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The Utility of Discriminant Analysis for Predicting Farmers' Intentions to Participate in Farmer-Managed Irrigation Systems in Iran

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Abstract: Participatory irrigation management has been problematic in most parts of the world and Iran has been no exception. The purpose of this study was to assess farmers' intentions to participate in irrigation management based on selected variables using discriminant analysis. A survey questionnaire was used to collect information from a sample of Water Cooperatives in Javanrood Townships using stratified random sampling (n = 106). Results indicated that age, educational level, attitude towards PIM, irrigation performance, landholding size, agricultural and non-agricultural income affected farmers' intentions to participate in irrigation management.

Key words: Irrigation, participation, water cooperatives, Iran, intention

INTRODUCTION

Water resource development is essential to maintain food security in the world. In order to feed the world's growing population, irrigation lands should expand. Thus the irrigated area in the world has reached 260 million hectare (Dorsan *et al*., 2004) which is nearly five times more than the amount that existed at the beginning of the twentieth century. At present, irrigated area in the world accounts for 15% of the total area, but contributes 40% of the total agricultural production (FAO, 2001). This dazzling benefit encouraged many countries, especially developing countries, to create more and more irrigation facilities. The results of those irrigation development projects did not achieve 100% success, as most of them were managed by the government where farmers' participation was lacking (Haydarian, 2007). During the 1980s and early 1990s, governments started to realize the significance of farmers' participation in management of irrigation systems in view of sharing the costs and contributing towards maintenance (Tanaka and Sato, 2005; Yercan, 2003; Sato *et al*., 2007; Wegerich, 2001). This kind of concept was adopted by many countries as a Participatory Irrigation Management (PIM). The purpose of PIM was to involve farmers in irrigation management including operation and maintenance. The merits of PIM were to decrease wasteful use of water (Tanaka and Sato, 2005), improve the efficiency, productivity and sustainability of irrigation (Koc *et al*., 2006; Gallati *et al*., 2006), improve the reliability of the system and increase cultivated area (Fami *et al*., 2007). Despite the widespread adoption of management transfer programs, there is still little information about their impact on the agricultural performance of irrigated systems. A review of turnover impact studies conducted by Koc *et al*. (2006) revealed that turnover has neither improved nor interfered with agricultural productivity. Other studies in irrigation management transfer in Asia have also shown a modest contribution of water user groups maintenance of irrigation systems (Koc *et al*., 2006). Some countries, such as Turkey and Mexico, have made success in establishing PIM-based projects, while other countries, especially monsoon-Asian countries, are yet to achieve their goal (Haydarian, 2007).

In Iran, a great portion of the irrigated area was controlled by public enterprises until the beginning of the 1991. Since then, it has been well understood that irrigation projects without the participation of farmers is proved ineffective. Thus, many institutional organizations such as Water Cooperatives were established in order to take on a greater role in replacing the farmer emphasis on the state as the central actor in developing and managing irrigation systems. However, despite the widespread establishment of Water Cooperatives across the country, the impact is not noticeable in terms of farmers' participation. The failure of the participatory irrigation management in Iran rest with the fact that very little attention was given to understanding how collective action arises to deal with farmer-managed irrigation systems and how it is sustained. Without addressing this critical question, the current policies to develop participatory irrigation management risk failure.

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Although much has been written on definition of collective action, what most definitions have in common is that collective action requires the involvement of a group of people, it requires a shared interest within the group and it involves some kind of common action that works in pursuit of that shared interest (Meinzen-Dick *et al*., 2004). Because participatory irrigation management is a dynamic process that relates to social relationships, it can be considered as a collective action with large number of variables affecting it. Among parameters that determine farmers' motivation for collective action is intentions towards a particular action (Gallati *et al*., 2006). According to the theory of reasoned action and planned behavior (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975) intentions are assumed to capture the motivational factors that influence a behavior; they are indicators of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior. As a general rule, the stronger the intention to engage in a behavior, the more likely should be its performance.

Former studies have already discussed problems or challenges in participatory irrigation management (Tanaka and Sato, 2005; Koc *et al*., 2006; Facon, 2007; Fami *et al*., 2007; Keremare *et al*., 2006). Because empirical studies of intentions to participatory irrigation management are rare, the main objective of this study is to determine the potential adopters of participatory irrigation management projects based on farmers' personal and professional characteristics. The specific objective was to identify personal and professional characteristics that would discriminate farmers' intentions towards participatory irrigation management in Kermanshah province.

MATERIALS AND METHODS

The study was conducted in 2005 in a small township of Javanrood in Kermanshah province. Javanrood has an area of 772 km^2 and is 1300 m above the sea level with 2712 irrigated land. The target population (N = 262) included farmers who were members of Sarab-bas and Sefid-barg Water Cooperatives. Using stratified random sampling procedures, 37 farmers were selected from Sarab-bas and 66 farmers were selected from Sefid-barg Water Cooperatives following the formula set up by Krejcie and Morgan (1970) with a 5% margin of error. A total of 103 farmer members were interviewed. The questionnaire was developed by the researcher. It contained 52 questions and was organized into six sections (demographic information, personal characteristics, attitude towards PIM, satisfaction towards PIM, incentives for participation and intentions towards PIM). A variety of question types were used including Likert-type items, closed-ended questions and open-ended questions. Content and face validity for the questionnaire were established by a panel of experts from Razi University faculty in Department of Agricultural Extension and Education and Water Cooperative experts in Agricultural Organization in Kermanshah province. To test for reliability, the questionnaire was pilot tested with a group of 30 members of Water Cooperatives not targeted in the study. Cronbach's alpha was calculated on data received and resulted in a coefficient of 0.70.

Using SPSS for Windows 7.0, stepwise discriminate analysis was conducted to determine if a linear combination of variables would be identified that maximally discriminate farmers' intentions towards participatory irrigation management. Discriminant analysis can be used to classify cases into one of several groups on the basis of two or more measurements (Todman and Dugard, 2007). In our context, farmers represent our cases and they are grouped as those with intentions to participate and those without intentions. Furthermore, they were grouped on the basis of their personal and professional characteristics. The selection of variables to be included in the discriminant analysis was conducted by examining significant univariate analysis. Those variables not yielding significance ($p \leq 0.05$) were deleted prior to the multivariate analysis. Moreover, descriptive statistics were used to describe the data and sample. Pearson product moment correlations were computed to assess the degree of relationship among variables.

RESULTS AND DISCUSSION

The average age of the farmers was 52 years old. As for educational level, the majority of farmers (61%) were illiterate and 27% had basic skills in reading and writing. Mean monthly household income of respondents from agricultural employment was $150.00 while non-agricultural employment was $120.00. Farmers indicated that almost 80% were working in agricultural related fields and the remainder (20%) was involved in non-agricultural occupations. Farmers were asked to indicate their major source of water in their farming practices. Results indicated that the majority of farmers (83%) used irrigation networks as their major source of water and 17% used nearby river to irrigate their fields. Descriptive statistics for landholding size among farmers revealed that farmers owned an average of 2.4 and 1.7 ha of rain-fed farming and irrigated farming, respectively.

Farmers' satisfaction towards performance of irrigation facilities was measured using 5 questions based

on a five-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). The mean values for 5 items ranged from 4.23 to 1.98. The item "there is a lot of conflict about water delivery among farmers" received the highest mean value (M = 4.23), followed by "irrigation management is the major problem among water users" (M = 3.76), "water distribution is fair" (M = 2.57), "water fee is fair" (M = 2.05) and "physical condition of irrigation systems are appropriate" (M = 1.98). Overall, farmers were somewhat satisfied with performance of irrigation systems.

Farmers' attitude towards participatory irrigation management was assessed using 15 questions based on a five-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). The mean values for 15 items ranged from 4.73 to 1.45. The item "irrigation networks belong to the government" received the highest mean value (M = 4.73), followed by "management of irrigation network is the responsibility of government" with a mean value of 4.72. The respondents tended to slightly agree with the items "farmers' participation would enhance management of irrigation networks" (M = 3.80) and "farmers' participation in irrigation management would enhance water use efficiency" (M = 3.72). The respondents disagreed with the items "farmers have the ability to manage irrigation facilities" (M = 1.73) followed by "farmers can pay water fees" (M = 1.45). In order to measure the overall attitude of farmers towards participatory irrigation management, a scale was developed based on summation across the 15 items. Scores were categorized according to the following standards: scores ranging from 22-29, negative; 30-37, somewhat positive; 38-42, positive and 43-58, very positive. The mean value of the overall attitude of the farmers towards participatory irrigation management was 35.54; the standard deviation was 6.605. This overall value to participatory irrigation management indicates that the farmers generally had a somewhat positive attitude towards participatory irrigation management.

Farmers' intent to participate in irrigation management was measured by the farmers' response to the question "to what extent do you think Water Cooperatives should operate and maintain irrigation networks?" A majority (53%, n = 54) of farmers responded negatively whereas 47% (n = 49) responded positively. Nineteen independent variables were examined for possible relationships with farmers' intent to participate in irrigation management. Of these nineteen variables, ten were significantly related to the dependent variable with magnitudes ranging from moderate to high.

Stepwise discriminant analysis was used to determine if a linear combination of the ten significantly correlated variables could be used to predict farmers' intentions towards participatory irrigation management. Out of 103 cases, 94 were used in discriminant analysis, due to missing data on the discriminating variable. Of these, 52 belonged to groups without intention to participate and 42 with intention to participate. The mean discriminant score (centroid) for groups with intent to participate (1.33) was significantly different from the mean discriminant score for groups without intent to participate (-1.21) (Wilks' λ = 0.37, Chi-square (7df) = 95.05, $p<0.10$). The analysis resulted in an eigenvalue of 1.65 and a canonical correlation of 0.78. The most distinguishing characteristics of farmers with intention to participate in irrigation management schemes, when compared with farmers without intention to participate in irrigation management schemes, can be determined by examining the standardized discriminant function coefficients (Table 1).

Table 1: Summary of data from the discriminant analysis procedure, predicting farmers' intention to participate in irrigation management

Variables	b	Group	Centroids
Age	-0.35	Farmers with intention to participate	1.33
Landholding	-0.67	Farmers without intention to participate	-1.21
Education	-0.65		
Agricultural income	0.58		
Non-agricultural income	0.43		
Attitude	0.48		
Irrigation performance	0.50		
Eigenvalue	Rc	Wilks' λ	
1.65	0.78	0.37	$p<0.10$

Farmers that intent to participate in irrigation management tend to be younger; are more likely to be smallholders operating rain-fed farming, have less education, earn higher income from both agricultural and non-agricultural practices, have positive attitude towards participatory irrigation management and are more satisfied with performance of irrigation systems than those who do not intent to participate in irrigation management schemes. The discriminant analysis resulted in an overall correct classification rate of 91.3%. Intentions to participate were correctly classified 79% of the time whereas no intentions to participate were correctly classified 70% of the time. Random assignments of farmers to groups with intention to participate would result in correct classification 50% of the time. Classification of farmers using the seven discriminating variables resulted in 53% fewer errors than would be expected from random classification (tau = 0.53).

This study was concerned with farmers' intention to participate in farmer-managed irrigation systems. The result of discriminant analysis clearly showed that farmers with and without intentions could be differentiated.

Moreover, results revealed that younger farmers are more inclined to participate than their older counterparts. This might be due to the fact that older farmers are more conservative and slow in adoption of innovations. These results are consistent with findings of Prasad Bhatta *et al.* (2006) and Serunkuma *et al.* (2004). Interestingly, small scale and rain-fed farmers were among the groups with more intention to participate. However, this is not in line with findings of Bagadion (2000); Wegerich (2001) and Serunkuma *et al.* (2004). These researchers found that irrigated farmers are more interested to participate in irrigation management schemes than rain-fed farmers. One possible explanation for this is opportunistic behavior that is a permanent challenge to collective irrigation management. As pointed out by Theesfeld (2001), opportunistic behaviors occur quite frequently in irrigation systems because irrigation institutions create many of such opportunities. Because of unreliability of rainfall in Iran, most dry farmers operate on a minimum input system. Over the years they have also learned that the better the rains are, the higher the yields are. Consequently when there is an opportunity to participate in water management, dry farmers have tendency to participate in the hope of getting a fair share of water resources.

In contrast with other studies, less educated farmers in this study had more motivation to participate in irrigation schemes than higher educated farmers. Studies of Prasad Bhatta *et al.* (2006) proved the opposite: higher educated farmers had more intentions to take part in participatory irrigation management. However, findings of Serunkuma *et al.* (2004) revealed that more educated farmers tend to be preoccupied with non-agricultural activities, thus making them less motivated to participate in local collective actions. Findings also suggest that farmers with higher agricultural and non-agricultural income had more intention to participate than did low income farmers. This is in line with previous studies describing more participation in water management among economically advantaged farmers (Bagadion, 2000; Wegerich, 2001).

Furthermore, as demonstrated in this study, intention to participate in water management was more among farmers who were satisfied with performance of irrigation systems. This is in line with findings of Joshi and Hooja (2000) and Koc *et al.* (2006) who concluded that worn-out of irrigation schemes as well as problems with irrigation scheduling decreased the motivation of water users to participate in water management. They further suggested that inadequate funds allocated to maintenance and repair along with aged and worn-out irrigation facilities had a negative influence on farmers' participation in government-based irrigation schemes.

Finally, farmers had positive attitude towards participatory irrigation management. According to Ajzen (1991), the more favorable the attitude with respect to a behavior, the stronger should be an individual's intention to perform the behavior under consideration. This supports previous studies describing attitude as a crucial element for the success of participatory irrigation management (Smith, 2001; Serunkuma *et al.*, 2004; Toma and Mathijs, 2005).

CONCLUSION

This study filled an important gap in water management schemes by identifying potential adopters of participatory irrigation management. It was found that farmers who intent to participate in irrigation management tend to be younger; are more likely to be smallholders operating rain-fed farming, have less education, earn higher income from both agricultural and non-agricultural practices, have positive attitude towards participatory irrigation management and are more satisfied with performance of irrigation systems than those who do not intent to participate in irrigation management schemes.

Based on the findings, the following recommendations are made:

Intervention strategies for PIM should be guided by farmers' age, education, landholdings, rain-fed/irrigated farms, income and attitude toward PIM

Before handing over irrigation projects, opportunities should be provided for farmers to visit successful project in order to increase their level of satisfaction with performance of irrigation systems.

Although caution needs to be exercised in generalizing the findings of anyone study, the results of this research suggest that it may be possible to predict farmers' intention to participate in irrigation management with reasonable amount of accuracy.

In closing, the importance of who will participate in irrigation management is emphasized. If Iranian irrigation policy makers are to overcome the current failure in participatory irrigation management, they need to identify the potential adopters based on their professional and personal characteristics. Furthermore, as demonstrated in this study, in those situations in which professional and personal characteristics of farmers are appropriate criteria, discriminant analysis is particularly useful statistical tool for estimating potential adopters of participatory irrigation management.

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