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Challenges for efficient land use in rice production of northern Iran: The use of modern cultivars among small-scale farmers

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ABSTRACT

In recent decades, precision technologies and agronomic innovations have spread widely in rice production, but a lag in adoption, particularly in developing countries, is often noted. A survey of 400 rice farmers was conducted on the basis of a structured questionnaire to collect data on the nature and reasoning behind the use of improved rice cultivars by paddy farmers in Guilan Province, Iran. Improved cultivars were used by 42.8% of the farmers. Almost half of the farmers perceived high profitability (55.2%) and high importance (49.8%) of this technology. Nevertheless, a noticeable fraction of the farmers perceived no profitability (14.8%) or no importance (12.5%) of this technology, while 9.8% and 16.2% of the farmers were not aware about these features of the technology. A close cooperation with other farmers about common production problems was observed for most farmers (60.5%). However, most farmers had low cooperation with extension agents (58.5%) and low participation in activities recommended by the local agricultural offices (59.8%). Logistic regression analysis revealed that the adoption of improved cultivars was determined by the perceived profitability of the technology, the perceived importance (necessity) of the technology, the experience in rice growing, and the number of livestock, with a positive relationship. Findings provide opportunities for more efficient land use in rice production by promoting the use of modern rice cultivars among small-scale farmers. Low adoption of improved cultivars is not related to the inappropriateness of the technology, but rather with the inconsistency of the technology with farming socio-economic conditions. Any attempt to promote adoption should consider the role of farmers in the information transfer to other farmers. Providing subsidized long-term facilities to low-income farmers' groups would also promote adoption.

1. Introduction

The recent decades have witnessed a growing interest in new farming technologies for rice production. In this context, the adoption of alternative farming practices by farmers is an attempt to exploit the new technology and accomplish ecological and profitable ways of production using the available physical, chemical, and biological resources (Bigdeli and Sedigi, 2010; Villano et al., 2015). Adoption of new technologies is expected to provide farmers with opportunities for boosting rice production and improving incomes (Mariano et al., 2012; Askary Bozayeh et al., 2017), but the dissemination of new technologies among rural communities will be successful, if they can change knowledge, attitudes, and behavior of farmers, so that the new technologies can be ultimately adopted. One major reason for the limited adoption of agricultural technologies is often farmers' unawareness of the agricultural technologies and the lack of appropriate promotion of innovations (Kalantari and Khadem Adam, 1997; Simtowe et al., 2016). Potential remedies lie in the promotion of agricultural innovations that improve agricultural productivity and thus increase the efficiency of smallholder agriculture.

Guilan Province enjoys unique attributes for the agricultural sector owing to its moderate climate and fertile lands for crop cultivation. Among various agricultural activities, the province has a dominant role in rice production that has long been known as a strategic commodity in the area (Keshavarz et al., 2010; Golichenari et al., 2014a, b). A large part of the rice fields in Iran is still under local varieties, because of their excellent quality traits (Rani, 1998). However, low yields (averaging 2.5 to 3.5 tonnes per ha) as well as lodging and susceptibility to blast (*Pyricularia grisea*) and stem borer (*Chilo* spp.) limit production. One way to enhance return per unit area is to use new technologies

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Table 1
Most common improved varieties in paddy fields of Guilan Province.

Variety	Aroma	Kernel length (mm)	Amylose content (%)	Paddy yield (kg/ha)	Resistance level	
					Rice Blast	Stem borer
Khazar	None	7.39	24.9	5000-6000	R	MR
Sepeed rood	None	7.28	27.2	6500-7000	R	S
Kadous	None	8.06	23.8	5500-6000	R	R
Gohar	Strong	8.20	23.8	8500-9000	MR	-
Gil 1	Strong	7.10	28.0	4000-4500	R	-
Gil 3	Strong	7.50	26.0	5000-5500	R	-
Bejar	Medium	6.00	25.1	6500-7000	R	-

R: resistant; MR: moderately resistant; S: susceptible.

(Dinpanah et al., 2009; Khonje et al., 2015). The use of appropriate technologies, in addition to generating significant growth in agricultural production, may reduce production costs and entail economical savings. After the establishment of Rice Research Institute of Iran in 1993, the main target was related to research activities for the development of modern rice varieties that produce high yield and are resistant to diseases and pests. The most common improved rice cultivars used in paddy fields of Guilan Province along with basic characteristics are illustrated in Table 1. However, farmers are often unwilling to adopt new technologies because various environmental, organizational, and socio-economic factors place barriers against adoption (Mariano et al., 2012).

The analysis of technology adoption is a very common topic in the literature. For example, in many Asian countries, the advent of the Green Revolution compelled many researchers to focus on the acceptance of agricultural innovations (Mariano et al., 2012). Education, experience, and the relationship with agricultural extension services affected positively the use of modern rice varieties in Nepal (Joshi and Pandy, 2005). Analyzing the adoption of modern rice varieties in southwestern Nigeria showed that land ownership, contact with extension agents, and cropping area had a significant positive effect on the adoption of the improved cultivars, while there was not a significant difference between adopters and non-adopters in terms of gender, type of agronomic system (e.g., monocropping or intercropping), and membership in associations (Saka et al., 2005). Education, land size, and experience in maize growing positively and significantly affected the adoption of hybrid maize varieties in Punjab, Pakistan (Iqbal et al., 1999). However, the age of farmers did not have a significant effect on hybrid maize varieties' adoption. The adoption of high-yielding cultivars was negatively impacted by uncertainty in the price of seed at the time of sale, low quality and marketability of high-yielding varieties, low profitability in comparison with local cultivars, lack of timely supply of inputs, long cropping period, high water and fertilizer requirements, and susceptibility to pests and diseases, which acted as inhibitors (Keshavarz et al., 2010). Seed availability and absence of seed policy were found as bottlenecks in rice production increase in Tillabéry, Niger (Sow et al., 2015). A recent study in Ghana recommended increasing farmers' education, ensuring access to extension services, and improving varietal characteristics for increasing farmers' adoption of improved maize varieties (Alhassan et al., 2016).

Due to the saturation of the cropping area and the constraints on the expansion of rice farm lands in Guilan Province, the attempts to increase rice production should focus on methods that can increase yield per unit area as the main choice in the agenda. Among the various methods of yield improvement, the use of modern inputs, including improved varieties, can be very promising. Nevertheless, adoption rates are always challenged by the design of the transfer process to the target community, which is characterized by its own features. Therefore, the determination of factors contributing to adoption of improved cultivars among farmers is necessary for the implementation of policy control measures to improve livelihoods through sustainable rice production. The aim of the current study was to explore what drives farmers to use of improved cultivars in the eastern part of Guilan Province. Findings are expected to shed some light on how this technology could be promoted among farmers and may have important implications for seed delivery systems in the study area.

2. Materials and methods

2.1. Study site

The study was conducted in Rudsar County of Guilan Province in northern Iran. Rudsar County is located in the eastern part of Guilan Province. The county has an area of 1,354 km^2, of which 18,878 ha are devoted to agricultural land. An area of 7,053 ha is cultivated with paddy rice, producing 26,224 tonnes of rice. The statistical population of this study consisted of all farmers living in Rudsar County, including farmers who adopted the technology of improved varieties and farmers who did not.

2.2. Sample selection

To determine sample size required for the study, the least sample size table needed for a definite community with categorical data provided by Bartlett et al. (2001) was used. Accordingly, the sample size of the research was determined to be 370 people. To avoid errors due to questionnaire non-return, an additional 10% of the determined number of participants was included, resulting in 400 farmers as the final sample size of the study.

2.3. Survey tool and data collection

After a comprehensive review of literature (Joshi and Pandy, 2005; Keshavarz et al., 2010; Sow et al., 2015) a questionnaire was developed as the main tool of the research. The questionnaire included the dependent variable of the adoption or non-adoption of improved cultivars (adopter = 1 and non-adopter = 0) and the independent variables of personal, economic, social, and technical-agricultural attributes. Social cooperation of farmers was evaluated on a five-point Likert-type scale as: very low, low, moderate (fair), high, and very high. Social participation can be broadly defined as a person's involvement in activities that provide interaction with other individuals. Also, the profitability and importance of improved cultivars as well as the usefulness of information resources were evaluated on a five-point Likert-type scale from none to very high. Profitability refers to how much the technology can boost farmers' financial interests, while importance refers to the usefulness and extent of necessity of the technology to the farmers. The content (face) validity of the questionnaire was determined by faculty members of the Agricultural Management Department of Mohaghegh Ardabili University, professors of agricultural extension and agronomy in Islamic Azad University of Rasht, and experts of Jihad-e-Agriculture Organization. To determine the reliability of the questionnaire, a