**Occupational Exposure to Pesticides: Personal Protective Equipment (PPE) Use and Safety Behaviours Among Apple Growers of Kashmir valley**

**Abstract**

Indiscriminate and unsafe use of pesticides in agriculture represents a major hazard to the human health and the environment. This study aimed to assess the use of personal protective equipments (PPE) and pesticide safety practices among apple growers in Baramulla, Kashmir.”A total of 300 Apple growers were randomly selected from the purposively selected 15 horticultural zones of district Baramulla. Face to face interview with farmers based on the structural questionnaire was conducted. The study revealed that majority of the farmers employ non-compliance with safety guidelines by not following the recommendations regarding safe use of pesticides. Face mask was the most used item by apple growers, followed by gloves and Hats. 1.33 per cent of the respondents were sensitive towards health issue and were always using PPE. Feeling uncomfortable, Hectic, and Unavailability of PPE were the main reasons cited by the respondents for not using PPE. Eating, drinking, smoking and using bare hands were the common unhealthy practices followed during pesticide usage. Majority (78.67%) of the farmers did not read pesticide labels. Storage of pesticides in multipurpose sheds was reported by 67.34 per cent of the farmers. Left over pesticides were re-sprayed to the sprayed area by majority (64.96%) of the farmers. Also, farmers adopted unsafe disposal practices by using pesticide empty containers within their households. In addition the proper use of PPE is not at a satisfactory level and unhealthy safety practices can pose a risk to the health of apple growers. Adoption of recommended safety measures are necessary to avoid harmful effects of pesticides. Sensitization programmes regarding the importance of bio-safety, comprehensive training programmes on pesticide safety practices are needed and availability of personal protective equipments must be ensured at each pesticide shop at low cost so as to enhance their popularity and usage among the farmers.

**Keywords:** Apple growers, Pesticide exposure, Safety practices, Health hazards and Trainings

**Introduction**

Pesticides have become an integral part of modern agriculture (Sharma et al.,2019) and play an important role in increasing agricultural productivity(Tudi et al., 2017). “It was estimated that about one-third of the agricultural products are produced by using pesticides” (Zhang et al., 2011). Without the use of pesticides, the damage caused by pests in fruits, vegetables and cereals may outstretch up to 78%, 54% and 32%, respectively (Hangloo, 2019). Crop loss due to pest injury declined by 35% to 42% when pesticides were used (Pimentel, 2005). Therefore for better productivity, pesticide use is imperative. Under susceptible and changing climatic conditions, Apple production in Jammu and Kashmir (UT) is not possible without the use of pesticides (Yousuf et al 2023). As per the data, total pesticide consumption in the year 2009 in UT of Jammu and Kashmir was 1828.5 MT (Baba *et al.*, 2017), which further increased to 2459 MT and 4086 MT in the year 2018 and 2021 respectively (Anonymous 2023a). “Farmers exposure to pesticides has been associated with inimical health effects like cancer, neurological disorders and birth defects resulting in thousands of fatalities, the majority of which occur in developing countries” (Litchfield, 2005).

 A literature review indicates that “the most common Personal Protective Equipment worn by pesticide users during pesticide handling is a long sleeve shirt, trousers, hat, and boots, while the lowest basic PPE worn being gloves, face mask, coveralls, goggles, and a respirator” (Damalas and Abdollahzadeh, 2016, Sapbamrer, 2018). “There are several reasons farmers don't choose to wear PPE when working with pesticides. Some farmers were found not to wear PPE during pesticide use due to weather conditions” (Watson et al., 2019), unavailability of PPE, “There was also a lack of certainty regarding use due to the price of PPE and feeling discomfort when being worn” (Bhandari et al., 2019) “With regard to pesticide safety practices, unsafe practices frequently reported were drinking, smoking and eating during pesticide application, improper disposal of leftover pesticide solutions, unsafe disposal of empty pesticide containers, storage of pesticides in living areas, not using the concentration recommended by the experts, ineffective laundry procedures and inappropriate personal hygiene following contact” (Sharifzadeh et al., 2019)

 Understanding farmers safety practices is vital not only to provide valuable information but also for identifying exposure situations that can contribute to educational and policy recommendations aimed at reducing or preventing the environmental and health hazards associated with pesticides. An evidence-based understanding of farmers safety practices and factors influencing PPE use has the benefit of facilitating the design of interventions to reduce pesticide exposure among agricultural pesticide users

**2. Materials and Methods**

**2.1. Locale of the study**

The study was carried out among Apple growers of district Baramulla of Jammu and Kashmir (UT). Baramullais the leading producer of Apple in Jammu and Kashmir (UT) having an area of 25307.15 ha and production of 238303.44 MT (Anonymous, 2023 b).

**2.2. Selection of Sample**

District Baramulla has 19 horticultural zones, among them 15 horticultural zones were selected purposively having maximum area and production under apple cultivation. A representative sample of 300 apple growers who were directly involved in pesticide application were randomly selected from the selected horticultural zones through proportionate allocation method.

**2.3. Questionnaire Development and Delivery**

A Questionnaire was developed in English and was administered in Kashmiri language on farm that was understood by all the farmers. A 5-continuum Likert scale was used for getting response ranging from always (Score 5) to never (score 1), (Likert, 1932). Nominal scale was used in questions pertaining to pesticide storage practices, disposal of leftover and pesticide empty containers

**2.4. Data Analysis**

Data were coded, entered and then analyzed using Statistical Package for Social Science (SPSS) Descriptive results were expressed as frequencies, percentage, mean and chi-square test was used to measure possible association between nominal variables, where p < 0.05 was used as a criterion for statistical significance.

**3. Results**

**3.1. Socio-demographic profile of farmers**

Majority (56.00%) of the farmers were in middle age group between 38-61 years with an average age of 49.37 years (Table 1**)**, slightly less than one-fourth (23.67%) were below 37 years and around one fifth (20.33%) were 61 years and above. Majority (52.33%) of the farmers were educated upto middle school, considerable number of farmers (17.00%) were illiterate or had not received any formal schooling, 11 per cent had received education upto high school level, 9.67 per cent upto senior secondary level and only 8.00 per cent were having graduate. Majority (87.34%)of the farmers were having marginal (upto 1 ha) land holding, 66 per cent of the farmers were having medium farming experience of 12-29 years with average farming experience of 19.84 years. While as only 11.67 per cent were having more than 29 years of experience.

**Table 1:** **Distribution of apple growers according to their personal and socio-eco- nomic characteristics.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Characteristics** | **Category** | **Criteria** | **F (%age)** | **Mean** | **S.D** |
| Age(Years) | Young | Upto 37  | 71 (23.67) | 49.38 | 12.43 |
| Adult | 38-61 | 168 (56.00) |
| Old | Above 61  | 61 (20.33) |
| Education | Illiterate | - | 51 (17.00) | - | - |
| Primary school | - | 81 (27.00) |
| Middle school | - | 76 (25.33) |
| High school | - | 33 (11.00) |
| Senior Secondary school | - | 29 (9.67) |
| Graduate | - | 24 (8.00) |
| Above Graduate | - | 06 (2.00) |
| Total land holding(ha) | Marginal | Upto 1 | 262 (87.34) | - | - |
| Small | 1.01-2 | 31 (10.33) |
| Medium | 2.01-5 | 07 (2.30) |
| Experience in apple cultivation(Years) | - | Upto 11 | 67 (22.33) | 19.84 | 9.39 |
| - | 12-29 | 198 (66.00) |
| - | Above 29 | 35 (11.67) |
|  |

**3.2. Farmers safety practices and PPE use against occupational pesticide exposure**

Effective protective measures against pesticide exposure during pesticide usage is important. Personal Protective Equipment use behaviour of apple growers was examined. Face mask was the most used item by apple growers with a mean of 4.36, followed by gloves (2.49), Hats (2.47), Long sleeved shirt (2.35), Boots (1,89), Waterproof Trousers (1.41), Goggles (1.32) and Coveralls (1.28),(Table 2 ). 1.33 per cent of the respondents were sensitive towards health issues and were always using PPE during pesticide usage, majority of the respondents (94.67%) were partially using recommended PPE. While as, 4.00 per cent had never used PPE. When farmers were asked to indicate main reasons for not wearing Personal Protective Equipment (PPE), Feeling uncomfortable while using (39.00%), Hectic (32.67%),Unavailable when needed (18.00%), Not interested (7.33%) and Expensive (1.67%) were the main reasons cited by the respondents who were partially using the recommended PPE and those who had never used PPE (Fig 1). Apart from PPE use, apple growers were asked whether, they implement other safety measures to minimize the risk of pesticide exposure, majority (79.67%) did not avoid eating and drinking during pesticide usage, 10.00 per cent sometimes avoid, 6.00 per cent oftenly avoid and only small fraction (4.33%) always avoid eating and drinking during pesticide usage with overall mean 1.55. Regarding smoking, a significant proportion (75.33%) of the apple growers always avoid smoking, 10.67 per cent never avoid, 6.33 per cent sometimes avoid, 4.00 per cent rarely avoid, while as 3.67 per cent oftenly avoid smoking when mixing or spraying pesticides with mean 4.29 .It was observed that more than one-third (37.34%) of the apple growers sometimes avoid using bare hands, more than one-fourth (25.33%) never avoid, 20.00 per cent rarely avoid, 15.00 per cent oftenly avoid and only 2.33 per cent always avoid using bare hands, while dealing with the pesticides, with mean 3.40.

 Furthermore, principal proportion (58.67%) of the apple growers sometimes avoid spraying during wind, (33.00%) always consider wind direction while spraying, 8.00 per cent never avoid, and a small fraction 0.33 per cent oftenly avoid spraying during wind, with mean 3.50. Majority (78.67%) of the apple growers reported that they never read labels before preparation, 16.33 per cent always read labels, 3.67 per cent oftenly read labels and only 1.33 per cent sometimes read labels before preparing/mixing pesticides with mean 1.79. Regarding the safety practice, using small wires to remove blockage majority (60.00%) of the apple growers sometimes follow this practice, significant proportion (38.33%) always follow this safety measure. While as small fraction 1.67 per cent oftenly follow this practice whenever there is any blockage, with mean value 3.78. Over 44 per cent of the apple growers did not wash work clothing used separately from other cloths, considerable proportion (31.00%) always wash work clothes separately, less than one-fourth (22.67%) sometimes avoid this practice. While as only 1.00 per cent and 0.67 per cent rarely and oftenly wash contaminated clothes in a separate load, with mean 2.72. Similarly, 77.67% of the apple growers were sometimes showering after completion of application, considerable proportion (19.33%) were taking bath after completion and a small fraction 2.33 per cent and 0.67 per cent never and oftenly shower after completion of pesticide application, with mean 3.34. Moreover, 54.33 per cent of the apple growers reported of not having first-aid availability, less than one third (31.34%) were sometimes having first-aid available and only 14.33 per cent were always having first-aid available in order to mitigate any untoward incident, with mean value 2.20. Where as, principal proportion (96.67%) of the apple growers were using unsafe practices for storage of pesticides and small fraction 3.33 per cent were storing pesticides at safe and separate places, with mean 3.27. Young and educated farmers were more likely to use PPE as compared to older farmers or farmers having low education (X2= 8.67, p<0.05). However no association was observed between farming experience, land holding and PPE use.

**Table 2: Distribution of apple growers according to safety practices followed during pesticide**

 **usage. N=300**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Category** | **Practice** | **Never****F(%age)** | **Rarely****F(%age)** | **Sometimes****F(%age)** | **Often****(F(%age)** | **Always****F(%age)** | **Mean** |
| **Personal protective equipments (PPE)** | Facemask | 12 (4.00) | 04 (1.30) | 23 (7.67) | 86 (28.67) | 175 (58.33) | 4.36 |
| Gloves | 76 (25.33) | 60 (20.00) | 112 (37.34) | 45 (15.00) | 07 (2.33) | 2.49 |
| Goggles | 233 (77.67) | 44 (14.67) | 19 (6.33) | 0 (0.00) | 04 (1.33) | 1.32 |
| Boots | 145 (48.33) | 56(18.67) | 88 (29.33) | 08 (2.67) | 03 (1.00) | 1.89 |
| Hats | 79 (26.33) | 62 (20.67) | 102 (34.00) | 51 (17.00) | 06 (2.00) | 2.47 |
| Coveralls | 239 (79.67) | 37 (12.33) | 15 (5.00) | 0 (0.00) | 9 (3.00) | 1.28 |
| Waterproof Trousers | 231 (77.00) | 0 (0.00) | 33 (11.00) | 17 (5.67) | 19 (6.33) | 1.41 |
| Long sleeved shirt | 120 (40.00) | 43 (14.33) | 75 (25.00) | 34 (11.33) | 28 (9.34) | 2.35 |
| **Safety practices** | Avoiding eating and drinking | 239 (79.67) | 0 (0.00) | 30 (10.00) | 18 (6.00) | 13 (4.33) | 1.55 |
| Avoiding smoking | 32 (10.67) | 12 (4.00) | 19 (6.33) | 11 (3.67) | 226 (75.33) | 4.29 |
| Avoids using bare hands | 76 (25.33) | 60 (20.00) | 112 (37.34) | 45 (15.00) | 07 (2.33) | 3.40 |
| Avoiding spraying during wind | 24 (8.00) | 0 (0.00) | 176 (58.67) | 01 (0.33) | 99 (33.00) | 3.50 |
| Reading labels before preparation | 236 (78.67) | 0 (00.00) | 04 (1.33) | 11 (3.67) | 49 (16.33) | 1.79 |
| Using small wires to remove blockage | 0 (0.00) | 0 (0.00) | 180 (60.00) | 05 (1.67) | 115 (38.33) | 3.78 |
| Washing contaminated clothes in a separate load | 134 (44.66) | 03 (1.00) | 68 (22.67) | 02 (0.67) | 93 (31.00) | 2.72 |
| Taking bath after completion of application | 07 (2.33) | 0 (0.00) | 233 (77.67) | 02 (0.67) | 58 (19.33) | 3.34 |
| First aid availability | 163 (54.33) | 0 (0.00) | 94 (31.34) | 0 (0.00) | 43 (14.33) | 2.20 |
| Storing at separate places | 290 (27.33) | 0 (0.00) | 214 (71.33) | 0 (0.00) | 10 (3.33) | 3.27 |

F= Frequency

 **Fig 1: Reasons for not Wearing PPE and Following other Safety Practices**

**3.3. Practices of farmers towards storage and disposal of pesticides and pesticide containers**

It is evident from the data in Table 3 that more than two-third (67.34%) of the apple growers were storing the pesticides in multipurpose sheds. A considerable proportion 19.33 per cent and 3.00 per cent reported storing pesticides in living areas and animal house. Farmers with higher education were significantly less likely to store pesticides in their living area (X2=18.23, p<0.01). 7.00 per cent were storing in orchards and meager fraction 3.33 per cent of the apple growers store their pesticides in separate chemical stores designated only for pesticides. Moreover, out of 300 apple growers, 26 (8.67%) of the apple growers were mixing the required amount of pesticides that is needed for the application at hand.

**Table 3: Distribution of apple growers according to pesticide storage practices and**

 **practices followed with the mixed leftover pesticides and pesticide containers.**

|  |  |  |
| --- | --- | --- |
| **Statement** | **Practice** | **Frequency (%age)** |
| **Where do you store pesticides****(n=300)** | Orchards | 21 (7.00) |
| Living area | 58 (19.33) |
| Separate pesticide store | 10 (3.33) |
| Animal house | 09 (3.00) |
| Multi-purpose shed | 202 (67.34) |
| **What do you do with the mixed left over pesticides (n=300)** | Dispose off in the field | 37 (13.50) |
| Apply on other crops | 58 (21.17) |
| Dispose in sewer | 01 (0.33) |
| Re-spray | 178 (64.96) |
| **What do you do with the pesticide empty containers (n=300)** | Use within household | 124 (41.33) |
| Wash and sell | 102 (34.00) |
| Reuse for other purposes | 74 (24.67) |

 Principal proportion (64.96%) were re-spraying the leftover solutions in an area which they feel less treated, considerable proportion (21.17%) of the apple growers reported that they apply the leftover solutions on other crops, 13.50 per cent disposed off the solutions in the field and small fraction 0.33 per cent of the apple growers dispose the leftover pesticides in sewer . Furthermore, the Table highlights that alarmingly 41.33 per cent of the apple growers were using the pesticide empty containers for household purposes, considerable proportion (34.00%) of the apple growers were selling them for recycling, less than one-fourth (24.67%) were using them for other purposes (fodder and drinking water purposes for livestock . A significant association (X2=8.34, p<0.05) was observed between farming experience, trainings received and pesticide storage and disposal practices.

 **Discussion**

Understanding farmers safety practices and lavel of PPE use is important for providing sound policy and educational strategies that aim at minimizing the environmental and health hazards caused by pesticides. A considerable number of the respondents in this study were illiterate (17.00%) or had limited formal education (52.33%). A significant number of apple growers have not received any technical support or training regarding safe use of pesticides, which has impeded their ability to read (Al-Zadjali et al., 2015) and acknowledge pesticide labels regarding safe use of pesticides or written correspondence about how to avoid risks of exposure (Kachaiyaphum *et al.* (2010) and Bhandari *et al.* (2019). The fact that the majority of the respondents (78.67%) indicated that they did not read or are unable to read (Yousuf et al 2024) or understand pesticide labels (Table 2) is a major hindrance towards safe use of pesticides and a great cause for concern and indicates a general ignorance of the importance of pesticide instructions in reducing exposure risks, more interactive and participatory training model is required, for example, by using pictograms to simplify pesticide labels and transmitting risk information. The pictograms should be unambiguous and easy to understand, to prevent misinterpretations of the risk information. Using pictograms could act as a key element for overcoming literacy challenges in communicating pesticide risk information (Rother, 2008). Educated farmers are more knowledgeable about pesticide safety, have better ability to read, understand and follow hazard warnings on labels, and conceptualized the consequences of poor pesticide usage practices (Karunamoorthi et al., 2012).

 Use of appropriate PPE, such as coveralls, facemasks, gloves and adoption of other safety measures and good personal hygiene such as not eating, smoking or drinking and showering immediately after pesticide application are considered good practices to reduce occupational pesticide exposure (Matthews, 2008). An increase in the use of protective measures decreases the probability of poisoning by 42% to 83% (Keifer, 2008), whereas inappropriate or lack of PPE use increases the potential for respiratory and dermal exposure to pesticides (Muhibbullah and Sarwar, 2018, Hogstedt, 1997). An important finding in this study is that there are low levels of adoption of protective measures to reduce occupational pesticide exposure. The main reasons cited by the apple growers were feeling uncomfortable, unavailability, hectic and some were not interested which might be due to their ignorance of knowing the importance of using Personal protective equipments (Jones 2009 and (Al-Zadjali, 2015). Lack of PPE use is made worse by some farmers, mixing using bare hands, not spraying according to the wind direction, non availability of first-Aid, eat, drink, and smoke when using pesticides, all of which increase the risk of poisoning (Matthews, 2008).

 The data also shows some worrying practices regarding storage of pesticides, majority (67.34%) of the apple growers were storing the pesticides in unlocked multipurpose sheds. A worrying 19.33 per cent and 3.00 per cent reported storing pesticides in living areas and animal house, 7.00 per cent were storing in orchards and only 3.33 per cent of the apple growers store their pesticides in separate chemical stores designated only for pesticides. This demonstrates the inappropriate approach of farmers for storing pesticides (Matthews,2008). Storing pesticides in living areas and unlocked multipurpose sheds may increase the potential for high exposure and storing in animal houses could pose livestock at risk. This risky behavior of farmers can be attributed due to lack of education or training on safe use and storage of pesticides (Jallow *et al.*, 2017). Majority (59.33%) were re-spraying the leftover pesticide solutions in an area which they feel less treated, (21.17%) of the apple growers reported that they apply the leftover solutions on other crops, 13.50 per cent disposed off the solutions in the field, which demonstrates a poor knowledge regarding disposal of pesticides which can increase harmful residues on soil and may contaminate water, posing human and environmental health at risk. 26 (8.67%) of the apple growers reported that they mix the required amount of pesticides and 0.33 per cent of the apple growers dispose the leftover pesticides in sewer, both were doing a good practice to reduce the hazards of pesticides on environment but unfortunately these farmers represent very small proportion of the total sample (Atreya *et al.* (2012) and Jallow *et al.* (2017).

 Regarding disposal of pesticide empty containers, alarmingly 41.33 per cent of the apple growers reported using the pesticide empty containers for household purposes, 34.00 per cent of the apple growers were selling them for recycling, 24.67 per cent were using them for other purposes (fodder purposes for livestock) indicating their unsafe behavior towards disposal of pesticide empty containers increasing chances of pesticide exposure, which can pose a serious threat to human as well as environmental health. This trend can be attributed due to low or limited formal education, lack of technical knowledge and ignorant regarding importance of bio-safety (Mekonnen and Agonafir (2002). The national agricultural extension service should play a pivotal role in the training of farmers, and the information they provide should be up-to-date, accurate, and easy to understand to inspire confidence and trust among the farmers.

**Conclusion**

The inimical effects of pesticides have been widely documented. However awareness among farmers regarding importance of protecting themselves and the environment from the adverse effects of unsafe pesticide handling practices is still lacking. The aim of the study was to investigate the PPE use and safety practices followed by the apple growers. Low level of PPE use and other safety practices was reported by most of the farmers. Facemask was the most common item used by the farmers, followed by gloves, hats and long sleeved shirt. While as unsafe practices like smoking, drinking, eating and using bare hands during pesticide usage were seen among majority of the farmers. Improper storage practices like storing in living areas, or on open sheds and using empty pesticide containers for domestic purposes indicates the risky behaviour of apple growers. To increase farmers knowledge regarding the importance of biosafety and long term effects of pesticides on human health, it is suggested that priority should be given to develop and implement pesticide safety and sensitization programmes, when provided the training must include health care works which could betterly address the harmful effects of pesticides on human health and the environment associated with the pesticide exposure and pesticide risk reduction techniques related to handling, disposal and storage of pesticides. Finally availability of personal protective equipments must be ensured at each pesticide shop at low cost so as to enhance their popularity and usage among the farmers.

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**Disclaimer (Artificial intelligence)**

I hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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