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Pesticide use in cereal production in Moghan Plain, Iran: Risk knowledge and farmers' attitudes

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ABSTRACT

Cereal cultivation, mainly of wheat (*Triticum aestivum* L.) and maize (*Zea mays* L.), occupies a large area in Moghan Plain, Iran, with frequent use of pesticides, but research pertaining to pesticide use and farmers' attitudes in the area is scarce. The main objective of the present study was to analyze farmers' knowledge of pesticide hazards and use of information sources regarding pesticide use in cereal production in Moghan Plain in northwestern Iran for better understanding what drives farmers' attitudes in pesticide use. To this end, a survey of 400 farmers was conducted. Pesticide use mainly concerned the most common herbicides used in cereal production in the area (2,4-D and MCPA), the most common fungicides used in wheat (mancozeb and propiconazole), and the most common insecticides used in maize (indoxacarb and chlorpyrifos). The surveyed farmers appeared divided, with almost half (49.2%) having rather negative attitude towards pesticide use and the other half (50.8%) exhibiting rather positive attitude. Experienced farmers and farmers with large cultivated land showed more positive attitude towards pesticide use. More than half of the farmers (53.0%) had rather weak knowledge of pesticide hazards, whereas one fifth (19.5%) had good knowledge. Retailers of agricultural inputs were the first priority of farmers among information sources, followed by neighboring farmers and personal experience. Structural equation modeling (SEM) showed a positive relationship between farmers' knowledge of pesticide hazards (causal impact 0.84) as well as farmers' use of information sources (causal impact 0.52) with their attitudes towards the use of pesticides. Data provide novel information on the role of risk knowledge in farmers' attitudes towards the use of pesticides and extends existing information on the role of farmers' use of information sources in decisions for pesticide use. Improving farmers' knowledge of pesticide risk and providing valid sources of information are fundamental for minimizing pesticide overuse in cereal production in Moghan Plain, Iran.

1. Introduction

Cereal cultivation, mainly of wheat (*Triticum aestivum* L.) and maize (*Zea mays* L.), occupies a large area in Moghan Plain, Iran. Wheat is the most important crop in Iran widely grown for many years in Moghan Plain of northwestern Iran (Hajieghrari, 2009). Management factors, including wheat cultivars, planting timing, nitrogen and phosphorus rates, crop rotation, and pest control are responsible for wheat yield gap in this region (Shirinzadeh et al., 2017). Wild oat (*Avena* spp.) and wild mustard (*Sinapis arvensis* L.) are major weeds in wheat fields of Moghan Plain, which are often controlled by herbicides, whereas stripe rust, caused by the obligate parasite *Puccinia striiformis* f.sp. *tritici* (Pst), is one of the most important diseases of wheat in Moghan Plain, which often requires fungicide applications (Khiavi et al., 2017). Maize is also an important cereal crop grown for fodder as well as for grain in Iran (Banaeian and Zangeneh, 2011). Approximately 320,000 ha of field corn were grown in Iran in 2010 with a production of 2,560,000 tonnes and an average grain yield of 8000 kg per ha (Anonymous, 2010). Johnsongrass (*Sorghum halepense* L.) and redroot pigweed (*Amaranthus retroflexus* L.) are common weeds in maize fields of Moghan Plain, which are often controlled by herbicides, whereas the European corn borer, *Ostrinia nubilalis* (Hübner), is an important insect pest of corn in Moghan Plain, which often requires insecticide applications (Moghanlou et al., 2014).

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Although pesticides are recognized as a key component of modern crop protection, they are also important sources of environmental pollution affecting health of living organisms, including humans (Damalas, 2009; Fan et al., 2015; Jallow et al., 2017a). Exposure to pesticides is probably the most common and serious occupational hazard that farmers and farm workers face in developing countries (Ghasemi and Karami, 2009; Hashemi et al., 2012). Evidence of high levels of contamination and poisoning among pesticide users and farm workers throughout the world is reported (FAO, 2010). Furthermore, almost three million people suffer from severe pesticide poisoning and about 25 million people from mild pesticide poisoning every year in rural communities of developing countries, ensuing about 180,000 deaths per year among farm workers (Zhang et al., 2011; Fan et al., 2015). Although in some countries, like Vietnam, 95% of farmers have specific pesticide-related trainings (Houbraken et al., 2016), in other countries, the majority of farmers have never attended even a single training course on how to use agrochemicals (Omari, 2014; Sankoh et al., 2016). Therefore, misuse of pesticides often occurs.

A first step for mitigating the risks of pesticides is to study farmers' knowledge, attitudes, and behaviors about pesticides used for crop protection (Yuantari et al., 2015; Shams et al., 2015). In general, investigation into individuals' attitudes is an important step, in the sense that attitude is one of the main and key components of human behavior and it can be used to judge human behavior and its consequences (Gorton et al., 2008). Therefore, one can predict behaviors to a large extent by understanding attitudes (Mahboobi and Ahmadigorji, 2017). A negative attitude towards the use of agrochemicals for pest control was observed among greenhouse holders in Iran, i.e., most participants perceived the use of pesticides to be harmful to human health and the environment (Ghasemi and Karami, 2009), but poor knowledge of pesticide risks was observed (Golzardi et al., 2011). Training courses played the most important role in influencing farmers' attitudes about the use of pesticides in Iran (Omidi Najafabadi and Mohammadi, 2011). Moreover, other studies reported that most farmers were aware of the impact of pesticides on human health (Karunamoorthi et al., 2012; Al Zadjali et al., 2013). Abdollahzadeh et al. (2015) reported that farmers using biological control of pests in Iran had adequate knowledge of the harmful consequences of pesticides and that the use of pesticides among this group of farmers was lower. Generally, farmers may be well aware of the dangers of chemical inputs, but this knowledge is not always evident in their behavior (Isin and Yildirim, 2007).

Herbicide and insecticide use in cereal production is frequent in Moghan Plain, but research pertaining to pesticide use and farmers' attitudes in the area is scarce. Therefore, farmers' behavior in the use of pesticides in the area should be clarified to provide advice to local and national authorities for shaping appropriate policies. Understanding farmers' behavior in the use of pesticides may minimize the hazards of occupational pesticide exposure over time. Previous studies in the literature have examined the role of risk perception in farmers' safety practices during pesticide use (Ríos-González et al., 2013; Khan et al., 2015; Jallow et al., 2017b; Jin et al., 2017; Wang et al., 2018), but they did not connect risk knowledge with farmers' attitudes towards the use of pesticides. Since the attitudes of farmers towards pesticides can shape their behavior in terms of frequency and mode of pesticide application, this study seeks to analyze the role of risk knowledge and the role of information sources about pesticides in shaping attitudes of farmers about using pesticides in Moghan Plain, Iran. Therefore, the main objective of this survey was to study whether the level of risk knowledge and the level of use of information sources about pesticides affect farmers' attitudes in pesticide use. The role of risk knowledge on farmers' attitudes towards pesticide use has not been examined in the literature, whereas few studies have dealt with the role of farmers' use of information sources in decisions for pesticide use (Van Mele et al., 2002; Jin et al., 2015). In line with the above, the following hypotheses were formulated within the theoretical framework of the current research:

H1. Farmers' use of information sources affects attitudes towards pesticide use.

H2. Farmers' use of information sources affects risk knowledge of pesticides.

H3. Farmers' knowledge of risks affects attitudes towards pesticide use.

2. Methodology

2.1. Study area

The area of Moghan Plain is located in northwestern Iran. This plain is a key agricultural region in Iran due to its suitable ecological conditions for crop growth, fertile soils, and appropriate moisture and temperature regimes. The main crops of the region are wheat, barley, and maize. Other common crops in the area are soybean and rapeseed. The maximum altitude of the plain is 500 m and the minimum is 50 m. The total area of Moghan watershed covers more than 5545 km^2. Three counties, Germi, Bilesuvar, and Parsabad, are included in Moghan Plain area.

2.2. Sample selection

The statistical population of this study composed of all cereal farmers in Moghan Plain (N = 9996). The sample size was determined to 370 farmers using the Krejcie and Morgan (1970) sampling table. Because of low rate of returned questionnaires in surveys and to further increase the confidence level, a total of 400 questionnaires were distributed among participants, who were selected by multi-stage sampling with proportional assignment in 2016–2017. Data were therefore randomly collected from seven districts, ten village groups (*Dehestan*), and 41 villages.

2.3. Survey instrument

The research instrument was a questionnaire consisting of four sections: selected demographic characteristics, attitudes towards pesticide hazards (13 items measured on a 5-point Likert-type scale ranging from 1 = totally disagree to 5 = totally agree), knowledge of pesticide hazards (eight items measured on a 5-point Likert-type scale ranging from 1 = very low to 5 = very high), and information sources for pesticide use (six items measured on a 6-point Likert-type scale ranging from 0 = never to 5 = very much). The above variables referred to various pesticides commonly used in the study area, such as 2,4-D and MCPA herbicides used in wheat and maize, mancozeb and propiconazole fungicides used in wheat, and indoxacarb and chlorpyrifos insecticides used in maize. All these pesticides, except mancozeb, belong to the hazard category II (moderately hazardous) of WHO hazard classification. The validity of the questionnaire was confirmed by a panel of relevant experts and faculty members. To assess the reliability of the designed statements for measuring variables, Cronbach's alpha was estimated. Cronbach's alpha exceeded 0.7 after some technical corrections, indicating the reliability of the research instrument.

2.4. Data analysis

Descriptive statistics (frequencies, percentages, means, and standard deviations) were used for each measured variable. The interval of standard deviation from mean (ISDM) was used for grouping farmers according to their attitudes or knowledge of pesticide hazards (Allahyari et al., 2016). This is a simple method of grouped frequency distribution, which summarizes grouping of all data values divided into mutually exclusive classes and it is a useful approach whenever a broad and easily understood description of data concentration and spread is needed (Orr, 1995). In this method, the data were divided into four