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Potato Growers' Attitudes and Perceptions towards Precision Irrigation Technologies in Ardabil County, Iran

Asghar Bagheri [a,] and Sahar Pirmoazzen [a]*

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Abstract

This study aimed to investigate potato growers' attitudes towards and perceptions of the drivers and barriers of precision irrigation technologies (PIT). A survey research method was employed for data collection from a sample of 240 potato growers of Ardabil County. A questionnaire was used as the research instrument. It was validated by a panel of experts. Cronbach's alpha was calculated to be 0.813, 0.870, and 0.766, implying the high reliability of the instrument for attitudes, drivers, and barriers, respectively. Results showed that the respondents were in middle age with good farming experiences. The majority of them were lowly literate. Their knowledge was low on working with PIT. More than half of them had moderate to high negative attitudes, while the attitudes of the rest were somewhat very positive. Attitudes showed a significant and positive correlation with level of education, income, and knowledge of PIT. However, age, farming experience, and cultivated areas showed a negative correlation with attitudes. Based on regression analysis, the variables of level of education, knowledge of PIT, and information sources accounted for 46.5 percent of the variance in farmers' attitudes. The sample was divided into two subgroups of 120 farmers, one for responding to the items of drivers and the other for responding to the items of the barriers. Factor analysis extracted three factors with eigenvalues of greater than one, namely water efficiency, easy farming practices, and financial benefit, which accounted for 63.18 percent of the variance in drivers, and the five factors of knowledge, technical, skill, managerial, and logistic barriers accounted for 63.12percent of the variance in barriers.

Keywords:
Attitudes; barriers; drivers; perceptions; precision irrigation

[a] *Department of Water Engineering and Agricultural Management, Faculty of Agricultural Sciences and Natural Resources, University of Mohaghegh Ardabili, Iran*

** Corresponding author's email: a_bagheri@uma.ac.ir*

INTRODUCTION

Iran is located in the arid and semiarid zone of the world. Its long-term average precipitation is 224-275 mm/year with no optimum spatial and temporal distribution (Forouzani & Karami, 2010). Water shortage is one of the main barriers to agricultural development in this country. Despite the water scarcity, water use is not optimal and the agricultural sector of Iran is the main consumer of water supply, accounting for 93 percent of the total water consumption (Ardakanian, 2005). Irrigation is mostly carried out by surface methods whose efficiency is hardly more than 30-50 percent (Ali, 2011; Nazari et al., 2018). Ardabil County, with an average annual precipitation of 296 mm, also suffers from water scarcity, while potato as a high water-consuming crop is the prevalent crop of the region (Hassanpanah et al., 2015). Therefore, the application of water-saving technologies is imperative for the region.

The main priority of the government in Iran has been to improve the irrigated agriculture productivity since 1960 (Forouzani & Karami, 2010). Several policies have been implemented, such as investments in infrastructures, low-interest loan provision, and subsidized agricultural water and energy use. However, the performance of many water management schemes is far from satisfactory (Keshavarz et al., 2013; Nazari et al., 2018). The current water resource management policy in Iran emphasizes an integrated approach towards water resource development to avoid or minimize any negative effects of irrigation development and maximize positive impacts. Based on the country's perspective, to control the overexploitation of groundwater resources, the surface water withdrawal percentage should be reduced from 43 percent at the present to 55 percent. Furthermore, Iran aims at decreasing the agricultural share in water consumption from 92 to 87 percent by increasing water use efficiency (FAO, 2008).

Modern irrigation technologies are of practical solutions to the efficient use of water in agriculture. The application of precision irrigation technologies (PIT), i.e., sprinkler and drip irrigation systems with efficiencies of more than 80 and 90 percent, respectively (Ali, 2011; Nowroozi & Chizari, 2006), is an essential strategy to deal with water scarcity and efficient management of water supply (Mohammadi et al., 2018). Despite the importance of such technologies in meeting crop water requirements and minimizing water loss, they have not been fully accepted and used while positive impacts of their implementation and use on yield and net income have been found in several studies (Ezzati et al., 2014; Shaterian et al., 2011).

Understanding the factors that determine the adoption behavior of irrigation technologies has been the focus of a sizeable body of literature. Economic (income, low- interest loan), technical (well-designed and implemented systems), extension-educational (information and visiting demonstration farms and agricultural experts), and risk factors have been found to influence the adoption and use of PIT (Afrakhteh et al., 2015; Evans et al., 2013; Ezzati et al., 2014; Mohammadi et al., 2018; Mostakhdemi & Razzaghi, 2012; Nouri and Nooripoor, 2013; Pezeshkirad et al., 2011; Koundouri et al., 2006; Shahzadi, 2013).

Based on the literature, socioeconomic variables have also been found to be critical factors in the decision on adopting irrigation technologies. Age and level of education showed different impacts on adoption behavior. Elderly farmers were often reluctant to adopt while younger and more educated farmers were more inclined to adopt these technologies (Rahmani et al., 2016; Shahzadi, 2013). Results as to the impact of farm size on the adoption behavior have been contradictory. Some studies have mentioned farm size as an influencing factor (Bagheri & Ghorbani, 2011; Pirayesh, 2013) while others have found it as a barrier to adoption (Shahzadi, 2013). Moreover, land fragmentation and dispersion have been other critical barriers to adoption.

Farmers' attitudes and perceptions are key factors affecting the adoption of PIT. Ezzati et al. (2014) categorized obstacles perceived by wheat growers to apply pressurized irrigation technology into four factors, i.e., technical, social, natural, and economic. Results of several studies in Iran have highlighted the impacts of perceptions and attitudes on the decision to adopt and use modern irrigation technologies, such as pressurized systems (Momvandi et al., 2018; Movahedi et al., 2017; Tohidyanfar & Rezaei-Moghaddam, 2015). Despite the impact of attitudinal factors on the adoption behavior of PIT, farmers' attitudes and perceptions have not been well established in the literature. This study aimed to investigate potato growers' attitudes towards and perceptions of PIT drivers and barriers. The theoretical framework of the study is presented in Figure 1.

METHODOLOGY

Study area: Ardabil plain (38°27′ - 38°55′ North and 48°37′- 48°90′ East) with an area of 1097 km^2 and an elevation of about 1300-1500 meters above sea level is located in the northwest of Iran. The average annual precipitation of the region is 296 mm and its temperature varies from -38°C to 40°C, respectively (Sobhani and Goldoost, 2016). The region has a high potential for agricultural development. However, due to the focus on water-consuming crops, especially potato, the region has been faced with groundwater over-abstraction in recent decades, resulting in the dramatic depletion of its water table. According to Rostamzadeh et al. (2015), the reduction amounted to 47 percent during 1980-2012. Therefore, water shortage is the most crucial obstacle to agricultural development.

The county has 112 thousand ha of croplands (65 thousand ha irrigated and 47 thousand ha rain-fed). Furthermore, there are 1982 ha of orchards and 100 thousand ha of rangelands in this county. Several crops are grown in this region. Potato is one of the main crops of the region, which is cultivated in rotation with wheat. Cereal, potato, beans, forage, and several other crops are grown in the county. With 24000 ha of potato farms including 17500, 5500, and 1000 ha in Ardabil, Namin, and Nir Counties, respectively, the Ardabil plain is the first/second top potato-producing region of Iran (Hassanpanah et al., 2015).

Instrument and data collection: A questionnaire consisting of some sections and scales related to socioeconomic profile and farmers' attitudes towards and their perceptions of drivers and barriers of the development of PIT was used for data collection. All items of attitudes and perceptions were in the form of five-point Likert-type scales ranging from one (very low) to five (very high). For a better understanding of farmers' perceptions, respondents were divided into two subgroups, one to respond to the items of drivers and the second to respond to the items of barriers. A panel of experts confirmed the questionnaire for face validity. Then, a pilot study was conducted among a small sample of 30 farmers

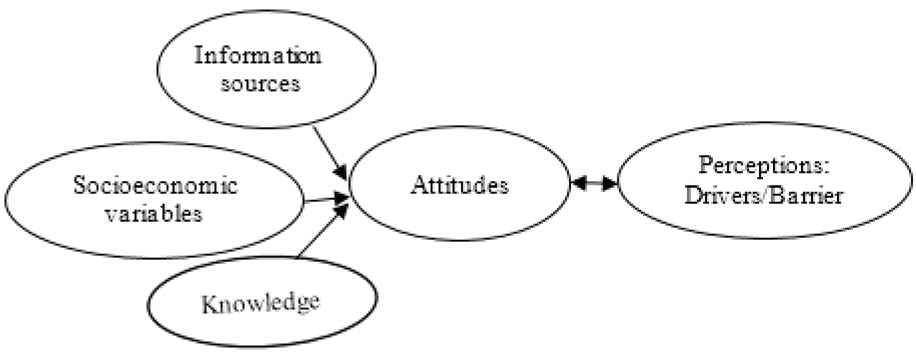

Figure 1. The Theoretical framework of the study

to calculate Cronbach's alpha and check the reliability of the questionnaire. The alpha values of 0.813, 0.870, and 0.766 for attitudes, drivers, and barriers, respectively showed the high reliability of the instrument. The final draft of the instrument was used for data collection.

Population and sample: All potato growers of the county (N=3500) (Bagheri & Shabanali Fami, 2016) constituted the statistical population of the study. Cochran's (1977) formula was used to determine the sample size, and a sample of 240 potato growers was selected using a multistage random sampling method (20 villages and 10-15 farmers from each village). The data were collected by a face-to-face interviewing method.

Data analysis: SPSS (ver. 22) software was used for data analysis. Farmers' attitudes towards PIT were measured using a Likert-type 12-item scale ranging from 1= very low to 5= very high. The item scores were then summed up to get an attitude score for each respondent to use in inferential analyses. Correlation, regression, and Mann-Whitney analyses were employed for inferential analysis of attitudes. Perceptions of the drivers and barriers of the development of PIT were examined using 12 and 14 items on five-point scales, respectively. Principal component factor analyses were used to summarize the statements of farmers' perceptions of the drivers and barriers in a few interpretable numbers of factors. The latent root criterion (eigenvalue of greater than one) was used as a guideline to determine how many factors must be extracted. According to Hair et al. (1998), factor solutions with different numbers of factors were examined before defining the structures. The Varimax rotation method was used to find factors easier to be interpreted.

Interval of standard deviation from the mean (ISDM) was used to divide respondents into negative to positive categories of attitudes as below (Ashoori et al., 2016):

A=Negative, A< Mean – SD
B =Relatively negative, Mean – SD<B< Mean
C= Fairly positive, Mean<C<Mean + SD
D = Positive, Mean + SD<D.

Stepwise regression Analysis was employed to explain factors affecting farmers' attitudes toward PIT. Tolerance and variance inflation factor (VIF) were tested. The higher the tolerance value, the higher the information about the variables, and the more possible the regression analysis. The regression analysis is not possible for tolerance values of <0.1, and in the case of values of < 0.2, collinearity is likely to occur. The lower value of VIF indicates the lower variance of the regression coefficient, implying more suitability of regression analysis for prediction. The VIF values may vary within the range of 0-10. Collinearity is likely to occur when VIF is greater than 10 (O'Brien, 2007; Rogge et al., 2007).

RESULTS

The demographic profile of the respondents (Table 1) showed that they were in middle age (47.24 years) with good years of farming experiences (mean=21.07 and SD=10.21). Two third of them were lowly literate (under diploma). On average, they had more than four hectares of farms under cultivation.

Data on farmers' information sources on PIT (Table 2) showed that the written material on PIT was the most essential source followed by Radio/TV agricultural programs. However, extension courses ranked as the least important. This result implies that extension policymakers should rethink extension programs and focus on water-saving technologies.

As shown in Table 3, the respondents had good knowledge of suitable times for crop irrigation followed by the benefits of PIT. However, their knowledge was low on working with PIT and appropriate cropping patterns to cope with water shortage.

Table 1
Socioeconomic Characteristics of the Respondents (n=240)

Variable	Levels	Mean	SD
Age (years)	-	47.24	14.65
Farming experience (years)	-	21.07	10.21
Family members	-	5.08	0.96
Farm income (MT*)	-	60.58	22.64
Land parcels	-	2.84	1.67
Cultivated areas (ha)	-	4.58	1.41
	Levels	Frequency	Percent
Level of education	Under diploma	165	68.75
	Diploma	46	19.17
	Higher education	29	12.08

MT= Million Tomans

Table 2
Farmers' Information Sources on PIT (n=240)

Information sources	Mean	SD
Written material on PIT	3.41	0.96
Radio/TV agricultural programs	3.35	0.64
Contact with agricultural experts	3.30	1.10
Visit to demonstration farms	2.96	0.98
Extension courses	2.92	1.07

Mean range from one (very low) to five (very high)

Table 3
Farmers' Knowledge about Irrigation Water Management

How much do you know on:	Mean	SD
Suitable times for crop irrigation	3.92	0.61
Benefits of PIT	3.32	1.1
Water requirement of cultivated plants	3.17	0.91
PIT maintenance	3.16	1.04
Appropriate cropping pattern to cope with water shortage	2.90	0.83
Working with PIT	2.57	0.95

Mean range from one (very low) to five (very high)

Table 4
Farmers' Attitudes towards PIT

Statements	Mean	SD
The government's financial support and low-interest loans encourage farmers to adopt and use.	4.94	0.23
It is difficult to use PIT.	4.0	0.65
Maintenance costs of PIT are high.	3.93	0.96
PIT saves water.	3.88	1.0
PIT is incompatible with the conditions of some crops.	3.71	0.97
PIT is more efficient than surface irrigation methods.	3.57	0.74
Drought and water shortage can be managed by PIT.	3.48	1.21
Crop yields using PIT are often higher than those of surface irrigation.	3.41	0.96
PIT prevents soil salinity.	3.42	1.21
Farmers with smaller farms are less likely to adopt and use PIT.	3.35	0.64
PIT saves irrigation and labor costs.	3.09	1.39
In windy areas, the use of sprinkler irrigation systems increases water loss.	3.07	1.04

Mean range from one (very low) to five (very high)

Table 5
The Classification of Farmers Based on Attitudes

Levels of attitudes	*f*	%
Negative	44	18.33
Relatively negative	92	38.33
Fairly positive	61	25.42
Positive	43	17.92

Attitudes towards PIT: Results on the measurement of the respondents' attitudes towards PIT are illustrated in Table 4. Among 12 items, the respondents showed a very positive attitude towards the item of *government's financial support and low-interest loans* (mean= 4.94) followed by *the application of PIT is difficult* (mean=4). This result indicates that due to the substantial investment needed for PIT, farmers have been dependent on government supports. However, having this support, these systems are perceived to be easy to apply.

Negative attitudes towards PIT were mostly related to costs and conditions. There were moderate attitudes towards the statements of *PIT save irrigation and labor costs* (mean=3.03), and *in windy areas, the use of sprinkler irrigation systems increases water loss* (mean= 3.07).

Based on the ISDM, the respondents were divided into four groups (Table 5). More than half of the respondents showed relatively to very negative attitudes towards PIT, but the attitudes of the rest were positive to very positive.

Based on the correlation analysis (Table 6), farmers' age, farming experiences, and culti-

Table 6
Spearman's Correlations Analyses of Attitudes and Other Variables

Variables	rho	*p*-value
Age	-0.371**	0.00
Level of education	0.637**	0.00
Farming experience	-0.164**	0.00
Cultivated areas	-0.182**	0.00
Income	0.435**	0.00
Knowledge	0.267**	0.00

** $p<0.01$

Table 7
Regression Analysis to Explain Factors Affecting Farmers' Attitudes

Model	Unstandardized coefficients		Standardized coefficients	t	*p*-value	Collinearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
Constant	24.693	1.958	-	12.610	0.000	-	-
Education	3.825	0.298	0.621	12.837	0.000	0.995	1.005
Knowledge	0.261	0.052	0.245	5.064	0.000	0.995	1.005
Information	0.362	0.180	0.097	2.017	0.045	0.999	1.001
R=0.687	R^2= 0.472	R^2Adj.= 0.465	Std.E*=4.209	F=67.606	0.000	Durbin-Watson=2.248	

*= Standard Error of the estimate

vated areas showed a negative correlation with attitude. The association of attitude with other variables, i.e., education, knowledge, and income, was positive and significant.

Regression analysis was applied to examine the impacts of independent variables on farmers' attitudes towards PIT. The F-value was significant. As shown in Table 7, the tolerance value was close to one for all variables entered in the model. A VIF value of one indicates low collinearity between the predicting variables of the model.

The results revealed that three variables were significant, so they were included in the model. Education, knowledge, and information sources captured 46.5 percent of the variance in farmers' attitudes towards PIT (Table 7). Based on the beta values, education (beta=0.621) was the key factor in explaining farmers' attitudes followed by knowledge (beta=0.245). According to the results, the following linear regression equation was formed, representing farmers' attitudes towards PIT:

Y= 24.693 + 3.825 (Education) + 0.261 (Knowledge) + 0.362 (Information)

Perceptions towards drivers and barriers developing PIT

Mean scores and standard deviations of drivers and barriers are presented in the second and third columns of Tables 8 and 9. The key driver for PIT was converting dry land to irrigated farms (mean=4.43), followed by improving product quality (mean=4.41) and increasing crop yields (mean=4.35). The lowest score was related to the possibility of multiple cropping (mean=2.89).

Factor analyses were separately employed to summarize statements of the drivers and barriers to small numbers of interpretable factors. Twelve items of perceptions towards drivers of PIT development were recognized to be appropriate for factor analysis. Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity (KMO=0.793 and Chi-square=679.28, $p<0.001$) confirmed the suitability of the data for factor analysis (Hair et al., 1998; Tabachnick & Fidell, 2007). The Varimax rotation method was used for factor rotation, and factor loadings of higher than 0.45 were assumed to be significant (Table 8). Based on the Kaiser criterion, three factors with Eigenvalues of >1 were extracted. An eigenvalue indicates the contribution of each factor to the total variance. The larger the eigenvalue, the more importance and the more significant the effect of the factor. The first factor was named *water efficiency* and had the highest share in variance accounted for (29.02%) followed by *easy farming practices* (18.72) and *financial benefits* (15.44), respectively. These three factors accounted for 63.18 percent of the variance.

1. Water efficiency, 2. Easy farming practices, 3. Financial benefit

As illustrated in Table 9, the main barrier of PIT development perceived by the respondents was *lack of training programs for farmers to fix systems' problem* (mean=4.40) followed by *the problem of dispersion of farm fragments* (mean=4.33) and *difficulty of using machinery in farms equipped with PIT* (mean=4.23).

Table 8

Factor Analysis for the Drivers of PIT

Drivers to develop pressure irrigation	Mean	SD	Factors 1	Factors 2	Factors 3
Converting dry-land to irrigated farms	4.43	0.91	0.624		
Improving product quality	4.41	0.93	0.789		
Increasing crop yields	4.35	0.97	0.753		
Increasing soil fertility	4.07	0.98	0.752		
Increasing irrigation water efficiency	3.80	1.19	0.559		
Controlling irrigation depth	3.73	1.07	0.552		
Reducing production costs	3.65	1.28	0.669		
Increasing area under cultivation	3.79	1.09		0.580	
Possibility of fertilizer and pesticide application with irrigation system	3.72	1.22		0.809	
Better pest and weed control and reducing pesticide use	3.71	1.19		0.618	
Government lending and facilities	3.63	1.17		0.532	
Possibility of multiple cropping	2.89	1.48			0.882
Variance accounted for (Total: 63.184)	-	-	29.02	18.72	15.44
Eigenvalues	-	-	3.48	2.25	1.85

Table 9
Factor Analysis for the Barriers to PIT Development

Drivers to develop pressure irrigation	Mean	SD	Varimax rotated component matrix				
			1	2	3	4	5
Lack of training to fix systems' problem	4.40	1.06		0.488	0.458		
The difficulty of using machinery in farms equipped with PIT	4.23	1.09		0.470			
Insufficient water supply and water pressure during the cropping year	4.0	1.28		0.568			
Lack of security and the problem of stealing system parts	3.87	1.65		0.756			
The problem of agricultural land fragmentation	3.52	1.39		0.548			
The problem of dispersion of farm fragments	4.33	0.99	0.777				
Lack of extension activities to introduce modern irrigation methods	4.18	1.08	0.731				
Lack of sufficient information on the benefits of new irrigation methods	4.14	1.14	0.595				
Lack of experts in new irrigation methods in the region	4.06	1.05			0.745		
Incompatibility of traditional cultivation practices with new irrigation methods	3.65	1.23			0.772		
Inadequate irrigation rotations	3.91	1.08				0.725	
Lack of proper planning for shifting and distribution of water among farmers	3.49	1.35				0.825	
Insufficient financial support to adopt new irrigation methods	4.05	1.16					0.722
Easier use of traditional methods compared to new irrigation methods	3.54	1.33					0.888
Variance accounted for (Total: 63.184)	-	-	14.25	13.22	12.32	11.79	11.54
Eigen values	-	-	1.99	1.85	1.72	1.65	1.62

To summarize the statements of the barriers into a small number of factors, factor analysis was employed. All the 14 statements of the scale were recognized to be appropriate for the analysis. The suitability of the data for factor analysis was confirmed by KMO and Bartlett's test of sphericity (KMO = 0.659 and Chi-square=374.78, $p<0.001$) (Hair et al., 1998; Tabachnick & Fidell, 2007). Factor loadings of higher than 0.45 were assumed significant (Table 9). Five factors with Eigenvalues of >1 were extracted. The first factor, which was named *knowledge* barrier, had the highest share in variance accounted for (14.25%) followed by *technical* (13.22%), *skill* (12.32%), *managerial* (11.79%), and *support* (11.54%) barriers, respectively. The five factors accounted for 63.12 percent of the variance.

1. Knowledge barrier, 2. Technical barrier, 3. Skill barrier, 4. Managerial barrier, 5. Support barrier

DISCUSSION AND CONCLUSION

Several studies have highlighted the impacts of attitudinal factors on the decision to adopt and use modern irrigation technologies. Therefore, farmers' attitudes and perceptions are key factors in PIT adoption (Momvandi et al., 2018; Movahedi et al., 2017; Tohidyanfar & Rezaei-Moghaddam, 2015). Using information from a sample of 240 potato growers from Ardabil county of Iran, farmers' attitudes towards and perceptions of the drivers and barriers of PIT were investigated in this study.

The results revealed that farmers' main information source was radio/TV agricultural programs followed by written material on irrigation. Despite the key role of extension training on the adoption of irrigation technologies (Zhang et al., 2019; Chuchird et al., 2017), extension courses were placed in the lowest rank. Radio/TV programs as mass media do not provide specific information on irrigation technologies. Despite the fact that it is suitable for positive attitudes, to adopt and use these technologies, complementary information should be provided through extension campaigns on the subject matter (Alcon et al., 2011). Regression analysis showed a positive and significant impact of information sources on attitudes toward PIT. Previous studies have found the impact of extension courses to be positive on attitudes and on the adoption of PIT (Afrakhteh et al., 2015; Pezeshkirad et al., 2011; Adeoti, 2009; Oladele, 2005). Therefore, these results indicate that extension policies and programs should be redirected to place more emphasis on water-saving technologies (Nejadrezaei et al., 2018).

Regression analysis also showed a positive influence of potato growers' knowledge on their attitudes. In line with previous studies (Alcon et al., 2011), this finding implies that the more knowledge is, the positive the attitudes will be and the more likely the adoption of PIT will be. Considering that two-thirds of the respondents were lowly literate, proper radio/TV and extension programs, especially on the maintenance of the systems, can be useful for changing potato growers' attitudes towards PIT. Failure to adequate training of farmers for maintenance after system installation, lack of availability of efficient repairs, inappropriate design, and implementation by companies, and low-quality components were found to be some barriers of the adoption to PIT in previous studies (Afrakhteh et al., 2015; Bagheri & Ghorbani, 2011).

Similar to previous studies (Bagheri & Ghorbani, 2011; Rahmani et al., 2016; Shahzadi, 2013), age was negatively correlated with farmers' attitudes, but education had a strong positive impact on their attitudes (Gockowski & Ndoumbe, 2004; Kohansal et al., 2009; Yigezu et al., 2013). This result indicates that younger and more educated farmers had positive attitudes towards modern irrigation systems. This result confirms several related studies in developing countries (i.e., Koundouri et al., 2006; Zhang et al., 2019). Including young and educated farmers in extension programs and providing them with facilities and low-interest credits (He et al., 2007) can be an essential factor in expanding their tendencies to adopt water-saving technologies and efficient irrigation water management.

Conflicting impacts of cultivated areas on farmers' attitudes towards and the adoption decision of PIT were reported in previous studies. Some studies have found a positive impact (Bagheri & Ghorbani, 2011; Chuchird et al., 2017; Zhang et al., 2019), and the others have shown a negative impact (Shahzadi, 2013). The result of this study showed a negative correlation in this regard. Considering the positive impact of farming income on attitudes, which comes from larger farm size (Table 1), this result may be related to fragmentation and dispersion of farmlands (Afshari, 2009) and the problem of replacing and handling equipment of the systems at distant fragments of farms (Afrakhteh et al., 2015; Bagheri & Ghorbani, 2011).

Results of factor analysis revealed that the three factors of *water efficiency*, *easy farming practices*, and *financial benefit* accounted for 63.18% of the variance in farmers' perceptions of the drivers of PIT. The respondents had suitable perceptions of PIT. As reported in previous studies, the primary objective of modern irrigation is to increase the efficiency of irrigation water so that these systems increase the efficiency of over 80-90% (Ali, 2011; Nowroozi & Chizari, 2006). Agrochemicals can be applied using PIT at reduced rates, which, in addition to protecting farmers' health and the environment, will contribute to saving on costs and labor and increasing financial benefits. Moreover, because the country suffers from water scarcity, farmers can achieve financial supports of the government for installing these systems.

Factor analysis also revealed five factors, including *knowledge*, *technica*l, *skill, managerial,* and *support* barriers, accounted for 63.12 percent of the variance in the barriers perceived by potato growers. Several studies on barriers to the adoption of modern irrigation technologies reported similar results. Rahmani et al. (2016); Zhang et al. (2019); Huang et al. (2017); Mohammadi and Alipour (2016) and Mahboobi et al. (2011) reported labor and installation costs, lack of credit, financial limitation, lack of proper knowledge and information and training on the use of the system after installation, technical and financial support and risk management related to systems as barriers to the adoption and development of these systems. Therefore, providing farmers with extension and training programs, on-time information, and financial support, as well as the availability of service centers, are essential for the adoption and development of PIT.

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