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FARMERS' LEVEL OF KNOWLEDGE ON THE USAGE OF PESTICIDES AND THEIR EFFECTS ON HEALTH AND ENVIRONMENT IN NORTHERN PAKISTAN

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ABSTRACT

Inappropriate applicationof pesticides can cause health issues among the farmers, children, and field workers. High dependence on pesticides for pest control by illiterate and untrained farmers has increased health hazards and polluted the agricultural environment in Pakistan. The prime purpose of the study was to make an assessment of the level of knowledge of contact farmers on the proper usage of pesticides in district Peshawar, Pakistan.A simple random sample of 300 farmers for the study purposes was drawn out of the total population of 4200 farmers living in the study area. Data were collected using a pre-tested questionnaire translated into the local language. Personal face-to-face interviews of the contacted farmers from all the 4 towns of the district Peshawar, Pakistan were conducted to meet the objectives of the study. The study revealed that the most important factors responsible for the problems caused by the pesticide applications include: low education level of the rural population, lack of information and training on the safe application of pesticides, poor spraying technology, and inadequate personal protection during pesticide application. About two thirds of the respondents (61.7%) get information from agricultural extension service providers; nearly half of the respondents sometimes get information from TV and Radio; while more than half (55.7%) of the respondents reported that they received average level trainings on pesticides. The study revealed that about two thirds (63.3%) of the contact farmers had enough awareness on the safe usage of pesticides and their hazardous effects on health and environment. However, it was noticed that the knowledge alone is rarely translated into actions. Many other factors like farmers' available resources and socioeconomic characteristics also play a significant role.There is a need to improve information exchange about pesticide-related issues between contact farmers and their sources of information, and to focus more on the sources from which the farmers get the least information, such as agricultural literature and programs on TV and radio. It is suggested to improve agriculture extension education programs and to include awareness campaigns about proper usage of pesticides for the capacity building of contact farmers. Alternate methods of pest control should be encouraged. Agricultural extension activities like farmer field schools on integrated pest management (IPM) deserve to be promoted.

Key words: Bio-safety, Capacity building, Environment, Extension education, Health, Knowledge levels, Pesticides, Technology transfer

INTRODUCTION

About 1.8 billion people worldwide are engaged in agriculture and most of them use pesticides to protect their crops. Pesticides are also used for public health purposes, while many others use pesticides for lawn and garden applications in and around their homes (Kiely *et al*., 2004). In recent decades, there has been a steady increase in the volume of pesticides marketed for agricultural uses. The total volume of global sales rose from US$31 billion in 2005 to US$38 billion in 2010, and the amount of pesticides used internationally has risen fifty-fold since 1950 (Keding *et al*., 2013).Global pesticides market is projected to grow from around $ 75 billion in 2017 to $ 90 billion by 2023 (Techsci Research, 2018)

It has been argued that pesticide misuse in various use sectors is associated with and causes health problems and environmental pollution worldwide (Soares *et al*., 2003; Mancini *et al*., 2005; Remor*et al*., 2009). Improper pesticide use poses a threat to farmers, children, and workers in the fields and there is a high risk of poisoning. High dependence on pesticides for pest control by untrained farmers has increased health hazards and polluted rural and agricultural environment (Akbar *et al*., 2009). The low literacy rate of the rural population, lack of information and training on pesticide safety, poor spraying technology, and inadequate personal protection during pesticide application have been reported to exacerbate pesticides hazards. However, the extent and determinants of pesticide hazards in developing countries may differ among countries (Atreya, 2008; Hurtig*et al*., 2003).

The use of agricultural pesticides in Pakistan began in 1952; the agricultural department of the government fully supported their applications to tackle the issues caused by pests and diseases to minimize yield

losses and realize healthy crop production (Rasheed, 2007). Since the majority of the farmers are illiterate and lack necessary knowledge about the proper use of pesticides, they oftenapply pesticides without knowing the population of insect pests, natural enemies and crop conditions. Farmers in Pakistan just apply pesticides on a calendar basis, and as one of them indicated "we consider pesticides as medicine rather than a source of poison".

The inappropriate application of pesticides is causing very serious health issues and severe environmental problems in Pakistan due to farmer ignorances on proper pesticide application. A large proportion of the pesticides applied to crops reach non-target areas because of malpractices during the application and faulty spraying equipment (Eddleston *et al*., 2002). Studies revealed that over-dosing can kill non-target organisms, which could give rise to the resurgence of insect pests (Hasnian, 1999). Farmers have little understanding about the hazardous effects of inhaling pesticides and the precautions required under harsh climatic conditions. Studies indicated that only 19% of farmers receivedtraining in pesticide handling and spraying (Plianbangchang*et al*., 2009). In a study conducted by Rijal *et al*., 2018 in Nepal, it was noticed that only 17% farmers were exposed to only one training program on the use of pesticides. Based on their study they recommended This study also emphasized the importance of understanding farmers' local situations and educating farmers on several aspects of pesticide use, disposal, and consequences of improper and illegal use.

Looking at the negative effects on human health caused by the inappropriate applications of pesticides, the Food and Agricultural Organization, FAO (2008), became extremely concerned. Ashburner and Friedrich (2001; Khan *et al*., 2015 Rijal *et al*., 2018) also reported that heavy use of pesticides in developing countries is causing innumerable negative health, environmental and economic issues. About one million people are being poisoned annually with 20,000 deaths (WHO, 2006). The chronic poisoning due to pesticidesuse can cause adverse immune functions, peripheral neuropathies, and allergic sensitization reactions, particularly with skin. Acute poisoning may vary from skin irritation to complex systematic illnesses resulting in death. Chemical-based pest control programs have disturbed the agro-ecosystem and killed non-target and environmentally friendly organisms such as parasitoids, predators and birds. Besides, as many as 10,000 farmers are poisoned annually by the indiscriminate and improper use of pesticides in cotton growing areas of Pakistan (Ejaz *et al*., 2004). The pesticides companies sell their products to the farmers without giving proper training to the farmers and in cases without providing information on their harmful effects.

Schreinemachers and his co-workers (2015) reported that a vast majority of the farmers in South Asian countries - including Pakistan, India, and Thailandwere using WHO-rated highly toxic and, in some cases, banned pesticides without knowing the negative consequences to their health and their living environment. Similarly, The study conducted by Rijal *et al*., (2018) established that that most of the farmers' knowledge on several aspects of a pesticides such as their use, types, characteristics, selection, and overall handling is extremely low. They also reported that improper handling and indiscriminate use of pesticides couldcause health-related risks and elevate undue expenses to both farmers and consumers. Farmers use chemical pesticides without considering insect pest monitoring and economic thresholds, pesticide label instructions, pre-harvest interval requirement, proper use of personal protective equipment and clothing, potential impact on non-targets and the environment. With this situation, the most economical remedy could be creating awareness among the farmers. It seems logical to train them on the safe use of pesticide applications. Many researchers (Allahyari, *et al*., 2017; Damalasand Koutroubas2017) suggested that educational programs on the safe usage of pesticides such as extension training, workshops, and community engagements have proven to be effective in improving farmers' knowledge levels in adopting improved pest management practices Awareness of farmers, spray men, and laborers handling pesticides about the hazards that might result from pesticide misapplication is essential for the proper use of pesticides. Before launching the training programs, it would be appropriate to assess the present level of farmer knowledge on the safe use of pesticides.

The present study aims at assessing the farmers' knowledge about the proper use of pesticides as a first step towards reducing health issues and environmental hazards. The specific objectives of the study were: To identify the farmers' level of knowledge about the safe use ofpesticides; To identify the farmers' potential health and environmental hazards associated with pesticide misuse; To explore farmer's sources of information about proper pesticide use and storage; and To explore the relationship between farmers' social and economic characteristics and their level of knowledge regarding safe pesticide use.

MATERIALS AND METHODS

The study was conducted in 2017 in Peshawar District (Pakistan) which is famous for growing different crops like sugarcane, wheat, maize, and all types of vegetables and different fruits.A simple random sample of 300 farmers for the study purposes was drawn out of the total population of 4,200 farmers (sampling frame). The data were collected through face-to-face interviews using a validated questionnaire. The interview schedule was designed with the help of the faculty from the College of Food and Agriculture Sciences, King Saud

University, Saudi Arabia. The questionnaire was pre-tested, modified and validated according to the feedback from respondents. To acquire precise and valid information, one of the researchers personally interviewed all the respondents in their fields and homes. The interview instrument was prepared in English, but the interview took place in local language (Pashto). To measure the farmers' level of knowledge regarding the safe use of pesticides and health and environmental hazards caused by pesticides, a knowledge scale consisting of 23 different questions was used. For each question, farmers had to choose one of two statements; one is correct and the other is wrong. The Statistical Package for Social Sciences (SPSS-21) was used for data analysis. Descriptive statistics were used to describe the respondents' demographic characteristics. To determine relationships between variables measured on an ordinal level, Spearman's Rank-order Correlation was used (Spearman, 1904). The Chi-square test of association was used to discover the relationship between two categorical (nominal) variables.

RESULTS AND DISCUSSION

Socio-economic characteristics that are expected to influence their level of knowledge regarding safe usage of pesticides are described below:

Respondents' age and years of using pesticides: Farmers' age and years of using pesticides in agriculture are presented in Figure 1 which shows that about (30.7%) of the respondents belong to the age group above 46 and 69.3% of them are below 46 years. This indicates that about two-thirds of the respondents are relatively young. As depicted in Figure 2, more than three fourths (77.3%) of the farmers are using pesticides for twenty years or less, while about one fifth of them (22.7%) reported that they had used pesticides for more than twenty years. Salameh,*et al*. (2004) reported that farmers who had a long experience with pesticide application usually take fewer prevention measures.

Farm ownership, total farm size and part- or full-time farming: Land tenure refers to the rights and arrangements under which the land is operated. Land tenure in Pakistan may be of the following types:

1. Owned farm: The farmer owns the entire land.
2. Tenant Farm: The entire land is rented from another household(s) against a fixed rent in cash or kind, or a share in the produce or under any other terms and conditions.
3. Owner-Cum-Tenant Farm: A farm in which part of the land is owned by the farmer household and the remaining is rented from another household(s) against rent or share of the produce or any other terms and conditions.

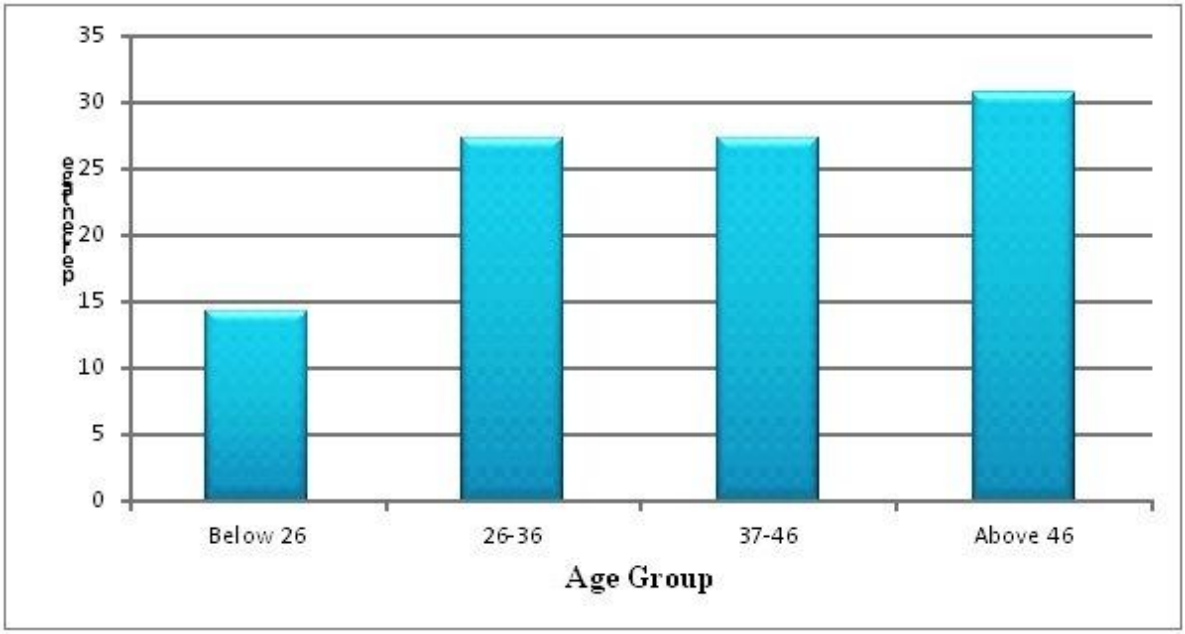

Figure 1. Respondents' age

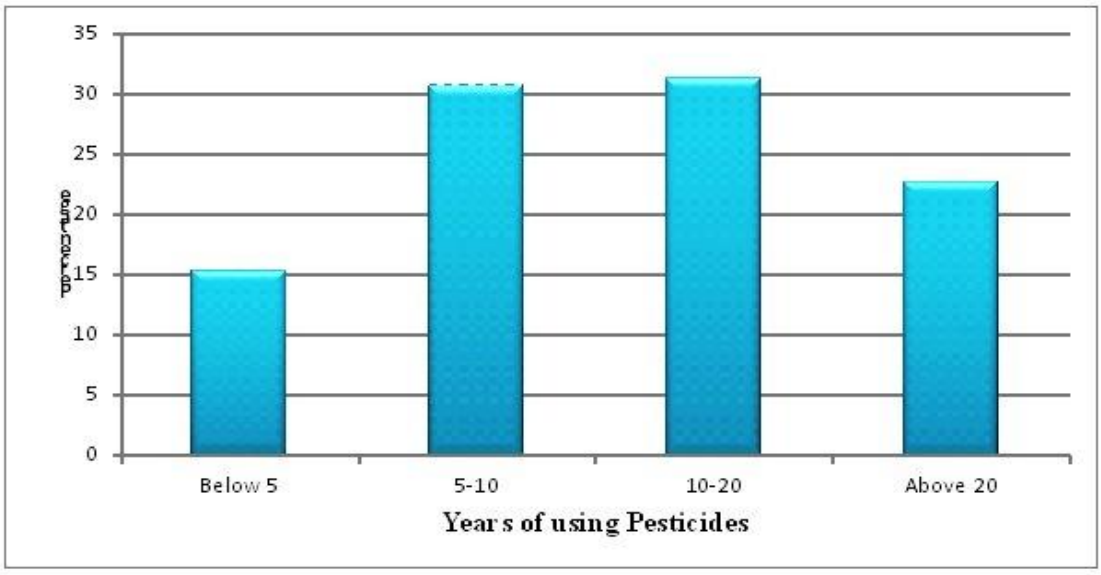

Figure -2 years of using of pesticides

Figure 3 shows that more than two thirds (69%) of the respondents were tenants and owner-cum-tenants, while 31% of the respondents were owners of their land. About half of the respondents (52%) have farms of less than five acres and 48% of the respondents have farms of 5-15 acres (Figure 4). The results may indicate that the majority of the farmers have small landholdings and cultivate lands as tenants or owner-cum-tenants.

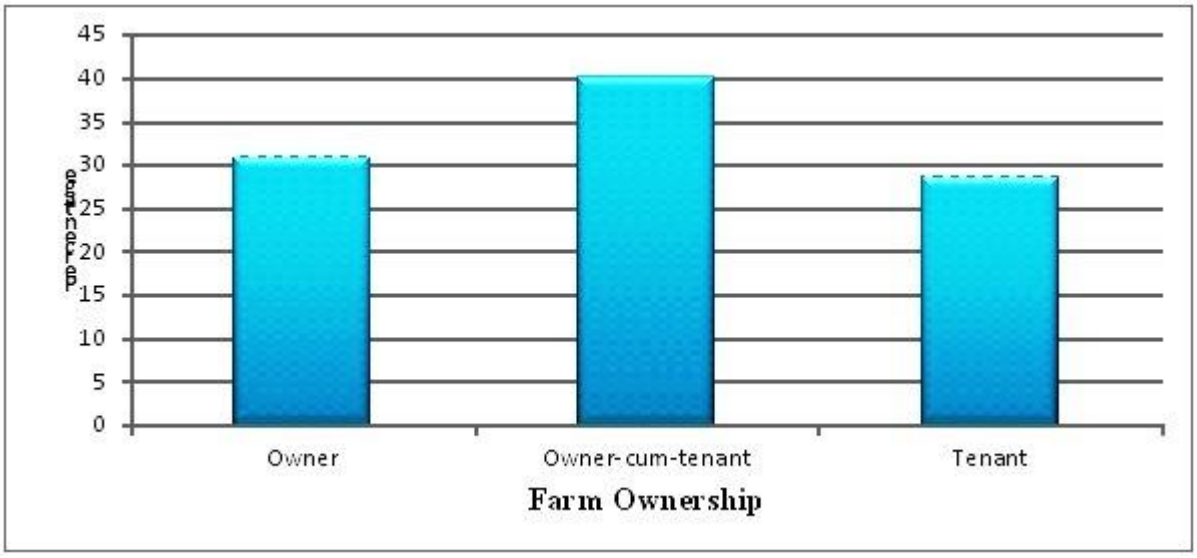

Figure 3. Farm Ownership

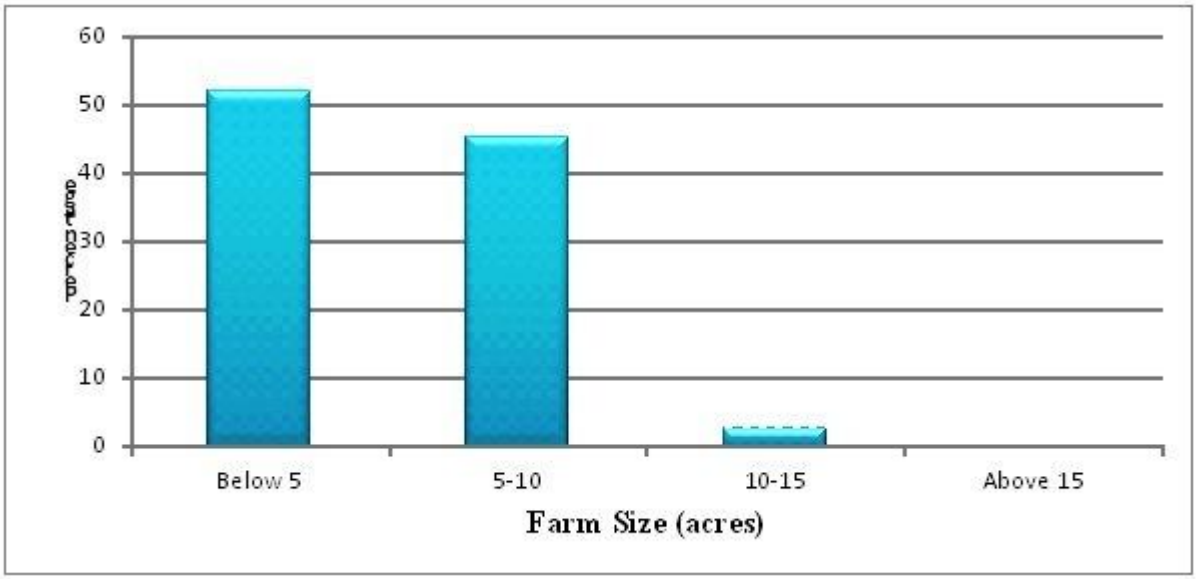

Figure 4. Farm size (in acres)

Agricultural income and income from sources other than agriculture: About three quarters of the respondents (74.3%) reported that their annual agricultural income is Pakistani Rupees (PKR) 160,000 or below, while 25.7% reported that their annual income is above PKR 60,000, clearly indicating that the respondents' income from agriculture is quite low in this region. The table also shows that farmers' income from sources other than agriculture is very low; more than two-thirds (67.3%) of the respondents have income less than PKR 80,000 and only 1.7% reported their income is more than PKR 160,000 (Figures 5 and 6). These figures indicate that the majority of the farmers are poor, and they may not be able to bear the expenses of having protective tools while spraying pesticides.

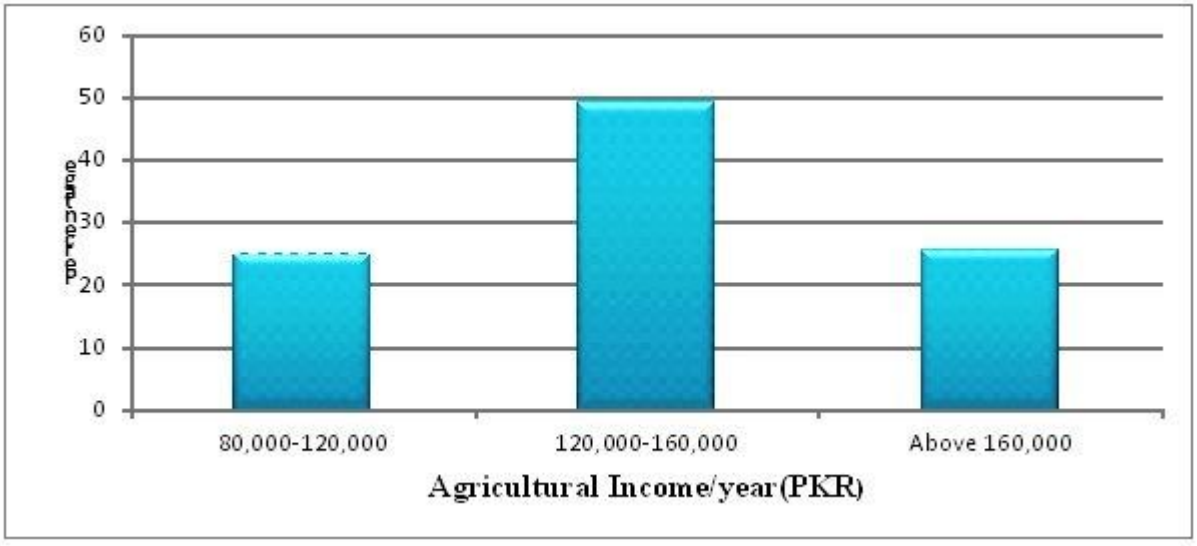

Figure 5. Agricultural Income/year (PKR)

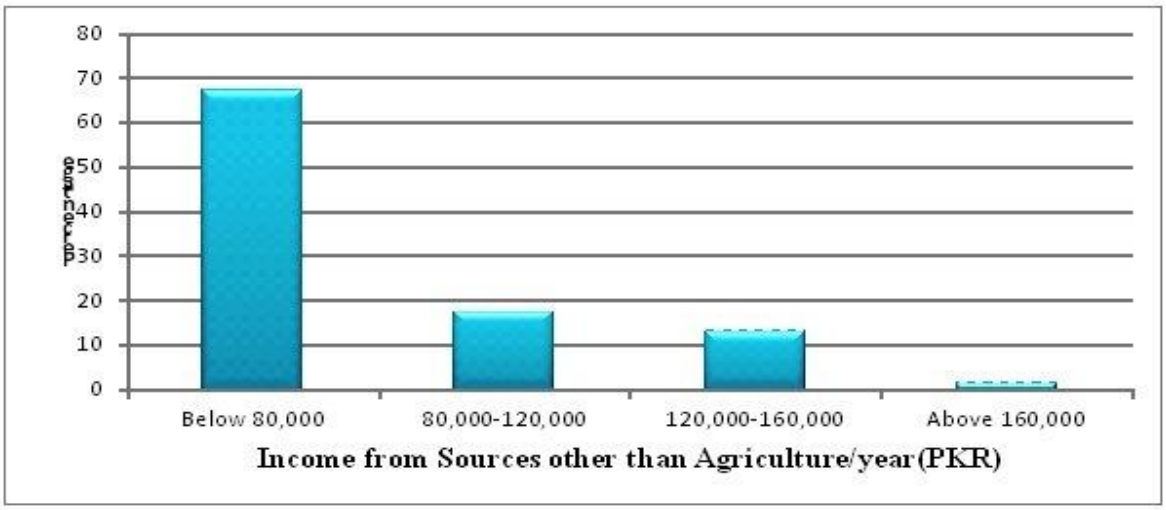

Figure 6. Income from other sources

Sources of information about pesticides and their usage: Table 1 shows the sources of the farmers' information about proper pesticide use and storage. The respondents were asked how often theyget information from the given sources using a 3-point Likert Scale (Rarely= 1; Sometimes= 2; Always=3).

Table 1. Respondents' sources of information about pesticides and its' usage (N =300).

Sources of Information	Rarely	Sometimes	Always
	Percentage	Percentage	Percentage
Agricultural Extension	10.0	61.7	28.3
Other Farmers	4.3	28.7	67.0
Representatives of the Pesticides companies	21.3	63.0	15.7
Agricultural Programs on Radio	35.3	48.7	16.0
Agricultural Programs on TV	38.0	49.7	12.3
Agricultural Literature	64.3	25.3	10.3

About two thirds (67%) of the farmers reported always getting information about pesticide use from their fellow farmers. Similar results have been reported by Bajwa (2004) and Rehman,*et al*. (2013) who stated that fellow farmers were playing an important role in exchanging informing with each other about proper selection, use and handling of pesticides and that the fellow farmers were the major information source of farmers.

Extension services are directed towards progressive and rich farmers. Extension agents' visits, radio and television were relatively less used as a source of information about pesticides and their use in Pakistan (Khan, 2009). About two-thirds of the respondents (61.7%) get information from agricultural extension. Nearly half of the respondents sometimes get information from television (48.7%) and radio (49.7%). The same finding 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, yet radio and television were the least used extension-farmer contact techniques. In this regard, Mahmood and Sheikh (2005) argued that agricultural programs on television were not broadcasted at primetime; therefore, electronic media was reported to be ineffective in disseminating agricultural information to the farming communities. A study conducted in Tanzania, by Ngowi (2003) revealed that farmers were not receiving agricultural extension services; hence they were trying various other sources of information, especially regarding pesticide use. Since they were constrained by the lack of appropriate knowledge, they were unable to use insecticides appropriately to address insect problem. Bajwa, (2004) reported that public sector extension was supposed to be very effective for educated farmers while extension personnel of the private companies were found to be more inclined to provide information about plant protection to rich and large holding landlords (at a price) mainly for increasing their profits. In both systems, farmers were identified as a bridge between public and private sector extension agencies to pass on agricultural information.

Ahmad *et al*. (2000) revealed that some farmers were found to be easily deceived by pesticide dealers. Expired pesticide products were sold to them on credit. Farmers were also not given any type of training on the potential harmful effects, toxicity of pesticides and spraying techniques by the pesticide companies. One of the major reasons behind the failure of most programs was over reliance on Farmers to provide agricultural information to farming communities. Farooq *et al*. (2007) revealed that fellow farmers, printed material, television, and private sector were the most commonly used sources of information.

To get the overall level of information which farmers got from different sources (Agricultural Extension, Other Farmers, Representatives of the Pesticides Companies, Agricultural Programs on Radio, Agricultural Programs on Television and Agricultural Literature) an overall information sources index was computed and recoded through SPSS into three different variables (Low = ≤ 10; Average = 11-14; High = ≥ 15). Table 2 shows that the majority of the farmers (72%) got an average level of information, about 22.3% of the farmers got low levels of information while only 5.3% farmers got high level of information from the available sources.

Table 2. Level of information farmers received from different sources.

Level of Information	Percent	Cumulative Percent
Low (≤ 10)	22.3	22.3
Average (11-14)	72.4	94.7
High (≥ 15)	5.3	100
Total	100	

Ahmad *et al*. (2007) carried out a survey in the Peshawar and Charsada Districts, which revealed that the services of extension workers were not very impressive.The majority 85% of the farmers were unaware of the services of the extension workers. Almost 88% of the farmers did not receive any benefit from extension workers while only 12% farmers received some benefits like technical advice (8.75%), demonstration (3.75%) and equipment (10%).

The majority (82.5%) of the farmers did not visit the local Agriculture Extension office and only 12.5% of the farmers reported visits of extension worker to their fields;and the majority of those reporting a visit were big and influential farmers. Davidson *et al*. (2001) reported that the private sector agriculture extension education service was limited to resourceful landlords only. Private sector extension was more concerned with serving the needs of larger, resource-rich farmers to the exclusion of other farmers because of its primary interest in generating profits. Achakzai (2013) reported that nearly half of farmers (46%) in Khuzdar district of Balochistan province mentioned that the trainers were lacking the ability to convince farmers. The farmers also highlighted the non-convincing and ineffective mode of the extension agents, low knowledge of extension workers, and the inability to remove doubts of the farmers. Salameh *et al*. (2004) stated that a lower proportion reported that they rarely receive information related to pesticide issues from a specialist or through reading.

Training received by the farmers on pesticides usage: Table 3 shows the percentage of the contacted farmers who have received training workshops in different areas.The numbers of trainings imparted to the farmers have been divided into three different categories: (No trainings, 1-3 sessions, and 4 or more training sessions). Farmers were asked about how many trainings they received in six areas related to the proper and safe use of pesticides. About two thirds (76.3%) of the farmers received (1-3) trainings and about 23.3% of them received 4 or more training sessions on how to use pesticides. The large majority(92.7%) of the farmers received 1 to 3 training sessions on health and safety measures related to pesticides use. About half (56 %) did not receive any training on how to store pesticides; similarly, about 68.3% of the farmers did not receive any training on the safe disposal of pesticides and 70.7% received no training on environmental issues causedby pesticides. Only 17% of the farmers received 4 or more trainings and about three fourths (80.7%) received 1 to3 training sessions on Integrated Pest Management (IPM).

Table 3. Number of training workshops received by the respondents on pesticides usage (N = 300).

Area of Trainings	No Trainings	1-3	4+
	Percentage	Percentage	Percentage
How to use Pesticides	0.3	76.3	23.3
Trainings on health and safety measures	7.0	92.7	0.3
Trainings on how to store pesticides	56.0	44.0	0
Trainings on disposal of pesticides	68.3	31.7	0
Trainings on environmental effects due to pesticides	70.7	29.3	0
Trainings on Integrated Pest Managements	2.3	80.7	17.0

Excessive use of pesticides is harming the health of farmers and the community in Pakistan. According to the United Nation's 1998 report, over 500,000 Pakistanis suffered annually from poisoning due to agrochemicals and 10,000 died (DAWN, 2004).About 22.7% of the respondents reported that they received low trainings; 21.7% received high trainings and more than half (55.6%) of the respondents reported that they received average trainings (Table 4).

Table 4. Level of trainings received by the respondents in different areas (N = 300).

Trainings	Percent	Cumulative Percent
Low (≤ 5)	22.7	22.7
Average (6-10)	55.6	78.3
High (≥ 11)	21.7	100
Total	100	

Akram *et al*. (2011) reported that only 11% of the farmers in their study received basic training on the safe handling of pesticides, while 89% said that they neither had any access to nor did they know who provides this training. Ahmad (1992) observed that farmers thought that extension workers were not able to communicate effectively with the farmers during training. Khooharo *et al*. (2008) reported that about one-fifth (20%) of the farmers had been given very few trainings in Integrated Pest Management through Farmers Field Schools. About 85% of the farmers expressed their needs for trainings related to the safe use of pesticides. Salameh *et al*. (2004) stated that the main objectives of training are to ensure that farmers recognize the health hazards of related pesticides, become familiar with and adopt proper work practices, use protective tools properly, practice personal hygiene measures, recognize early symptoms of overexposure or poisoning, and obtain first aid at the earliest time possible.

All the training sessions received by the respondents in different areas related to pesticides usage were computed and recoded through SPPS into three different levels (Low = ≤ 5 trainings; Average = 6-10; High = ≥ 11).

Correlation between the respondents' socioeconomic characteristics and number of trainings they received on pesticides use: A Spearman correlation was calculated to explore the relationship between the number of trainings received by farmers on pesticide use and their age, level of education, farm ownership, farm size, income from agriculture, income from other sources and the years of using pesticides. The analysis revealed that there was a positive and significant correlation between the trainings received by the farmers and age (r =0.556), total farm size (r= 0.232) and years of using pesticides (r = 0.642), and a negative but significant correlation (r= -0.126) between the trainings received and the income from sources other than agriculture (Table 5). This may indicate that older farmers have more chances to receive trainings on pesticide use; similarly,those with more land are likely more interested in trainings. Also, more experienced pesticide users tend to have more training.

Table 5. Correlation between socioeconomic characteristics and level of trainings received by farmers.

Dependent Variable	Independent Variables	Correlation coefficient
Level of trainings received on different pesticides related issues	Age	0.556**
	Total farm size	0.232**
	Income from other sources	-0.126*
	Years of using pesticides	0.642**

Significant at 0.05 level of significance ;Significant at 0.01 level of significance*

The Chi-Square test was used to examine the relationship between marital status, part- or full-time farming, and level of trainings received. Tables 6 and 7 show that there is a significant relation between marital status and part or full-time farming and the number of trainings received on different pesticides related issues (chi-square = 32.036, p = 0.00), (chi-square = 6.596, p = 0.037). Married and full-time farmers had more opportunities to receive trainings. This might be due to the fact that married farmers were older and full-time farmers spent more time on their fields and were more interested in such training. Therefore, both married and full-time farmers had more chances to get trainings on pesticides' related issues. Akhtar *et al*. (2007) reported that farmers need training on pest management in areas such as pest identification, pest control and pesticides, respectively.

Farmers' level of knowledge regarding safe use of pesticides: The percentage of farmers giving correct answers regarding the safe use of pesticides and health and the environmental hazards caused by pesticides was 79.40 and 76.3 percent, respectively (Table 8 and 9).

Similar results were reported by Khooharo*et al*., (2008) that on an averagebasis, contact farmers' score about 83.2% when it comes to proper usage and safe handling. Eighty percent of the farmers knew that it is necessary to wear protective clothing, hand gloves, glasses, cap, and shoes to prevent pesticides entering the human body. The majority of farmers (86.7%) properly

recommended the direction of spraying considering the wind direction. The majority of the farmers (85%) were of the opinion that it is dangerous to smoke and chew tobacco while spraying or handling pesticides. They stated further that themajority of the farmers, however, smoked cigarettes /or ate meals, without washing their hands with soap.

Table 6 Relation between farmers' marital status and level of trainings received by them.

Total Trainings received	Single (%)	Married (%)	Total (%)
Low	45.2	16.8	22.7
Average	53.2	56.3	55.7
High	1.6	26.9	21.7
Total percentage	100	100	100
Total frequency	62	238	300

Chi-square = 32.036, p = 0.00

Table 7. Relation between part or full-time farming and trainings received by the respondents.

Total Trainings received	Part-time farming (%)	Full-time Farming (%)	Total (%)
Low	30.5	19.7	22.7
Average	56.1	55.5	55.7
High	13.4	24.8	21.7
Total percentage	100	100	100
Total frequency	82	218	300

Chi-square = 6.596, p = 0.037.

Chronic pesticide poisoning could be suspected from this practice. Feenstra *et al*. (2000) reported that 60% of the farmers were aware of the health hazards of pesticides, but theylack protective tools and are not low willing to wear protective clothing in the hot season, this places them at a high risk for pesticide poisoning. Khan *et al*. (2010) reported that most of the farmers did not use any personal protective equipment during pesticide handling. Only a few used shoes (31%), masks (14%) and gloves (9%) during pesticide spray.

Table 8 Farmer's knowledge regarding different dimensions of safe usage of pesticides

Statements	Percentage of farmers' answers	
Farmers' knowledge regarding safe use of pesticides	**Know**	**Do not know**
When using pesticides, the user should read and follow the directions before any pesticides application given on the pesticides container.	73.3	26.7
Before applying, the user should not use his hands for mixing pesticides, but a stick.	96.0	4.0
When applying pesticides, the user must wear protection tools such as hat, gloves, mask, boots, and clothes covering all the body parts.	79.7	20.3
It is not safe to have food, drink, or smoke during pesticides application.	68.7	31.3
When the nozzle becomes clogged during spraying pesticides, the user should use a small wire instead of his mouth to move the clog out.	97.3	2.7
The user should dispose the unwanted pesticides and empty containers in accordance with label direction or to take it to the pesticides collection site, if there is any.	63.0	37.0
The empty pesticides' containers should not be reused for any other purpose in home.	94.7	5.3
It is not safe to harvest plants and vegetables sprayed by pesticides untimely	75.3	24.7
The user should store the pesticides away from food storages of men and animals, and out of children in the original containers.	78.3	21.7
It is better to build specific chemical store if possible, to restrict any body's access to pesticides.	77.0	23.0
Avoid keeping a large amount of pesticides but only the amount that is sufficient for use.	91.3	8.7
The most appropriate use of pesticides is to use it with integrated pest management practices.	58.3	41.7
Total average	**79.40**	**20.6**

Table9 Farmer's Knowledge about Health and Environmental hazards caused by pesticides

Statements	Percentage of farmers' answers	
Farmer's Knowledge about Health and Environmental hazards caused by Pesticides	**Know**	**Do not know**
Pesticides' application may cause several health problems like weakness, dizziness, headache, eye irritation, parched throat, and skin rash.	95.0	5.0
Pesticides use can affect the nervous system that can paralyze human being or can cause human blindness	71.7	28.3
Accidental ingestion of pesticides can cause death of human being or any other animal.	89.3	10.7
The user should never begin pesticides application when wind and temperature favors pesticides drift to an off target area which causes soil and water contamination	85.0	15.0
When applying pesticides, the user should leave buffer zones around water, buildings, wildlife habitats and other sensitive areas.	73.3	26.7
The user has to be careful not to release the rinse water into any drain or on any site not listed on the product label; it could contaminate the environment.	83.7	16.3
The user should take shower with soap and water after completion of pesticides application	66.7	33.3
Pesticides application just before rainfall or irrigation may result in reduced efficiency and can cause pesticides-contaminated runoff	66.0	44.0
The use of pesticides can cause reduction in beneficial species or non-target organisms	64.0	36.0
The use of pesticides can cause the contamination of soil and reduce fertility.	73.3	26.7
The use of pesticides could damage the environment when they polluted the air, soil, and water	71.3	28.7
Total average	**76.3**	**23.7**

All the 23 knowledge variables were computed through SPSS and then divided and recoded into three new variables (Low= ≤10; Average= 11-17; High= ≥18) to check the farmers' level of knowledge. Table 10 shows that 9.3% of the contacted famers have low, 27.3% have average and 63.3% have high knowledge levels about the safe use of pesticides, and health and environmental hazards caused by pesticides, respectively.

Table 10. Farmers' level of knowledge regarding safe use of Pesticides.

Level of Knowledge	Percent	Cumulative Percent
Low (≤10)	9.3	9.3
Average (11-17)	27.3	36.7
High (≥18)	63.3	100
Total	100	

Similar results were reported by NFDC (2002) that 65% of the farmers had basic information about pesticide use. Khooharo *et al*. (2008) reported that overall 74.8 percent of the farmers gave correct answers.

Bajwa (2004) reported that contact farmers play the role of a bridge between farmers and public and private sector extension agencies to pass on agricultural information, which shows that the contact farmers have more chances to get useful information and have better knowledge about safe usage of pesticides as compared to other farmers. The results by Hashmi and Khan (2011) are similar in that most of the farmers (90%) had knowledge about the detrimental health effects of pesticides but were not well aware of the safety measures concerning pesticide handling. However, many workers reported that they washed hands and bodies after work.

Unfortunately, knowledge rarely is translated into practice (Murray and Taylor, 2000).

Waichman *et al*. (2007) reported that the information displayed on product labels was not effective in promoting protective and safety measures. Farmers usually do not read the labels, reporting that the fonts are too small; and that the instructions are too long. Salameh *et al*. (2004) reported that about 69.9% of the farmers considered pesticides as toxic products, yet most of them were lacking enough information. Almost half of them did not know any pesticide name, and about two-thirds could not name any hazardous pesticide. In the Gaza Strip, farmers have high levels of knowledge of pesticides, but the use of protective measures was poor (Richter *et al*., 1997).

Many factors play a role in determining farmers' actual pesticide practices as they act realistically within the context of their available resources and socioeconomic objectives (Rola, 1993). There is insufficient legislation for pesticide use and registration in most of the developing countries in addition to a lack of technical regulatory research facilities to monitor pesticide residues and effects (Kimani and Mwanthi, 1995).

Presently, chemical pesticides are the least expensive and most effective means for pest control in the short run in developing countries. The supply agents have been subsidized by the governments to accelerate national crop production. Moreover, the popularity of chemical pesticides stems from their rapid action and prolonged duration (FAO, 2008). It is also mentioned by Ajayi and Akinnifesi (2007), upon asking about precautions, that most of the respondents said they cover their body with protective clothing. The use of masks and glasses was almost nonexistent, but they usually use cloths to cover their faces instead of using a mask. Use of gloves and boots were also limited. The main reasons for not using protective clothing was the high cost of inputs, the non-availability of these materials, and that their discomfort due to hot weather.

Akram *et al*. (2011)stated that most farmers do not get proper treatment when they suffer symptoms from pesticide exposure; they take these symptoms as a routine matter and they do not worry about them. Usually they cure themselves by using home-made remedies such as drinking lemon juice, salty water in case of vomiting and body massage with bitter oil in case of skin irritation. Only a few of them visited a doctor.

Kishi *et al*. (1995) reported that only 24% of the farmers took medication when they had symptoms and less than 1% of farmers went to a health center with symptoms related to pesticide spraying. Similarly, Ajayi and Akinnifesi, (2007) noted that 80% of the farmers did not think that they would face dangerous health problems from pesticide application. Only in 2% of the cases did the victims visita health care centers to see doctors. These results indicate that the official estimates of pesticide-related sickness may be hideously under-represented since only hospital cases are recorded.

Correlation between respondents' socioeconomic characteristics and their knowledge level on pesticides safe usage: Table 11 presents the correlations between the respondents' socioeconomic characteristics and their knowledge level on safe pesticides use. Farmers' education was significantly correlated to their knowledge level on pesticide safe use (r = 0.436 at 0.01 level).

Table 11. Correlation between farmers' socioeconomic characteristics and their level of knowledge.

Dependent Variable	Independent Variable	Correlation coefficient
Knowledge level of farmers regarding pesticides use	Education	0.436 **
	Income from other sources	0.118 *
	Age	0.071
	Years of using pesticides	0.057

*Significant at 0.05 level of significance
**Significant at 0.01 level of significance

The correlation between respondents' income from other sources and knowledge level on pesticides use was also significant (r = 0.118 at 0.05 level), while the correlation between respondents' age and years of using pesticides was not significant. This might be because of old farmers and those with more experience have more trust in their own judgment and experience.

As reported by Ajayi and Akinnifesi, (2007), farmers are likely to think less of the health problems that are associated with pesticide use. Pesticides falling under the extremely and highly toxic categories were being sold to illiterate farmers who had received little or no training in handling toxic products. In less developed countries, adequate protective clothing is often neglected for reasons of discomfort and/or high cost.

Table 12. Relation between farmers' marital status and their level of knowledge.

Level of Knowledge	Single (%)	Married (%)	Total (%)
Low	30.6	3.8	9.3
Average	21	29	27.3
High	48.4	67.2	63.3
Total percentage	100	100	100
Total frequency	62	238	300

Chi-square = 41.946, p = 0.000

No national regulations require farmers working with pesticides to observe specific precautions (Wilson

and Tisdell, 2001). Farmers did not generally use necessary protective equipment, which should be compulsory for handling such toxic chemicals. The poor farmers were totally ignorant of hazards involved in the use of highly toxic products (Eavy*et al*., 1995). TheChi-Square test was used to define the relationship between the nominal independent variable and dependent variables. The Tables 12 and 13 show that there was a significant relationship between marital status (chi-square = 41.964, p = 0.00) and part-or-full-time farming (chi-square = 6.940, p = 0.031) and the knowledge level of farmers.

Table 13. Relation between part or full-time farming and farmers' level of knowledge.

Level of Knowledge	Part-time farming (%)	Full-time Farming (%)	Total (%)
Low	15.9	6.9	9.3
Average	20.7	29.8	27.3
High	63.4	63.3	63.3
Total percentage	100	100	100
Total frequency	82	218	300

Chi-square = 6.940, p = 0.031

This might be due to the fact that married farmers tend to be older and age is significantly correlated to the knowledge level of farmers. Full-time farmers spend more time on their fields and are more interested in effective pest management. Therefore, married and older farmers are more likely to have more training on the pesticide use.

Conclusions: This study attempted to assess farmers' level of knowledge, their sources of information, and the trainings they received about the proper use of pesticides. From these findings, the following conclusions can be drawn:

- A major proportion of the farmers were 46 years of age or below and the majority of them were using pesticides for 20 years or less.
- Most of the respondents were educated to the secondaryschool level.
- A majority were full-time farmers with the farm size of 10 acres or less.
- The main sources of information for the farmers were their fellow farmers and agricultural extension advisors, while agricultural literature and agricultural programs on television were perceived as infrequent sources of information about the pesticides and their proper use.
- A majority of the respondents received an average level of information; similarly,themajority of them received an average number of trainings on pesticides related issues.
- Assessment of the study revealed that 63.3% of the farmers have a high level of knowledge about the proper use of pesticides.
- The high percentage of contact farmers were knowledgeable enough regarding the safe use of pesticides; and health and environmental hazards caused by pesticides. The significant relationship found between the contact farmers' knowledge level with some of their demographics suggest that the contact farmers had high level of knowledge about the proper usage of pesticides.
- Many other factors play a pivotal role in determining farmers' actual pesticide practices as they act realistically within the context of their available resources and socioeconomic characteristics.

Recommendations: There is a need for special training programs for farmers regarding the right selection, safe use and appropriate handling of pesticides. In this regard, print and electronic media may be used to provide maximum information to the farmers.

- There is a need to improve the information exchange about the pesticide issues between farmers and their sources of information and to focus more on the sources from which the farmers get the least information such as agricultural literature and programs on television and radio.
- It is suggested to improve the agriculture extension education programs and to include the awareness campaigns about proper usage of pesticides for the capacity building of farmers.
- Alternate methods of pest control should be encouraged. Agricultural extension activities like the farmers field schools on integrated pest management may be encouraged and fully supported so that health and environmental risks associated with the over/misuse of pesticides could be reduced and pesticide-residue-free agricultural products may be produced.

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