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Perceived usefulness of personal protective equipment in pesticide use predicts farmers' willingness to use it

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HIGHLIGHTS

- Farmers' willingness to use PPE and perceptions of PPE usefulness were examined.
- Some farmers (36.7%) showed unwillingness and other (25.2%) were unsure of using PPE.
- Farmers who perceived usefulness of PPE were more willing to use it in the future.
- Those who perceived non-usefulness of PPE were less likely to use it in the future.
- Incorporating farmers' preferences in extension programs is necessary.

GRAPHICAL ABSTRACT

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ABSTRACT

Personal protective equipment (PPE) can substantially reduce the risk exposure from pesticide spraying, but compliance is rather low, particularly among small-scale farmers. In this study the connection between farmers' willingness to use PPE in pesticide handling and perceptions of PPE usefulness was examined through a survey of 341 small-scale farmers in Gorgan county of Golestan Province, Iran. Farmers who were not using PPE when working with pesticides were purposively selected to better serve the objective of the study. Multinomial logit regression models were employed to examine differences in farmers' willingness to use PPE in the future. Almost four out of ten farmers (38.1%) showed willingness to use PPE. However, 36.7% of the farmers showed unwillingness and 25.2% were unsure about using PPE. The average score of farmers' perceptions of PPE disadvantages ($x = 0.55$) was significantly higher than the corresponding score of PPE advantages ($x = 0.38$). Low availability and high price were considered the most important constraints in PPE use by the majority of farmers (75.4% and 74.8% of the farmers, respectively). Farmers who perceived usefulness of PPE, such as effectiveness, safety, and ease of use, were more willing to use PPE in the future. Those who perceived non-usefulness of PPE, driven by unavailability, high price, lack of use by neighbors or colleagues, and ignorance of PPE in extension trainings, were less likely to use PPE in the future. Findings revealed that willingness to use PPE among small-scale farmers when working with pesticides is strongly linked to their perception of PPE usefulness. Findings raise our understanding of the important role of farmers' knowledge in PPE acceptance and use and can motivate policy-makers to pay more attention to the role of farmers' perceptions and awareness in the success or failure of health and safety programs. It is necessary to incorporate farmers' preferences in extension programs to promote safety measures during working with pesticides.

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1. Introduction

Iran is among the ten largest producers of the world for 14 horticultural commodities. Horticultural products are the backbone of Iranian agricultural exports (Azizi and Yazdani, 2004), providing 80% of the agricultural exports and contributing to approximately 51% of the country's total agricultural production (Baghbani et al., 2011). The coastal regions of the Caspian Sea in Iran (including Guilan, Mazandaran, and Golestan provinces) account for a significant share of the country's horticultural production and have experienced intensive use of various pesticides in recent years (Veisi, 2012). In Iran, over 27,000 t of pesticides including >140 different active ingredients are used annually, with 60% of this usage occurring in the coastal regions of the Caspian Sea (Hashemi et al., 2012; Veisi, 2012). The horticultural production in these regions relies mainly on smallholders, who make up the main share of workforce in the production process (Ardestani et al., 2010). Small-scale farmers always try to improve crop yield by minimizing the development of pests, like insects and fungi. Therefore, the use of pesticides has increased substantially in this region over the years (Abdollahzadeh et al., 2015).

The use of pesticides in the agricultural production undoubtedly helps to increase crop yield and minimize post-harvest losses (Damalas and Eleftherohorinos, 2011). However, it also poses risks simultaneously for human health, the environment, and food quality because of the possible presence of pesticide residues in the harvested crops (Damalas et al., 2008; Abhilash and Singh, 2009). Therefore, reducing these risks can be critical in preventing pesticide poisoning during handling, mixing, storing, and spraying. The use of personal protection equipment (PPE), including gloves, mask, coveralls, goggles, boots, and respirator, is widely recommended for prevention of the adverse health effects of pesticides (Hernandez-Valero et al., 2001; Hines et al., 2007; Salvatore et al., 2008; Damalas and Abdollahzadeh, 2016). Many studies demonstrated the efficacy of PPE as a highly reliable way of preventing exposure during pesticide application (Gomes et al., 1999; Damalas and Hashemi, 2010; Tsakirakis et al., 2010; Damalas and Abdollahzadeh, 2016). Despite the reliability and efficacy of PPE in promoting safe use of pesticides, the level of PPE use is generally low and farmers frequently suffer from pesticide-related symptoms (Damalas et al., 2006; Feola and Binder, 2010; Zyoud et al., 2010; Esechie and Ibitayo, 2011). Additionally, knowledge of PPE among farmers as a way of safety behavior during pesticide application is low, especially in developing countries (Hashemi et al., 2012; Yuantari et al., 2015; Negatu et al., 2016) despite the fact that farmers' knowledge plays an important role in explaining their behavior (Abdollahzadeh et al., 2015; Kearney et al., 2015).

There are different reasons why knowledge of PPE and compliance may remain low among farmers. Many studies revealed that most farmers do not have adequate levels of knowledge concerning pesticide handling and safety and they are not aware of safety precautions when working with pesticides, resulting in exposure to pesticide hazards (Phung et al., 2013). Some studies reported that most farmers are unaware of the type of PPE that should be worn during pesticide handling (Damalas and Abdollahzadeh, 2016). Weng and Black (2015) mentioned that the main reasons of farmers for not wearing PPE were the discomfort (50.6%), the unavailability of PPE when needed (23.4%), the extra time required for using it (15.6%), and the non-necessity of PPE for every situation (15.6%). Damalas and Hashemi (2010) stated that since farm work includes several different activities, control measures may not always be feasible for workers' protection. Mohanty et al. (2013) reported that farmers with good knowledge of pesticides used more protective measures compared to farmers with poor knowledge. Some researchers found that although farmers generally understood the potential hazard of pesticides, their knowledge and use of PPE were poor (Norkaew et al., 2010). Yuantari et al. (2015) reported that the importance of using PPE is known and well understood by the farmers. However, in practice almost no farmer used PPE that was approved, in good condition, and complete. Moreover, decisions to use PPE and properly handle/apply pesticides may be driven by risk-accepting personality traits (DellaValle et al., 2012).

Numerous studies have examined the unsafe use of pesticides and the detrimental effects on human health and the environment (Esechie and Ibitayo, 2011; Weng and Black, 2015). However, few explored farmers' willingness to use PPE during pesticide use, and to our knowledge, none have done so in an Iranian context. Informed by the transtheoretical model of behavior change (also known as stages of change model), in the present study we studied willingness to use PPE among smallholder farmers. The transtheoretical model specifies the stages of change or degree of readiness to change or begin new behaviors (Clement, 2008). The stages in the model include precontemplation, contemplation, preparation, action, and maintenance (Henry, 2005). The transtheoretical model, especially the stages of change concept (Prochaska et al., 1992), is useful in assessing how prepared and willing people are to engage in the change process.

Examining farmers' willingness to use PPE provides opportunities of better understanding an alternative stage of the cognitive process in which safety decisions during working with pesticides are made. In this study, we examined the relationship between small-scale farmers' knowledge and awareness regarding PPE and willingness to use this equipment. Findings could provide a better understanding of farmers' background with the aim to develop specific extension programs for farmers to protect them from pesticide-related occupational hazards.

2. Methodology

2.1. Study area

The study is based on survey data from a cross-section of horticultural farmers for the cropping year 2016 collected from Gorgan County, Golestan Province, where olive groves and fruit orchards (peaches, nectarines, plums, pomegranates, apples, and citrus) form an important proportion of the agricultural land. Citrus, pomegranates, peaches, and nectarines are among Iran's important export products, including also walnut production, which has begun to grow rapidly in the recent years.

The surveyed area was selected for the study because the majority of small-scale farmers in the area rely on synthetic pesticides to control pests and weeds. Moreover, a considerable portion of farmers in these regions do not use PPE during working with pesticides (handling, mixing, and spraying) due to constraints such as limited accessibility and low affordability. Additionally, after several field visits and discussion with people from some local institutions, such as village councils and board members of farmers' associations and groups, it was revealed that farmers in this area were open minded and ready to share information.

2.2. Questionnaire and sampling

The initial questionnaire was designed by the authors. Then, the questionnaire was peer-reviewed by six crop protection experts, officials, and extension technicians from Golestan Agri-Jihad Organization and Gorgan Agri-Jihad Management. Finally, a sample of 20 farmers who were excluded from the final survey was used to pre-test the questionnaire for evaluating the clarity and comprehensiveness of the questions as well as the feasibility of the survey as a whole. Finally, the main survey was carried out from March to July 2016. Five local extension agents were recruited to administer the questionnaire by face-to-face interviews with the farmers in the local language.

The 2329 fruit farmers of Gorgan County were the population of this study. This analysis focused on a sub-population of farmers who had never used PPE when working with pesticides to better serve the objective of the study, which was to investigate how perceptions regarding advantages and disadvantages of PPE connect to willingness to use PPE rather than actual use. For this reason, we focused only on non-