



Pesticide risk behaviors and factors influencing pesticide use among farmers in Kuwait



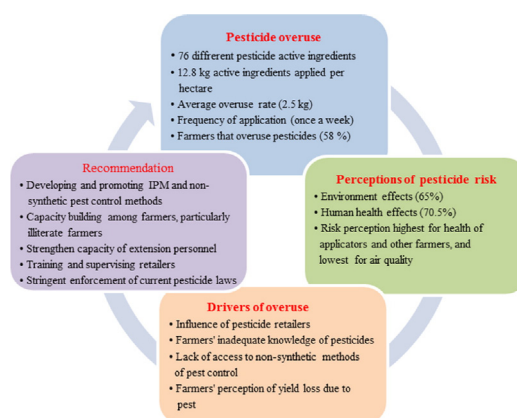
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HIGHLIGHTS

- Pesticide use and risk perceptions among Kuwaiti farmers was investigated.
- Farmers' heightened risk did not have a positive effect on pesticide use practices.
- Pesticide overuse was found among farmers.
- Overuse influenced by retailers and farmers' inadequate knowledge of pesticides.
- Measures for reducing pesticide overuse and related hazards were recommended.

GRAPHICAL ABSTRACT



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ABSTRACT

The widespread overuse of pesticides in agriculture has generated increasing concerns about the negative effects of pesticides on human health and the environment. Understanding farmers' perceptions of risk of pesticides and the determinants of pesticide overuse is important to modifying their behavior towards reducing pesticide use. A survey of 250 randomly selected smallholder vegetable farmers in Kuwait was conducted to quantify the extent of pesticide use, their pesticide risk perceptions and factors influencing their pesticide use behaviors. The majority of the farmers perceived pesticides pose some risk to the environment (65%) and human health (70.5%), while younger farmers were more likely to perceive this risk than older farmers. When asked to rate how risky pesticides were regarding several aspects of human health and the environment on a scale of 1 (not risky) to 5 (extremely risky), concern was highest for the health of applicators ($x = 4.28$) and lowest for air quality ($x = 2.32$). The risk perceptions of the farmers did not have a positive influence on their pesticide use practices. A total of 76 pesticide active ingredients were found in use, and 9% of these belong to the WHO toxicity class II (moderately hazardous). On average, farmers applied 12.8 kg of active ingredients per hectare per year, and 58% of the farmers were found to have overused pesticides, with an average overuse rate of 2.5 kg. Pesticide application frequency ranged from two times a month up to once a week, depending on the crop. A binary probit model reveals that farmers' inadequate knowledge of pesticides, the influence of pesticide retailers and lack of access to non-synthetic methods of pest control are positively associated with pesticide overuse, while the propensity to overuse decreases with higher levels of education, training in Integrated Pest Management (IPM) and

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the safe use and handling of pesticides, and access to extension support. Comprehensive intervention measures for reducing pesticide overuse and limit the health and environmental hazards caused by pesticides are provided in this paper.

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1. Introduction

Pesticides are considered a vital component of modern farming, playing a major role in maintaining high agricultural productivity. Consequently, high-input intensive agricultural production systems in which greater and widespread use of pesticides to manage pests has emerged as a dominant feature (Tilman et al., 2002). However, reliance on pesticides is difficult to sustain because of unintended long-term adverse effects on the environment and human health (Pimentel, 2005). For example, farm workers exposure to pesticides has been associated with adverse health effects like cancer and birth defects resulting in hundreds of fatalities, the majority occurring in developing countries (Litchfield, 2005; FAO, 2014). Many of the environmental and human health impacts of pesticides are a direct result of the overuse and misuse of pesticides, such as deviating from recommended application procedures and dosages (Dasgupta et al., 2007), use of obsolete and banned pesticides (Hajjar, 2012; Verger and Boobis, 2013), and improper storage, handling and disposal of pesticides (Damalas et al., 2006; Stadlinger et al., 2011).

Some scientists argue that the improper and excessive use of pesticides, especially in developing countries, is linked to the lack of education and training in pesticide use, lack of alternatives to pesticides, inadequate information on related hazards, stringent market requirements for crop aesthetic perfection, and the unwillingness of farmers to accept the risk of crop loss (Wilson and Tisdell, 2001; Hashemi and Damalas, 2011; Khan et al., 2015). Higher levels of education, gives farmers better access to information about pesticides and more knowledge of how much pesticides to use (Shetty et al., 2010). While less educated farmers may be hampered in their ability to access information about pesticides and follow recommended safety and application guidelines (Matthews, 2008).

Other scientists argue that pesticide overuse is an inevitable consequence of weak enforcement of pesticide laws and regulations, national policies that create incentives for pesticide use, and active sales promotions by agrochemical companies and their intermediaries (Marcoux and Urpelainen, 2011; Schreinemachers and Tipraqsa, 2012). Other factors, such as social and farm characteristics, lack of access to extension support, and farmers' perceptions of pesticide risk, have also been presented as major factors influencing farmers' behavior towards pesticide overuse. For example, farmers with low levels of pesticide risk perception are more prone to pesticide overuse than farmers with heightened risk perception (Dasgupta et al., 2007; Damalas and Hashemi, 2010; Hashemi et al., 2012; Liu and Huang, 2013). Although in some studies, heightened perception of pesticide risk was not associated with reduced pesticide use (Damalas et al., 2006; Khan et al., 2015). The lack of extension support is also positively correlated with pesticide overuse (Sarker and Itohara, 2009).

Kuwait is currently a net importer of agricultural products for its nearly 3.5 M population (Kuwait Agricultural Statistics, 2014). More than 55% of the food consumed in the country and 80% of animal feed are imported, making it one of the countries most reliant on food imports in the world (FAO, 2011). To address this challenge, the government has made significant investments in the past two decades towards developing new agricultural strategies, and has created a favorable environment for agricultural expansion to help facilitate at least a modest level of self-sufficiency in food production. Consequently, there is a growing interest in agricultural activities, especially vegetable production for fresh market consumption. Most vegetables in Kuwait are produced under protected environments, accounting for more

than 90% of the total greenhouse crop production (Kuwait Agricultural Statistics, 2014).

One of the most prevalent problems for protected cultivation in Kuwait and many countries in the Middle East is plant diseases and insect pests, for which there are few management options (Abdal et al., 2009). Consequently, faced with several pest complexes, farmers simply rely on chemical pesticides to address pest problems. The annual consumption of pesticides in Kuwait was about 9.5 kg ai ha⁻¹ in 2013, the second highest in the Middle East and one of the highest in the world (UN-ESCWA, 2013). Not only is this high input of pesticides perceived as necessary, pesticide mixtures are generally considered desirable. Even more disturbing, some farmers do not perceive pesticides as hazardous or that they have to be handled judiciously. Additionally, some farmers tend to apply pesticides too close to harvest, thus contaminating the crop prior to sending their produce to the market. This excessive amount of pesticide use does not translate into increased crop yields for the farmers, but rather increases the potential to adversely affect human health and the environment. Pesticide residue have been detected in a number of vegetables in Kuwait (Saeed et al., 2001, 2005; Hajjar, 2012), and the presence of chlorinated pesticides in the breast milk of lactating women has raised even greater concerns about possible health risks to breastfed infants (Saeed et al., 2000, 2005).

Evaluating the factors that influence the overuse of chemical pesticides in agriculture is especially pertinent in the light of evidence that pesticides may pose a significant risk to human health. Even though there is mounting literature regarding the adverse consequences of pesticide use in Kuwait and the Middle East, only a few studies published to date have focused specifically on identifying the underlying factors influencing the overuse and misuse of pesticides (see, for example Al-Zadjali et al., 2014). The focus of the work described in this paper are firstly, to determine, through a survey, the extent of pesticide use in Kuwait *vis-à-vis* farmers' perceptions of pesticide risk; and secondly, to identify the key factors influencing pesticide overuse. Understanding the farmers' behavior in pesticide use and the factors that influence their decision to overuse pesticides will provide valuable information that can contribute to educational and policy recommendations that aim at reducing pesticide use. This information is also critically important in enhancing agricultural sustainability and reducing the negative effects of pesticides on human health and the environment.

2. Material and methods

2.1. Description of the study area

The State of Kuwait is located at the northwestern end of the Arabian Peninsula with a population of about 3.7 million, and total land area of approximately 17,818 km². The environment is characterized by high ambient temperatures, dry winds, sand dominated soils and annual precipitation ranging between 75 mm to 170 mm per year (Droogers et al., 2012). Despite this challenging environment for agriculture, local crop production meets nearly 45% of the country's food needs. Wafra and Abdally regions in the northern and southern part of the country, respectively, were selected for this study. These two regions account for more than 90% of the total crop production in Kuwait (Kuwait Agricultural statistics, 2014). Cropping systems are mainly based on open field and greenhouse production, with about 30,000 ha under cultivation. Farms of about 5 ha dominate the agricultural landscape, mostly growing dates, vegetables, cereals, pulses, and forages. Greenhouses for vegetable production cover about 7000 ha, which is almost 23% of

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