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Full Length Research Paper

Adoption and non-adoption of sprinkler irrigation technology in Ardabil Province of Iran

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This survey study was carried out to identify the adoption, discontinuance and non adoption of sprinkler irrigation systems among farmers who were trained to apply those in Ardabil Province of Iran. Farmers were divided into 3 groups as: adopters, abandoners after adoption and non-adopters. A sample of 160 farmers, including 20 adopters, 80 abandoners and 60 non-adopters were randomly selected. Results show that no significant differences among three studied groups exist regarding access to agricultural research and extension service centers. Adopters had lower farming experiences however, were more educated, having larger farm sizes including irrigated and rainfed lands, with more fragments and less distances among them. They were more informed about irrigation methods specially, sprinkler systems than the other two groups. Such awareness enabled them to solve problems occurred after installation of equipments in their farms. On the other hand, weakness of awareness had affected abandoners` decisions to reject the technology. Nevertheless, all of the respondents showed positive attitude towards optimum use of irrigation water. Significant relationships exist among contact with agricultural experts and extension agents as well as training programs of radio, TV and adoption behaviors. Meanwhile, differences among groups regarding ability to read written materials on irrigation were statistically significant. Overall, farmer's reasons for adopting and non-adopting of sprinkler systems were classified.

Key words: Water policy, water efficiency, water allocation, sprinkler irrigation.

INTRODUCTION

Iran is located in arid and semi- arid regions with average annual precipitation of 250 mm. In these regions the main constraint for agricultural development is water shortage (Kardavani, 1996). Despite the water shortage, irrigation is usually carried out through surface methods with the maximum efficiency not more than 30 to 40% (Kohansal and Rafiei, 2008). Improved water use efficiency in agriculture is advocated to reduce water use among existing users and to increase the supply available for new users (Bjornlund et al., 2008). In recent years government has been trying to extend Sprinkler systems, however because of technocratic view without holistic approach, its' adoption has encountered with several problems (Karami, 2006).

Previous studies indicated that different factors affect technology adoption. For example, knowledge and understanding of farmers, the amount of water that is needed, yield, slope and quality of soil, farm situation, resources conditions (energy, water and soil), farmers characteristics (education, experience, managerial ability), land ownership, productions, farm size and etc influence non adoption of irrigation technology (Whittlesey, 2003; Marques et al., 2005; Blanke et al., 2007; Bjornlund et al., 2008).

By considering previous studies from different parts of Iran (Jafari and Torkamani, 1998; Karbasi, 2001; Hayati and Lari, 2000; Jahannama, 2001; Karami, 2006), various factors affect decision of sprinkler systems which generally can be categorized as economical, social, managerial, technical and extension educational factors. These studies emphasized that several issues were affecting adoption, abandonment and non-adoption of these systems. Special emphasis of studies was considered less in farmers' training and supervision on corporations' performance of equipments and supportive services. None of the conducted studies were in Ardabil Province.

thus, this study aimed to determine factors influencing

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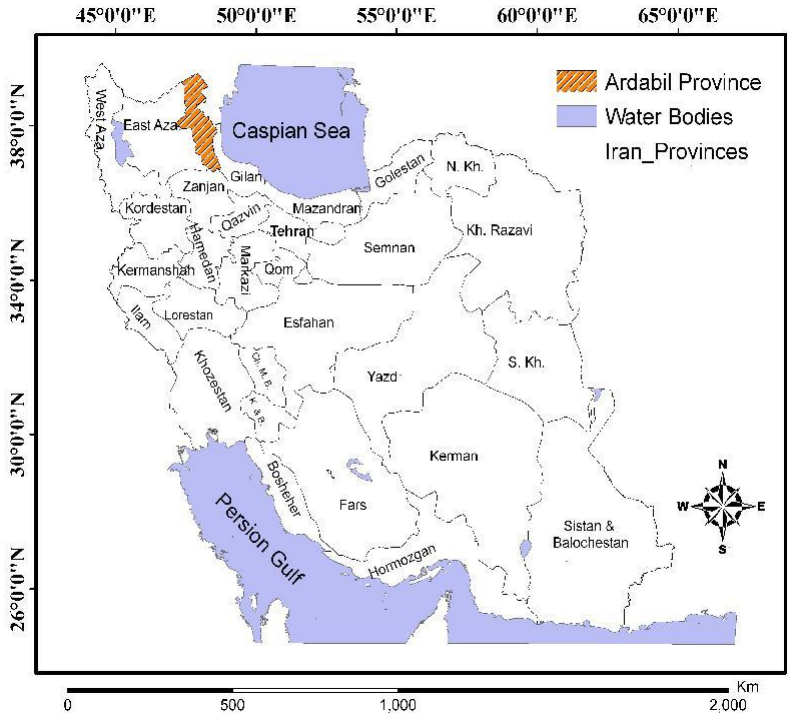

Figure 1. The study area (Ardabil Province).

adopters, abandoners and non adaptors of the sprinkler irrigation among farmers of this Province.

MATERIALS AND METHODS

This study was conducted on 21 villages from 9 townships of Ardabil province (37°04 to 39°42 N. and 47° 02 to 48° 55 E.), which is located in North-West of Iran (Figure 1). The main reason for selecting the study area was its problematic situation regarding adoption and use of sprinkler systems. To alleviate the problem of frequent drought and water shortages, the Ministry of Agriculture has launched an extension campaign to promote sprinkler systems. Agricultural and Extension Centers had been allocated a quota of the systems to extend in Ardabil Province. Despite more than two decades of advocating extension approaches, Ardabil's sprinkler irrigation campaign has encountered to a complicated situation and a study was needed to find solutions of the problem. Although there is no official record, this province had disappointing discontinuance because at the time of the study only 20 farmers had been using the systems.

Descriptive survey design for data collection was adopted in this study. The population of the study was 600 farmers, who have been trained to apply sprinkler irrigation systems. The samples included 160 farmers that were determined using Cochran formula. Stratified random sampling method was used in the selection of the respondents. These farmers were divided into three groups: 1) adopters, who had been using the systems in their farms when the research was undertaken (20 farmers); 2) abandoners, who rejected systems after adoption; they removed systems' equipments from their farms after installation (60 farmers) and 3) non adopters, who did not have willingness to apply and use of systems after initial request (80 farmers).

The instrument of the study was a questionnaire including fixed response and open-ended questions. In the questionnaire regarding education, farmers were classified into three groups: illiterate, low literate and literate and then the latter group was divided into three sub-groups consisting technician, Bachelor and Master of Science. In order to study the relationships between farmers' awareness of irrigation methods and their adoption behavior, farmers were asked to list at least one advantage and drawback for five kinds of irrigation (including sprinkler). They were scored according to responses. To study the relationships between access to information sources and adoption behavior, the respondents were asked about access to seven information sources, namely: visiting from demonstrative fields, visiting from agro- industrial corporation farms, studying extension publications on irrigation, studying irrigation books, listening radio's agricultural programs, watching TV's agricultural programs, advisory contact with agricultural and extension experts. In regard with distance of farms from water sources, respondents were divided into three groups: near (less than 100 m), medium (100 to 500 m) and far (more than 500 m).

To validate the instrument, the content validity was used. The instrument was validated by a panel of experts of university staff members and two experienced extension agronomy and irrigation specialists of the research area. Initially, a pilot study was conducted in two villages with collaboration of 30 people. However, Cronbach's alpha computed to measure the reliability of the instrument and alpha value was 0.86. Having the tested questionnaire for validity and reliability it was filled out by researchers. Data were analyzed using SPSS v. 11.5.

RESULTS AND DISCUSSION

Demographic results of the study showed that respondents' mean age and farming experiences were 50.68 and 35.12. Their average household number was 8.56. The average size of their land holding (irrigated and

Table 1. ANOVA to compare respondents groups.

Classifying variable	F	P
Distance from extension center	0.06	0.94
Distances from research station	1.44	0.24
Distances from agric. manage.	0.66	0.52
Age	1.01	0.34
Farming experience	4.66	0.01**
Household number	3.36	0.04*
Farm land size	5.51	0.01*
Irrigated farm area	0.85	0.43
Rain-fed farm area	4.38	0.01**
Land fragments	6.22	0.01*

* ρ <0.05 ** : ρ <0.01.

Table 2. Kruskal-Wallis H tests to compare groups for access to information sources.

	Visit demonstrative fields	Visit agro-indust. farms	Study ext. pub.about irrig.	Study irrig. books	Listen radio agric. programs	Watch TV agric. programs	Advisory contact with agric. Ext.experts
^{2}	3.225	2.449	10.955	16.208	1.178	0.027	0.198
P	0.199	0.294	0.004**	0.001**	0.555	0.986	0.906

* ρ < 0.05; ** : ρ <0.01.

rain-fed) was 21.58 ha. Distances between their villages and county agricultural extension center, research station and township agricultural management were 6.76, 38.48 and 20.57 km, respectively.

In the case of access to the agricultural information centers, as Table 1 depicts, there was no significant difference among 3 groups of respondents. Regarding farmers' age, the majority of them were aged. However, there was significant difference among farming experiences as reported by other studies in Iran (Hayati and Lari, 2000; Jahannama, 2001).

The most of modern agricultural technologies are labor saving which decrease farm labor requirement. To study whether the number of family farm labor was a significant factor in technology adoption or not, three groups were compared. Table 1 shows there were significant differences among the three groups. Adopters had smaller households. Therefore sprinkler irrigation could solve the limitation of farming labor requirements and increase their productivity. Moreover, this technology could decrease the opportunity costs. In agreement with some studies (Hayati and Lari, 2000; Karbasi, 2001; Bjornlund et al., 2008), the result of ^{2} test shows that education has significant effect on adoption behavior (p = 0.01) therefore, adopters were more educated than two other groups. On the contrary to some studies (Carolan, 2005) observing relationship between land ownership and technology adoption, the result of ^{2} test shows no significant relationship between the kind of land ownership and adoption behavior.

The result of F- test showed that the differences were significant (p = 0.027) and adopters were more informed about the advantages and disadvantages of irrigation methods. These results confirmed previous studies (Blanke et al., 2007; Jahannama, 2000), which revealed the positive effect of awareness on technology adoption.

Table 2 depicts results of Kruskal-Wallis H test for all variables which were measured by the frequency of access to such sources. Table 2 shows, there were no significant differences among groups regarding the use of radio and TV's agricultural programs, thus no effects of them in the adoption of irrigation technology. Similar results were achieved among the groups for access to the information sources and agricultural and extension experts. According to Rogers (2003) categorization, it can be expected that extension agents played an active role in the first stages of technology diffusion, especially in information and persuasion steps. Because of easy and frequent contact with extension agents, farmers had encouraged to adopt sprinkler systems, however in the next step (complete adoption and use of technology) the advantages of new technology did not demonstrate to the farmers. Lack of significant difference among respondents indicates that there were other and more effective factors. This result confirmed the findings of Morrison (2005) for lack of demonstrable benefits and Blanke et al. (2007) for lack of strong incentives. Table 2 shows, reading written extension materials was one of

Table 3. The main reasons of respondents for adopting sprinkler systems.

Reasons	Percents of responses	
	Importance	
	Low	High
Limitation of water and need to economic use of irrigation water	14.3	85.7
Reducing of production cost,	28.6	71.4
Increasing of planted area,	33.4	66.6
Changing rain-fed farms into irrigated ones,	33.3	66.7
Increasing crop yield and quality	14.3	85.7
Increasing quality of products,	23.8	76.2
Increasing of soil fertility,	38.1	61.9
Controlling of the irrigation depth.	38.1	61.9

them. As these materials were available for most farmers, it could be resulted that self endeavor/competency was an important factor which motivated adopters to continue the use of technology. These finding confirmed by some studies such as Jahannama (2001), Karbasi (2001) and Jafari and Torkamani (1998). Farmers' positive attitude toward optimum use of water is an important factor leading them to use water saving technologies. This factor was measured by eight statements. The results showed that all of three groups had positive attitudes toward optimum use of water in agriculture and no significant differences exist among them. Thus, it resulted that the problem of non adoption or discontinuance does not relate to farmers' attitudes.

Results showed significant differences regarding landholding size and adopters had more farm land than the two other groups. This finding is supported by previous studies, which reported farmers with greater farm sizes, were more interested to adopt the sprinkler irrigation systems (Lin, 1991; Stephenson, 2003). Some studies in Iran have also pointed out that the farm size is one of the important factors in adopting sprinkler systems (Hayati and Lari, 2000), as well as smallness and dispersion of land fragments is a barrier to adoption of the systems (Jafari and Torkamani, 1998; Karbasi, 2001). As Caswell and Zilberman (1985) reported, one of the main reasons for the application of sprinkler systems is to save water as well as to convert rain-fed farms to the irrigated one. Regarding dry land farming extent, F-test showed that adopters had significantly larger farms in comparison with the other two groups. The majority of respondents (82.7%) reported that water shortage was the main reason for dry land farming. There was also significant differences among respondents in regards to their land fragments ($F = 6.223$, $p = 0.003$), the number of land fragments of adopters were more than the other two groups. The distance among farmers' fragmented lands was significantly ($^2 = 10.65$, $F = 0.005$) different and for adopters it was less dispersed than the other two groups. The same results were reported by Bjornlund et al. (2008), Whittlesey (2003) and English et al. (2002). As they show, there is no reason for saving water through this technology but rather the technology has increased water efficiency and farmers tended to irrigate more farmlands and thereby increased water application.

The KW test showed significant ($^2 = 6.65$; $p=0.04$) differences among the three groups. Averagely, adopters' farms were located near to water sources and their fragments were located near each other in comparison with the other two groups. However, there was no significant relationship between the amount of water and adoption. In the other word, all the three groups were confronted with the problem of water limitation.

Some researchers believe that variables, such as slope of land and quality of soil are related to adoption behavior. In this study, soil texture of farms was classified into three levels. The results indicated that 12.1% of their soil texture was sandy, 56.7% sandy- clay, and 31.2% was clay. Also, their slopes were: 38.9% relatively plane, 40.1% medium and 21% high. In these cases, there were no significant differences among farmers. Although lands with low quality faced problems later however, it could be concluded that the quality of soil was not a determinant factor in adopting sprinkler systems. Finally, farmers were asked to identify the reasons of adoption and non-adoption of the technology. These results are summarized in Tables 3 and 4, respectively. As depicted in Table 3 all classified variables and reasons, were important factors in acceptance of this systems by farmers. On the other hand, by considering Table 4 all respondents believed that all classified variables and reasons were affective factors in rejection of these systems.

Conclusion

To improve the acceptance of new technologies as well as sprinkler systems: 1. It is essential to encourage young and literate people to engaging in agriculture using suitable incentives such as long-term and low-interest rate loans; 2. Local TV and radio stations should prepare

Table 4. The main reasons of respondents for abandonment of sprinkler systems.

Reasons	Percents of responses	
	Importance	
	Less	More
The problem of replacing of pipes and instruments in field and fragments of farms,	33.7	66.3
Windiness of the area and the problem of runoff caused by sprinklers	46.2	53.8
	29.9	70.1
Inappropriateness of introduced systems with agro-ecological conditions,	44.9	55.1
Low quality of equipments and damaging quickly,	44.9	55.1
High cost of replacement and repairing of pieces,	45.0	55.0
Lack of skilled representatives of corporations for designing and setting up of systems in the fields, irresponsibility of installer corporations for services after selling and installing	43.3	55.7
The problem of water quota system to supply enough water for sprinkler irrigation system.	48.7	51.3

and broadcast appropriate agricultural programs especially in soil and water conservation aspects; 3. Training local agricultural experts and extension agents before training farmers; considering agro-ecological conditions for selecting sprinkler systems; 4. Conducting adaptive researches to fit new irrigation technologies with farms situations before transferring them; designing and implementing training and educational courses for farmers; 5. Creating suitable conditions for land integration as a basic principle for applying sprinkler systems; field trips and visiting successful farms with operating sprinkler systems; 6. Enacting some regulations for urging the setting companies to be responsible for appropriateness of installed irrigation systems and to offer after-sales and after-setting service.

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