Investigating Factors Influencing Adoption of Pressurized Irrigation Systems by Farmers Case Study: Garmsar County, Iran

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Abstract: Since lack of water causes major limitations for agricultural activities, adoption of more efficient irrigation systems -including pressurized irrigation systems- is a way to optimize utilization of the limited water resources for food production. The main purpose of this study was to investigate factors influencing adoption of pressurized irrigation systems by farmers. The population consisted of farmers in Garmsar County, Iran. A sample of 143 farmers was selected by using random sampling method. Data were collected by means of a questionnaire and were analyzed using SPSS, Excel and Eviews. In this research, a logit model was applied to estimate the adoption of pressurized irrigation systems by farmers. The findings revealed that education, land ownership, bank loan, land size and annual income had positive and significant effects on adoption of pressurized irrigation systems. While, age and household size had negative effects on adoption of pressurized irrigation systems. The final effects revealed that bank loan had the considerable effect on the probability of pressurized irrigation systems adoption by farmers. Hence, it is recommended that incentives such as long-term and low-interest loans be given to farmers.

Key words: Pressurized irrigation systems • Logit model • Adoption • Loan • Education

INTRODUCTION

Water is becoming increasingly scarce worldwide. Water shortage is aggravating the natural scarcity while population is growing and the demand for water faces an increased competition among water user sectors [1]. World Bank predicted that by the year 2035, three billion people will live in the tough conditions because of water shortage [2]. The same scenario regarding the water scarcity is going in Iran. Iran is situated in the Middle East region of Southwestern and is located between 25 to 40 north latitude and between 44 and 63 east longitude. Iran is one of the most water scarce countries and faces the multiple challenges of limited freshwater availability, a rapidly growing population and over-exploitation of groundwater [3]. In Iran, the average annual rainfall is 250mm (apart from a small part in the North of Iran which has suitable raining), which is lower than the average annual rainfall in the word [4]. Hence, the governments of water scarce countries face the challenges of optimizing utilization of the limited water resources for food production [5]. Management of water resources especially in agriculture sector has always been a major issue. Agriculture is the major sector contributes to the growth of Iran’s economy [6] and lack of water causes major limitations for agricultural activities. The overall irrigation efficiency in Iran ranges from 33 to 37 percent, which is lower than the average for both developing countries (45%) and developed countries (60%) [7]. Agriculture sector is therefore forced to find new approaches to cope with water scarcity but adopting sustainable water use issues. So, it is important to move away from traditional irrigation methods. Governments throughout the world have searched approaches to manage water consumption more efficiently and effectively [8]. Pressurized irrigation systems can help to achieve this goal. The efficiency of irrigation with pressurized irrigation systems is more than 70 percent compared with the 33 percent efficiency of traditional irrigation methods [4].

Since adoption of more technically efficient irrigation systems may be a way to facilitate production, it is important to find factors influencing adoption of pressurized irrigation systems by farmers and to use...
schemes in order for farmers to benefit. Attention to studies in the field of factors influencing adoption and application of technologies, including irrigation technologies, has found different factors. Karami et al. [9] in their study found that there were considerable differences on demographic, awareness, income and technology ownership between farmers who used pressurized irrigation system and who didn’t use of the technology. Albercht and Ladewing [10] found that land size was the most important factor in the adoption of irrigation technologies. Noroozi and Chizari [11] found that there was significant correlation between farmers’ attitude toward development of irrigation systems and factors such as contacts with extension agents use of communication channels, social participation and knowledge about water management.

Chandran and Chackacherry [12] in their study found that the socio-psychological variables, including social participation and attitude of the individuals significantly influenced the extent of farmers’ participation in irrigation management. Dinar and Yaron [13] reported a significant correlation between application of pressurized irrigation system and increases on prices of water and agricultural products.

Smith and Munoz [14] stated that consultancy services had an important role in the adoption of irrigation systems. Jahannama [15] found that socio-economical factors such as awareness, financial ability and communication had the most effects on adoption of pressurized irrigation system. Caswell and Zilberman [16] found that adoption and use of new technologies of irrigation depended on the land quality. Use of these technologies in areas with the best quality of land had the most frequency, while traditional methods had been used in the areas with frequent water and flat ground. Shresta and Gopalakrishnan [17] found that increasing in the price of water, income and work force had an important role in the use of pressurized irrigation systems by farmers.

The main purpose of this study was to investigate factors influencing adoption of pressurized irrigation systems by farmers. The special objectives of the study were:

- Identifying characteristics of farmers;
- Logit regression for estimating adoption and non-adoption of pressurized irrigation systems by farmers.

![Map showing the study site in Semnan Province, Garmsar County](image)

**Fig. 1: Study site (Semnan Province, Garmsar County)**

**MATERIALS AND METHODS**

This study was a descriptive-correlation research, carried out in Garmsar County- which is located in Semnan Province, Iran (Fig 1). The statistical population of the study included two groups of farmers; adopters and non-adopters of pressurized irrigation systems. A sample of 143 farmers was selected by using random sampling method.

From a review of literature, the researchers developed a questionnaire divided into different sections. Adoption of pressurized irrigation systems considered as a dependent variable. Adoption is a complicated process that may be influenced by a set of independent variables, including individual, social and economical variables. Some variables hypothesized to influence farmers’ adoption of pressurized irrigation systems in our study are shown in Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Number of years</td>
</tr>
<tr>
<td>Household size</td>
<td>Number of people in household</td>
</tr>
<tr>
<td>Experience</td>
<td>Number of years</td>
</tr>
<tr>
<td>Education</td>
<td>1, illiterate; 2, elementary school; 3, secondary school; 4, high school; 5, post high school; 6, bachelor of science; 7, master of science</td>
</tr>
<tr>
<td>Participating in extension-education courses</td>
<td>Number of participation</td>
</tr>
<tr>
<td>Land ownership</td>
<td>1, if owned; 2, if rented land</td>
</tr>
<tr>
<td>Land size</td>
<td>Area of farm land (ha)</td>
</tr>
<tr>
<td>Bank loan</td>
<td>1, if yes; 0, if no</td>
</tr>
<tr>
<td>Annual income from agriculture</td>
<td>Level of income (Dollars)</td>
</tr>
</tbody>
</table>

Table 1: Names and measurement type of the research variables
Data were analyzed descriptively and inferentially using SPSS (Statistical Package for Social Science) for Windows, Microsoft Excel and Eviews. Descriptive statistics included frequencies, percentages, mean and standard deviation, while inferential statistics included logit model.

In this research, a logit model was applied to estimate the adoption of pressurized irrigation systems by farmers. Logit model is a popular statistical technique in which the probability of a dichotomous outcome is related to a set of independent variables and is widely used in adoptive studies [18]. Logit model has a dummy dependant variable that specified with Z; (equation 1).

\[ Z_i^* = \alpha + \sum_{i=1}^{n} \beta_i X_i + u_i \]  

(1)

Equation (1) shows that (α) and (β) are used as equation parameters and (u) is equation error. A set of variables including individual, social and economic can affect adoption of pressurized irrigation systems. So, variable Z, can be defined as a binary variable with one and zero value. If Z;>0, then Z; is received value 1. Otherwise, Z; is received value 0.

In this research, adoption of pressurized irrigation systems considered as a dependent variable. Adoption was defined in terms of a binary variable (adoption/ non-adoption). The variable Z; was defined as a binary variable with a value of 1 for those farmers who have adopted pressurized irrigation systems and 0 for those who have not adopted it.

\[ Z_i = \alpha + \sum_{i=1}^{n} \beta_i X_i \]  

(2)

When Z; is “1” means that ith farmer adopted irrigation technology and “0” means not adoption. In the logit model, the probability for adoption of irrigation technology by the ith farmer is as the following equation:

\[ P_i = F(Z_i) = F(\alpha + \sum_{i=1}^{n} \beta_i X_i) = \frac{1}{1 + e^{-z_i}} = \frac{1}{1 + e^{-(\alpha + \sum_{i=1}^{n} \beta_i X_i)}} \]  

(3)

The probability for non-adoption of irrigation technology by the ith farmer is as the following equation:

\[ 1-P_i = \frac{1}{1 + e^{z_i}} = \frac{1}{\alpha + \sum_{i=1}^{n} \beta_i X_i} \]  

(4)

By dividing the probability of irrigation technology adoption by farmers on the probability of irrigation technology non-adoption and calculating logarithm, the following equations will be obtained.

\[ \frac{P_i}{1-P_i} = \frac{1 + e^{z_i}}{1 + e^{-z_i}} = e^{z_i} \]  

(5)

\[ L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i \]  

(6)

L; is referred to as the log of the odds ratio in favor of acceptance.

By deriving of the equation 3, the effects of explanatory variables on the probability of irrigation technology adoption by the ith farmer can be calculated. For example, the effect of kth variable changes in the probability of irrigation technology adoption, is as the following equation:

\[ \frac{\partial P_i}{\partial X_{ik}} = \frac{e^{z_i}}{(1 + e^{z_i})^2} \beta_k \]  

(7)

RESULTS AND DISCUSSION

Characteristics of Respondents: Characteristics of the sampled farmers are shown in Table 2. 78.3 percent of respondents were male and the rest (21.7%) were female. The respondents were relatively middle age with an average age being 51 years. Respondents’ experience in agricultural activities was 30 years on average.

Logit Regression: Table 3 shows the results of logit model. Analysis of the results showed that 7 variables were significant in the decision to adopt pressurized irrigation systems by farmers.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>51</td>
<td>12.5</td>
<td>22</td>
<td>85</td>
</tr>
<tr>
<td>Household size</td>
<td>7</td>
<td>2.7</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Experience</td>
<td>29.88</td>
<td>13.5</td>
<td>7</td>
<td>70</td>
</tr>
<tr>
<td>Education</td>
<td>3.16</td>
<td>1.5</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Participating in extension-education courses</td>
<td>1.46</td>
<td>0.5</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Land ownership</td>
<td>1.81</td>
<td>0.4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Land size</td>
<td>22.72</td>
<td>35.9</td>
<td>1.9</td>
<td>220</td>
</tr>
<tr>
<td>Bank loan</td>
<td>0.5</td>
<td>0.5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Annual income from agriculture</td>
<td>129.7</td>
<td>111.3</td>
<td>10</td>
<td>900</td>
</tr>
</tbody>
</table>
Table 3: Results of logit model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-Statistic</th>
<th>Final effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-11.52***</td>
<td>3.495</td>
<td>-3.293</td>
<td>-</td>
</tr>
<tr>
<td>X1 Age</td>
<td>-0.203***</td>
<td>0.053</td>
<td>-3.817</td>
<td>-0.04</td>
</tr>
<tr>
<td>X2 Household size</td>
<td>-0.978***</td>
<td>0.358</td>
<td>-2.728</td>
<td>-0.19</td>
</tr>
<tr>
<td>X3 Education</td>
<td>0.134*</td>
<td>0.118</td>
<td>1.765</td>
<td>0.03</td>
</tr>
<tr>
<td>X4 Participating in extension-education courses</td>
<td>0.706**</td>
<td>1.098</td>
<td>0.642</td>
<td>0.12</td>
</tr>
<tr>
<td>X5 Land ownership</td>
<td>1.863***</td>
<td>1.663</td>
<td>4.125</td>
<td>0.33</td>
</tr>
<tr>
<td>X6 Land size</td>
<td>1.187***</td>
<td>0.054</td>
<td>3.419</td>
<td>0.03</td>
</tr>
<tr>
<td>X7 Bank loan</td>
<td>1.901***</td>
<td>2.971</td>
<td>14.775</td>
<td>0.34</td>
</tr>
<tr>
<td>X8 Annual income from agriculture</td>
<td>3.10***</td>
<td>8.86</td>
<td>3.498</td>
<td>0.38</td>
</tr>
</tbody>
</table>

***p< 0.01 * p< 0.10

Mean dependent var. = 0.295 Mc Fadden R² = 0.748
LR statistics = 104.475 Probability = 0.000 Count R² = 0.63

Mc Fadden R² was 0.748 showed that 74.8% of variations in dependant variable could be explained by the explanatory variables of the model. Count R² of 0.63 showed the suitable goodness of fit for the research model.

The findings showed that land ownership, bank loan, land size and annual income had positive effects (p<0.01) on adoption of irrigation systems. Accordingly, with increase in land ownership, bank loan, land size and annual income, the probability of pressurized irrigation systems adoption by farmers will increase. Also, education had a positive effect (p<0.10) on adoption of irrigation systems. Therefore, more educated farmers were more likely to adopt pressurized irrigation systems than less educated farmers.

Age and household size had a negative effect (p<0.01) on adoption of irrigation systems. This means that older farmers were less likely to adopt pressurized irrigation systems than younger farmers. Also, with increase in household size, the probability of pressurized irrigation systems adoption by farmers will decrease. Participating in extension-education courses was found to have no significant effect on pressurized irrigation systems adoption.

Final effects of research variables on the probability of adoption revealed that for every 1 unit increase in farmers’ age, 0.04 times will decrease in the log-odds of the probability of adoption. For every 1 unit increase in annual income, 0.38 times will increase in the log-odds of the probability of adoption. For every 1 unit increase in household size, 0.19 times will decrease in the log-odds of the probability of adoption. Also, for every 1 unit increase in land size, 0.03 times will increase in the log-odds of the probability of adoption.

Final effect of land ownership was 0.33 indicating that the probability of adoption for farmers who owned lands was 0.33 more than farmers with rented lands. Final effect of education and bank loan were 0.03 and 0.34 respectively, indicating that the probability of adoption for educated farmers was 0.03 more than uneducated or less educated farmers. Also, the probability of adoption for farmers who used bank loan was 0.34 more than farmers who didn’t use it.

According to the final effects, it is revealed that annual income from agriculture and bank loan had the most effects on the probability of pressurized irrigation systems adoption by farmers.

**CONCLUSION**

Agriculture is the dominant user of water. So, adoption and application of more technically efficient irrigation systems is a way to optimize utilization of the limited water resources. Accordingly, the role of new irrigation systems - including pressurized irrigation systems - in water management has lead to researches about the factors influencing adoption of pressurized irrigation systems by farmers. The findings revealed that education, land ownership, bank loan, land size and annual income had positive and significant effects on adoption of pressurized irrigation systems by farmers. In contrast, age and household size had negative and significant effects on adoption of pressurized irrigation systems. Neupane et al. [19] showed that individuals with higher levels of educational attainment adopted new technologies more than their counterparts. Albercht and Ladewing [10] found that land size was the most important factor on the adoption of irrigation technologies.

According to the results, education had positive effect on adoption of pressurized irrigation systems. To explain the finding we can say the more educated farmers know more than their counterparts about the positive effects of new technologies on optimizing water use and on agriculture production. So they will accept
the new irrigation systems faster and more easily compared with uneducated and less educated farmers. Hence, it is imperative that uneducated farmers be aware and knowledgeable about pressurized irrigation systems. The most benefits of pressurized irrigation systems clearly perceived by farmers, the more probably the technology will adopted by those. It is recommended that knowledgeable experts with high awareness about pressurized irrigation systems be sent to the villages to familiarize farmers with new irrigation technologies.

According to the final effects, it is revealed that bank loan has considerable effect on the probability of pressurized irrigation systems adoption by farmers. Hence, it is recommended that requirements for giving loan be changes; so that low-income farmers are able to use the loan. It is recommended that long-term and low-interest loans be given to farmers, to boost budgets of poor farmers. Also, it is imperative that farmers be aware of the regulations for giving loan. Hence, it is recommended that necessary information be delivered to the farmers. Finally, it is recommended to provide incentives such as financial support to adopter farmers for improving adoption and application of pressurized irrigation systems by farmers.

REFERENCES


