Evaluation of the Effective Parameters on Pressurized Irrigation System by Iranian Farmers

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Abstract: This paper evaluates the determinants of farmers' decisions to adopt pressurized irrigation systems. In 2010, based on survey conducted among 320 Iranian farmers; a binary logistic regression model was successfully applied. This survey showed that 13 variables were significant in explaining farmers' acceptance decisions. Farmers' educational background, number of people in Household, contact with extension, farmer proprietorship, subsidy and training received for irrigation systems, positive attitudes towards pressurized irrigation systems and agricultural land area, village being close to agriculture service center were variables that have significantly positive effect on acceptance of pressurized irrigation systems; while farmer's age and distance from the water storage tanks, consequence of applying irrigation systems have significantly negative correlation with the acceptance. From the present research several useful conclusions were drawn that provide insight on pathways to increase the acceptance of pressurized irrigation systems.

Key words: Pressurized irrigation systems · Effective parameters · Agricultural economics · Adoption · Iranian farmers

INTRODUCTION

Fresh water, a renewable but limited resource, is scarce in many areas of developing world because of unplanned withdrawal of waters from resources such as rivers and underground aquifers causing severe environmental problems like contamination of water sources to arsenic [1-3]. In many countries, the amount of consumed water has exceeded the annual amount of renewal water which is creating unsustainable situation [4, 5]. Agriculture is one of the main water consuming sectors and lack of water causes major limitations for the agricultural activities. In Iran, Water is considered as the key point for environmental development. The required water by crops is supplied by nature in the form of precipitation, but when it becomes scarce or its distribution does not coincide with demand peaks, it is then necessary to supply artificially such as irrigation. In a country faces water scarcity due to increasing rate of consumption, irrigation and industrial demand; the water administration may needs special attention. In all economic activities, water demands depend on two factors known as efficient production and wise consumption [6]. In most parts of

the world, the demand for available water resources is rapidly exceeding the supply and competition. The increasing demand has created intensities for various sectors of the economy for scarce water. In response to these conditions, policymakers, researchers and farmers are increasingly pursuing various innovative, technical, institutional and policy interventions to enable the efficient, reasonable and sustainable utilization of scarce water resources. Several irrigation techniques are available and the selection of one depends on factors such as water availability, crop, soil characteristics, land topography and associated costs. As the rate population increases, the future demand for irrigated agriculture is in increasing trends; it is estimated about two-thirds of agricultural and food products are produced by irrigation systems [7]. The growing dependence on irrigated agriculture coincides with an accelerated competition for water and increased awareness of unintended negative consequences of poor design and management [8]. Desired and wise management of available water resources at farm level is needed; because of the increasing demands, limited resources, water table variation in space and time and soil contamination [9].

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Since 1993, rainwater harvesting and supplementary irrigation technology have been promoted by research and development agencies in Gansu Province, in semiarid region of northwest China [10, 11]. The rainwater catchment and storage has increased the available water for crops to stabilize agricultural production [10, 11]. Since in semiarid regions where natural irrigation water is not available pressurized irrigation systems are especially useful approaches for the needful irrigated agricultural water demand. According to Li *et al*. [12], supplemental irrigation has provided at critical stages of crop growth. Such irrigation has been practiced which enhanced and significantly increased in crop yields [12]. The irrigation had superior qualities of small-scale, simple operation, high adaptation and low cost; and therefore, was ideally suited to the socioeconomic and biophysical conditions of semiarid rural areas [12]. Pressurized irrigation systems also are profitable to improve water-use efficiency, reduce soil erosion, advance soil fertility and increase agricultural productivity [10, 12, 13].

The purpose of this paper was to determine the major factors influencing farmers' acceptance irrigation decisions and economical factors those are effective on acceptance of pressurized irrigation systems by farmers. In conclusions that pressurized irrigation systems might help in developing policy and institutional interventions to encourage acceptance of supplemental irrigation.

MATERIALS AND METHODS

Based on introduced objectives for Iranian farmers, it is necessary to define household. The household is a group of people who normally live and eat their meals together in the same dwelling [14]. The data used to estimate the models were obtained from a survey using face-to-face interviews with the farmers during 2010. The survey was conducted among 320 households randomly selected from farmers of sixteen townships. The description of the dependent and explanatory variables specified in the empirical logistic model and theirs hypotheses is presented in Table 1.

The collected farmers' profiles with statistical analysis are shown in Table 2. Farmers' acceptance analysis, acceptance is usually defined in terms of a binary variable (acceptance/ non-acceptance). The variable Z_i 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. The acceptance of under pressurized irrigation systems is a complicated process that may be influenced by a set of interdependent biological, physical, social and economical factors. The 18 explanatory and dummy variables include conditions of household, agriculture, institutional, ecological and economical factors that are hypothesized to influence farmers' acceptance of pressurized irrigation systems in the study area.

Table 1: Descriptions of the variables specified in binary logistic model

Acronym	Description	Type of measure
Dependent variables		
Z_i	Whether a farmer has adopted or not	Dummy (1, if yes; 0, if no)
Explanatory variables		
X_1	Household head's age	Number of years
X_2	Educational background of the household head	Number of years of formal education
X_3	number of people in Household	Numbers
X_4	History of Agriculture	Number of years
X_5	Farmer has any off-farm activity	Dummy (1, if yes; 0, if no)
X_6	Level of family income	
X_7	Attitudes of farmer towards systems	Dummy (1, feels that will have positive effects; 0, if negative)
X_8	Level of household head's risk preference	1, Risk averse; 2, risk love
X_9	Contact with research extension	Dummy (1, if yes; 0, if no)
X_{10}	Training received for irrigation systems	Dummy (1, if yes; 0, if no)
X_{11}	Obtained fertilizer, seed, cash credit	Dummy (1, if yes; 0, if no)
X_{12}	Subsidy received for irrigation systems	Dummy (1, if yes; 0, if no)
X_{13}	Type of irrigated crop	1, Only potato; 2, potato, wheat; 3, potato, wheat and other cash crops
X_{14}	Walking distance of the water tank from the dwelling	Total minutes of walking
X_{15}	Status of land ownership	1, if owned; 2, if rented land
X_{16}	Distance of village to the agriculture service center or downtown	1, near; 2, far; 3, very far
X_{17}	Agricultural land area	acreages of farm land
X_{18}	Consequence of applying irrigation systems	Dummy (1, if good; 0, if bad)

Table 2: Statics of variables used in the empirical econometric model

Variable	Mean	S.D.	Minimum	Maximum
X1	45.12	15.63	20	83
X2	5.35	4.58	0	12
X3	6.13	2.89	3	13
X4	26.31	17.23	2	73
X5	0.5	0.5	0	1
X6	4.26	2.36	2.5	22
X7	0.5	0.5	0	1
X8	0.5	0.5	0	1
X9	0.5	0.5	0	1
X10	0.5	0.5	0	1
X11	0.5	0.5	0	1
X12	0.5	0.5	0	1
X13	1.5	0.68	1	3
X14	1.6	0.89	1	3
X15	1.12	0.87	1	2
X16	3.52	3.16	1	16
X17	6.53	6.72	1	30
X18	0.5	0.5	0	1

Source: Computed based on collected data in 2010.

The variable X_1 measures age of the headman of the household. According to the theory of human capital, young members of a household have a greater chance of absorbing and applying new knowledge and advanced technology [15]. Thus it is hypothesized that older people will be less likely to adopt with pressurized irrigation systems. The variable X_2 measures the level of education of the farmer. Most studies appear in the literatures [16, 17] showed that farmers with higher levels of educational attainment are most adoption with new technologies or practices. Hence, it is expected that the variable X_2 has a positive impact on acceptance. The variable X_3 measures the size of the family. It is notable that irrigation systems are labor intensive and as we know larger family size is generally associated with a greater labor force available. Due to the high labor demands of irrigation systems, the larger the family size the greater will be the availability of labor for supplementary irrigation works. In this study, it is hypothesized that family size (X_3) has a positive influence on the acceptance. The variable X_4 refers to the history of agriculture. It is expected a negative influence on the acceptance of pressurized irrigation systems with years of farming because farmers fall in to habit with traditional. The variable X_5 is a dummy variable which measures whether or not the farmer has any off-farm activity (1, if yes; 0, if no). Studies in this case indicate negative relationships between off-farm income and acceptance of soil conservation measures. However the role of off farm

income on the decision to adopt is unclear [18]. Higher level of the family income (X_6) implies the ability to invest in systems and to bear the risk associated with its acceptance. The variable X_7 measures farmers' attitudes, defined as the degree of a farmer's positive or negative feelings towards under pressurized irrigation. In this study, a positive attitude toward pressurized irrigation systems is hypothesized to have a positive effect on systems acceptance. The variable X_8 measures the risk preference of the headman. There is no consensus on the role risk-aversion plays in acceptance decisions [19]. Thus, it is difficult to predict the impact of this variable. Farmers, who have frequent contacts with extension workshops and experts (X_9) and easy access to information problems, potentials and performances of water catchments and supplementary irrigation projects on rain fed land, can regularly upgrade their knowledge of technology [11]. Hence, it is hypothesized to positively relationship between X_9 and acceptance. Farmers' training for the promotion of agricultural technology (X_{10}) is similar to education [15, 20] and it is expected a positive effect on the acceptance in this case. The accessibility to fertilizer, seed and cash credit (X_{11}) can help to increase production and consumption. Hence, the variable X_{11} may have positive effect under pressurized irrigation systems acceptance. The variable X_{12} is a dummy variable for estimate the farmer received assistance such as government subsidies to cover investment cost for irrigation systems (1, if yes; 0, if no). It would be expected

that the variable X_{12} dummy variable have a positive influence on acceptance of pressurized irrigation systems. Several farmers reminded that pressurized irrigation systems is important for realizing high profits from cash cropping, thus we hypothesize that irrigated crop (X_{13}) including cash crops have positively relations with technology acceptance of farmers. The closer the reservoir is to the residence (X_{14}), the more direction and attention provided by consumer, while increasing distance is hypothesized to negatively influence decision to accept technologies. The variable X_{15} estimates ownership of land. Farmers by reason of losing the land in the rental lands have a sense of insecurity. This discourages them from investing and improving their lands technologies. The variable X_{16} measures distance of village to the nearest agriculture service center or downtown. It is hypothesized that the greater the distance of the village from the nearest agriculture service center the likelihood of farmers to adopt irrigation systems is the lesser. Agricultural land area (X_{17}) is an explanatory variable that indicates acreages of farm land. It is hypothesized that it has positive effect on adoption. Consequence of applying irrigation systems (X_{18}) is another variable that have very important effect on adoption and it has negatively relations with irrigation systems acceptance.

Binary logistic regression is a popular statistical technique in which the probability of a dichotomous outcome (such as acceptance or non-acceptance) is related to a set of explanatory variables and has been widely applied in acceptance studies [14, 21-23]. Logistic regression has a dummy dependant variable that specified with Z_i and when is "1" represents that ith farmer adopted irrigation systems; and "0" not adopted. The variable Z_i is a linear function from (k) explanatory variables (X) and dummy variables (D) and is expressed as:

$$Z_i = \beta_0 + \Sigma_k^{i=1} \beta_i X_i + \Sigma_k^{i=1} \beta_i \, D_j \qquad (1)$$

Where explanatory and dummy variables are the set of parameters including social, economic, institutional factors and village characteristics which influence the acceptance decisions of the ith farmer.

The value β_0 is the intercept term and $\beta_1, \beta_2, \beta_3, ... \beta_i$ are the coefficients associated with each variable including $X_1, X_2, X_3,..., X_{ki}$ and dummy variables $D_1, D_2, D_3,…, D_j$. Gathered in a vector X, these factors explain the pressurized irrigation systems acceptance decision, or the probability that the ith farmer adopts irrigation technologies.

$$P_i = E(Z_i) = E(y=1|x_1, x_2... x_k, D_1, D_2... D_k) =$$
$$E(\beta_0 + \beta_i X_i + \beta_j D_j) = \frac{1}{(1+e^{-zi})}$$
$$(2)$$

$$P_i = \frac{e_{zi}}{1+e^{-zi}} \qquad (3)$$

Where P_i denotes the probability that the ith farmer's acceptance decision and (1- P_i) is the probability that Z_i is 0. The odds (Z = 1 versus Z = 0) to be used can be defined as the ratio of the probability that a farmer adopts (P_i) to the probability of non-acceptance (1 - P_i). By taking the natural log, one can get the prediction equation for an individual farmer:

$$L_i = Ln(\frac{P_i}{1 - P_i}) = Ln(e^{zi}) = Z_i \qquad (4)$$

Where Z_i is also referred to as the log of the odds ratio in favor of acceptance.

RESULTS AND DISCUSSION

Results for the logistic model are summarized in Table 3. Analysis of the results showed that 13 factors of regression are significant in the decision to accept irrigation systems. The analysis showed that at the 5% level, age of household head had a negative impact. Educational background of the household head has a positive impact on adoption that reveals the adoption of pressurized irrigation systems among younger farmers is higher than the older farmers, while, the results may indicated that more educated farmers are more likely to adopt pressurized irrigation systems than less educated farmers. Chianu and Tsujii [14] studied young farmers when they were promoting acceptance and increase in farmers' educational can increase the probability of agricultural technology acceptance that is in the direction with the results concluded in the present work. Results showed that number of people in household is positively correlated with acceptance and significant at the 5% level. Coefficient shows that holding all other explanatory variables constant, for every 1 unit increase in number of people in household, 0.306 times increase in the log-odds of acceptance (the probability of acceptance) because of the increasing in number of people in household that increase the number of labor force availability and as a result of these increase tendency for acceptance of pressurized irrigation systems.

Table 3: Parameters estimates binary logistic regression model

Variables	Coefficient	t-statistic	S.E.	Correlation
Constant *	4.36-	1.26	2.89-	0.356
X1*	0.398-	0.769	1.979	0.426
X2*	0.662	1.413	2.135	0.453
X3*	0.306	0.811	2.653	0.231
X4*	0.51-	1.081	2.12-	0.316-
X5*	0.233	0.727	3.123	0.36
X6*	0.421	0.778	1.85	0.523
X7*	2.03	0.564	1.763	0.611
X8*	0.831	3.496	4.213	0.463
X9	0.41	2.304	5.62	0.423
X10*	0.111	2.4392	3.96	0.89
X11	-0.361	0.915	-2.536	0.231
X12*	0.03	6.936	2.312	0.362
X13	0.632	4.098	2.589	0.254
X14*	0.063-	0.106	1.69	0.526
X15	0.261	2.046	4.01	0.426
X16	0.163-	22.3	1.843-	0.012-
X17*	0.213	0.438	2.06	0.291
X18*	0.433-	0.995	2.298-	0.145

Source: Computed based on collected data in 2010.

As hypothesized, a farmer's positive attitude towards under pressurized irrigation systems (X_7) has a significant impact on the probability of acceptance at the 5% level. The obtained results showed that the odd of a farmer who has a positive attitude adopts pressurized irrigation systems is 2.03 times the odds of a farmer who has not positive attitude. The results imply that farmers' responsiveness to pressurized irrigation systems depends heavily on the strength of the technology-related attitude. The findings of some empirical studies such as Somda *et al*. [22] showed that farmers with a generally positive attitude are eager to accept irrigation systems. A household head's risk preference (X_8) is shown significantly positive influence to pressurized irrigation systems acceptance decisions. The results indicate that there were 0.831 times differences between risk averse and risk love farmers. Contact with experts (X_9) is found to have an insignificant effect on pressurized irrigation systems acceptance. It indicates farmers who were in contact with research and development or extension agencies have not more likelihood of adopting pressurized irrigation systems. Both the training received for irrigation systems (X_{10}) and subsidy received for irrigation systems (X_{12}) variables are significant at the 5% level. This finding is fit with objects of present research and expectation. Results also showed that holding all other explanatory variables constant, farmer who received the project

subsidy adopts pressurized irrigation systems is 0.03 times the odds of a farmer who does not received it. This is because of the pressurized irrigation system requires substantial amounts of financial and material resources, which are often unaffordable to individual farm households [11]. As expected, the influence of training on acceptance decision is significantly positive, with the likelihood to adopt by a trained farmer increased compared relative to an untrained farmer. For every 1-unit increase in training score, we expect 0.111 times increase in the log-odds of adopting with systems, holding all other explanatory variables constant. But in contrary that is expected, the greater the availability of fertilizer, seed and cash credit services (X_{11}) is insignificant and don't have any effect on farmer adopting the pressurized irrigation systems. The diversity of irrigated crops (X_{13}) is insignificant at 5%level and didn't correlate with acceptance of pressurized irrigation systems. Walking distance of the water tank from the dwelling (X_{14}) is consistent with our hypothesis and it is significant and its coefficient is negative. The closer the water storage tank is to the dwelling, the more supervision and attention available from the family and a higher probability of pressurized irrigation systems acceptance [11]. Results showed that 1 unit increscent in distance of the water tank from the dwelling 0.063 times decrease in the log-odds of adopting with systems. The results of present study

showed that the status of land ownership (X_{15}) is not significant as an effective factor for adopting pressurized irrigation systems acceptance. The results indicated that the index of agricultural land area (X_{17}) is positively significant (at 5% level) in explaining pressurized irrigation systems acceptance. This suggests the likelihood that farmers' adoption with pressurized irrigation systems will increase with an increase of agricultural land's area. In the study area, the distance of the village from the nearest road or the town is shown that it may not be significantly influence on acceptance decisions. Findings indicated that consequence of applying irrigation systems is an effective factor on adopting irrigation systems. It is negatively significant i.e. if applying systems which are revealing undesirable consequences adopting irrigation systems -0.433times decrease adoption.

CONCLUSION

In general from the present research, it can be extracted several useful conclusions that provide insight on pathways to increase the acceptance of under pressurized irrigation systems:

First, the demonstrated results of this paper indicated that the pressurized irrigation systems extension project should incorporate consideration of farmer age, farmer educational attainment and number of population in the household.

Second, the benefits of pressurized irrigation systems must be clearly perceived by farmers given their own socioeconomic conditions. Enhancing farmers' knowledge and perception of pressurized irrigation systems through better access to technical information, extension and training will help them to develop a positive economic assessment of pressurized irrigation systems.

Third, the results also suggest the need for greater political and institutional input into pressurized irrigation systems projects. In particular, there is a need to design and develop alternative policy instruments and institutions for extension, technical assistance, training, credit services that will facilitate acceptance of the farmer participatory practices to suitable fit and the needs of farmers. With the outcome of the present research the following suggestions are summarized:

- Level of technical knowledge and skills of farmers in the field of construction and protection irrigation systems should be improved. This aim can be conducted with holding educational and training workshops by experts in the related field.

- Knowledgeable experts with high awareness and skills about water management issues, including modern techniques of farming and irrigation technologies can be sent to villages to demonstrate new methods of irrigation and familiarize the engineering concepts to farmers.

- To encourage Farmers to upgrade and enhance the application of irrigation systems. Also government should provide grant banking facilities, including long-term low-interest loans to boost budgets of poor and less poor farmers.

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