



Integrated management of agricultural water resources among paddy farmers in northern Iran

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ARTICLE INFO

Article history:

Received 24 April 2017

Received in revised form

28 December 2017

Accepted 29 December 2017

Keywords:

Rice

Water resources

Cropping pattern

Post-rice succession planting

ABSTRACT

While growing populations and increasing water requirements are a certainty, there is a big uncertainty about how these requirements will be affected by human activities. Given the importance of integrated management as a tool for optimum management of water resources by farmers under water deficit conditions, the general objective of the present study was to identify factors underpinning integrated management of agricultural water by paddy farmers in Langarud County of Guilan Province in northern Iran. For this purpose, a survey of paddy farmers was conducted. The irrigation canals were the most widely used source of water in local paddy farms (44.0%) followed by rivers (28.1%). The majority of the paddy farmers (70.6%) were using more than one water resource for irrigating their fields. The farmers believed that 'post-rice succession planting', 'cropping pattern and land use change', and 'fuel subsidy' were the most important factors affecting integrated management of agricultural water. Using exploratory factor analysis, five factors affecting integrated management of agricultural water among paddy farmers were revealed: i) availability of irrigation infrastructure, ii) cropping pattern, iii) supportive role of local institutes, iv) irrigation experience, and v) traditional beliefs. These factors together captured 60.1% of the total variance in the management of agricultural water. According to cluster analysis and factors identified by factor analysis, paddy farmers using integrated water resources were classified in three clusters: i) modernists (37.1%) who showed the strongest motivation response to changes and they generally showed a high reaction to most motivational factors, ii) conservatives (34.7%) who tended to resist the change and were more satisfied with the current conditions, and iii) holists (28.2%) who showed a favorable response to motivational factors, but they were not pioneers. The findings provide a better understanding of paddy farmers' drivers for integrated management of agricultural water that could assist policy-makers to focus on strategies for improving irrigation water productivity and supporting more sustainable water use in rice production in the study area and similar arid cropping regions of the world.

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1. Introduction

Water is a shared resource with multiple functions, uses, and merits (Ballester and Mott Lacroix, 2016). Today, this resource confronts serious environmental, economic, social, and political challenges in the Middle East (Shevah, 2013). In this context, experts express their concern that the exploitation of water resources in Iran without caring for their limitations would pose grave prob-

lems for the country (Madani, 2014; Charkhestani et al., 2016). The limitations of water resources in Iran along with their overexploitation, especially in rice farms, have revealed the pressing need for improving the use efficiency of this precious input in rice farms (Darijani et al., 2012). Water productivity deals with the role of each water unit in the gross domestic product. If water use is seen from this perspective, then the efficiency of water use in its productivity is very low in Iran (Alizadeh, 2001). Under these conditions, the biggest challenge to the agricultural sector lies in improving water productivity and water use efficiency (Cai et al., 2011).

In Iran, water has a very heterogeneous spatial distribution due to natural climatic conditions and resultant temporal distribution of rainfall. The amount of precipitation varies across years and even

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seasons, posing problems to different sectors, including the agricultural sector and the supply of drinking water in urban areas in recent years, causing substantial economic losses to these sectors. The province of Guilan possesses about 7.7% of the renewable water of Iran. The amount of renewable water is around 10 billion m³ and the total water demand of rice farms is around 3 billion m³ in Guilan Province. Although the total surface water inflow to the province constitutes about 30% of the total water input, this amount of water by itself supplies about 72% of the current water requirements of rice farms (Guilan Irrigation and Drainage Network Exploitation Firm, 2011). However, the construction of multiple dams on the branches of Sefid-Rud River has affected the quantity and quality of irrigation water available to most rice farms in Guilan Province, so that if methods, e.g. water productivity improvement, are not adopted, not only will the economy of Guilan confront serious challenges, but also one of the main producing regions of this strategic crop in Iran will be jeopardized.

Nearly 171,000 ha of Guilan rice farms are covered by an irrigation network of Sefid-Rud River and 66,903 ha are irrigated traditionally by permanent or seasonal streams, barrages, springs, and wells. The total water requirement of rice farms in Guilan is estimated at 3 billion m³ per year (Guilan Irrigation and Drainage Network Exploitation Firm, 2013). Given the direct employment of over 300,000 users in the rice farming sector and its gross production of over 42,000 billion IRR (Iranian Rial), it can be said that Guilan economy is based on rice production (Jahad-e Agriculture Organization, 2013). Therefore, it is imperative to pay attention to the sound management of water resource exploitations, the groundwater recharge, the retention of the surface waters, and the improved management of water use and its productivity enhancement. Integrated management of water resources can be the least, but a serious step. In some parts, the overexploitation of water resources has increased the risk of degradation. Overall, the use of water by the agricultural sector is not optimum in Iran. Langarud County of Guilan Province is not an exception, even though the economics and subsistence of this county are based on agriculture. The main approach to cope with these issues is to reduce use and adopt water conservation measures in the agricultural sector. One strategy is to adhere to integrated management of agricultural water resources. Integrated exploitation of surface and ground water resources is a step towards sustainable use of water resources (Hu et al., 2014).

While the theoretical knowledge of optimal rice cultivation methods has increased, the understanding of farmers' attitudes towards water management in rice remains poor. However, a given policy is likely to elicit a range of responses among individual farmers (Mayberry et al., 2005). Farmers are key stakeholders in the use of water for irrigation, but their position at the end of the water chain means that they are often marginalized in water resource decision-making processes (Huibers and van Lier, 2005). From this point of view, an understanding of the heterogeneity of farmers may shed a light on particular policy options, whereas a failure to appreciate the range and complexity of behavioural drivers among farmers may lead to a failure of water management policies (Yazdanpanah et al., 2014). To date, there is very limited literature available concerning factors underpinning integrated management of agricultural water by paddy farmers in Langarud County of Guilan Province in northern Iran. Thus, given the importance of integrated management of agricultural water resources by paddy growers in Langarud County, Guilan Province, the objective of the present study was to identify factors underpinning integrated management of agricultural water among local paddy farmers. Findings would be useful to policy-makers in designing strategies for enhancing water productivity of irrigation in rice, while reducing potential groundwater depletion in the study region and similar arid production regions in the world.

2. Materials and methods

2.1. Study area

The study was conducted in Langarud County of Guilan Province in northern Iran. With an area of 438 km², Langarud County is located to the east of Guilan Province, limited by the Caspian Sea from the north. The county has a plain and a mountainous part located to the south. The slopes of this part are covered with forests up to the altitude of about 1,300 m, where the sea humidity can reach, but it is covered with natural pastures in higher altitudes with no trees due to low temperatures and humidity. Out of 9,100 ha of paddy farms in Langarud, 7,600 ha are irrigated with a modern integrated system and 1,500 ha by a traditional system in which 700 ha are fed from the Shelmanrud and Barkely rivers in Otaqvar District and 800 ha from pools, wells, and small streams in Kumeleh District.

2.2. Sampling strategy

The statistical population of this study composed of all paddy farmers in Langarud County of Guilan Province in northern Iran. This county is composed of three districts (Markazi, Kumeleh, and Otaqvar) and eight *Dehestan* (village groups). The respondents were selected by multistage cluster sampling using the table of Krejcie and Morgan (1970) and considering the least sample size for factor analysis. Then, 360 questionnaires were administered to the paddy farmers of Langarud County (in proportion to the population share of each district), considering a margin of error 3% and alpha 5%. Finally, 347 filled-out questionnaires were received and included in the data analysis.

2.3. Data collection

Data about integrated management of agricultural water resources were collected by a questionnaire composed of some closed-ended questions. The section concerning factors underpinning the integrated management of water resources composed of 27 items. The respondents were asked to show the extent of their agreement about each item on a five-point Likert-type scale (very high to very low). In addition, the questionnaire had some demographic variables, including age, gender, education, family size, number of members active in paddy production, experience in agriculture, total farm area, paddy farm area, number of farm lots, type of paddy farm ownership, agricultural activities other than rice farming, and type of irrigation resource. Content and face validity of the questionnaire were assessed. To ensure content and face validity, the remarks made by professors of the Agricultural Management Department of Islamic Azad University of Rasht, experts of the Rice Research Institute of Iran, and experts of the Jahad-e Agriculture Organization of Guilan Province were applied to the questionnaire. The reliability was estimated by Cronbach's alpha at 0.916, showing a high reliability of the questionnaire. The type of irrigation water resources was used as a grouping variable and the respondents were asked to check the type of resource they used among irrigation canal network, river, spring, well, and pool (pond). The respondents were allowed to check more than one choice. Then, they were included in our analysis as paddy farmers using integrated irrigation resources.

2.4. Data analysis

Descriptive statistics (frequency distributions, means, and standard deviations) were calculated. Also, the variables for which the respondents could check more than one choice were included in multiple response analysis. The variables influencing integrated

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