Barriers of pressurized irrigation development in shush city

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ABSTRACT

In spite of the governmental supports and usage of tools such as loans, Shush city is one of Khuzestan province’s regions in which the pressurized irrigation is not developed. So the new irrigation methods’ rejection causes were evaluated in a case study in 1388-89. A binary Logit model was used in this study. Region’s farmers were evaluated in two groups of adopter and non-adopter of new methods. Because of the first group’s limitation, the farmers information was collected through capitation from 11 farmers and the second group’s information was gained through random sampling from 62 ones. Findings showed that non-ownership of the lands, smallness of the lands and the loan problems are the most important factors intercepting of new irrigation methods. In addition, education, under cultivation area, and land ownership, among the individual and agricultural characteristics, are some factors improving the development of pressurized irrigation.

Key words: pressurized irrigation, Logit model, Shush.

Introduction

Three factors of low annual rainfall, evaporation and Transpiration, and unsuitable dispersion caused that the water share of each hectare of Iran dry lands from the water resources is even less than a quarter of the global average [4]. This water resource limitation and population growth are causing a gap in country's water supply and demand sector, which, according to the forecasts of different organizations such as the international institute of water management, Iran will have a critical crisis of water resources in the next decade [9]. This crisis makes the correct and wise management in the regional and national scales necessary and undeniable. In different developmental programs, to overcome this problem, major investments are done in the water supply sector (inhibition of the surface waters) [8].

But the mentioned limitations in the water resources supply sector and Iran’s position in the arid and semi-arid zones of the earth caused that the use of supply sector policies, alone, are not enough for countering the crisis of the country’s water recourses. So, in the recent years, use of tools for reducing the water demand especially in the agriculture sector were considered as the most important sectors consuming the water resources. Lots of credits were allocated to develop the pressurized irrigation in order to increase the agriculture water efficiency, which is one of the most important steps in the recent years. Using suitable irrigation methods in the agriculture of Iran, as a policy to improve the water demand management, are emphasized in many studies- Jahan Nama, [9], Jaffari et al [8], Panahi and Malekmohammadi, [17], Wojdani et al. However, based on the report of the water economy office of the planning deputy of the water resources company, using traditional methods is still one of the most important economical and social problems of the agriculture sector. During the first country’s economical development plan, about 40466 hectares of pressurized irrigation has carried out in the country and this number was 144459 in the second one. Totally, at the end of the third economical development plan, more than 350 thousand hectares of pressurized irrigation has carried out in the country.

These statistic show that in spite of the efforts done in different development plans for replacing new irrigation methods with the traditional ones, less than 3 percent of the country lands are equipped by pressurized irrigation systems [19]. Using new irrigation systems are introduced as innovation in agriculture in many studies [11,18,9], which should not only be compatible with the local, regional, and technical conditions, but should be adopted by the farmers and farm managers as people with specific social, economical and agricultural characteristics.
So these researchers emphasize on identifying the economical, social and agricultural components affecting the adoption pressurized irrigation methods. Panahi and Malekmohammadi [17] determined the factors affecting the adoption of new irrigation methods in the Iran agriculture system; they concluded that income, rate of farmer’s cooperation with the organizations active in the agriculture water resource management, empowering the individuals in the agriculture water resource management, and the farmer’s land size are factors affecting the use of under pressure irrigation methods. Kohansal et al [11] evaluated the environmental and non-environmental factors affecting the overhead irrigation adoption as a new irrigation method in Khorasan Razavi province. Binary Logit model approach was used in this study. Results showed that variables such as farmer age, number of family labor, number of lands, number of products, and condition of access to water have negative effect on the overhead irrigation adoption. In contrast, variables of farm area, level of literacy, farmer’s occupation as the main occupation, land gradient, soil heterogeneity, and access to credits and loans have positive and significant effects on the overhead irrigation adoption.

Bameri et al [3] evaluated factors limiting the development of under pressure irrigation methods in Sistan. They believed that factors such as soil heavy retexiture, unsuitable weather conditions, yeomancy system in the region lands, nonexistence of certain water resources, unsuitable cultivation model ,nonexistence of the needed energy, high costs of exploitation, maintenance, investment, region’s social and cultural considerations and skilled human forces are the barriers of the exploitation and development of pressurized irrigation waters. Jahan Nama [9] in a study in Tehran province, stated that individual and social characteristics such as age, work experience, awareness, financial amenities and more communications affect the under pressure irrigation systems adoption. This study showed that the exploiters’ dissatisfaction is mostly because of the loan delivery manner, designer companies work manner, and the quality of the received devices; this leads the system-less exploiters to resist against pressurized irrigation systems’ adoption. Albercht and Ladewing [2], in a study entitled “adoption of the irrigation technology “, evaluated the effects of personal, structural, and environmental variables in Texas, US. Results showed that the farm size is the most important variable affecting the new irrigation methods’ adoption. In addition, the environmental variables such as soil moisture, soil saturated layer diameter are more important than the economical variables in the new irrigation methods’ adoption. Schuck et al [20], in their essay – adoption of irrigation systems to counter the drought in the US, believed that the key factors affecting the new irrigation systems adoption are land rental time, farm size and the accessible water.

They believed that farmers owning their own farm, ones owning more lands, and having access to more water are more likely interested to use new irrigation systems to counter the drought.

Evaluating the mentioned studies, kind and rate of the variables’ affect on the new irrigation methods’ adoption of farmers are different in various regions of the country. In the other hand, statistics gained from the northern cities of Khuzestan province showed that in spite of the recent droughts, the new irrigation methods’ non-adoption of farmers is very obvious in this province. Evaluations indicated that less than 3 percent of Shush’s farmers use the under pressure irrigation. Using the traditional irrigation methods not only causes a water loss in the region, but originates other problems for the ground water resources of the region. Thus, this study is aimed at evaluating the causes of new irrigation methods non-development in Shush city.

Material and method

Dependent variable of this study is a binary variable of zero and one, meaning that if this variable’s amount is represented by $Y_i$, will be it 1 when the pressurized irrigation method is adopted and it will be zero when the method is not receipted. So, the used model is the logit binary model. If the probability of the dependent variable is 1 and 0, it will be illustrated by F function as follow:

$$
prob(Y = 0) = 1 - F(\beta'X_i)
$$

$$
prob(Y = 1) = F(\beta'X_i)
$$

(1)

Use of the Logistic distribution functions can turn this function into a probability function as follow:

$$
prob(Y = 1) = \frac{e^{\beta'X}}{1 + e^{\beta'X}} = \Lambda(\beta'X)
$$

(2)

In the relation above, $\Lambda(\cdot)$ is the logistic cumulative distribution function and $e$ is the natural logarithm base. Estimating the regression functions in the logit models, the maximum likelihood extermination function is used.

$$
F(\beta'X_i) = prob(Y = 1) = \frac{e^{\beta'X}}{1 + e^{\beta'X}} = \Lambda(\beta'X)
$$

$$
f(\beta'X_i) = \Lambda(\beta'X_i)[1 - \Lambda(\beta'X_i)]
$$

(3)

In the formula above, $f(.)$ is the function derivate $F(.)$. the maximum likelihood extermination function can be used as follow to estimate the regression model of the logistic function [6].
\[ L = \prod_{x_i} F(\beta'X)[1-F(\beta'X)] \]
\[ = \prod_{i} \left[ F(\beta'X) \right]^{y_i} \left[ 1-F(\beta'X) \right]^{1-y_i} \]

(4)

To obtain the \( \beta \) parameter, maximizing of the relation above on this parameter and equalization of the relation with zero are used.

\[ \frac{\partial \ln L}{\partial \beta} = \sum_{i} \left[ y_i f(\beta'X) + (1-y_i) \frac{-f(\beta'X)}{1-F(\beta'X)} \right] = 0 \]

(5)

The \( F(\beta'X) \) function amounts and its derivate from the relations above can be replaced in the equation above so that the logistic cumulative distribution function (CDF) is resulted as below.

\[ \frac{\partial \ln L}{\partial \beta} = \sum_{i} \left[ y_i(1-\Lambda(\beta X)) - (1-y_i)\Lambda(\beta X) \right] X_i = 0 \]

(6)

The repetitive method of Newton Raphson is used for solving the nonlinear equation above. To determine the effect of the independent variables entering virtually in the model, marginal effect concept is used. This effect of the rate of probability change \( (Y_i = 1) \), in the logit models, explains the single change in the independent variable, which can be calculated as follow (Judge, 1988).

\[ ME = \frac{\partial P_i}{\partial X_k} = \frac{e^{\beta X}}{(1+e^{\beta X})^2} \beta_k \]

(7)

In the relations above, \( \varphi(t) \) is the density function of probability for the normal distribution and ME is the marginal effect of the entered -in- model independent variables. Probability of an obvious accident like adoption of new technologies of irrigation and probability of an alternative accident like non-adoption of new technologies of irrigation are illustratable as \( P_i \) and \( 1-P_i \) by the following relation in the logit model, respectively.

\[ P_i = \frac{e^{\beta X}}{1+e^{\beta X}} \]

(8)

\[ (1-P_i) = \frac{1}{1+e^{\beta X}} \]

In this case, the probability of an accident to its improbability can be calculated by the odds ratio:

\[ Odds = \frac{P_i}{1-P_i} \]

(9)

In the twosome models, elasticity of the \( K^{th} \) explanatory variable can be calculated by the following relations:

\[ E^k = \frac{\partial \Lambda(\beta'X)}{\partial X_k}, \frac{X_k}{\Lambda(\beta'X)} \]

(10)

\[ = \frac{e^{\beta X}}{(1+e^{\beta X})^2} \beta_k \]

Elasticity related to each variable shows that a 1 percent change in a number of percent independent variable causes a change in the probability of Yi=1. The statistical society of the study is the villages of Shush. In Shush, because of the water sample salinity, designing and executing the pressurized irrigation systems face many problems. Totally, in this city, 1609 hectares of the lands are accepted for the execution of pressurized irrigation systems, which, of course, a little part of this system has been completely executed and exploited. Only 3 percent of the exploiters of this city are using new irrigation methods [19]. Because a little percent of farmers were using new irrigation methods in the region, capitation method was used to collect information from this group of the society, but the random sampling method was used to collect information from the second group. At the end, 11 persons were studied under capitation in the first group and 61 persons were selected as samples from the second group.

Results:

Results gained through the estimation of the logit model in the studied region are illustrated in table1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>T</th>
<th>Elasticity</th>
<th>EXP(\beta)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>-0.28</td>
<td>-2.42</td>
<td>-13.32</td>
<td>0.75</td>
</tr>
<tr>
<td>ECU</td>
<td>1.82</td>
<td>1.98*</td>
<td>4.13</td>
<td>6.17</td>
</tr>
<tr>
<td>HEK</td>
<td>0.14</td>
<td>1.99*</td>
<td>2.48</td>
<td>1.15</td>
</tr>
<tr>
<td>OWN</td>
<td>1.74</td>
<td>2.04*</td>
<td>2.47</td>
<td>5.69</td>
</tr>
<tr>
<td>NUM</td>
<td>-1.36</td>
<td>-1.9</td>
<td>-2.67</td>
<td>0.25</td>
</tr>
<tr>
<td>WR</td>
<td>0.11</td>
<td>2.11</td>
<td>0.12</td>
<td>1.11</td>
</tr>
<tr>
<td>Constant</td>
<td>14.14</td>
<td>-0.3</td>
<td>-1.14</td>
<td>0.32</td>
</tr>
<tr>
<td>MC Fadden R²</td>
<td>0.8</td>
<td>Log of Likelihood Function</td>
<td>-6.16</td>
<td></td>
</tr>
<tr>
<td>Maddalas R²</td>
<td>0.42</td>
<td>Likelihood Ratio Test</td>
<td>-49.55</td>
<td></td>
</tr>
<tr>
<td>Percentage of Right Prediction</td>
<td></td>
<td></td>
<td>0.71</td>
<td></td>
</tr>
</tbody>
</table>

***significant 10%  **significant 5%  *significant 1%
Results showed that all variables entered in model have a suitable level of significance. In addition, because it was thought that the rate of work experience can also affect the farmers’ reaction, this variable was considered in the primary model, but it is not considered in the secondary model because of the linear problems. Madala and Mcfadden indexes confirm the suitability of the model’s fit.

In this model, coefficient of 0/28 (with a negative sign) is gained for the age variable. This indicates that the farmers’ adoption rate of new methods of irrigation is reduced as the age is increased. The resulted tension for this coefficient for the education variable is 1/82. This positive coefficient indicates an increase of the probability of Shush farmers’ use of new irrigation methods by increasing their education. In other words, results show an increase of the probability of using new irrigation methods by increasing the awareness level and farmers’ education. The positive sign gained for the under cultivation area variable shows that farmers having larger lands are more interested in using under pressure irrigation methods. EXP resulted for this variable indicates that the owners of larger lands’ adoption probability of under pressure irrigation is averagely 1/15 times more than the owners of smaller lands. Positivity of the resulted ownership variable’s coefficient shows that the ownership of lands increases the adoption probability of new irrigation methods among the farmers. EXP resulted for this coefficient indicates that the adoption of farmers owning their own land is 5/69 times more than farmers working on rental lands.

Dispersion of lands is one of the problems for executing the pressurized irrigation plans. Thus, number of lands, as a variable indicating this characteristic, can be considered in the model. As prospected, sign of 1/36 coefficient for this variable is negative meaning that increasing of the land number can cause a reduction in the farmers’ adoption probability of new irrigation methods. Tension of 0/25 with negative sign for this variable shows that the 1 percent increase in the lands number can cause a 0/25 percent reduction in the adoption probability of new irrigation methods. In addition, in the model, the effect of irrigation resource’s kind variable has become significant. In other words, in this city, well users are more interested to use pressurized irrigation than those using the surface water resources. In the evaluated model, variables such as household size and having a non-agricultural job are also considered, but the resulted coefficients were deleted from the model for their lack of statistical significance.

In the logit model, what is more aimed in the artificial variables is the usage of the concept of these variables’ marginal effect. Results of these calculations are illustrated in table 2.

A basic condition was considered to calculate the marginal effect in this study, in which activities of illiterate farmer in the region were studied. This farmer is working on the rental land, having no job but agriculture, and his irrigation source is the river. The effect of each introduced variables was separately calculated by entering the one number in the column related to the variable, while the coefficient of each variable remained as it was. In this case, the different of two probabilities shows the marginal effects related to the aimed variable. The probability of the basic condition with the zeroes of each variable above is 55/33 percent. This probability was increased to 88/39 percent by entering the value of 1 for the education variable. In other words, the marginal effect of the education variable for Shush farmers is more than 33 percent. Since this probability is 88/39 percent for no owner farmers, it is increased to 97/75 percent for owner. This shows that the marginal effect of ownership is about 9/36 percent. Finally, difference in the kind of irrigation in Shush caused that a variable for explaining this difference is located in the model. The marginal effect calculated for this variable is about 0/2 percent indicating the lowness of marginal effect to the variables of education and ownership.

One thing was more considered in this study is the causes of non-adoption of new irrigation methods in the first group. As illustrated in the following table, three factors of lands’ smallness, how to get the loan, and lack of land ownership are the most important factors limiting the use of pressurized irrigation. Equipment expensiveness, unsuitability with the product kind, geometrical form, and the farms’ topography, and low quality of the equipments are other factors limiting the farmers’ adoption of under pressure irrigation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Primary state</th>
<th>Education</th>
<th>Ownership</th>
<th>Irrigation source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.28</td>
<td>48.5</td>
<td>48.5</td>
<td>48.5</td>
<td>48.5</td>
</tr>
<tr>
<td>Education</td>
<td>1.82</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Land size</td>
<td>0.14</td>
<td>18.58</td>
<td>18.58</td>
<td>18.58</td>
<td>18.58</td>
</tr>
<tr>
<td>Ownership</td>
<td>1.74</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Number of piece</td>
<td>-1.36</td>
<td>2.17</td>
<td>2.17</td>
<td>2.17</td>
<td>2.17</td>
</tr>
<tr>
<td>Irrigation source</td>
<td>0.11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>constant</td>
<td>14.14</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Forecasting</td>
<td>0.21</td>
<td>2.03</td>
<td>3.77</td>
<td>3.88</td>
<td></td>
</tr>
<tr>
<td>Probability</td>
<td>55.23</td>
<td>88.39</td>
<td>97.75</td>
<td>97.98</td>
<td></td>
</tr>
</tbody>
</table>
Discussion and conclusion:

Results showed that the farmer’s tendency to use new irrigation methods is reduced as their age is increased. This hypothesis is confirmed by the explanatory data meaning that, in the explanatory data, the age average of the first group is more than the second one. This result has been confirmed by Jahan Nama [9], Vojdani et al [21], Rafeae and Bakhshhodeh [18], Kohansal et al [11], and Albercht and ladewing [2], too. This result is reasonable because the younger, in counteracting the problems, are more interested to change their position and like to find new solutions. The recent drought and dehydration in the region has forced the young farmers to use pressurized irrigation method instead of the traditional ones. This study’s first hypothesis was that the group of educated farmers are more interested to use the new irrigation methods. This result was also confirmed by using the explanatory data indicating the high level of education of the second group to the first one. Jahan Nama [9], Hayati and Lari [7] and others has emphasized on this result meaning that as the farmers’ education (especially in field of agriculture), knowledge and awareness level about their problems is increased ,they select the use of new technology as a solution to counter the problem. In this group, lack of knowledge about the new technologies of agriculture has caused a problem for low- educated farmers to adopt these innovations.

Results showed that farmers having larger lands are more interested to use the new irrigation methods. Evaluation of the explanatory information confirms this matter meaning that the land area average of the second group is more than the first one .Easiness of the execution of pressurized irrigation projects in the large lands, lowness of costs in the larger lands, and more ability of farmers having larger lands are reasons justifying this issue. Hayati and Lari [7], Torkamani and Jafari, Vojdani [21], Kohansal et al [11], Bameri et al [3] and others believed that smallness of agriculture lands is one of the most important reasons of pressurized irrigation projects’ fail in different regions of Iran. In this study, there is a hypothesis that the ownership of the agriculture lands affects the farmers view about the adoption or non-adoption of new irrigation methods. Positivity and significance of this variable shows that farmers owning their own land are more interested in executing pressurized irrigations than those working on the rental or joint lands. Nozari and Chidzi [16], and Schuck et al [20] believed that the land ownership is an important and positive factor in adopting the new irrigation methods. Naturally, when a farmer owns his own land, the ownership sense and his attention to use the resources optimally, in one hand, and having more credential and options, in the other hand, can be a factor justifying this effectiveness. One of this study’s hypothesis is that the dispersion of the farmers’ lands can have a negative effect on their adoption of pressurized irrigation. Increasing of the executive costs, problems of using equipments in the dispersed lands, and impossibility of carrying out some activities in many dispersed lands are the most important reasons of choosing this hypothesis.

The negative and significant sign of this variable’s coefficient shows that this hypothesis is confirmed in binary models. Explanatory data show that the average of farm numbers in the lands of farmers using the traditional methods is more than the group it was compared with. Torkamani and Jafari, Panahi and malekmohammadi [17], Rafiee and Bakhshhodeh [18] have studied the adoption of new irrigation methods showing that the dispersion and increasing of the land numbers are the problems of Iran’s agriculture having a negative effect on the performance of pressurized irrigation projects in different regions of Iran. Farmers’ use or non-use of wells for providing the water resources is one the observed differences between them. The sign of this variable is negative and significant .this issue indicates that the owners and users of wells and ground waters are more interested to use new irrigation methods. Kulshreshtha [12] believed that because of the high cost of water extraction, selection of new and water saving technologies such as overhead and drip irrigation is more among farmers using wells as water resource than those using the surface waters.

Bameri et al, [3] mentioned the inaccessibility of certain water resource as one of the most important reasons of the farmers’ lack of tendency to use pressurized irrigation. According to this, it is natural that the ground water resources can be considered as more certain resources than the surface ones. Results of evaluating the marginal effect of the explanatory variable show that education, ownership, and the kind of irrigation source are factors affecting the adoption probability of new irrigation methods.

| Table 3: Distribution of sample’s reasons for unused pressurized irrigation. |
|---------------------------------|--------|-------|------------|
| factors limiting the use of pressurized irrigation | Frequency | Percentage | Accumulative percentage |
| 1 low quality of the equipments | 3 | 4.6 | 4.6 |
| 2 lands’ smallness | 16 | 24.6 | 29.2 |
| 3 No fit with product | 8 | 12.3 | 41.5 |
| 4 Farm topography and land form | 7 | 10.8 | 52.3 |
| 5 How to get the loan | 15 | 23.1 | 75.4 |
| 6 Equipment expensiveness | 6 | 9.2 | 84.6 |
| 7 lack of land ownership | 10 | 15.4 | 100 |
| Sum | 65 | 100 | 100 |
Resulted information shows that three factors of lands’ smallness, how to get a loan, and lack of land ownership are the most important factors limiting the use of pressurized irrigation. Jahan Nama [9], Monfared [15], and Kohansal et al [11] selected these factors as some of the most important factors being barriers of the under pressure irrigation projects’ success. The following suggestion are dedicated based on the findings of this study to increase the tendency of farmers to use pressurized irrigation methods.

1. Because a high percent of the agriculture activities are carried out in the rental and joint lands in the studied region, policies to submit the ownership to the farmers can be a positive act for developing pressurized irrigation in the region.

2. Providing conditions in order to increase the level of farmers’ education and awareness can expand the usage of new irrigation methods; new strategies such as filed farmer school (FFS) are suggested.

3. Making policies to integrate the lands is certainly followed by the expansion of pressurized irrigation methods usage.

4. According to the policies made by the authorities the to give facilities for providing pressurized irrigation costs, it seems that the financial problem of this projects is resolved; but according to the study findings, it is cleared that preparing a suitable ground to smooth the progress of this issue can increase the tendency of farmers to use this kind of irrigation.

References


