), and skin irritation (poor=34%, non-poor=29%). Many of the farmers reported that they experienced multiple health effects.

When suffering from symptoms, most of the farmers do not get proper treatment from doctor and many of them believe that these symptoms are routine matter or common and they are not worry about them. Usually they cure themselves by using home-made remedies such as drinking lemon juice, saltish water in case of vomiting and massage to the body with bitter oil (tara mera) in case of skin irritation. Only few of them visited doctor because they felt that illness was serious. These results tend to analogous to other studies. Kishi et al (1995) reported that only 24% of all the pesticide applicators who reported symptoms took medication and "less than 1% of pesticide applicators went to a health center with symptoms related to (pesticide) spraying". Similarly, Ajayi (2000) noted that 80 percent "pesticide applicators did not think that they encountered extraordinary health problems that are beyond normal levels during the pesticide application. Only in 2% cases, the victims visited health care centers for medical consultation or to seek for formal medical assistance." These results indicate that the official estimates of pesticide related sickness may be grossly under-represented since only those cases are recorded that are taken to hospitals.

4. Conclusion and implication

Use of pesticides in Pakistan is on the rise over the last few decades. Most of the pesticides used are in the WHO hazardous categories I and II. This colossal increase in pesticide use raises serious health and environmental concerns. The field evidences indicate that farmers are highly dependent on the use of pesticides and this reliance has led to increased production and health costs.

The study attempts to see whether poor farmers are more responsible for degradation of agri-environment and resultantly they are the victim of that pollution. The survey results indicate that although the poor are currently using smaller amounts of pesticides, they are using relatively more toxic pesticides which have certainly serious health hazards. According to the WHO risk classification indicator, the poor are using a greater percentage of WHO category I pesticides like carbamates, organophosphates, and pyrethroid. Analogously, by classifying pesticide use by its chemical class, it was found that the non-poor are using relatively greater amount of WHO Category II pesticides.

Regarding health effects, farmer self-reported data were compared. A large proportion of farmers reported episodes of skin irritation, eye irritation, dizziness, headaches, shortness of breath and vomiting after using pesticides. Once again, we see a consistent pattern among the poor, where they are experiencing significantly higher average number of health effects. In terms of protective measures, again we noted that it is the poor who are taking less safety measures. The overall evidence suggests that poor are more vulnerable to environmental hazard. It is therefore, recommended that while taking pesticide management decisions e.g regulating misuse or overuse of pesticides, launching awareness programs for farmers, or intending to banning highly hazardous pesticides, focusing on poor farmers may better address these issues.

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Notes

Note 1. Calorie Intake Method sets the poverty line, based on minimum food requirements, expressed in terms of calorie intake per day. The calorie target is then transformed in monetary terms, in Pakistan this method is used for the assessment of the Poverty.

Note 2. 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.

Note 3. It is based on experiments with animals.

Note 4. The WHO toxicity rating is based on the lowest published oral LD_{50}, typically tested on rats. While WHO ratings generally reflect acute toxicity, they also take into account other toxic effects such as reproductive and developmental toxicity (WHO, 2002; Meisner, 2005).

Note5. Pesticide associated cancers include: skin cancer, lung cancer, brain cancer, rectal cancer, ovarian cancer, breast cancer, bladder cancer, liver cancer, stomach cancer, kidney cancer, multiple myeloma, prostate cancer, pancreatic cancer, leukemia,, testicular cancer, soft-tissue sarcomas, and non-Hodgkin's lymphoma' (People & the Planet, 2007).

Note 6. Depending on the pesticide's toxicity and the dose absorbed by the body, pesticide exposure can produce intoxication symptoms within few minutes or hours, in case acute toxicity is high. The general acute effects identified by different studies are headache, flu, skin rashes, blurred vision, eye irritation and other digestive problems. In addition, prolonged exposure to pesticides can lead to many chronic health problems like cardiopulmonary problems, adverse dermal effects, cancer and neurological and hematological symptoms (Dasgupta, 2005).

Note 7. Are self-reported health effects a credible measure? Detailed information for farmers is actually non-existent and beyond the scope of this study, however, as Dasgupta (2005) explained that the studies using medical tests of farmers conducted on rice and vegetable farmers in Philippines, Indonesia and Vietnam revealed that 58% - 99% of the farmers exposed to pesticide had at least one health effect (Kishi et al., 1995; Rola and Pingali, 1993). This evidence suggests that the degree of upward bias may not be large (Dasgupta et al., 2005).

Table 1. Classification of poverty

Poverty classification	Number	Percent
Poor (Income ≤ Rs 1,144.8/month)	125	39.0
Non-poor	193	61.0
Total	318	100.0

Table 2. Education attainment of different age groups

	Education attainment							
Age categories	Illiterate		Up to Primary		Matric		Above Matric	
	Poor	Non poor	Poor	Non poor	Poor	Non poor	Poor	Non poor
≤ 20	2	3	6	0	1	4	0	2
21-30	13	19	11	14	11	32	1	12
31-40	20	7	33	20	6	27	0	8
41-50	9	1	11	2	6	17	0	4
51-60	4	5	10	1	1	13	0	1
61+	0	1	0	0	0	0	0	0
Total	48	36	51	37	25	93	1	27

The above table shows that poor farmers are more likely to fall in illiterate and primary education categories and more than 50 percent of the poor has only primary education, while a large percentage of the non-poor farmers has high school or higher levels of education.

Table 3. Distribution of farm size by poor/ non poor

	Poor	Non-poor
Farm size	No. of farmers	No of farmers
Up to2.50	35	9
2.6-5.0	43	12
5.0-10.0	47	31
10.1-25.0	0	101
25.1-50.0	0	26
50.1-100	0	7
above 100	0	7
Total	125	193

Table 4.Total amount of pesticide applied by WHO classification

Category	Total (kg A.I.)	Percent
Extremely hazardous (Ia)	0.0	0.0
Highly hazardous (Ib)	1137.8	23.3
Moderately hazardous (II)	2666.0	54.7
Slightly hazardous (III)	878.5	18.0
Unlikely (U)	193.1	4.0
Total	4875.4	100

Table 5.WHO Hazard Classification

Pesticide Class	LD50 for the rat (mg/kg body weight)	
	Oral	
	Solids	Liquids
Ia (extremely hazardous)	5 or less	20 or less
Ib (highly hazardous)	5-50	20-200
II (moderately hazardous)	50-500	200-2000
III (slightly hazardous)	500-2000	2000-3000
IV (unlikely if used safely)	Over 2000	Over 3000

WHO recommended classification of pesticide by hazard and guidelines to classification, 2004.

Source: Murphy .H (2002) & WHO (2006)

Table 6. Use of pesticide on major crops by WHO classification (%)

	Category I	Category II	Category III	Category U	Total
Cotton	22.2	66.1	8.3	3.4	100.0
Vegetables	34.2	35.0	23.2	7.6	100.0
Wheat	2.3	9.4	88.0	0.3	100.0
Others	50.0	30.3	9.9	9.8	100.0

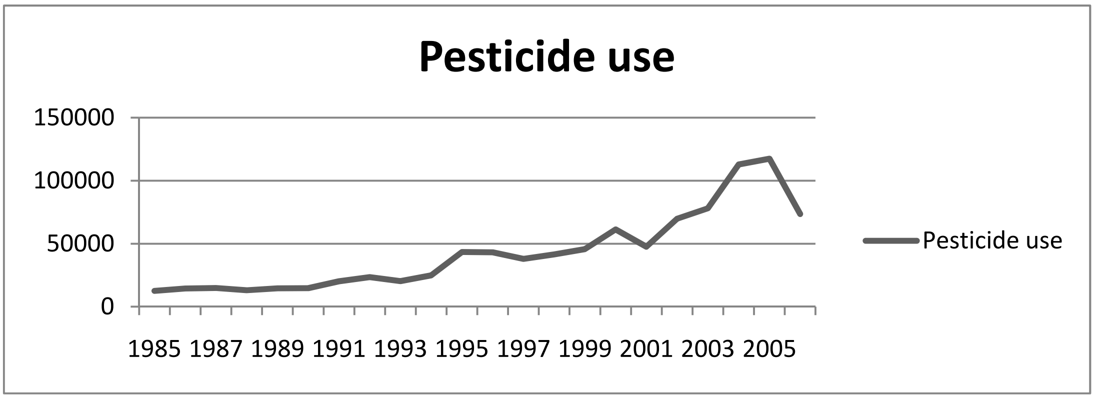

Figure 1. Pesticide consumption in Pakistan (mt)

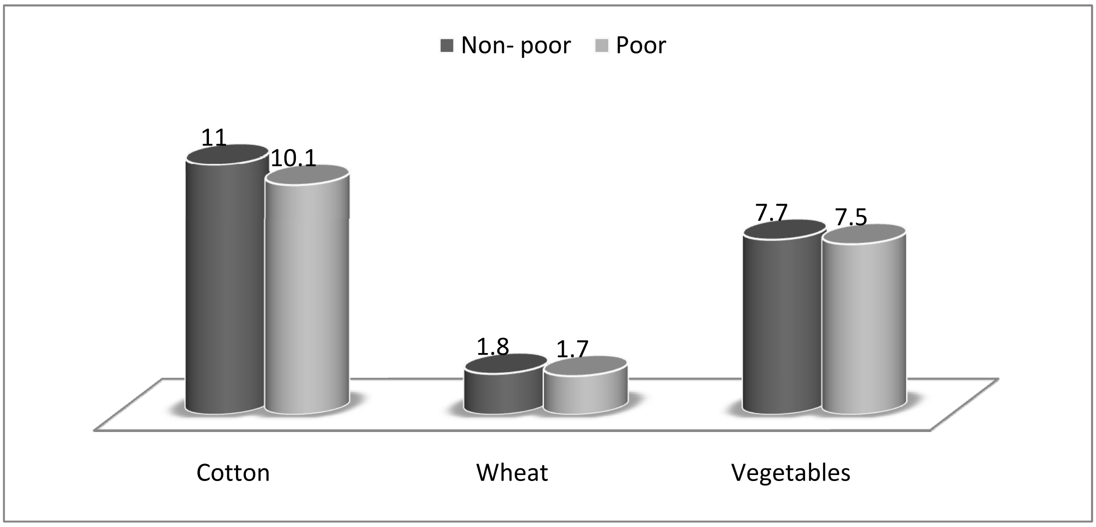

Figure 2. Pesticide use (kg/per acre) by selected crops

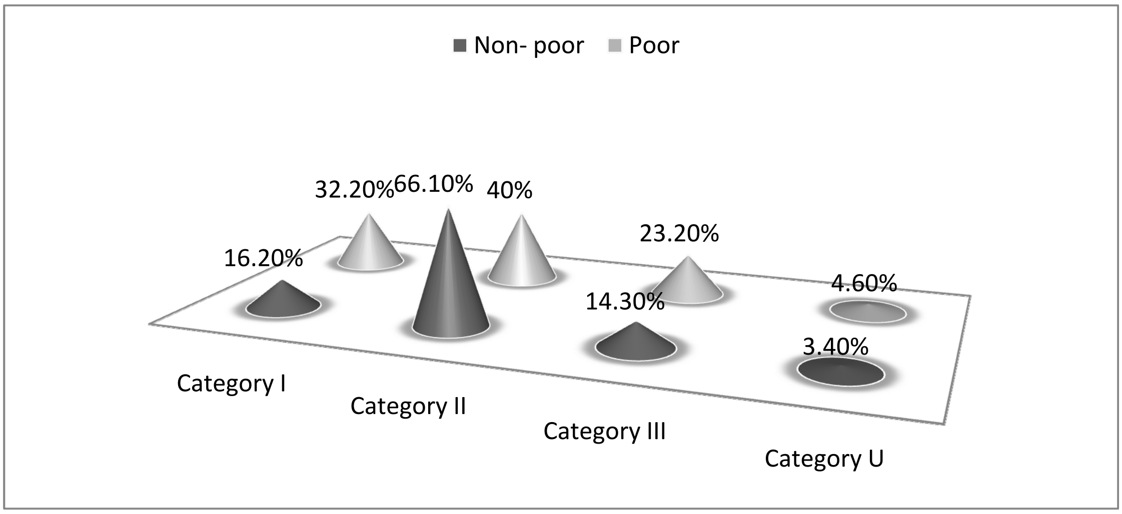

Figure 3.Use of pesticide by WHO hazardous classification

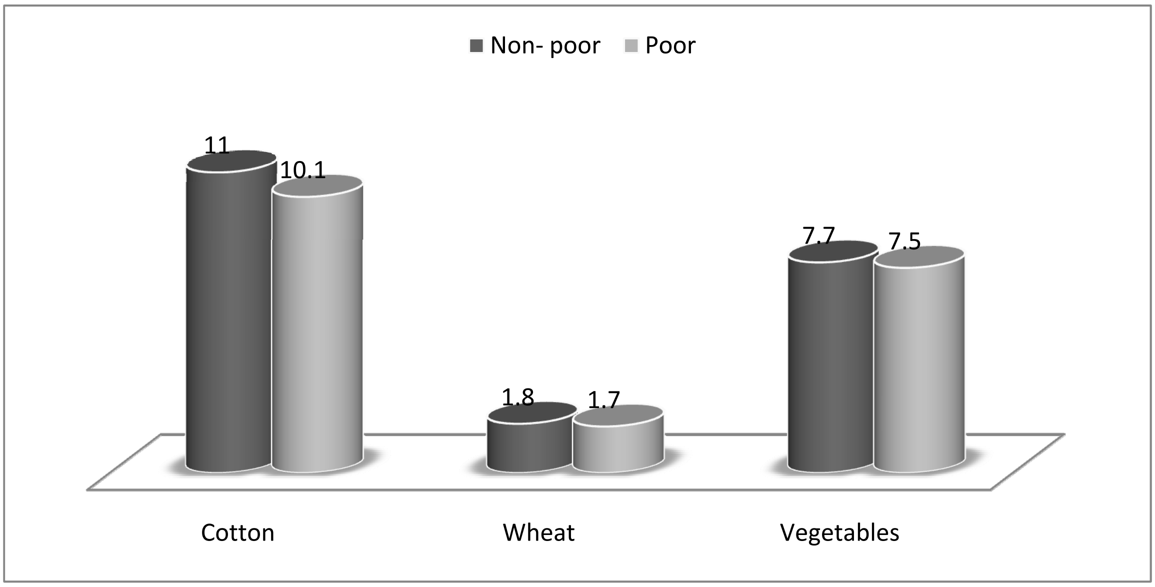

Figure 4. Mean pesticide application on selected crops

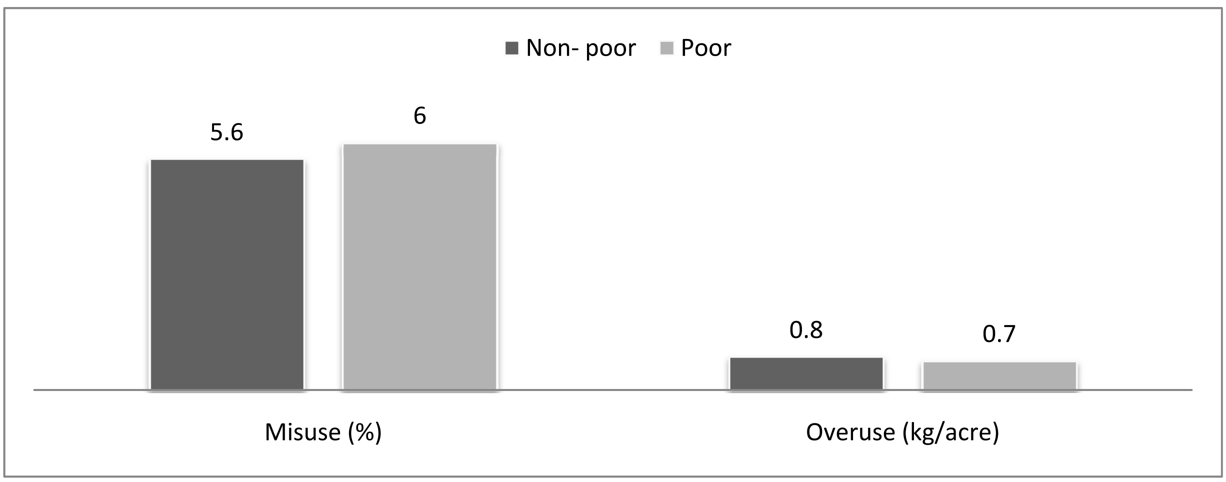

Figure 5. Misuse and overuse of pesticides

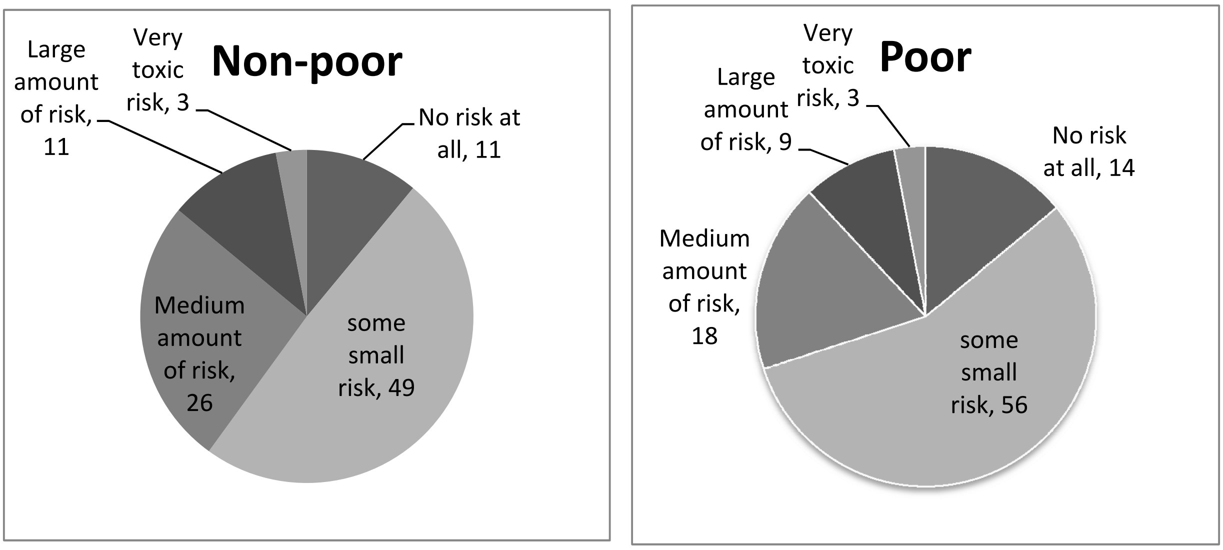

Figure 6. Farmer's perception of pesticide risk (%)

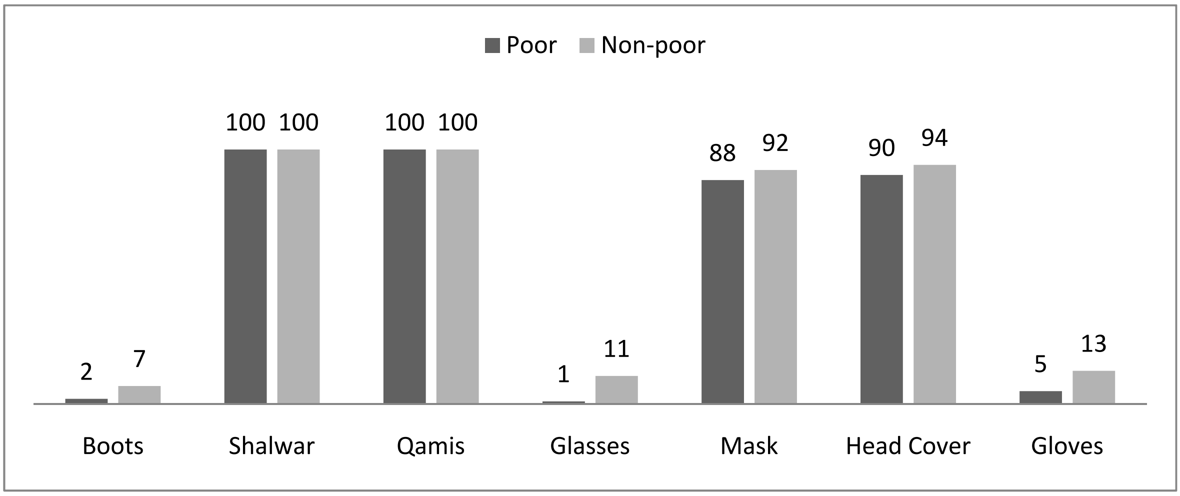

Figure 7. Use of protective equipments during spray (%)

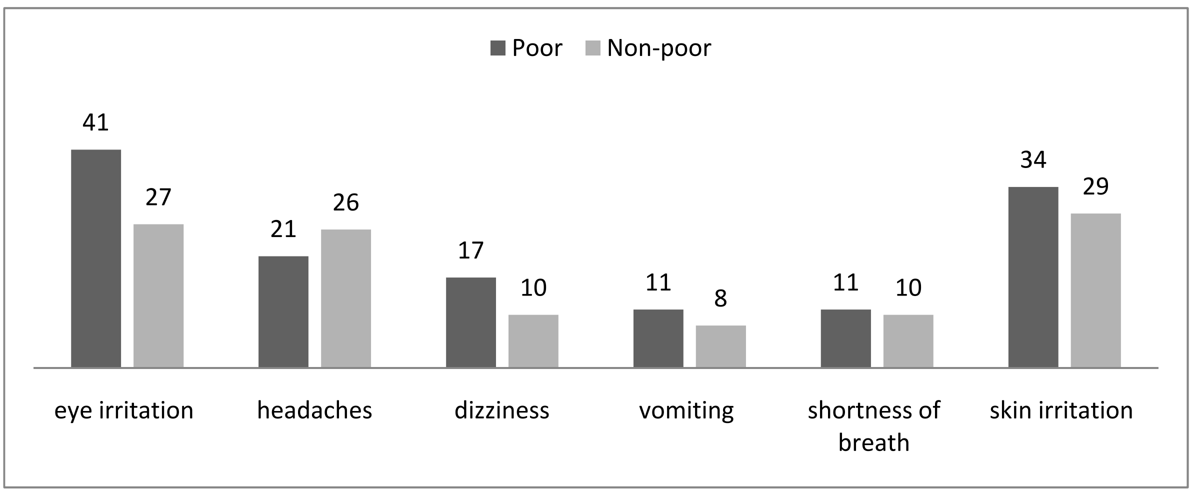

Figure 8. Distribution of health effects experienced by farmers (%)