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Motivations for adopting biological control among Iranian rice farmers

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ABSTRACT

While research on biological control of crop pests is quite popular, it seldom targets motivations of farmers for adopting this practice. A survey of 283 rice farmers was conducted in Mazandaran province of northern Iran to study farmers' motivations for biological control adoption as an alternative control method of Asiatic rice borer [*Chilo suppressalis* (Walker)] and explain potential differences in motivations among different groups of farmers. Face to face interviews were used to address farmers' motivations based on a list of motivation statements found in previous studies and modified by extension officers and farmers who had adopted biological control in the study area. Factor analysis of a motivation list with 15 items revealed four main groups of factors explaining the adoption of biological control by rice farmers; these were 'health maintenance', 'economic benefit', 'social acceptance', and 'environmental protection'. Men gave high scores to motivations related to 'economic benefit' and 'social acceptance', whereas women preferred mostly motivations related to 'health maintenance'. Well-educated farmers (e.g., some college education) preferred motivations for 'health maintenance' more than farmers with lower education or no education at all. Participation in extension programs was associated with preference of non-economic motivations of biological control adoption, while membership in local associations (such as rural cooperatives or producers' groups) encouraged motivations related to 'social acceptance'. Farmers who used family labor force in their fields or farmers who perceived pesticides as harmful substances showed strong motivations primarily for 'health maintenance' along with 'environmental protection'. Small area of land under cultivation and low annual farm income were strongly linked with motivations for 'economic benefit'. Besides economic motivations, policies for the promotion of biological control adoption should embrace a wide set of farmers' motivations when developing new and properly tailored extension programs.

1. Introduction

Rice farming is one of the most important sources of employment and income for farmers in Mazandaran province of Iran (Razzaghi-Borkhani et al., 2013). In 2013, the share of rice crop in this province to the total cultivated land and to the total production in the country was over 50% (MAJO, 2013). Most farm households in this area are actively involved in rice cultivation which constitutes a substantial portion of their agricultural income (MAJO, 2013). The Asiatic rice borer, *Chilo suppressalis* (Walker) (Lepidoptera: Crambidae), is a major pest problem to rice production in Mazandaran paddy fields (Noorhosseini et al., 2010). It is estimated that the Asiatic rice borer causes about 15% yield losses annually (Asadpour, 2011). These losses translate to an annual income loss and a constant risk of food insecurity to the affected farm households. The major control method since the first outbreak in the 1970s is the indiscriminate use of insecticides (Samiee et al., 2009), such as diazinon, an organophosphate insecticide that is applied up to six times in a cropping season (Noorhosseini-Niyaki, 2010).

Many farmers use a combination of pest control strategies, involving pesticide use as well as biological and cultural control measures. Nonetheless, the use of chemical control methods dominates other pest control methods because many farmers consider pesticides to be more effective (Abdollahzadeh et al., 2015). Thus, pesticides rapidly gained acceptance in the agricultural sector by effectively controlling pests, but the indiscriminate

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use not only led to public health and environmental issues (Damalas, 2009; Damalas and Eleftherohorinos, 2011), but also led to resistance development of pests to pesticides (Karamidehkordi and Hashemi, 2010) and reduced populations of natural enemies of many harmful pests (Sabet et al., 2012). These problems with pesticides are often observed in many developing countries (Hashemi et al., 2012; Khan and Damalas, 2015; Khan et al., 2015). An alarming issue is that while many farmers are adequately informed about pesticide risks, this knowledge does not always translate into self-protection behaviors with pesticide use (Damalas et al., 2006a, b). Although pesticide use is ubiquitous, new pest control methods are continuously being developed (Seiber et al., 2014) to provide efficient pest control, while protecting the environment and human health. Biological control of pests is often a key component of integrated pest management strategies; however, the ineffectiveness of biological control tactics has led to heavy reliance on pesticides (Abdollahzadeh et al., 2015).

In the 1980s, the development of sustainable methods for the control of Asiatic rice borer received particular attention by the Crop Protection Organizations of Iran (Asadpour, 2011). In the 1990s, the release of natural enemies, especially *Trichogramma* spp. (Hymenoptera: Trichogrammatidae), was identified as a solution for the control of Asiatic rice borer (Rani, 1998). Thus, biological control was supported and promoted through various governmental incentives, such as the free supply of parasitoid agents to the farmers and the free access to extension services. These incentives were proved crucial for the reduction of pesticide applications in many rice fields of the area (Karamidehkordi and Hashemi, 2010), but despite continuous support for further expansion of biological control in rice fields of northern Iran, the number of farmers who used releases of *Trichogramma* spp. remained relatively small (Veisi et al., 2009). It is argued that this lack of a broad base adoption by the farmers signals a disconnection between policy intentions and farmers' motivations, and therefore extension programs should be designed to address this (Greiner and Gregg, 2011).

Adoption of an innovation is influenced by the characteristics and circumstances of the farmer and the characteristics of the practice, especially its relative advantage over existing practices and landholders' ability to trial the practice (Pannell et al., 2006). Farmers adopt an innovation if they expect that the practice will help them achieve their personal goals, which may include economic, social, and environmental goals. Farmers make land-use decisions not only in a business context (product prices and input costs), but also in a personal context. The personal context refers to intrinsic motivations for decision making (Ingram et al., 2013) and relates to individual and social conditions in which farmers operate, farmers' capabilities, such as knowledge, skills, and power, as well as various psychological dimensions. Obviously, farmers' motivations play an important role in explaining the decision-making process and in shaping adoption behaviors (Ahnström et al., 2009; Greiner and Gregg, 2011; Greiner, 2015). Farmers have a central role in implementing biological control in their farms and therefore understanding their motivations in voluntary schemes is crucial for designing effective policy incentives. Understanding farmers' motivations has received more attention recently, as scientists, advisors, and policy makers consider how to encourage farmers to make changes of various kinds (Greiner et al., 2009).

To date, research on farmers' motivations in relation to biological control adoption remains scarce, with the majority of the available examples relating to the adoption of IPM along with associated barriers, perceptions, and attitudes of farmers (Timprasert et al., 2014; Hussain et al., 2011). These studies suggest that understanding the diversity of motivation is important to promote the adoption of sustainable farming practices. In particular, the type of motivation for the adoption of sustainable practices is related to the characteristics of the farming context and its environmental conditions along with various socio-economic and demographic characteristics of farmers (Ahnström et al., 2009). When these motivations are finally identified, strategies to encourage the development of new technologies may lead to sustainable changes. However, these studies generally analyze actual adoption behavior, rather than the intention to adopt, whereas there is little understanding of the psychological constructs underlying farmers' decisions (Hansson et al., 2012). The need to better understand knowledge systems of farmers has been recognized as a basis for the development of pest management technologies adapted to local farmers' situations (Van Huis and Meerman, 1997; Damalas and Hashemi, 2010; Hashemi and Damalas, 2011). A socio-psychological theory that is pertinent to the analysis of farmers' decisions and behavior is the theory of planned behavior (TPB) (Hansson et al., 2012). In the TPB, human behavior originates from individuals' intentions, which in turn are determined by three central psychological constructs: attitude, subjective norm, and perceived behavioral control. Recently, the Means-End Chain (MEC) approach was used to study the relevant attribute-consequence-value relations through setting up farmers' hierarchical value maps that can facilitate the understanding of farmers' choice of crop protection practices (Lagerkvist et al., 2012). The interesting contribution of the MEC approach is that it offers a way to describe qualitatively what objective (i.e., utility) the growers are maximizing.

The objective of this research was to study farmers' motivations for adopting biological control with *Trichogramma* spp. as an alternative Asiatic rice borer control method. To meet the above goal, two specific research questions were set for this study: i) what motivates farmers to use biological control with *Trichogramma* spp. for Asiatic rice borer control in rice fields and ii) whether there are differences in the motivations for using biological control among farmers with different socio-demographic characteristics. Apart from the formulation of a scale for evaluating motivations in adoption studies of pest management technology, the study aspires to highlight the role of motivations in technology adoption and assist future extension programs in the identification of target groups based on farmers' motivations.

2. Materials and methods

2.1. Study area

The study was carried out in two sub-districts (Mazkoreh and Esfiverd-Shorab) of the central district of Sari county in Mazandaran province (Fig. 1) from August 2014 to April 2015. Mazandaran province is located in the northern part of Iran. This region, also referred to as the rice belt, contains some of the most fertile agricultural land in Iran. The Asiatic rice borer is a major pest problem to sustainable rice production in the area. The choice of the study area was motivated by the predominant use of *Trichogramma* spp. as a strategy for biological control of Asiatic rice borer.

2.2. Sampling and data collection

The target population for this study was defined as the rice farmers who had experience with the use of *Trichogramma* spp. for Asiatic rice borer control. Initially, a list of farmers who used *Trichogramma* spp. for the control of Asiatic rice borer was obtained from the agricultural office of the district and then the accessible population of farmers was defined. A sample of 290 farmers was selected by stratified sampling in the two sub-districts based on the population of farmers (1181 farmers). The sample strata were